Advances in Geographical and Environmental Sciences

Subhash Anand
Madhushree Das
Rituparna Bhattacharyya
R. B. Singh *Editors*

Sustainable Development Goals in Northeast India

Challenges and Achievements

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Editors

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Foreword

I deem it a matter of real pleasure for me to write the foreword of a book on a theme looking as appealing as the distinguished academician Prof. Narendra Nath Bhattacharyya, in honour and felicitation to whom the book project is dedicated by a group of his enchanted scholars, colleagues and admirers. Professor Bhattacharyya is well known for his academic brilliance, notable scholarship and passionate commitment to the cause of teaching and research. As this book carries an extended narrative on different facets of his academic, professional, social and family life and achievements in a subsequent chapter, I would like to restrict myself here to mention few of the salient aspects of his persona that impressed me most and liven up our relationship over the years bringing feelings of mutual bonhomie. Being colleagues in the faculty of the Geography Department of Gauhati University during my tenure in the Department from 1971 to 1998, we had numerous occasions of intimate interaction and close association on diverse matters of academic and personal interests. A man of amiable nature, pleasant disposition and marked simplicity, Prof. Bhattacharyya was a devoted teacher and an assiduous researcher who had contributed immensely towards the growth and development of the subject in Gauhati University as well as its popularization in the NE region. Among the most noticeable traits observed in his words and deeds are his strong sense of integrity, modesty and diligence in all academic works related to teaching, research and publication. Offering my heartfelt felicitations to Prof. Bhattacharyya for his remarkable academic achievements and significant contributions to the cause of higher education, especially in the field of Human Geography and as my valued long-time friend and well-wisher, I wish him a long and healthy life with his near and dear ones in the family. Having discussed so far, the raison de'tre of the book project, I would like to briefly talk about some of salient features of the book and its potential and prospect for academic research and practical utilization.

The overarching central theme that binds the organizational framework of the book is the Sustainable Development Goals (SDGs) vis-a-vis their pattern of achievement on a wide range of topics in different states of the Northeast region. It is a pioneering corpus of study in the shape of a compendium extending over a panoramic landscape of diverse physical, socio-economic, cultural, ecological–environmental

setting marked by immense potentialities and ridden with disturbing levels poverty, insecurity and underdevelopment. The book is divided into three parts (Part I: Introduction, Part II: SDG and North-East India and Part III: Case studies). These three parts, in turn, carry between them a total of 30 chapters authored by 62 scholars. The opening chapter is the flagship of the study that sets the tone of the book through lucid and relevant presentations highlighting the areas related to methodological framework for the NE region District SDG Index, performance on SDG in different states of NE India, SDG goal-wise good performance of different districts and composite scores of SDG performance of top-10 and bottom-10 districts.

In the wake of the phenomenal break through made in the area of SDG methodology and their application potentials, the concept of sustainable development which has been a popular catchphrase in the last several decades, presently equipped itself with spectacularly more effective methodological tools and techniques making it, in its new *Avatar*, more focused, effective and operational with improved clarity, authenticity and applicability. The SDGs were adopted by the United Nation in 2015 as a universal call for action and a blueprint to achieve a better and more sustainable future for all, ending poverty, protecting the planet and ensuring that by 2030 all people would enjoy peace and prosperity.

While poring over the foreword of the book, I am reminded of a project way back in mid-1990s on Sustainable Development, covering Hamren subdivision of Karbi Anglong district and the Puthimari river basin of Kamrup district of Assam in which I was involved as a Project Scientist and Head (Honorary) of the Assam Remote Sensing Centre at Guwahati. It was a part of a national-level project called Integrated Mission for Sustainable Development (IMSD) that covered more than 170 districts in the country and sponsored by the Planning Commission through the Department of Space, Government of India, in collaboration with the State Remote Sensing Centres. With this memory in the back of the mind, when I browse over the draft contents of this book which is based on the completely new and distinctly more focused, meaningful and operational strategy based on the SDGs, I am delighted to find that the current strategy has been able to rid itself of most of the earlier shortcomings and challenges ushering in newer and brighter horizons for success and fulfilment. Especially, the 'Means of Implementation targets' (finance, trade, capacity building and/or science and technology and innovation, etc) and 'Outcome targets' lately introduced under Goal 17 to support member states of UN seem to be of great relevance for us in the NE region. Similarly, the innovation and effectiveness observed in the construction of Index and Dashboard to track the achievement and rank the states' performance in achieving goals looks quite enthralling.

It is expected that the book will open up new avenues in many more promising fields for further exploration and research. Over and above their intellectual and academic excellence in different domains of knowledge, the authors seem to have abiding interest and affinity for the region and understanding of its people and their habitat, culture, livelihood, economy and welfare which are reflected in the large

number of case studies included the book. To me the authors have been able to do full justice to the fascinating subject they have chosen to study. If the study could arouse academic, scientific and technological interests on the subject and the region, the authors should feel amply rewarded.

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Acknowledgements

Professor Ram Babu Singh (1955–2021) ***Source*** **The Editors**

The vision and the conceptual idea of this volume emerged from late Professor Ram Babu Singh, who is the fourth editor of this volume under the series *Advances in Geographical and Environmental Sciences*. Professor Ram Babu Singh was the first Indian Geographer to have accomplished the dual distinction of becoming International Geographical Union (IGU) Secretary General & Treasurer and ICSU Scientific Committee Member. Professor Singh was also the first Indian and second Asian Secretary General and Treasurer of the IGU from 2018 to 2022. Unfortunately, Prof. Ram Babu Singh left for heavenly abode before the execution of this dream project on 22 July 2021. This book volume is his brain child on North-East India, while

offering our humble obeisance, we dedicate this project to his memory. We wish you were here to see this volume being published!

Chapter 2 of this project is in honour of the academic contribution of Prof. Narendra Nath Bhattacharyya. We thank Mr. Pranjal Bhattacharyya, Mr. Prantar Bhattacharyya and Mrs. Pallavi Chakravarty for providing us with the personal and academic information about Prof. Narendra Nath Bhattacharyya.

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Finally, we thank our families and close-knit relatives for their continued support and, of course, our parents for their unconditional blessings.

Subhash Anand
Madhushree Das
Rituparna Bhattacharyya
R. B. Singh

About This Book

The responsible series editor of this book is Dr. Ram Babu Singh.

Contents

Chapter 1
Sustainable Development Goals in Northeast India—Challenges and Achievements

Rituparna Bhattacharyya, Subhash Anand, and Madhushree Das

Abstract This project is a festschrift honoring the academic contributions of Professor Narendra Nath Bhattacharyya to North East India. This chapter overviews the region's accomplishments and challenges of the Sustainable Development Goals. Alongside, this chapter attempts to pull all the chapters included in this book by dividing it into three parts—Part I: Introduction; Part II: SDG and North East India and Part III: Case studies.

Keywords Sustainable development goals · SDG index · Challenges · Achievements · North East India

1.1 Introduction

This book project is a festschrift to celebrate the academic contributions of Professor Narendra Nath Bhattacharyya. Professor Bhattacharyya took to the challenges of very scant educational resources of the time of developing and sustaining geographical scholarship (both human and physical geography) of North East India. It is needless to mention that North East India is one of India's resource-limited and under-developed regions.

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Comprising of eight states—Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim,[1] (Fig. 1.1), the border states share approximately 99% of its boundaries with five neighbouring countries—Nepal in the west (97 km or 60 miles), Bhutan in the north-west (455 km or 283 miles), Bangladesh in the south-west (1596 km or 992 miles), Myanmar in the east (1640 km or 1020 miles) and Tibet Autonomous Region, of China in the north (1395 km or 867 miles) constituting about 8% of the geographical area of India, which is 262,230 km^2 or 101,250 mi^2. The seven states of the region (excluding Sikkim), known as the land of seven sisters, is connected to mainstream India by a narrow corridor, which is 33 km (20.5052 miles) on the eastern side and the 21 km (13.0488 miles) on the western side which are often subjected to segregation because of heavy rainfall and floods (Bhattacharyya 2005). Arguably, the region's strategic terrestrial location linked to its national security can be referred to as "sensitive space" (Cons 2016).[2] Because of this strategic sensitivity, which is home to 46 million (357 constitutional communities—32 scheduled castes and 182 scheduled tribes) (Census of India 2011), the region has remained more or less isolated from the mainstream since independence leading to alienation of the population, under-development coupled with socio-political unrest—insurgency and ethnic conflicts (Bhattacharyya 2005; Bhattacharyya 2018, 2019a, b; Goswami 2015).

However, despite being under-developed, the region's people are more or less straightforward, welcoming and highly hospitable; therefore, the region can be labelled as the land of Namaste (N = Nagaland, A = Arunachal Pradesh, M = Manipur, Meghalaya and Mizoram, A = Assam, S = Sikkim, T = Tripura and E = East). The first of its kind, this interdisciplinary project aims to foreground the region's challenges and achievements of Sustainable Development Goals (SDGs), which hitherto can be claimed as highly under-researched.

1.2 Sustainable Development

According to the 1987 Report of the World Commission on Environment and Development: Our Common Future, known popularly as the Brundtland Report, after Gro Harlem Brundtland, the Commission's chairwoman, "[s]ustainable development is

[1] There remains a confusion as to when Sikkim became a part of North East India. In Goswami's (2015) edited book, *Troubled Diversity: The Political Process in North East India*, it mentions that Sikkim was added to North East India in 1992, while in other literature, it is mentioned that Sikkim became a part of North East India in 2002 (Bhattacharyya, 2018; 2019a, b) following an amendment to the North Eastern Council Act, 1971 (Evaluation of NEC Funded Projects in Sikkim, 2010).

[2] Of course, Cons (2016) applied it in the case of the enclaves along the Indo-Bangladesh border following the partition in 1947—there were 111 Indian enclaves in Bangladesh covering 17,160.63 acres and 51 Bangladesh enclaves in India covering 7,110.02 acres (for details, please read, Ferdoush 2019; also Das et al. 2022). On 31 July 2015, the historic Land Boundary Agreement was ratified and signed between the two countries through which the exchanges of enclaves between the two countries were facilated offering the residents to choose nationality according to their choice(for details, please read: India & Bangladesh: Land Boundary Agreement).

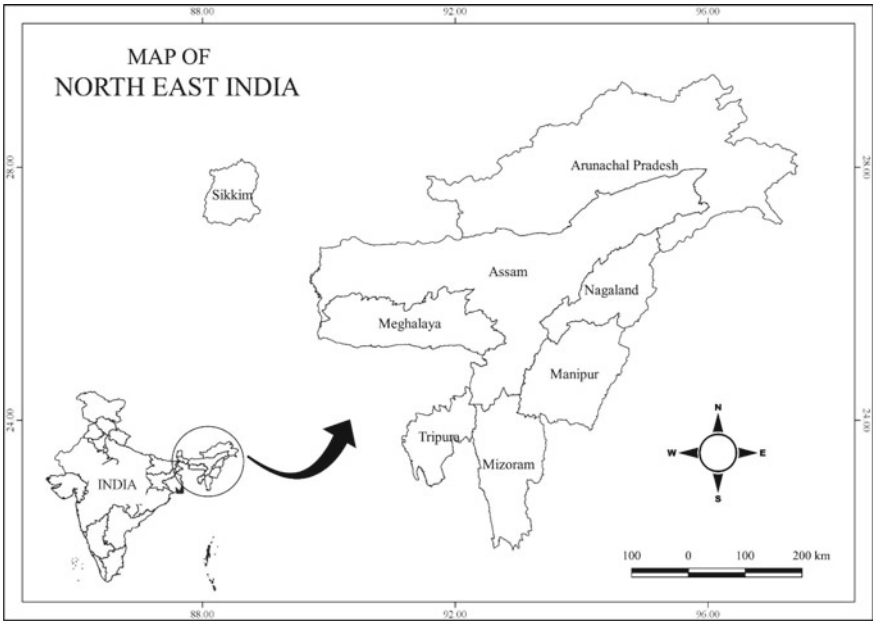

Fig. 1.1 Location map of North East India. *Source* Prepare by Authors

[the] development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report 1987). This report which was published more than three decades ago is one of the most proficient reports that put to the fore the incongruities of the ramifications of economic development and economic growth on climate change and the environment, and at the same time, the necessity for such development and growth remains paramount to tackle current and future poverty as well as other indicators of SDGs. As the (Brundtland Report, 1987) put:

Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainable development does imply limits—not absolute limits but limitations imposed by the present state of technology and social organisation on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organisation can be both managed and improved to make way for a new era of economic growth. The Commission believes that widespread poverty is no longer inevitable. Poverty is not only an evil in itself, but sustainable development requires meeting the basic needs of all and extending to all the opportunity to fulfil their aspirations for a better life. A world in which poverty is endemic will always be prone to ecological and other catastrophes.

It is common knowledge to state that sustainable development became an established notion in the two weeks summit—3–14 June 1992, at the United Nations

Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil. Commonly known as the Earth Summit, it produced a 600-page *Agenda 21* charting encyclopedic action plans among the stakeholders—global, national and local organisations of the United Nations System, Governments and other significant groups, which was consequently adopted by more than 178 countries. Simultaneously, the Earth Summit also launched an international environmental treaty, the United Nations Framework Convention on Climate Change, wherein Article 2 (p. 9) of the treaty aims to tackle "dangerous anthropogenic interference with the climate system" to reduce concentrations of greenhouse gas in the atmosphere (United Nations Framework Convention on Climate Change 1992). One hundred fifty-four states signed this treaty and ratified it by 50 states; it became effective on 21 March 1994.

In parallel, the Earth Summit also floated the idea and started drafting on 9 May 1992 for a multilateral environmental treaty—Convention on Biological Diversity (or Biodiversity Convention), thereby opening for signatures, which was ratified by 30 states and became effective on 29 December 1993. This convention further went for two supplementary agreements—The Cartagena Protocol on Biosafety to the Convention on Biological Diversity adopted on 29 January 2000 and came into force on 11 September 2003 and The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity adopted on 29 October 2010, which became effective on 12 October 2014.

In the wake of the Millennium Summit of the United Nations in 2000, followed by the adoption of the United Nations Millennium Declaration, all 191 United Nations member states and about 22 international organisations pledged to accomplish the eight Millennium Development Goals (MDGs) by 2015, which was obviously highly ambitious appearing hollow. However, at the end of the 2015 MDG era, the United Nations General Assembly on 25 September 2015 adopted a resolution to transform the world via the adoption of 17 interconnected global goals of sustainable development by 2030 (Transforming our world: the 2030 Agenda for Sustainable Development 2015), which looked highly ambitious even at the pre-pandemic level. For example, baseline projections showed that 6% population of the world would be living on the brink of extreme poverty by 2030.[3] The ongoing COVID-19 pandemic has worsened the situation in a generation, suggesting that it has pushed an additional 119–124 million people to the edge of extreme poverty.[4] Obviously, North East India is no exception. In the following section, we discuss SDGs and North East India.

[3] Goal 1: End poverty in all its forms everywhere. *UN Sustainable Development Goals*. https://www.un.org/sustainabledevelopment/poverty/.

[4] Goals 1: End poverty in all its forms everywhere. United Nations: Department of Economic and Social Affairs Sustainable Development. https://sdgs.un.org/goals/goal1.

1.3 SDGs and North East India

Like other countries of the world, in India, the NITI Aayog, in collaboration with the Union Ministries and States/Union Territories, launched the SDG Vertical, the nodal agency meant for coordinating and monitoring the SDGs of the respective states and union territories. Following this, for the first time, the NITI Aayog developed the NER District SDG Index (Fig. 1.2) to track the progress and failure of the SDGs at the district level of the eight states of the region deploying 84 indicators enveloping 15 of the global goals transversing 50 targets. The central objectives of the NER District SDG Index were fivefold: to strengthen the level of monitoring for all the districts of the eight states of the region; establishment of NER District SDG Index, which would serve as a comprehensive monitoring tool to examine the performance of each SDG at the micro-level, that is the district level; to help the districts and the states identify critical gaps in the SDG sectors; to build and stimulate healthy competition among the stakeholders of the districts and states; and to promote and smoothen mutual learning via good practices and challenges. This NER District SDG Index was developed after the North Eastern Region SDG Conclave 2020 organised by NITI Aayog in Guwahati in February 2020. NITI Aayog drafted the North Eastern Region District Indicator Framework (NEDIF) and shared the same with all the eight states for inputs and feedback. This NEDIF draft also included inputs from the District Infrastructure Index prepared by the Ministry of DoNER in 2009. Taking all the pieces of feedback into account, the NER SDG Index computed SDG-wise scores for each district on 15 SDGs (SDG 14—life below water and SDG 17—partnerships for the goals were omitted as they bear the least relevance to the region). Following this, the NER SDG Index generated composite district scores taking the goal-wise scores to calculate the aggregate performance of the district on the basis of its performance across the 15 SDGs. The scale of the scores ranges from 0 to 100. A 100 score signals that the district has accomplished the set targets for 2030, while a score of 0 indicates that the district has failed to achieve the target, thereby occupies the bottom of the index. Based on the NER District SDG Index score, the districts have been classified under categories—Aspirant (0–49), Performer (50–64), Front Runner (65–99), Achiever (100).

Table 1.1 presents the breakdown of the SDG performance of the eight states of North East India, 2018–2021, indicating that Sikkim's overall SDG performance is better than the all-India average followed by Mizoram and Tripura.

A pedantic analysis of the NER District SDG Index unveils that the East Sikkim district of Sikkim occupied the first position in the region while the districts Gomati and North Tripura, both located in Tripura, occupied the second position. SDG goal-wise good performing districts of NER are illustrated in Table 1.2, while in Table 1.3, the names of the Top-10 and Bottom-10 districts of the region based on their composite scores of SDG performance are shown. Interestingly, the top-10 districts are located in Sikkim, Tripura and Mizoram, whereas in the bottom 10, six districts are located in Nagaland, followed by Arunachal Pradesh and Meghalaya (Table 1.3). Arguably, the poor levels of SDG performance in the districts of Nagaland (Longleng,

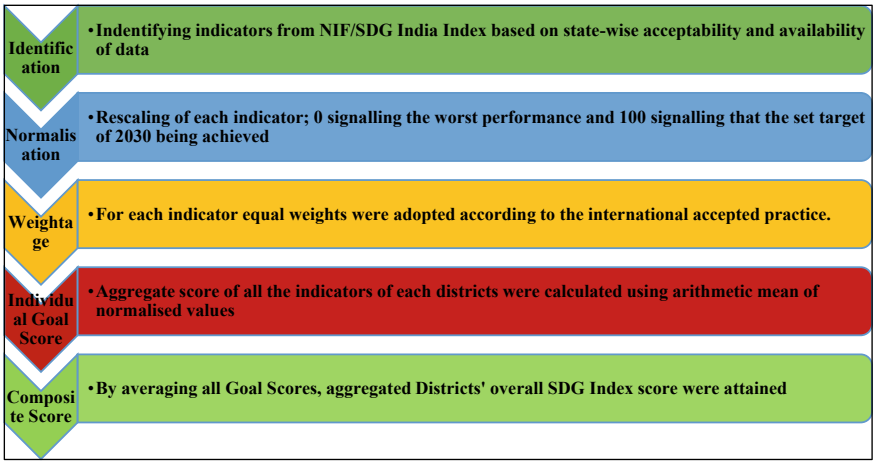

Fig. 1.2 Methodology of the North Eastern Region District SDG Index. *Source* Created from NER District SDG Index and Dashboard 2021–22: An Introduction to the Baseline Report

Phek, Mon, Tuensang, Zunheboto and Kiphire), Arunachal Pradesh (Shi Yomi, East Kameng, Kamle and Kra Daadi) and Meghalaya (North Garo Hills) *inter alia* can perhaps be attributed to remote location coupled with hilly terrain and inaccessibility. But the question is that even Sikkim's geographical location is hilly, and the landscape is highly susceptible to weathering and erosion. Moreover, even Tripura and Mizoram share a substantial amount of hilly/mountainous terrain. However, Sikkim is more or less a conflict-free state. Even in Tripura, Armed Forces Special (Powers) Act was revoked in 2015 following gradual normalisation of law and order situation and reduced incidents linked to militancy (Bhattacharyya 2018; Lal 2015). Except for sporadic violence since October 2020 in connection to the border dispute between Assam and Mizoram,[5] the state of Mizoram has remained in peace post the signing of the Mizo Peace Accord on 30 June 1986 (Sharma 2016).[6]

The socio-political unrest (insurgency and ethnic conflicts) plays a significant role in poor SDG performance. Therefore, the leaders of the Naga National movement and other similar stakeholders of the entire region (including the political leaders) should realise as to what have they contributed towards the performance of SDG in the name of leading various forms of political movements (Bhattacharyya 2018; 2019a; Bhattacharyya and Pulla 2020a, b; Goswami 2015; Sarma and Bhattacharyya 2021).

[5] The Hindu Net Desk (2021, 28 July). Watch | What is Assam-Mizoram border conflict?. The Hindu. https://www.thehindu.com/news/national/other-states/watch-what-is-assam-mizoram-border-conflict/article35576378.ece.

[6] Memorandum of Settlement (Mizoram Accord). New Delhi, 30 June 1986.https://peacemaker.un.org/sites/peacemaker.un.org/files/IN_860630_Mizoram%20Accord.pdf.

Table 1.1 Performance of the North Eastern states on SDGs (2018, 2019–20 and 2020–21)

States	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 15	SDG 16	Composite SDG
Arunachal Pradesh	**52**	**58**	**38**	**44**	**32**	**64**	**44**	**72**	**16**	**47**	**44**	**n/a**	**n/a**	**73**	**77**	**51**
	34	*66*	*50*	*58*	*33*	*88*	*74*	*52*	*31*	*38*	*43*	*67*	*31*	*71*	*62*	*53*
	54	***66***	***64***	***41***	***37***	***67***	***85***	***50***	***31***	***69***	***39***	***77***	***58***	***93***	***64***	***60***
Assam	**53**	**53**	**30**	**54**	**36**	**42**	**18**	**61**	**35**	**75**	**32**	**n/a**	**n/a**	**100**	**53**	**49**
	48	*39*	*44*	*44*	*33*	*78*	*70*	*62*	*46*	*67*	*40*	*68*	*47*	*90*	*52*	*55*
	51	***41***	***59***	***43***	***25***	***64***	***98***	***50***	***39***	***65***	***55***	***66***	***53***	***78***	***62***	***57***
Manipur	**44**	**74**	**67**	**65**	**25**	**44**	**39**	**33**	**72**	**98**	**31**	**n/a**	**n/a**	**100**	**70**	**59**
	42	*69*	*62*	*70*	*34*	*87*	*72*	*27*	*43*	*81*	*28*	*85*	*37*	*100*	*70*	*60*
	60	***64***	***68***	***63***	***41***	***87***	***96***	***36***	***35***	***70***	***65***	***89***	***57***	***60***	***69***	***64***
Meghalaya	**68**	**43**	**52**	**38**	**36**	**40**	**11**	**62**	**42**	**100**	**39**	**n/a**	**n/a**	**94**	**53**	**52**
	68	*35*	*53*	*55*	*34*	*70*	*52*	*65*	*22*	*76*	*22*	*60*	*36*	*99*	*59*	*54*
	77	***37***	***70***	***48***	***51***	***75***	***50***	***63***	***25***	***88***	***51***	***73***	***62***	***64***	***72***	***60***
Mizoram	**71**	**69**	**53**	**54**	**43**	**67**	**78**	**65**	**0**	**100**	**32**	**n/a**	**n/a**	**69**	**71**	**59**
	67	*75*	*52*	*61*	*37*	*81*	*81*	*42*	*8*	*66*	*33*	*50*	*45*	*75*	*63*	*56*
	80	***72***	***79***	***60***	***54***	***85***	***100***	***51***	***32***	***64***	***61***	***87***	***66***	***48***	***81***	***68***
Nagaland	**59**	**69**	**34**	**45**	**42**	**58**	**45**	**40**	**0**	**80**	**32**	**n/a**	**n/a**	**75**	**87**	**51**
	56	*70*	*29*	*47*	*42*	*75*	*70*	*28*	*23*	*61*	*23*	*100*	*51*	*94*	*84*	*57*
	73	***64***	***61***	***39***	***48***	***87***	***69***	***48***	***30***	***46***	***48***	***91***	***69***	***63***	***79***	***61***
Sikkim	**64**	**67**	**52**	**47**	**50**	**78**	**47**	**57**	**1**	**67**	**56**	**n/a**	**n/a**	**98**	**66**	**58**
	65	*66*	*59*	*58*	*49*	*79*	*97*	*68*	*27*	*64*	*74*	*60*	*38*	*100*	*69*	*65*
	80	***69***	***62***	***58***	***58***	***89***	***100***	***71***	***52***	***61***	***85***	***76***	***65***	***73***	***72***	***71***

(continued)

Table 1.1 (continued)

States	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 15	SDG 16	Composite SDG
Tripura	**71**	**58**	**53**	**56**	**38**	**38**	**32**	**52**	**38**	**89**	**38**	**n/a**	**n/a**	**86**	**71**	**55**
	70	*49*	*61*	*55*	*32*	*69*	*56*	*63*	*48*	*45*	*31*	*92*	*37*	*88*	*73*	*58*
	82	***52***	***67***	***42***	***39***	***82***	***83***	***57***	***35***	***85***	***67***	***99***	***41***	***69***	***80***	***65***
India	**54**	**48**	**52**	**58**	**36**	**63**	**51**	**65**	**44**	**71**	**39**	**n/a**	**n/a**	**90**	**71**	**57**
	50	*35*	*61*	*58*	*42*	*88*	*70*	*64*	*65*	*64*	*53*	*55*	*60*	*66*	*72*	*60*
	60	***47***	***74***	***57***	***48***	***83***	***92***	***61***	***55***	***67***	***79***	***74***	***54***	***66***	***74***	***66***
Target	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Sources SDG India Index-Baseline Report 2018/2019–20/2020–21

Note Aspirant: 0–49, Performer: 50–64, Front Runner: 65–99, Achiever: 100 SDGs 14 and 17 not included, n/a: not available (denoted by: Bold), (denoted by: Italic), (denoted by: Bold Italic)

Table 1.2 SDG goal-wise good performers of the districts of North Eastern Region are

Goals	Districts (States)
Goal 1: no poverty	East Sikkim (Sikkim), Serchhip (Mizoram), South Sikkim (Sikkim), Kamrup Metropolitan (Assam), Champhai (Mizoram)
Goal 2: zero Hunger	Phek (Nagaland), Bishnupur (Manipur), Peren (Nagaland), Champhai (Mizoram), Imphal West (Manipur), Kohima (Nagaland)
Goal 3: good health and well being	Champhal (Mizoram), East Sikkim (Sikkim), North Sikkim (Sikkim), Upper Siang (Arunachal Pradesh), East Siang (Arunachal Pradesh), Saiha (Mizoram)
Goal 4: quality education	Aizawl (Mizoram), Kolasib (Mizoram),East Sikkim (Sikkim), Champhai (Mizoram), Serchhip (Mizoram) and West Sikkim (Sikkim)
Goal 5: gender equality	Anjaw (Arunachal Pradesh), Pakke Kessang (Arunachal Pradesh), Shi Yomi (Arunachal Pradesh), Tirap (Arunachal Pradesh), East Kameng (Arunachal Pradesh), Longding (Arunachal Pradesh), Siang (Arunachal Pradesh)
Goal 6: clean water and sanitation	Kolasib (Mizoram), Lower Dibang Valley (Arunachal Pradesh), Kohima (Nagaland), Mamit (Mizoram), North Sikkim (Sikkim)
Goal 7: affordable and clean energy	Aizawl (Mizoram), Imphal West (Manipur), East Sikkim (Sikkim), Kolasib (Mizoram), Kamrup Metropolitan (Assam)
Goal 8: decent work and economic growth	Papum Pare (Arunachal Pradesh), West Siang (Arunachal Pradesh), East Sikkim (Sikkim), West Kameng (Arunachal Pradesh), West Tripura (Tripura)
Goal 9: industry, innovation and infrastructure	Kamrup Metropolitan (Assam), Morigaon (Assam), Hailakandi (Assam), Jorhat (Assam), Nagaon (Assam), Nalbari (Assam), Sepahijala (Tripura)
Goal 10: reduced inequalities	South West Khasi Hills (Meghalaya), Bishnupur (Manipur), East Garo Hills (Meghalaya), South West Garo Hills (Meghalaya) and West Khasi Hills (Meghalaya)
Goal 11: sustainable cities and communities	North Tripura (Tripura), Dhalal (Tripura), Sepahijala (Tripura)
Goal 12: responsible consumption and	Udalguri (Assam), Karbi Anglong (Assam), Unakoti (Tripura), Gomati (Tripura), South Tripura (Tripura)

(continued)

Table 1.2 (continued)

Goals	Districts (States)
Goal 13: climate action	West Jaintia Hills (Meghalaya), South Garo Hills (Meghalaya), East Garo Hills (Meghalaya), West Garo Hills (Meghalaya), Darrang (Assam), Sivasagar (Assam), Mokokchung (Nagaland)
Goal 14: life below water	Not Applicable to North East region
Goal 15: life on land	12 districts from Arunachal Pradesh, Assam and Sikkim share the first rank
Goal 16: peace, justice and strong institutions	Leparada (Arunachal Pradesh), Serchhip (Mizoram), Mamit (Mizoram), Champhai (Mizoram), Churachandpur (Manipur) and Aizawl (Mizoram)

Sources NITI Aayog Releases North Eastern Region District SDGIndex and Dashboard 2021–22, Ministry of Development of North-East Region. https://pib.gov.in/PressReleasePage.aspx?PRID=1749292; NER District SDG Index and Dashboard 2021–22: An Introduction to the Baseline Report. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/aug/doc202182601.pdf; North Eastern Region: District SDG Index. India's First Regional District-Level SDG Index. NITI Aayog, Ministry of Development of North Eastern Region and UNDP. https://sdgindiaindex.niti.gov.in/NER/dashboard/#/

1.4 Chapters on SDGs

Notwithstanding, both environment and development are facets of the same coin and, therefore, inseparable. Indeed, sustainable development is a process of continuous transformation via which resources need to be exploited, and investments need to be directed, alongside the induction of technological development and institutional change, which ought to be congruent with future and present requirements (Brundtland Report 1987). Considering these backdrops, we present 29 chapters on SDGs contributed by social science, humanities and pure science scholars in this book project.

We have arranged the chapters according to the sequence of the SDGs, but some chapters of this multidisciplinary book project overlap the SDGs; therefore, they have been divided into three parts: **Part I-Introduction**, **Part II-SDG and North East India** and **Part III-Case studies**, which are outlined below:

1.4.1 Part I: Introduction

In Chap. 2, as stated above, Bimal Kumar Kar writes this historical article titled Professor Narendra Nath Bhattacharyya: Professional Career and Contributions to memorialise the geographical and other academic contributions of Professor Bhattacharyya in North East India. Professor Bhattacharyya's writings and publications

Table 1.3 Composite scores of SDG performance of Top-10 and Bottom-10 districts of the North East India

Top 10 districts	Composite score	Districts/States
	75.87	East Sikkim (Sikkim)
	75.73	Gomati, North Tripura (Tripura)
	75.67	West Tripura (Tripura)
	74.87	Serchhip (Mizoram)
	74.80	South Sikkim (Sikkim)
	73.47	Unakoti (Tripura)
	72.87	Lunglei (Mizoram)
	72.60	Dhalai (Tripura), Sepahijala (Tripura)
	72.40	South Tripura (Tripura)
	72.27	Kolasib (Mizoram)
Bottom-10 districts	59.07	Longleng (Nagaland)
	58.60	Shi Yomi (Arunachal Pradesh)
	58.27	East Kameng (Arunachal Pradesh), Phek (Nagaland)
	57.40	Kamle (Arunachal Pradesh)
	56.87	North Garo Hills (Meghalaya)
	55.93	Mon (Nagaland)
	55.87	Tuensang (Nagaland)
	55.60	Kra Daadi (Arunachal Pradesh)
	54.53	Zunheboto (Nagaland)
	53.00	Kiphire (Nagaland)

Source NER District SDG Index and Dashboard 2021–22: An Introduction to the Baseline Report. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/aug/doc202182601.pdf

span from the regional geography of North East India through to Population and Biogeography. Through his teachings, research, publications and mentoring, he shaped the lives of hundreds of students, researchers and colleagues.

Syeda Fahima Shahnaz Sultana, Payel Saha, Chandan Bhuyan, Madhushree Das, Rituparna Bhattacharyya and Subhash Anand in their chapter, Just Transition via (Re) Vision 2020: The Story Hitherto, placed in Chap. 3, revisit the vision document—North Eastern Region Vision 2020, an important document for all the region's eight states to accomplish inclusive growth and development so that the region can emerge as an architect—the lead arrowhead in the country's Act East Policy. The document, however, unveils the complexities and challenges of the region while drawing a roadmap for new development strategies. However, NER District SDG Index suggests that despite some SDG goals' positive and incredible performance in many districts of the region (Tables 1.2 and 1.3), much still needs to be done to achieve development in a true sense. Moreover, 2020 is already gone. So, applying the notion of Just Transition, the authors urge to revise the vision document to set an

achievable target of at least 2070 (the same year when India pledges to attain carbon neutrality at COP 26 in Glasgow, 31 October to 12 November)[7] to accomplish the SDG targets via acceleration and inclusive growth and governance.

1.4.2 Part II: SDG and North East India

In their Chap. 4, An Analysis of the Performance of Sustainable Development Goals (SDGS) in the North East Region of India: An Economics Perspective by Pawan Kumar and Paramjit employ an economic perspective to analyse the performance of the SDGs in the entire NER.

India ranks 101 on Global Hunger Index (GHI). In 2000, GHI for India stood at 38.8, which has reduced gradually to 37.4 in 2006 through to 28.8 in 2012 to 27.5 in 2021 (Global Hunger Index 2021). SDG Goal 2 aims to end hunger, achieve food security and improved nutrition and promote sustainable agriculture by 2030. Article 47 of the Constitution of India enshrines that the State must raise the level of nutrition and the standard of living to improve public health. Food and Agriculture Organization of the United Nations (1998, p. 43) publication titled *The Right to Food: In theory and practice*, state that:

The State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties, and, in particular, the State shall endeavour to bring about prohibition of the consumption except for medicinal purpose of intoxicating drinks and of drugs which are injurious to health.

Intending to provide food at subsidised rates to its citizens in need, India has passed The National Food Security Act in 2013 (Bezbaruah 2013).[8] The act aims to provide food via schemes like Midday Meal, Integrated Child Development Services scheme and the Public Distribution System. Reinforcing the importance of food security and agriculture, even the Journal Space and Culture India, a ten-year-old journal, has published a few case studies on India's food security (Nandi & Mistri 2019; Siddique & Mukherjee 2017; Sankar 2020).

In 2006, the Government of India had passed the Mahatma Gandhi Rural Employment Guarantee Act (MGREGA), a flagship programme, a form of food security scheme providing 100 days of guaranteed employment to its beneficiaries. Amid its failures, corruption and success, the MGREGA proved as a rural lifeline (Bhattacharyya and Vauquline 2013; Bhattacharyya 2016; Ramya 2018). In the wake of the migrant crisis that surfaced on the first phase of lockdown in March 2020, there is ample evidence to suggest that MGREGA served to salvage the lives of the labourers

[7] Special Correspondent (2021, 02 November). CoP26 summit | India will achieve net zero emissions by 2070, says PM Modi. *The Hindu.* https://www.thehindu.com/sci-tech/energy-and-environment/prime-minister-narendra-modi-addresses-cop26-un-climate-summit-in-glasgow/article37292550.ece.

[8] The National Food Security Act, 2013 (No. 20 of 2013). Ministry of Law and Justice. The Gazette of India. https://www.egazette.nic.in/WriteReadData/2013/E_29_2013_429.pdf.

who were hit hard during the pandemic (Bhattacharyya et al. 2020). In this project on SDGs, SDG 2 performance by the North Eastern states and the district-level performance have been presented in Tables 1.2 and 1.3. Taking diverse perspectives and its challenges on food (in)security, the authors—Raju Mandal Binoy Goswami Munmi Sarma and Hiranya Nath; Navneet Hazarika Joyeeta Deka, Praditya Kumar Das and Kandarpa Kumar Saikia; Dibyajyoti Dutta and Akhil Ranjan Dutta; and Vimla Singh and Nivedita Chaudhary, respectively, present their research in Chaps. 5, 6, 7 and 8:

Chapter 5: Extreme Weather Events and Food Insecurity in Northeast India
Chapter 6: Food Security in North East India: the Role of Agriculture, Challenges and the Road Ahead
Chapter 7: Juxtaposing Food Security and Sustainable Development Goals (SDGs) in Northeast India: Evidence and Explanations
Chapter 8: Land Degradation, Desertification and Food Security in North East India: Present and Future Scenarios

The common thread of analysis of these chapters is food security and livelihood. Chapter 9 by Priyanka Puri critically examines and analyses the geographical and temporal evolution of the Enhanced Vegetation Index (EVI) and Land Use for the seven North East India sister states excluding Sikkim. K. V. Chamar & Rekha Dhanak, in Chap. 10, using the district-wise Census of India (2011) data and applying z-score, examines the quality level of living space among rural households in the NER. In Chap. 11, Eeshankur Saikia & Parvej Reja Saleh argue for the deployment of artificial intelligence tools coupled with computer vision and machine learning (ML), demonstrating how such techniques would advance further the growth of agriculture and other allied activities.

Health remains a critical indicator of the everyday life of an individual. Without the sound health of its population, it remains a daunting task for a state to attain development (Bhattacharyya 2016a; Sarma and Bhattacharyya 2015). As already stated, Tables 1.1 and 1.2 demonstrate state-level and district-level performances of all the SDGs, including SDG3. Mridul Kumar Sarma in Chap. 12 Sustainable Development Goals (SDG 3) "health and wellbeing": What's ailing north eastern states? critically reviews the region's health challenges while in Chap. 13, Sahana Bhattacharjee, applying data-based assessment probes as to what extent the states of NER in comparison with India as a whole have been able to accomplish the set target of SDG3.

It is generally reckoned that in North East India women enjoy a higher status and mobility when compared to their counterparts of the rest of India (Bhattacharyya 2009; 2021; Behel 2002). While this is true to a great extent primarily because of the matrilineal influence of the societies of Khasis, Jaintias and Garos[9] and have remained a dowry-free and sati-free region. However, this does not mean that the region is free from gender-related discrimination (Bhattacharyya 2016b; Bora and Das 2019; Vauquline 2015). Applying the theories of socialisation, double-burden,

[9] It is also believed that the Chutiya kingdom of thirteenth century followed a system which was not solely patrilineal but had elements matrilineality as well.

sticky floor and schema, Lovleen Gupta, Shubham Singhania and Rohit Kumar Shrivastav investigate the status of gender equality in the states of NER in Chap. 14; Ashu Rani and K. V. Chamar in Chap. 15 have used village-level census data of 2001 and 2011 to examine dominant and deficient functions of rural female workers of NER (excluding Sikkim).

Using varied examples from NER about cyber-attacks and cyber-frauds stemming from increased digitisation, in Chap. 16, Subimal Bhattacharjee examines the evolving paradigm of cybersecurity in the region.

1.4.3 Part III: Case Studies

This section is devoted to presenting SDG case studies from different states of NER.

In Chap. 17, Payel Saha, Syeda Fahima Shahnaz Sultana, Ankabehari Saha and Madhushree Das critically analyse the impact of the performance of SDGs in the state of Assam; similarly, Barnali Gogoi and Swapnali Saikia, in their Chap. 18, critically identify the causes and measure the gaps to achieve the SDG 1 in Assam.

Applying an interdisciplinary approach alongside a questionnaire survey, Rituparna Bhattacharyya, Bowen Tan and Diganta Bhusan Das, in Chap. 19, examine the complex problem of drinking water during times of an emergency (floods, ethnic riots, etc.) in the state of Assam. In doing so, the authors discuss the factors of drinking water treatment practices in Assam. The study's findings intend to develop a decentralised water treatment system (DWTS) that could be useful during emergencies and everyday living. In a similar but slightly different context, connecting to SDG 5 and SDG10, Bikash Chetry in Chap. 20 presents the treacherous geographies of erosion and floods of Majuli, one of the largest riverine islands of the world. In doing so, Bikram Chetry meticulously illustrates how the lack of good governance and the Community-Based Disasters Risk Reduction (CBDRR) strategies or programmes of Majuli are non-inclusive and continue to create gendered inequalities. Similarly, in Chap. 22, Nazifa Ahmed presents a meticulous analysis of the perilous geographies of precarity and vulnerability of the ecosystem of *char* (shifting sandbars) dwellers or *charuas* in Assam during floods and how the dwellers are fighting the annual natural hazard of the state.

In Chap. 23, Chandrama Goswami and Manisha Bhattacharyya probe how "work" definition has transformed over time. Using a time use survey of 100 women in Guwahati, the authors explain why and how unpaid work has been subsumed in the Sustainable Development Goals (SDGs); how unpaid work invisibly control and impact the entry of women into livelihoods and labour markets vis-à-vis the performance of women on the same.

There are two chapters on two famous wildlife sanctuaries of Assam—Manas National Park (MNP) and Pabitora Wildlife Sanctuary. MNP, located in Chirang and Baksa District, Bodoland Territorial Region was recognised as a UNESCO World Heritage site in 1985. However, it was significantly affected by socio-political unrest of the Bodos resulting in the loss of its glory as a World Heritage site in 2003. In

Chap. 21, the authors, Pranjit Kumar Sarma, Rituparna Bhattacharyya, Sanatan Deka, Amal Sarma and Sanjay Prasad, demonstrate how the success stories of biodiversity and bioresource conservation through the participation of the people of the fringe villages of MNP helped in regaining not only its lost heritage status in 2011 but developed sustainable livelihood among the inhabitants of the surrounding region. Similarly, Pranjit Kumar Sarma, Bibhab Kumar Talukdar, Pradipta Baruah and Mukul Tamuli in Chap. 24 revisit Pabitora Wildlife Sanctuary to assess wildlife habitat dynamics. To evaluate the sanctuary's habitat dynamics (including habitat characterisation data), they used Dji Phantom drone. The study aimed at redeveloping a habitat classification scheme for sustainable development of the sanctuary focussing primarily on how the current developmental activities in and around the sanctuary are (in)directly impacting its unicorns. The collected data was analysed using Arc GIS 10.3 and ERDAS Imagine 9.3 software.

Unlike the mainstream, tourism in North East India is unique because it is naturally wedded to its paradisiacal beauty linked to the Himalayan landscape and culture. Therefore, the next two chapters, Chaps. 25 and 26, are devoted to the region's sustainable tourism. Shikha Yadav, Gautam Kakaty and Usha Rani, in Chap. 25, studied 200 samples through a questionnaire survey, taking 100 each from Kaziranga National Park and Majuli to assess the prospects of tourism in Assam. Then, in Chap. 26, Parijat Borgohain and Barnali Patowary develop the concept of ethnic tourism in the state of Arunachal Pradesh, which is home to 26 major tribes and over 110 sub-tribes, who bear intimate relationships with its surrounding natural environment embedded in cultural beliefs and traditional knowledge of conservation and management. To set the notion of sustainable ethnic tourism, the authors studied Apatani and Monpa tribal communities reckoned as essential tourist circles of the state circumambient—Tezpur-Bhalukpong-Bomdila-Tawang and Itanagar-Ziro–Daporizo-Along-Pasighat circuits.

The final four chapters of this volume are devoted to the state of Manipur.

Reviewing National Family Health Survey (NFHS-5) and connecting it to SDG3, Esther Ngaihte and Anushruti in Chap. 27 unfold the retrogression of the overall healthcare services of Manipur and urge for its redressal.

With the application of GIS and secondary statistics alongside the notion of sustainability, which is composed of three pillars—the economy, society and environment, Irom Luckychand Meitei and Gurumayum Jadumani Sharma in Chap. 28 examine the interconnection between food, population, arable land and economy in Manipur.

In the penultimate chapter, in Chap. 29, Lunghim Rongmei, Irom Luckychand Meitei and Ekta Raman apply Remote Sensing and GIS techniques to assess landslide hazard zonation in Tamenglong District of Manipur and thereby demonstrate how such natural hazard can be reduced in a mountainous landscape of Manipur.

Finally, in Chap. 30, applying secondary data, Himani Tiwari and Harshita Tiwari critically analyse the development-induced trade-offs of the Loktak Multipurpose Project located in the Loktak lake, which was built with an aim to increase the economy of Manipur. Hence, present book volume contributes critically for achieving the sustainable future of the North East region of India.

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Part I
Introduction

Chapter 2
Professor Narendra Nath Bhattacharyya: A Brief Profile of His Life, Academic Career and Contributions

Bimal K. Kar

Abstract Professor Narendra Nath Bhattacharyya, a second-batch post-graduate in geography from Gauhati University and a distinguished faculty member of geography, Gauhati University, has been well known among the geography fraternity of North-East India and other parts of the country as a dedicated teacher and researcher of geography. After obtaining doctoral degree for his research on urban morphology of Guwahati city from Utkal University, Prof. Bhattacharyya devoted his long service career in Gauhati University through his research largely in the fields of settlement, urban and political geography. His far reaching academic contribution is also well reflected in a number of books authored by him in the field of biogeography and regional geography. A humble attempt is made here to present a brief academic and professional career of Prof. Bhattacharyya and his contributions to the field of geography education and research.

Keywords Professor Narendra Nath Bhattacharyya · His Life · Academic Career · Contributions · Geography of North-East India · India

2.1 Introduction

Professor Narendra Nath Bhattacharyya (Fig. 2.1) has been a well-known name in the geography fraternity of North-East India and other parts of the country. He is a distinguished geography teacher and researcher of great repute. He made a substantial contribution to promoting geography education and research during his more than four decades-long association as a teacher in the Department of Geography, Gauhati University. The research carried out by him and his research guidance and publications very well reflect his interest in the fields of settlement, urban, historical and political geography. Being one of his students in the mid-1980s, I came in close contact with him after I got the opportunity to join the department as a lecturer in 1993 when he was head of the department. With this long association, I hereby endeavour

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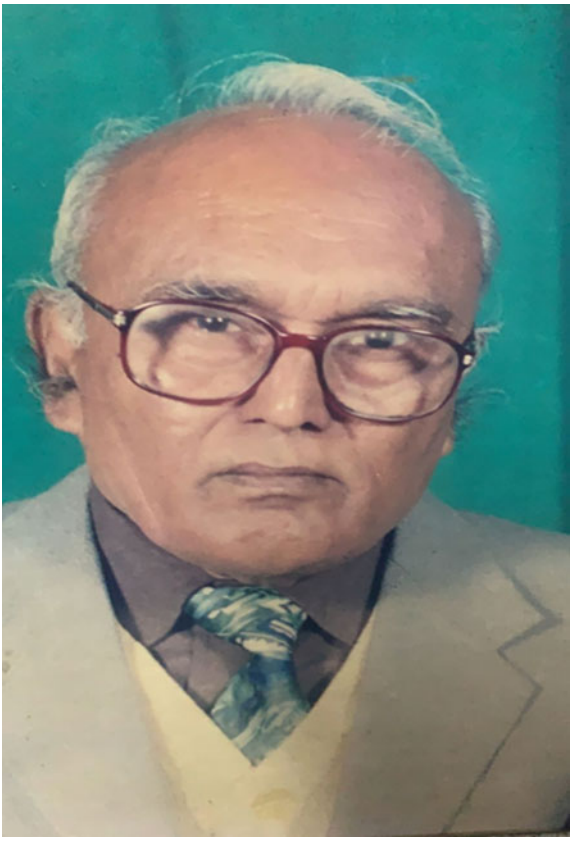

Fig. 2.1 Professor Narendra Nath Bhattacharyya. *Source* Capture by Author

to present a brief sketch of my respected teacher Professor Bhattacharyya's academic and professional career and contributions to geography, academics and society.

2.2 Childhood and Schooling

He was born in an impoverished family of an infamous small village named Ichadaghariya (a village originally settled with great desire by ten households mostly belonging to Brahmin community) in Pub Barigog Mouza near Rangia, Kamrup district of Assam on 21st January 1936. Professor N. N. Bhattacharyya spent his childhood in the village environment. He is his father's seventh child, late Rabi Nath Bhattacharyya and mother, late Ambika Devi. Professor Bhattacharyya started his education at Kaniha M. V. School and went to P. B. Kaniha venture high school with abysmal infrastructure. In 1953, after passing the class IX examination, he

moved to Guwahati and got admitted in class X at Kamrup Academy, where from he successfully passed his matriculation examination in 1954.

2.3 Higher Education and Academic Career

After matriculation, Professor Bhattacharyya started his further education in the science stream at Cotton College, Guwahati and passed I.Sc. Examination in 1956. He then got admitted at Gauhati University to pursue a B.Sc. course with Anthropology, Geology and Geography (Honours) and earned his B.Sc. degree with first-class first position in 1959. He then joined Master's course in geography at Gauhati University and came out successfully with first-class first position (Gold Medalist) in 1961. As per then provision, he prepared a dissertation on "A Study in Urban Geography of Gauhati Town" in place of a special paper "Cultural Landscape" as a part of his Master's course. With this work, he developed a keen interest in carrying out his further research in the field of urban geography. He had a stint of a school teaching career at Kaniha Barigog High School of Kamrup district in a regular post as a science teacher before his admission for post-graduation in Gauhati University.

2.4 Doctoral Research

Although Professor Bhattacharyya started doctoral research in Gauhati University in the early 1960s to work on the changing urban morphology of Gauhati city under the guidance of Professor H. P. Das, the founder head of the post-graduate department of geography, and later in Queen Mary College, University of London, under internationally renowned urban geographer Professor Arthur E. Smailes, he could not continue with his research work due to some personal constraints. However, the opportunity to interact with Professor Smailes in London had greatly helped him strengthen his conceptual understanding of conducting research in the field of urban geography later. Later on, he decided to pursue his doctoral research at Utkal University, Bhubaneswar, under the supervision of his then teacher-like colleague Professor D. K. Singh, who served in the Department of Geography, Gauhati University around during 1961–1973. Accordingly, he carried out his research work during 1973–1977 titled *Gauhati: A Study in Urban Morphology* (Bhattacharyya 1977b) and he was awarded the degree of Ph.D. from Utkal University in 1978. Apart from throwing the light on the growth and changing face of Gauhati city from a historical perspective, this comprehensive research work is largely devoted to understanding a number of dimensions of urban morphology through empirical data and analysis.

The entire research work has been presented altogether in eleven chapters covering 339 pages, including 26 tables, 34 figures and 11 plates. The overall structure and approach of the research work would be more clearly understood from the chapter plan as given below.

Chapter 1: Introduction: Aim and objectives of the study, Methods of morphological study, Organization of the Study

In this chapter: Historical background

Chapter 3: Geographical setting of the city

Chapter 4: Growth and changing face of Gauhati: Ahom, British and Post-Independence periods

Chapter 5: Morphology of the city today

Chapter 6: Urban morphology: Networks

Chapter 7: Urban morphology: Building fabrics, Housing and Residential structure

Chapter 8: Urban morphology: Shopping centres and Community facilities

Chapter 9: Urban morphology: Industrial landscape

Chapter 10: Land-use pattern and Urban communities Functional areas, City zones, Intensity of urban land-uses, Density of houses, Distribution of population, Movement of population within city limit

Chapter 11: Summary and Conclusion

The contribution of the whole research work may also be appreciated from the concluding remarks of Prof. Bhattacharyya, which goes like "The morphological analysis developed here opens a wide field of research in two lines. In the first place, it needs to be connected with a full investigation of the associated patterns of land use and building types in order to produce a complete interpretation of the urban landscape. Secondly, it could be extended to cover other towns of Assam and India under similar geographical conditions. Although Gauhati is a small provincial capital city in accordance with its function as a regional service centre, its long history has rendered the physical arrangement of its built up area more interesting. It also serves to demonstrate the morphological analysis in evolutionary lines. It is hoped that the study would stimulate the interest of urban geographers of this part of the country where the geographical inquiry of such problems is still at its preliminary stage" (Bhattacharyya 1977a, b: pp. 292–293).

2.5 Service Career

While he was doing doctoral research, Professor Bhattacharyya got appointed as a Lecturer in the Department of Geography, Gauhati University on 2nd January 1963. In fact, he was among the very few who got the opportunity of getting a direct appointment as a University teacher. Later, he got promoted to the post of Reader on 8th June 1981 and Professor on 14th October 1990. As he was not much involved in the organizational activities of various professional bodies of geographers in different parts of the country and outside, Professor Bhattacharyya devoted his maximum time to teaching and research in the department. During his more than three-decades-long illustrious teaching career in Gauhati University till his retirement on 31st October, 1997, Professor Bhattacharyya adorned the position of the Head of the Department from 1991–1994. As a senior faculty, he also served as

a member of the Gauhati University Court and Academic Council. During his long University career, he mainly used to teach Biogeography, Human Geography, History of Development of Geography, Settlement Geography, Urban Geography, Cultural Geography and Political Geography. After he retired from services, the University utilized his academic experience as a guest teacher for the benefit of the students and researchers in the department for about three years. Later, he also served as a visiting Professor of Geography at Manipur University for about three months.

2.6 Research Guidance

Professor Bhattacharyya started guiding research (both M.Phil. and Ph.D.) from 1982, after he got promoted to the post of Reader. Altogether fourteen Ph.D. and twelve M.Phil. students obtained their degrees under his supervision. Most of the research works guided by him have been associated with settlement and urban geography (7), political geography (4) and population and cultural geography (2).[1] Among the doctoral works he guided, the first two in 1989 are *Rural–Urban Interaction in the Brahmaputra Valley* by Sailendra Barthakur and *Rural–Urban Interaction and Pattern of Lingages in the Khasi-Jaintia Hills Area* by Kamal Kumar Jhunjhunwala. Both the scholars attempted to quantitatively assess the nature and degree of spatial interaction between rural and urban areas in the respective regions of Assam and Meghalaya, including the zones of urban influence.

The third doctoral research on *Post-Independence Rural Transformation Pattern in Darrang District* under his guidance was carried out by Charu Saharia Nath in 1991. This research work is primarily devoted towards understanding the causes, pace of transformation of rural landscape and emerging socio-economic development in the traditional agrarian society of Darrang district in the post-independence period.

Bhaben Chandra Kalita carried the fourth doctoral work under his supervision on *Administrative Systems of Karbi Anglong District, Assam and its Socio-Political Relevance from Karbi Perspective: A Politico-Geographical Analysis* in 1994. This work mainly focuses on the transformation of the administrative system in the Karbi Anglong district and the emerging socio-political transformation among the Karbis.

The fifth PhD work supervised by Professor Bhattacharyya is on *Spatial Organization of Settlements in Sipajhar Region of Darrang District, Assam,* as carried out by Jadav Chandra Nath in 1994. It intends to examine the nature of distribution of rural settlements in the study area and assess their impact on socio-economic development in the area.

Professor Bhattacharyya supervised the sixth PhD thesis on *Geopolitics of North-East India: A Strategical Study* carried out by Joysankar Hazarika in 1995. This work is broadly concerned with understanding the geopolitical significance of the north-east region and emerging boundary conflicts.

[1] The numbers in parenthesis include the number of scholars.

As guided by him, the seventh PhD thesis is on *Greater Guwahati: A Study of Urban Land Use Pattern.* Millie Kakati carried it out in 1995. This work is primarily devoted to understanding the prevailing spatial variation in the residential status of the city localities with respect to civic amenities, drainage condition and dwellers perception.

Mazibur Rahman carried out the eighth doctoral work under the guidance of Professor Bhattacharyya in 1997. The title of the thesis is *Settlement Pattern of Dhubri District: A Geographical Analysis.* This work is mainly devoted to understanding the origin, growth and distribution pattern of settlements in the district and their role in socio-economic development.

As guided by him, the ninth PhD work is on "*A Socio-Economic Study of the People of Darrang District, Assam: An Anthropogeographical Approach (A Case Study of Chapai Mauza).*" Tandrali Choudhury undertook it in 1997 with a co-guide Professor A. N. M. Irshad Ali from Anthropology. It basically examines the ethnic makeup and associated ethnic relations and demographic characteristics in the Chapai Mauza area.

Roselin Jahan carried out the tenth research work leading to a PhD degree under his supervision in 1999. The title of her research is *Socio-Economic Characteristics of the Muslims of Nagaon and Morigaon Districts: A Geographical Analysis.* This work is primarily devoted to understanding the growth and distribution patterns of the Muslim population and examining their demographic and socio-economic characteristics in the study area.

The eleventh doctoral work supervised by Professor Bhattacharyya is on *Housing Problem of Nalbari District: A Geographical Analysis.* Dibakar Sharma carried this research in 2002. This work explores the factors controlling housing conditions and assesses the prevailing household amenities in the densely populated Nalbari district.

Bhupendra Talukdar carried out the twelfth doctoral thesis under his guidance in 2005. The work title is *Electoral Politics and Voting Behaviour in Assam Legislative Assembly Elections, 1952–2001.* This work is mainly devoted to understanding the geopolitical setting of Assam and examining the people's voting behaviour concerning various socio-economic elements.

As guided by him, the thirteenth doctoral work was on *The Pattern and Problems of Road Transportation in the City of Guwahati: A Geographical Analysis.* Chayanika Sharma researched this topic in 2006. This work is primarily associated with understanding the growth of Guwahati city and the emerging problems of road transportation and its management.

The fourteenth doctoral work guided by him as a co-guide of Parbati Barthakur, a researcher from Political Science, is *The Bodo Tribal in the Changing Socio-Political Landscape of the Brahmaputra Valley: A Study in Political Geography.* It was carried out in 1997 with Professor Anuradha Dutta of Political Science as supervisor. This research examines the geographical and socio-political factors associated with a political uprising among the Bodo tribal groups in the Brahmaputra valley.

Besides the above doctoral works, Professor Bhattacharyya also supervised dissertations of twelve M.Phil. students in the Department of Geography, Gauhati University, during 1983–1998. Among these, six scholars researched in the field of settlement geography. They are—Rabindra Patowari (1983), Sailendra Barthakur (1983), Charu Saharia (1985), Hari Prasad Majumdar (1986), Keshab Chandra Nath (1986) and Surajit Barman (1990); while three worked in the field of population geography—Umesh Chandra Saharia (1993), Rani Devi Bora (1995) and Tosheswar Nath (1997); Bhaben Chandra Kalita (1984) worked in the field of political geography; Chayanika Sharma (1989) conducted her study in urban geography, and Kamaleswar Kalita (1998)[2] researched in one of the topics of industrial geography. All these studies carried out by twenty-six researchers under the supervision of Professor Bhattacharyya testify that he maintained consistency in his research, mainly in the fields of settlement, urban and political geography.

2.7 Publications

Professor Bhattacharyya has many publications to his credit, which can be found in the forms of journal research papers, chapters in edited books and other writings in reference books, textbooks and magazines. As already mentioned above, most of the research publications are related to settlement, urban and political geography, and these are primarily single authored. He, in fact, started publishing his research articles since the launch of the first issue of the *North-Eastern Geographer* in 1969, a research journal published by the North-East India Geographical Society, Gauhati University, Guwahati. He altogether published seventeen articles (including two co-authored) in this journal from 1969 to 1994 dealing with structure and characteristics of Indian towns (1969); urban morphology of Gauhati (1970); Kamrupa: A study in historical geography (co-authored with M. Taher) (1973); rural settlements in the Brahmaputra valley (1974); urban morphology of Mangaldai town (1976); measuring circularity in the shape of Gauhati urban agglomeration (1977a); population density gradient of Gauhati city (1978); central places of Darrang district (1979b); settlement systems of North-East India (1980); geopolitical setting of North-East India (1984) ; the geopolitical significance of McMahon line (co-authored with J. Das Chowdhury) (1989a); rural settlement system in Barpeta region (1985); settlements in North-East India; Geopolitics of North-East India (1989b); contemporary geopolitical problems of North-East India (1991); thrust areas of geographical research in North-East India (1993) and origin and growth of urbanization in India (1994). Among the other publications that appeared in different journals and edited books—linguistic and tribal regions of North-East India (1990); the growth and spatial structure of Gauhati city (1979a) and viability of the states of North-East India (1989a) are worth mentioning.

[2] The year in the parenthesis refers to the year the scholar accomplished their respective MPhil degrees.

During the post-retirement period, Professor Bhattacharyya ventured into the writing of books and accordingly contributed significantly in enriching the studies of the regional geography of North-East India and its different parts and biogeography by way of bringing out a number of textbooks published by the Rajesh Publications, New Delhi. These include *Biogeography* (2003); *North-East India: A Systematic Geography* (2005); under Land, People and Economy Series *Manipur* (2008), *Meghalaya* (2008) and *West Bengal* (2008); and *Assam: A Systematic Geography* (2011). He, along with Prof. D. K. Singh also authored a geography textbook entitled *Rudiments of Physical Geography* published by Kalyani Publishers, New Delhi (1984). Besides these, during the early stage of his teaching career, Professor Bhattacharyya authored a number of textbooks on geography for school and undergraduate courses of Assam in Assamese language. Moreover, after completing doctoral research, he authored a research-oriented book *Morphology of the Towns of Assam with Special Reference to the City of Gauhati: An Analytico-Synthetic Study* published by Mani Manik Prakash (1981).

Professor Bhattacharyya's contributions to academics and society may also be found in the forms of many popular articles in Assamese concerning the ancient geography of Assam, ancient rivers and hills of Assam, growth of Guwahati city, the emergence of regional politics, philosophies of Sankardeva, the importance of geography education, etc. in various magazines and newspapers like *Bijnan Jeuti, Bhougolika, Asom Bani and Dainik Asom.*

2.8 Organizational Linkages and Academic Activities

Since its inception as one of the founder life members, Professor Bhattacharyya has been very actively associated with the North-East India Geographical Society (NEIGS). He served NEIGS in various capacities for its growth and development as General Secretary (1973–74; 1977–78), Editor of North-Eastern Geographer (1977–1982) and President (1990–92). Besides attending many of its conferences held at different places of Assam, he also delivered lectures in the extension lecture programmes organized in different colleges and schools. Since its formation, he had also been associated with North-East India Council for Social Science Research (NEICSSR), Shillong, and served as Vice-President of the same. In addition, he almost regularly used to attend its annual national seminar held at Shillong.

2.9 Family Life

As a man of very simple living, Professor Bhattacharyya has a very pleasant and successful family life. He married Mrs Meera Bhattacharyya, who hailed from a highly educated Borthakur family of Jorhat, on 12th October 1969. Despite having a bright academic career, his wife joined a teaching job in a high school at Dalibari

Fig. 2.2 Professor Narendra Nath Bhattacharyya with his wife, Mrs Meera Bhattacharyya. *Source* Capture by Author

(around 6 km from Gauhati University) after their three children (Rituparna, Pranjal and Prantar) completed at least primary schooling. Mrs Bhattacharyya, who retired after serving the school as a very successful Head Mistress for about 22 years until January 2006, predeceased Professor Bhattacharyya on 24th February 2015 (Fig. 2.2). All the three children of Prof. Bhattacharyya family are highly educated and well established in their respective fields. The eldest child (daughter), Rituparna Bhattacharyya, who is a post-graduate in Geography from Banaras Hindu University, India, and earned her doctorate from Newcastle University, UK, is currently a Senior Fellow, Advance HE, UK and Editor-in-Chief (Joint), Space and Culture, India. She is a resident of Newcastle with her lead consultant microbiologist husband Dr. Jayanta Biswa Sarma and their two bright children (Maitreyee pursuing Masters in Physics at Imperial College, London and Dhritiman, in his year 13 at Kings Priory School, Tynemouth). The second child (son), Pranjal Bhattacharyya, who is a B.Tech. and Assistant Executive Engineer in PWD, Guwahati, has been a resident of Guwahati with his post-graduate wife Rupjita Bhattacharyya (Homemaker) and two Don Bosco School going children (Tanvi and Ritvik). The youngest child (son), Prantar Bhattacharyya, who is an LL.B. and Trial Court Advocate in Guwahati, has been staying at his parental house at Padumbari, Guwahati, with his ageing father and graduate wife Pallavi Bhattacharyya (Homemaker) and only primary school-going child (Animesh). In this way, Professor Bhattacharyya, 85 now, has been peacefully passing his retired life along with his children and grandchildren.

2.10 Conclusion

Professor Bhattacharyya has been very successful in his teaching and research career in geography at Gauhati University. In fact, he is well known as a very sincere and

devoted teacher among his many students. He has also made significant contribution to the growth and development of the discipline geography in the north-east region. The books authored by him after his retirement from services have proved to be highly useful to many college and university students.

We look forward to the continuance of his long, healthy and peaceful days ahead.

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Chapter 3
Just Transition, (Re)vision 2020—The Story Hitherto

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Abstract The cluster of the eight North-Eastern states, connected to the rest of India by only a narrow strip of land, regressed to a state of lost glory with the economy struggling to be at par with the other Indian states since independence. Constituting of 7.98% of the country's total geographical area, the region hosts 3.77% of its population. The North-East India despite being rich in resources, natural and human suffers from stunted development due to failure of proper implementation of programmes and poor governance. The region, characterized by diverse physiography and population, faces social, economic and political challenges. The North-Eastern Region Vision 2020 Document was designed by the Ministry of Development for the North-East Region and the North-Eastern Council and unveiled by the Government of India in 2008 to push the North-Eastern states towards prosperity and growth by identifying intervention areas and mechanisms for the development of the region. Development being the necessity should be sustainable. This chapter traces the transformations underwent in the region's social, structural, demographic and economic

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climate since the inception of the Vision Document through an assessment of the different components of the strategy proposed in the document. However, 2020 is already gone, and the ambition to achieve the challenges in just over a decade was perhaps overzealous. Using the notion of Just Transition, we call for a (re)vision of the vision's document with an achievable set target of 2070, in line with PM Modi's pledge of attaining carbon neutrality by 2070 in the COP26 summit in Glasgow so that the region transpires as avant-garde in Act East Policy. Alongside, this chapter also attempts to untangle the complexities and analyse the different indices and the coherence of development in the region with the SDGs. Arguably, achieving growth parity through sustainable development is crucial for North-East India, and the chapter focuses on evaluating the same.

Keywords Development · Just transition · North-East India · Parity · Sustainable

3.1 Introduction

North-East India, a mosaic of diverse cultures, traditions, languages and beliefs, and nested in the picturesque beauty of hills, valleys, clouds and rivers, has long remained an exotic gateway to many with its varied colours and contours (Pulla et al. 2020; Sultana et al. 2020). From being one of the most prosperous regions of India at the time of India's Independence, the North-East went from riches to rags, and despite the beauty, its struggle for prosperity continues even after seventy-five years of independence. The North-Eastern Region Vision 2020, which was released by the Government of India in July 2008, aimed at securing growth and development for the region through increasing regional engagement, ensuring self-governance, fostering peace and making North-East India a ground for promoting economic and commercial ties, and strategic and security cooperation through facilitating connectivity with the neighbouring nations. A rising global power that India is (Bhattacharyya 2017), India has actively pursued its foreign policy, bringing overwhelming attention to its domestic politics and pursuits. One of India's many notable endeavours concerning international relations is to advocate India's soft power through cultural diplomacy (Puthan 2020). But how does this relate with the NER Vision 2020, one may ask? The North-Eastern Region Vision 2020 document focused on extending historic cultural linkages and economic and strategic connectivity with the neighbours by roping in a North-East perspective of the Look East Policy, which is now known as Act East Policy (AEP) (Nath and Kumar 2017; Pulla et al. 2020a).[1] How far has the NER Vision document been successful? Applying the notion of 'Just Transition', is the question that this chapter seeks to answer.

[1] In 1991, along with the launch of the neoliberal reforms in the form of new economic reforms (Bhattacharyya 2009), the Look East Policy was launched in 1991 by Narsimha Rao government (1991–1996) aimed at building strategic and economic relations with the countries of East Asia including China. The strategies of this policy were built in such as way that while developing the relations with the countries of East Asia, the states of North-East India would witness development as the development initiatives would reopen or redevelop many roads and airports/aerodromes that were closed during World War II and /or in the aftermath of India's partition for trade and business (Nath and Kumar 2017; Pulla et al. 2020). This Look East Policy was renamed by the Modi government as Act East Policy since November 2014.

Just Transition is an approach aiming to accomplish a low carbon footprint economy. It subsumes 14 of the 17 Sustainable Development Goals (SDGs) but is explicitly interlinked with the goals associated with climate protection (SDG 13), affordable clean energy (SDG 7), decent work and economic growth (SDG 8), reduced inequalities (SDG 10) and poverty eradication (SDG 1) (Smith 2017;European Bank for Reconstruction and Development [EBRD], n.d.). This chapter uses Just Transition to untangle the complexities of the North-Eastern Region Vision 2020 (NER2020) document, which might help work towards an inclusive, greener economic development of NER, wherein the Act East Policy can perhaps emerge as a driving force of development via which all SDGs can be accomplished by 2070 alongside a net-zero carbon economy as envisaged in the COP 26 summit concluded at Glasgow, 2021.

The NER2020 document is a product of the Ministry of Development for the North-East Region (MoDONER) and the North-Eastern Council (NEC), the nodal agency for the economic and social development of the North-Eastern Region. The document consisting of three volumes was accepted and signed by all the members of the Council in the 56th Plenary session on 13 May 2008, at Agartala, Tripura, and was later launched by the former Prime Minister of India Manmohan Singh, in July 2008, at New Delhi. The NER2020 holds immense importance for the region as it has set targets, identified challenges and suggested implementation strategies for uplifting the various sectors of development in the region. This is for increasing opportunities and empowerment, for building the capacity of people and institutions, for ensuring peace, prosperity and security and for making it feasible for the North-East to take its deserved place in the Indian polity and economy (MoDONER 2008a). The document NER2020 is not just a set of new ideas and actions to be adopted but a thorough revisit to the past success and failures in governance, growth and development.

The Central Government and the Governments of the eight North-Eastern States have tried their best to transform the Vision Document into an actionable achievable plan. Yet, many contrasting opinions arose and still exists, making the NER Vision 2020 document debatable. On one hand, where the NER Vision 2020 document promised opulence and inclusiveness of the people and the region, on the other, plunged both into more restrictions, less freedom and increased grievances, a portion claimed. Duncan (2009, pp.313–314) has rightly revealed the contradictory politics of the NER Vision 2020 document:

> Yet, in practice, the political manifestations of increased regional engagement are contradictory. Each measure designed to break the region's isolation by connecting it with neighbouring countries is countered by measures to restrict connectivity; each new set of policies designed to boost the region's economies is implemented by maintaining the patronage of loyal elites in the region, and each new initiative to engender participation from civil society is carefully controlled. Not only does this underscore the extent to which counter-insurgency and the legacy of the Armed Forces Special Powers Act (1958) (AFSPA) are embedded in the mindset of the Indian state in imagining and governing the North-East, but the contradictory politics inherent in the implementation of this alleged new vision appear destined to exacerbate grievances among the peoples of the region (Duncan 2009, pp. 313–314).

The present chapter brings forth the different components adopted by the eight North-eastern states pursuant to the strategies propounded in the Vision document to comprehend the document's contradictory nature and acknowledge the developments achieved so far. Another critical facet this chapter tries to assess is the consonance of the developmental agendas incorporated in the NER Vision 2020 document with the Sustainable Development Goals, which along with the other United Nations Member States, was re-adopted by India on 25 September 2015, at the United Nations General Assembly (United Nations Development Programme [UNDP], n.d.) and application of the notion 'Just Transition'. Both these objectives are achieved by gauging the region's economic growth and economic development. Development is imperative for any state, and the development being sustainable and just, the present-day world's prerequisite.

The chapter has been divided into five sections. The first section gives a brief locational and demographic overview of the North-Eastern Region, the second deals with the strategy of the NER 2020, the third section is concerned with empowering of the people and institutions, the fourth with necessitating a hospitable environment of growth and the fifth part deals with economic growth and economic development, which is followed by the conclusion.

3.2 A Window to the North-East of Location and People

As already discussed in the introduction, the eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura together constitute North-East India, and this region extends to the north and east of the narrow 27 km wide Siliguri corridor. The locational extent of the region lies between 21.57° N and 29.30° N latitudes and between 88° E and 97.30° E longitudes (NEDFi Databank, n.d.). These eight states are spread over an area of 2,62,189 sq. km. (MoDONER, 2008b, p. 3), and has a population of 45.59 million, which is almost 3.77% of the country's total (Census of India 2011). Being the country's eastern-most edge, the North-East shares borders with many nations, including Bangladesh, Bhutan, China, Myanmar (Burma) and Nepal. China and Bhutan fall to the north of North-East India, Myanmar falls to the east, Nepal to the west and Bangladesh to the south and west of this Indian region (MoDONER 2008b, p. 3). Sharing 5182 km of border with these five nations, the region shares 99% of its total geographical boundary internationally (Krishnan and Panda 2019). It is thus more connected to the neighbours than to mainland India with the Siliguri corridor or the Chicken's Neck being the only tract of land, though narrow, physically connecting the North-East with the rest of the nation (Fig. 3.1).

This physical isolation from the mainland has given rise to deprivation, separatism, insurgency, racism, poverty, otherness, misperceptions, misgovernance, being a few of many (Bhattacharyya 2018; Duncan 2009; Pulla et al. 2020). These factors act together and not alone to pull North-East India further backwards in the path of

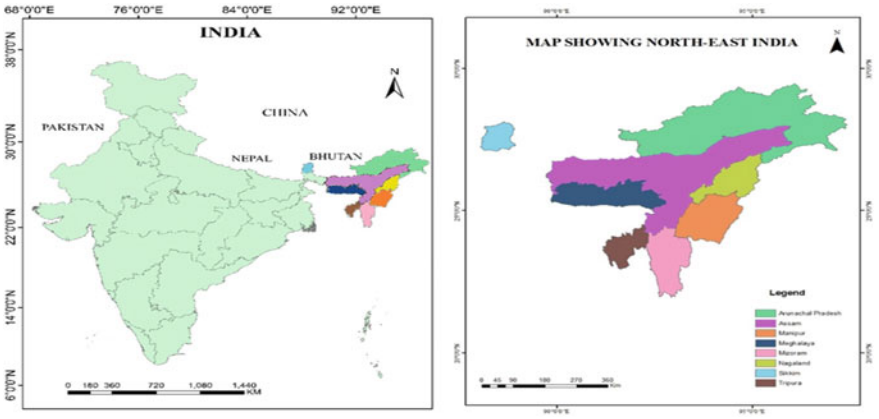

Fig. 3.1 Map of India highlighting North-East India

prosperity and people's perceptions. The NER2020 tried to address some of these issues by propelling growth through developmental strategies for the region.

2020 has been a year of fear, anxiety, loss, struggle and hope due to the outbreak of the COVID-19 pandemic that witnessed exacerbated incidences of racism against the North-easterners. Every day an incident being reported from any nook and corner of the 'mainstream' India where the people of North-East were hurled slurs and their 'Indianness' being mocked. This is because, for Indians from other parts of the country, the 'Indianness' is limited to certain facial phenotypes, food habits, cultures and traditions (Haokip 2020). Pulla et al. (2020) demonstrated the subtle forms of discrimination and racism faced by North-East Indians in the mainstream. Are the North-easterners less Indians? The answer is certainly 'No'.

North-East India is home to over 200 tribal communities out of the 635 in the country, with most residing in the hill states of Mizoram, Meghalaya, Nagaland and Arunachal Pradesh, where they constitute a majority of the population in each of these states (MoDONER 2008b, p. 5). Though the neat categorization of this ethnically diverse population is nearly not feasible, the Indian state has included the population under the three groups—Scheduled Tribes, Scheduled Caste and non-scheduled with the Scheduled Tribes falling under the Sixth Schedule of the Constitution of India, enjoy certain land, governance and security rights (Duncan 2009). The North-Eastern states have a preponderance of Scheduled Tribe population, with the state of Assam having the lowest (12.4%), while Mizoram has the highest (94.4%) and is followed by Nagaland (86.5%), Meghalaya (86.1%) and Arunachal Pradesh (68.8%). Tripura, Sikkim and Manipur have 31.8%, 33.8% and 35.1% of the total population as ST population, respectively (Census of India 2011). In addition, the North-East being ethnically diverse with tribal and non-tribal population, the region houses a linguistically diverse, religiously diverse and culturally diverse population. Diversity being different from plurality, the heterogeneity of the region's populace too gives rise to

intra- and inter-state security issues. The counter-insurgency measures have been advocated in the NER 2020.

The state of Assam has the highest population among the eight North-eastern states (Table 3.1). The decadal growth rate of population is the lowest for Nagaland, while it is the highest for Meghalaya, followed by Arunachal Pradesh and Mizoram. The decadal growth rate of population for these three states and Manipur is higher than the all India average. The region is predominantly rural, with more than 70% population of each state, except for Manipur and Mizoram, being rural residents (Census of India 2011). The urban percentage share of the total population is the least for Assam, while it is the highest for Mizoram, with more than half of the state's population being urban residents. The percentage share of urban population to total for the seven states excluding Mizoram is lower than that of India. The sex ratio among the eight North-eastern states is highest for Manipur, while it is the least for Sikkim. The region has a high literacy rate as compared to the national average. In the case of literacy rate for the eight states, the highest is for Mizoram (91.58%), while it is the lowest for Arunachal Pradesh (66.95%), Assam has aliteracy rate of 73.18% which is slightly lower than all India average(74.04%). (census of India 2011).

The region is resource-rich and is also identified as one of the world's biodiversity hotspots, but despite this richness, cultural and natural, the region is still to harness development, which formed the crux of the NER Vision 2020 document. The following section outlines strategies laid in the NER2020.

3.3 North-Eastern Region Vision 2020 (NER2020) Strategy

The North-Eastern Region Vision 2020 (NER2020) has mentioned four basic deficits concerning the development of the North-East, which have been identified by the High-Level Commission appointed by the Prime Minister in its report submitted in 1997. The deficits identified are:

1. A basic needs deficit
2. An infrastructure deficit
3. A resource deficit and
4. A two-way deficit of understanding with the rest of the country.

And to the above four deficits should be added the governance deficit (MoDONER 2008a, p. 16).

The NER2020 document is a framework for bringing North-East India at par with the other developed regions of the country with respect to economic, structural and social development by meeting these deficits, and planned to achieve the same through decentralized governance, participatory planning, structural transformation, poverty eradication, harnessing resources, building capacity in people and institutions, strengthening infrastructure, creating a conducive economic and commercial

Table 3.1 Demographic profile of the North-East India

States	Population (in lakh)		Decadal growth (in %)	Density (no. of persons per sq. km.)		Sex ratio (no. of females per 1000 males)		Urban population (in %)		Literacy rate
	2001	2011	2001–11	2001	2011	2001	2011	2001	2011	2011
Arunachal Pradesh	11.0	13.83	25.92	13	17	893	920	20.75	22.67	66.95
Assam	266.6	311.69	16.93	340	397	935	954	12.90	14.08	73.18
Manipur	22.9	27.22	18.65	103	122	974	987	25.11	30.21	79.85
Meghalaya	23.2	29.64	27.82	103	132	972	986	19.58	20.08	75.48
Mizoram	8.9	10.91	22.78	42	52	935	975	49.63	51.51	91.58
Nagaland	19.9	19.81	−0.47	120	119	900	931	17.23	28.97	80.11
Sikkim	5.4	6.08	12.36	76	86	875	889	11.07	24.97	82.20
Tripura	32.0	36.71	14.75	305	350	948	961	17.06	26.18	87.75
India	10,288.4	12,101.93	17.64	325	382	933	940	27.81	31.16	74.04

Source Census of India 2001 and 2011

environment and effective governance. The strategy propounded in the NER2020 can be summarized under six components (MoDONER 2008b, p. 11). These are:

1. Empowering people by maximizing self-governance and participatory development through grassroots planning, and creating a secure, responsive climate for economic development and ensuring a corruption-free administration.
2. Fostering rural development with a focus on improving agricultural productivity and growth and creating non-farm employment and economic opportunities.
3. Developing sectors that will bring about the welfare of the people through the optimal utilization of the region's resources.
4. Facilitating capacity development of the people and institutions of both public and private sectors to enhance economic productiveness and economic climate.
5. Creating a hospitable investment climate by providing state-of-the-art infrastructure, communication and intra- and inter-state and with the neighbours.
6. Generating public investment and resources and encouraging private participation, which is vital to the development and growth of the people and region.

These six components are needed to be realized to accelerate the developmental process in the North-eastern region.

3.4 Empowering of the People and Institutions—Inclusive Growth Through Inclusive Governance

The terms 'empowering of the people' and 'inclusive governance' are synonymous for achieving 'inclusive growth'. Inclusive growth refers to the growth in which the disadvantaged section of the population can improve their condition and exercise their rights. Suryanarayana (2008) has defined inclusive growth as the idea that the growth process being proposed or initiated benefits all the sections of the society, including the socio-economically weaker stratum who otherwise are devoid of participating in or benefitting from the growth process. The NER2020 document has identified a paradigm shift in developmental strategy, and achieving inclusive growth through inclusive governance is undoubtedly one of the most important components of this strategy, with self-governance forming the bedrock. The document (MoDONER 2008b) clearly states:

> The key component of our 'strategy of inclusive growth' must be inclusive governance as a means of empowering the disadvantaged with the aim of enabling them to overcome their poverty. It is effective empowerment of the disadvantaged through the effective devolution of functions, finances and functionaries to representative institutions of local self-government such as Panchayats (where Part IX of the Constitution applies) and Village Councils (VCs), Village Development Boards (VDBs) and similar institutions elsewhere, on the principle of subsidiarity, which states that anything which can be done at a lower level should be done at that level and no higher level, that will pave the way for the effective implementation of other measures of inclusive growth (p. 15).

The 73rd and 74th amendments to the Constitution of India are considered to be of historical significance as constitutional status was conferred to the local self-government institutions of rural and urban areas of the country. The Eleventh Schedule and the Twelfth Schedule to the Indian Constitution define these local self-governance institutions—panchayats and municipalities—and contain their powers, authority and responsibilities. The Panchayat Raj system comprehensively covers the states of Sikkim and Arunachal Pradesh. Panchayat Raj Institutions' three-tier system was established in Arunachal Pradesh through the NEFA Panchayat Raj Regulation, 1967, which came into effect from 2 October 1968 but was dissolved in 1997. The Panchayat Raj Institutions were later restored, and the first general elections to the Panchayat Raj Institutions under the new Act following the 73rd Amendment to the Constitution of India happened in 2003 (Arunachal Pradesh State Election Commission, n.d.). In Sikkim, a two-tier system of Panchayat Raj Institutions was established through the passing of the Sikkim Panchayat Act, 1993. Of the 185 Gram Panchayats, there are two traditional local self-governance institutions, known as Dzumsas, at Lachung and Lachen in North Sikkim (Indian Audit and Accounts Department, n.d.). Assam, Tripura and Manipur states have both Panchayat Raj and non-Panchayat Raj institutions (MoDONER 2008b, p. 18). In fact, Assam has been one of the pioneer Indian states to establish Panchayat Raj in the state enacting the Assam Rural Panchayat Act, 1948 (Panchayat and Rural Development, n.d.). The three states of Mizoram, Meghalaya and Nagaland have their own local system of self-governance. The Sixth Schedule contains provisions for the Administration of the Tribal Areas in Assam, Meghalaya, Tripura and Mizoram (George 2020). This devolution of power has strengthened democracy at the grassroots level by making governance and institutions more participatory, social and gender-inclusive and transparent (Table 3.2).

Table 3.2 State-wise number of Panchayati Raj Institutions and Urban Local Bodies

States	District panchayats	Intermediate panchayats	Village panchayats	No. of traditional bodies	Urban local bodies
Arunachal Pradesh	22	177	1785	N.A	19
Assam	26	191	2201	512	99
Manipur	6	N.A	161	3533	27
Meghalaya	N.A	N.A	N.A	6746	12
Mizoram	N.A	N.A	N.A	905	23
Nagaland	N.A	N.A	N.A	1250	32
Sikkim	4	N.A	185	N.A	7
Tripura	8	35	591	628	20

Source Basic Statistics of Panchayat Raj Institutions and CountryProfile 2019
Note N.A. = Not available

An Expert Group on Grassroots Level Planning constituted by the Ministry of Panchayati Raj which was headed by Shri V. Ramachandran, former Chief Secretary and Vice Chairman of the Planning Board of Kerala, demarcated six preconditions to strengthen the decentralization system and to ensure the benefits of the participatory planning be reaped by the people. Of the six preconditions, the first is concerned with activity mapping for the different levels of subsidiarity, the second with the engagement of all stakeholders, especially of the historically marginalized sections of the society, including women, in the process of participatory planning and its grassroots implementation. The third precondition dealt with the devolution of adequate funds in an untied manner so that the funds made available under the various schemes be allotted to the projects on a priority basis, whereas the fourth, fifth and sixth preconditions delineated by the Expert Group concentrated on granting more flexibility and autonomy, building capacity for financial functioning, and maintaining proper management and statistical information system for the local governance institutions to perform effectively(MoDONER 2008b, pp. 20–21). Based on these recommendations, the Planning Commission issued guidelines to the respective State Governments to facilitate an efficient bottom-up governance approach. The Ministry of Panchayati Raj too appointed another Expert Group on Planning under the Chairmanship of Shri V. Ramachandran for the areas covered by the Sixth Schedule (MoDONER 2008b, p. 22). Table 3.3 presents the number of Elected Representatives in different hierarchies of the Panchayat and Urban Local Bodies.

The local government institutions require funding to carry out adequate developmental activities in the region. However, these funding are released in an untied

Table 3.3 States/UTs wise numbers of elected total and women representatives

States	Elected representatives (ERs)						
	Gram panchayat		Block panchayat		District panchayat		Urban local bodies
	Total	Women	Total	Women	Total	Women	Women
Arunachal Pradesh	7416	2966	1785	625	182	67	N.A
Assam	24,200	12,100	2200	1100	420	210	N.A
Manipur	1663	836	0	0	60	32	149
Meghalaya	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Mizoram	3502	828	N.A	N.A	N.A	N.A	6
Nagaland	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Sikkim	986	493	N.A	N.A	110	55	N.A
Tripura	6111	2760	419	192	116	54	158

Source (i) Basic Statistics of Panchayat Raj Institutions (ii) Country Profile 2019
Note N.A. = Not available

Table 3.4 Aggregate grants to local bodies for 2020–21

States	Grants to rural local bodies (INR in million)	Grants to urban local bodies (INR in million)
Arunachal Pradesh	2310	1110
Assam	16,040	7720
Manipur	1770	850
Meghalaya	1820	880
Mizoram	930	450
Nagaland	1250	600
Sikkim	420	200
Tripura	1910	920

Source XV Finance Commission: Report for the year 2020–21

manner, wherein the available funds aid the local government institutions with financial freedom and encourage them to implement schemes for more participatory development (Table 3.4).

The Ministry of Panchayati Raj has been providing financial and programmatic support for strengthening the Panchayati Raj Institutions (PRIs) through capacity building of the elected representatives of the PRIs and the other stakeholders. The Rajiv Gandhi *Panchayat Sashaktikaran Abhiyaan* (RGPSA) was implemented during the period 2012–13 to 2015–16 by the Ministry to strengthen the system of Panchayati Raj throughout the country and to address the constraints that arise in the functioning of the Panchayati Raj Institutions. The Ministry too provided financial support to the states under Capacity Building-*Panchayat Sashaktikaran Abhiyan* (CB-PSA) for Capacity Building & Training (CB&T) in alignment with the Gram Panchayat Development Plan (GPDP) during 2016–17 and 2017–18. The *Rashtriya Gram Swaraj Abhiyan* (RGSA) is a Centrally Sponsored Scheme for strengthening the PRIs to achieve Sustainable Development Goals in convergence with Mission Antyodaya. Mission Antyodaya is a convergence and accountability framework espoused in the Union Budget 2017–18 aimed at obtaining optimal use and management of resources granted by 27 Ministries/Department of the Government of India under varied programmes meant for the development of rural areas. It is contemplated as a state-driven initiative deploying Gram Panchayats as central points of convergence efforts.[2] The period of its implementation is 01.04.2018 to 31.03.2022, and the scheme will have the convergence of Self-Help Groups and Panchayati Raj Institutions for better service delivery and effective community mobilization (Ministry of Panchayati Raj, 2019, p. 38).

The institutional framework includes local governance institutions, government agencies and departments, Self-Help Groups, Non-Governmental Organizations, Community-Based Organizations, etc. and the capacity building of these institutions

[2] Mission Antyodaya, Ministry of Rural Development, Government of India. https://missionantyodaya.nic.in/

requires proper planning, which will facilitate service delivery and accountability. Many schemes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme, Jawaharlal Nehru National Urban Renewal Mission (JNNURM), etc. are carried out by the local self-governance institutions. The SHGs and NGOs have been playing an expanding role in promoting rural productivity and human health and well-being. Social audit, National Panchayat Portal, IT-enabled planning, etc. are other adopted measures for enhancing capacity and supporting growth and development.

Along with institutional growth, there remains the necessity of individual growth. The growth of individuals should be inclusive. Inclusive growth facilitates the eradication of multidimensional poverty, inequality and deprivation. Poverty is experienced in various facets such as Economic Poverty, Nutritional Poverty, Human Poverty and Basic Amenities Poverty, and each type is interrelated with the other. The vesting of powers in the local self-government institutions did facilitate reducing poverty from the grassroots level in these eight Indian states. However, due to the ongoing pandemic, people have been again pushed back to the brink of extreme poverty (Bhattacharyya et al. 2020). Globally, 1.6 billion workers employed in the informal economy risked losing their livelihoods. In the second half of 2020, approximately 400 million employees across the globe lost their jobs.[3]Being Goal 1 of the Sustainable Development Goals (SDGs), removing poverty becomes one of the topmost criteria for every state to be achieved by 2030. The Sustainable Development Goals 1, 2, 3, 4, 5, 6, 7, 10, 11 and 16 work together to reduce and remove the different forms of poverty prevalent.

The NER2020 has identified a fivefold programme of development perspectives for the eradication of the various types of poverty, the five perspectives being (MoDONER 2008b):

1. Economic Development Perspectives (EDP)
2. Institutional Development Perspectives (IDP)
3. Participatory Development Perspectives (PDP)
4. Human Resource Development Perspectives (HRDP)
5. Infrastructure Development Perspectives (Infr. DP) (pp. 33–34).

3.4.1 Economic Development Perspectives (EDP)

This perspective of decelerating poverty anticipates the optimal use of resources, participatory growth, rural and agricultural development, market and sector development. The NER2020 identified critical areas of development for poverty reduction, and it included:

(a) Improvement in agriculture and allied activities:

[3] Goals 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. United Nations Department of Economic and Social Affairs Sustainable Development. https://sdgs.un.org/goals/goal8

It focused on increasing agricultural productivity through the cultivation of High Yielding Variety (HYV) crops and the facilitating of HYV seeds, it too aimed at replacing the traditional methods of agriculture with modern optimal methods. It focused on promoting horticulture, floriculture, organic farming, plantations, forestry and conservation and the gradual phasing out of jhum cultivation.

(b) Modernizing agriculture, market and rural economic development:

Modernizing agriculture involves mechanized farming practices, hybrid varieties of seeds, minor and major irrigation, farmer credit, crop insurance, etc. Market and rural economy development call for land reforms, rural credit and banking, agricultural extensions, proper forward and backward linkages, cold chain links and cold storages, export, fiscal incentives, etc. The rural economy development too includes the accelerated growth of non-farm engagements and the economy's secondary and tertiary sectors.

Arunachal Pradesh has set three objectives for developing agriculture and allied sectors. The objectives are (i) intensive agriculture for achieving high growth through raising productivity, (ii) horizontal and vertical expansion of cropping system with a focus on small and marginal farmers as well as women and (iii) agricultural sustainability through crop diversification which shall also include livestock and fishery development. These three objectives shall help double the farmers' income by 2022. The state has also launched CM *SashaktKishan Yojana* to focus on cash crops and to expand areas under kiwi, cardamom, orange, walnut, apple, off-season vegetables, etc. cultivation. The state has also enhanced farm power availability from 0.40 KW/Ha to 0.49 KW/Ha through Agriculture Farm Mechanization Programme, and nearly 1700 Hectares of land has been brought under sprinkler and drip irrigation. Arunachal Pradesh also has 50 Farmer Producer Organizations (FPOs) with 7500 farmers under it and has generated and issued 50,000 Soil Health Cards. The state has also allocated INR 300million in the budget 2020–21 for cluster-based intensive horticultural activities. A Mega Food Park is also coming up in the state, and Kisan Melas will also be held every quarter to showcase products and technologies (Government of Arunachal Pradesh, 2020).

The Assam State Government has adopted several schemes for increased agricultural productivity and doubling the farmers' income. 25,27,830 Soil Health Cards were issued during the Financial Year 2019–20. Under the Chief Minister's *SamagraGramyaUnnayan Yojana* (CMSGUY), 11,462 tractors with a capital subsidy of INR 7010 million has been distributed among 2,24,470 farmers. Demonstrations on 'Zero Tillage Potato Farming' using potato planters and potato harvesters are being delivered for the benefit of the state's farmers under the World Bank funded 'Assam Project on Agribusiness and Rural Transformation' (APART). The state has also instituted Town Milk Supply Schemes in Khanapara and has proposed for the same in Lakhimpur, Dibrugarh, Silchar and Tezpur. The proposed AssamDHENU, which

is a composite of multiple suits of application for digital accessibility to operational and monitoring aspects of the Animal Husbandry and Veterinary Department, is another step forward (Government of Assam 2020).

Manipur has received the Krishi Karman award on 02 January 2020 for the highest food grain production under Category-III. The state has also introduced a scheme, 'Cultivation of horticulture crops as an alternative to poppy cultivation' to provide farmers engaged in poppy cultivation with an alternative source. A Mega Food Park is also to be established in the state (Government of Manipur 2020).

The Government of Meghalaya has initiated Mushroom Mission, Lakadong Mission, Milk Mission, Aquaculture Mission, Jackfruit Mission, Megh-Aroma Mission, etc. for the growth of agriculture and allied sector (Government of Meghalaya 2020).

In the budget 2020–21, Mizoram allocated INR 27,908.3 million for the Economic Services Sector, including agriculture and allied services, rural development, irrigation and flood control (Government of Mizoram 2020).

Chief Minister's *FasalBima Yojana*, Chief Minister's Assured Irrigation Programme, Mission Organic Value Chain Development for North-East Region (MOVCDNER), etc. are schemes adopted by the Tripura Government aimed at facilitating economic prosperity through the primary sector of the economy (Government of Tripura 2020).

It is arguable that North-East India is primarily agriculture driven, and therefore, it becomes necessary to achieve agricultural prosperity in the region and thus economic development.

3.4.2 Institutional Development Perspectives (IDP)

The Institutional Development Perspective focuses on developing and reviving institutional infrastructure. Rigid, advanced and effective institutional infrastructure plays a significant role in addressing poverty and uplifting the region. The institutional infrastructure development involves transparent, inclusive and effective local self-governance bodies, government agencies, research and development and extension bodies, civil societies, traditional bodies, etc.

Arunachal Pradesh has taken up steps for an efficient administration, effective rolling out and enhanced monitoring of schemes and a bottom-up development approach. The State Government has launched a flagship scheme, *Sarkar AapkeDwar*, to provide governance services at the people's doorsteps residing in even remotest areas. The Arunachal Monitoring Portal has been developed by the State Government for geo-tagging of projects for effective implementation and eliminating loopholes such as duplicity. The state has received the India Geo Spatial Excellence 2019 Award for implementing this project. The extensive use of Information Technology through developing or introducing of applications like Arunachal e-Services, e-Inner Line Permit (e-ILP), CM Helpline, e-Office, e-Cabinet, Secretariat Wi-Fi, *Jeevan Pramaan*, Centralized Public Grievances Redress and Monitoring System

(CPGRAMS), National Scholarship Portal (NSP) Arunachal, e-Vidhan, etc. have been undertaken by the State of Arunachal Pradesh to address the grievances of the citizens and deliver services. Schemes as *MukhyamantriRogi Kalyan Kosh* were launched to provide decision-making and fund allocation in a decentralized manner and also help the institutional strengthening process (Government of Arunachal Pradesh 2020).

One-time Establishment Grant for *Gaon Burahs*, revamping Anganwadi Centre, *Orunodoi*, etc. are certain schemes of Assam Government for institutional development. INR 28,000 million has been allocated for Governance delivery and poverty alleviation through the *Orunodoi* scheme. This scheme facilitates a minimum guarantee of nutrition and health to the poorest through a Direct Benefit Transfer of INR 10,000 annually to 2.7 million poor households in the state. A revolving fund of INR 25,000and INR 10,000 for female Self-Help Groups (SHGs), INR 50,000 to each SHGs availing/eligible to avail bank loans and scooties for*JeevikaSakhis* along with the monthly allowance of INR 500 is made available through the *VistaritaKanaklataMahilaSabalikaranAsoni*(Government of Assam 2020).

The Meghalaya Government has strengthened decentralized governance through institutionalization of the village employment councils to deliver development and large projects. In addition, there is the Social Audit Act on transparency, and Meghalaya is the first state in the country to pass a social audit legislation to control irregularities(Government of Meghalaya 2020).

Nagaland was ranked first among the North-East and Hill State category in the State Services Portal Assessment in 2019 due to adoption of good practices such as digital signature, online payment facility, single payment gateway for all channels, seamless integration of portals with social media applications, online submission of forms, applications for citizen services and online payment for services which are availed through mobile devices, etc. (Government of Nagaland 2020).

Tripura has proposed a Centre for Good Governance in State Institute of Public Administration and Rural Development (SIPARD) to improve the standard of governance in the state and to undertake governance reforms by bringing together knowledge, soft skills, technology and people of the state (Government of Tripura 2020).

The institutional framework is vital for any state, and improving its functioning through schemes, programmes and projects become crucial to development.

3.4.3 Participatory Development Perspectives (PDP)

Participatory Development Perspective requires social or community mobilization and proper planning and adoption of Management Information and Digital Information Systems. This perspective depends on creative and collaborative partnerships between and among civil societies, target groups, stakeholders and grassroots institutions to induct people into the planning and implementation process in this participatory mode of reducing poverty.

A community-based organization, the Nyishi Elite Society, adopting Government schools in Arunachal Pradesh is an example of participatory development (Government of Arunachal Pradesh 2020). A Mega Awareness Drive against Social Evils to be launched by Assam Science Technology and Environment Council, and many such schemes adopted by the Government of Assam and the recognition and award of grants to tribal communities facilitate participatory development (Government of Assam 2020). The Department of School Education in Nagaland has taken up several innovative participatory development measures; one such step is to revive the old culture and traditional values and improve the quality of learning through Morung traditional methods through collaboration with NGOs in Tuensang and Longleng districts (Government of Nagaland 2020).

Citizen participation is mandatory for the establishment of good governance in a state. The civil societies and all the stakeholders play a greater role in making the region prosper.

3.4.4 Human Resource Development Perspectives (HRDP)

This perspective is associated with creating human capital to increase human lives' productivity, opportunity, dignity and security. The creation of human capital is feasible by providing quality education, health care, improving access, improving facilities, encouraging art and culture, sports and cocurricular, developing skills and providing all the basic amenities.

The Chief Ministers *Samast Shiksha Yojana* has been launched in the state of Arunachal Pradesh with the aim to provide decentralized resources at the district level for the facilitation of education sector schemes. The Chief Minister Arogya Arunachal Yojana (CMAAY) has 82,000 families enrolled, and the CM Free Chemotherapy Scheme has provided benefits to around 1500 beneficiaries in Arunachal. The DeenDayal Upadhyay Swavalamban Yojana has been successfully launched in the state for the economic engagement of the youths. Arunachal Pradesh Social Entrepreneurship Meet 2020 was organized in the state to help promote a business-friendly environment (Government of Arunachal Pradesh 2020).

Pragyan Bharati, *YuvaArohan*, *SonaliShaishab*, *Rupali Pathsala*, Assam Cancer Care Foundation, partnerships with reputed private hospitals to provide Newborn Intensive Care Unit (NICU) and Paediatric Intensive Care Unit (PICU) services are few schemes of the Government of Assam and also the redesigning of 'Swami Vivekananda Youth Empowerment Yojana' and the setting up of the Skill, Employment and Entrepreneurship Department (SEED), all these together contribute to the Human Resource Development Perspective (Government of Assam 2020).

The 'Go to School' Mission (School Phagathansi Programme) is an initiative of the Government of Manipur and aims to provide quality education in government schools through quality teaching and quality infrastructure. Manipur had a budgetary allocation of INR 8460million for medical, health and family welfare services. In the state of Manipur, skill development has been taken up under schemes as Pradhan

Mantri Kaushal Vikas Yojana (PMKVY), Skills Acquisition and Knowledge Awareness for Livelihood Promotion (SANKALP) and Skill Strengthening for Industrial Value Enhancement (STRIVE) (Government of Manipur 2020).

Major investments in the secondary sector of education in the state of Meghalaya are made through the Asian Development Bank (ABD) funded project 'Supporting Human Capital Development in Meghalaya'. The Government has established the Enterprise Facilitation Centres (EFCs) in all the blocks where some form of enterprise facilitation is provided. The Government of the state has also recently approved the Free Drugs Policy, under which 76 essential drugs will be provided free of cost to patients in Government healthcare facilities (Government of Meghalaya 2020).

To ensure that the Mizoram State Healthcare Scheme subscribers receive timely reimbursement of their medical expenses, the Mizoram State Government has allocated a sum of INR 2,00million under Mizoram State Healthcare Scheme (Government of Mizoram 2020).

The Department of Youth Resource and Sports of the State of Nagaland will be taking up a programme 'Career Guidance and Employability Skills Development Program' to create career awareness among 2000 students and help them make informed decisions about their future through choosing the right career choices. The Department of School Education has started the Chief Minister's Meritorious Students Fellowship Programme (CMMSF), and awards have been given to 50 meritorious students amounting to INR 50,000 per student per annum. (Government of Nagaland 2020).

Sikkim proposed Sikkim Education Reforms Commission's appointment to bring together experts and stakeholders to draw a comprehensive education policy. The state has also created a Higher Exposure and Skill Rebuilding Fund (HESRF) for teachers training to make teaching–learning go beyond traditional methods. Young Professional Programme, Traffic Management Study, etc. are specific other schemes adopted for human development in the state (Government of Sikkim 2020).

In the state of Tripura, schemes as Tripura Beti Bachao Beti Padao Abhiyan, Chief Minister's *Poshan Abhiyan*, Tripura Menstrual Hygiene Scheme, MukhyamantriMatrupushtiUphar, Skills Acquisition and Knowledge Awareness for Livelihood Programme (SANKALP), etc. are adopted for facilitating human resource development in the region (Government of Tripura 2020).

A state can prosper only when its citizens do, and therefore, developing human resources becomes one of the primary objectives to be achieved in the path of growth.

3.4.5 Infrastructure Development Perspectives (Infr. DP)

This poverty reduction perspective encourages the development of infrastructure such as road connectivity, rail connectivity, air connectivity, cyber and telecom connectivity, inland waterways, power, etc. as infrastructure forms the backbone of any developmental activity. The improved infrastructure reduces the socio-spatial inequalities, thereby diminishing poverty in the region.

In the state of Arunachal Pradesh under the Pradhan Mantri Gram Sadak Yojana (PMGSY)-II, 80 road works for the upgradation of 550 km of road has been cleared by the Ministry of Rural Development. Under the 'Chief Minister's Comprehensive State Road Development Plan 2019–24', the State Government has already approved projects for the improvement of 100 km of Capital Complex Road, 252 km of district headquarter roads, 324 km of road connecting ADC/SDO headquarter to MDR standard (Government of Arunachal Pradesh 2020). The Airports Authority of India has started constructing a Greenfield Airport at Hollongi, 15 kms from Itanagar (Singh 2020). The Building Infrastructure Development Plan 2019–24 was announced in 2019 to replace the old semi-permanent type of building (Government of Arunachal Pradesh 2020).

The Government of Assam under the Asom Mala Scheme has been working for the transformation of 57,617 km of State highways and Major district and other roads. Under the Uttoron scheme, INR 3000 million has been earmarked for Signature Projects of infrastructure development by the State Government (Government of Assam 2020).

In Manipur, the construction of the Imphal Ring Road through Externally Aided Project (EAP) funding is proposed (Government of Manipur 2020).

In the state of Meghalaya, planning process has been started for the World Bank aided 'Meghalaya Integrated Transport Sector' Project (Government of Meghalaya, 2020).

Infrastructure is the base of development of any region. Having good, improved and scientific infrastructure is vital as having effective institutions and resources, human and natural. Moreover, increased pace of Information Technology (IT) usage and growth of IT infrastructure is observed in all these eight states.

3.5 Creating a Hospitable Climate- Economic, Political, and Transnational

All the developmental strategies require resources capital resources, human resources, natural resources, technological resources, etc. and the security of these resources. This section delves into the economic resources required for carrying out the developmental activities, the necessity of securing infrastructural resources and the role of AEP in the investment climate of the North-Eastern region aimed at attaining both sustainability and climate action to prevent any severe climate-related disasters while sticking to low/net-zero carbon goals. Investments are the precondition for any infrastructural or economic development and are generally public, private or both. The public finance sources can be seen in budgetary contributions, including State's own revenues, Central transfers, capital receipts, fiscal balances, etc. But the major contribution to the development of the North-Eastern Region is sought through boosting up the market-economy, that is, the private investments (MoDONER 2008b, pp. 245–252). An increase of private investments in the region is seen as a way of

upscaling the economy of the region, but this also necessitates securing the economic and political environments in and around the region (MoDONER 2008b, p. 261) and possibly promulgating a carbon budget legislation by the state governments of North-East India and the Central Government. However, simply, implementing a carbon budget law is not enough, the government has to simultaneously develop alternative ways/infrastucture of attaining carbon netural sustainable development. At the same time, increased private investments can be enabled through providing subsidies and incentives, less government interference in the market-based economy, flexible import and export laws, accessible credit facilities, tax holidays, foreign direct investments, improved infrastructure, supportive land policies and environment policies, secure political and economic climate, etc. Much private investment is sought through the Public–Private Partnership (PPP) model, which involves economic collaboration between government agencies and private sector companies to provide public assets and/or services. The Indian Government is giving increased importance to the various modes of the PPP models for large-scale government projects. The private investments for these projects can be sourced from domestic and international markets as well (Krishna 2010).

With increasing importance to private investments to advance the region's economy, increasing steps for ensuring a secure economic environment is necessary. North-East India has been a hotbed of insurgency and, together with poverty, forms a vicious cycle that deters the developmental process in the region (Bhattacharyya 2018; Duncan 2009). India being a growing soft power (Bhattacharyya 2017) has increased its political and economic cooperation with its neighbours by being part of international bodies as the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), ASEAN Regional Forum - The Association of Southeast Asian Nations, BRICS and rest for encouraging mutual development and benefits. As already outlined above, the AEP plays a vital role for the North-Eastern region as it seeks to enhance the international cooperation of India with the neighbouring nations of the North-East, which will help in uplifting the region. North-East India has much strategic significance, with it being culturally aligned to a greater extent with the neighbours than mainstream India. However, Duncan (2009) has criticized the NER2020 document as being no different from the otherwise dormant 'Look East' foreign policy of 1991, which intended to expand India's economic and political relations with Southeast Asia and China. Duncan (2009) also talked about the contradictory politics of counter-insurgency, of increased regional engagement and development still controlled by the centre as observed in the NER2020 where the contradictoriness is manifested in six ways which include the trans-nationalizing of counter-insurgency, the fencing of opened borders, the fear of connectivity, the centre-state patronage, the significant development and the restriction of the public sphere. But despite these paradoxes, the AEP, which facilitates both the Look East Policy and the NER2020 in their objectives, has gone well beyond India's actively pursuing foreign relations. Sajjanhar (2016) talks about how the AEP has facilitated trade climate for India:

> Bilateral trade between India and ASEAN grew from $3 billion in the early '90s to $12 billion in 2003, and to $79.3 billion by 2012. Since then, however, economic engagement between India and ASEAN countries has languished, in part due to the continuing international financial and economic crisis, and the subsequent Eurozone sovereign debt crisis.
>
> But with the introduction of the AEP, India's multidimensional ties with ASEAN have been given greater vigour and dynamism. This is especially important in a context of rapidly changing geopolitical realities, defined by the assertive rise of China. So far, AEP-driven changes and progress have been eightfold (para. 4–5).

Barua (2020) suggests the adoption of LEP in 1991 as mirroring the domestic economic transition to a progressive greater economy. As the LEP upgraded to a more pro-active AEP in 2014, because of its strategic location, the development of North-East India became more crucial to harvest the benefits of the economic, strategic and cultural linkages with the Asia–Pacific region fostered byAct East Policy. To achieve the foreign policy objectives, various bilateral, multilateral and regional plans have been charted to develop and strengthen the connectivity of India with that of the Southeast Asian countries through culture, commerce, connectivity and capacity building (Singh 2020; Kesavan 2020). Since, the economic liberalization in 1991 economic growth and development has been imbricated with the development of connectivity infrastructure in the country. Infrastructural connectivity has always been a catalyst for development, and the development of the same in the North-eastern region has been integral to enhanced trade, economic and strategic relationships with the ASEAN countries (Barua 2020). AEP has welcomed industrial investors and traders from within and outside for the region's growth. Several initiatives have been undertaken to enhance global connectivity with North-East India. The Kaladan Multimodal Transport Project is a multimodal platform connecting Sittwe Port in Myanmar with the India–Myanmar border for cargo shipments from the eastern ports to Myanmar to North-East India (Barua 2020). The 'India Myanmar Thailand Trilateral (IMT) Highway' project, which is currently under construction, will link Moreh in the North-Eastern state of Manipur with Mae Sot in Thailand via Myanmar. India is undertaking the construction of two sections of the Trilateral Highway in Myanmar, including the construction of 120.74 km Kalewa-Yagyi road section and the construction of sixty-nine bridges along with the approach road on the 149.70 km Tamu-Kyigone-Kalewa (TKK) road section. Bangladesh has recently shown interest to join the IMT Trilateral Highway to boost connectivity with South East Asia (Anand 2020; Chaudhury 2020a). A total of 740 km of existing highways in the North-Eastern states of Assam, Meghalaya, Nagaland and Manipur, which connects the towns of Dawki, Shillong, Jorabat, Nagaon, Dimapur, Kohima, Imphal and Moreh, have become part of routes AHI and AH2 of Asian Highways (Barua 2020; United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP] 2003, p. 42). The signing of the Border Trade Agreement (BTA) between the Government of India and the Government of Myanmar in1994 initiated the agreement of opening up four border trade zones along the Indo-Myanmar border, namely Moreh-Tamu, Zokhawthar-Rih, Longwa in Nagaland and Pangsau Pass in Arunachal Pradesh. Of the four, only Moreh-Tamu and Zokhawthar-Rih have become functional (Sangpui et al. 2020). The Government of Arunachal

Pradesh constitutes a committee to examine and prepare a report on the feasibility of reviving the Stilwell Road connecting the state with the neighbouring nation of Myanmar through Nampong and submitting the same to the Government of India (Government of Arunachal Pradesh 2020). Besides strengthening the road connectivity, stress is also laid on air, water and rail connectivity. The NEC has funded upgradation of infrastructure in 12 operational airports in the North-Eastern region in 2017 (Outlook 2017), and the Central Government's ambitious airport modernization project is expected to be completed by 2022–23, under which four airports were selected in the North-east for a facelift and several greenfield airports are on the way (Deol and Mohan 2021). The Ministry of Civil Aviation has identified 24 routes under the UDAN 4.0 scheme (Ministry of Civil Aviation 2021). The Agartala-Akhaura Rail Link connecting Tripura, India, with Akhaura, Bangladesh, which will be completed by 2021, would pave the way for the first train to run between north-East India and Bangladesh (Ali 2020). Development of waterways ultimately secures the path of economic development and improves the relationship of North-East India with ASEAN countries. An inland water transit and trade protocol 'Indo-Bangladesh Protocol on Inland Water Transit and Trade' exists between India and Bangladesh under which inland vessels of either country can transit through the specified routes of the other country (Assam Inland Water Transport Development Society, n.d.).

The 111-km long Jiriram-Imphal railway project, which is currently under construction at a pier height of 141 m, will further stimulate rail connectivity in the region.[4] The recently inaugurated Maitri Setu connecting Sabroom in South Tripura to Ramgarh in Bangladesh would be a critical link between the neighbours and help boost connectivity in the Indo-Pacific region and thus increase trade (Gupta 2021). The development of global and domestic connectivity to the North-Eastern region will attract investments, industries and traders and help explore the resources that will ultimately result in the development of these states. On the political side, 'Act East Policy' has borne fruit with excellent relations between India and several East Asian countries, notably Japan, South Korea and Taiwan. India has strengthened its ties with these countries over democratic and human rights. Japan and South Korea are two central pillars in India's Act East Policy, and Japan has agreed to extend US$ 33.5 billion public and private investments in India, with around investment of INR 130,000 million in several ongoing and new projects in North-East India (Kesavan 2020; Singh 2019). India has signed a free trade agreement with Sri Lanka (Taneja and Bimal 2020) and a trilateral maritime dialogue with Sri Lanka and the Maldives (Chaudhury 2020b). As evident from this discussion, through facilitating more connectivity with its neighbours despite the temporary setbacks with the bilateral or multilateral projects, India is gradually improving its economic, strategic and cultural ties with the countries of the Asia–Pacific region.

It is reckoned that the AEP will boost the region's economy by escalating connectivity and cooperation with the neighbours that the region shares border with irrespective of the contradiction and convolution that the NER Vision 2020 has unfolded

[4] Jiriram-Imphal project: Know about world's tallest railway bridge in Manipur. *ABP News*. https://www.youtube.com/watch?v=yFPg2Jrxm5U.

to possess. The cultural and the security dimension and the economic developments work to benefit the North-East.

3.6 Just Transition, Economic Growth and Economic Development: NER2020

The NER Vision 2020 document laid emphasis on achieving the six components of the developmental strategy to accelerate economic growth and development for the region. The most important question that arises is how far the components of the NER2020 have been achieved. The answer to this is through analysing economic growth and development indicators. Economic growth refers to an increased economic capacity of a state to produce goods and services compared to one period of time, while economic development indicates the qualitative improvement in the economic progress of the state (IAS Gateway 2019). Todaro and Smith (2011) have aptly defined development as:

> Development must therefore be conceived of as a multidimensional process involving major changes in social structures, popular attitudes and national institutions, as well as the acceleration of economic growth, the reduction of inequality and the eradication of poverty. Development, in its essence, must represent the whole gamut of change by which an entire social system, tuned to the diverse basic needs and evolving aspirations of individuals and social groups within that system, moves away from a condition of life widely perceived as unsatisfactory towards a situation or condition of life regarded as materially and spiritually better (p. 16).

Both economic growth and development are indispensable for a country. The indicators as Gross Domestic Product (GDP), Gross National Product (GNP), per capita Net Domestic Product (NDP), etc. are used as measures for economic growth, whereas for economic development, the indicators being used are Human Development Index (HDI), Multidimensional Poverty Index (MPI), Gender Inequality Index (GII), Infant Mortality Rate, literacy rate, etc. For evaluating the success of the strategy propounded by the NER2020, the economic growth is assessed through the Gross State Domestic Product (GSDP) (Table 3.5) and the economic development is assessed through the Multidimensional Poverty Index (MPI) found out for the region in the different works as well as the SDG Index Score for the eight North-Eastern states (Table 3.7).

As already discussed above, the Gross Domestic Product of any state or country is an essential indicator of economic growth for that state, country or region. As evident from Table 3.5, the growth rate of the Gross State Domestic Product for Assam, Meghalaya, Nagaland and Tripura is higher than the GDP growth rate for entire India for the financial year 2018–19 at Constant Prices. On the other hand, the lowest growth rate of GSDP at constant prices is recorded for the state of Mizoram. The inter-state differences in the growth rate of GSDP as observed are attributed to factors as more dependence on the primary sector, public resources, etc. The share of these eight states in the country's GDP at current prices for 2018–19 lies in the range

Table 3.5 Gross state domestic product for North-East India: 2018–19

State	2018–19		Growth rate of GSDP at (2011–12) Prices (%)
	GSDP at Current Price (INR in million)	GSDP at constant (2011–12) prices (INR in million)	
Arunachal Pradesh	246,028.8	166,759.5	4.59
Assam	3,158,812.1	2,340,479	6.42
Manipur	278,687.1	193,004.1	2.93
Meghalaya	334,806.4	246,819.6	9.38
Mizoram	195,199.1	145,243.9	1.92
Nagaland	272,830.4	176,473.6	7.05
Sikkim	287,234.4	187,222.7	5.94
Tripura	498,454.7	369,627.8	9.96
All India	189,712,370	139,814,260	6.12

Source (i) Handbook of Statistics on Indian States 2019–20, Reserve Bank of India
(ii) Handbook of Statistics on the Indian Economy 2019–20, Reserve Bank of India

0.104–1.67%, with Mizoram having the lowest share and Assam the highest. The percentage share of the six other states is 0.26% (Tripura), 0.18% (Meghalaya), 0.13% (Sikkim), 0.14% (Manipur), 0.13% (Nagaland) and 0.12% (Arunachal Pradesh). The highest share among all the Indian States and Union Territories is Maharashtra (14.58%). Assam occupies the 17th rank, followed by Tripura, which occupies the 24th rank with respect to the share of GSDP in the GDP of India. The other six North-eastern states occupy the lowest rank among all the Indian States and UTs (Handbook of Statistics on Indian States 2019–20; Handbook of Statistics on the Indian Economy 2019–20; Statistics Times, n.d.).

For the state of Arunachal Pradesh, the GSDP at Current Prices as projected for the financial year 2020–21 is INR 299,740 million (Department of Finance, Planning & Investment 2020).The GSDP at Current Prices of Assam for 2020–21 is projected to be INR 4,08,6270 million, a 12.4% increase over the revised estimate for the financial year 2019–20 (Vaishnav, 2020). The GSDP of Manipur, Meghalaya and Nagaland estimated for the financial year 2020–21 is INR 335,696.7 million (Government of Manipur, 2020), INR 430,041.2 million (Government of Meghalaya, 2018–19) and INR 283,500 million (Govt. of Nagaland, 2021) at Current Prices, respectively. The GSDP for 2020–21 for Mizoram, which is estimated to be INR 312,405.6 million at Current Price, has a growth rate of 17.61%, which is slightly lower against the previous year's GSDP growth rate of 19.44% (Government. of Mizoram, 2020). Sikkim for the financial year 2018–19 recorded a growth rate of 10.60 per cent at Current Prices and 13.13 per cent for 2019–20. For Tripura, the growth rate of GSDP at Current Prices for 2018–19 is 14.02% and for 2019–20, 11.06%, respectively (Handbook of Statistics on Indian States 2019–20).

The NER2020 estimated the required growth rate of per capita GSDP for the region to be 11.6% for the year 2020 to match the per capita GDP of the rest of

the country, but with the outbreak of the pandemic that caused serious distress to life, rights and economy, the GSDP took a blow too. For most of the North-Eastern states except Mizoram, the growth rate of GSDP at Current Prices for the financial year 2018–19 had been in the range 8.06–14.02% (Table 3.6). A 10% growth in the nominal GDP was estimated in the 2020–21 union budget, with more than half of the states to have estimated their nominal GSDP growth rate within the range 8 to 13%. The COVID-19 and subsequent lockdowns impacted the growth rate of GDP and GSDP in 2020–21 negatively, and the nominal GDP in the first two quarters contracted by 22.6% and 4%, respectively (Tiwari & Surya 2020). The Reserve Bank of India (RBI) projected the country's real GDP to contract by 7.5% in 2020–21 which is an upward revision against the earlier projected negative growth rate of 9.5% (Noronha 2020). The RBI further projected the Indian economy to grow by 26.2% during the first half of 2021–22 (Business Today 2021). As the country's economy is gradually bouncing back, with the many incentives of the Central Government, the GSDP of these eight states is expected to accelerate; nonetheless, the region's populace continues to suffer multidimensional poverty (SDG1), signalling that the inequalities (SDG 10) remain rife with meagre economic growth (SDG8)—arguably, the ingredients of Just Transition remain ubiquitous.

The Multidimensional Poverty Index, launched by the United Nations Development Programme (UNDP) and the Oxford Poverty and Human Development Initiative (OPHI) in 2010, treats poverty as not unidimensional but a multidimensional issue. The index emphasizes the non-income aspects of poverty and portrays the percentage of poor and the deprivations each poor person experiences simultaneously. The MPI uses three dimensions and ten indicators to determine the incidence

Table 3.6 Gross state domestic product for North-East India (at current prices)

State	Base: 2011–12 (INR million)				
	2015–16	2016–17	2017–18	2018–19	2019–20
Arunachal Pradesh	185,091.6	198,454.3	224,324.7	246,028.8	270,366.4 (A.E)
Assam	2,279,588.3	2,543,823.6	2,831,648.9	3,158,812.1	3,636,115.4 (A.E)
Manipur	195,306.7	212,938.9	257,892.3	278,687.1	319,890 (A.E)
Meghalaya	251,173.6	274,386.2	295,083	334,806.4	365,718.1
Mizoram	151,388.6	171,919.1	187,402.4	195,199.1	258,691.4 (P.E)
Nagaland	195,239.5	217,224.5	244,917	272,830.4	312,347.8 (A.E)
Sikkim	180,339.4	206,871.9	259,708.2	287,234.4	324,959.9
Tripura	359,377.3	394,794	437,158	498,454.7	553,580.8
India	137,718,740	153,916,690	170,983,040	189,712,370	203,398,490

Source Handbook of Statistics on Indian States 2019–20, Reserve Bank of India, Directorate of Economics and Statistics, Government of Arunachal Pradesh, Finance Department, Government of Assam, Economic Survey Manipur 2020–21, Budget 2019–20, Government of Mizoram, Nagaland Statistical handbook 2020

AE advance estimates, *PE* provisional estimates

Table 3.7 Performance of the North-Eastern States on each SDG: 2018 and 2019–20

States	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 15	SDG 16	Composite SDG
Arunachal Pradesh	*52*	*58*	*38*	*44*	*32*	*64*	*44*	*72*	*16*	*47*	*44*			*73*	*77*	*51*
	34	**66**	**50**	**58**	**33**	**88**	**74**	**52**	**31**	**38**	**43**	**67**	**31**	**71**	**62**	**53**
Assam	*53*	*53*	*30*	*54*	*36*	*42*	*18*	*61*	*35*	*75*	*32*			*100*	*53*	*49*
	48	**39**	**44**	**44**	**33**	**78**	**70**	**62**	**46**	**67**	**40**	**68**	**47**	**90**	**52**	**55**
Manipur	*44*	*74*	*67*	*65*	*25*	*44*	*39*	*33*	*72*	*98*	*31*			*100*	*70*	*59*
	42	**69**	**62**	**70**	**34**	**87**	**72**	**27**	**43**	**81**	**28**	**85**	**37**	**100**	**70**	**60**
Meghalaya	*68*	*43*	*52*	*38*	*36*	*40*	*11*	*62*	*42*	*100*	*39*			*94*	*53*	*52*
	68	**35**	**53**	**55**	**34**	**70**	**52**	**65**	**22**	**76**	**22**	**60**	**36**	**99**	**59**	**54**
Mizoram	*71*	*69*	*53*	*54*	*43*	*67*	*78*	*65*	*0*	*100*	*32*			*69*	*71*	*59*
	67	**75**	**52**	**61**	**37**	**81**	**81**	**42**	**8**	**66**	**33**	**50**	**45**	**75**	**63**	**56**
Nagaland	*59*	*69*	*34*	*45*	*42*	*58*	*45*	*40*	*0*	*80*	*32*			*75*	*87*	*51*
	56	**70**	**29**	**47**	**42**	**75**	**70**	**28**	**23**	**61**	**23**	**100**	**51**	**94**	**84**	**57**
Sikkim	*64*	*67*	*52*	*47*	*50*	*78*	*47*	*57*	*1*	*67*	*56*			*98*	*66*	*58*
	65	**66**	**59**	**58**	**49**	**79**	**97**	**68**	**27**	**64**	**74**	**60**	**38**	**100**	**69**	**65**
Tripura	*71*	*58*	*53*	*56*	*38*	*38*	*32*	*52*	*38*	*89*	*38*			*86*	*71*	*55*
	70	**49**	**61**	**55**	**32**	**69**	**56**	**63**	**48**	**45**	**31**	**92**	**37**	**88**	**73**	**58**
India	***54***	***48***	***52***	***58***	***36***	***63***	***51***	***65***	***44***	***71***	***39***			***90***	***71***	***57***
	50	***35***	***61***	***58***	***42***	***88***	***70***	***64***	***65***	***64***	***53***	***55***	***60***	***66***	***72***	***60***

(continued)

Table 3.7 (continued)

States	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 15	SDG 16	Composite SDG
Target	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**

Source (i) SDG India Index: Baseline Report 2018 (denoted by: Italic)
(ii) SDG India: Index & Dashboard 2019–20 (denoted by: Bold)
Note Aspirant: 0–49, Performer: 50–64, Front Runner: 65–99, Achiever: 100
SDG 14 and 17 not included

and intensity of poverty experienced by a population. The three dimensions assessed are education, health and standard of living. A person is considered to be multidimensionally poor if she/he/they is/are deprived in one third or more of the weighted indicators and those who are deprived in one half or more, are considered to be living in extreme multidimensional poverty. It is the recent best method for scaling poverty and is closely associated with the SDGs (Alkire et al. 2021).

Bagli (2017) found out the Multidimensional Poverty Index for the North-Eastern states. The author gauged the three dimensions with different indicators selected on the basis of the author's own justification. For the dimension of knowledge, the author made use of the indicators—(i) the percentage of illiterate population and (ii) the percentage of financially literate households, with each indicator being assigned a weightage of 1/6. For the health dimension, the indicators used were—(i) percentage of households using an unsafe source of drinking water and (ii) the percentage of households having no access to improved sanitation. Each indicator here too was assigned the weightage of 1/6. On the other hand, for the dimension of living standard, four indicators were used, with each being assigned a weightage of 1/12. The indicators used were—(i) the percentage of households having a dilapidated residence, (ii) the percentage of households having no census assets, (iii) the percentage of households using dirty cooking fuel and (iv) the percentage of households having no access to electricity. The author calculated the MPI by gauging the normalized inverse 'Euclidian distance' of the observed vector of the indicators of deprivation from the vector indicating the worst state of multidimensional poverty and categorized the states as well as districts into three ranges of multidimensional poverty. The range $0.5 < \text{MPI} \leq 1$ denotes the high level of multidimensional poverty, whereas the range of $0.2 < \text{MPI} \leq 0.5$ indicated a moderate level of poverty and a relatively low level of multidimensional poverty represented by the range $0 \leq \text{MPI} < 0.2$. The author found the state of Mizoram to have the least multidimensional poverty among all the eight states and Meghalaya to be the worst. Thirty-one districts (36%) of North-East India suffer from a high level of multidimensional poverty. In contrast, poverty of moderate level is observed in 51 districts (59%), and only 4.6% of the districts in the region have a low level of multidimensional poverty.

Every state has its fair share of problems, and the MPI clearly reflects this. This is not a result of reasons universally applied to all the mentioned states. Lack of homogenous availability of resources, lack of economic opportunities and insufficient and inefficient resource distribution can be identified as reasons—enclasping SDG1, SDG8 and SDG10. But the hope rides on the fact that only more than a third of the population in the North-Eastern region has borne the worst burnt of poverty. While the number is still staggering in a populous country like India, it can still be mitigated through careful planning and directive policies. For this, the SDG India Index has been constructed by the NITI Aayog to assess the progress made by the different States and the Union Territories of India to achieve the targets set for each of the SDGs through the indicators allocated or adopted annually. Chapter 1 has explained about the NER District SDG Index, which was developed in the wake of the North-Eastern Region SDG Conclave 2020 organized by NITI Aayog in Guwahati in February 2020. This chapter has also shown the district level SDG performance.

The NER2020 document emphasized strengthening the economic, institutional, infrastructural and social fronts of the region, and in doing so, the region must achieve the targets set for the SDGs. Though some of the states of the region are not able to achieve the targets, as evident from Table 3.7, these eight states along with the rest have aligned their developmental agendas with the SDGs and are committed to achieve the same.

Arguably, achieving the SDGs of equal significance is a road to untangling a Just Transition from an extractive economy to a regenerative economy marking an inclusive and sustained growth of people, resources, and earth, and thereby attaining both gender and climate justice. The notion 'Just Transition'can be defined as 'a principle, a process and a practice' (Climate Justice Alliance, 2021), which saw the light in the 1990s when the North American trade unions began developing the concept (Kohler 1998). Initially understood as a programme of support for workers who lost their jobs or as a process of softening job losses in sectors brought about by environmental protection policies, the scope of the concept broadened over time (Kohler 1998; Smith 2017). Just Transition ensures the benefits incurred from the switch to a green economy be inclusive of countries, regions, economies, industries and communities (EBRD, n.d.). The principle, process and the practice of decarbonising an economy using Just Transition have been recognized in the preamble of the Paris Agreement (2015),

> Taking into account the imperatives of a Just Transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities

Just Transition therefore focuses on achieving growth while keeping in check the climate, sustaining the environment, promoting green investments, creating green and decent work, enhancing skills, encouraging social inclusion and eradicating poverty (Smith 2017). The main components of this transition are thus, the earth, the environment and the people of all socio-economic strata.

The International Trade Union Confederation calls for a Just Transition that will (Smith 2017):

- respect the contribution that workers in fossil fuel industries have made to today's prosperity and provide income support, retraining, redeployment and secure pensions for older workers
- recognize that investing in community renewal is critical to gain the hope and trust of affected regions and townships whether energy transition, industrial transformation or disaster
- support innovation and shared technology to enable energy and manufacturing companies to make the Transition with 2020 and 2030 targets for emission reductions and for jobs
- involve workers in the sectoral plans for the development of clean mega cities
- formalize the jobs in rescue, rebuilding and resilience associated with climate disasters
- ensure investment in the jobs and decent work vital to both adaptation and mitigation

- guarantee essential social protection and human rights
- be backed up by a Just Transition fund in every nation and
- be based on social dialogue with all relevant parties, collective bargaining with workers and their unions and the monitoring of agreements which are public and legally enforceable (pp. 4–5).

With important agencies emphasizing the importance of a Just Transition, achieving the same with every development intended becomes imperative. Social dialogues become crucial to a Just Transition. Negotiations, consultations and information exchange occur between and among the stakeholders: Government, Social partners as Unions and Employers, Communities and Investors (Smith, 2017) for a smooth transition to a green, inclusive economy. A Just Transition is the present and future of a sustainable nation and green earth. The world economies aiming for this transformation has set sail, and India is no left behind. North-East India has adopted many green practices applying the notion of Just Transition which are discussed below:

The state of Arunachal Pradesh is committed to an expansive development of the energy sector with a major emphasis on providing affordable and clean energy. Despite being one of the richest in the country in terms of hydropower potential, the state is producing merely 2 per cent of its capacity to generate 50,000 MW of hydropower through the operating 128 small/ mini/ micro hydropower projects of various capacities. To address the failure in the operation of these projects in their optimum capacities and in harnessing the maximum hydropower potential, the State Government has allocated INR 200million for the optimum performance of the projects in the budget 2020–21. Moreover, an additional INR 20million has been allocated to carry out the scheme of capacity building, public sensitization, awareness, confidence-building and legal consultancy services for hydropower development. In February 2020, a one-day seminar 'Prosperity of Arunachal Pradesh through Accelerated Hydropower Development' was organized by the state department of Hydro Power Development, which believed to have fostered enthusiasm and a positive environment among the stakeholders concerned (Government. of Arunachal Pradesh 2020; 'Arunachal Pradesh has potential' 2020). In addition to hydropower, the Arunachal Pradesh Energy Development Agency (APEDA) is also involved in harnessing solar, bio and wind energy. Many schemes and programmes as Solar Photovoltaic Programme, Solar Thermal Programme, Bio-Mass Programme, etc. have been successfully carried out (Government of Arunachal Pradesh, n.d.). Arunachal Pradesh has also started work on a Mega Food Park at Banderdewa in the Papum Pare district. This project will benefit the farmers and entrepreneurs of the state. A Green Building for the Office of Principal Chief Conservator of Forests is constructed at Itanagar and in the state budge 2020–21, a sum of INR 50million has been allocated for continuing the works (Government of Arunachal Pradesh 2020). Lohit Solar Park was launched on 29 April 2015 to generate 20 MW of power.

In Assam, 80-m Wind Monitoring Stations which is a project under the collaboration of National Institute of Wind Energy (NIWE) Chennai, Assam Energy Development Agency (AEDA) and Oil India Ltd in the districts Dhubri, Goalpara, Barpeta,

Nalbari, Kamrup (rural), Karimganj, Hailakandi and Cachar. Moreover, seven such projects are to come up at Morigaon, Nagaon, Gohpur, Biswanath, Lakhimpur and Dhemaji districts of the state. In the state, the six districts of Barpeta, Nalbari, Kamrup Rural, Darrang, Udalguri and Goalpara have been identified for the MNRE—UNDP/GEF (Ministry of New and Renewable Energy-United Nations Development Programme/Global Environment Facility) Project 'Scale Up of Access to Clean Energy for Rural Productive Uses'. The Suryamitra Skill Development Programme is also launched in Assam along with the other Indian states (Assam Energy Development Agency, n.d.). The Guwahati Railway Station has been India's first fully solar-powered railway station (Sushma 2018), and the project is now extended for rooftop solar projects for Kokrajhar, Dhubri, and Salakati Railway Stations with capacities of 25 kW, 10 kW, and 10 kW, respectively, by the railways (Parikh 2020). The Assam State Transport Corporation (ASTC) has also contributed towards a green and Just Transition through its schemes as *Gyan Deepika*, Electronic ticketing system for local and sub-urban buses, running of 15 electric buses under the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAMEi-I) Scheme of Department of Heavy Industry, Government of India, Rooftop solar panels at the ASTC premises, etc. (ASTC, n.d.).

In the state of Meghalaya, mining has been streamlined through the Meghalaya Minor Minerals Concession Rules so that there is no indiscriminate mining and that the mining done is carried on a sustainable basis. Massive awareness campaigns for citizen engagement and behaviour change are also carried out in the state (Government of Meghalaya 2020). Solar Park in Meghalaya was launched in 2014, bearing a capacity of 20 MW.

The world's first fully organic state, Sikkim (Fagotto 2020), is all set to make a green leap forward to get the branding of 'Green Capital of India' and for this, Sikkim is turning to green energy, agriculture, industry, business, technology, environment, culture, buildings and infrastructure and more seriously on green thinking and green principles (Chakraborty and Chakma 2016; 2019).

In addition to the above green projects and schemes, the eight North-Eastern states have adopted green principles. These green principles on one hand, sustain the environment, on the other, supports the people. The accelerated adoption of green energy in the North-East and the skilling up North-East India through schemes as Pradhan Mantri Kaushal Vikas Yojana (PMKVY) [a flagship scheme of the Ministry of Skill Development and Entrepreneurship (MSDE) for securing a better livelihood of the Indian youth by enabling them to take up vocational training and certification. PMKVY 1.0 was launched in 2015, wherein 1.9 million students were successfully trained. The scheme was relaunched as PMKVY 2.0 (2016–20) with an aim to train ten million youth by the year 2020. PMKVY 3.0 has been recently launched to empower 0.8 million youth with employable skills over 300 + skill courses across 600 districts (MSDE 2019, 2021)], Green Skill Development Programme (GSDP) [adopted by the Ministry of Environment, Forests and Climate Change (MoEF&CC), it is an initiative for skill development in the environment and forest sector to facilitate India's youth with gainful employment as well as self-employment through utilizing the vast network and expertise of ENVIS Hubs/RPs.This programme intends to

develop skilled green workers with technical knowledge and commitment to sustainable development, which will help in a Just Transition (Green Skill Development Programme. (n.d.)], and other state-initiated schemes, and social inclusion schemes as Welfare Schemes for the Tea Tribes and Adivasi—this flagship programme of the Government of Assam includes wage compensation of INR 18,000 for nine months with pre-natal and post-natal health check-ups and nutritional security; it also includes educational benefits to the students belonging to the Tea Tribes and Adivasi, and 14,000 youths to get INR 25,000 for entrepreneurial activities among other schemes (Government of Assam 2020)]. Comprehensive Social Security Schemes are another flagship programme of the Government of Assam embracing schemes such as *Swahid Kushal Konwar Sarbajanin Briddha Pension Asoni*, *Deen Dayal Divyang Sahayjya Asoni, Aideu HandiqueMahila Samman Asoni,* Widow Pension and one-time grant of INR 25,000 as family assistance to widows enabling social security (Government of Assam 2020). Sikkim Social Endowment Fund (SSEF) of Sikkim Government is the pool of funds to be managed, operated and evaluated by a team of Sikkimese Civil Society and Private Sector, wherein the contribution formula is 5:1, that is, on contribution of INR 5000 by a philanthropist to this fund, the Government of Sikkim will contribute INR 1000 to it (Government of Sikkim 2020), DeenDayal Upadhyay Gram Jyoti Yojana (DDUGJY), Saubhagya Scheme, etc. has certainly helped in a Just Transition by supporting people of the different socio-economic strata. Moreover, the COVID-19 pandemic, which has hit North-East India and other parts of the country and world in 2020 and is still ongoing, can be seen as a transition accelerator for creating decent green jobs (Urpelainen 2020), indicating increased poverty (SDG1) and inequalities (SDG 10) and decreased economic growth (SDG8).

3.7 Conclusion

This chapter aimed at revisiting North-Eastern Region Vision 2020 document applying Just Transition. Indeed, this is the first chapter which applies the notion of Just Transition to unfold the complexities of the region by reviewing the North-Eastern Region Vision 2020 document. This document calls North-East a 'rainbow country …extraordinarily diverse and colourful, mysterious when seen through parted clouds' (MoDONER 2008a, p. 1). A rainbow country that North-East India is, the different colours bring different essence to the land and its people, but challenges too arise because of this contrast in lore and land. The NER2020 document concerned with reimagining North-East India in the country's political, social and economic discourse has to a significant extent succeeded in fulfilling the strategy and its varied components developed to thrust North-East to the mainstream. However, much is still left to accomplish the 17 SDGs to obtain a decarbonized inclusive economy. The governments and stakeholders of the NER region should coordinate together and work in tandem to translate the components of AEP into reality. However, challenges are rife—the challenges that arise in achieving growth and development are external

and internal, with internal far exceeding the external difficulties (Bhattacharyya 2018; Duncan 2009; Haokip 2020; Pulla et al. 2020). North-East India too aspires for prosperity, recognition and inclusion in the minds and hearts of the mainstream Indians and institutions. Though the COVID-19 scenario painted a black picture of unwantedness and unbelonging, there is still hope for covering the black with colours diverse, and this is feasible only with the involvement of the Centre, the States and all the stakeholders concerned. Therefore, we urge that the document needs further revision via the deployment of Just Transition while taking on board the current economic complexities into context so that sustainability and gender and climate justice can be attained by 2070 when India aims to achieve its pledge of net-zero carbon emission.

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Part II
SDG and North East India

Chapter 4
An Analysis of the Performance of Sustainable Development Goals (SDGs) in the North-East Region of India: An Economics Perspective

Pawan Kumar, Paramjit, and Subhash Anand

Abstract Today, the world is facing the worst ever crisis in the form of Covid-19 led pandemic. Among others, it caused the major setback to the world in its endeavour in achieving the Sustainable Development Goals (SDGs). The story of SDGs begins with the identification of Millennium Development Goals (MDGs) by the UN in 2000, wherein a considerable progress is made in many MDGs, but still, 'poverty and inequality' is a global problem. In 2020, with the mark of fifth anniversary *2030 Agenda for SDGs*, India, a signatory of SDGs, has moved considerably on all the five critical dimensions of Agenda 2030—people, prosperity, planet, partnership and peace. The North-East Region (NER), troubled by history and geopolitics, remained one of the most backward regions of the country. Overtime, since 2015, things improved remarkably in the NER. For instance, in the SDG 01, no poverty, out of the 6 Front Runner states, 4 belong (Tripura, Meghalaya, Mizoram and Sikkim) to the NER, and so in other goals situation improved. A multi-prolonged strategy played a pivotal role in the progression towards achieving these SDGs in the country and the NER. Consistent high growth rate over 8%, increased labour productivity, targeted programmes like MNREGA (Mahatma Gandhi Rural employment Guarantee Act), technology or innovation like ICT, environment protection (controlling CO_2 emission), infrastructure and support services in the form of banking and insurance are some of the feature of the strategy.

Keywords Performance of sustainable development goals · Millennium development goals · SDG report 2020 · North-East India · Economic perspective

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4.1 Introduction

Today, the world is facing the worst public health and economic crisis of the century, led by the Covid-19 pandemic. Among many others, it has caused a major setback to the world to achieve the Sustainable Development Goals (SDGs). According to the latest SDG Report (Sustainable Development Report, 2020), there is a silver line, using the right approach to crisis management; we can learn important positive lessons for the future.

The story of SDGs begins with the identification of Millennium Development Goals (MDGs) by the UN in 2000, wherein efforts were initiated across countries, regions or states to diagnose the prevalent inherent development problems and solve them holistically in a time-bound manner. Empirically, though the world made considerable progress in the many MDGs, but still, poverty and inequality are global problems. In the late 2014, the UN merged the MDGs into 17 newly designed SDGs, believed to be more systemic, comprehensive, detailed and internationally comparable, to be achieved by 2030 under the Sustainable Development Goals.

In 2020, with the mark of fifth anniversary *2030 Agenda for SDGs*, India, a signatory of SDGs, has moved considerably on all the five critical dimensions of Agenda 2030—people, prosperity, planet, partnership and peace. Intuitively, given the size of GDP, employment or geographical area, India carries strategic importance for 2030 Agenda, i.e. every SDGs progress in India will add to global progression towards achieving the SDGs. In the last five years since 2015, India has made fast stride in most SDGs, the composite score for India improved from 57 in 2018 to 60 in 2019, indicating its overall progress towards achieving SDGs (SDG India Report, 2019–20). India's ranking in SDGs index has improved consistently since 2015.

In India, the North-East Region (NER), constituting eight states, Assam, Arunachal Pradesh, Tripura, Nagaland, Manipur, Mizoram, Meghalaya and Sikkim, carries strategic importance, politically, economically and socially in the country. Troubled by history and geopolitics, the NER has remained one of the most backward regions of the country. Till mid-1960s, however, the region performed better than the rest of India in most socio-economic development parameters be it per capita GSDP, literacy rate, IMR, MMR, among others.

According to the North-Eastern Region Vision 2020, the uneasy relationship with most of the neighbouring countries has adversely affected development process; with 96% of international boundary, private investment has shied away, leading to overwhelming dependency on central government and public investment. Government failure to control floods or river bank erosion cause unparalleled damages to properties and lives, leaving the region in a perpetual state of backwardness with poor infrastructure, low factor productivity and no or least market accessibility.

Overtime, since 2015, things improved remarkably in the NER. For instance, gaining 7 points, Sikkim is now placed in the category of Front Runner (with 65–99 scores) in 2019 along with 7 other states. Interestingly, in the SDG 01, No Poverty, out of the 6 states Front Runner, 4 belong (Tripura, Meghalaya, Mizoram and Sikkim) to the NER, and so in other goal like SDGs 02 (Zero Hunger), wherein 5 states

(Mizoram, Nagaland, Manipur, Arunachal Pradesh and Sikkim) out of 7 are in the NER.

A multi-prolonged strategy played a pivotal role in the progression towards achieving these SDGs in the country and the NER. Consistent high growth rate over 8%, increased labour productivity, targeted programmes like MNREGA (Mahatma Gandhi Rural employment Guarantee Act), technology or innovation like ICT, environment protection (controlling CO_2 emission), infrastructure and support services in the form of banking and insurance are some of the feature of the strategy.

In the chapter, an analysis is made to evaluate the performance of the SDGs in the NER, which for decades have been able to keep pace vis-à-vis the rest of India.

4.1.1 The Evolution of SDGs in India: A Socio-Economic Perspective

For quite sometimes, till the early 1990s, 'development' was defined 'narrowly' in terms of planned structural change in economic growth and employment in favour of manufacturing or services sectors, given increasing returns to capital assumed to be lower in agriculture. Accordingly, most development planning focussed on rapid industrialization and urbanization for increased economic growth leading to higher per capita income and considered the panacea of all social-economic ills like poverty, unemployment, inequality or environmental concerns, among others. But empirically, economists concluded happiness (or satisfaction) and PCI income are positively related only up to a point, i.e. till $10,000 to $20,000 but not beyond (Todaro and Smith 2017). The 'happiness economics' thus questioned the existence of the conventional wisdom of all existing development theories; and indicated income or wealth per se is not an end in itself. This was the beginning of assuming 'development' a multi-dimensional concept.

Quite uniquely, Amartya Sen defined 'development' in terms of 'capability enhancement' an approach which stressed that the real meaning of 'development' lies not merely in the availability of resources, but the way it is being used (Sen 1999). Or, 'human well- being' means 'being well' in terms of being healthy, well nourished, well clothed, literate, long lived and more broadly community participate and having freedom of choices. This was one of the bases towards the adoption of 8 Millennium Development Goals (MDGs) by the UN, wherein universally agreed objectives were decided for tackling extreme poverty, hunger, preventing deadly disease and expanding primary education to all children, among other in a time-bound manner by 2015. Empirically, the world has made fast strides in many of these objectives. For instance, extreme poverty has declined from nearly 50% in 1990 to 14% in 2015; proportions of under-nourished people have fallen by almost half to 12.9% in 2014–16 from 1990–92, and similarly, the number of out of school children has dropped by half the worldwide to 57 million in 2015 from 100 million in 2000; HIV/AIDS infection dropped fell by 40% since 2000 (MDG Report 2015). But, on

other measures of development like inequality, safe or productive work environment, still there is a long way to go.

Eventually, to fill the gaps in the MDGs, a strategy was changed in the form of another set of comprehensive, well defined, detailed and visionary approach called 2030 Agenda, wherein 17 SDGs were decided by the UN in 2015 to be achieved by 2030. In nut shell, the 2030 Agenda countries and thus the world is made to move for prosperity, people, planet, peace and partnership, known as five Ps (SDG Report 2019).

Agreeing to all this, India has played a pivotal role in the adoption of MDGs and the 17 SDGs; a reflection of its bold commitment towards inclusive development in terms of peace, prosperity or justice for all under the Agenda 2030. Being the largest democracy in the world, fifth largest economy and sharing nearly 17% of total world population, every gain towards SDGs in India is a global gain.

In terms of overall performance in SDGs, with 61.1 score, India ranked 115 in 2019 in the list of 162 countries, with Denmark on the top, followed by Sweden, Finland, France and Germany with their respective score as 84.7, 84.56, 83.77, 81.13 and 80.77. The arrows, → , ↗, ↑ and ↓ signify stagnating, moderately increasing, maintaining achievement and decreasing. In the year 2020, India's ranking slipped by 2 points to 117 but with improved SDGs 161. 9; thus indicating, though in absolute terms India has improved it position over last year, but not as compared to the other countries. A closer analysis of Table 4.1 shows that in two of the SDGs, SDG 06 (Clean Water and Sanitation) and SDG 09 (Industry Innovation and Infrastructure) India has improved its position from stagnating to moderately increasing. In 6 of 17 SDGs, India is seemed to have made no progress, compared to last year (2019); these includes SDG 04, SDG 05, SDG 11, SDG 16 and SDG 17 in 4 SDGs; India witnessed maintaining achievement, in 4 SDGs moderately increasing and not so good in the remaining goals whereas countries on the top are doing better than India in many respect, which is areas where there are rooms for improvement. An interesting case is of Bhutan, Bangladesh and Sri Lanka which being on the same league has performed better than India in many respects.

An assessment of the SDGs in India indicates huge regional variation, i.e. certain regions such as the North-East Region (NER) has not done fairly vis-à-vis. the rest of India. The whole story is illustrated below.

4.2 SDG in the North-East Region (NER) in India

Called the *rainbow of country*, NER has extraordinary diverse biodiversity, endowed with ethnic diversity, abundant water, mineral and other valuable resources. Comprised of 8 states, Arunachal Pradesh, Assam, Manipur Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, constitute nearly, NER constitutes 7.98% total geographical area and 3.79% of the total population. Further, nearly, 96% of the NER is covered by international boarder, China and Bhutan in the North, Myanmar

Table 4.1 List of the SDGs, value and the world ranking of India

Year	SDGs	2020	2019
2020 SDG rank		117	115
SDGs value		61.9	61.1
G1	No poverty	↑	↑
G2	Zero hunger	↗	↗
G3	Good health and well-being	↗	↗
G4	Quality education	→	•
G5	Gender equality	→	→
G6	Clean water and sanitation	↑	↗
G7	Affordable and clean energy	↗	↗
G8	Decent work and economic growth	↑	↑
G9	Industry, innovation and infrastructure	↗	→
G10	Reduced inequality		•
G11	Sustained cities and communities	→	→
G12	Sustained production and consumption		
G13	Climate action	↑	↑
G14	Life below water	→	→
G15	Life on land	↓	↓
G16	Peace justice and strong institution	→	→
G17	Partnership for the goal	→	•

Source Sustainable development report, 2019 and 2020, NITI Aayog

in the East, Nepal in the West and Bangladesh in the West and South, thus making it important for international relations.

Theoretically, in terms of structural transformation, the region is on the lowest pedestal of economic development, given the predominantly rural economy, i.e. over 84% of population lives in rural areas. The NER has close to 200 different tribes (of around 600) in the country speaking Tibeto-Burmese languages and dialect with a strong tradition of social and cultural identity. Among all, Arunachal Pradesh, Meghalaya, Mizoram and Nagaland stated are hilly, inhibited predominantly by tribal people. With 68% of the total NER population, Assam is also the biggest state in terms of total NER area (NER Vision 2020).

At independence, the NER was one of the most prosperous regions of the country. For almost, 150 years, the region was at the forefront of trade and development; the vast river system and its small tributary were a means of livelihood for majority of the people in the region. For a long time, the international trade was conducted through the sea route, a network of inland waterways and land transport through roads and railways. Historically, two cities, Dibrugarh and Chittagong, have been the trading centre developed by British. The rapid spread of tea garden followed by the first establishment of tea garden in the country in 1835 and the first tea export to Britain

in 1838 (NER Vision 2020). The report further adds that, the first oil refinery was set up in Digboi in 1890, considered to the foundation of development in the undivided Assam. Also, the NER constitutes nearly 20% of the total petroleum and natural gas reserve potential.

As evident in Table 4.2, a periodical analysis of the performance of the region shows during 2013–14 to 2017–18, out of the 932 factories set up in NER, maximum number took place has been in Assam state (821), followed by Tripura (59), Manipur (31) and Meghalaya (24) whereas two states Arunachal Pradesh and Nagaland witnessed de-industrialization, instead of new firms coming up they witnessed decline in the number of new factories, thus indicating huge variation among states in the NER. Similarly, in terms of employment, wages, gross fixed capital formation (GFCF) or profit, Assam did better than the rest of region. Employment elasticity (EE), which indicates the employment content of the output produced, against the average 0.5 the country recorded, NER witnessed much lesser, so the states within the NER except Manipur (see Table 4.3).

In India, the average living standard, measured by the per capita income (PCI), is growing, from Rs. 63,462 in 2011–12 to Rs. 114,968 in 2017–18 at current price. Comparatively, within the NER, in 2011–12, all states except Arunachal Pradesh and Sikkim; PCI remained lower than the national average, i.e. only 63% in case of Manipur and 65% in Assam. The situation seemed remained the same overtime, with Meghalaya an exception having PCI higher than the national average (1.23).

Table 4.2 Principal characteristics of the organized sector in the NER from 2014–15 to 2017–18

Characteristics	All India	Arunachal Pradesh	Assam	Manipur	Meghalaya	Nagaland	Sikkim	Tripura
No. of factories (absolute change)	7.249	−7	821	31	24	−11	15	59
Number of factories	1.0	−1.9	6.9	6.1	6.9	−1.9	7.0	3.5
Number of workers	4.4	−3.0	3.4	3.7	−3.2	2.6	10.7	−3.8
wages to Workers	11.1	3.3	4.8	7.9	−1.6	5.7	35.3	3.7
fuels consumed	5.4	−0.5	−2.8	−14.9	6.4	1.0	34.7	1.0
NVA	8.0	−28.9	18.6	6.3	25.0	2.5	34.0	−13.5
GFCF	−1.1	6.1	−1.2	10.4	−28.7	1.8	100.7	−7.0
Profits	7.8	−40.4	27.5	−2.3	−327.6	0.8	35.3	−29.6
EE (NVA)	0.5	0.1	0.2	0.6	−0.1	1.0	0.3	0.3

Source Own computation using the ASI data 2014–15 and 2017–18
(Figures. in % terms)

Table 4.3 PCI of the NER (as % of the country)

States	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18
Assam	0.65	0.63	0.63	0.61	0.64	0.63	0.65
Arunachal Pradesh	1.15	1.15	1.16	1.28	1.18	1.11	1.11
Manipur	0.63	0.58	0.60	0.61	0.58	0.57	0.57
Mizoram	0.91	0.92	0.98	1.19	1.20	1.21	1.23
Meghalaya	0.95	0.90	0.82	0.75	0.73	0.70	0.71
Nagaland	0.84	0.86	0.90	0.90	0.87	0.88	0.89
Tripura	0.74	0.74	0.78	0.80	0.88	0.87	0.91
Sikkim	2.50	2.45	2.46	2.47	2.59	2.68	2.76
India	63,462	70,983	79,118	86,647	94,7	1,04,659	1,14,958

Source Economic survey, 2018–19

Another remarkable fact about the NER is, there lies huge variation among states with Sikkim having nearly three times higher PCI than the national average.

Increasing income inequality is another binding constraints towards sustainable development globally, and so for India and for states. Stiglitz, the Nobel Laureate, in his book, the Price of Inequality (2013), remarks why income inequality is bad for the society at large. He said, 'money moving from bottom to the top lower consumptions because high income individuals consumes a smaller proportion of their income than do lower income individuals (those at the top saves 15 to 20% of their income, those at the bottom spend all their income)'. In any country like India, inequality encourages rent seeking, ways or means by which the political system helps the rich at the cost of others.

Amartya Sen identifies five sources of disparity between real income and actual advantages, personal heterogeneities, environmental diversity, social climate, income distribution within family, relational perspective (i.e. 'to appear in public without shame', a phrase used by Adam Smith that included good quality clothing such as leather shoes in high income countries than in low income countries). Thus, looking at the per capita income or even the level of consumption is not an end in itself but rather a means towards overall development or enhancement in the capability of an individual per se; known as 'Sen's Capability Approach' (Sen 1999).

As mentioned above, NER occupies a special place in the socio, economic and political paradigm of the country. How have the SDGs performed, in the NER, has been a major issue of debate for quite some times since 2015. Performance of the SDGs in the NER is illustrated blow.

4.2.1 Poverty and Inequality

Today, poverty and inequality are two major issues globally, affecting the 'global order' of growth and development process. In India, theoretically, the new economic policies since 1991, led by liberalization and globalization, revamped the economic policy framework favouring market over state regulations (or public sector institutions) in the country a whole and so the NER. Since then, though growth rate accelerated but with no major dent in poverty, which still persists all across states including the NER. Why is it so? In their famous book, entitled, Poor Economics', A. Banerjee and Dueflo, the Noble Laureates, stated, 'all too often, the economics of poverty gets mistaken for poor economics, because the poor possess very little, there is nothing interesting about their economic existence we have to abandon the habit of reducing the poor to cartoon character and take the time to really understand their lives in all their complexities and richness. In the past fifteen years we have done just that'.

Intuitively, most SDGs are interrelated, directly or indirectly and so the SDG 01 (No Poverty); decline in poverty results in positive and significant impact on literacy, inequality, health, women empowerment, among others. The SDG 01 must thus be pursued holistically leading to inclusive growth and participative development. The constitutional provisions (73rd and 74th Constitutional Amendments) empowered the Panchayats and Municipalities, to address all major development issues at the grass root level with people's oriented democracy and community participation.

In terms of poverty, as evident from Table 4.4, the NER witnessed marginally higher poverty (22.1%) against the national average (21.9%) in 2018. Within the NER, there lies huge variation. Arunachal Pradesh, Assam and Manipur recorded higher poverty ratio than the national or the NER averages, whereas Sikkim the lowest (8.2%). Further, in terms of the percentage of women covered under social security benefit like maternity leave, against the target of 100%, performance of the NER has again been poor. Only, one-third working women are covered under the maternity benefit in the whole region, Assam doing the best with 66.1% and Arunachal Pradesh the least (20.5%). Similarly, in terms of people living in kutcha house, another major poverty measure, the NER lags behind with an average 6% of household live in kutcha houses, the highest being in Arunachal Pradesh (26%) and lowest in Sikkim and Nagaland 0.6% and 0.7%, respectively.

The picture looks more or less the same while talking about inequality in the NER. No doubt, high inequality is a global concern. According to *Joseph Stiglitz* (2013)*, the Noble Laureate, "Widely unequal societies do not function efficiently, and their economies are neither stable nor sustainable in the long term"*.

For instance, as evident in Table 4.5, per capita expenditure of the bottom 40% people grew at 13.6% against the target of 15.6% in rural area in the country. The NER recorded it 5.6%, far lesser the national average and so the target in 2018. Within states in the NER, it is alarming to record that two states, Arunachal Pradesh and Tripura, witnessed negative growth rate and no states having it above than the

Table 4.4 Performance of SDG 01 (no poverty) in the NER

Area	Population living below national poverty line (%)	Households with any usual member covered by any health scheme or health insurance (%)	Persons provided employment as a percentage of persons who demanded employment under MGNREGA (%)	Proportion of the population (out of total eligible population) receiving social protection benefits under maternity benefit (%)	Households living in kutcha houses (rural + urban) (%)
Target	10.95	100	100	100	0
India	21.92	28.7	85.26	36.4	4.2
Arunachal Pradesh	34.67	58.3	93.39	20.5	29
Assam	31.98	10.4	87.3	66.1	2.4
Manipur	36.89	3.6	95.45	26.2	2.5
Meghalaya	11.87	34.6	97.85	28	2.3
Mizoram	20.4	45.8	99.92	47.5	6
Nagaland	18.88	6.1	95.08	29.7	0.7
Sikkim	8.19	30.3	93.07	29.4	0.6
Tripura	14.05	58.1	95.68	32.6	2.6
Average (NER)	22.1	30.9	94.7	35	5.7

Source SDG India index and dash board report 2019–20, NITI Aayog, Government of India

national average. So is the same story in the urban areas in most of the NER states except Meghalaya.

Technically, inequality is measured by Gini co-efficient, i.e. higher is the co-efficient higher is the income inequality and vice versa. Against the target of 0, most NER states recorded it lower than the national average, in both rural and urban areas. In terms of other measure of SDG 10 like the percentage of seats reserved for in PRIs, against the target of 50%, India with 46% stands and so the NER and its constituent states.

4.2.2 Hunger, Health or Well-Being

Globally, an estimated 26% of world population (2 billion people) suffered moderate to severe food insecurity in 2019, up from 22.4% in 2014. The situation is seemed to have deteriorated further in wake of the Covid-19 led pandemic crisis in 2020 (SDG

Table 4.5 Performance of the NER in terms of inequality (SDG 10)

Area	Growth rates of household expenditure per capita among the bottom 40% of the population in rural India (%)	Growth rates of household expenditure per capita among the bottom 40% of the population in urban India (%)	Gini coefficient of household expenditure in rural India	Gini coefficient of household expenditure in urban India	Gini coefficient of household expenditure in urban India, country
Target	15.59	11.27	0	0	0
India	13.61	13.35	0.283	0.363	0.311
Arunachal Pradesh	−8.63	−0.81	0.346	0.365	0.35265
Assam	5.3	8.77	0.221	0.326	0.25775
Manipur	12.48	10.65	0.211	0.209	0.2103
Meghalaya	10.15	31.17	0.19	0.226	0.2026
Mizoram	1.24	9.55	0.24	0.233	0.23755
Nagaland	15.81	3.5	0.192	0.232	0.206
Sikkim	14.97	4.36	0.197	–	
Tripura	−6.31	−0.61	0.219	0.297	0.2463
NER Average	5.6	8.3	0.227	0.269	

Source Same as in Table 4.4

Report (2020)). It further adds, no doubts, the proportion of such children under 5 years has decreased from 32% in 2000 to 23% in 2015 and then 21% in 2019, but still it is a long way from the stated objective of 'No Hunger' or zero hunger (Sustainable Development Report 2020).

For any country, food security is a pre-requisite for sustainable growth and economic development. In India, food grain production index has increased remarkably over the years since independence; majorly post-1965–66 resulting in the Green Revolution (Economic Survey 2019–20). For instance, the index increased from 100 in 2007–08 to 136.8 in 2017–18 but declined to 135.3 in 2018–19, mainly due to poor performance of coarse cereals and pulses. In absolute terms, food grain production increased from 252 million tonnes in 2014–15 to 285 million tonnes in 2018–19. Similarly, the net food availability, another major indicator of food security, has increased marginally from 177.7 kg per year in 2016 to 179.6 kg per year or from 486.8 g per day to 491 g per day, respectively. In addition to this, for the country as a whole, in 2019, nearly, 78.6 million tonnes were distributed under PDS, up from 60.8 million tonnes in 2016 (Economic Survey 2019–20).

In terms of the performance the SDG 02 and its various components used in India, the NER displays a mixed picture, good in some respect and not so good in

others. Against the national average of 1.01% of the households with member with highest income less than Rs. 5000 and is covered under PDS, it is 1.07 in the NER, i.e. marginally higher and with least variation among states constituting the NER. Further, as evident in Table 4.6, the average percentage of children (below the age of 5) who are stunted in NER is found lower than the national average (1.29%) and so across different NER states except Meghalaya. In addition to this, in series other such measures like percentage of pregnant women who are anaemic or the percentage of underweight children, not only the NER average is better than the national average but so among NER states.

SDG 02 and SDG 03, Good Health and Well-being, are closely related in any country. Evidently, in terms of the SDG 02, no doubt, the world has made a fast stride, but there is a long way to go, particularly by under-developed or developing countries like India. The Covid-19 has put strain on the development process towards SDG 03 across countries including India and so the NER. According to the latest SDG Report (2020), the Covid-19 is causing significant loss of life, essential health service or life-saving interventions. How has the NER performed is illustrated below.

Table 4.6 Performance of the NER in SDG 02 (no hunger)

Area	Ratio of rural households covered under public distribution system to rural households where monthly income of highest earning member is less than Rs. 5000	Children under age 5 years who are stunted (%)	Pregnant women aged 15–49 yrs who are anaemic (11.0 g/dl) (%)	Children aged 6–59 months who are anaemic (Hb < 11.0 g/dl) (%)	Children aged 0–4 years who are underweight (%)
Target	1.29	2.5	25.15	14	0.9
India	1.01	34.7	50.3	40.5	33.4
Arunachal Pradesh	0.92	28	33.8	28.3	16
Assam	1.09	32.4	44.8	33.7	29.4
Manipur	1.36	28.9	26	10	13
Meghalaya	1.04	40.4	53.1	32.9	30
Mizoram	1.06	27.4	24.5	24.4	11.3
Nagaland	1.14	26.2	28.9	8	16.3
Sikkim	1.04	21.8	23.6	33	11
Tripura	0.94	31.9	54.4	33	23.8
Average (NER)	1.0	29.6	36.1	25.4	18.9

Source Same as in Table 4.4

Among the number of different measures and the goals decided by the government, in terms of the infant mortality rate (the number of children below 5 years who die per 1000 live birth), with an average 45, the NER is going fairly well than the national average (57). Something, witnessed across all states except Assam and Arunachal Pradesh suffering development deficiency'. Similarly, in terms of institutional deliveries, the region has done tremendously well. For instance, three states, Tripura, Mizoram and Manipur, with 70.7%, 64.3% and 58.7%, respectively, have done remarkably well as compared to the country as a whole (with the average 54.7%). Finally, in terms of the percentage of children fully immunized, number of tuberculosis cases or HIV cases, married women using modern methods of family planning and so on, the NER states, by and large, have done better than the country as a whole, as evident in Table 4.7.

4.2.3 Quality Education and Gender Equality

Quality education is one of the important parameters for a socio-economic and politically rich society in any state, region or a country per se. Initially, it was initially difficult to define it, given no consensus internationally as to what constitutes 'quality education'. Given the lack of uniformity across countries, the definition varies, thus leading to missing objectivity. Overtime, after threadbare discussion globally, the issue of 'quality education' gained popularity and objectivity and it emerged as the SDG 04. It made it binding for all member countries to do the needful to reach to the target systematically.

In India, for the SDG 04, the measures used to indicate the level of 'quality education' for the country or across different states are listed in Table 4.8. Among many, for the adjusted Net Enrolment Ratio at Elementary and Secondary Level, against the target of 100% in 2018, the national average stood at 75.8% and the NER average at 74%, quite close to the national average. Within NER, i.e. at the disaggregated level among states, as evident from Table 4.8, five out of the eight states, Arunachal Pradesh, Assam, Manipur, Mizoram and Tripura, did far better than the country as a whole and so the NER, thus reflecting inherent intrinsic regional inequality across states in the NER.

Similarly, in respect of children (belonging to 6–13 years age) who are out of school, another measure of SDG 04, against the national average of 3%, it stands 1.7% for the NER hence indicating better its performance. Interestingly, all states have done better than the national average. Among all, Sikkim has done the best (with the minimum 0.6%), i.e. close to the SDGs; followed by Mizoram (0.6%), Nagaland (0.9%), Manipur (1.7%), Assam (2.8%), Meghalaya (2.9%) and Arunachal Pradesh (2.92%).

Further, the measure 'drop out at the secondary level reflects the opposite scenario as mentioned above. For instance, it stood at 27.2%, far above the national average (19.8%). This is the trend being observed across all states in the NER, but with huge regional variation, highest in Nagaland and the lowest in Manipur. Similarly, in terms

Table 4.7 Progress towards health and well-being (SDG 03) in the NER

Area	Proportion of institutional deliveries (%)	Under-5IMR	Fully immunised children in 0–5 years (%)	No. of tuberculosis per 1 lakh population	HIV cases per 1000 uninfected population	Married women aged 15–49 years using family planning (%)	Total physicians nurses and midwives per 10,000 population
Target	100	25	100	0	0	100	45
India	54.7	50	59.2	160	0.07	47.8	38
Arunachal Pradesh	45.3	33	41.3	216	0.05	26.6	24
Assam	53	57	46.1	126	0.04	37	23
Manipur	58.7	26	75.1	97	0.58	12.7	44
Meghalaya	47.5	40	52	139	0.06	21.9	28
Mizoram	70.7	46	73.4	210	1.32	35.2	54
Nagaland	40.6	37	12.8	208	0.59	21.2	1
Sikkim	49.3	32	65.1	221	0.03	45.9	24
Tripura	64.3	33	39.6	66	0.05	42.8	22

Source Same as in Table 4.4

Table 4.8 Progress of the NER towards quality education (SDG 04)

Area	Adjusted net enrolment ratio at elementary (classes 1–8) and secondary (%)	Children in the age group of 6–13 who are out of school (%)	Average annual drop-out rate at secondary level (%)	Gross enrolment ratio in higher education (18–23 years) (%)	Gender parity index for higher education (18–23 years)	Percentage of schools with Pupil Teacher ratio less than/equal to 30 (%)
Target	100	0	10	50	1	100
India	75.83	2.97	19.89	26.3	1	70.43
Arunachal Pradesh	79.02	2.92	29.93	29.7	0.99	88.87
Assam	80.65	2.88	27.6	18.7	0.95	75.33
Manipur	88.21	1.72	21.05	33.7	1.01	93.15
Meghalaya	68.39	2.9	28.07	25.8	1.17	86.87
Mizoram	79.6	0.6	30.67	25.7	0.94	94.23
Nagaland	56.24	0.9	31.28	18.7	1.11	95.91
Sikkim	45.47	0.58	24.15	53.9	1	99.03
Tripura	94.72	0.79	29.76	19.2	0.83	95.08

Source Same as in Table 4.4

of 'the proficiency in education level at different class level in the school', gender parity or pupil teacher ratio, NER states are doing better than the nation as a whole. Lastly, in terms of quality of teacher, some NER states are doing worst, i.e. in Assam and Sikkim only 18.5% and 27% teachers, respectively, are trained in the elementary and secondary school education.

In terms of higher education, among all NER states, Sikkim seems to be doing far better than the rest of India, with 53% as gross enrolment ratio, highest among all states and more than double the country average. This is a subject of intense research what led to this gulf between the two sets of states, i.e. despite many odds in terms of structural infrastructural constrains, why some states emerged winner and what led the other states held back in the process of growth and development of 'quality education' and what the latter can learn from the former to reach to the desired results of SDG 4.

Similarly, gender inequality is a global issue. For instance, against 74% men, only, 47% women are in labour force (World Employment and Social Outlook Report, 2020). According to the latest Human Development Report (2019), in terms of gender inequality, India is ranked 123 out of the list of 189 countries, placed in the category of medium human development. So, a lot needs to be done in terms of gender equality. In one of the seminal books, the Idea of Justice (Sen, 2010), Amartya Sen argued that in any society, equality and capability are central to human lives and thus are an important aspect of human freedom. Compared to men, women tend to have survival

disadvantages in India, like most parts of the world as being in terms of mortality rate, which tend to be higher than their male counterparts across all age groups (at least until recently). The phenomenon of 'missing women' has been an issue of intense debate in India, reflecting how gender biases is hampering the process of growth and development. When women lacks equal right and patriarchy is deeply engrained, parents prefer boy over girl child. Today, of estimated, 80 million more men than women living in the world are largely in India or China (Washington Post, April, 2018).

Therefore, overtime the issue assumed global importance in the form of SDG 05, indicating how sustainable development of a region, country and the world rests on 'inclusive development' in terms of gender equality, among others. Let us evaluate it in respect of SDG 05 for India with a special reference to NER.

Starting with the gender or sex ratio, compared to the country as a whole, NER is far better as evident in Table 4.9. A trend observed for even across all states. Some states like Manipur, Meghalaya and Mizoram are performing not only better than the rest of India but also compared to other NER states, hence indicating a tendency towards reducing gender inequality, seen to be prevalent in all walks of life. This can further be substantiated by the fact that male to female wage ratio averaged at 0.8 in the NER, marginally better than the national average (0.78) against the target of 1. This gap can be termed as 'women wage development gap', 0.2 in the NER and 0.22 for the country as a whole. Interestingly, in some NER states, Sikkim and Mizoram, the ratio being more than 0.9 for both, are quite close to SDG 05 target 1 and making the reference for the rest of India to follow. Ironically, their lies huge variation within the NER, i.e. some states like Arunachal Pradesh and Assam are lagging far behind compared to other states including the non-NER category. Further, in terms of spousal violence against married women, another important criterion of gender equality, again, the NER with 26.8% average is doing better than the country as a whole (33.3%), reinforcing the tendency towards reducing gender inequality or women empowerment. Sikkim, for instance, as shown in Table 4.7, recorded the lowest level, 3.5%, thus becoming a 'Model State' not only for the NER or the country but for the world as a whole in in the SDG 05.

Similarly, in terms of labour force participation rate, against the target of 100% as per SDG 0 stands very low in the country at 17.5%, and the NER 19.23% average is doing marginally better than India. In two NER states, Meghalaya and Sikkim, it is recorded to be close to 35%, highest not only in the NER but in the country as well. However, in terms of 'crime against girl child as proportion of the total crime against children' the average (94%) in NER, another aspect of development, being higher than the national average, presents gloomy picture.

4.2.4 Target 08: Clean Water and Sanitation

As evident in Table 4.10, performance of the country in general and NER in particular in respect of Goal 06, Clean Water and Sanitation, both at the aggregated level

Table 4.9 Gender equality (SDG05) in the NER and the Country

Area	Sex ratio at birth, 2011	Female to male ratio of regular wage salaried employees	Rate of crimes against women per 100,000 female population	Married women aged 15–49 who have ever experienced spousal violence (%)	% of sexual crime against girl children to total crime against children	Seats won by women in the general elections to state legislative assembly (%)	Female labour force participation rate (LFPR) (%)	Operational land holdings—gender wise (%)
Target	954	1	0	0	0	50	100	50
India	896	0.78	57.9	33.3	59.97	8.32	17.5	13.96
Arunachal Pradesh	938	0.72	53.4	34.8	55.49	3.33	10.7	0.01
Assam	958	0.74	143.6	26.6	43.04	6.35	9.8	0.03
Manipur	992	0.75	18.1	54.7	44.19	3.33	17.7	0.01
Meghalaya	989	0.75	40.7	31	142.34	5	34.9	0.05
Mizoram	976	0.96	57.6	17.5	170.26	0	23.4	0.01
Nagaland	931	0.8	6.9	16.6	88.12	0	13.1	0.01
Sikkim	890	0.92	53.1	3.5	99.19	9.38	34.2	0.002
Tripura	960	0.76	51.2	29.7	112.59	5	10.1	0.048
NER Average	956	0.8	53.08	26.8	94.4	4.05	19.24	0.02

Source Same as in Table 4.4

or the disaggregated level, indicates an encouraging picture. For instance, against the target of 100%, an average 96% of households have access to 'safe and clean source of drinking water' in the country against 91% in the NER and hence indicating development deficit vis-à-vis the stated target and the country as a whole. Interestingly, within the NER, it is worth mentioning the remarkable achievement of Sikkim, which has attained the 100% in most aspects of the SDG 06. The other states following closely are Arunachal Pradesh and Mizoram, but Manipur with 75% lags behind hence indicating regional variation.

Another biggest achievement not only the NER but the whole country feels proud is the 100% rural households having individual household toilets, largely owing to the 'Swatchh Bharat Abhiyan' the biggest ever mission in terms of scale in the world towards making India 'open-defecation' free (Economic Survey, 2019–20). The urban households in general also are not too far behind, i.e. following closely the national average, whereas the NER with 57% average is lagging far behind the national average (97%) or a development gap. Again, there lies huge regional variation in the NER, the rose picture of Assam with 100% achievement mark is accompanied by three least performing states, Meghalaya, Mizoram and Tripura with 22%, 18% and 31%, respectively.

Lastly, in 2019, when an average 96% of schools reported to have separate toilet facilities for girls in the country, it is 94% in the NER, again not too far behind, with least regional variation among states in the NER.

4.2.5 SDG 07: Affordable and Clean Energy

Theoretically, affordable and clean energy is an integrated part of sustainable development in any country per se. Affordable and clean energy is an important source of productivity enhancement of labour or capital (Todaro and Smith, 2019). Historically, in the past three decades, 'environmental economics' not only emerged as a separate field within development economics but also many aspects of SDGs are directly and indirectly based on it. The SDG 7 is nothing but the result of this.

While evaluating the performance of SDG 07 in India in general and NER in particular, among many, two measures, namely, the percentage of households electrified, and the percentage of households using LPG, a clean gas gained prominence. In the former, as evident in Table 4.11, the stated target of 100%, the country attained in 2019 itself. It is worth mentioning a point, i.e. India, which is lagging behind in many aspects other development measures or SDGs mentioned above, is going with perfect 100 score in this respect. Similarly, in the latter, i.e. households using LPG gas towards cooking, against the target of 100%, with the national average being at 64%, the NER is following closely the national average despite all infrastructural odds in the process of growth or development in the region. Within NER, Meghalaya and Tripura lag far behind the rest of states with 35% and 41%, respectively, thus reflecting regional variation.

Table 4.10 SDG 08, clean water and sanitation in the NER

Area	Households having improved source of drinking water (%)	Rural households with individual household toilets (%)	Urban households with individual household toilet (%)	Districts verified to be open defecation free (%)	Proportion of schools with separate toilet facility for girls (%)	Percentage of industries complying with waste water treatment as per CPCB norms	Blocks over-exploited (%)
Target	100	100	100	100	100	100	0
India	96	100	97	88	97	88	18
Arunachal Pradesh	99	100	80	100	96	80	0
Assam	91	100	100	85	83	90	0
Manipur	75	100	75	100	99	100	0
Meghalaya	91	100	22	100	84	94	0
Mizoram	96	100	18	100	99	80	0
Nagaland	85	100	66	36	98	87	0
Sikkim	100	100	67	100	97	50	0
Tripura	88	100	31	25	100	80	0

Source Same as in Table 4.4

Table 4.11 Performance of the NER towards SDG 07, affordable and clean energy

Area	Households electrified (%)	Households using clean cooking fuel (LPG) (%)
Target	100	100
India	100	61.4
Arunachal Pradesh	100	64.7
Assam	100	59.2
Manipur	100	62.9
Meghalaya	100	34.7
Mizoram	100	74.3
Nagaland	100	59.9
Sikkim	100	96.3
Tripura	100	41.3
	100	61.6

Source Same as in Table 4.4

4.2.6 Goal 08: Decent Work and Economic Growth

Theoretically, employment is a pre-requisite for growth and development in a country. No doubt, quantitatively, for quite some times, till the Covid-19 led global crisis, world economy has witnessed an upward trend of employment growth but not qualitatively. Still, quite a good percentage of labour force is engaged in informal or unorganized sector, i.e. with poor working condition with no or least social security in terms of employment, wage, health, pension, etc. (World Employment and Social Outlook Report 2020). The report further added, nearly, 473 million labour the world over are underutilized, and 20% of the total persons employed are poor. For instance in India, a vast proportion, around 90%, of labour force is engaged in informal sector, with close to 99.7% in agriculture sector (World Development Report, 2019). Thus, to improve the qualitative aspect of employment globally in a time-bound manner, 'Decent Work and Economic Growth' is placed as SDG 08.

Given this, an evaluation of the SDG 08 in India, and in the NER, displays many interesting results. As illustrated in Table 4.12, against the national average 6% employment growth, NER with recorded 9% growth rate is doing far better than the rest of India quantitatively. In addition, high average SDP growth rate (6%) in the NER than the national average (5.6%) resulted in high employment elasticity (EE), indicating higher employment content of output. Let us now evaluate the qualitative aspect of employment growth at the disaggregated level across different states in the NER.

Within the NER, in 5 out of 8 states, unemployment rates are recorded higher than the national average and also the NER average. Interestingly, in the remaining three states, Arunachal Pradesh, Meghalaya and Sikkim, unemployment rate is not only lower but the least at 1.6% in case of Meghalaya, hence making it a model

Table 4.12 Performance of goal 08, decent work and economic growth in the NER

Area	Annual growth rate of net domestic product (NDP) per capita	Ease of doing business score (EODB)	Unemployment rate (%)	Labour force participation rate (%)
Target	7.5	100	0	100
India	5.66	67.23	6	49.8
Arunachal Pradesh	5.08	0	5.8	45
Assam	6.24	84.75	7.9	47.5
Manipur	2.04	0.27	11.5	48.1
Meghalaya	6.99	0	1.6	63.2
Mizoram	6.59	3.66	10.1	51.6
Nagaland	2.1	14.16	21.4	41.8
Sikkim	6	0.14	3.5	60.9
Tripura	13.34	22.45	6.8	45.1
Average (NER)	6.04	15.6	8.5	50.4

Source Same as in Table 4.4

state, like Sikkim, recording it close to 3.5% in 2018. Among all, Nagaland is the worst performing states with unemployment rate above 21%. Further, it is worth mentioning, only in 3 out of 8 states, Meghalaya, Mizoram and Sikkim, the labour force participation (percentage of people in the age group of 15–59 who are willing to work) is recorded to be higher than the national average and low the other NER states.

Intuitively, employment depends on output growth, which in turn depends on capital formation or investment. Investment growth per se is positively related to expansion of the banking facilities like the number of banking facilities per 100,000 people, among others. Over the years, series of banking sectors reform starting from the nationalization of banks in 1969 and mainly after the 1991 economic reforms, huge banking sector infrastructure erected all across the country, but with deep regional inequality. In 2018, as the data show, NER has done fairly well compared to the rest of India. In 5 out of 8, NER states are doing even better than the national average in terms of banking intensity, percentage of household having bank accounts, which reached 100 in the country and so in the NER states. Further, as the data shown in Table 4.12, nearly, 50% women have account in PMJDY.

4.2.7 Goal 09: Industry, Innovation and Infrastructure

However, in terms of SDG 09, the region seemed to have lagged far behind. For instance, power consumption, an important indicator of growth, remained abysmally low at 110.4 kwh against the national average 411.1 kwh., nearly 4 times lesser, thus indicating a huge industrial gap. Within the NER, however, there lies huge variation; Assam (85.3 kwh), Manipur (70.05 kwh) and Nagaland (87.2 kwh) are the least performing states.

Further, in terms of innovation and technology, no doubt the country has taken great leap forward be it tele-density or internet density. According a report by TRAI (2020), as on September, there were nearly 1196 million telephone subscriber in the country, with majority of the services were provided by the private players (89%) leading to 90.5% of tele-density (i.e. 90.5 phones per 100 population). It is worth mentioning, the urban areas registered 160. 7 level of tele-density compared to 58 in rural areas, an indication of ICT resolution in the country in general and urban areas in particular. Similarly, in case of the internet/broadband, subscribers are concerned; there are 687 million subscribers in the country (of which nearly 70% are in urban areas); taking the overall internet density in the country to 52 (with 104 in urban areas and 28 in rural areas). Another remarkable fact worth mentioning is that on an average 10.37 GB data are used per subscriber the report further adding.

The NER comprises three Territorial Telecom Circles, Assam (covering the entire Assam), NR-I (comprising Meghalaya, Mizoram and Tripura) and NE-II (includes Arunachal Pradesh, Manipur and Nagaland). The eighth state (Sikkim) is under the West Bengal Circle. In the North-East Vision Document, a special emphasis is laid on the overall development of the region through improving the telecom infrastructural base of the NER. Towards the induction of new technology in telecom sector in the NER, a scheme has been launched wherein about Five Pilot Project shall be provided subsidy; support is also provided for renewable energy resources (Solar, Wind, Diesel Hybrid Solution) for 28 sites on the Pilot basis including one each from NER states. Support is also being considered for mobile charging station in 5000 villages in the country through TERI project through Lightening a Billion Lives (LoBL), of which 100 villages would be selected from Assam.

The Telecom Commission is planning to implement BharatNet in NER, wherein 4240 g Panchayats are to be connected by broadband by satellite connectivity by December 2018, with an investment of Rs.733 crore (Economic Times, Jan 16, 2018). It is further added that 2817 mobile towers by BSNL in Arunachal Pradesh and two districts of Assam, and the work of 2004 towers in six states has been completed in 2017 using optical fibres, taking the total Rs. 15,000 crore investment in the region. It is expected that by 2020 the tele-density in the region will rise to 100.

As evident in Table 4.13, the region is not doing well in terms road infrastructure or proportion of manufacturing employment as percentage of total, but certainly yes in terms of development and diffusion of ICT, i.e. tele-density or internet density.

Table 4.13 Growth of industries, infrastructure and innovation (SDG 09) in the NER

Area	Targeted habitations connected by all-weather roads under Pradhan Mantri Gram Sadak Yojana (%)	Manufacturing employment as a proportion of total employment (%)	Number of mobile connections per 100 persons in rural and urban area (mobile tele-density)	Number of Internet Subscribers per 100 population
Target	100	20	100	100
India	69.89	12.13	88.41	48.48
Arunachal Pradesh	140	1.53	7.42	25.88
Assam	58.92	6.65	69.44	34.38
Manipur	57.27	12.06	14.65	51.08
Meghalaya	21	1.77	15.68	54.66
Mizoram	0	4.19	6.01	20.94
Nagaland	18.18	5.68	13.45	46.9
Sikkim	74.29	6.91	3.66	12.75
Tripura	68.89	6.96	21.63	75.41
NER Average	54.8	5.73	18.99	40.25

Source Same as in Table 4.4

4.2.8 Goal 11: Sustained Cities and Communities

Structural transformation, an important feature of the development process of a country, involves industrialization and urbanization. Quantitatively, this involves sustainability of cities or communities, measured in terms of population density or nature of dwellings, among others. Empirically, the current process structural transformation leading to urbanization with slums devoid of basic amenities like drainage system, cleanliness, or safe drinking water, pollution etc. putting stress on the whole process of development.

In India, with 1/3rd population now staying in urban areas, urbanization is keeping pace with industrialization, i.e. share of agriculture sector declined to 15% in 2019 from close to 25% of GDP a decade ago, in favour of industry or services sector. Something witnessed all across the states but with varied degree. As evident in Table 4.14, under the PMAY (PM Awas Yojana), which ensures pucca house, 31% net demand for houses met in the country as a whole. But, in the NER, it has not been as successful, 23% except two states, Sikkim and Tripura and much low in Mizoram and Manipur with 5% and 7%, respectively, the report further added. Also, in terms of population living in slums, against the national average of 5%, it is 3.4% in the NER, lowest in Assam, Arunachal Pradesh or Meghalaya with 0.6%, 1.1% and 1.9%, respectively, in 2018.

Table 4.14 SDG 11, sustained cities and communities in the NER

Area	Houses completed under PMAY as a percentage of net demand assessment for houses	Urban households living in slums (%)	Wards with 100% door to door waste collection (%)	Waste processed (%)	Installed sewage treatment capacity as a proportion of sewage generated in urban areas
Target	100	0	100	100	1
India	31.01	5.41	90.99	56.00	0.38
Arunachal Pradesh	26.16	1.12	100.00	0.00	0.00
Assam	18.92	0.63	62.21	41.00	0.00
Manipur	7.48	–	68.63	50.00	0.00
Meghalaya	22.35	1.94	23.68	4.00	0.01
Mizoram	4.79	7.16	80.49	35.00	0.11
Nagaland	13.37	4.16	44.44	14.00	0.00
Sikkim	44.61	5.14	100.00	70.00	1.33
Tripura	46.03	3.80	27.10	40.00	0.00
	22.96	3.42	63.32	31.75	0.18

Source Same as in Table 4.4

Similarly, in terms of community cleanliness, against the 100% target, in more than 90% wards, there is a provision of door to door waste collection, something not very encouraging in the NER (with 63% average). Within NER there lies huge variation, 100% in Arunachal Pradesh and Sikkim and only 23% in Meghalaya. More or less the same picture witnessed in waste management.

4.2.9 Sustained Production and Consumption

According to the latest SDGs Report (2020), sustained production and consumption is aimed to promote resource and energy efficiency in the country, region or a state. Human use more resources than what the planet can afford or renew every year. It further says, we will need three earths to sustain current life styles for everyone in 2050 if the world population reaches the 9.6 billion. How big the global concern measures by the fact that the quantum of raw material extracted to meet the consumption demand has increased 113% from 43 billion metric tonnes in 1990 to 92 billion metric tonnes in 2019 and is projected to grow to 190 billion metric tonnes in 2060 (SDG Report (2020)).

In the past couple of decades, no doubt India has made fast strides in terms of growth but with persistent poverty and inequality. Conservation of natural resources

is another big challenge. Empirically, India has reduced the emission intensity of GDP by 21% and reducing it further to 30–35% by 2030, as accorded under the Paris Agreement (Business Line, December, 2020).The Paris Accord is an agreement under the UN Framework Convention on Climate Change (UNFCCC), which is aimed at addressing issues related to greenhouse gas emission, adaptation and finance.

As evident in Table 4.15, for the SDG 12, seven national level indicators have been identified to measure India's performance, given the availability of data across different states in the country. There lies a huge variation across states, with the score varying from 30 to 100. It is worth mentioning, among the top 10 performing states in SDGs 12, 5 belongs to NER, with Nagaland leading with 100 index score, followed by Tripura (93), Mizoram (85), Karnataka (72) and Maharashtra (71) in 2019. These states are called the Front Runner, having the score 65 and above and thus being role models for other states in terms of the SDGs 12. In all the seven parameters, NER is doing better than the rest of India.

According to the latest Gender Inequality Index Report (2019), India ranked 123 out of the list of 189 countries, placed in the category of medium human development (Human Development Report, 2019). So, a lot needs to be done in terms of gender equality. In one of the seminal books, the Idea of Justice (2010), Amartya Sen argued that in any society, equality and capability are central to human lives and thus are an important aspect of human freedom. Compared to men, women tend to have survival disadvantages in India, like most parts of the world as being in terms of mortality rate, which tend to be higher than their male counterparts across all age groups (at least until recently).

The phenomenon of 'missing women' has been an issue of intense debate in India, reflecting how gender biases is hampering the process of growth and development. When women lacks equal right and patriarchy is deeply engrained, parents prefer boy over girl child. Today, of estimated, 80 million more men than women living in the world are largely in India or China (Washington Post, April, 2018).

4.2.9.1 SDG-13: Climate Change, Life Below Water and Life on Land

Climate change is one of the most important and integrated aspect of growth and development of not only a state, region, country but the globe. The reasons behind it, as enumerated in the latest SDGs Report (2020), are be it the rise in global temperature, which increased by almost 1 degree in 2017 over the 1951 to 1980 average, carbon dioxide (CO_2), leading to immediate impacts of growth and development. For instance, global warming directly results into a decline in average yield of food crops, mainly wheat, rice and maize, rise in sea level and so the health hazards associated with carbon emission in the climate.

India homes huge biodiversity resulting from high climate change or weather condition in a region. It has its own pros and cons, i.e. making vast region vulnerable to change adversely affect as manifested in the frequency of the number of floods or draughts (water stress) and food production among others, across different parts in the country, according to a report by IPCC (Intergovernmental Panel on

Table 4.15 Performance of sustained production and consumption (SDG 12 and its various indicators) in the NER

Area	Groundwater withdrawal against availability (%)	% use of nitrogen fertilizer out of total NPK (nitrogen phosphorous potassium)	Per capita hazard waste generated	Ratio of processed quantity of hazard waste sent to recycle to hazard waste generated	Municipal solid waste (MSW) treated against MSW generated (%)	Installed capacity of grid interactive bio-power per 100,000 population	Wards with 100% source segregation (%)
Target	70	57	0	1	100	2.11	100
India	63.33	64.49	0.0057	0.04	20.75	0.75795	67.76
Arunachal Pradesh	0.28	0	–	–	0	–	14.67
Assam	11.25	66.46	0.0009	–	0	–	31.05
Manipur	1.44	68.45	–	–	–	–	39.22
Meghalaya	2.28	0	0	0.0725	26.44	0.48252	23.68
Mizoram	3.82	75.7	0	0	0	–	56.4
Nagaland	0.99	47.35	0	1	–	–	8.12
Sikkim	0.06	0	0.0012	0	0.61	–	94.34
Tripura	7.88	54.24	0.0001	0.8832	60.34	–	66.13
	3.5	39.025	0.000367	0.39114	14.565	0.48252	41.70125

Source Same as in Table 4.4

Table 4.16 Performance of the SDGs 13, climate change in the NER

Area	Number of human lives lost per 10,000,000 population due to extreme weather events	Renewable share of installed generating capacity (%)	Co2 saved from LED bulbs per 1000 population	Installed capacity of solar power as proportion of installed grid interactive renewable power (%)
Target	0.00	40.00	165.29	57.00
India	16.00	35.22	28.74	24.30
Arunachal Pradesh	362.00	75.12	38.81	2.22
Assam	49.00	30.79	20.98	7.74
Manipur	–	40.41	11.80	3.92
Meghalaya	–	73.95	15.87	0.03
Mizoram	–	65.51	59.05	1.05
Nagaland	91.00	52.34	47.11	1.12
Sikkim	–	90.64	25.87	0.01
Tripura	44.00	12.41	27.62	10.02
	136.50	55.15	30.89	3.26

Source Same as in Table 4.4

Climate Change). As many as 32 states have State Action Plan for Climate Change to devise policies related to climate change (SDGs Report 2020). As mentioned above, India, being an active member of United Nations Framework Convention on Climate Change (UNFCCC), strongly support the Paris Agreement, to reduce by the target of emission intensity of GDP by 33–35% by 2030. It is targeted that by 2022, 175 GW of renewable (100 GW from solar, 60 GW from wind, 10 GW from bio-mass and 5GW from small hydropower), which has recently been increased to 228 GW, the report further added.

Further, as shown in Table 4.16, a cross-state analysis shows that the index value for SDG-13 ranges from 27 to 71, thus reflecting huge state variation. In this regard, NER performance is not worth encouraging; no state falls in the category of top 10 performing states, however two states, Assam and Nagaland in list of top 15, and five in bottom 10 category, with the score ranging from 31 to 37. It is strongly recommended that something should be done in this regard.

4.2.9.2 SDGs 16: Peace, Justice and Strong Institution

No society can grow or develop without peace or with growing injustice. In terms of SDG 16, countries strive to become more civilized. In 2018, as evident in Table 4.17, India seems to lag behind the stated targets and so the NER. For instance, in

terms of reported murder per 1 lakh population, against the target to reduce it to 1.1, an average 2.2 murders takes place in the country and 2.7 in the NER (higher than the country as a whole). Within NER, Arunachal Pradesh is doing worst with 5.9 and Nagaland the best 1.5. In the country, on an average, every third person is subject to *physical psychological or sexual violence in the previous 12 months,* with 30.7% average Assam is the worst performing state (78.6%) and Nagaland better than all (9%). In terms of reported cognizable crimes against children per 1 lakh population or the number of victims of human trafficking per 100,000 populations by sex age and form of exploitation, NER is not doing better than India.

Further, in terms of the presence of court, an integral part towards SDG 16, India has not done well, with only 12.8 courts per 1 lakh population, against the target of 33.8, wherein the NER is doing better with an average of 15.7. It is more or less the same in terms of cases registered under the Prevention of Corruption Act related to section of IPC per 1lakh population.

For instance, the North-East Region Community Resource Management Project (NERCORMP), started jointly by the Fund for Agricultural Development and Government of India (GOI), aims to enhance local governance in the livelihood sector, through bringing together the knowledge, expertise ideologies of government IFAD and local communities towards SDG.

4.3 Conclusion and the Way Forward

The NER, the rainbow of the country, has moved great deal in terms of SDGs mainly poverty (SDG1), good health (SDG3), education (SDG04) and decent work (SDG 08), like the rest of India. Richly Endowed with natural resources with species rich tropical rain forests supporting flora and fauna, NER is world's biodiversity hotspot. With nearly 52% of forest cover, the NER is used to provide global public goods; it not only limits the availability of cultivable land but enhances transaction cost of delivery of goods and services (including public goods) to the population living in sparse interior areas of the region. The regions constitute nearly a fifth of country's total petroleum and natural gas potential. In terms of water, however, the region is covered by mighty Baramputra-Barak river systems and their tributaries; it has been source of misery rather than the source.

The challenges to achieve SDGs in NER are formidable compared to the rest of India. Even within the NER there lies heterogeneity, particularly between population living in hill and plain areas and between rural and urban areas. Unlike, the rest of India, wherein, increasing proportion of labour force engaged in agriculture is moving to non-agricultural sector and from rural to urban areas, the NER is losing on both these except Assam. In terms of standard development, indicators like road length, access to health care and power consumption are far below than the national average. The region generates less than 8% of its hydraulic power generation potential or per capita power consumption only one fourth of the national average. In terms of other

Table 4.17 Peace and justice in India and the NER

Area	Reported murders per 1 lakh population	Proportion of population subjected to physical psychological or sexual violence in the previous 12 months	Reported cognizable crimes against children per 1 lakh population	Number of victims of human trafficking per 100,000 population by sex age and form of exploitation	Estimated number of courts per 10 Lakh persons	Cases reported under prevention of corruption act & related sections of IPC per 100,000 population	Births registered (%)	Population covered under Aadhaar (%) (Goal
Target	1.1	0.0	0.0	0.0	33.8	0.2	100.0	100.0
India	2.2	33.1	28.9	0.5	12.8	0.3	86.0	88.8
Arunachal Pradesh	5.9	48.1	29.5	0.0	–	0.8	192.6	78.9
Assam	3.5	78.6	41.6	1.0	8.1	0.1	103.9	14.6
Manipur	2.4	31.7	11.3	1.0	6.9	0.0	–	80.9
Meghalaya	3.1	25.4	37.8	0.1	5.6	0.0	–	28.2
Mizoram	1.9	13.2	59.3	5.7	13.1	0.5	136.0	87.4
Nagaland	1.5	9.0	13.9	0.0	–	0.5	218.2	56.2
Sikkim	2.0	26.8	93.6	0.8	25.3	0.0	66.2	84.9
Tripura	3.2	41.0	22.3	0.5	20.3	0.0	82.4	88.6
Average (NER)	2.7	30.7	33.8	1.0	15.7	0.2	123.2	70.8

Source Same as in Table 4.4

development indicators also like PCI or road length among others, the region lags behind the national SDGs achievement except in poverty, health and literacy.

The development strategy towards attaining SDGs Mission 2030 must therefore be inclusive empowering people with maximizing self-governance given the resources, need or aspiration of people. Rural development must evolve expansion of rural non-farm activities with scale economies, leading to more employment with enhanced productivity, given saturation in agricultural growth constrained by adverse geographical conditions. Development process of agro-based industries like sericulture, horticulture, bamboo and supporting services like tourism needs to speed up; this requires adequate investment measures. According to some studies, the NER requirement of investment equivalent to its total population share, nearly 4%, needs to be largely met by public investment. This, in turn, requires greater coordination among the centrally sponsored, the state sponsored and the local development initiative of the PRIs and urban local bodies.

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Chapter 5
Extreme Weather Events and Food Insecurity in Northeast India

Raju Mandal, Binoy Goswami, Munmi Sarma, and Hiranya K. Nath

Abstract Frequent occurrences of extreme weather events such as droughts, floods, cyclones, and hailstorms—arguably caused by climate change—are likely to increase food insecurity across the globe, especially in developing countries. They pose formidable challenges to achieving the United Nations Development Program's (UNDP) Sustainable Development Goal (SDG) of ending hunger and ensuring access by all to safe, nutritious, and sufficient food all year round by 2030. Using household survey data for eight states of India's Northeast Region (NER) obtained from the India Human Development Survey for 2011–12, this chapter empirically analyzes the incidence, intensity, and inequality of food insecurity among the households in the region, which is known for its remoteness and relative economic destitution. Applying econometric techniques to household data and village-level weather data, it further investigates the impact of the extreme weather events on food insecurity after controlling for several demographic and socio-economic factors. The results of this exercise indicate that extreme weather events interact with household income to significantly increase the likelihood of food insecurity in the short as well as long run, although they do not have statistically significant impacts on their own. Further, there is some evidence of floods and hailstorms increasing the likelihood of food insecurity through their interactions with the household income in the long run. Similarly, the results suggest that droughts and floods increase the probability of food insecurity through their interactions with the distance to the market and household income in the short run. These results are robust to the inclusion of additional control variables and the use of alternative functional assumption of the regression model.

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5.1 Introduction

The 2020 Global Hunger Report (GHR) suggests that there are a large number of countries that are still vulnerable to food and nutrition insecurity.[1] Although the level of hunger at the global level is currently moderate, there are regions where it is still severe. According to *The State of Food Security and Nutrition in the World 2020*, a report jointly prepared by the Food and Agricultural Organization (FAO) of the United Nations, International Fund for Agricultural Development (IFAD), the United Nations International Children's Emergency Fund (UNICEF), World Food Programme (WFP), and the World Health Organization (WHO), nearly 746 million people (9.7% of the world population) were severely food insecure in 2019 (FAO et al. 2020). However, there are regional variations. For example, this proportion of severely food insecure people is 19% in Africa and 17.8% in South Asia. Furthermore, the prevalence of moderate or severe food insecurity in the world increased from 22.7% in 2014–16 to 25.5% in 2017–19. In South Asia, it increased from around 31 to 33.4% during the same period (FAO et al. 2020). The regions with higher incidence of hunger remain extremely vulnerable to food and nutrition insecurity. Health, economic, and environmental crises intensify this vulnerability.[2] As noted in the above report, climate variability and extremes are two major factors undermining efforts to end hunger, food insecurity, and malnutrition (FAO et al. 2020). The developing countries where the agriculture sector is still the source of livelihood for a substantial portion of their populations are likely to suffer the most (Mandal and Sarma 2020). Climate change manifested in increases in average temperature and rainfall and their variability, and extreme weather shocks such as droughts and floods are likely to adversely affect the weather-sensitive agriculture sector in these countries. Mahato (2014) argues that the developing countries may experience an average decline of 10–25% in agricultural productivity by 2080s owing to climate change that in turn will affect food security considerably.

As a result of the Green Revolution introduced in the mid-1960s, India became self-sufficient in food production by the mid-1970s and had an unmanageable stock of food grains by the mid-1990s (Goswami 2018a). The production of both food grains and several non-food crops increased many folds over time (Narayanamoorthy 2017). In fact, India now exports food grains to many countries. Yet, India's rank as per the GHR 2020 was 94. South Asian countries like Sri Lanka and Nepal ranked much

[1] The concept of food (in)security has evolved over time. The World Food Summit in 1996 articulated the widely accepted definition of food security. It highlights four dimensions of food security, namely availability of sufficient food of proper quality; command over resources to access food; absorption of food to meet all the physiological needs; and stable supply of food at all times. Most studies on the topic use this framework to examine and understand various aspects of food (in)security.

[2] The report is available at: https://www.globalhungerindex.org/pdf/en/2020.pdf.

ahead of India at 64 and 73, respectively. Thus, prevalence of hunger continues to be a challenge despite more than adequate food production in India. Using data from FAO et al. (2020), Bansal (2020) estimates that while 27.8% of India's population suffered from moderate to severe food insecurity in 2014–16, this proportion rose to 31.6% in 2017–19. India alone accounted for 22% of the global burden of food insecurity, the highest for any country, in 2017–19 (Bansal 2020). While there are variations in vulnerability to hunger and food security across states, at the macro-level, climate change-induced challenges have threatened to exacerbate the problem of hunger and food security. For instance, Gupta et al. (2014) show that increase in temperature and erratic rainfalls are harmful for the yield of rice, one of India's primary crops.

India's Northeast Region (NER) accounts about 8% of total geographical area and approximately 3.8% of overall population of the country in 2011. The per capita income in the region is only 72% of that at the national level in 2013–14.[3] The region however shows lower prevalence of food insecurity. Mandal and Sarma (2020) present evidence to show that except for Meghalaya, the percentage of food insecure households in other states of the region is much lower compared to the national average. Yet, the concern remains as the region experiences extreme weather events frequently. NE India receives very high rainfall during the pre- and summer monsoon seasons. The excess rainfall results in landslide and flood that in turn cause extensive damage to crops. At times, life comes to standstill (Mahanta et al. 2012). In other words, there is a possibility that extreme weather events may render people food insecure in this part of India, at least transitorily.

Against this backdrop, the chapter investigates the impacts of extreme weather events on food insecurity in NER. While Mandal and Sarma (2020) examine the effect of rainfall deficiency (as a proxy for extreme weather shocks) on food security in the Indian context, there is no study that exclusively investigates the problem in case of NER. The specific environmental and socio-economic characteristics of the states in the region call for a study that exclusively focuses on these states. Thus, this study uses household survey data for eight NER states obtained from the India Human Development Survey for 2011–12, to empirically analyze the incidence, intensity, and inequality of food insecurity among the households in the region, which is known for its remoteness and relative economic destitution. Applying econometric techniques to household data and village-level weather data, it further investigates the impact of the extreme weather events on food insecurity after controlling for several demographic and socio-economic factors. The results of our analysis indicate that extreme weather events interact with household income to significantly increase the likelihood of food insecurity in the short as well as long run, although they do not have statistically significant impacts on their own. Further, there is some evidence of floods and hailstorms increasing the likelihood of food insecurity through their interactions with the household income in the long run. Similarly, the results suggest that droughts and floods increase the probability of food insecurity through their

[3] Calculated from the information available here: http://necouncil.gov.in/sites/default/files/uploadfiles/BasicStatistic2015-min.pdf.

interactions with the distance to the market and household income in the short run. These results are robust to the inclusion of additional control variables and the use of alternative functional assumption of the regression model.

The remainder of the chapter is organized as follows. Section 5.2 includes a brief review of the relevant literature. We discuss the data and methodology for our empirical analysis in Sect. 5.3. Section 5.4 presents and discusses the empirical results. We include a summary and a few concluding remarks in Sect. 5.5.

5.2 Literature Review

There is a growing literature on the effect of climate change on food insecurity. We can broadly divide the studies into two groups: (*i*) those that examine the relationship between broadly defined climate change and food insecurity and (*ii*) those that narrowly focus on the effect of extreme weather events—arguably a reflection of climate change—on food insecurity. In this section, we discuss some relevant studies in each category.

5.2.1 Climate Change and Food Insecurity

Through its complex interaction with the food system, climate change can affect all dimensions of food insecurity. It may affect the availability of food by adversely impacting crop yield and livestock production. Further, climate change may exacerbate food insecurity at the global level by reducing the size of arable land (Krishnamurthy et al. 2014). Iizumi et al. (2018) find that average yields of wheat, maize, and soybeans at the global level decreased by 1.8, 4.1, and 4.5%, respectively, due to climate change between 1981 and 2010. Using different methods, Zhao et al. (2017) also show negative impacts of the increase in temperature on crop yields. Several studies show that detrimental effects of climate change on crop yield and production will be severe with the increase in warming. Asseng et al. (2015) estimate that global wheat yield will reduce by 6% with one-degree increase in warming. Further, climate change may induce changes in pollination services, pest, and diseases and thereby can reduce yields of the crops. Bebber et al. (2014) report that pests and diseases have already changed as a consequence of climate change. Not only the grain crops, but fruits and vegetables are also likely to be affected (Mbow et al. 2019).

These effects are however region-specific and contingent upon concentrations of CO_2 and fertility levels. An increase in temperature will help agriculture in the temperate regions in terms of expansion of cropland, longer growing period, higher crop yields, and increased pasture productivity. The fourth IPCC report also shows that a moderate rise in temperature in mid- to high-latitude regions accompanied by an increase in CO_2 can be beneficial for the yields of rain-fed crops such as rice, wheat, and maize (Aberman and Tirado 2014). In contrast, in some tropical regions

such as Sub-Saharan Africa, land for multiple cropping will decline substantially (Schmidhuber and Tubiello 2007). The dry land areas, especially in the developing countries, may be affected more adversely by the climate change-induced food insecurity as these regions have low adaptive capacities (Shah et al. 2008). In dry and tropical regions, a small increase in temperature can reduce yields (Aberman and Tirado 2014). Iftikhar et al. (2014) find that climate change worsens food insecurity in Pakistan through reduction in production of crops, fruits, and vegetables, changes in the intensity of rainfall and floods, water shortage, and soil erosion. These effects of climate change also result in the loss of different physical and human assets. Using panel data for five African countries over the period of 2000–14, Mahrous (2019) analyzes the impact of global climate change on food security. The study presents evidence of a negative effect of rising temperature and of a positive effect of increasing rainfall on food security in the region.

Increased temperature and variability in rainfall affect the livestock systems through their impacts on animal health, availability of water, and so on. Changes in temperature and rainfall affect the quality and quantity of pasture, and thereby impact livestock. In particular, livestock systems are adversely impacted due to a reduction in feed quantity and quality and changes in disease and pest prevalence (Campbell et al. 2016). Brander (2010) suggests that spatial availability of marine species may change as they move in search of suitable habitats when ocean temperature and marine environment changes due to climate change.

The impact of climate change on crop yields and livestock systems is likely to be felt non-uniformly by different sections of the societies. It is not difficult to guess that the small and marginal farmers will be the hardest hit due to these impacts of climate change. The overwhelming dependence of the small farmers on agriculture and allied activities and given their limited resources for taking adaptive measures makes this category of farmers more vulnerable to climate change. While delving into the uneven impact of climate change, Krishnamurthy et al. (2014) emphasize that the number of malnourished children may increase in the developing world as a result of reduced availability, access, and food absorption capacity vis-à-vis advanced economies.

Climate change can also affect access to food. By affecting availability due to decreased yield and production and disrupting distribution, climate change may reduce access to food, primarily through making food costly (Krishnamurthy et al. 2014). In an integrated model, Nelson et al. (2014) simulate different climate change scenarios and find that agricultural production, prices, trade, and cropland area show the highest variability in response to climate change. Low-income households, women, and children are likely to be adversely affected to a larger extent due to higher prices of food and disruptive supply (Mbow et al. 2019).

Diet and health are the two channels through which climate change can impact food utilization (Aberman and Tirado 2014). The diet channel relates to the impact of climate change on the nutrient content of the food. In contrast, the health channel relates to water and food safety, and diseases and infections that impact human body's nutritional requirement and its ability to absorb nutrients. Due to heavy rainfall and

rise in sea level, flood may become frequent and that will expose people to diarrhea and other infectious diseases. The risk of animal diseases getting transmitted to human may increase with climate change due to survival of pathogens and changes in carriers and natural ecosystems. Besides, the temporal and spatial distribution of the vector-borne diseases may change. The exposure to these diseases will reduce the ability to absorb the nutrients in the food and increase the nutritional needs (Krishnamurthy et al. 2014). Climate change may create a vicious cycle wherein infectious diseases reduce the capacity of the body to absorb food and thereby making more susceptible to infectious diseases. The overall impact of such developments can be reduced labor productivity and increased poverty as well as mortality (Schmidhuber and Tubiello 2007).

Changes in the climate, such as increasing temperature, impact a host of biological process (such as metabolic rate) in plants and animals, which in turn affect the nutrient concentrations. Further, increased concentration of CO_2 in the atmosphere reduces the availability of zinc and other nutrients in foods (Mbow et al. 2019). Consequently, the quality of food declines and that in turn affects utilization of food. Taub (2010) documents that protein concentration in some important crops declines as CO_2 increases in the atmosphere. The concentrations of other minerals such as calcium and magnesium may also fall with increased CO_2. However, these changes vary markedly across regions. Nelson et al. (2018) suggest that climate change alters the availability of micronutrient in some regions more than in others.

Climate change may affect food security by affecting the storage system as well. One of the adaptive responses to climate change is to store food safely so that food is available during contingency. However, Moses et al. (2015) present evidence to suggest that the grain storage is affected by increased temperature that creates favorable conditions for the growth of insects and pests. Consequently, it may become difficult to store food and make it available throughout the year.

In the Indian context, a large number of studies examine the effects of climate change on crop yields. Birthal et al. (2014) analyze the impact of changes in temperature and rainfall on the yields of some major crops in India during the period from 1969 to 2005. The study finds that an increase in maximum temperature has a negative effect on crop yields although an increase in minimum temperature has a positive effect. As per the study, the crops that are more vulnerable to increased temperature are pigeon pea, chickpea, rice, and wheat. In contrast, evidence suggests that increased rainfall has a positive effect on majority of the crops. Gupta et al. (2014) also show that increase in temperature and erratic rainfalls are harmful to the rice yield in India. Birthal et al. (2014) project respective declines of 15 and 22% in rice and wheat yields by 2100 in case of significant changes in temperature and rainfall. Given that India has agricultural land constraint, a decrease in yields of main crops like rice and wheat has important implication for food security. The study further suggests that climate change will impact food security through its impact on livestock systems as well. Any fall in crop area or production will result in less fodder supplies and will reduce production of livestock. While Kumar et al. (2015) analyze the impact of climate change on the yield of an important crop, i.e., potato in the Indo-Gangetic Plains, Boomiraj et al. (2010) conduct a similar study in case

of mustard. Saseendran et al. (2000), Aggarwal and Mall (2002), Mandal and Nath (2018) examine the impact of climate change on rice yields, and Dubey et al. (2014) do the same in case of wheat.[4] A review of these studies shows that the empirical evidence of the impacts of climate change in Indian agriculture has been mixed.

5.2.2 Extreme Weather Events and Food Insecurity

Climate change is expected to result in increased frequency and magnitude of extreme weather events such as drought, flood, heat wave etc. (IPCC 2018). Such extreme weather shocks will not only affect production, trade, and thereby availability of food but will also increase food prices. The overall impact would be reduced access and increased food insecurity.

Jahn (2015) and Beer (2018) discuss the potential impact of various extreme weather events on different sectors of the economy over time. Crop damages and the resulting shortfall in the availability of food due to flood, storm, and drought are major losses in the agricultural sector in the short run. Flood may cause deterioration in the soil quality by dumping polluting materials, and this negative effect may last for a long time. In the long run, extreme weather events may cause diseases in crops and silting of irrigation channels. Floods can damage natural organic resources. Storms can damage forest and marine ecosystems. Droughts have detrimental effect on both plants and animals. All these effects of extreme weather events have implications for food security. Besides these direct effects, extreme weather events may affect other sectors of the economy, such as energy and transport, and result in significant loss of incomes, which in turn worsen food insecurity. Further, extreme weather shocks by destroying transport system, storage, and other essential infrastructure can disrupt supply chains thereby impacting both availability of and access to food.

Misra (2014) suggests that frequency and intensity of droughts and floods will increase with the rise in temperature. Further, due to reduced infiltration of surface water in arid and semi-arid areas, restoration of groundwater is likely to be unsustainable. In coastal areas, due to infiltration of salt water as a result of rise in sea level, groundwater may become unusable. These developments will threaten food production and hence food security. Change in cropping pattern, crop breeding, and use of such technologies that use less water are some of the adaptive measures to be adopted. Using field data from Pakistan, Ali and Erenstein (2017) also identified major adaptation measures practiced by the farmers. These measures include adjustment in sowing time, use of drought tolerant varieties, and shifting to new crops. Further, they find that farmers who implement these adaptation measures are likely to have better food security.

There exist some country-specific studies that investigate the impact of extreme weather events on food security. Using a spatial bio-economic modeling framework,

[4] For an exhaustive review of the existing literature on the impacts of climate change in Indian agriculture, see Mandal and Nath (2018).

Gbegbelegbe et al. (2014) assess the implications of the extreme weather of 2012 in the USA for food security in the developing countries. The study finds evidence of negative impacts of extreme weather on food security. In particular, those extreme weather conditions reduced maize production substantially in the USA. The global production also declined. Although consumption in the USA did not decline much, exports of maize from the USA fell. The fall in global production and US exports increased food insecurity in the Eastern Africa, the Caribbean and Central America, and India. The study further analyzes the impact of a similar weather shock if that were to occur in 2050. With the assumption that there will not be any climate change adaptation, the study predicts that the impact of such weather extremes on global food insecurity will be worse.

Beer (2018) studies the aftermath of two tropical cyclones, namely Yasi of 2011 and Larry of 2006 in Australia. Both cyclones destroyed substantial quantity of banana crops in the country resulting in short supply of the fruit for the rest of the respective years. Further, price of banana increased by 400–500% throughout the country.

Hussain et al. (2016) examine the impacts of extreme weather shocks on agriculture and household food security in the Hindu-Kush Himalayan (HKH) region. The study uses data on more than 8000 households from Pakistan, India, Nepal, and China. Most households reported to have experienced frequent floods, droughts, landslides, livestock diseases, and crop pests. This climate-related irregularities resulted in low agricultural production and income. The study also reports that the households experienced transitory food insecurity after the extreme weather events.

While there exist a large number of studies that analyze the impact of climate change on agriculture (especially on average yield and variability in yields of major crops), we came across only one study on the impact of extreme weather events on food security in India. Mandal and Sarma (2020) analyze the impact of weather shock—deviation of rainfall from the normal level—on food insecurity of households in India. They find a positive impact of erratic rainfall on food insecurity. The study suggests that erratic rainfall is harmful to agriculture, and by reducing agricultural output, it worsens food insecurity.

Given that the work on the issue under consideration is scanty in the Indian context, the present work will be a major addition to the literature.

5.2.2.1 Other Determinants of Food Insecurity

This section presents a brief discussion of the factors other than climate change and extreme weather events that may affect household food security. These factors are namely various household demographic characteristics, income and asset position, access to basic services, social safety nets, use of improved agricultural inputs, access to credit, and access to extension services (Mandal and Sarma 2020 and Beyne 2016). In our investigation of the impacts of extreme weather events on food insecurity, we consider some of these variables as covariates.

The household demographic characteristics include age and education level of the head of household, family size, and proportion or number of dependent family members. For households with agriculture as the primary source of income, the presence of an elderly head may be helpful for farming due to his or her experience (Haile et al. 2005). Further, experience may also help coping with risk and thereby may contribute positively to food security. Higher level of education is likely to impact food security positively (Beyne 2016). A household with higher dependency ratio is more likely to be food insecure. Even if a household has food security, intra-household inequality may lead to food insecurity at least for some members of the family. The dependent family members, such as housewives, children, and elderly people, may be at higher risk (Mbow et al. 2019). Thus, the gender and age composition of the household also matters.

Mandal and Sarma (2020) in their study in the Indian context use 'highest educational attainment of the female members of the household' also as a relevant variable that impacts food security. Educated women are more likely to be aware of the nutritional content of food, and hence, it is expected that expenditure allocation on nutritious food and thereby food security improves with the increase in the education of the female members of the household. The impact of family size on food security is ambiguous. While more family members imply higher demand for food, it also suggests higher availability of workers to earn income and food, especially if the household has more working age members. Household income and asset position have positive impact on food security. It is obvious that a household with higher income is better positioned to access food and hence likely to have higher food security. Further, assets in the form of agricultural land, livestock, and other non-agricultural assets allow a household to tide over contingencies. These assets work as insurance and ensure food security. Tesso et al. (2012) suggest that household with a diversified source of income is more capable of coping with risk relative to a household with only a single source of income and therefore is more food secure. Mandal and Sarma (2020) also hypothesize that households with cultivation as the primary source of income are likely to be food secure. The same study also suggests that households that receive remittances from migrating family members can spend more on food. The study also finds that urban and poor households are more likely to be food insecure.

The use of improved agricultural inputs increases yield and production, which in turn increases the availability of food and income that can be spent on food items that are not grown by the household. The access to extension services helps farmers in diversifying crop portfolio and also in growing cash crops (Goswami 2018b; Goswami and Bezbaruah 2017). A diversified cropping pattern and higher income generation through the cultivation of cash crop can positively impact food security. The access to credit also has a similar effect like that of access of extension services (Goswami 2018b).

Further, the access to basic services such as water facility, health center, and market is also important determinant of household-level food security. It helps households in managing health and food shocks. The presence of social safety nets is also important

for ensuring food security. During times of emergency due to health, income, or environmental crises, assistance received through social safety nets, such as local government institutions or NGOs, can help in stabilizing food supply at the household, local, and regional levels (Beyne 2016).

5.3 Data and Methodology

5.3.1 Data Source and Study Sample

This study is based on secondary data compiled from the second round of *India Human Development Survey* (IHDS-II). The reference year for this round is 2011–12. The IHDS is a nationally representative sample survey conducted jointly by the University of Maryland, College Park (USA), and the National Council of Applied Economic Research (NCAER), New Delhi (India). Because the present study focuses on the Northeast Region (NER) of India, we obtain household-level data from this source only for the eight states of the region that includes Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. The IHDS-II provides data on various dimensions of human development. However, we obtain data only on the variables that are relevant for the current study. The total number of observations in our sample is 1887. Table 5.1 presents the distribution of households and individuals by states in our sample.

Table 5.1 State-wise distribution of the sample households in NER

States	Number of sample households	Number of sample persons (% share in total for NER)	Percentage distribution of population in 2011 (%)
	(1)	(2)	(3)
Arunachal Pradesh	159	668(7.62)	3.0
Assam	991	4651(53.08)	68.6
Manipur	88	481(5.49)	5.7
Meghalaya	134	686(7.83)	6.5
Mizoram	78	347(3.96)	2.4
Nagaland	110	508(5.80)	4.3
Sikkim	107	503(5.74)	1.3
Tripura	220	919(10.49)	8.1
Total (NER)	1887	8763(100.00)	100

Source: Authors' estimation based on IHDS-II, 2011–12 and the Indian Census 2011

5.3.2 Methodology

5.3.2.1 Defining Food Insecurity Line

In order to measure the magnitude of food insecurity, we construct three alternative aggregate measures of food insecurity.[5] The first step toward obtaining an aggregated measure of food insecurity involves identifying the households that are food insecure. To that end, we discuss and define food insecurity lines—thresholds that help such identification—for rural and urban households living in different states of NER.

The food insecurity lines in this chapter have been defined following Mandal and Sarma (2020). It may be noted that it is not only the quantity of food available and accessible but also its nutritional contents that are important from food security point of view. As Nandakumar et al. (2010) argue, the issue of food security is not so much about availability of food grains but about the composition of the overall food basket.[6] Therefore, keeping in view nutritional requirements, the food insecure households are identified as follows. The Expert Group's report to the Planning Commission (Government of India 2014) outlines the normative requirements of expenditure on food comprising calories, proteins, and fats.[7]Following the recommendation of this report, we define monthly per capita food expenditures of Rs. 554 and Rs. 656 (2011–12 prices) on calorie, protein, and fat as the respective food insecurity line for rural and urban areas. These national average food insecurity lines are then adjusted by relevant price indices to estimate state-specific food insecurity lines (separately for rural and urban areas) so as to capture spatial differentials in the price level.[8] A household with per capita monthly expenditures on calories, proteins, and fats below this benchmark is considered to be food insecure.[9] Table 5.2 presents the national and state-specific food insecurity lines.

5.3.2.2 Measuring Food Insecurity

After we identify the food insecure households, we calculate three aggregate measures of food insecurity: head count ratio (HCR), food insecurity gap index

[5] We borrow the basic ideas from the poverty measurement literature.

[6] A change in the consumption patterns from cereals to high-value food is observed in both rural and urban areas of India.

[7] This Expert Group was constituted in June 2012 by the Planning Commission under the Chairmanship of Dr. C. Rangarajan to suggest a methodology for measuring poverty in India. It re-computed the average requirements of calories, fats, and proteins on the basis of the 2010 Indian Council of Medical Research norms (Government of India 2014).

[8] See Mandal and Sarma (2020) for details.

[9] For the items that are either home grown or obtained through the Public Distribution System at a subsidized rate by a household, imputed values of expenditure on those items were calculated on the basis of their existing market prices.

Table 5.2 Food insecurity lines for NER states

States	Food insecurity line (2011–12 INR)	
	Rural	Urban
	(1)	(2)
Arunachal Pradesh	656.03	691.41
Assam	573.75	662.12
Manipur	675.51	728.16
Meghalaya	633.04	710.72
Mizoram	701.64	794.44
Nagaland	700.95	753.34
Sikkim	641.92	719.25
Tripura	533.21	641.80
All India	*554*	*656*

Source: Authors' calculation from IHDS-II, 2011–12

(FIGI), and squared food insecurity gap index (SFIGI).[10] These measures are defined as follows:

$$\text{HCR} = \frac{N_{FI}}{N} \tag{5.1}$$

$$\text{FIGI} = \frac{1}{N} \times \sum_{i=1}^{N} \left(\frac{G_i}{L} \right) \tag{5.2}$$

$$\text{SFIGI} = \frac{1}{N} \times \sum_{i=1}^{N} \left(\frac{G_i}{L} \right)^2 \tag{5.3}$$

where $N$is the population size, N_{FI} is the number of food insecure persons, $L$is the food insecurity line, and G for food insecurity gap which is the gap between the actual per capita monthly expenditure on calories, proteins, and fats, and L (as defined in Sect. 3.2.1). We assign a value of 0 to G for the food secure households.

HCR measures the incidence of food insecurity in terms of the percentage of people who are food insecure. While it is easy to calculate and interpret, it cannot capture the depth and inequality of food insecurity among the insecure households. In contrast, FIGI captures the depth of food insecurity by measuring how far the food insecure people, on average, are away from the food insecurity line. Its value also shows the cost of eliminating food insecurity. However, FIGI does not reflect inequality or its severity among the food insecure people. This problem is alleviated by SFIGI, which is sensitive to inequality among the food insecure people. That is, if

[10] These are analogous to head count ratio, poverty gap index, and squared poverty gap index in the literature on poverty measurement.

the distribution of per capita monthly expenditure on food is changed by transferring some amount from one food insecure household to another then the value of the index changes.[11] Thus, these three measures of food insecurity reflect its incidence, depth, and inequality, respectively.

5.3.2.3 Examining the Determinants of Food Insecurity

We now use a binary logistic regression model to examine the potential determinants of food insecurity at the household level with a special focus on extreme weather events.[12] The general specification of the model is as follows[13]:

$$P(FI_i = 1|x_i, \beta) = 1 - \left(\frac{e^{-x_i'\beta}}{1 + e^{-x_i'\beta}}\right) = \left(\frac{e^{x_i'\beta}}{1 + e^{x_i'\beta}}\right) = \left(\frac{e^z}{1 + e^z}\right) = F(z) \tag{5.4}$$

where $F(z)$ is the cumulative distribution function for a standard logistic random variable. Here, FI_i indicates the food insecurity status of the ith household, and it takes a value of 1 if a household is food insecure and 0 otherwise. x_i is the vector of explanatory variables that potentially affect food insecurity status of the households. It includes extreme weather events (drought, floods, cyclones and hailstorms) as the variable of interest. In our baseline estimation, we use two dummy variables alternatively to examine the long-run and short-run impact of extreme weather events on food insecurity. Note that we define these variables at the village level. Thus, the long-run dummy variable takes the value of 1 if one or more extreme weather events occurred in a village during a five-year period from 2007 to 2011 and 0 otherwise. Similarly, the short-run dummy variable takes the value of 1if one or more extreme weather events occurred in a village during 2011 and 0 otherwise. We argue that the extreme weather events variable captures the stability of food supply aspect of food insecurity.

We further consider a number of variables that are potential determinants of food insecurity. Each variable is likely to affect one of the three other aspects of food insecurity, namely availability, accessibility, and utilization. We list them below by these three aspects to indicate the likely mechanism of their impacts on food insecurity.

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[11] In the context of poverty measurement, this is known as 'Pigou-Dalton Transfer Principle'. According to this principle, if some income is transferred from a not-so poor to a relatively poorer individual, then social welfare must increase and vice versa.

[12] For this, household-level data is combined with village-level data. Note that data on the variable of interest—extreme weather events—is available only for the villages. Therefore, we use the survey data only for the rural households for our regression analysis.

[13] See Greene (2012) or Wooldridge (2000)

A. Availability

(i) Distance to the nearest market (in kilometer)
(ii) Distance to the nearest *kirana* store (in kilometer)
(iii) Household size (in number of household members)

B. Accessibility

(i) Poverty (a dummy variable that takes the value 1 if the household is below the poverty line and 0 otherwise)
(ii) Per capita income (in 2011–12 Indian Rupee)
(iii) Remittances (in 2011–12 Indian Rupee)
(iv) Nonfarm income (a dummy variable that takes the value 1 if the household earns any nonfarm income and 0 otherwise)
(v) MGNREGA income (a dummy variable that takes the value 1 if any member of the household receives income under MGNREGA and 0 otherwise)
(vi) Share of food items in total household consumption expenditure (2011–12 Indian Rupee)
(vii) Dependents (number of household members younger than 15 or older than 64)

C. Utilization

(i) Highest level of adult education (in number of years)
(ii) Highest level of male adult education (in number of years)
(iii) Highest level of female adult education (in number of years)

In our baseline specifications, we do not include the distance to the kirana store as it is highly correlated with the distance to the nearest market. Further, we include the highest level of adult education as the only utilization variable. We consider the other two by gender for our sensitivity analysis. We do not include any village-level fixed effects as there are other village-level variables including our variables of interest.

Finally, we include religion, caste categories, and state fixed effects as additional controls. In particular, we add dummy variables for being Muslim, Christian, and others with Hindu being the benchmark group. Similarly, we incorporate dummy variables for households belonging to Other Backward Caste (OBC), Scheduled Caste (SC), Scheduled Tribe (ST), and others with those belonging to the general category being the benchmark. For the states, dummy variables are added with Assam as the benchmark.

5.4 Empirical Results

In this section, we present and discuss the results from our empirical analysis. We first present the aggregate food insecurity measures. We then present and discuss the results from our regression analysis. In addition to the baseline results, we also include results from a variety of sensitivity analyses.

5.4.1 Extent of Food Insecurity Across NER States

Table 5.3 presents the aggregate measures of food insecurity for eight states of NER. Column 2 of the table shows that about 29% of sample persons (HCR) in the region are food insecure with marked variations across different states of the region. The proportion of food insecure people is as high as 60% in Meghalaya and about 50% in Sikkim. With about 31% of the sample persons being food insecure, Assam, the most populous state in the region, ranks third. In contrast, Nagaland has the lowest incidence of food insecurity with an HCR value of 4%.

The food insecurity gap index (FIGI), a measure of the depth of food insecurity, shows that each food insecure person in NER, on average, needs about 7% of the required monthly per capita food expenditure (on calories, protein, and fat) to get out of food insecurity. However, this gap varies between 21% in Meghalaya and less than 1% in Nagaland. Further, the inequality among food insecure people—as captured by SFIGI—is the highest in Meghalaya, followed by Sikkim and Assam. Thus, these measures reflect the variations in incidence, depth, and inequality of food insecurity among the NER states. In all three counts, Meghalaya and Nagaland are respectively the worst and best-performing states.

Table 5.3 Measures of food insecurity by states in NER

States	HCR (%)	FIGI (%)	SFIGI (%)
	(1)	(2)	(3)
Arunachal Pradesh	21.41	4.86	2.15
Assam	30.90	7.09	2.67
Manipur	22.66	2.33	0.40
Meghalaya	59.91	21.30	9.58
Mizoram	10.95	1.92	0.57
Nagaland	4.13	0.63	0.10
Sikkim	49.70	10.61	3.23
Tripura	17.63	4.11	1.44
Total (NER)	29.34	7.08	2.72

Source: Authors' calculation from IHDS-II, 2011–12

5.4.2 Regression Results

In this section, we present the regression results for the binary response model. We first present the logistic regression results for our baseline specifications in Subsect. 4.2.1. In order to investigate the robustness of our results with respect to the extreme weather event variables—the variables of interest—we conduct several sensitivity exercises with models that (i) include separate dummy variables for four types of extreme weather events, namely drought, flood, cyclone, and hailstorm; and (ii) include additional control variables. We also estimate Probit regression models of the basic specifications to examine the robustness of the results to different functional assumption. We present these results in Subsect. 4.2.2.

5.4.2.1 Baseline Specifications

We estimate four baseline models. In Model 1, we include long-run extreme weather event dummy variable—as defined in Sect. 5.3—as the variable of interest in addition to a number of control variables that capture availability, accessibility, and utilization aspects of food insecurity. Model 2 includes the short-run extreme weather event dummy variable as an alternate variable of interest. In Models 3 and 4, we include interactions of the extreme weather event variables with distance to the market (an availability variable) and per capita income (an accessibility variable). Table 5.4 presents the coefficient estimates of the logistic regression model.

Columns (1) and (2) of Table 5.4 indicate that the extreme weather events on their own do not have any significant impact on the probability of being food insecure irrespective of whether we consider a long-run or a short-run time horizon. However, the results in Columns (3) and (4) suggest that extreme weather events significantly increase the probability of being food insecure via their interactions with per capita income. However, the interactions with the distance to the market are not statistically significant. The marginal effects presented in Table 5.5 indicate that occurrence of such event during the past five years increases the probability of food insecurity by 0.008 or 0.8% (Col. 3) when we take into account these interactions. Further, an occurrence in the immediate past increases the probability by 0.122 or 12.2%. Thus, an extreme weather event has a much larger impact on the probability of being food insecure in the short run. In the long run, households may have more room to adapt in a way of avoiding food insecurity.

Among the control variables, distance to the market, being poor, and household size have significant positive impacts on the probability of food insecurity. Thus, as expected, the longer the distance to the nearest market, the higher is the probability of being food insecure. Longer distance to the market may reduce the availability of food. The households below the poverty line are likely to be more food insecure. More specifically, a poor household is about 77% (see Table 5.5) more likely to be food insecure. Similarly, larger households are more likely to be food insecure. This result is consistent with those presented in Joshi and Joshi (2016), Sekhampu

Table 5.4 Logistic regression results: baseline specifications

Explanatory variables	Estimated coefficients			
	Mode1 1	Model 2	Model 3	Model 4
	(1)	(2)	(3)	(4)
Constant	2.55[c] (0.63)	2.41[c] (0.63)	2.76[c] (0.66)	2.56[c] (0.64)
Extreme weather over 2007–11	−0.19 (0.24)		−0.72[a] (0.39)	
Extreme weather in 2011		0.12 (0.26)		−0.73[a] (0.39)
Distance to the market	0.05[c] (0.01)	0.05[c] (0.01)	0.05[c] (0.02)	0.05[c] (0.02)
Poverty dummy	4.14[c] (0.26)	4.12[c] (0.26)	4.18[c] (0.27)	4.14[c] (0.26)
Household size	0.23[c] (0.06)	0.23[c] (0.06)	0.24[c] (0.06)	0.24[c] (0.06)
Per capita income	−0.00003[c] (0.000007)	−0.00003[c] (0.000007)	−0.00004[c] (0.00001)	−0.00004[c] (0.000008)
Remittance	0.000004 (0.000003)	0.000004 (0.000004)	0.000002 (0.000003)	0.000001 (0.000004)
Nonfarm income dummy	−0.57[a] (0.31)	−0.58[a] (0.31)	−0.57[a] (0.31)	−0.55[a] (0.32)
Food expenditure share	−0.09[c] (0.01)	−0.09[c] (0.009)	−0.09[c] (0.009)	−0.09[c] (0.009)
Dependence ratio	0.22 (0.16)	0.22 (0.16)	0.23 (0.16)	0.25 (0.16)
Education level of an adult member	−0.04 (0.03)	−0.04 (0.03)	−0.04 (0.03)	−0.04 (0.03)
Extreme weather over 2007–11 × Distance to the market			−0.0002 (0.06)	
Extreme weather over 2007–11 × Per capita income			0.00002[b] (0.00001)	
Extreme weather over 2011 × Distance to the market				0.08 (0.07)
Extreme weather over 2011 × Per capita income				0.00003[c] (0.00001)
Other backward caste	−0.84[b] (0.39)	−0.87[b] (0.39)	−0.88[b] (0.40)	−0.96[b] (0.40)
Scheduled caste	−0.47 (0.44)	−0.53 (0.44)	−0.38 (0.43)	−0.49 (0.43)
Scheduled tribe	−0.18 (0.39)	−0.23 (0.39)	−0.12 (0.39)	−0.22 (0.40)

(continued)

Table 5.4 (continued)

Explanatory variables	Estimated coefficients			
	Mode1 1	Model 2	Model 3	Model 4
	(1)	(2)	(3)	(4)
Others	−0.65 (0.95)	−0.44 (0.94)	−0.80 (0.93)	−0.70 (0.90)
Muslim	0.04 (0.40)	−0.04 (0.41)	0.10 (0.40)	0.14 (0.42)
Christian	0.11 (0.63)	0.13 (0.62)	0.17 (0.64)	0.12 (0.64)
Other religion	0.69 (0.45)	0.72 (0.45)	0.63 (0.45)	0.53 (0.44)
State fixed effects	Yes	Yes	Yes	Yes
McFadden R	0.47	0.47	0.48	0.48
Likelihood ratio test	644.11	643.71	649.93	654.42
p-value	0.00	0.00	0.00	0.00
Observations	1103	1103	1103	1103

Note: Standard errors are in parentheses. [a]significant at the 10% level; [b]significant at the 5% level; [c]Significant at the 1% level

(2017), and Agidew and Singh (2018). Per capita income that provides the means to procure food has a statistically significant negative impact, and this result accords well with those reported by Bashir et al. (2012), Maziya et al. (2017), Sekhampu (2017), and Ngema (2018). Thus, households with higher per capita income are less likely to be food insecure. Having a nonfarm source of income also significantly reduces the likelihood of being food insecure. Furthermore, households that spend a larger proportion of their consumption expenditure on food items are, as expected, less likely to be food insecure.[14] Our results indicate that remittances, number of dependents, and the highest level education of an adult member of the household are not significant determinants of food insecurity.

Among the socio-cultural controls, only belonging to OBC has significant impact on the probability of being food insecure. Our results indicate that the households belonging to the Other Backward Castes are 14–15% less food insecure than those belonging to the general castes. This result can be explained by the fact that people belonging to some OBCs are economically successful although they may be

[14] In the context of the developing countries, the proportion of food expenditure is sometimes taken as a proxy for economic status of a household. As per Engel's law, with improvements in economic condition, people tend to have a lower proportion of food expenditure. Thus, this result seems to have contradicted our results with respect to poverty and per capita income. However, we need to recognize that the estimated coefficient of food expenditure share reflects the effect of food expenditure share after controlling for poverty and per capita income.

Table 5.5 Marginal effects of explanatory variables based on the logistic regression results

Explanatory variables	Model 1	Model 2	Model 3	Model 4
	(1)	(2)	(3)	(4)
Extreme weather over 2007–11	−0.037		0.008	
Extreme weather in 2011		0.024		0.122
Distance to the market	0.001	0.001	0.002	0.001
Poverty dummy	0.773	0.772	0.776	0.774
Household size	0.007	0.006	0.007	0.006
Per capita income	−0.0000008	−0.0000007	−0.0000008	−0.0000010
Remittance	0.0000001	0.0000001	0.0000001	0.0000000
Nonfarm income dummy	−0.104	−0.024	−0.028	−0.023
Food expenditure share	−0.003	−0.002	−0.003	−0.002
Dependence ratio	0.006	0.006	0.007	0.006
Education level of an adult member	−0.001	−0.001	−0.001	−0.001
Other Backward Caste	−0.140	−0.140	−0.147	−0.151
Scheduled Caste	−0.085	−0.092	−0.072	−0.086
Scheduled Tribe	−0.037	−0.046	−0.024	−0.042
Others	−0.111	−0.077	−0.133	−0.114
Muslim	0.009	−0.008	0.021	0.028
Christian	0.023	0.026	0.034	0.023
Other religion	0.155	0.158	0.139	0.113

Source: Authors' calculation using the results presented in Table 5.4

Note: The marginal effects for the continuous variables are calculated by using the mean values of the continuous variables in the following equation. For the discrete (dummy) variables, we simply take the difference between $P(FI_i = 1|x)$ and $P(FI_i = 0|x)$ with these probability values evaluated at mean values of other variables: $\frac{-\partial p}{\partial x_i} = \frac{\widehat{\beta_i} e^{x'\hat{\beta}}}{\left(1+e^{-x'\hat{\beta}}\right)^2}$

socially backward (e.g., Galanter 1978). Our results also indicate that the households belonging to religious minority communities are more likely to be food insecure than their Hindu counterparts. However, these differences in probability are not statistically significant.

We also include state fixed effects (results not reported). A test of joint significance of these fixed effects indicates that they are relevant. As discussed in Sect. 5.3, we use Assam as the benchmark state. The results indicate that the probability of food insecurity is significantly higher in Sikkim. Further, this probability is higher in Meghalaya and lower in Mizoram than that in Assam, but these differences are not statistically significant. Other states experience significantly lower likelihood of food insecurity than does Assam.

5.4.2.2 Robustness Results

The effects of extreme weather events on the probability of food insecurity may vary by the types of such events. Therefore, we now include separate dummy variables—both long run (at least an event occurring during 2007–11) and short run (at least an event occurring in 2011)—for drought, flood, cyclone, and hailstorm instead of one extreme weather event dummy in our baseline specifications. Since the coefficient estimates for the control variables are very similar to those included in Table 5.4, we present only those for the extreme weather events and their interactions with the distance to the market and per capita income in Table 5.6.

Columns (1) and (2) of Table 5.6 indicate that with no interactions, only drought seems to increase the probability of food insecurity in the short run. As the coefficient estimates for the interaction terms in Col. (3) indicate, flood and hailstorm

Table 5.6 Logistic regression results for different types of extreme weather events

Explanatory variables	Estimated coefficients			
	(1)	(2)	(3)	(4)
Drought	−0.05 (0.37)	0.92[b] (0.45)	0.55 (0.63)	−3.49[b] (1.52)
Flood	−0.35 (0.27)	−0.47 (0.31)	−1.23[c] (0.43)	−1.46[c] (0.45)
Cyclone	−0.14 (0.45)	0.04 (0.04)	1.76[a] (0.92)	0.70 (0.67)
Hailstorm	0.53 (0.43)	0.004 (0.49)	1.05 (0.87)	3.49[c] (1.22)
Drought × Distance to the market			−0.18 (0.16)	1.56[b] (0.64)
Flood × Distance to the market			0.09 (0.07)	0.16[b] (0.08)
Cyclone × Distance to the market			−2.13 (1.43)	−0.34 (1.47)
Hailstorm × Distance to the market			−0.45 (0.32)	−0.90[c] (0.34)
Drought × Per capita income			0.000003 (0.00002)	0.00003[a] (0.00002)
Flood × Per capita income			0.00002[a] (0.00001)	0.00003[b] (0.00001)
Cyclone × Per capita income			0.00005 (0.00004)	0.00003 (0.00003)
Hailstorm × Per capita income			0.00002[a] (0.00001)	0.00001 (0.00002)

[a]significant at 10% level; [b]significant at 5% level; [c]significant at 1% level
Note: Standard errors in parenthesis
Source: Authors' estimation

significantly increase the likelihood of food insecurity in the long run through their interactions with household per capita income. Furthermore, droughts and floods interact with both availability (as captured by the distance to the market) and accessibility (as captured by per capita income) to significantly increase the probability of food insecurity in the short run.

We now add a number of additional control variables to our basic specifications following suggestions from the extant literature. These variables include: age of the male head of the household, the age of the female head of the household, the distance to the nearest kirana store, income from MGNREGA, and highest level of education of the male and female members of the household separately (instead of any adult member). In the models with interactions, we also include interactions of the extreme weather event variable with the distance to the local kirana store. In the interest of saving space, we do not report the coefficient estimates for the control variables. Thus, Panel B of Table 5.7 reports the coefficient estimates for the variables of interest along with their interactions with other control variables. For the ease of comparison, we include the coefficient estimates from our baseline specifications in Panel A of the table. The table shows the coefficient estimates for the extreme weather event variables, and their interactions with distance to the market and per capita income are mostly similar in sign and statistical significance. There are two differences. *First*, the estimated coefficient for the interaction between long-run extreme weather event and distance to the market is negative in the baseline models, whereas it is positive in the extended model (Col. 3). However, they are both statistically insignificant. The extended model includes another distance variable, namely the distance to the kirana store. As we mentioned earlier, these two distance variables are highly correlated (a correlation coefficient of 0.64) and that may have driven this result. *Second*, the estimated coefficient for the short-run extreme weather event is negative and statistically significant at the 10% level in the baseline model. However, it is not statistically significant, although negative, in the extended model.

We also estimate Probit regression models of our baseline specifications. The estimated coefficients are qualitatively the same in terms of their signs and statistical significance.[15]

Overall, our results suggest that extreme weather events interact with household per capita income to significantly increase the likelihood of food insecurity in the short as well as long run. Further, there is some evidence of floods and hailstorms increasing the likelihood of food insecurity through their interaction with the household income in the long run and droughts and floods through their interactions with the distance to the market (availability) and household income (accessibility) in the short run. These results are robust to the inclusion of additional control variables and the use of alternative functional assumption of the regression model.

[15] To save space, we do not report the results here. However, interested reader may request.

Table 5.7 Logistic regression results: extended specifications

Explanatory variables	Estimated coefficients			
	Model 1	Model 2	Model 3	Model 4
	(1)	(2)	(3)	(4)
Panel A: baseline models				
Extreme weather over 2007–11	−0.19 (0.24)		−0.72[a] (0.39)	
Extreme weather in 2011		0.12 (0.26)		−0.73[a] (0.39)
Extreme weather over 2007–11 × Distance to the market			– 0.0002 (0.06)	
Extreme weather over 2007–11 × Per capita income			0.00002[b] (0.00001)	
Extreme weather over 2011 × Distance to the market				0.08 (0.07)
Extreme weather over 2011 × Per capita income				0.00003[c] (0.00001)
Panel B: extended models				
Extreme weather over 2007–11	−0.21 (0.26)		−0.86[b] (0.41)	
Extreme weather in 2011		0.19 (0.28)		−0.43 (0.42)
Extreme weather over 2007–11 × Distance to the market			0.06 (0.07)	
Extreme weather over 2007–11 × Distance to the *kirana* store			−005 (0.03)	
Extreme weather over 2007–11 × Per capita income			0.00003[b] (0.00001)	
Extreme weather over 2011 × Distance to the market				0.11 (0.08)
Extreme weather over 2011 × Distance to the *kirana* store				−0.13[b] (0.07)
Extreme weather over 2011 × Per capita income				0.00003[b] (0.00001)

Note: Standard errors are in parentheses. [a]significant at the 10% level; [b]significant at the 5% level; [c]significant at the 1% level

5.5 Concluding Remarks

Using household survey data for eight states of India's Northeast Region (NER) obtained from India Human Development Survey for 2011–12, this chapter empirically analyzes the incidence, intensity, and inequality of food insecurity among the households in the region, which is known for its remoteness and relative economic

destitution. Applying econometric techniques to household data and village-level weather data, it further investigates the impact of the extreme weather events on food insecurity after controlling for a number of demographic and socio-economic factors. The results of this exercise indicate that extreme weather events interact with household income to significantly increase the likelihood of food insecurity in the short as well as long run, although they do not have statistically significant impacts on their own. This is especially true in the case of floods and hailstorms. Similarly, the results suggest that droughts and floods increase the probability of food insecurity through their interactions with the distance to the market and household income in the short run. These results are robust to the inclusion of additional control variables and the use of alternative functional assumption of the regression model.

The results presented in this chapter could be informative for public policies aimed at reducing food insecurity in NER of India. While preventing and controlling extreme weather events may require long-term, multipronged, concerted efforts on the part of everyone living on the earth, the government may formulate and implement policies that will ensure availability of and access to food in order to keep the incidence of food insecurity in check.

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Chapter 6
Food Security in North-East India: The Role of Agriculture, Challenges, and the Road Ahead

Navneet Hazarika, Joyeeta Deka, Pradiptya Kumar Das, and Kandarpa Kumar Saikia

Abstract With a population of above 1.3 billion people, India is dependent on agriculture to cater to the nutritional requirements of its people. Since Independence, the Five-Year Plans that were implemented by the government focused more on the growth of the agriculture sector as a way to boost national economy, create employment, and generate livelihoods and self-sufficiency in food production. Despite these positive efforts, the issue of food security has not received due attention particularly in North-Eastern India so far. Dimensions of food security in this region are not identical with the rest of the country. With the ongoing under-utilized agricultural potential in term of production, it will be a challenge to achieve SDG 2 (zero hunger) but adopting practices in line with SDG 12 (responsible consumption) could provide a way. The diet of the Northeast Region (NeR) is dominated by rice, which is water intensive as well as labour intensive crop. This paper looks at the different agricultural practices as well as alternative models that can be adopted to address the issue of food security in NeR. It also analyses the different food policies undertaken by the states and its impact towards SDGs 2 and 12.

Keywords Food security · SDGs · NeR · Cultural heterogeneity

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6.1 Introduction

North-East India, the land tucked away from mainland glance possesses a lot of potential with its abundance of natural resources. The region is characterized by fragility, cultural heterogeneity as well as marginality (Vision 2025 ICAR). With a population of over 45 million people, the North-East region of India accounts for about 3.76% of the country's total population (Dikshit and Dikshit 2014). Naturally, the question of food security comes into the picture to sustain the population. Rice dominates the diet of the people in most North-Eastern states and is hence a major crop cultivated in the region covering 89% of total cultivated area. It also accounts for 92% of the total food grain production (Ramakrishnan 1992).

Before proceeding further, we need to ask a crucial question. What do we mean when we talk about 'food security'?

According to the Food and Agriculture Organization (FAO), "all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life" and is not limited to only ensuring adequate food supply to people. The food should also carry proper nutritional values necessary for sustenance. Food security, thus, points to a spectrum of food production, accessibility, sustainability, and nutrition. Having food security is also ensuring the freedom from famines or the mass population facing starvation as well as having the nutritional requirements of the people being met adequately. Having food security is an entitlement that every citizen of a country or a resident of a state has a right to.

Although the North-Eastern region boasts of rich biodiversity and fertile soils in the plains comprising 84% of total geographical area, the uneven and hilly terrains of the region, in general, do not warrant uniformity of fertile cultivation. With the highest net sown area of 34.1%, the green plains of Assam are known to be highly fertile. The Brahmaputra plains have nutrient-rich soil that supports the cultivation of rice. Food security is also dependent on sustainable agriculture, which is determined by the sustainable utilization of resources (Bedi and Shiva 2002). The main prevalent weakness of this region is subsistence agriculture along with the poor framework of roads and the market. Apart from these, the NEI regions are highly vulnerable to natural adversities, especially flood, causing low and undetermined productivity. In addition current input practices, small shareholding, negligible use of enhanced seed varieties effect the equilibrium between livelihood and sustainability.

6.2 Dimensions of Food Security

Food security has three main aspects: availability, accessibility, and utilization. As discussed in the above paragraphs, the first component refers to having a constant supply of a variety of food grains and production in different forms available for the people so that there is no shortage. It has to be sustainable in nature in the sense that

it is not a one time or a limited time supply. The cycle of production has to be in motion all the time, it cannot stop.

Secondly, the component of accessibility comes into the picture. The available food has to be accessible by all and to all. As mentioned earlier, the guarantee of food production is a right that the people, as citizens of a country or residents of a state, are entitled to. It is a basic right to have access to food and is a very important component of food security as having enough supply of produce is not the end in itself. If it becomes an exclusive commodity that only a certain group in the community or certain sections of the society has access to, the notion of food security becomes irrelevant. Lastly, the utilization of the available food sets the way in the discourse of ensuring food security and to what extent. The available quantity of food cannot be concentrated in one or two groups of people in the society. Moreover, the different components of food available also need to be considered to establish food security. For instance, having an abundance of rice production with negligible production of other food grains is not equivalent to having food security as the nutrient requirements of a person are also not being met. Roy et al. puts forth the issue of nutritional security as a part of food security. Nutritional security, as the name suggests, refers to ensuring that the nutritional requirements of people are being met by providing adequate food. It refers to the fact that the food being consumed has to be nutritionally rich and safe and contribute to the overall well-being of the consumer (Roy et al. 2017). Meat makes up the major portion of the dietary intake of people of the North-Eastern region, making it important for assessing food security, in terms of both nutrition and total calories consumed.

6.3 Food Production

When it comes to NeR, the per capita requirement of food grains dictates its access which is further dependent on the population in the states, its terrain, dietary preference and climatic condition. Since quantity/output of food grain production varies across the northeastern states due to the above mentioned factors, it also does not register uniform deficit values. According to the report, the deficit in per capita per day access to food can range between 11 g in the state of Tripura to that of 287 g in the state of Meghalaya (Sati 2015).

The availability of per capita food grains is high in the state of Arunachal Pradesh compared to Sikkim. Assam ranks much below in this factor. However, Assam ranked the highest in the percentage of expenditure on food while it was the lowest in Sikkim. This points to the unequal access to food security and in regions where food availability is scarce; the expenditure on it increases due to high demand and less supply.

According to data from the National Sample Survey (NSS), rural areas have a higher expenditure on cereals and food grains than urban areas of the North-Eastern states.

The Table 6.1 shows production of food grains in the North-Eastern states during 2014–2019.

Assam accounts for highest food grain production in the North-East region, followed by Tripura and Nagaland. Mizoram records the lowest production of food grains within the period from 2014 to 2019. As it can be seen, the total food grain production in NeR falls behind greatly in comparison to the national average. One plausible reason for the deficit may be that agricultural production in NeR is primarily for subsistence and not for mass production. However, this results in the states not being able to fulfil the nutritional needs of the people on their own.

With reference to Table 6.2, we see that Assam leads the way as the highest producer of rice among the NeR states, followed by Tripura. Sikkim lags in rice production while Mizoram too struggles with the production of rice.

Table 6.1 State-wise production of total food grains in North-East region from 2014 to 2019 (in '000 Ton)

State/Year	2014–15	2015–16	2016–17	2017–18	2018–19
Arunachal Pradesh	409	327.5	343.3	359.1	365.2
Assam	5458.8	5358.6	4952.5	5525.9	5465.9
Manipur	429.3	435.7	525.1	706.5	495.0
Meghalaya	353.8	357.7	260.1	361.8	260.7
Mizoram	75.3	77.4	75.2	74.2	76.9
Nagaland	649.6	515.8	536.9	552.3	558.1
Tripura	761.5	818.3	859.6	855.4	836.4
Sikkim	102.2	94.1	101.3	93.9	92.0
NeR total	8239.5	7985.1	7654.0	8529.1	8150.2
India	*252,025*	*251,541.7*	*275,111.7*	*285,013.5*	*285,209.4*

Source Handbook of Statistics on Indian States (2019–2020), RBI

Table 6.2 Production of rice in North-East regions from 2014 to 2019

States	2014–2015	2015–2016	2016–2017	2017–2018	2018–19
Arunachal Pradesh	285.0	204.0	220.0	233.3	240.0
Assam	5222.7	5125.1	4727.4	5283.7	5220.6
Manipur	334.1	338.8	430.4	607.8	401.6
Meghalaya	298.2	301.1	203.	304.6	202
Mizoram	60.7	62.1	61.5	59.6	60.0
Nagaland	454.2	318.8	336.7	349.6	356.7
Sikkim	20.1	13.1	19.7	17.6	17.2
Tripura	747.0	794.9	814.7	812.1	793.2
NeR total	7422.5	7157.9	6813.4	7668.3	7291.3

Source Handbook of Statistics on Indian States (2019–2020), RBI

One of the major reasons why there is food insecurity in the NeR is because the region as a whole, even after a few of its states having surplus rice production, is heavily deficit in terms of pulses production. According to reports, India is 82% deficit in pulses production against its requirements as per ICMR recommendation (Mishra and Kumar 2015). As per the records of multiple government sources during the 2013–2014 time period, India produced 19.25 million tonnes of pulses from a 25.2 million hectares area.

As a step of intervention to bridge the gap of pulses deficit, more emphasis has been given to pulses production in the National Food Security Mission (NFSM). NFSM began during the implementation of 11th Five-Year Plan (2007–2011) with the aim to increase the production of pulses by 2 million tonnes by the end of 2012. The goal was reached successfully, and it was also incorporated in the 12th Five-Year Plan (2012–2016) to increase pulses production up by 4 million tonnes (Roy et al. 2017).

Table 6.3 shows the low production of pulses in the states of North-East India which falls way below the rate of total pulses production in the country. Assam leads the production of pulses in the NeR with Nagaland and Manipur occupying the second and the third position in the region.

Mizoram and Sikkim rank at the bottom of the list with extremely low levels of production of pulses. The comparison between the total pulses production in the entire NeR with that of the national production shows the drastic difference that exists between the two with the former almost producing a hundred times less than the national production.

Along with the production of food grains such as rice and pulses, the cultivation of oilseeds is another important element of production in North-East India.

In the production of oilseeds, the NeR does not contribute significantly to the national production with Mizoram producing as low as 3000 tonnes or less than that

Table 6.3 State-wise estimates of production of total pulses, 2014–15 to 2018–19

States	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019
Arunachal Pradesh	14.5	13	13.1	13.5	12.0
Assam	111	107.6	107.5	115.8	113.5
Manipur	30.8	29.8	30.3	30.0	29.5
Meghalaya	11.3	11.7	11.8	11.9	13.4
Mizoram	6	5	4.8	5.1	5.93
Nagaland	42.4	43.1	44.5	46.1	46.4
Sikkim	5.8	5.4	5.5	5.1	4.8
Tripura	8.4	10.9	23.2	19.3	18.9
NeR total	230.2	226.5	240.7	246.8	244.4
India	**17,154.4**	**17,154.4**	**23,130.9**	**25,416.22**	**22,075.96**

Source Handbook of Statistics on Indian States (2019–2020), RBI
(Production in '000 Tonnes)

Table 6.4 State-wise estimates of production of total oilseeds, 2014–15 to 2018–19

States	2014–15	2015–16	2016–17	2017–18	2018–19
Arunachal Pradesh	33.9	36.4	36.6	37	37.0
Assam	205.7	215.2	204.3	200.6	198.4
Manipur	31.7	31.8	32.3	32.8	32.21
Meghalaya	14.9	15.2	14.9	15.1	15.1
Mizoram	2.4	3	2.5	2.4	2.76
Nagaland	68.1	68.6	68.9	69.2	69.5
Sikkim	7.1	6.3	6.4	5.8	5.61
Tripura	7.1	9	12.5	13.8	14.0
NeR total	370.9	385.5	378.4	376.8	374.6
India	*27,510.8*	*25,250.8*	*31,275.6*	*31,459.26*	*31,521.77*

Source Handbook of Statistics on Indian States (2019–2020), RBI
(Production in '000 Tonnes)

of (as seen in the Table 6.4). Assam leads the oilseed production by contributing to more than 50% of the total production in the NeR. Nagaland is the second highest producer of oilseeds in the region.

However, the issue of low productivity of oilseeds is an issue that applies to the entire country. India, as a whole, struggles with the low production of oilseeds. About 70% of the total edible oil is imported, which amounts to about 14–15 million tonnes (National Food Security Mission 2020–2021).

6.4 Cropping Pattern/Land Use

The North-Eastern region is located at various altitudes. Around 56% of its area lies in high altitude, 33% mid-altitude, and 11% in low altitude (Roy et al. 2015).

Due to its topography, the plains of north-east get disrupted by hilly terrains and elevated regions in most parts because of which cropping patterns vary greatly from one region to the next. Jhum cultivation has been used as a predominant form of cultivation by the local tribes of the hilly regions. At any given time, 5 lakh families are engaged in practicing jhum cultivation covering about 1.67 mha of which 17% is being jhummed at any time. (Roy et al. 2015).

Cultivation in the north-east is characterized as the complex diverse risk-prone (CDR) type, and agricultural production has mostly been done only for sustenance, never on a large scale. It has always been for use by the cultivators and their sustenance. According to reports published by the Ministry of Agriculture (GoI), the North-Eastern region contributes to only 3.1% of national food grain production and imports food grains even for its own consumption.

Over the years, with the expansion of markets and an increase in production due to technological innovation, that trend is changing. The introduction of high-yield seeds and crops has also enabled an increase in agricultural production in the region.

Apart from a difficult topography, cultivation in NeR is also marked by faulty land-use patterns. Annually, over 46 tonnes/ha of topsoil is lost due to improper land use. The number is higher than the national average of 16 tonnes/ha. The massive loss of topsoil results in reduction of yield. Even when it comes to water harvesting methods, out of 42.5 mhm of water available, only a mere 0.88 mhm is used (Babu et al. 2015).

6.5 Agricultural Challenges Prevalent in the Region

The topographic differences have led to adoption of different agricultural and agrarian structures in the NeR. The traditional form of agriculture in the hills is the shifting cultivation or jhum which has been dominant for ages (Das 2006). With the passage of time and the significant increase in population and shortage of land, the jhum cultivation has progressively become shorter and a decline in productivity has been witnessed. Loss of top soil and forest cover over the ages has been a major reason behind environmental degradation (Giribabu 2013). Over the years, a significant decline in the area under jhum cultivation can be seen. Nomadic tribal communities can be seen switching to wet rice cultivation in valleys for more stability. There has been limited success to the programs and packages which were tried out as an alternative to jhum cultivation (Borah 1993).

North-East India has diverse agro-climatic conditions along with different types of soil and is lagging in agricultural development. The NER was one of the dominant supporters of the country's food production before the introduction of the Green Revolution in India. But now the region is sliding down to the bottom level and has started importing agricultural products from the mainland of the country. The agricultural practices of North-East India are of two types: (i) shifting cultivation and (ii) settled or plains agriculture. About three-fourths of the population depends on agriculture and other allied activities. The supporting food to the populace of the NER region is rice and maize, which are also the leading crops in this region. Apart from these, the modern agricultural inputs used in agriculture are comparatively low (Ramakrishnan 1992).

North-East India's subtropical climate is influenced by both, the north-east and the south-west monsoons. The adverse effect of climatic changes can be seen mainly in developing countries as they are highly dependent on climate-sensitive livelihoods like rain-fed irrigation for agriculture, water, and forestry. A large number of small landholders with low-intensity agri-inputs, and negligible seed/variety replacement add to the precarious vulnerabilities that also threaten livelihood sustainability. Natural calamities add to the loss, especially floods. In addition to this, erosion and siltation of the agricultural land can be witnessed. Sometimes the damages caused due to floods and river bank erosion are almost irreversible. This kind of situation

compels households to migrate for alternative livelihood opportunities in other cities (Das 2016).

In a period of fifty years, between 1951 and 2001, North-East India's population grew by 350%. The exponential population growth also exerted pressure on land as the population kept increasing, but the cultivable land area remained the same. To cope up with the increasing demand to sustain a growing population, cultivators had to over-cultivate on the same patch of land without proper knowledge about crop rotation or the use of soil supplements which immensely affected the soil fertility. The pressure on land also resulted in the further breaking of the cultivable areas into fragmented land holdings which was only enough for the farmers to earn enough to sustain their immediate needs. There was no room for earning a profit out of it. These conditions prevented the farmers from investing more capital on their lands to increase their production because it included a lot of risks without a guarantee of assured profits.

The farmers' relationship with the markets was also strained. The markets did not prove to be a solid source of revenue for the farmers, they also refused to experiment with new crops as there would be no assured buyer. The response from the market is important for the farmers as well. A good response from the buyers and earning profits through trade encourages the farmers to increase their production using high-value crops that not only suit their small landholdings but also provide greater value in terms of yield.

Apart from Assam, there is a very minimal scenario of mechanization in the other states of North-East India. Farmers are still engaged with manually ploughing, sowing, harvesting, and winnowing their crops. The lack of mechanization in the agricultural process can be attributed to two main reasons. Firstly, due to the hilly topography, it is not feasible for mechanized operations to take place in major parts of this region. Secondly, even if somehow the farmers did happen to own land in the plains but the small landholdings would prevent them from making the kind of investment required for mechanization. Due to connectivity issues in some remote regions of the region, transportation becomes costly and time consuming. Hence, the farmers tend to use hand woven bamboo baskets to carry their produce and sell it in the nearby areas. Thus, due to this issue, some crops are only locally produced and exclusive to specific areas.

Lack of mechanization also adds to labour costs as manually cleaning, slicing, and drying the produce becomes too labour intensive. One distinct example can be seen in the case of the turmeric farmers who have to sell their produce mainly in their raw state for a lesser price. If there would have been proper mechanization facilities, their product could have been sold at much higher prices.

Thus, improper infrastructure, connectivity challenges, and fragmented land holding have resulted in a high post-harvest loss of around 30%. These factors only add up to the challenges faced by the farmers of North-East India. If any kind of development plan for the economy of North-East India is being planned, then it has to be tied with the agriculture sector which is the backbone of the region for it to be successful. Such a success could create many agricultural jobs in North-East India too.

The literacy rate of rural India is much lower as compared to the urban population. This figure can be increased in the rural areas if we start educating the farmers because education, apart from being a basic right, will also help them to accept opportunities and provide scope for improving one's circumstances in life.

It can be seen from research that jhum cultivation, although the most popular practice among the farmers of North-East India, is also one of the most harmful practices environmentally. An average of 20 years as fallow period is required for the land to regain its fertility during jhum cultivation but due to the increasing pressure on land, the fallow period is now less than 3 years. Since the farmers are not equipped with proper knowledge and also do not have access to alternative methods, they are still practising these techniques. There is also the absence of proper information and implementation of government agricultural schemes aimed towards farmers because of which they are often unable to capitalize on the available schemes (Jana and Basu 2018).

6.6 Linking Agriculture and Sustainable Development Goals

Achieving food security does not exist in a vacuum space. It is also an essential element of the Sustainable Development Goals (SDGs) laid down by the United Nations. The issue of food security is important to achieve SDG 2 (zero hunger) and falls in line with SDG 12 (responsible consumption and production).

Poverty in itself is a very complex phenomenon. It has overlapping and intersecting socio-economic and political manifestations of its own. Being landless, having a low per capita income, poor health, disabilities of any kind, as well as the insecurity of resources, play a significant role in the reality of poverty. When it comes to India, poverty is measured in terms of caloric consumption. Hence, hunger and poverty are not exclusive categories. People get subjected to hunger and food insecurity due to poverty or inadequate resources. 66th round of consumer expenditure organized by NSS revealed that Manipur had the highest poverty ratio (Giribabu 2013).

Although the SDGs are applicable for all nations, countries, and regions, the North-Eastern states have also taken steps on their own to make the goals a reality by 2030.

Assam has adopted SDG 1 and SDG 2, i.e. ending poverty (in Assam) by 2030 and zero hunger (in Assam) by 2030. Both of these goals are interlinked to one another. Poverty and hunger are key issues that plague the state. According to data released by the Government of Assam, the poverty headcount ratio for the state was estimated at 27.34% in 2015–16. This is much higher than the national average of 20.74% (Eradication of poverty n.d).

Hunger also remains a major problem for the state. Almost 30% of children under the age of 5 are malnourished in Assam (Saloi et al. 2017). Although concrete data is not available for the rate of hunger and malnourishment among the general

population, it is assumed that there is a similar negative trend present here too. Thus, Assam is determined to address both these issues and achieve the relevant SDGs by 2030.

6.7 The Impetus for Agricultural Growth and Ensuring Food Security

India, with its growing population, is a challenge in terms of existing agricultural practices. It demands constant reinvention from farm to fork policy. The current state demands economic growth, food security, and environmental sustainability simultaneously. For maintaining regional food security, the gap between demand and production needs to be bridged. The extensive agrarian distress in modern India is due to the low and uncertain farmer's income. Hon'ble Prime Minister of India, based on the recommendations of the National Commission on Farmer (2006) has emphasized the need to double farmer's income, which impacts adoption of many modern agricultural practices.

Indian Council of Agricultural Research (ICAR) has been playing a major role in developing high yielding cultivars suitable for Indian conditions. Adopting these genetically superior varieties of different crops can ensure improved crop yield. To ensure the maximum utilization of such genetically enhanced crops, it needs to be supplemented by sustainable mechanization processes. The right use of agricultural process automation not only ensures yield maximization but also ensures a balanced shift from subsistence farming to a market-oriented one with minimal stress on the available natural resources (Top 5 Challenges 2016). The adoption of a sustainable mechanization process can be carried out at every level of farming, like sowing, weed management, pest control, harvesting, etc. With the development of Internet of Things (IoT), big data, and advanced data analytics, the concept of "smart agriculture" has come into play. Some of the major use of IoT applications in the field of agriculture are.

- Sensor-based system to monitor the factors influencing the crops, soil, harvesting, and post-harvest handling
- Use of drones and autonomous robots
- Data analytics

The use of IoT can enable farmers to monitor their production in real time, enabling them to take appropriate actions as the systems are highly precise in making needful predictions. These systems have been developed to minimize the use and loss of natural resources ensuring sustainability in the long run. Adoption of smart farming technologies will not only help in achieving a cleaner agricultural practice by reducing the overall use of fertilizers and pesticides but also enhance the agility of the farmers to respond to dynamic factors like weather, humidity, air quality, and the health of the soil and the crop (Saraswathi et al. 2020).

It has been predicted that by 2050, the population will rise to about 9 billion, and 70% of which will be living in urban environments. The prediction extends to a 50% reduction of arable land along with 110% increase in the demand for agricultural produce (Griffith et al.). Adoption of practices such as hydroponics, aquaponics, and vertical farming can increase agricultural production by enabling farmers to cultivate in urban and semi-urban regions, with minimal land resources. Adoption of such farming techniques will not only reduce the dependency on land availability and climatic factors but also ensure a more sustained year-round cropping. Soil less farming techniques are up to 90% more efficient in the terms of water utilization and require much fewer inputs in terms of pesticides and fertilizers, making them much safer for human consumption. With the reduced dependency of the farm lands, they can be left to regain their natural state, aiding in CO_2 sequestration. These farming techniques also come with lesser than average farm hazard potential and enable the farmers to sell directly to the urban settings, reducing CO_2 footprint.

Modern communication technologies can be adopted for monitoring real-time market information that includes market values, trends, and developments for implementation of the right pricing strategies. Advanced GPS- and GIS-based systems supported by RFID technology can be incorporated to ensure a leakage free and efficient distribution system (Mishra and Kumar 2015).

6.8 Policy Reforms for Sustainable Growth

India has taken various steps to address the issue of food security in the country. The National Food Security (NFS) Bill was introduced in the Indian Parliament in 2011 and was passed by both the Houses after long debates, thus making it an Act in September 2013. The passing of this Bill made having access to food security a Right to those who were entitled. The Act aims to cover around 50% of the total urban and semi-urban population along with 75% of rural areas falling under the Below Poverty Line (BPL) under a program of highly subsidized food grain through the Public Distribution System (PDS). Food grains such as rice, wheat, and coarse cereals will be given to the beneficiaries at a nominal rate of Rs 3/2/1, respectively. Each household of the beneficiaries is entitled to 5 kgs of the food grains at the fixed rate per kg (National Food Security Act 2013).

The percentage of beneficiaries that the Act covers varies from state to state depending on their composition of the BPL population. Hence, a greater population will be covered in states having a high number of people sustaining under Below Poverty Line.

Since the Act makes the availability of ration arrangements a legal right, the government is liable to pay cash compensations to the affected beneficiaries in the form of "food allowance" if the provisions are not met.

Prof. M. P Bezbaruah, in his paper "Food Security: Issues and Policy Options (2013)" further elaborates on the debates surrounding the NFSA. Although the Act

looks almost perfect on paper, some discrepancies arise when it comes to implementation at the ground level. There are a lot of debates surrounding the Act. Its critics state that the Act only focuses on fulfilling the caloric needs of an individual but does not look into providing provisions for a balanced diet. Thus, it does not ensure nutritional security. The supporters of the Act argue that the Act indirectly fulfils overall nutritional needs as the subsidized food grains ensure that some part of their remaining income can be spent on buying other components such as vegetables and eggs.

Another section of critics argue that the Act should have had universal coverage under PDS for it to be truly meaningful. Universal coverage will ensure that a larger group of people will be included which will also include voices against improper implementation.

In addition to NFSA, the Antyodaya Anna Yojana (AAY) scheme, launched in 2000, provides for 35 kg of ration consisting of wheat and paddy to some of the poorest BPL households every month. The eligible households are issued different coloured ration cards to separate them from other ration cards. The present government has set a target of feeding 2.5 crore people falling under the Below Poverty Line.

In 2006, the National Commission on Farmers, Ministry of Agriculture, Government of India, put forth Policies for Farmers. It was a first of its kind policy drafted to ensure the development of farmers and transform the scenario of agriculture.

Some of the major goals of the Policy include ensuring a "minimum net income" for farmers and measuring agricultural advances by improving that income. It also aims to complete unfinished land reform agendas as well as initiate comprehensive asset reforms. The farmer-centric policy emphasizes on the need of a robust social security and support system. It also highlights the need of biosecurity, in terms of both crops, natural vegetation and the livestock to safeguard the work and secure the income of the farmers (Bezbaruah 2013).

6.9 Conclusion

North-East India is unique in terms of diversity. Smaller population groups, diverse food habits, and cultural variability pose a challenge to food security. There needs to be aggressive strategies to deal with the diverse needs to even up in terms of growth and production in the agricultural sector.

Unequal development in addition to topographical differences bring about a vast difference in the level of production of overall food grains in the North-Eastern region with Assam leading as the largest producer of most crops including rice and pulses as shown in the tables above. The fertile plains of Assam, aided by the Brahmaputra River Basin provides the state with ample scope for cultivation. The hilly terrain of surrounding states along with inadequate sources of irrigation does not provide suitable conditions for high production of crops. Further, agriculture in the north-east has historically been done for subsistence purposes which is an important point to be

considered while looking at the low yield of crops in comparison with the national average.

Although the socio-economic as well as climatic conditions of the NeR is not the same as that of mainland India which pose a lot of agricultural challenges for the region attempts at developing the agricultural sector at par with the national level has been made. The introduction of the National Food Security Act across pan-India helped the economically marginalized sections of people from this region get access to basic food grains at subsidized rates and other policies under the Act addressed the issue of food security in the region.

The above sections of the paper also put forth possible alternate measures that can be undertaken to ensure food security through agricultural growth in the North-Eastern region. It also discusses the policy reforms initiated by the Central Government towards ensuring access of food by the economically weaker sections of the society falling under the Below Poverty Line. With ongoing studies and researches coming up, the issue of food security, especially in the context of North-East India, has been gaining a lot of momentum in a region which was earlier unintentionally neglected. This topic provides scope for further discussion and debates by academicians, policy makers, as well among the people themselves to collectively take part towards a more sustainable future.

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Chapter 7
Juxtaposing Food Security and Sustainable Development Goals (SDGs) in North-East India: Evidence and Explanations

Dibyajyoti Dutta and Akhil Ranjan Dutta

Abstract The issue of food security has been a key concern for humankind as nearly 821 million people in the globe are undernourished and languishing in abject poverty, out of which 63% belong to the continent of Asia (UNDP:2017). The concern for food security has increasingly been felt in all quarters impelling the policy makers, leaders and common people to think and act in terms of ensuring availability, accessibility and affordability of food for all. The Goal 2 of the SDG that is, to end all forms of hunger and malnutrition by 2030 calls for promotion of sustainable agriculture, supporting small-scale farmers and equal access to land, technology and markets. Being at the margins of developmental voyage, the states of North-east India have been experiencing multitudes of issues in realising most of the above objectives. On the one hand, the pan-Indian policies grossly remain inadequate to address the expectations of the people of the region, on the other hand, the custom-made policies also fail to deliver owing to diverse sociopolitical and geographical setting. In these backdrops, this chapter scrutinises the efforts of the Indian state in achieving the objectives of the SDGs through policies, institutions and infrastructures in the context of the North-east India in general and advancing food security and warding off hunger in particular. The Acts and Statues of the Central Government as well as state specific rules and provisions are examined to scrutinise the Indian mission of advancing food security.

Keywords Food security · Hunger · SDGs · Malnutrition · Indian state

7.1 Introduction

With a vision to protect and preserve the planet and to ensure people's prosperity, the United Nations Sustainable Development Goals (SDGs) have come up with renewed

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plans to address issues that have severely impacted human lives across geographical boundaries. The 17 sustainable goals and 169 targets set to achieve by 2030 calls for an integrated and collective action by all parties involved in the process. The Goal 2 of the SDGs that intends to end all forms of hunger and malnutrition by 2030 and to make sure that all people, especially children have sufficient and nutritious food throughout the year invites urgent state action. Malnutrition has been considered as a serious global public health epidemic deepening the crisis of unequal access to culturally viable and nutritious food by the persons in distress. The most vulnerable groups that suffer from it are poverty-stricken people, children, adolescents, aged persons, persons with prolonged illness, lactating and pregnant women. Hunger on the other hand remained as a grave challenge for humankind as has been presented in the 2020 Global Hunger Index (GHI). The '2020 Global Hunger Index: One Decade to Zero Hunger, Linking Health and Sustainable Food Systems' shows that although gradually declined since 2000, the progress to attain a hunger free world has been very slow. As per the report nearly 690 million people are undernourished; 144 million children suffer from stunting, which is a sign of chronic undernutrition; 47 million children suffer from wasting, which is a sign of acute undernutrition and 5.3 million children died (as per 2018 data) before their fifth birthdays, in many cases as a result of undernutrition. India has been ranked 94th out of the 107 countries assessed, whereas Nepal (73), Sri Lanka (64), Bangladesh (75) and Pakistan (88) fared well compared to India (von Grebmer et al. 2020).

The Right to Food receives universal recognition and occupies central focus as a human right. The Universal Declaration of Human Rights (UDHR), 1948 (Article 25) stipulates that everyone has the right to a standard of living including food, clothing, housing, etc. (United Nations 1948). The International Covenant on Economic Social and Cultural Rights (ICESCR) recognises (Article 11) the rights of individuals to have adequate standard of living, including food, and the right to be free from hunger. The ICESCR mandates the state parties to take measures individually or through international cooperation so that hunger, malnutrition, etc., can be addressed (OHCHR 1966). The Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) also focuses on the significance of the right to food. The CEDAW recognises (Article 12) the right of pregnant and lactating women to have special protection with regard to adequate nutrition and in the Article 14 the right of rural women to have equal access to land, water, credit and other services, social security and adequate living conditions, etc. (OHCHR 1979). The Convention on the Rights of the Child (CRC) recognises the right to the highest attainable standard of health (Article 25) and the right to an adequate standard of living (Article 27) inclusive of food and nutrition (OHCHR 1989). The World Food Conference convened by the General Assembly of the United Nations adopted the Universal Declaration on the Eradication of Hunger and Malnutrition, 1974 highlighting the food concerns faced by millions in the globe and directed the states to take proactive measures in handling the situation (OHCHR 1974).

The SDGs mandate the states to intervene progressively by promoting sustainable agriculture, supporting small-scale farmers and ensuring equal access to land, technology and markets in order to ensure food security and ward off hunger and

poverty and reduce the prevalence of malnutrition. The United Nations contemplates for developing of mechanisms that ensures increased productivity by means of restoration and augmentation of degraded lands, afforestation, improved irrigation and by developing new varieties of drought resistant crops and further pressing for reversing land degradation through sustainable soil and water practices and by making extensive use of organic fertilisers instead of chemical-based ones (Hindwan 2018).

7.2 Structure of the Chapter

The core objective of the chapter is to investigate and scrutinise into the role of Indian state in its effort to ensure food security to its people by juxtaposing the Sustainable Development Goals. The policies, infrastructures and institutions for advancing food security have been examined in order to assess the progress contextualising the evidences from the North-east India.

The chapter is divided into the following sections:

1. The introduction lays down both the theoretical foundation and the pursuit of the right to food security agenda at the global level through a number of UN initiatives culminating in the SDGs;
2. The remaining section of the chapter is divided into two parts:
   (a) The first part delves deep into examining the issue of food insecurity and farming distress in the country with a view to assess the institutional arrangements and role of Indian state in ensuring food security;
   (b) The second part offers a critical assessment of the policy frameworks being furthered in the North-eastern states with regard to food security juxtaposing the Sustainable Development Goals (SDGs).

7.3 Food Insecurity, Farming Distress and Institutional Arrangements of Ensuring 'Food for All in India'

India presents a unique case of rapid economic growth vis-a-vis mounting impoverishment. India manages to produce enough food (from 217 million tonnes recoded in 2006–07 to 275.11 million tonnes in 2016–17) but unsuccessful in warding off hunger and malnutrition owing to inadequate schemes and inappropriate policies and poor distribution system (Jitendra 2018). It is evidenced by the 'State of Food Security and Nutrition in the World (SOFI) Report, 2020' that India accounts for 22% of global burden of food insecurity, highest for any country since 2017–19 (FAO 2020). The report further demonstrates that the prevalence of food insecurity in India increased by 3.8 percentage points between 2014 and 2019 (Bansal 2020).

A brief account of India's food security arrangements are highlighted underneath for a general understanding of the issue.

In its bid to make adequate arrangements for distribution of food, Government of India revitalised the rationing system introduced in 1939 by the British rule. The British Government introduced the first structured public distribution of cereals in India through the rationing system, i.e. sale of a fixed quantity of ration (rice or wheat) to entitled families (ration card holders) in specified cities and towns at the time of World War II. When the War ended, the rationing system was abolished in 1943. India retained public distribution of food grains as a deliberate food policy, when it embarked on the path of planned economic development in 1951. Changes were made in 1991–92 through a crash programme designated as 'Revamped PDS' (RPDS) and in 1997, the system had been made target-based. The 'Targeted Public Distribution System' (TPDS) was operated under joint responsibility of the Central and State Governments. Central Government through Food Corporation of India (FCI) assumed the responsibility of procurement, storage and bulk allocation of food grains to states, on the other hand, operational responsibility, viz. allocation within state, identification of poor under below poverty line and supervision of fair price shops were entrusted with the State Governments. Apart from such arrangements, India adopted series of policies and programmes to address food insecurity, some of them were direct cash for food programmes and others were indirect programmes to generate employment, viz. Integrated Rural Development Programme (IRDP), Training of Rural Youth for Self Employment (TRYSEM), National Rural Employment Programme (NREP), Rural Landless Employment Generating Programme (RLEGP), Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Midday Meal Scheme (MDMS), etc.

With the introduction of National Food Security Act, 2013, India made considerable leap in addressing food insecurity. As on March, 2021, India could reach to 757.7 million beneficiaries spreading over 720 districts of the country under the provisions of the Act. In 2020, however, three contentious bills have been placed in the parliament and eventually got passed sprouting massive uproar among the farmers of the country. These are (a) Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020 (b) Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Act, 2020 and (c) Essential Commodities (Amendment) Act, 2020. The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020, mandates that farmers can enter into 'written agreements' with anyone, including a company, and sell their produce for a set period of time, as per the set terms of the contract. In other words, private companies can have contracts with the farmers for buying produce. They can set the price for the produce, the standards and qualities and other legalities beforehand (Business Standard 2020). T**he Farmer (Empowerment and Protection) Agreement of Price Assurance and Farm Services Act, 2020, on the other hand, allows farmers to sell their produces outside the existing system, that way facilitating private players to enter into agreements with farmers. The** Essential Commodities (Amendment) Act, 2020, seeks to remove commodities like cereals, pulses, oilseeds, edible oils, onion and potatoes from the list of essential commodities. The reform ends the era

of frequent imposition of stock-holding limits except under extraordinary circumstances (Ministry of Finance, Government of India 2021, p. 254). These three Acts have been pursued by the ruling National Democratic Alliance (NDA) with much floridity.

At a time, when the successive Governments at the centre have been seen facilitating the interests of private players in the agriculture sector, a huge chunk of the farmers are protesting against the contentious legislations. It needs special mention that as per Census 2011, about 54.6% of the total workforce in the country is engaged in agricultural and allied sector activities accounting for approximately 17.8% of the country's Gross Value Added (GVA) for the year 2019–20 (Ministry of Finance, Government of India 2021, p. 230). Low return on agricultural produces, bad debt (informal and formal), drought, flood, inadequate irrigation, poor mechanisation, volatile market, etc., have been severely affecting the farmers. In other words, farming distress has been rapidly growing in the country. Its adverse effects could be seen in the ever-growing rate of farmer's suicide. As per the Ministry of Home Affairs (National Crime Records Bureau, Government of India), 10,281 farmers committed suicides in 2019. Farmers and daily wagers of the country committing suicides in the year accounted for 42,480 (National Crime Records Bureau 2019). Apart from suicides, data reveals that between 1991 and 2011, over 14 million financially stressed farmers of the country quit farming (Bansal 2020).

There has been an unceasing debate in India with regard to the linking of Aadhaar (a card issued by the Unique Identification Authority of India (UIDAI) which uses biometric credentials for identifying a person) with ration card. A Bench led by Chief Justice of India, Sharad A. Bobde hearing a petition of Ms. Koili Devi, represented by senior advocate Colin Gonsalves expressed dissatisfaction that such cancellations had led to starvation deaths across the country. A report submitted by the petitioner's side in the Apex Court said, '*the insistence on Aadhar and biometric authentication had led to the cancellation of nearly four crore (40 million) ration cards in the country according to the Union of India. The Union of India casually gives an explanation that these cancelled cards were bogus. The real reason is that the technological system based on iris identification, thumb prints, non-possession of Aadhaar, non-functioning of the internet in rural and remote areas,* etc., *led to largescale cancellation of ration cards without notice to the family concerned'* (Rajagopal 2021). As per the National Food Security Portal (retrieved on 20.03.2021), India presently has 23,58,80,154 Ration Cards benefiting 79,27,89,966 persons of the provisions of National Food Security Act (NFSA), 2013, out of which 20,96,68,662 ration cards and 70,38,86,990 beneficiaries have been seeded with Aadhaar. As per the above statistics, 88.79% of the total beneficiaries have been seeded with Aadhaar to accomplish the objective of 'food grain to the right person using Aadhaar' set by the Government of India. Given the infrastructural bottlenecks and institutional inadequacies as mentioned in the petition by Ms. Koili Devi, the issue therefore resurfaces a new dimension to the Government's willingness to address food insecurity in the country.

From the above, it becomes apparently clear that the policies and programmes being implemented in the country have grossly been inadequate and implemented

rather lackadaisically. The already subsidised food security provisions have further been subsidised by some State Governments in their own jurisdictions indicating a clear bend towards election centric populist agenda.

7.4 Food Security and Sustainable Development Goals (SDGs) in North-East India: Evidence and Explanations

The states in the North-east India present a unique yet divergent mode of characteristics in terms of culture, economy and polity. A NITI Aayog pamphlet while considering the economic conditions of these states noted that the states of North-east relies on the Central Government for financial assistance, especially Plan assistance, which continues to be given on a 90:10 basis that is 90% is central assistance while the States raise 10% of the budget (NITI Aayog 2020). These figures clearly demonstrate over-reliance on the Centre for financial requirements of these states in order to meet the growing developmental needs. Before critically assessing the food security scenario of the region, a cursory look at the region from the lens of NITI Aayog shall be of paramount significance as the NITI Aayog has been mandated with overseeing the adoption and monitoring of SDGs at the national as well as in the regional level so as to achieve the SDGs by 2030 (Press Information Bureau 2020). The following challenges of the region has been highlighted by the Concept Note prepared for the 'SDG Conclave 2020: Partnerships, Cooperation and Development of North-Eastern States' by the NITI Aayog which was held in Guwahati from 24 to 26 February, 2020.

1. The region is yet to leverage India's position as a fast growing emerging economy and market for development.
2. Overall poor infrastructure development impending development.
3. Low population density—119 per sq. k.m. (UP 828, Punjab 554, Bihar 1102).
4. Lack of employment opportunities.
5. High operational cost.
6. Subsistence farming—organised groups and strategies to achieve economies of scale through collective production and marketing missing.
7. Ecological fragility made worse by persistent environmental degradation—destruction of tropical rainforest, dying of wetlands, shrinkage of biodiversity cover, soil erosion and air and water pollution.
8. State Governments are financially strapped, falls under special category (NITI Aayog 2020).

The above challenges noted by NITI Aayog vividly portray the state of the economy and society of the region. The region although is clubbed for its geo-climatic similarities and contiguity, in terms of agricultural practices and food habits, however, there exists gross regional variations. Apart from crop pattern differences, there are variances in terms of problems confronted by farmers as well. For example

in 2007–2008, the farmers of Mizoram faced a 'famine'-like situation locally known as 'mautam'. The 'mautam' is associated with flowering of a particular variety of bamboo grown abundantly in the region and its consumption by the rats. The rats upon consumption of these bamboo flowers/seeds grow unusually big and fertile, thereby causing population growth of the rats to pestilential proportions. The rats devour whatever being planted just before harvest resulting in serious food insecurity. The 'mautam' in 2007–2008 affected more than 141 thousand people in Mizoram.

Hussain (2004) while examining the food insecurity in the North-east highlighted that the entire north-eastern region is deficit in food production. He identified the problems of landlessness; environment, development and conflict-induced displacement, recurring floods, etc., among many others that cause the region food insure. The matters relating to food security of the region, according to him has largely been overshadowed by unremitting focus on the questions of 'identity' and 'insurgency'. Advocating for a broader perspective of food security including water security especially among the Internally Displaced Persons (IDPs) and Tea Garden communities of the region, Hussain postulated the need for urgent governmental intervention to address the imminent danger. De (2000) provides an interesting account of the concerns of food insecurity in the state of Tripura. The author in his study found that the working of the public distribution system (PDS) and other government policies have not been successful in achieving food security at the desired level in the state owing to infrastructural bottlenecks and policy inadequacies. While examining the sustainability of agriculture in the face of damages wrought by natural calamities in the state of Assam, Phanindra Goyari (2005) contemplated for the fusion of food security and agricultural sustainability in the greater policy approach of the government. Goyari noted that the recurrent floods have been causing serious damages to the sustainable agriculture as it has been the prime source that destroys standing crops, creates water loggings, soil erosion and affects large crop areas and thus threatening the sustainability of the drive towards higher productivity and production of various crops in the state. Basu et al. (2006) estimated that approximately 36% of the people of North-east India lived below the poverty line and argued that those who live below poverty level are unable to buy enough food, in almost all the states of North-east India.

The state of Assam was a self-sufficient state in food, especially in rice production until 1980s. During the period from 1951 to 1980, the average yield of rice production in Assam was higher than overall India's yield of rice. Since the later part of 1980s, the yield of rice production gradually decreased. The rapid growth of population and shrinkage of farmlands resulted in reduced rate of production of food grains. Although per hectare rice production remained stable; the shrinkage of farmlands and population explosion caused irreparable damage to the well-being of the economy. The decadal growth of population recorded in Assam in the census of 2011 was 17.07%, while in the previous decade it was 18.85%. On the other hand, the geographical area of Assam is 78.44 lakh hectares out of which only 27.53 lakh hectare area are recorded as net cropped area (which is 35% of the Gross Crop Area of 39.57 lakh hectares). Further, out of the net cropped area, 4.75 lakh hectares are chronically flood prone area and 4.75 lakh hectares are recorded to be chronically

drought prone area (Government of Assam 2018). Most parts of the cultivable lands of Assam are not irrigated which adds further uncertainty in production.

Agriculture accounts for more than a third of Assam's total income employing 69% of its workforce (Planning and Development Department, Government of Assam 2003). Most of the farmers work on small and marginal farms and sometimes on the basis of tenancy system. The small size of farms, traditional farming methods combined with low levels of mechanisation are significant factors accounting for low productivity. In these backdrops, it would be worthwhile to examine the food security scenario in Assam with special reference to the agriculture sector. Agriculture is a state subject, which means the primary responsibility for the promotion of farm sector rests with State Governments. The state of Assam lags far behind in thus front in comparison to most of the other states in India despite it employs a huge chunk of population on farming. With nearly 2.52 million hectares of cultivable fertile land fed by the mighty Brahmaputra and its tributaries, Assam could have contributed immensely in food grain production (The Assam Tribune 2014a, b), Some issues which impact farming in Assam are traditional mode of agriculture, lackadaisical response of the State Government, small land holding pattern, use of agricultural land for other purposes, the issue of irrigation, recurring floods, droughts, etc. In Assam, 85.90% of people reside in rural areas and more than 80% of rural population depends on agriculture as a primary source of income (DowerahBhuyan 2010, p. 69).

The farmlands in Assam are vulnerable to environmental threats. The environmental threats are river bank erosions, landslides, floods, etc. Some argue that it is also vulnerable because of some irrational policies of the Government. The Government often resorts to certain illogical policy decisions, which for many are taken for vested interests. The Office Memorandum bearing No. RSS/288/201/TT/25-A issued by the Government of Assam was opposed at many quarters. This Office Memorandum has allegedly facilitated handing over of farmlands to traders and corporate houses for non-farming activities (The Assam Tribune 2014a, b). It has been criticised by a section of intellectuals and conscious social activists of Assam that the haphazard move of the Government to divert such agricultural land which is lying idle for 10 years for industrial and commercial purposes is far from pragmatic. It has been feared that it would open floodgates for large-scale transfer of croplands for industrial or commercial purposes.

The farmers of Assam rely on traditional methods of farming owing to multitudes of reasons. The significant among them are small holding of cultivable lands, frequent floods and droughts, etc. These issues negatively impact on the production of food grains. Further, inadequate infrastructure to facilitate high production is a grave concern confronting the state's farm sector.

Rest of the states of North-east India presents a gloomy picture of the food security scenario. The same could be found in the report of the 'National Family Health Survey, 2019–2020'. As the direct reflection of food insecurity is stunting, the report highlighted that the states with highest and lowest stunting levels among all 22 states and union territories in National Family Health Survey-5 Phase 1 are from the North-east Meghalaya with 46.5% and Sikkim with 22.3% stunting levels, respectively (Saigal and Saumya 2021). These statistics only reveal the apathetic character

of Indian state in handling the matter arising directly out of food insecurity and malnutrition.

Arunachal Pradesh was the first state in the North-east to roll out the provisions of the Food Security Act, 2013. Before that in line with the Essential Commodities Act, 1955, the State Government promulgated series of control orders to regulate the food and civil supply programmes. Some important orders among them are as follows:

(a) Arunachal Pradesh Food Stuff (Hoarding and Profiteering) Control Order, 2005
(b) Arunachal Pradesh Declaration of Stocks and Prices of Essential Commodities Order, 2005
(c) Arunachal Pradesh Public Distribution of Articles Order, 2005
(d) Arunachal Pradesh Food Grains (Licensing Control) Order, 2005 (Government of Arunachal Pradesh 2021).

The Arunachal Pradesh Public Distribution of Articles Order, 2005, is an extensive order accommodating all aspects of the distribution of food grains to the beneficiaries. It mentions about the infrastructures and institutions that are significant for implementation of the provisions of food security of the state. The other three orders facilitate the stockpiling, management, procurement and transportation of the essential commodities. As per Government data, the people of the state are mostly agrarian (Government of Arunachal Pradesh 2021). Seventy per cent of the population practices either '*jhum*' or terrace cultivation. Arunachal Pradesh is located quite strategically sharing international borders with Bhutan, China and Myanmar, and therefore, it receives special attention from the Central Government. The reliance on the Centre by the state is visible in the food security front as well. Although the state comes up with CM's Sashakt KisanYojana, CM's Krishi SamuhYojana, etc., the people have not received full benefits of these schemes as there exists operational hindrances.

The states like Manipur, Mizoram, Sikkim and Nagaland have been confronting with almost similar situations in terms of food security and sustainable agriculture. There are ample scopes for facilitating sustainable agriculture in these states as the majority of the population are agriculturists, however owing to lackadaisical policy intervention, improper planning, training and management, insufficient and ineffective resource usage, etc., have been some grievous challenges among many that pose in front of these states. Tripura has done significantly well in terms of ensuring food security to its people. As per the State Government estimates, the average paddy yield in the state is 2.2 tonnes per hectare, which is a little above the all-India average (2 tonnes per hectare). However, this is not indicative of the fact that the state does well in other crop yields as well. The State Government realises this and approximates the growth performance of the food grain to be around 1.5% annually (Government of Tripura 2021). The Tripura Government have been implementing all centrally sponsored schemes such as the National Food Security Scheme, National Mission on Sustainable Agriculture (NMSA), National Mission on Agriculture Extension and Technology (NMAET), provisions of the Rashtriya Krishi Vikas Yojana (RKVY),

Pradhan Mantri Krishi Sinchai Yojana (PMKSY) and Pradhan Mantri Fasal Bima Yojana (PMFBY) among others along with different state plan schemes.

7.5 Conclusion

Food security has been a grave challenge in realising the Sustainable Development Goals in the North-eastern part of India. As reflected in the second edition of the Sustainable Development Goals (SDG) India Index, many states of the region have performed badly in comparison with the Arjun Tendulkar Committee estimates of the national average of below poverty line (21.92%). According to the report, only Meghalaya, Tripura, Nagaland and Mizoram are among the states, which are close to taking the percentage of people living below the poverty line to 10.95% by 2030 (Lyngdoh 2020). The report further highlights that acute deprivation and exclusionary processes accentuated by natural calamities conspire to make poverty persist. It holds merit as the deprivation and exclusionary processes are evidently visible in these states both in the Central Government's attitudes as well as the states. The populist policies forwarded by the states exclude many deserving and needy persons making the entire food security scenario of the region critical. The recurrent floods, droughts, cyclones, erosions, etc., add misery to the already serious situation. In order to address the concerns of food security and poverty, concerted strategy coupled with holistic plans are required to be furthered by the states juxtaposing the Sustainable Development Goals for an equitable and egalitarian society.

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Chapter 8
Land Degradation, Desertification, and Food Security in North-East India: Present and Future Scenarios

Vimla Singh and Nivedita Chaudhary

Abstract Land degradation and desertification are an extremely fast emerging problem in the present scenario for North-East (NE) India. The climate of NE India is tropical, mountainous terrain, steep hills with thick vegetative cover. In recent time due to increasing population and exploitation of the rich natural resource, unsustainable land use, agricultural practices, and changing climatic conditions, such as intense rainfall and flood, lead to cause land degradation and desertification. People residing in near the bank of the river are most vulnerable due to food shortage and poverty. Land use of NE India is changing attributed the rapid increase in population, mining activities, increasing urbanisation, reduction in forest cover, unsustainable agriculture practices leading in the declining of the fertility of the soil and creating a significant challenges to food security in future. The rate of reduction in the area of productive land accelerating as compared to the past due to increasing the incidence of climate change. There is a critical requirement of efficient measures for land management and conservation in NE India. Therefore to assess the present and prediction of future scenarios, the objective of the present chapter is to study the relationship with land degradation, desertification, food security, and approaches to emphasis for mitigation measures for land degradation and desertification.

Keywords Land degradation · Desertification · Climate change · Food security · North-East India

8.1 Introduction

Land degradation is local as well as a global issue that threatens the land productivity with water quality, human health, and ecosystems leads to the loss of biodiversity

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with climate change in the region (SAC Desertification Atlas report 2016). Land degradation led to desertification by declining the productivity of land so; desertification is the land degradation due to various climatic and anthropogenic factors leading to loss of productivity of the land. Land degradation and desertification both are complex phenomena caused by natural and anthropogenic factors, facing by NER with many part of country. Natural factors include wind and water agents, and anthropogenic factors involve deforestation, and mining and modern agriculture practices contribute to soil erosion. In North-Eastern Region (NER), poverty and environmental degradation are a significant concern where the maximum population is dependent on forests resources, and these resources contribute significantly to rural livelihoods and to eradicate poverty; hence, it is the utmost requirement to protect the land from deforestation, degradation, and desertification (MOEF & CC, UNCCD Report 2010). Land degradation and desertification both severe threats not addressed sufficiently, but spread awareness that helps in land management decisions with more sustainable and resilient agricultural systems. However, degradation caused a severe problem with the considerable loss of money (Bhattacharyya et al. 2015). This cost is documented and reported by crop productivity reduction with declining profit, change in land-use intensity, and cropping patterns (Srinivasarao et al. 2013), all affected to food security. Despite richness in natural resources, the NER of India is one of the country's most backward areas, home for the high proportion of the poor with risky agriculture and low productivity (Baruah et al. 2014).

NER abundant natural resources are under-utilised resulted drought situation on the one hand and frequent floods on others. To provide the food security, there is urgent need of management of the natural resources and reduction of the policy gap between supporting infrastructure, coordination, and implementation of the developmental schemes. NER suffered with severe land degradation due to its geographical and climatic condition. Part of NER land comprising steep hills, deep terrains, and thick vegetation cover with varied climatic zones and ecological niches for flora, fauna, and human beings characterized by large variations in topography and 750 mm to 12,500 mm rainfall (Satapathy and Sarma 2001). NER showed very high rate of degradation and desertification in the last ten years. In terms of area under the threat of desertification and land degradation compared to the total area of the country, the NE states do not fare bad in comparison with others (Shillong Times 2016). The consequences of land degradation lead to the reduction in the quality of the land and deprivation in the soil health related to induce activities of humans and causing the effects on the production of the food and environment. The present chapter deals with the cause and effect of land degradation and desertification leads to the potential impact of food security in NE region of India.

8.1.1 About the North-Eastern (NE) Region

NER comprising eight states namely Sikkim, Assam, Manipur, Meghalaya, Tripura, Nagaland, Arunachal Pradesh, and Mizoram called seven sisters excluding Sikkim,

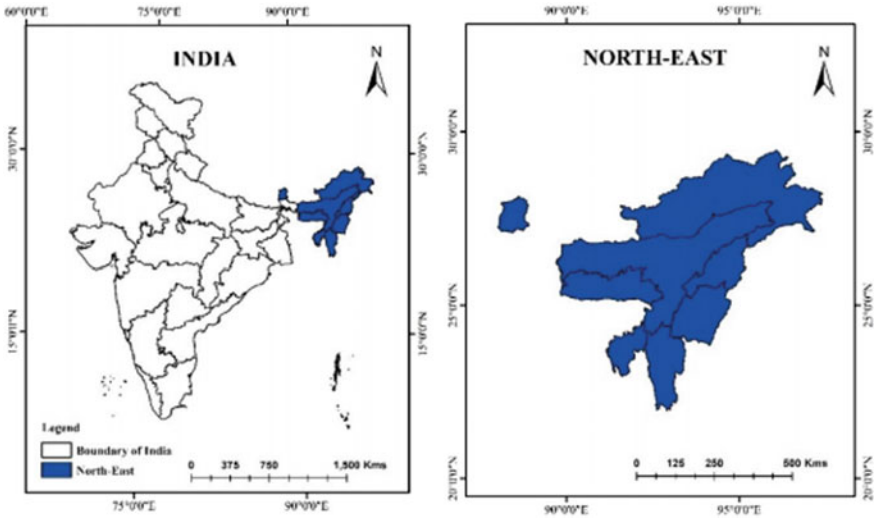

Fig. 8.1 Map represents North-Eastern region (NESAC 2020)

enriched with lushgreen vegetation and minerals with other resources. NER occupies 2.55 1akh km^2 geographical area with North-Eastern (NE) hills and basin having a total 65% area while Brahmaputra valley and Meghalaya plateau covers 22% and 13% area, respectively. NER accounting 8% of country's total geographical area covered by thick and mixed deciduous and semi-evergreen forest and rich in biodiversity. In NER, except the Brahmaputra Valley, the rest of the land is hilly and has a mountainous track with steep slopes. Due to lack of concerted efforts, the state cannot provide the necessary support system to manage resources for the benefit of the people so; there is need to urgent planning.

NER of India has been divided into Eastern Himalaya and NE India (Purkayastha 2016), based on floral biodiversity and the local climate (Rodgers and Panwar 1988). NER is commonly called as geographical 'gateway' for India's flora and fauna resulted one of the richest regions in the world in terms of biodiversity with high species richness and endemism (Chakravarty et al. 2012) (Fig. 8.1).

8.1.2 Land Use Pattern

Land use pattern reflects the character of interaction between human being and physical environment influenced the mankind's basic economic activities (Singh and Dubey 2012). So, it's a component of physical and human relationship to fulfil the human needs for its development and becoming a scarce resource due to immense agricultural and demographic pressure. Agriculture in NER is mainly comprises with primitive and slash and burn type thus follows traditional agriculture practices, and

area is little far in development. The conventional agricultural systems like shifting cultivation, cultivation on series of bed (bun method) on slope with contour bunds are widespread. Hill communities played significant role to evolve their economic activities and strategies in undulated topographies. Land use of NER basically is the result of techniques and customs adopted by different tribal communities lived in the region and affected by elevation, climatic condition, and mountainous terrain.

When we compare the data of land use and land cover (LULC) of various NE states generated by NRSC, ISRO, Hyderabad, it is found that there is dramatic changes in between year 2005–06 and 2015–16. There are following LULC comparative analysis of eight NER namely Sikkim, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura, respectively (Fig. 8.2), shows that most of the NE states suffering with the agriculture and forest area loss from past to present (2005–06 to 2015–16) due to developmental, mining, and other anthropogenic activities. The waste land or barren land increased in all NE states except Assam, Meghalaya, and Tripura because these states have reduced the waste land through wasteland reclamation and development programme run by government. Built-up land (including rural, urban, and mining) increased in all NE states except Arunachal Pradesh and Tripura because still flood, food security, and unemployment problem prevail in NER so, people migrate to other states in search of job, food, and safe habitat. But now the situation is improving in many states like Assam, Sikkim, Meghalaya, Manipur, and Mizoram, and the built-up land is also increased. Snow and glacier increased in Sikkim between the period of 2005 and 2015–16, while in other states it is decreased, wetland also decreased in all NE states due to over exploitation and anthropogenic activities. So, overall the LULC pattern of NER changed dramatically in last 10 year due to increasing population pressure, mining, shifting cultivation and other developmental activities (Fig. 8.2).

8.2 Land Degradation and Desertification in NER of India

NER is facing the most critical environmental issues of land degradation and desertification (Saowanee 2020). The land is one of valuable natural resources that support the life system on earth through biomass production to provide food, fodder and fuel for human beings and live stocks either directly or indirectly, including pisciculture (Patiram and Kumar 2005). NER enormously suffering from land degradation and desertification (Zdruli et al. 2010) from the past to present, the area under degradation increased with increasing population pressure. It has a very close connection with major issues like climate change and biodiversity loss. There is an urgent need to take proper measures to control land degradation for ensuring food, shelter and water to ensure environmental security for improving living conditions. As NER suffers from heavy rainfall during NE–SW monsoon, extreme rainfall acidifies land of North-Eastern (NE) states of India. This frequent heavy rain caused floods, degrading land and cripples agricultural livelihood (Sangomla 2018).

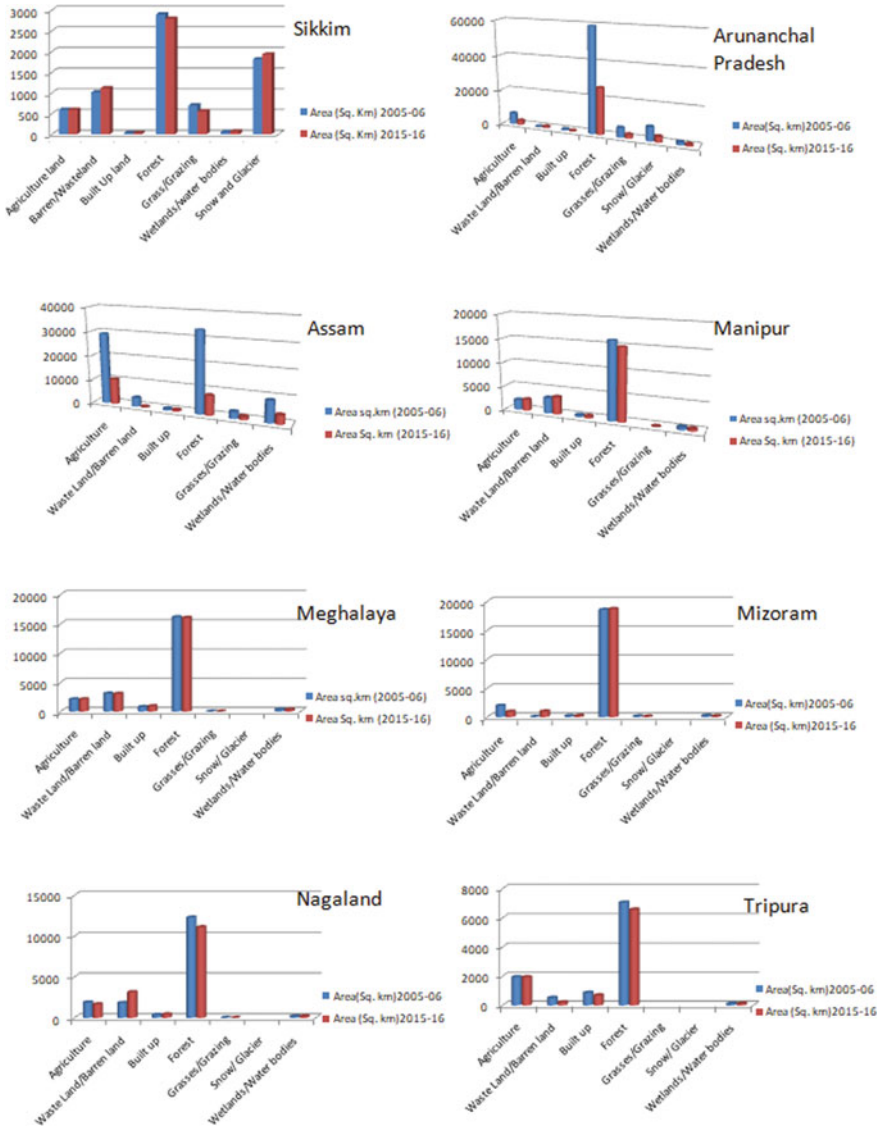

Fig. 8.2 LULC comparison of NER (8 states) from 2005–06 to 2015–16 (based on NRSC, Bhuvan LULC data)

According to Indian Space Research Organization's (ISRO) and National Remote Sensing Centre (NRSC) land degradation and desertification report among the top seven states, six belongs to NE states and facing the highest threat of land degradation in the last ten years (Down to Earth report 2018). It is indicated in the report that one of the significant causes of land degradation (Yazdani et al. 2015) is high rainfall,

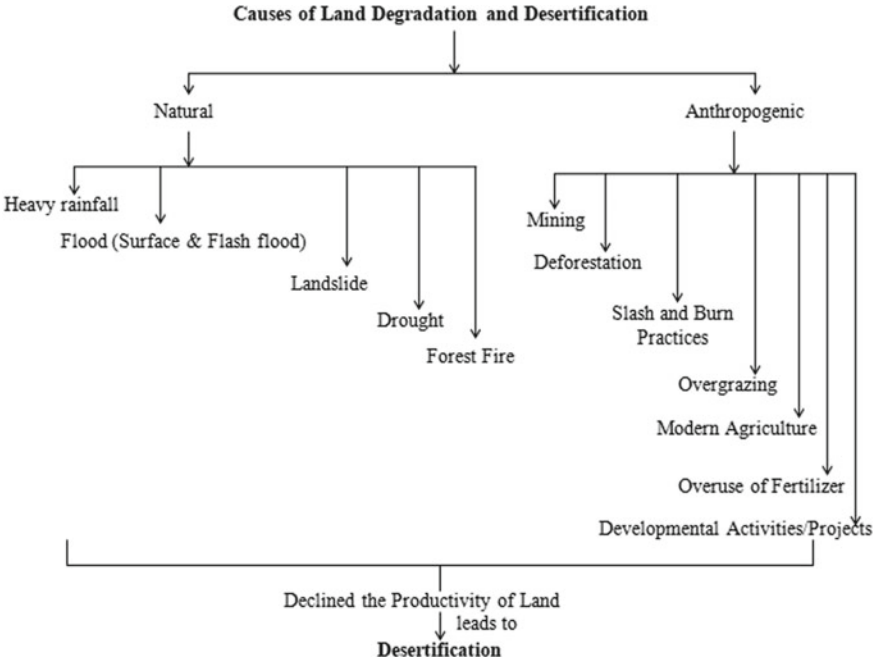

Fig. 8.3 Causes of land degradation and desertification

responsible for devastating floods and landslides throughout the NER. Five NE states, namely Assam, Manipur, Tripura, Mizoram and Nagaland, suffered from the flood in 2018 and 2019, led to land acidification. So, flood and land degradation are turning into an iniquitous cycle for the NE population due to acidification that's prevalent cause of land degradation in NER (Fig. 8.3). Both natural and anthropogenic activities impart in land degradation and desertification as it's represented by flowchart in Fig. 8.3.

8.3 The Vulnerability of Land Degradation and Desertification in NER

In the NER of India, there are lots of factors responsible for land degradation and desertification. Beside the richness in natural resources and biodiversity, the land is vulnerable to flood, soil erosion, waterlogging, drought and landslide etc. Shifting cultivation, urbanization, mining, over exploitation of natural resources, intensive use of fertilizer, monoculture plantation, overgrazing, deforestation, etc., are the various causes that leads to land degradation, reduction of fertility and desertification in the NER. There are the following reasons that led to degradation and desertification of land.

8.3.1 Overgrazing and Deforestation

As population pressure increased leads to exploitation of natural resources by cutting of trees, mining, overuse of water, and overgrazing, etc. So, overgrazing and deforestation caused degradation which is now have >20% wasteland (NRSA 2000). Modern agricultural and other human-induced activities such as land clearing, overgrazing, industrial wastes and mining of natural resources resulted deforestation, soil degradation with increased pollution and biodiversity loss. Unsustainable practices like fuelwood and fodder extraction beyond carrying capacity and encroachment by agriculture into forest land subject to land degradation (Gomiero 2016).

8.3.2 Shifting Cultivation or Slash and Burn Practices

Being a hilly region, NER of India devoid of bare agriculture land and comprises with very sloppy hilly, mountainous terrain and thick vegetal cover cleared for agricultural practices by tribal peoples to meet the food requirement. The people cutting down the trees of one region for agriculture practices and when the fertility declined, shifted to another area, cleared the next patch of forest, led to deforestation, soil erosion, reduced soil fertility, and long-term desertification.

Agricultural activities caused land degradation based on land use and management practices. Land clearing practices resulted deforestation, low or poor farming depletes soil nutrients, excessive irrigation caused water logging, overdrafting and infrastructure development leads to land degradation and converts arable land into barren. Hill forest ecosystem threatened by various factors such as climatic and anthropogenic both caused flood, loss of forest land through deforestation and overgrazing for mainly agriculture and infrastructure development purpose.

8.3.3 Urbanization and Mining

Urbanization, mining and infrastructure development converting fertile land to non-productive and taking away land from agriculture and forestry caused land degradation. Surface mining is prevalent in the NER due to availability of the number of resources disturb the all properties of soil including physical, biochemical and socio-economic features. Open mining led to devegetation, defacing of topography, land degradation, lowering of ground water table, soil contamination, loss of biodiversity, soil, air and water pollution. Overexploitation of resources through mining caused significant loss of vegetation and rich topsoil declines fertility of land (Sahu and Dash 2011). Explosion of human population and livestock population exerting heavy pressures on NER limited land resources.

8.3.4 Socio-natural Sources of Land Degradation

Natural causes include earthquake, drought, landslide, heavy rainfall, flood and wildfire in NER, resulted from degradation of land. Some social reasons like land shortage, land availability, economic land pressure, poverty, and population increase also caused land degradation. So, both natural and social causes land degradation that leads to desertification in the long run.

8.3.5 Land Scarcity, Fragmentation and Poor Economy

In NER, small land holding (Bhattacharya et al. 2015) or shortage of land is a very common and important feature resulted severe economic pressures on farmers due to limited land and capital resources. Agriculture pressure makes land as scarce resource and this land shortage and poverty leads to unsustainable land management practices. Improper crop rotations and unbalanced fertilizer use are underlying causes of land degradation (FAO 1994, 2017).

8.3.6 Over Irrigation, Flood and Water Management

Poor irrigation practices due to improper planning and management caused excess extraction of ground water and rise of the water table in the region. In monsoon season, excess precipitation and poor water management system caused flooding and water logging in the region and increased salinity with loosing soil fertility of the agriculture land.

8.3.7 Monoculture and Poor Crop Rotations

Monoculture and poor crop rotation due to lack of soil and water conservation measures led soil erosion. Monoculture declines the soil fertility and productivity of land while cultivation of marginal lands on steep slopes resulted in land degradation and low production.

8.3.8 Inorganic Fertilizer and Pesticide Overuse

Indiscriminate and overuse of inorganic fertilizer and pesticides leads to soil contamination and affects the food chain through biomagnifications and caused eutrophication in nearby water bodies like stream, lakes and ponds. Improper disposal of industrial effluents in the nearby water bodies and land, municipal wastes and pesticides caused heavy metal pollution, soil degradation with lots of severe threats to natural diversity and human health.

8.4 Land Degradation Mitigation Measures and Strategies

NER has minimal agricultural land while available land is facing land degradation and desertification. So, to combat the land degradation and desertification there are various strategies and soil conservation measures, such as conservational till farming, contour farming, strip farming, bunding and terracing helps to reduce soil erosion and water run-off. Mechanical measures such as physical barriers, sand embankments, wind or shelter breaks and soil husbandry helps to control soil erosion (Srinivasarao et al. 2014).Watershed management practices in an integrated manner involves soil and water conservation with suitable crop management proved as an excellent strategy to mitigate soil erosion and land degradation. Other techniques like intercropping or mixed cropping, crop rotation, mulching, and green manuring are fundamental practices associated with the field and crop nutrient management.

Mechanical soil and water conservation measures help retain rainfall in slopes or in hills with safe disposal of excess runoff in India's NER foothill region. Hence, these structure and measures are used to revive the soil suffering from degradation. Thus, combating land degradation is vital to ensuring resilient livelihood. In India, combating desertification and land degradation is one of the focus areas of the Ministry of Environment, Forest and Climate Change (MoEF & CC). There is the target set by UNCCD to combat land degradation and desertification till 2030, India, is a signatory of it and committed to achieving the target.

8.5 Effects of Land Degradation and Desertification (Past and Present Scenario) on Food Security

According to the food security definition, it is considered to be fundamentally related to the sufficient and healthy food requirement available by the people for attaining healthy life (FAO 2015). On a broader term, FAO (2010, 2011) suggested that land degradation comprises the ecosystem components, interaction and biodiversity widely affected the intensive unsustainable agriculture leads to the food insecurity. The land is considered the critical resource for fulfilling food requirements to humans

and directly linked for sustaining life on Earth with the growth and productivity. In the last few decades in India's North-Eastern region affected by the land resources' degradation primarily attributable to over-utilization of the forest for fodder and timber, fuel, shifting cultivation, inadequate land use performs practices, infrastructure suggested by Hazarika (2017). Badapalli et al. (2019) reported that the Indian Space Research Organization (ISRO), 96 million hectors or 30% of India's agricultural land, is affected by land degradation. FAO (2011) reported that reducing soil health due to land degradation contract the ecosystem capacity in terms of loss of crop productivity, leading to the diminishment of ecosystem services, mainly human activities such as deforestation, overgrazing, desertification salinization, and soil erosion.

India is one of 70 countries that are coal to the United Nations Convention to Combat Desertification (UNCCD), which has pledged to reach land degradation neutrality targets by 2030 as a part of the Convention's Land Degradation Neutrality Strategy. Land reclamation is essential, and the more pressing concern is to help communities cope with the immediate effects that desertification has on their economic situation and quality of life. Several initiatives seek to increase land productivity and improve climate adaptability (Davies 2019). According to FAO (Land and Water report 2018) globally almost 52% of the agricultural lands are under the moderate to severely degraded land, affecting the majorly food, energy and water interconnected with the land. Therefore, continuous land degradation up to the present time possesses a significant threat to food security affecting local to the regional scale. In South Asia region, Indian North-East states considered to be affected by the low quality of soil particularly related to the lack of technology for sustainable agriculture affected by degradation is likely for large areas of poor quality of the soil across NE India where shifting cultivation system are currently used. Still, farmers are under pressure to intensify (Sara and Yadav 1996). Land degradation and desertification correlate with food security as land productivity suffers from land degradation, desertification, abandonment, and pollution. Often, degradation can stem from an alteration to the distribution of vegetation linked to land-use change. Therefore, it can yield vegetative patches separated by bare soil, which is often seen as an indicator of desertification (Stringer et al. 2011). A significant correlation observed with the land degradation and food security observed globally, scarcity in the vegetation affected by the human impact causing the reduction in the soil moisture, increasing temperature, affecting reduction in the top soil also the change in the land use and land cover due to extensive urbanization and loss in biodiversity and change in the landscape (Stringer et al. 2011).

8.6 Prediction in Land Degradation and Desertification Concerning Food Security

Arable land reduced to 0.25 ha in the year 2010 then 0.4 ha in the year 1960 reported by data of United Nations, and it is also predicted to reduce to less than 0.2 by the year 2050 (Bruinsma 2009). Saha et al. (2012) reported that Northeast region is a diverse geographic area and an agroclimatic region comprising almost 54.1% of the forests and 16.6% land use for agriculture, and rest of the are unused due to topography, degraded soil and land erosion and unreachable terrain; however, deforestation, timber collection and shifting cultivation affects the soil health and increase the vulnerability of the land degradation. Bhattacharyya et al. (2015) suggested that land degradation comprises loss of the topsoil cover, erosion of the soil, impact of urbanization and also increasing the effect of acidification, depends upon the effect in India particularly problem-related to the densely agricultural region. In part like North-East India already land scarcity leads the demand for high crop management costs. Presently, India is having almost 18% of the world's human population; however, only 2.4% of the world land area. Degradation of land and soil degradation reduces agricultural productivity and causing a potential threat to food security. Choudhury and Sundriyal (2003) suggested that the agriculture in the mountainous region facing intense pressure from the past few years due to changing climate conditions and human-induced impacts affects crop productivity despite the increase in land area under agriculture. The main practice comprises the shifting cultivation, however, often being suggested as the destructive agricultural practice causing sedimentation in low lands and deforestation (Sillitoe 1998).

8.7 Sustainable Development Goals for Land Degradation and Desertification

In the 68th United Nations General Assembly acknowledged land degradation and significance to the conservation of soil. It declared 2015 as International Year of Soils (IYS) also FAO designated to employ the IYS 2015. Globally, this framework helps to induce awareness for land degradation and food security threat and mitigating measures (Gupta 2019). An inclusive study conducted by the Indian Space Research Organization, Ahmedabad for mapping the land degradation and assess that almost 96.40 million hectares of the total geographic area of India was experiencing the land degradation, majorly in Delhi and three North-East states Tripura, Nagaland and Mizoram had vulnerability for the land degradation (SAC 2016).

Bhattacharyya et al. (2015) suggested that the unsustainable agricultural practices lead to the land degradation through various factors, for instance, crop management practices, cultivation in marginal sloping lands and forest clearing for agriculture, depletion of soil nutrients, excessive irrigation and increasing urbanization. Various strategies for the mitigation of the land degradation include soil erosion control,

including bunding, contour ploughing, terraces and stripes building, restriction in the run-off of water, soil husbandry development, barriers windbreaks, embankments (Srinivasarao et al. 2014). Mitigating measures also included water harvesting, development of engineering structures, contour farming and intercropping, watershed approaches, organic farming and integrated nutrient management, reclamation of soil affected by the salts, maintenance of the irrigation (Bhattacharyya et al. 2015).

Saha et al. (2012) reported that almost 37.1% land of the North-East Indian facing a threat to the land degradation mainly due to the soil erosion, and increasing urbanization arises a significant concern to the soil fertility leading to the food insecurity. Further, Saha et al. (2012) suggested the long-term mitigation measures soil conservation such as plantation of multipurpose trees, development of agroforestry interventions in the degraded lands, improvements for the soil fertility, observation of the soil health, measuring soil sequestration potential, conservation of soil and water, the practice of conservation tillage, management of in situ residue, maintenance of nutrient supply and development of pastures.

8.8 Conclusion

Desertification and land degradation are the two major threats to agricultural productivity in NER and India. NER facing low food production due to land degradation with the other parts of the country. As the population increases, puts the direct pressure on resources that accelerates the land degradation and desertification process, resulted from low food production. The central and state governments implement many programmes and schemes to achieve the objectives to combat land degradation and desertification. Hence, there is a necessity to control the process of land degradation and desertification to ensure sustainable development and to protect the resources like soil, water, and biodiversity to sustain life on earth and at the same time also the encouragement towards the sustainable agricultural which can combat the challenges of food security.

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Chapter 9
Enhanced Vegetation Index and Land Use Analysis for Seven Sister States of India (2000–2022)

Priyanka Puri

Abstract The Seven Sister States of northeast India are an enormously rich and diverse biodiversity region. Natural vegetation is, in fact, the dominant land cover class for the whole region. The aspect of examining vegetation, hence, becomes very important in many regards. It can act as an indicator of land use changes and also as a clear indicator of impact of processes operating in the region, natural and human induced. Currently, climate change has made such examinations very relevant. Enhanced Vegetation Index (EVI) becomes an important methodology of analysis in this context. The current study attempts to examine the spatio-temporal pattern of EVI for the Seven Sister States of India and attempts to find its evolving pattern geographically and temporally in the recent context. Results indicate that for the region as a whole, no specific change is observed in the land cover but the trends in EVI are not very encouraging.

Keywords EVI · Northeast India · MODIS · Land cover · Copernicus · Vegetation

9.1 Introduction

Land as an asset does not require any specific introduction as it is the base of human life and its existence. In its definitional aspect, land comprises a defined geographical surface of the Earth with identifiable features and recognizable attributes above and below it (Foley 2005; FAO 2022). Land becomes a resource when all these features (Vink 1975) along with socio-economic components are utilized (Rawat and Kumar 2015). The two mentioned aspects lead to the concept of land cover and land use, wherein, the earlier is natural and the latter is human induced due to human activities and interactions with natural resources on land (Liping et al. 2018; Hu et al. 2019).

Land use is a more complicated term as compared to land cover as it denotes human activities which are diverse and do not always fit into exact boundaries

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(Ellis 2007; Liping et al. 2018). It is very important to note in this regard that at all geographic levels in the current times, an increasing population and changing consumption behaviours have remarkably altered the landscape at the local, regional (Rojas et al. 2011; Verma et al. 2020) and global level (Rojas et al. 2011; Bajocco et al. 2012). Studies related to land use and land cover (LULC) change, popularly termed as LULCC, describe these changes which come up due to complex interactions between the natural and human induced factors.

Studies related to these concepts are not only concurrent but also relevant as they are clear indicators of changes taking place at various spatio-temporal scales (Liping et al. 2018). Besides, land use changes have the capacity to alter the land cover (Liping et al. 2018). These changes are also effective in inducing local and global level changes (Verma et al. 2020). All this has made land degradation a major environmental problem across the world (Bajocco et al. 2012) and LULC studies as that of pertinence across the world (Tewabe and Fentahun 2020; Nedd et al. 2021). Studies examining the updated aspects of land use change do not only provide comparative information for various purposes (Ramankutty 2006; Keshtkar et al. 2017) but also help in examining the nature and rate of these processes affecting them (Turner and Meyer1998; Liping et al. 2018).

Remote sensing and GIS provide qualitative and quantitative information for examining LULC and are used widely (Herold et al. 2003; Roy and Roy 2010; Karakus et al. 2015; Gansari and Dwarakish 2015; Mridha et al. 2016) while playing an unmatched role in this regard (Karakus et al. 2015). Remote sensing has now become an essential element in such analysis as it can provide more information that can be gathered through ground surveys (Ellis 2007; Mayaux et al. 2008). Derivation of characteristics of land and LULC is highlighted as the most significant kind of remotely sensed data (Giri 2016). The changes in LULC are well captured by satellites as they are able to detect these variations generated by natural and human induced factors, thereby making remote sensing and analysis through Geographic Information System a significant tool in LULC studies (Mridha et al. 2016). The quality of data is a major concern in this methodology (Nedd et al. 2021). In this aspect, there exist LULC datasets at various levels ranging from local to global (Nedd et al. 2021). However, examination of land resource through remote sensing can also have major issues related to cost, data availability, timing of data and overlapping land uses (Giri 2016).

Land use in India has also recorded pertinent changes due to population increase, urbanization and, agricultural area increase at various points in history to present day (Tian et al. 2014) and a considerable alteration is observed in LULC (Roy et al. 2015). It is noteworthy, particularly in the context of northeast India, that a lot of changes have taken place in land use and vegetation (Mridha et al. 2016). Vegetation removal is a very significant concept in studying LULC due to many aspects it involves (Hu et al. 2019). In northeast India, including the state of Sikkim, natural vegetation as dense forests occupies for about 55% of the total land area, and 12–16% of the land area is occupied by small shrub vegetation followed by agricultural land at 12–13% and of the total area of the region. Observations on land use in this region

indicate a predominance of hillslope vegetation and river Brahmaputra floodplains (Shougrakpam et al. 2010).

The current examination focuses upon examining the recent land cover characteristics and diversifies it further to observe the changes in vegetation through the Enhanced Vegetation Index (EVI) for these states. The purpose is to check the changes in land cover and to discover the alterations in the category of vegetation. Remotely sensing vegetation can provide a clear information on changes in vegetation (Matsushita et al. 2007) as well as land cover and land use if monitored over a longer period of time (Setiawan and Yoshino 2014). In this regard, EVI is highlighted as being near to Normalized Difference Vegetation Index (NDVI), which is a very popular method of estimating density of green cover in an area (NASA 2000). EVI tends to improve the output by correcting certain atmospheric disturbances and the 'canopy background noise' (USGS 2022). This gives it an advantage to be very sensitive in areas of dense vegetation (USGS 2022) as is the present case of the area in study (Rao and Murti 1990).

Multiple sources exist for getting satellite generated EVI data, and these have proved to be quite accurate with site observations (Huete et al. 2002). EVI has been constructed to enhance vegetation analysis by removing canopy signal in the background and reduces the influence of atmospheric disturbances (Huete et al. 2002). In this are involved removal of Rayleigh and ozone absorption influences, a blue band to correct aerosol influences, treating of differential NIR and transfer of red radiation through canopy and effects of soil; all of which are very useful in monitoring vegetation where aerosols are in high concentration and burning of biomass is involved (Huete et al. 2002).

EVI can also show seasonal patterns of vegetation (Brede 2014). However, it has also been observed that NDVI has an advantage over EVI depending upon the area under study (Li et al. 2010). There are various data sources available for generating EVI, among which Landsat, MODIS and, Sentinel-1 and Sentinel-2 satellite data sources can be highlighted (He et al. 2021).

According to studies, deforestation rate in the northeastern region in the twentieth century has caused a loss of tree cover by 70% between 2001–2018 (Dhar 2021). The current examination is an attempt to observe the land use patterns in the Seven Sister States of India from 2000–2020 and the trends in vegetation index of EVI. It is also aimed to find out the spatio-temporal patterning of EVI for the time period. This chapter is an attempt to probe the spatio-temporal pattern of the Enhanced Vegetation Index (EVI) and land use for the Seven Sister States of northeast India (excluding Sikkim) through remote sensing. In doing so, the chapter is an attempt to examine its geographical and temporal vegetation and land use evolving pattern for the period 2000–2022.

9.2 Study Area

The current study examines the recent most changes in the land use pattern in the Seven Sister States of India along with a study of extent of vegetation through the Enhanced Vegetation Index (EVI), specifically with reference to the twenty-first century. These states are Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura (Dash et al. 2012). Along with Sikkim, these eight states comprise Northeast India (NEI) as a region (Dash et al. 2012). Covering about 8% area and approximately 2.1% of the country's population, these states have varied and diverse physiography and hydrogeology (Das et al. 2016). The approximate location of these states is from 20° N–30° N latitudes and 87° E–98° E longitudes (Agrawal et al. 2021). The 'land of seven sisters' was termed by a Tripura journalist, Jyoti Prasad Saikia in 1972, which has also been used as the Seven Sister States in terminology (Sivaramakrishnan et al. 2016). The region generally has a mountainous relief with two thirds of its territory occupied by hills and mountains, giving it the shape of an 'amphitheatre', nearly 30% by plains and the remaining by plateau region (Dikshit and Dikshit 2013).

With diversity in population and ethnic background, these states have a tribal population of around 75% (Das et al. 2016). All these states are extremely rich in biodiversity and are among the 'biodiversity hot spots' of the world (Chakraborty 2009; Das et al. 2016). A varied topography ranging from high hills, plains, ridges, valleys, numerous streams and lush forests dominates the landscape (Sangomla 2021) with the mighty Brahmaputra river flowing almost through the middle of the region with significant river basins (Ahmad and Lodrick 2021).

With regards to respective states, Assam has an uneven landscape composed of hills, plains and rivers (Assam 2019); Arunachal Pradesh's topography is dominated by plateaus and ridges with the Himalayan peaks running to the east and south (Lodrick 2019); Manipur is marked by a plain interior and uneven hills and narrow valleys in the periphery; Meghalaya's topographic features are observed with hills and plateaus (Raghavan and Lodrick 2020); Mizoram's topography is dominated by rolling hills, rivers and lakes; Nagaland's topography is marked by dissected hill ranges (Nagaland n.d.); and Tripura observes three individual topographic zones as hills, rolling plateau and plain (Lodrick 2020). Besides, whole of the region is extremely rich hydrologically with a number of rivers, their tributaries, streams, marshes and lakes (Bhaduri n.d.; SANDRP n.d.) (Fig. 9.1).

The region due to its location and topography experiences one of the heaviest rainfall in the country and also in the world (Sangomla 2021; Department n.d.) but with a low variability (I.M.D. n.d.). With regards to vegetation, the region can be broadly divided into two realms—the mountains with forest cover and plains with agricultural land (Dikshit and Dikshit 2013).

Data Source and Methodology-The aim of the current study is to observe the changes in land cover in the study area along with observed changes in vegetation through satellite data. In this regard, vegetation—both natural and agricultural—forms the dominant land use for the region. The attempt is to first classify the change

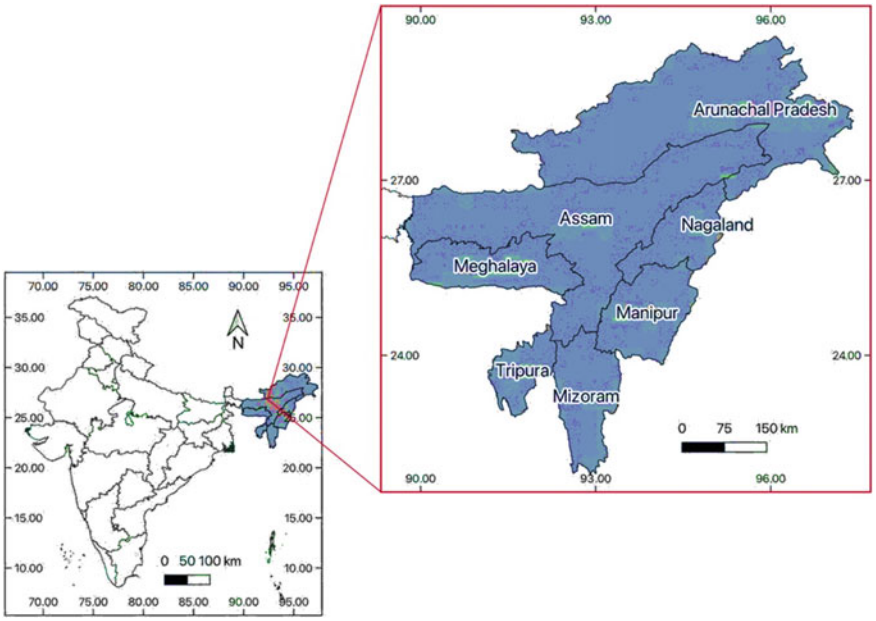


Fig. 9.1 India—Location of Seven Sister States. *Source* Prepared by Author, 2022

in land use pattern over the selected time period, i.e. 2000–2022 for the region as a whole and then observe the EVI patterns. The study of EVI in the current context has been done in the following forms:

a. **Spatial analysis of Land cover, land use and EVI-**Land cover and land use information for the study area has been derived from Copernicus Global Land Cover Layers: CGLS- LC 100 Collection 3 from the Google Earth Engine (GEE). This information is available for years 2015–19. The database is defined as a dynamic one with a resolution of 100 m with an accuracy of 80% for discrete categories of land use. For 2020, land use information is derived from ESA World Cover 10 m 2020 which provides land cover map at 10 m resolution from Sentinel-1 and Sentinel-2 data. This data has been mapped, and land cover categories have been observed for share of classes. It provides 11 land cover classification classes. These have been further interpreted for their share in land cover. The study of EVI is attempted next by deriving the general pattern of the Index at the region's level, and then, this is interpreted for each state of the region. The data is generated for this from the MODIS Terra Vegetation Indices 16-Day Global 250 m data through GEE. The MOD 13 Q1. 061 Terra Vegetation Indices 16-Day Global 250 m database provides EVI information by reducing canopy distraction and has a good response over highly vegetated areas as is in the study area. It uses a blue band as mentioned earlier to reduce the effects of smoke and thin clouds with the output being masked for disturbances through water and so

on. This is examined through the land use classes. Spatial data has been mapped and analysed through QGIS 3.16.

b. **Temporal analysis-**To supplement the spatial analysis, temporal data for the study area is generated through MODIS Terra Vegetation Indices 16-Day Global 250 m data. This examination has been extended at the regional level and also at the respective state levels to see the trends in EVI as a vegetation index. This analysis has been conducted from 2000–2022* (till April).

c. The findings are discussed and cross-checked to find the trends in EVI in the light of land cover in the region. This is supposed to provide a broad idea of the correlation between the two parameters in the light of climate change and effects of other factors in the region.

9.3 Analysis

The analysis initiates with the observations of land cover classes in the study area from 2015–2020. These are then examined for their individual share. Following observations have been derived.

Figures 9.2 and 9.3 indicate that natural vegetation and cropland dominate the land cover of the region. As per Table 9.1, natural vegetation dominates the land cover class. When changes are considered in land cover, as indicated by Fig. 9.3, major or notable changes are not observed for the region as a whole. Open forests indicate the category of maximum change and that is in a negative trend. Some land cover classes such as cultivated land have shown an increase but that is marginal. On the whole, slight fluctuations of increase and decrease are observed in almost all categories of land cover. A few variations are observed in data recorded by both databases in which Copernicus has recorded Urban Built-up at around 0.8% while the ESA database finds it at 0.2%. Also, mosses and lichen category is not recorded by Copernicus but by ESA. The analysis is next extended to examine the EVI patterns in the region on spatial and temporal basis.

a. **Spatial Analysis of EVI-**This has been conducted at two levels—the first is general regional analysis, and the second is state-wise specific analysis. The findings have been mapped in Figs. 9.4 and 9.5. EVI values generally range from a value of −1 to 1 indicating unhealthy to healthy vegetation. The formula for its calculation is as follows:

Formula for MODIS Terra EVI Indices: EVI = G * (NIR – RED)/(NIR) + (C1 * RED) − (C2 * BLUE) + L).

NIR = Near Infrared Radiation; **C1 and C 2** = coefficients of aerosol resistance term (which uses the blue band for correction of influences of aerosols); **L** is the canopy background adjustment for corrections; **G** = scaling factor = 2.5.

The Earth Engine applies a scaling factor of 0.0001 which is used in analysis here.

- **Index is without scaling; values after scaling range from 0.1 to 0.5 for Fig. 9.5 (Scaling parameter is 0.0001 in this case).**

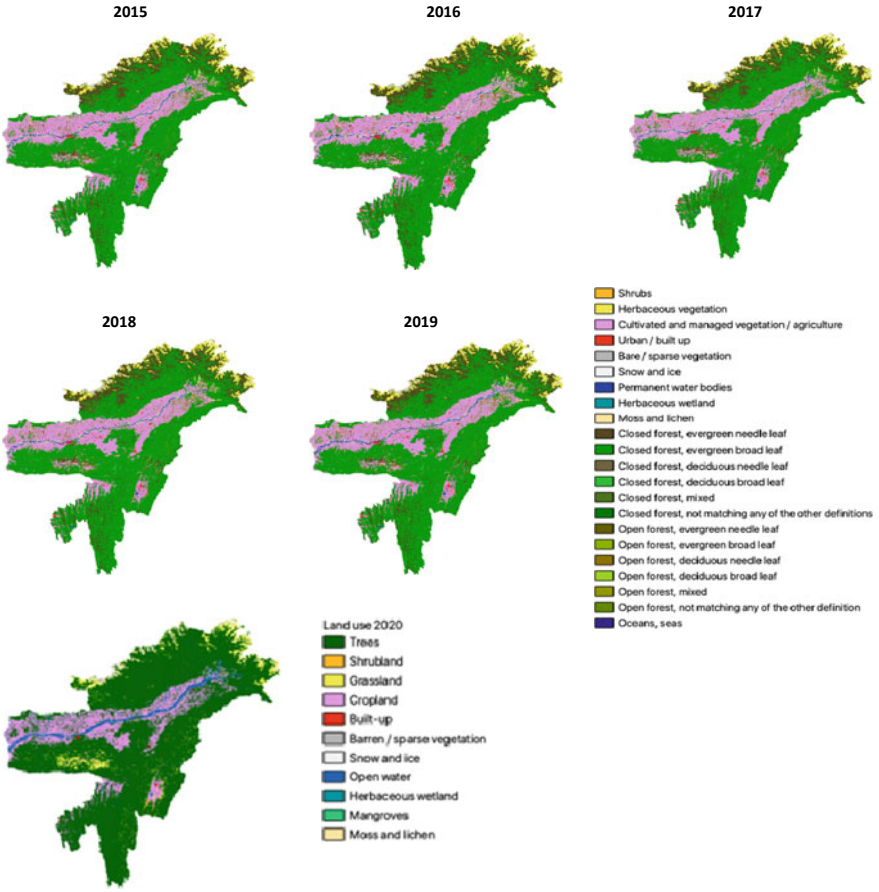


Fig. 9.2 Seven Sister States—Land Cover (2015–2020). *Source* Derived by Author, 2022 (Engine G. E., 2022); Copernicus database (2015–19), ESA database (2020)

As is visible from Fig. 9.4, the range of EVI from 2000–2022 for the region is −0.002 to 0.55. In the north and north-eastern part and the river Brahmaputra, the trend is largely negative. These are the snow regions of the Himalayas in Arunachal Pradesh and vegetated hill slopes and water body of river Brahmaputra. Highest EVI zone is observed from the central part of the region to the extreme south from Assam to Mizoram states. The temporal examination stands as follows:

Figure 9.5 indicates that the temporal trend of EVI for the region from 2000–2022 has been fluctuating through these years to a great extent and the middle part of the year exhibits a higher trend of EVI which increases further in the later part of the year. This generalized pattern is similar throughout the time period with fluctuations but the pattern remains the same. Higher EVI values are co-terminus with rainfall of the southwest monsoon season (I.M.D. n.d.). But on the whole, severe oscillations in trend of EVI are indicative of human activities as well. It is also interesting to

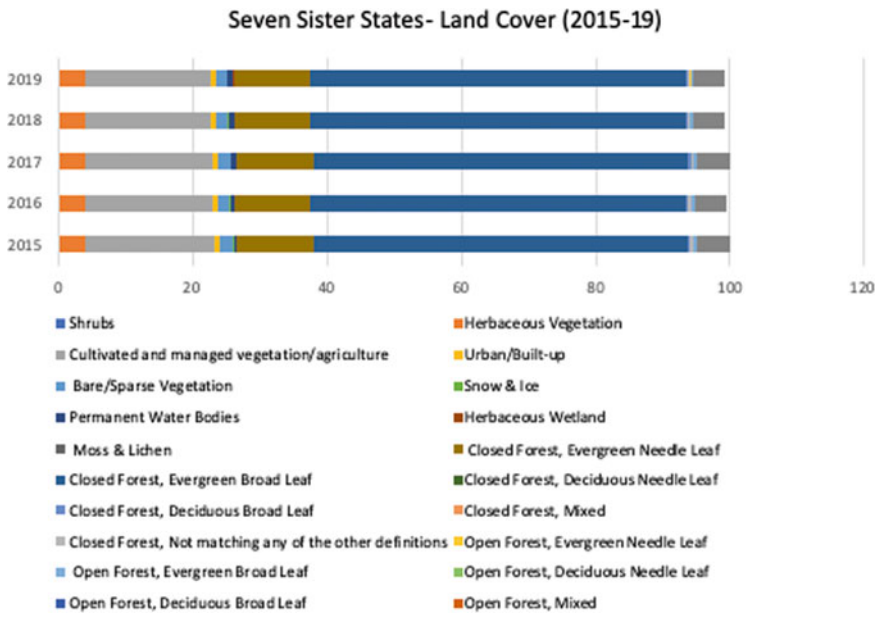


Fig. 9.3 Changes in and Cover Classes—Seven Sister States (Copernicus database). *Source* Author, 2022 derived from Table 9.1

note that these values turn almost similar during the end of the year to the early part of the year when the curves are not only smooth but also parallel to each other with overlaps.

The spatial and temporal examination can be extended to respective states as well. Figures 9.6 and 9.7 indicate these trends. It is observable that the maximum EVI values are recorded for the states are generally synonymous with naturally vegetated regions and agricultural land exhibits a lower EVI value. On the whole, spatially, the state of Mizoram followed by Tripura have the maximum EVI values. As is also visible from Fig. 9.2, these states have the maximum land cover under natural vegetation. The probable reason can also relate to lesser human interference in these regions, lack of built up and lesser cultivation. Generally, the regions and states with a larger share of natural vegetation have more EVI. Regions with land cover of snow and water bodies obviously depict a lower EVI. In spatial analysis here, it is very significant to note that the negative values of EVI are observed in the hilly and snow-clad regions of Arunachal Pradesh. This is also the region of closed forest land cover; so it can be forwarded that deforestation rate is high here.

The Brahmaputra valley region of Assam is another region with a negative range of EVI. What is notable in this regard for the region is that the positive value of EVI is also observed from 2000–2022, in some areas, which is an indicator that the vegetation is under less threat there. However, there are certain pockets in the region where lower EVI values are reflected, and as per the land cover observed, these are the croplands. But, as is also visible from Figs. 9.4 and 9.5, lower values of EVI in

Table 9.1 Seven Sister States—Percentage under each Land Cover Class

Land cover class/year (Copernicus database)	2015	2016	2017	2018	2019	2020* (ESA database)
1. Shrubs	0.1	0.09	0.09	0.09	0.1	1. Trees-76.6
2. Herbaceous vegetation	4	3.9	4	3.9	3.8	2. Shrubland-0.02
3. Cultivated and managed vegetation/agriculture	19	18.9	18.8	18.8	18.8	3. Grassland-4
4. Urban/built-up	0.8	0.8	0.9	0.8	0.8	4. Cropland-14
5. Bare/sparse vegetation	2	1.8	1.8	1.6	1.5	5. Built-up-0.2
6. Snow & ice	0.2	0.2	0.2	0.2	0.2	6.Barren/sparse vegetation-0.8
7. Permanent water bodies	0.4	0.5	0.7	0.7	0.8	7. Snow & ice-0.7
8. Herbaceous wetland	0.1	0.1	0.1	0.2	0.3	8. Open water-2.6
9. Moss & lichen	–	–	–	–	–	9.Herbaceous wetland-0.4
10. Closed forest, evergreen needle leaf	11.3	11.3	11.3	11.3	11.3	10. Mangroves-
11. Closed forest, evergreen broad leaf	55.8	55.8	55.9	55.8	55.8	11. Moss & lichen-1.7
12. Closed forest, deciduous needle leaf		–	–	–	–	–
13. Closed forest, deciduous broad leaf	0.4	0.39	0.4	0.3	0.3	
14. Closed forest, mixed	–	–	–	–	–	
15. Closed forest, not matching any of the other definitions	0.5	0.4	0.4	0.4	0.4	
16. Open forest, evergreen needle leaf	0.03	0.03	0.03	0.03	0.03	
17. Open forest, evergreen broad leaf	0.5	0.48	0.5	0.4	0.4	
18. Open forest, deciduous needle leaf	–	–	–	–	–	
19. Open forest, deciduous broad leaf	0.06	0.002	0.001	0.002	0.002	
20. Open forest, mixed	–	–	–	–	–	
21. Open forest, not matching any of the other definitions	4.8	4.7	4.8	4.7	4.7	
22. Ocean/seas	–	–	–	–	–	

Source Calculated by Author, 2022 through Q.GIS.3.16 and MS Excel

• Column total is not exactly 100% but between 99–100% due to decimal values generated through pixel calculations

• ESA land cover classes are different from Copernicus classes

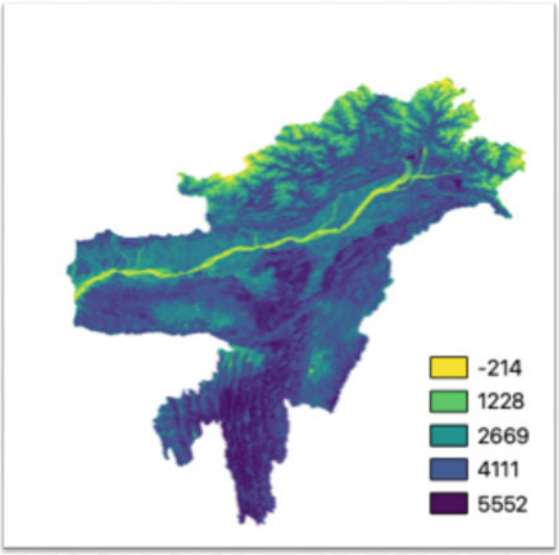


Fig. 9.4 Seven Sister States—Spatial Trend of EVI (2000–2022*). *Source* Author, derived from GEE (Engine C., 2022)

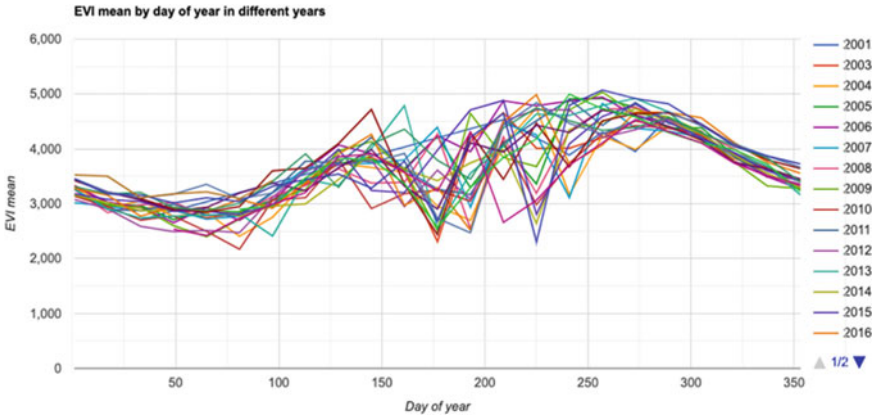


Fig. 9.5 SevenSister States—Temporal Trend of EVI (2000–2021). *Source* Author, derived from GEE (Engine C., 2022). Index is without scaling; Values after scaling range from- 0.02 to 0.55 (Scaling parameter is 0.0001 in this case)

the range of 0.2–0.55 dominate the regional extent. This is although an indicator of a healthy vegetation but the density of vegetation is not very high as expected for the region with regards to the nature of climate and vegetation. A higher EVI would have indicated a denser vegetation but this range is not very high.

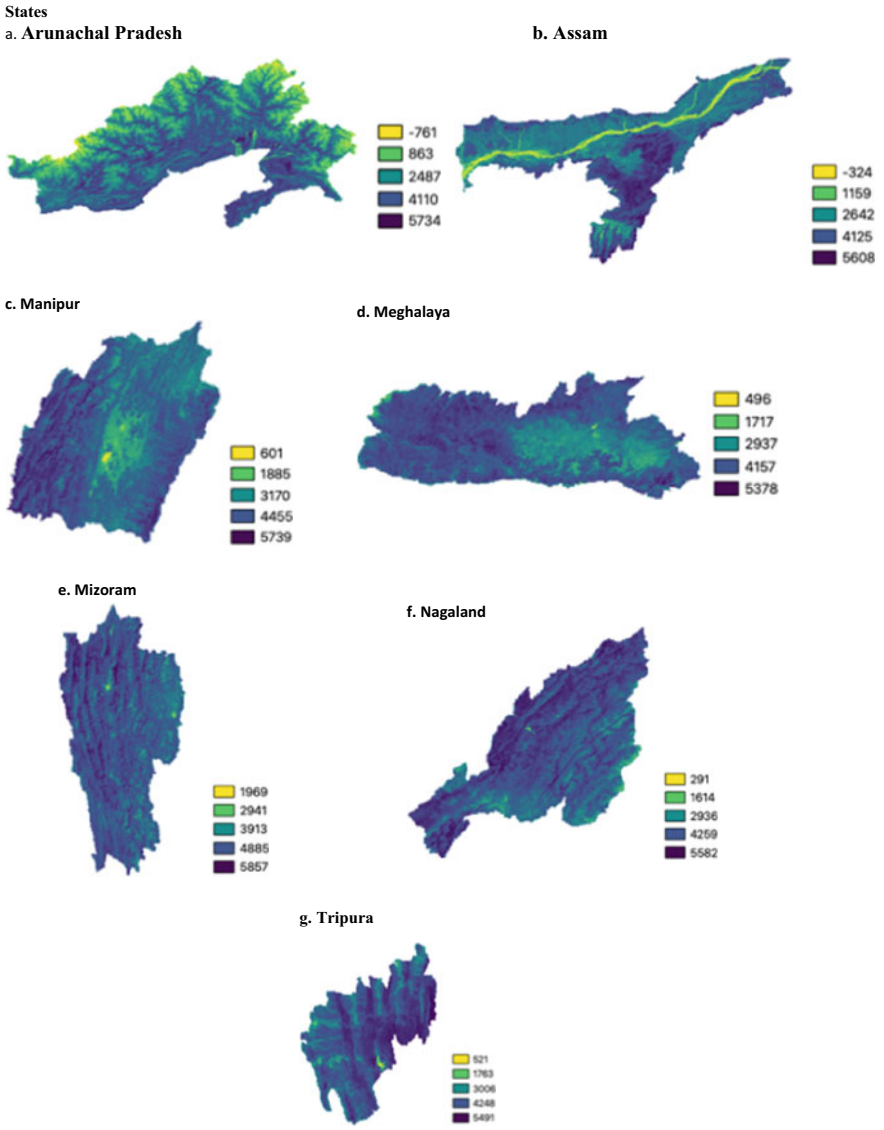
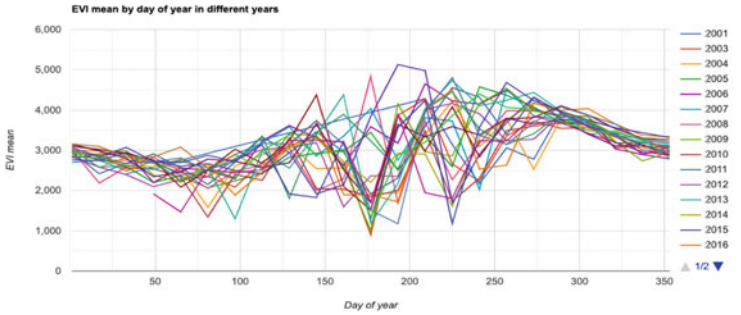


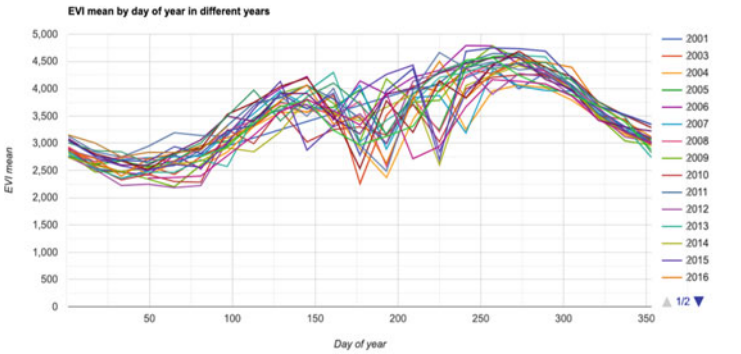
Fig. 9.6 SevenSister States—Spatio-Temporal Trend in EVI (2000–2022). *Note* Maps are not to a common scale. Index is without the scaling factor. *Source* Author, 2022, derived from GEE (Engine C., 2022)

a. Arunachal Pradesh



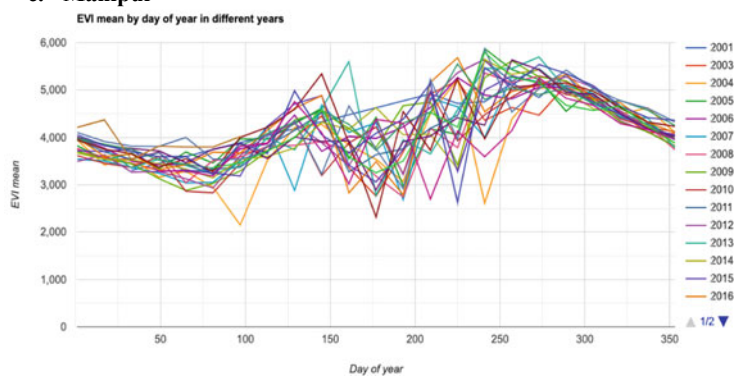
EVI Data range after scaling- 0.1- 0.5 (approximately)

b. Assam



EVI Data range after scaling- 0.2- 0.48 (approximately)

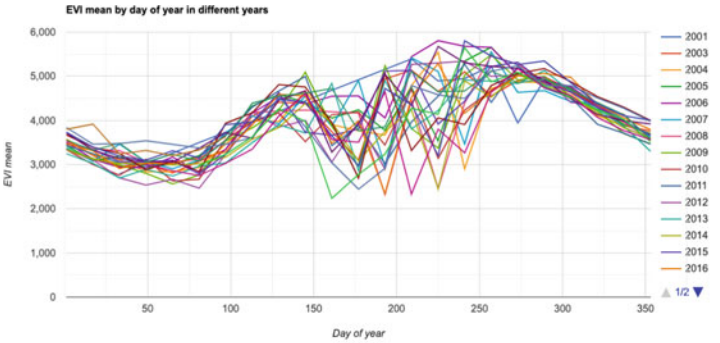
c. Manipur



EVI Data range after scaling- 0.2- 0.58 (approximately)

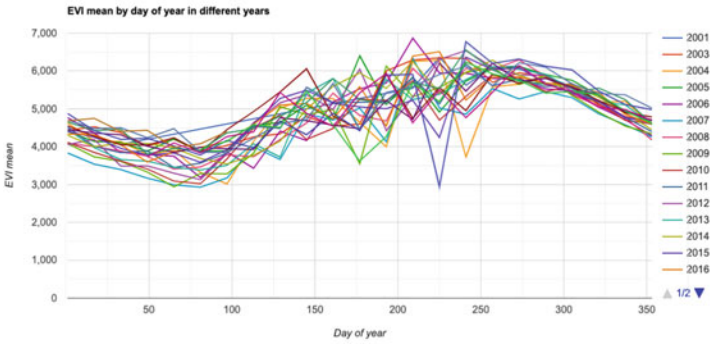
Fig. 9.7 Seven Sister States—temporal trend in EVI (2000–2022)

d. Meghalaya



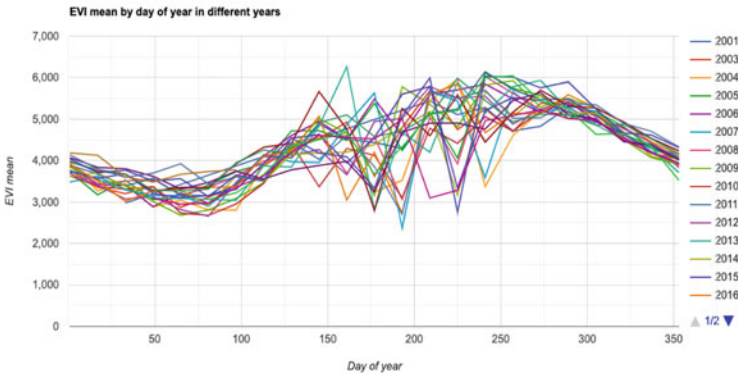
EVI Data range after scaling- 0.22- 0.58 (approximately)

e. Mizoram



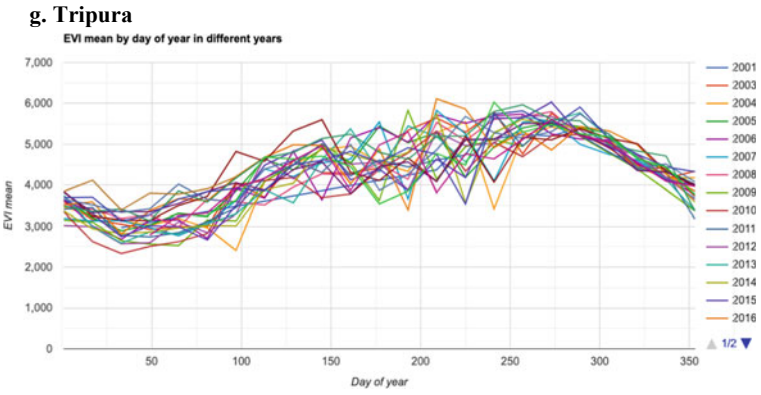
EVI Data range after scaling- 0.3- 0.7 (approximately)

f. Nagaland



EVI Data range after scaling- 0.23- 0.63 (approximately**)**

Fig. 9.7 (continued)



EVI Data range after scaling- 0.25- 0.61 (approximately)

Fig. 9.7 (continued)

The spatial trend is supplemented with temporal analysis in Fig. 9.7. The information derived corroborates with the spatial trend. Firstly, there is no temporal clarity in the trend of EVI for any state as there are fluctuations which are observed in the data on year-to-year basis. Probably, rainfall (IMD, 2020) or forest fires can be cited as the operating factor in this regard. Secondly, the fact is supported by the observation that the yearly trend of EVI for every region shows a distinct pattern during specific time period of the year. The states of Meghalaya and Mizoram exhibit the highest values of EVI indicating a more dominant natural vegetation. EVI pattern seems to stabilize towards the last quarter of the year after around 250 days which again is a probable indicator of the effect of rainfall. Sudden plunges during the middle part of the year in the index are visible across all states which can be strongly attributed to rainfall and/or any specific pattern of agriculture as a human activity.

Thus, it can be concluded that the EVI values for the region are although on the positive side but the range is not on the higher end as can be expected from a region rich in biodiversity and favourable climatic conditions for vegetation. A combination of natural and anthropogenic factors seem to be determining this trend.

9.4 Results and Conclusions

It can be fairly derived from the above analysis that natural vegetation being the dominant land cover is responsible for higher values of EVI for the region. It requires a constant monitoring as deforestation seems to be a possible cause in certain states due to which a very high value of EVI is not observed for the region. Agriculture is the next dominant land cover class, and its expansion seems to be checked for maintaining a level of EVI for the region. But since the EVI still is operating in

positive values, concerted efforts can help in preventing it from a further decline and also improving it.

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Chapter 10
Quality of Living Space Among Rural Households in North-Eastern Region of India

K. V. Chamar and Rekha Dhanak

Abstract Availability of various household amenities and assets reflects a household's quality of life. Nowadays, the household possessions are the sign of social status and have been instrumental in an improved quality of life in rural areas. The 'Land of Seven Sisters' is one of the most culturally diverse region in the world reflecting cultural contrast between the hills and plains. Therefore, analysis of the levels of quality of living space among rural households in north-eastern region of India is an important exercise. Based on district-wise census data for the year 2011 on 20 select indicators, the present study is an endeavour in this direction. The z score value of 20 select indicators has been calculated. The values of z score of a particular observation (i.e. a district in the present case) across all the selected variables were aggregated to derive its overall levels of quality of living space. The analysis of aggregate values of z score reveals a marked regional variation in quality of living space in north-eastern region of India. The study highlights that nearly nine-tenths households have their own house and about three-fourths households are enjoying the facility of kitchen inside the house. While on the other hand more than half of the households have the facility of electricity as source of lighting, computer/laptop with internet is available to less than one per cent of the households, on the other. Similarly, four wheelers that is car/jeep/van are available to only a little over three per cent of the households while nearly eight per cent households possess scooter/motorcycle/moped. Only 2.5% households have the facility of closed drainage outlet connection for disposal of waste water. It is also observed that about one-fifth of the households have permanent houses and nearly 13% have four or more rooms in the house. Relatively better quality of living space is observed in central parts of the study area in the form of patches while low and very low quality of living space is witnessed mainly peripheral parts of the region. Papum Pare in Arunachal Pradesh attained the highest composite z score value of 33.2, while Dhubri in Assam

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witnessed the lowest composite z score value of minus 18.3 in terms of availability of household amenities and modern assets among rural households in the region.

Keywords QoL · Households · Amenities · Modern assets · Composite z score

10.1 Introduction

Availability of various household amenities and assets reflects a household's quality of life. In modern life, household possessions are both, a sign of social status and instruments for better life in rural areas. 'Quality of living space' is a multi-dimensional concept, which includes economic, social, demographic and cultural dimensions of human life. Various domains of life such as housing, health and social relations are taken into consideration in order to monitor the quality of life (Glatzer and Hans 1987). The quality of life, as 'the state of social wellbeing' of an individual or group, can either be perceived or identified by observable indicators (Johnston et al. 1994). Generally, environmental and economic conditions of the people are reflected in the use of building materials. The rich and well-to-do people generally build their houses with burnt bricks while the poor class lives in mud walled and grass/thatch/bamboo roofed houses.

'Safe drinking water and sanitation facilities reduce the prevalence of gastrointestinal diseases in any society. Likewise, new fuels and improved stoves provide a cleaner environment and better health. Availability of piped water within the household and use of liquefied petroleum gas for cooking reduce drudgery of women in domestic chores, thus allowing more time for other activities. Better electric appliances and furniture facilitate effective education among children. Availability of automobiles, communication and mass media strengthen the household's connection to the country as a whole and any area in particular. Access to these amenities thus reflects a household's quality of life. They act as a sign of social status and instrument for a better life among various social groups in modern life' (Desai et al. 2010).

Nayar (1997) highlighted that 'the factors affecting the health status of the people in any society can possibly be grouped into three sets: (i) health factors which include medical intervention; (ii) health-promoting factors such as housing, water supply, sanitation and hygiene; and (iii) non-health factors which include social and economic factors. The health-promoting factors such as housing conditions, availability of drinking water and sanitary facilities are much more required for health improvement among the population sometimes even more significantly than others'. The availability of modern assets such as computer/laptop, television and motor vehicles has been an important part of any household. Motor vehicles like car/jeep/van; scooter/motorcycle/moped and television strength the household's connection to the country as a whole and area in particular. In any study of rural areas, the investigation about the availability of amenities and modern assets in the households is very important because it is the centre of social status in the society.

The study on quality of living space as a broad theme has been a popular topic of research among geographers, educationists, economists, demographers, medical practitioners, health planners, the media and government organizations, etc. Geographers and other scholars have carried out many detailed studies on kind, conditions and quality of household amenities and availability of assets in India. Most of these studies explore regional variations in the country or individual states using data drawn from various secondary sources. Using latest state level data from 2011 census, Krishan (2017) has studied 'quality of living space in India with the help of three sets of factors like status of housing conditions, availability of living space and provision of amenities. The study highlights a marked 'north–south' contrast in quality of living space. Tiwari and Nayak (2013) examined inter-regional disparity and its determinants with regard to drinking water and sanitation facilities in Uttar Pradesh. In the same vein, Prabhuswamy (2014) studied decadal change in 'availability and accessibility of basic amenities to the households in the state of Karnataka during 2001 and 2011. Data on such household amenities as housing conditions, drinking water, separate kitchen, LPG connection and toilet facilities were used. Based on district-wise data, the author also attempted to examine the influence of urbanization, literacy rate and GDP on the status of basic amenities.

Some scholars have focused their studies on urban areas specifically (see for instance Kundu et al. 1999). Just as elsewhere in the less developed parts of the world, urban India is marked with a sharp contrast in access to basic amenities among different segments of urban dwellers. Urban poor which largely comprise slum dwellers have thus engaged the attention of researchers (see for instance Kundu 1991; Mahadeva 2001). Based on data drawn from 2001 census, Hassan and Daspattanayak (2008) studied regional variation in the levels of basic amenities in urban Orissa, in general, and across size class of urban centres, in particular. Some scholars have undertaken micro-level study on quality of life of individual town or cities. Bhagat and Sharma (2001), for instance, have studied the 'quality of life' in Rohtak, an important city of Haryana. The study is based on indicators like education, occupation, per capita monthly income of the household, housing occupancy status, number of rooms, availability of bathroom, toilet, sewerage system, source of drinking water and select durable assets.

Keeping in view the fact that a major part of the population in the country still resides in rural areas, researchers have devoted their attention to rural areas exclusively as well. Chamar and Sharma (2020) in a recent study have examined regional variations in the 'levels of socio-economic status of female-headed households in rural Haryana' using district-wise census data for the year 2011. Likewise, there are numerous studies at micro-level on quality of living space in rural areas of the country. In one of the earliest studies, Chamar (2002) examined the distribution of rural dwellings, their types and distribution based on shape and size, functional characteristics, building materials and house plan in Bhiwani district, a prominent part of desert land of Haryana. The study revealed a marked contrast in the house types between the eastern and the western parts of the district. The general condition and the architectural design of the houses in the eastern parts are good and attractive because of prevailing prosperity of the local people. On the other hand in the western

part which is inhabited by the poorer classes, houses are generally kaccha with lack of modern facilities. Scholars have also undertaken studies on quality of living space among the most disadvantaged marginalized segments of population like scheduled castes. While some of these studies explore regional inequalities in the quality of living space in the rural areas of Haryana using tehsil level census data (e.g. Bairagi and Chamar 2019; Chamar and Bairagi 2019), others are based on data collected from primary survey at micro-level. In the year 2013, Chamar and Chamar studied rural dwellings and house types in a village Sirsa Kheri in Jind district in Haryana. The study examined household structure in terms of population size, number of rooms and building materials used for floor, wall and roof among different social groups. The study revealed that the scheduled castes in the village have undergone rapid transformation in their socio-economic conditions during the recent past due to their occupational mobility. Using a similar approach, some studies have examined differentials in quality of living space among different clans in scheduled castes in different rural areas of Haryana at micro-level (see for instance Chamar and Rekha, 2016; Chamar and Chamar, 2018; Chamar and Chamar; 2019; Rani and Chamar; 2019).

With a significantly larger proportion of population still residing in rural areas, rural housing conditions provide a very good insight into living standard of the people in an area. The present study therefore endeavours to analyse the levels of quality of living space among rural households in north-eastern region of India.

10.2 Objective of the Study

The main objective of the present research work is to analyse the levels of quality of living space among rural households in north-eastern region of India.

10.3 North-Eastern Region

The north-eastern region of India is extending between 22° 0′ 0″ to 29° 05′ 0″ North latitudes and 88° 0′ 0″ to 97° 30′ 0″ East longitudes and shared international border with Bangladesh, Bhutan, China and Myanmar. The total area of the region is 2, 55, 083 km^2. The region is commonly known as the 'Land of Seven Sisters' (excluding Sikkim) and one of the largest salients (panhandles) in the world. It comprises seven states, namely Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya and Assam with 82 districts as per census 2011 (Fig. 10.1). It accounts for 7.9% of the total geographical area of the country. The total rural population of the region is 369.12 lakh persons which reside in 74.37 lakh households. The region also shared nearly 35% of rural scheduled caste and scheduled tribe population in proportion to total rural population of the region. The average rural

Fig. 10.1 North-eastern region

literacy rate is recorded about 66% while sex ratio is observed 960 females/1000 males. The average size of household is recorded 5.0 persons per household.

10.4 Database and Methodology

The district-wise census data of 2011 on various aspects of housing conditions have been used for the present study. To analyse the 'levels of quality of living space among rural households in north-eastern region', the district-wise percentages of rural households availing amenities and modern assets have been used. The following twenty indicators related to amenities and modern assets have been considered.

X_1 Condition of Census House 'Good condition';
X_2 Material of Roof 'G.I/ Metal/Asbestos sheets/Concrete roof';
X_3 Material of Wall 'Burnt Brick/Concrete wall';
X_4 Material of Floor 'Cement/Mosaic/Tile floor';
X_5 Number of Dwelling Rooms 'Four and more rooms';
X_6 Status of Ownership 'Owned houses';
X_7 Drinking Water within the premises 'Treated tap water';
X_8 Source of Lighting 'Electricity';
X_9 Latrine facilities within the premises 'Flush/Pure Flush';
X_{10} Bathing facility within the premises 'Bathroom with roof';
X_{11} Waste Water outlet connection 'Closed drainage outlet';
X_{12} Fuel used for Cooking 'LPG/NPG';
X_{13} Kitchen facilities 'Inside the house';
X_{14} Households having availability of 'Banking Services';
X_{15} Households having availability of 'Television';
X_{16} Households having availability of 'Computer/Laptop with Internet';
X_{17} Households having availability of 'Mobile Only';
X_{18} Households having facility of 'Scooter/Motorcycle/Moped';
X_{19} Households having facility of 'Car/Jeep/Van';
X_{20} Structure of Census Houses 'Permanent'.

To find out the levels of quality of living space, 'z score' in respect to each of the indicator in a district has been calculated with the help of the following formula:

$$Z \text{ score} = \frac{x - \overline{x}}{\sigma}$$

where $\boldsymbol{x}$ is percentage value of the indicator in a district; $\overline{\boldsymbol{x}}$ is mean value of the indicator; and $\boldsymbol{\sigma}$ is standard deviation.

The 'z scores' of all the selected 20 indicators thus arrived have been added to obtain the 'composite z score'. On the basis of 'composite z scores', levels of quality of living space at district level among rural households in north-eastern region of India have been identified. Finally, maps were prepared with the help of Arc GIS (Arc Map Version 10.4.1) and tables were drawn to interpret and analyse the results.

10.5 Results and Discussion

Table 10.1 highlights that nearly nine-tenth households have their own house and about three-fourth households are enjoying the facility of kitchen inside the house. It is recorded that about two-fifth of the households are in good condition, while nearly 18% of the households structure are permanent and nearly 13% households have four or more rooms.

Table 10.1 Average values of selected amenities and modern assets among rural households, 2011 India: north-eastern region

S. No.	Household amenities and modern assets	Quality of amenities and modern assets	Average (per cent)
X_1	Condition of census house	Good condition	41.5
X_2	Material of roof	G.I/metal/asbestos sheets/concrete roof	67.9
X_3	Material of wall	Burnt brick/concrete wall	10.9
X_4	Material of floor	Cement/mosaic/tile floor	12.0
X_5	Number of dwelling rooms	Four & above rooms	12.8
X_6	Status of ownership	Owned house	89.7
X_7	Source of drinking water	Treated tap water	12.0
X_8	Source of lighting	Electricity	51.3
X_9	Latrine facility (within premises)	Flush/pour flush	27.2
X_{10}	Bathing facility (within premises)	Bathroom with roof	22.7
X_{11}	Waste water (outlet connection)	Closed drainage outlet	02.5
X_{12}	Fuel used for cooking	LPG/PNG	10.5
X_{13}	Kitchen facility	Inside the house	76.9
X_{14}	Facility of banking services	Available	37.2
X_{15}	Facility of television	Available	26.2
X_{16}	Facility of computer/laptop with Internet	Available	00.7
X_{17}	Facility of mobile	Only mobile	37.2
X_{18}	Facility of scooter/motorcycle/moped	Available	07.9
X_{19}	Facility of car/jeep/van	Available	03.3
X_{20}	Status of census house	Permanent	17.7

Source Census of India. 2011a, b. *House Listing and Housing Census Data, HLPCASC, HH-14*, New Delhi. Compiled by Authors

Similarly, more than half of the households have the facility of electricity for lighting. Likewise, more than one-fourth households have latrine facility within the premises, 23% households have bathroom with roof within the premises, and 12% households are using treated tap water for drinking, while about one-tenth households are using LPG/PNG as fuel for cooking.

Nearly two-fifth households are enjoying the facility of mobile only, and a little more than one-fourth of the households have the facility of television as per census 2011. The vehicles like car/jeep/van are available to only a little over three per cent of the households while nearly eight per cent households possess

scooter/motorcycle/moped. It is noted that about two-fifth of the households are availing the facility of banking services.

More than two-third roofs of the houses are made of G.I./metal/asbestos sheets/concrete, and 11% walls of the houses are made of burnt bricks/concrete, while 12% houses have cement/mosaic/tile floors. It is noted that 2.5% households have the facility of closed drainage outlet connection for disposal of waste water. The facility of computer/laptop with internet is available in only less than one per cent among rural households in north-eastern region of India.

10.6 Availability of Household Amenities and Assets and Position of Districts

The important statistics like highest and lowest positions in availability of various select indicators based on z score values are also summarized in Table 10.2.

The study on the whole reveals that Serchhip district of Mizoram witnessed highest z scores in amenities and assets like status of census house, bathroom with roof, facility of mobile only, availing of banking services and electricity as source of lighting. Papum Pare district of Arunachal Pradesh is followed by Serchhip district with highest position in computer/laptop with internet, scooter/motorcycle/moped, closed drainage outlet connection and LPG/PNG fuel used for cooking. Thus, Serchhip and Papum Pare districts have attained highest position in nearly half of the indicators.

Likewise, Imphal West district of Meghalaya state also recorded highest position in availability of car/jeep/van and television facilities in the house. However, there are other districts, namely West Kameng, East Siang and Tirap (Arunachal Pradesh); Kohima and Dimapur (Nagaland); Jaintia Hills (Meghalaya); Aizawl (Mizoram); Kamrup Metropolitan (Assam); and Tamenglong (Manipur) which have recorded highest position only in one amenity and asset like treated tap water, condition of house, kitchen inside the house, materials of roof, materials of floor, number of dwellings rooms, latrine facility within the premises, materials of wall and status of ownership, respectively (Table 10.2).

On the other hand, Kiphire district of Nagaland registered lowest position in six household amenities and assets such as banking services, availability of car/jeep/van, material of wall, fuel used for cooking, status of census house and computer/laptop with internet (Table 10.2). It is followed by Dhubri district of Assam with lowest z score values in five household facilities like kitchen inside the house, electricity as source of lighting, facility of television, closed drainage outlet connection and availability of scooter/motorcycle/moped. It may be noted that taking into account of all the amenities under study Dhubri district of Assam emerged at the bottom (Table 10.3C). The district Barpeta (Assam) has recorded highest negative position in two amenities such as condition of house and source of drinking water.

Table 10.2 Districts recording highest and lowest position in quality of living space among rural households, 2011 India: north-eastern region

S. No.	Household amenities and modern assets	Quality of amenities and modern assets	District and *Z* score			
			District	Max. value	District	Min. value
X_1	Condition of house	Good condition	East Siang	2.3	Barpeta	−1.9
X_2	Material of roof	G.I/ metal/A. sheets/concrete	Kohima	1.4	Tirap	−2.8
X_3	Material of wall	Burnt brick/concrete	K. Metropolitan	2.5	Kiphire	−1.2
X_4	Material of floor	Cement/mosaic/tile	Dimapur	3.9	Tuensang	−1.2
X_5	Number of dwelling rooms	Four & above	Jaintia Hills	3.4	Dhalai	−1.4
X_6	Status of ownership	Owned house	Tamenglong	1.0	Lower Dibang Valley	−3.5
X_7	Source of drinking water	Tap water (treated)	West Kameng	3.4	Barpeta	−1.1
X_8	Source of lighting	Electricity	Serchhip	1.9	Dhubri	−1.6
X_9	Latrine facility (within premises)	Pipe sewer/septic tank/others	Aizawl	3.1	Kurung Kumey	−1.5
X_{10}	Bathroom facility	Bathroom with roof	Serchhip	3.6	South Garo Hills	−1.2
X_{11}	Waste water (outlet connection)	Closed drainage	Papum Pare	3.7	Dhubri	−1.1
X_{12}	Fuel used for cooking	LPG/PNG	Papum Pare	2.9	Kiphire	−1.1
X_{13}	Kitchen facility	Inside house	Tirap	1.3	Dhubri	−2.9
X_{14}	Banking services	Availing	Serchhip	2.5	Kiphire	−1.8
X_{15}	Television facility	Available	Imphal West	2.7	Dhubri	−1.6
X_{16}	Computer/laptop with Internet	Available	Papum Pare	5.2	Kiphire	−1.0
X_{17}	Mobile facility	Available	Serchhip	2.6	Upper Subansiri	−2.2
X_{18}	Scooter/motorcycle/moped	Available	Papum Pare	4.0	Dhubri	−1.0
X_{19}	Car/jeep/van	Available	Imphal West	3.2	Kiphire	−1.3
X_{20}	Status of census house	Permanent	Serchhip	3.8	Kiphire	−1.1

Note A. Sheets: Asbestos Sheets; K: Kamrup; Max: Maximum, Min: Minimum

Other districts having lowest position in only one amenity or asset are Lower Dibang Valley, Tirap, Upper Subansiri and Kurung Kumey (Arunachal Pradesh); Dhalai (Tripura) Tuensang (Nagaland); and South Garo Hills (Meghalaya) which have recorded highest negative position only in one amenity and asset like status of ownership, materials of roof, facility of mobile only, latrine facility within the

Table 10.3A India: north-eastern region: district-wise Z scores of selected amenities and modern assets among rural households, 2011

Census code	Name of the district	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	$X1_8$	X_{19}	X_{20}	CZS
A																						
245	Tawang	0.6	1.0	−0.5	0.8	−0.5	−0.9	2.2	1.6	0.9	−0.2	0.6	2.0	0.4	2.0	1.4	−0.2	−1.4	−1.1	1.1	2.9	12.7
246	West Kameng	0.6	0.2	0.4	2.1	−0.5	−2.5	3.4	1.3	0.3	0.2	0.8	2.1	0.2	0.7	1.4	−0.2	−0.5	−0.4	0.9	0.8	11.4
247	East Kameng	−0.2	−0.6	−1.0	−0.3	−1.0	0.3	1.4	−1.4	−1.1	−0.9	−1.1	−0.6	0.4	−0.6	−1.4	−1.0	−1.8	−0.1	−0.4	−0.9	−12.3
248	Papum Pare	0.8	0.5	1.3	3.1	0.1	−2.1	1.8	1.2	1.4	0.6	3.7	2.9	0.4	1.5	1.9	5.2	1.5	3.0	4.0	0.4	33.2
249	Upper Subansiri	−0.5	−2.7	−1.1	−1.0	−1.0	0.5	0.2	−1.2	−0.8	−0.9	−0.3	−0.4	0.7	0.0	−1.2	−0.5	−2.2	−0.2	−0.3	−1.0	−13.8
250	West Siang	1.3	−2.3	−0.7	−0.1	0.0	−0.4	0.6	0.3	1.1	−0.2	0.0	0.0	0.6	0.7	0.8	−0.2	−0.5	1.7	1.4	−0.7	3.3
251	East Siang	2.3	−2.2	0.0	0.5	0.2	−1.3	0.7	0.6	0.5	−0.5	−0.2	−0.3	0.4	1.1	1.0	1.5	0.9	2.4	2.3	−0.3	9.5
252	Upper Siang	2.3	−1.2	−0.3	−0.1	−0.8	−0.5	3.0	1.3	−0.3	−0.6	0.4	−0.3	0.6	0.7	0.2	−0.7	−0.2	0.8	0.0	−0.5	3.8
253	Changlang	0.6	−1.8	−0.7	−0.3	0.0	−1.3	−0.4	−0.3	−0.5	−0.4	−0.6	−0.2	0.4	−0.6	0.0	−0.7	−0.7	−0.2	−0.3	−0.8	−8.8
254	Tirap	1.1	−2.8	−0.8	−0.6	0.2	0.3	0.9	1.1	−0.6	−0.8	−0.2	−0.6	1.3	1.4	−0.4	−0.8	−0.9	−0.5	−0.6	−0.8	−4.0
255	Lower Subansiri	1.3	0.6	−0.2	1.1	−0.4	−0.5	0.6	1.1	1.3	0.4	1.7	0.6	0.5	1.4	1.1	2.2	0.6	2.0	3.4	−0.4	18.5
256	Kurung Kumey	0.1	−1.4	−1.2	−1.0	−0.9	0.9	−0.2	−1.2	−1.5	−1.1	−0.7	−0.8	0.4	−1.0	−1.6	−0.5	−1.6	−0.4	0.0	−1.1	−14.9
257	Dibang Valley	0.1	−1.6	−0.9	−0.1	−1.0	−0.5	0.5	−0.4	0.8	−0.6	1.9	−0.1	1.0	0.0	−0.6	−0.3	−1.0	1.4	0.2	−0.5	−1.7
258	Lower D Valley	0.2	−1.6	−0.4	0.5	−0.6	−3.5	0.1	−0.3	−0.1	−0.2	0.0	0.4	1.1	0.2	0.3	1.0	0.9	1.8	1.0	−0.5	0.2
259	Lohit	−0.1	−1.9	−0.6	−0.1	−0.1	−2.4	−0.8	−0.1	−0.6	−0.6	−0.9	0.1	0.4	−0.5	0.4	−0.5	−0.4	0.4	−0.3	−0.6	−9.3

(continued)

Table 10.3A (continued)

Census code	Name of the district	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	$X1_8$	X_{19}	X_{20}	CZS
260	Anjaw	0.0	−1.2	−0.5	0.1	−0.4	−1.0	1.5	−0.3	−1.1	−0.5	−0.9	0.0	0.4	0.3	0.0	0.0	−1.1	0.1	−0.6	−0.5	−5.6
261	Mon	−0.5	−2.1	−0.9	−0.8	0.1	0.3	−0.9	−1.0	−0.8	0.2	−0.1	−1.1	1.1	−1.5	−1.5	−0.8	−1.1	−0.9	−0.7	−0.9	−14.0
262	Mokokchung	1.9	0.8	−0.3	−0.1	0.6	−0.7	−0.7	1.7	2.3	2.4	1.5	−0.3	1.2	−0.8	1.1	−0.3	0.2	0.6	1.0	−0.6	11.6
263	Zunheboto	1.0	1.3	−0.8	−0.5	−0.5	0.1	0.1	1.8	0.2	1.6	−0.2	−0.9	0.8	−0.8	0.0	−0.3	0.3	−0.9	0.9	−0.8	2.5
264	Wokha	0.5	0.9	0.1	1.8	0.4	0.1	−0.9	0.8	0.8	0.8	0.7	−0.8	1.0	−0.6	−0.1	−0.5	−0.2	−0.6	0.0	−0.2	4.0
265	Dimapur	0.8	0.2	2.2	3.9	1.1	−2.7	−0.8	1.5	2.5	1.8	1.8	2.6	0.5	0.3	2.4	3.2	2.0	0.9	3.1	0.8	28.1
266	Phek	0.1	1.4	−0.3	−0.2	−0.1	−0.3	0.0	1.8	0.8	1.2	0.4	−0.8	0.4	−0.6	−0.4	−0.7	0.0	−1.0	0.3	−0.5	1.3
267	Tuensang	0.0	−0.4	−1.2	−1.2	−0.7	0.6	−0.7	0.2	−0.1	1.5	0.2	−1.1	1.0	−1.4	−1.1	−0.8	−0.9	−1.1	−0.6	−1.1	−9.0
268	Longleng	−0.8	−0.2	−1.0	−1.0	−0.7	0.7	−0.9	0.0	−0.7	0.2	−0.5	−1.1	1.1	−1.6	−1.4	−1.0	−0.9	−0.9	−0.7	−0.9	−12.4
269	Kiphire	0.0	0.9	−1.2	−1.1	−0.9	0.5	−0.6	1.3	−1.2	0.9	−0.8	−1.1	−0.1	−1.8	−1.6	−1.0	−1.3	−1.3	−0.9	−1.1	−12.5
270	Kohima	1.9	1.4	1.4	1.7	0.9	−0.3	−0.3	1.8	1.0	0.7	0.1	−0.5	1.0	0.1	0.9	0.3	1.4	−0.7	2.9	1.0	16.6
271	Peren	0.4	−0.5	−0.6	−0.2	0.4	0.3	−0.4	0.8	0.6	−0.3	−0.2	−1.0	0.9	−1.3	−0.6	−0.7	−0.4	−0.7	−0.4	−0.8	−4.6

Source Compiled by Authors. *Note* X_1 to X_{20} See text for nomenclature. *Note* CZS; composite z score

premises, number of dwellings rooms, materials of floor and bathroom with roof, respectively. Thus, the study highlights that on the basis of availability of household amenities Papum Pare district and Dhubri district attained the top and bottom positions, respectively, among rural households in north-eastern region of India. The district level quality of living space has been discussed as under.

10.7 Levels of Quality of Living Space

The quality of living space among rural households is marked by striking regional variations in north-eastern region of India. A wide range of variation in composite '*z* scores' has been obtained on the basis of indicators on selected household facilities and assets. It varies from a maximum of 33.2 composite z score values recorded by Papum Pare district of Arunachal Pradesh (Table 10.3A, census code 248) to minimum of minus 18.3 composite z score values witnessed by Dhubri district of Assam (Table 10.3C, census code 301). The district-wise composite z score has also been shown in Tables 10.3A, 10.3B and 10.3C. Further, to describe the levels of quality of living space, following five types of areas have been identified:

(i) **Areas of Very High Level of Quality of Living Space**

The district recording composite z score values of more than 20.0 are included in this category of areas of very high level of quality of living space among rural households (Fig. 10.2). This category is represented by only four districts, namely Papum Pare (Arunachal Pradesh) with a composite z score of 33.2 followed by Dimapur of Nagaland (28.1), Aizawl of Mizoram (24.3) and Imphal West of Manipur (23.9), and all the four districts are located in the central parts of the region in the form of small scattered patches.

It is observed that all the four districts have highly better facilities and assets in ten out of 20 indicators selected for the purpose. Among all the indicators, the highest z score value that is 5.2 is attained in availability of the asset of computer/laptop with internet in the Papum Pare district of Arunachal Pradesh, while the lowest (−2.7) is attained in the facility of own house in Dimapur district of Nagaland which falls under this category. Such a high values of composite z score recorded in these districts are mainly due to better facilities and amenities like flush/pour flush latrine facility within the premises, use of LPG/NPG as fuel for cooking, facility of television and mobile in all these districts. It is also recorded that the district of Papum Pare has moderate to better facilities and amenities in all the indicators except own house followed by Dimapur district (except own house and treated tap water), Aizawl (except own house, material of wall, number of dwelling rooms and availability of computer/laptop with internet facility) and Imphal West (except banking services and permanent house) selected for the purpose.

(ii) **Areas of High Level of Quality of Living Space**

Table 10.3B India: north-eastern region: district-wise *Z* scores of selected amenities and modern assets among rural households, 2011

Census code	Name of the district	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	CZS
B																						
272	Senapati	−0.3	0.3	−0.7	−0.4	1.5	0.7	0.2	0.9	0.0	0.1	0.7	−0.6	0.2	−1.0	−0.4	0.0	−0.4	−0.9	−0.3	−0.7	−1.0
273	Tamenglong	−0.5	−1.1	−1.2	−0.7	0.7	1.0	−0.4	−0.4	−0.3	−0.4	−0.4	−1.0	0.2	−1.7	−0.8	−0.7	−1.5	−1.0	−0.8	−1.1	−12.0
274	Churachandpur	0.2	−0.3	−0.3	0.1	0.2	−0.2	−0.1	0.2	1.3	0.1	0.6	1.4	0.0	0.0	0.5	1.2	0.3	0.6	0.0	−0.6	5.3
275	Bishnupur	1.4	0.6	−0.8	−0.9	1.6	1.0	0.5	0.8	1.1	−0.2	−0.3	0.9	1.0	−0.9	1.8	0.5	1.3	0.6	0.0	−0.9	9.2
276	Thoubal	1.5	0.4	−0.7	−1.0	0.9	1.0	−0.3	0.0	1.0	−0.4	0.2	0.0	0.7	−1.2	0.7	0.3	0.8	0.5	−0.2	−0.8	3.5
277	Imphal West	1.6	1.1	0.3	0.5	1.2	0.8	1.0	0.9	1.7	0.3	0.3	2.5	0.7	−0.4	2.7	2.5	1.8	3.2	1.3	−0.2	23.9
278	Imphal East	1.4	0.6	−0.3	0.2	1.4	0.9	0.3	1.2	1.5	0.2	0.2	1.7	0.9	0.0	2.0	1.3	1.5	2.6	0.7	−0.5	17.7
279	Ukhrul	−1.3	0.9	−1.0	−1.0	0.0	0.6	−0.3	−0.7	0.5	1.1	0.7	−1.0	−0.5	−1.4	−0.8	−0.2	−0.7	−1.0	−0.3	−1.0	−7.4
280	Chandel	−0.3	−0.1	−1.1	−1.1	0.3	1.0	−0.7	0.4	−0.4	−0.7	−0.2	−0.7	−0.2	−1.0	0.0	−0.3	0.2	0.6	0.0	−1.0	−5.3
281	Mamit	0.2	−0.4	−1.0	−0.5	−0.7	−0.5	−0.6	0.6	0.2	0.5	2.1	0.5	0.5	−0.5	0.4	−0.5	1.0	−0.1	−0.4	1.3	2.1
282	Kolasib	0.7	0.0	−0.6	0.3	−0.9	−1.7	2.7	1.1	1.4	0.7	−0.1	2.1	0.2	−0.3	0.8	−0.3	1.9	0.4	−0.4	1.1	9.1
283	Aizawl	1.7	1.1	−0.6	0.0	−0.3	−1.0	0.3	1.6	3.1	2.5	3.5	2.6	0.8	0.6	1.8	−0.2	2.4	0.7	0.3	3.4	24.3
284	Champhai	0.4	0.9	−1.0	−0.8	−0.7	−0.6	2.2	1.6	2.1	2.6	3.1	0.4	−0.4	0.5	1.3	−0.5	1.8	0.4	−0.2	2.8	15.9
285	Serchhip	0.0	1.2	−0.9	−0.6	−0.8	−0.7	0.4	1.9	1.5	3.6	2.1	1.2	−0.6	2.5	1.7	0.2	2.6	0.5	0.2	3.8	19.8
286	Lunglei	0.4	−0.4	−1.1	−0.9	−1.0	0.0	−0.8	0.7	0.1	1.0	0.3	0.0	−0.1	−0.5	0.2	−0.7	0.5	−0.3	−0.6	1.2	−2.0
287	Lawngtlai	0.3	−1.7	−1.1	−0.9	−0.5	0.0	−0.6	−0.9	−0.6	−0.3	−0.4	0.0	0.2	−1.0	−0.4	−0.5	−1.4	−1.1	−0.6	0.1	−11.3
288	Saiha	1.6	0.0	−1.2	−0.9	−0.3	0.1	−0.4	−0.2	0.2	1.2	−0.4	0.2	0.0	−0.7	−0.3	−0.5	−0.8	−1.2	−0.7	0.0	−4.4
289	West Tripura	1.0	1.1	−0.7	−0.4	−1.3	0.8	0.1	0.7	−1.1	−0.8	0.7	−0.4	0.6	2.3	1.4	−0.3	0.3	−0.4	−0.7	−0.4	2.5
290	South Tripura	0.9	0.7	−0.9	−0.5	−1.3	0.9	−0.2	0.4	−0.7	−1.1	−0.8	−0.7	−1.4	2.5	0.5	−0.7	−0.2	−0.6	−0.8	−0.7	−4.7
291	Dhalai	0.3	−0.1	−0.9	−0.6	−1.4	0.6	−0.5	0.0	−1.3	−1.0	−0.6	−0.7	−0.8	2.3	0.0	−0.7	−1.0	−0.9	−0.9	−0.9	−9.1

(continued)

Table 10.3B (continued)

Census code	Name of the district	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	CZS
292	North Tripura	0.1	0.4	−0.1	−0.3	−1.3	0.3	0.1	−0.2	−1.1	−0.8	−0.4	−0.6	−0.1	1.9	−0.4	−0.5	−0.4	−0.7	−0.7	−0.4	−5.3
293	West Garo Hills	0.3	0.5	0.2	0.4	−0.5	0.7	−0.5	−0.6	0.5	−1.0	−0.1	−0.8	−2.2	−0.5	−0.2	0.0	−0.8	−0.1	−0.7	−0.2	−5.6
294	East Garo Hills	0.5	−0.3	−0.3	0.2	−0.4	1.0	−0.6	−0.6	0.9	−1.2	−0.7	−1.1	−2.0	−1.0	−0.4	−0.7	−1.4	−0.3	−0.8	−0.5	−9.8
295	S Garo Hills	0.3	0.6	−0.6	0.4	−0.2	0.8	0.2	−0.4	0.7	−1.2	−0.1	−1.1	−2.2	−1.2	−0.1	−0.3	−1.4	−0.3	−0.4	−0.7	−7.2
296	W Khasi Hills	−0.5	0.4	−0.2	0.2	0.3	0.7	0.6	−0.2	−1.2	−0.5	−0.8	−1.1	−0.3	−1.2	−0.8	−0.8	−0.9	−1.2	−0.4	−0.1	−8.0
297	Ribhoi	−0.1	−0.3	0.8	1.7	1.5	−0.3	1.0	0.6	−0.5	−0.6	0.3	−0.7	0.5	−0.3	0.3	−0.2	0.2	−0.8	0.2	0.3	3.7
298	East Khasi Hills	−0.3	0.9	0.9	2.0	0.8	−0.7	2.1	0.9	−0.4	1.1	−0.2	−0.8	0.6	0.2	−0.2	−0.5	−0.4	−1.1	0.0	1.4	6.4

Source Compiled by Authors. *Note* X_1 to X_{20} See text for nomenclature. *Note* CZS; composite z score

Table 10.3C India: north-eastern region: district-wise *Z* scores of selected amenities and modern assets among rural households, 2011

Census code	District	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	CZS
C																						
299	Jaintia Hills	0.3	0.4	0.9	2.8	3.4	0.2	0.2	0.4	−0.7	2.3	0.9	−0.6	0.8	−0.3	−0.3	−0.3	0.4	−1.2	1.1	0.7	11.5
300	Kokrajhar	−0.7	0.2	0.4	−0.2	−0.6	0.8	−0.9	−1.3	−1.3	−0.9	−0.9	−0.6	−1.4	−0.4	−1.0	−0.5	0.0	−0.4	−0.8	0.0	−10.6
301	Dhubri	−1.8	0.6	−0.3	−0.9	−1.1	0.9	−1.0	−1.6	−1.3	−1.0	−1.1	−0.9	−2.9	−1.0	−1.6	−0.8	−0.7	−0.9	−1.0	0.0	−18.3
302	Goalpara	−1.1	0.9	0.8	−0.2	−0.6	1.0	−1.0	−0.6	−0.9	−0.7	−0.9	−0.5	−2.1	−0.4	−0.7	−0.5	0.4	−0.3	−0.7	0.3	−7.9
303	Barpeta	−1.9	0.6	0.0	−0.6	−0.7	1.0	−1.1	−1.3	−0.6	−0.7	−1.1	−0.1	−2.0	−0.2	−1.2	−0.5	0.2	−0.3	−0.8	−0.2	−11.5
304	Morigaon	−1.5	0.2	0.5	−0.8	−0.2	0.9	−0.9	−1.1	−1.0	−0.8	−0.9	−0.4	−1.4	0.3	−1.0	−0.3	0.0	−0.4	−0.7	−0.1	−9.6
305	Nagaon	−1.1	−0.1	1.0	−0.3	−0.1	0.6	−0.8	−1.0	−0.6	−0.5	−0.7	−0.2	−1.3	−0.3	−0.8	−0.3	0.2	−0.2	−0.6	0.2	−6.9
306	Sonitpur	−0.8	0.3	1.7	0.2	0.4	−0.5	−0.6	−0.9	−0.2	−0.2	−0.7	0.1	−0.4	0.0	−0.3	0.0	−0.2	0.0	−0.5	0.6	−1.9
307	Lakhimpur	−1.3	0.2	0.8	0.1	1.0	0.5	−0.9	−1.1	−0.5	−0.4	−0.8	0.0	0.3	0.4	−0.7	−0.2	0.2	0.5	−0.3	0.1	−2.1
308	Dhemaji	−1.4	−0.7	−0.4	−0.5	0.8	0.8	−1.0	−1.4	−1.1	−0.7	−0.8	−0.2	−0.1	−0.2	−0.8	−0.2	0.1	0.1	−0.4	−0.6	−8.7
309	Tinsukia	−0.2	−0.1	2.2	0.1	1.7	−2.2	−0.8	0.0	0.3	−0.1	−0.2	0.4	0.4	0.2	0.6	0.3	−0.3	0.2	0.0	0.9	3.4
310	Dibrugarh	−0.1	0.3	2.1	0.1	2.6	−1.4	−0.8	−0.5	0.0	0.1	0.2	0.6	0.8	0.5	0.8	1.0	0.1	0.8	0.5	0.8	8.6
311	Sivasagar	−0.6	0.7	1.9	0.6	2.6	−0.9	0.3	−0.3	0.1	0.7	−0.3	0.9	0.9	0.6	0.8	1.2	0.8	1.5	0.9	0.7	13.2
312	Jorhat	−0.8	0.8	1.6	0.3	2.2	0.0	0.4	−0.4	−0.2	0.4	−0.3	0.9	0.9	0.7	0.4	0.7	0.5	1.3	0.4	0.5	10.3
313	Golaghat	−1.1	0.7	0.5	−0.4	1.4	−0.2	−0.1	−0.8	−0.6	0.0	−0.6	0.2	0.6	0.5	0.1	0.2	0.1	0.4	−0.1	−0.1	0.8
314	K.Anglong	−0.9	−0.6	−0.5	−0.6	0.3	0.3	−0.8	−1.2	−0.8	−0.8	−0.7	−0.6	−0.3	0.0	0.0	0.2	−0.2	−0.3	−0.7	−0.7	−8.9
315	Dima Hasao	−0.7	−0.7	−0.5	0.3	−0.6	0.2	−0.3	−1.1	0.3	−0.8	−0.2	−0.6	0.0	0.0	−0.7	−0.5	−0.9	−0.9	−0.8	−0.6	−9.1
316	Cachar	−0.8	−0.1	1.2	−0.3	−1.2	0.4	1.5	−0.9	−0.3	−0.5	0.3	−0.3	0.4	−0.1	−0.6	−0.2	−0.1	−0.7	−0.7	0.3	−2.6
317	Karimganj	−1.1	−0.4	2.1	−0.4	−1.2	0.7	−0.5	−1.1	−0.3	−0.5	0.1	−0.5	0.4	−0.2	−1.2	−0.3	−0.1	−1.0	−0.8	0.7	−5.6
318	Hailakandi	−1.4	−0.3	1.2	−0.8	−1.2	0.7	0.0	−1.0	−0.5	−0.6	−0.1	−0.8	0.4	1.8	−1.3	−0.2	−0.4	−0.9	−0.7	0.3	−5.7

(continued)

Table 10.3C (continued)

Census code	District	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	CZS
319	Bongaigaon	−1.4	1.0	0.4	−0.3	−0.6	0.8	−1.0	−1.1	−1.0	−0.7	−1.1	−0.1	−1.9	0.9	−0.9	−0.3	0.5	−0.1	−0.5	0.0	−7.3
320	Chirang	−0.8	0.4	−0.1	−0.4	−0.5	0.8	−0.9	−1.3	−1.2	−1.0	−0.8	−0.5	−1.5	−0.1	−1.0	0.0	0.1	−0.3	−0.6	−0.4	−10.1
321	Kamrup	−1.0	0.8	1.5	0.5	0.4	0.9	−0.9	−0.6	−0.4	0.0	−0.6	0.9	−1.0	0.3	0.0	0.3	0.8	0.4	−0.1	0.6	2.8
322	K. Metropolitan	−0.3	0.8	2.5	1.3	0.7	−0.2	−0.2	0.0	0.4	0.6	0.4	1.9	0.1	1.2	1.2	1.7	1.6	0.8	0.7	1.0	16.2
323	Nalbari	−0.9	0.8	1.7	0.3	0.3	0.9	−1.0	−0.5	−0.3	0.2	−0.8	1.0	0.4	0.9	0.0	0.2	1.0	0.5	−0.3	0.6	5.1
324	Baksa	−1.3	0.5	−0.3	−0.8	−0.1	0.8	−1.0	−1.2	−0.9	−0.9	−0.9	−0.5	−0.1	−0.2	−0.6	−0.2	0.3	−0.3	−0.7	−0.6	−9.0
325	Darrang	−1.3	0.4	0.7	−0.5	−0.9	0.9	−0.9	−1.3	−0.9	−0.7	−1.0	−0.5	−2.8	−0.1	−1.1	−0.3	−0.3	−0.3	−0.7	0.0	−11.5
326	Udalguri	−1.0	0.5	1.3	−0.5	−0.5	−0.2	−0.3	−0.9	−0.8	−0.8	−0.8	−0.5	−1.3	−0.1	−0.1	0.2	0.2	−0.3	−0.7	0.4	−6.2

Source Compiled by Authors. *Note* X_1 to X_{20} See text for nomenclature. *Note* CZS; composite z score

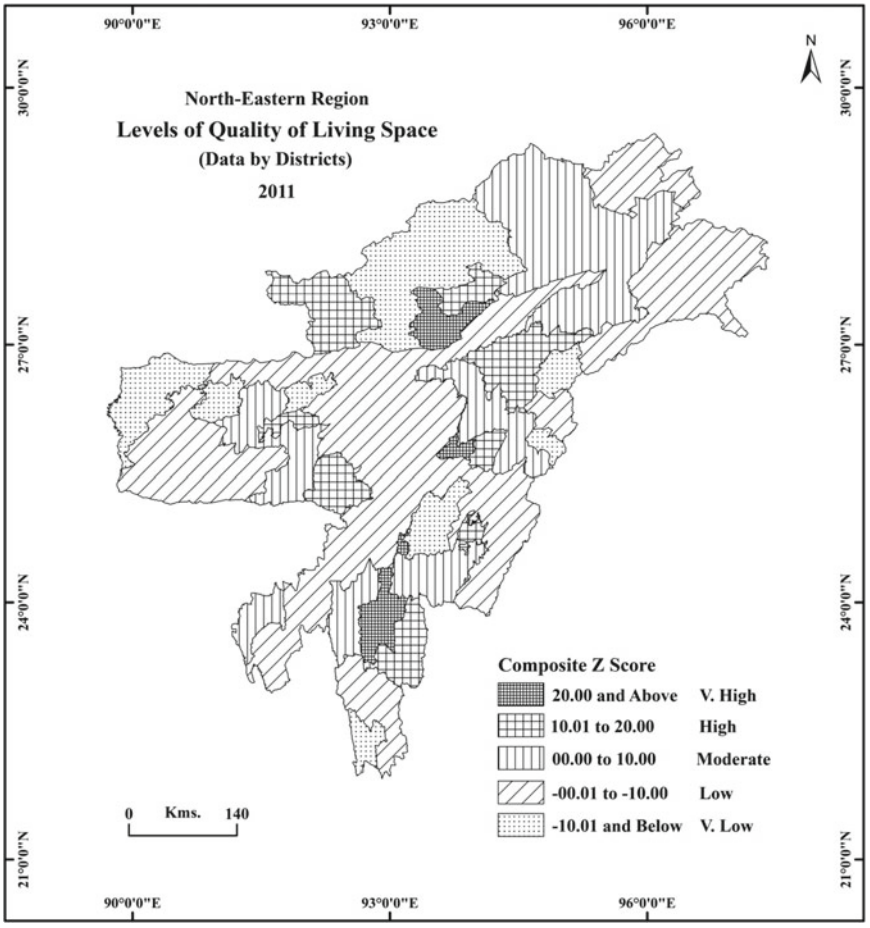

Fig. 10.2 Level of quality of living space

The districts that have recorded composite z score values between 10.01 and 20.0 are included in this category. The highest level of quality of living space among rural households has been noticed in Serchhip district of Mizoram with a composite score of 19.8 followed by Lower Subansiri (18.5), while the lowest value of composite z score (10.3) under this category can be seen in Jorhat district of Assam. Twelve districts, spreading over most of the central and peripheral parts of the study area, come under this category. It may also be noted that barring only Tawang, Mokokchung and Jaintia Hills, all the districts have moderate to better facilities and amenities in three-fourth indicators selected for the purpose. Moderate to better facilities were recorded in 18 indicators out of 20 indicators (except materials of wall and permanent houses) in the district of Imphal East (Table 10.3B, census code 278) followed by district Kamrup Metropolitan (Table 10.3C, census code 322) which have moderate

to better conditions in 17 indicators (except condition of census house, status of ownership and treated tap water). The moderate to high values of composite z score are also recorded in more than three-fourth indicators in the district Lower Subansiri of Arunachal Pradesh; Kohima of Nagaland; and Sivasagar and Jorhat of Assam.

(iii) **Areas of Moderate Level of Quality of Living Space**

The districts recording composite z score of 0.01 to 10.0 are included in this category. The moderate quality of living space is witnessed by 20 districts accommodating nearly one/fourth of the total districts of the region (Fig. 10.2). It may be noted that all the districts which fall under this category except Upper Siang (Arunachal Pradesh); West Tripura (Tripura); Mamit (Mizoram); and Phek (Nagaland) have better to moderate conditions in more than half of the indicators. By recording composite z score of 9.5, East Siang district (Table 10.3A, census code 251) tops in this category. This district has highly better facilities and amenities like good condition houses, availability of banking services, computer/laptop with internet, scooter/motorcycle/moped and car/jeep/van.

This is followed by district of Bishnupur (9.2), Kolasib (9.1) and Dibrugarh (8.6). The highly better facilities and amenities like good condition houses, four and above number of rooms, latrine facility within the premises, availability of television and only mobile are observed in the households of Bishnupur district. Similarly, the availability of facilities like treated tap water, electricity, latrine facility within the premises, use of LPG/NPG as cooking fuel, availability of only mobile and permanent house are responsible for witnessing moderately high composite score by Kolasib district. Apart from the above, the districts like Dibrugarh, East Khasi Hills, Churachandpur, Nalbari, Wokha and Upper Siang are other important districts that also come under this category of areas having moderately high level of quality of living space among rural households. It is also observed that moderate to moderately high level of facilities like kitchen inside the house is available in all the districts except Kamrup district of Assam and availability of television except in the districts of East Khasi Hills of Meghalaya; Wokha and Phek districts of Nagaland.

(iv) **Areas of Low Level of Quality of Living Space**

The districts with the values of composite z score ranging from minus 0.01 to minus 10.0 are included in this category. The district Senapati of Manipur with composite scores of minus 1.0 tops in this category followed by Dibang Valley of Arunachal Pradesh state. Among all the indicators, it is recorded that the highest z score value that is 2.5 is attained in availability of the facility of banking services in the district of South Tripura (Tripura) while the lowest (−2.8) is attained in the facility of roof materials in Tirap district of Arunachal Pradesh in all the 33 districts which fall under this category. Further, it may be noted that very poor conditions and lack of facilities and amenities in half of the indicators are found in all the districts like materials of floor, electricity as source of lighting, latrine facilities within the premises, bathroom with roof within the premises, closed drainage outlet connections, fuel used for cooking, availability of television, computer/laptop with internet, scooter/motorcycle/moped

and car/jeep/van. Likewise, very poor condition of availability of car/jeep/van is recorded in all the districts except Dibang Valley of Arunachal Pradesh and Chandel of Manipur. Similarly, very poor condition of bathing facility within the premises is observed in all the districts except Senapati, Lunglei, Saiha, Ukhrul and Tuensang. However, the better facility like owned houses is also observed in more than three-fourth of the districts in this category.

(v) **Areas of Very Low Level of Quality of Living Space**

The composite z score with negative values ranging from minus 10.01 and below is included in this category. The highest z score value that is 1.4 is attained in the facility of treated tap water in East Kameng district of Arunachal Pradesh while the lowest value (−2.9) is attained in the facility of kitchen inside the house in Dhubri district of Assam among all the indicators in all the 13 districts which fall under this category. The district Chirang with composite scores of minus 10.01 tops in this category followed by Kokrajhar (−10.6) district of Assam state; on the other hand, the Dhubri district of Assam recorded the lowest position in level of quality of living space with composite score of minus 18.3 in north-eastern region of India. Further, it may be noted that very poor conditions and lack of facilities and amenities in half of the indicators are found in all the districts like materials of floor, latrine facilities within the premises, closed drainage outlet connections, fuel used for cooking, kitchen inside the house, availability of banking services, television, computer/laptop with internet, mobile only, scooter/motorcycle/moped and car/jeep/van. Likewise, poor conditions and lack of facilities and amenities are observed in all the districts except the facility of four and above number of rooms in Tamenglong of Manipur and Mon of Nagaland; treated tap water in East Kameng and Upper Subansiri districts of Arunachal Pradesh; and electricity as source of lighting in Longleng and Kiphire districts of Arunachal Pradesh. However, the only better facility like owned houses is also observed in all the districts in this category.

10.8 Conclusions

It is concluded that the quality of living space among rural households is marked by striking regional variations in north-eastern region of India. The study highlights that on the basis of availability of household amenities and modern assets, Papum Pare district of Arunachal Pradesh and Dhubri district of Assam attained the top and bottom positions, respectively, among rural households in north-eastern region of India. It may be noted that Serchhip district of Mizoram witnessed highest z scores in five amenities and modern assets followed by Papum Pare district of Arunachal Pradesh. On the other hand, Kiphire district of Nagaland registered lowest position

in six household amenities and modern assets, followed by Dhubri district of Assam with lowest z score values in five household facilities.

It is also observed that a relatively better quality of living space is observed in central parts in the form of scattered small patches while low and very low quality of living space is witnessed mainly in peripheral parts.

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Chapter 11
Augmentation of North-East Resources: Intervention Through Data Science and Advanced Technology

Eeshankur Saikia and Parvej Reja Saleh

Abstract As a road-map for SDGs, specific to North-East India, a thrust to agriculture and allied activities requires the intervention of advanced technology, starting from soil and crop monitoring and post-harvest value addition to agricultural robots and precision agriculture. Computer vision and machine learning (ML) allows robots to see and train on their surroundings, and in turn, decrease costs of connected sensors would help develop low-cost connectivity solutions on which Internet of Things (IoT) devices, drones and cameras could operate. Besides, they may be used for surveillance too in this strategic geo-political region. Artificial intelligence (AI) would help in determining the best possible combination for value-added food preparation, based on locally available natural sources, nutritional value, and cost. Data analytics techniques are also proposed to be used for monitoring wastewater, using remote sensing data, so that timely intervention is possible to control hazards, such as contamination of river water, locating the source of Pb or other contaminants to preserve the sensitive ecosystem. The methodology to use AI tools in traditional knowledge documentation, taxonomy and bioinformatics too will be discussed for enhancing performance and future prospects.

Keywords Artificial intelligence · Machine learning · Data science · Precision agriculture · Agricultural robots

11.1 Introduction

Artificial intelligence (AI)-based advanced technology is being explored today by both defense scientists and R&D laboratories of the corporate (Smriti Srivastava (2019); Cem Dilmegani (2021)). The objective being straight and simple—to minimize risk and maximize profit. Intelligent machines are being planned in other parts of the globe with capabilities, such as thinking, learning, problem solving and even decision making. Coupled with advances in materials science and sensors, data collection,

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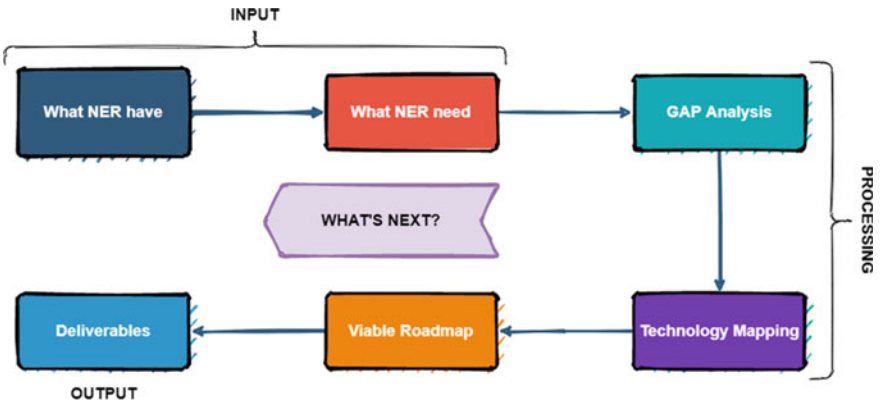
data analytics and computational power, these machines are going to supplement as well as complement human to live life with much more ease and comfort.

Apart from the technical infrastructure, there is a need of facilitating better road connectivity, adequate electrification, enhanced cold storage facilities, counselling and timely information services at Farmer's Information Centre, and financial literacy campaigns. Government must also ensure inclusive financial hand-holding to the rural poor through Self Help Groups (SHGs).

Given the foundation in the form of essential infrastructure and conducive policy decisions, the next step would be to intervene with right kind of technology so that the existing natural resources are conserved adequately and used judiciously, besides enhancing man's efficiency Though there have been commendable progress in basic science and mathematics so far as providing the base is concerned, switching it to the application mode and converting the science into technology have been the challenge for techno greats, such as IBM (Alessandro and Kathryn (2020), Rig Wagner (2020) and Toby Cubitt (2019)). India, the fastest growing economy, is gearing up too for responding to contribute and claim her stake in AI revolution. NITI Aayog is mandated for formulating National Program for AI (Union Budget 2018–2019), and most recently, 2020–21 Union Budget allocates INR 8000 crore for Quantum Computation (Union Budget 2020–2021), another essential component needed for AI implementation through data analytics. However, a comprehensive plan, a road-map for execution, and need assessment for customizing the plan as per regional attributes are still awaited. The present work is our proposed road-map for the North-East Region (NER) of India, based on the preliminary technical progress made in AI, data analytics and material science, may not be directly implemented on natural resources of NER though (Saha et al. 2016, 2018, 2020a, b; Saleh et al. 2019). In order to make the readable to the common audience, details of the technological schemes are not discussed here, indicating the proposed line of intervention instead. The flow of the article may be summed up as follows:



Out of the hosts of possible interventions, the most needed as well as easily implementable dimensions are discussed in following sections, which we believe, would not only augment North-East resources, but also help us make optimum use in an efficient manner, delivering the goods to all the sections of the society at the right time.

11.2 Agricultural Yield and Post-harvest Value Addition

- To develop low-cost connectivity solutions on which IoT sensors, drones and cameras and other AI hardware could operate
- To apply ML models to come up with the best possible combination on the basis of locally available natural sources, nutritional value and cost. computer vision that enables robots to observe and train on things around them, and in addition, reduces connected sensors's costs.
- To apply advanced tools to provide easy and affordable financial hand-holding/loan through P2P (peer-to-peer) model to the farmer to ensure both higher agricultural growth.

Research and Development in Phase-I may be planned on –

(i) Disease control of Muga, HYV paddy for low-lying water-logged areas, value addition through post-harvest processing and management in agriculture, using the tested, and customized AI tools for biochemistry.
(ii) Product diversification of handlooms and handicrafts, design and quality improvement. Improvement of looms/toolkits and computer-aided designs (CAD).

Three key areas were figured out for effective technical activity.

11.2.1 Agricultural Robots

Autonomous robots design and preparation to deal with important agriculture activities, such as irrigation, higher volume crop harvests, and speeds than human help. It is predicted that while there will be around 10% decline in the manpower engaging in agriculture from 2014 to 2024, the demand of food grains is going to rise by at least 40%. Harvest CROO Robotics (Source: https://harvestcroo.com/) states the robot can cultivate 8 hectares in one day and substitute 30 people, which is significant in the case of fruits and vegetable based agriculture where need of human beings to tend to the crop is the highest. Taking into account the terrain and local requirements, customization of the advanced technology incorporated in the robotics is a must.

11.2.2 Crop and Soil Monitoring

Utilizing computer vision (CV) and deep learning (DL) algorithms for processing data obtained by drones and/or software-driven technologies for the protection of crops and soils, Blue River Technology introduced a robot known as "*See & Spray*" (Source: http://smartmachines.bluerivertechnology.com/) which spray weeds on cotton plants precisely reportedly. Sprinkling precision can prevent resistance to herbicides. Sprinkling with precision can actually reduce tolerance to herbicides. It is claimed that precision technology eliminates 80% of the volume of chemicals normally sprayed on crops and, thus, can reduce herbicide expenditures by 90 per cent. The overall economy is influenced significantly due to the degradation of soil quality, primarily caused as a result of deforestation. Deep learning application named "Plantix" (Source: https://plantix.net/en/), which is based in Berlin and recognizes possible soil defects and nutrient deficits, is developed by agricultural tech startup "PEAT". Software algorithms which correlate specific leaf patterns with certain soil defects, plant pests and diseases are used for analysis. A picture recognition app recognizes potential defects from images from the smartphone camera of the user. Computer algorithms are used for research to associate complex vegetation characteristics with specific soil anomalies, plant pests and ailments. Potential defects can be detected by images recorded from the mobile camera app of the individual, providing solutions to their problems in connection with the soil or the crop. Similarly, "Trace Genomics" (Source: https://tracegenomics.com/), a California-based company, also provides soil testing services using machine learning and other such advanced technologies. This particular service not only provides bacteria- and fungi-related pathogen screening, but also a thorough microbial evaluation of the soil to the farmer which is reported to have yielded significant rise in production.

11.2.3 Predictive Analytics

Machine learning (ML) models that will be built to monitor and forecast diverse environmental effects, such as change in temperature, flood, etc., in crop yield. It is reported that agricultural results extracted from images taken by satellites and drones, ML models can predict the user where exactly the crop needs fertilizer, thus reducing the usage of fertilizers by at least 40%. Moreover, advanced technology intervention in case of daily weather prediction as well as periodic predictions of natural calamities, such as flood and landslide would surely help the farmer of the region to prepare well to minimize the damage.

Early recognition of crop disease with non-destructive techniques may reduce direct plant protection interference by humans. For an initial recognition of disease, multiple neural networks (NN) were used. In recognizing and medicating plant diseases, the training abilities of NNs are indeed very effective. An exact NN model is typically connected to a learning function, which applies all the weights and biases to

the allocated layers to ensure successful detection of a disease. In order to effectively manage disease, fast and reliable early treatment of plant disease is important. In the past years, hyperspectral data along with NN have been used to identify and treat plant disease early. However, visual scouting is still an initial way of early inspection of disease symptoms (Figs. 11.1 and 11.2).

Convolutional neural networks (CNNs) and prototype-based methods, such as Learning vector quantization (LVQ) can be used with great success in case of plant disease detection. Various standard machine learning algorithms can be used such as

- K-nearest neighbour (KNN) because it is very similar in flavour to prototype-based methods
- Linear support vector machine (SVM) as its efficiency is tested
- Decision trees, because these have also shown good performance, particularly the extremely randomized trees (extra trees) algorithm.

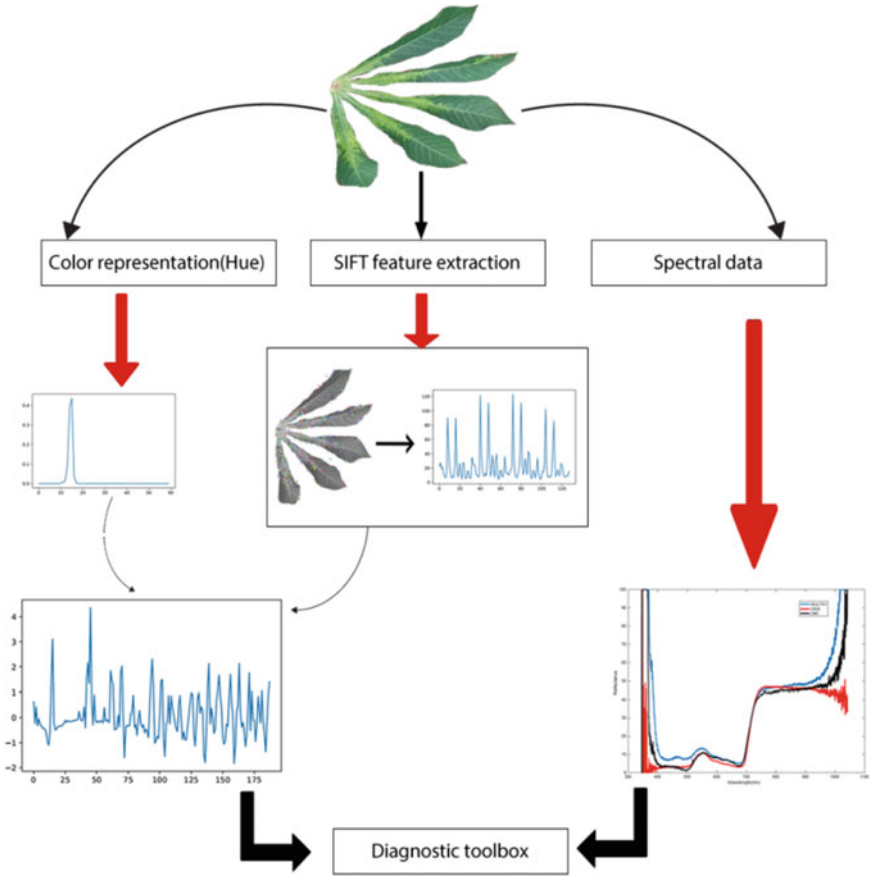


Fig. 11.1 Disease automated diagnostic pipeline (*Source* Owomugisha et al. 2018)

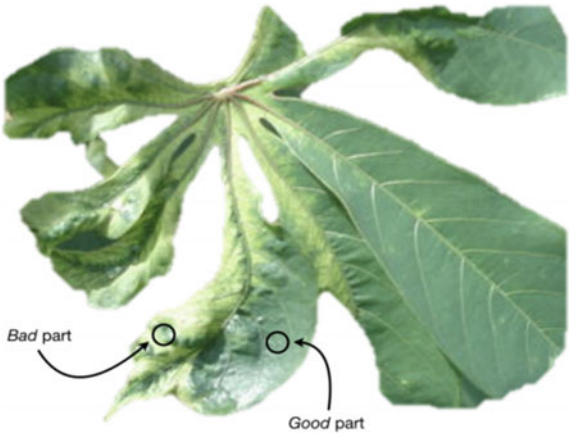


Fig. 11.2 Depiction of good and bad part of leaf (*Source* Owomugisha et al. 2018)

But the hypothesis is that spectral data offers better representation of the inherent disease in the plant than image data. In order to conduct field diagnosis of disease, it is found that spectral data is more efficient as compared with image data, the de-facto automated diagnosis methodology. Another advantage is that prediction accuracy for disease with spectral data shows a significant gain. Also, the spectral data collection from different parts of the leaf is consistent. Particularly of interest will be the collection of spectral data from the good part of the leaf which will implicate for detection of disease in the plants before they are symptomatic.

The first part of the challenge of this approach is to identify the disease and then to estimate the precise intervention needed to manage it, depending on the status of the infection. Figure 11.3 shows a portion of the infected area of the plant. Thus, with the help of machine learning, the system will be able to localize the intervention on the basis of the estimation of the probability of a disease and assessment of the position of the infected area on the plant body.

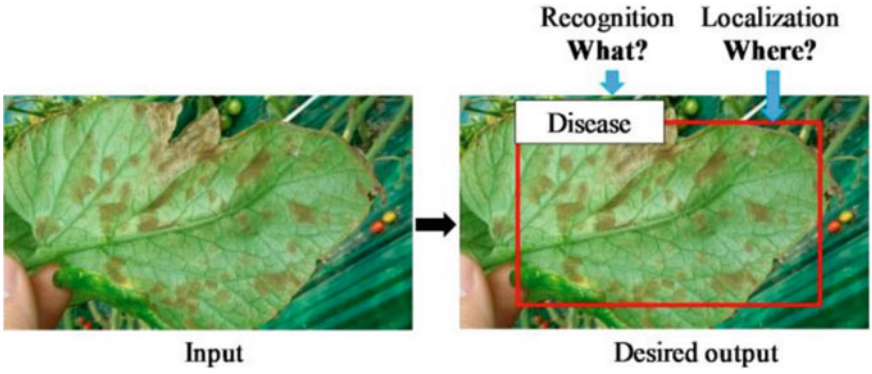


Fig. 11.3 Recognition and localization of plant diseases and pests (*Source* Fuentes et al. (2017))

11.3 Precision Agriculture

Since the terrains of the three main geographical regions of the North-East, namely, Surama valley, North Eastern Hill Basin and the Brahmaputra valley are significantly different when it is analysed considering the availability of water, population density, habitation patterns, climatic conditions, soil quality and forestry and biodiversity, a comparative study on the advantages and disadvantages of initiating an agro-based economic activity is a must. Though the primary livelihood activities adopted by the communities residing in a particular region is already known, this traditional knowledge based decision needs to be scrutinized using modern tools. Whether pisciculture and fishery is viable in the border areas of Assam-Arunachal region, even though they are avoided traditionally, is to be analysed from new perspectives, collecting necessary data using smart devices. AI-based models are found to provide appropriate guidance in this regard. Due to lack of land and provision for irrigation, people from the hill regions have been asking the question—instead of depending on jhum agriculture, if it is advisable to go for new ventures involving technology based farming, such as floriculture, horticulture and organic farming. We believe, it is high time now to address this question so that viable new economic activities, customized for the land and the people of a specific area, may be prescribed (Fig. 11.4).

As shown in the figure above, application of the tools of big data analytics and ML models to identify optimum conditions for robust growth of a particular agro-product (e.g., black ginger, rice, etc.) in the given terrain and under given air–water–soil conditions would definitely play a significant role in net yield when the farmer uses this knowledge, available on his/her smart phone, to decide on the crop to be cultivated in a particular plot of land. The AI-based platform is tailored to latest commodities and regional accents to provide the increasingly growing population with food production. The platform will provide farmers with insights into issues related to crop thinking and planning, cultivation, sprinkling of insecticides and harvest through the combination of analytical technologies and data insights.

11.4 Database on Taxonomy and Bioinformatics

North-Eastern region boasts of sitting on one of the first 25 richest biodiversity hotspots in the world. If India happens to be the home of 15,000 different plant species, NER has very rich biodiversity, contributing almost 53% to this rich collection. While India claims to possess 315 plant families, NER's quota is almost 63%. Out of the 60 species of cane, 138 species of bamboo, 90 species of Rhodondron, 1145 species of orchids, 1072 species of Ptederidophytes and 64 species of Gymnosperms, NER has stakes of 67%, 65%, 89%, 72%, 47% and 62%, respectively. Arunachal Pradesh, with a haul of 5000 species of flowering plants, is the richest among the seven sisters, followed by Meghalaya and Assam.

To develop augmented reality (AR)-enabled database management system for easier and quicker access to information and enhanced application, a large amount

Fig. 11.4 Yield forecast (Novuslight 2019)

of biological data is being processed, organized and analysed in bioinformatics. The management of so many data goes beyond human beings, and AI will greatly assist us in this huge work. Some of the areas where the AI use is of great benefit are described below.

11.4.1 DNA Sequencing

DNA Sequencing is the process through which one can find out the order of the four nucleotides–Adenine, Thymine, Guanine and Cytosine in the DNA. There is a particular nucleotide basis sequence for each organism. While DNA's double helix nature was discovered long ago in 1953, full DNA sequencing could not be carried out in view of the massive crushing of the data. The emergence of artificial intelligence and the related data storage capability made this possible. The sequencing of the human genome in 2003 was accomplished with these developments. A new discipline, called pharmacogenomics, was also created with DNA sequencing which leads to more personalized medicines.

11.4.2 Protein Classification

Proteins are the driving forces behind all bio-processes in one cell. Polypeptides, the building blocks of protein, are made up of chains of amino acids, and chains of such polypeptides fold onto themselves to give the 3D structure of a functional protein (Reynolds and Tanford (2003)). Due to identical primary structure and a common evolutionary track, protein classification remains to be a challenge. Similar structure can also be found in unassociated protein families. All this can be achieved with artificial intelligence and its extensive computational abilities. One approach is to create a computer software that relates the unspecified amino acid sequence to the identified protein sequences and reports the objective protein classification. Precise analyses and characterization of proteins are crucial since most important functions of the organism are dependent on that. The information can also reveal the protein's catalytic role and biological function.

11.4.3 Analysis of Gene Expressions

The process of converting genetic code into functional products such as proteins is gene expression. Transcription and translation are two major steps of gene expression. It is a closely controlled process that enables a cell to react to its changing surroundings. Micro-arrays of gene expression frequently referred as the gene chips allowed measurement and analysis of gene expression. Without AI's support, this would not be possible. In the case of cancer research, the creation and classification of cancers on a molecular level by microarrays and RNAs combined with artificial intelligence has demonstrated their potential.

11.4.4 Genome Annotation

Genome annotation is the mechanism by which genes and all coding regions in a genome are identified. The roles of these genes are also determined. Genome annotation implies necessarily some automation degree. Many thousands of protein sequences encoded in a genome cannot be manually analysed. Advanced machine learning software supports these activities. The key benefit of the programme for machine learning in genome annotation is its ability to recognize patterns automatically in an extensive number of details.

11.4.5 Computer Aided Drug Design (CADD)

Computer-aided drug design is the discipline specialized in simulating drug receiver interactions by computational methods. CADD depends heavily on IT, databases and computing tools. The activities can only be effectively controlled by AI. The CADD can be used in different phases of drug development, such as hit detection with a virtual screening.

11.5 Environment

While the country and the world are going through an environmental crisis, the North-East India, though seems to lack any threat, a close look would reveal that the region too has not been spared the experience of environmental problems. The major threats are observed in the form of air and water pollution, rapidly vanishing wetlands, alarmingly high rate of tropical rainforest destruction and shrinking biodiversity cover. Depleting forest cover is yet another environmental problem of North–East India. Though visitors still view the area as evergreens and dense forestland, an analysis of forest data speaks of the dreadful truth of the area. Forest Survey of India (FSI) reported that the area lost and area of 783 km^2 of forest cover in 1995 relative to the countries of other countries, while the rest of the world recorded a gain of 276 squares of kilometres all in all (Forest Survey of India (1995)). The analysis of the FSI reports in 1997 and 1999 confirms loss of forest cover in the region by 316 km^2 and 216 km^2, respectively (Forest Survey of India (1997, 1999)). Although tropical forests and rain forests are in the surrounding area, there is significant hazard to the area's ecosystems. Alarm bells are ringing loud to bring it to our notice that many different microbial species are getting extinct, leading to land degradation and also soil erosion in both the valleys and the hills of the northeast India. After the great earth quake land mass. The devastating earthquake in 1950 leads to perturbation of the river courses and thus imbalance to the surrounding ecosystem, causing random frequency and intensity of siltation as well as floods (Rao (1952)). Soils erosion,

accumulation of silt and increase of the surface of river beds were also intensified due to changes in the hills. Growth in population and the ever-increasing demand for basic survival needs as well as other lifestyles demanded expansion jhum lands of the hill countryside. In addition to the settling farming in the valleys, the problem was exacerbated by industry development, road building, mining, urbanization, etc. The lower jhum cycles, the slides and the hillside characteristics have begun to take a fresh, man-made look. The relevance of soil erosion in river beds and the resulting siltation is varied. The river beds are rising vertically and horizontally, and flood intensity and the constant problems of the northeastern plains increase. The water quality is degraded substantially, sedimentation or opacity are increased, plant life is decreased at the surface, quality change in the physical and chemical ecosystem of the water, river benthic disruption, spawning perturbation, aquatic animal breeding areas and many more. Therefore, the amount and quality of marine life are overall depleted. Until 1950, the siltation rate was found to be very fast, and in a couple of years, the river bed raised by three metres in some places. Due to continued chopping of trees in the water sources, the scenario has been worsened which leads to soil sweeping on the river Brahmaputra. In August of 2006, a survey of the Assam Pollution Control Board reported that petroleum industry contaminated the state's rivers and damaged rainforests. With state-owned exploration companies, OIL and ONGC, Assam manufactures 15% of India's onshore crude, supplying crude oil to Indian oil refineries. The study found that refineries discharged into the Brahmaputra River and its tributaries organic waste such as oil and grate, phenolic compound and sulphides well beyond allowable limits. Water from Ward's Lake (located in a park in the centre of Shillong town) is not chemically suited to direct utilization, as per the Meghalaya State Pollution Control Board. The Umium lake is still very contaminated in the same way. In 1990 paper, the Shillong Times classifies its water as "c". Acid mine runoff from coal mining is considered to emit various heavy metals into the atmosphere in addition to other adverse effects. In the Jaintia hills, Meghalaya water flowing through the belt was found to be high in iron, manganese, chrome and zinc. Cement dust known to contain several metal impurities such as copper, cadmium lead and zinc was shown to be responsible for the elevated levels of some of these metals in the body tissues of honey produced from hives located near a cement factory at Cherapunjee, in Meghalaya. Besides, instead of preservation, we, the people of NER, are causing damage to the wetland of the region, which is so vital in maintaining the habitat diversity as they are the natural reservoirs of the plants and fauna of the region. These wetlands help in keeping as well as restoring balance in the ecology of a region by regulating exchange of energy and matter in the ecosystem interacting with the physical environment.

To start with, PyTorch deep learning platform is being used to come up with AI solutions with machine learning models to implement real-time monitoring of NE ecosystem for effective intervention through—

Assessing the water quality of the Brahmaputra river using artificial neural network models. In the Lakhimpur district of Assam, Gogoi (2015) studied three

types of Subansiri river basin inland wetlands. The plains flooded by the river Subansiri seasonally. This study was made in relation to fishery perspective and aims to improve the fishery development in the flood plains (Fig. 11.5).

Moran (2019) performed an ecological health assessment for a period of two years in the two rivers—Dhansiri and Kaliani of Golaghat district of Assam affected by effluent of the Numaligarh refinery. The abundance and density of phytoplankton and zooplankton were calculated and compared between the control area and contaminated area. In the study, a distinct fluctuation was observed in both physiochemical parameters and bio-community structures of the two rivers (Fig. 11.6).

The use of statistical methods and artificial neural networks plays a crucial role in developing solutions which can model the water quality of the river (Karunanithi et al. (1994); Agarwal et al. (2006)). With specific constituents of the river water, monitored continuously for a period of few years can collect a suitable amount of data needed to feed in machine learning model to perform classification/prediction depending on the use cases. Singh et. al. (2009) introduced a similar method in order to quantify the intake for biochemical oxygen dissolved in the Gomti River (Fig. 11.7).

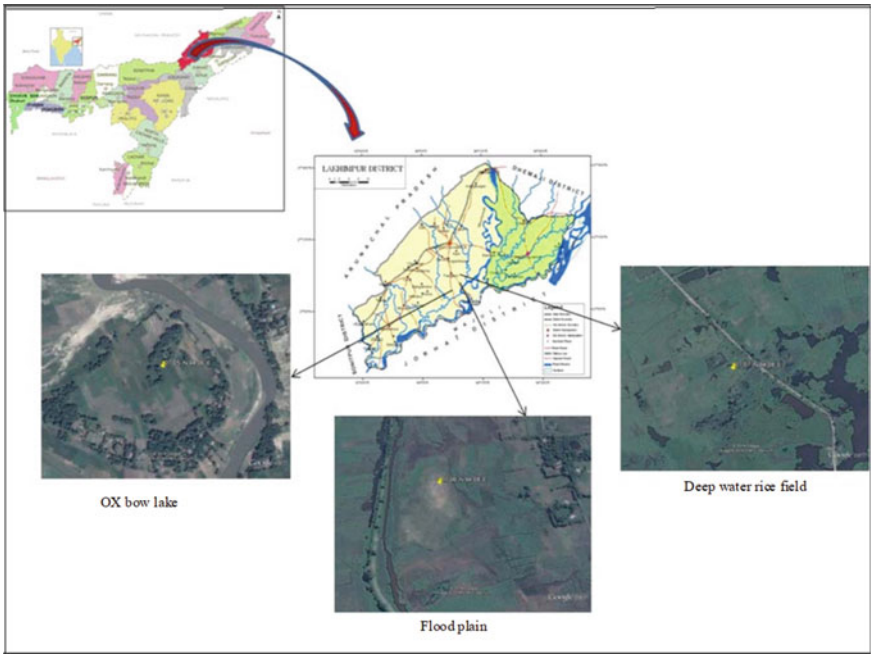


Fig. 11.5 Map of study area of the flood plain wetlands of Subansiri river (*Source* Gogoi (2015))

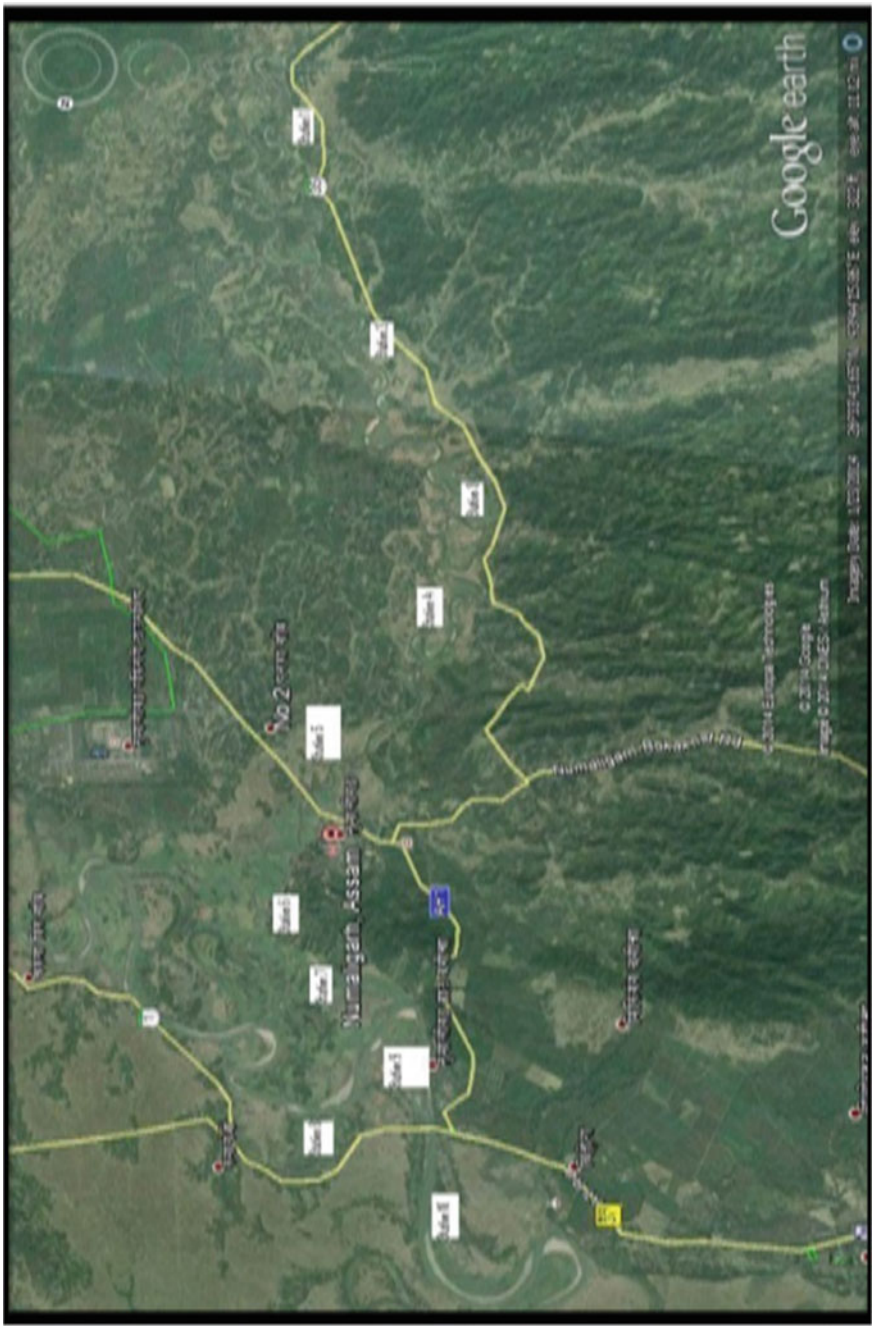


Fig. 11.6 Satellite image of Dhansiri and Kaliani river (*Source* Moran, 2019; Google Earth)

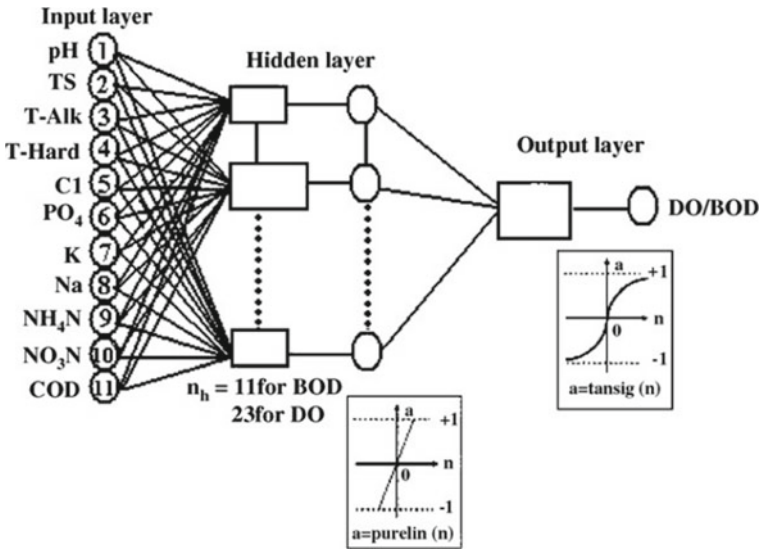


Fig. 11.7 Conceptual design of an artificial neural network for computation in a river (*Source* Singh et al. (2009))

11.6 Traditional Knowledge Documentation

To use tools of data analytics in general, and natural language processing (NLP) in particular, for documentation and develop AR-enabled database management system for easier and quicker access to information for further processing.

Content producers are now switching to their potential customers from printable to digital technology. Media technology versions are progressively using the same tools or more from the start, planned for use in the digital environment than the print counterpart. Both the publishers and the user will be able to find contents, whether in web or print, or on the tablets, just be using a augmented reality (AR)-enabled device. The objective of the present work is to provide a viable road-map for the future where any printed material, be it a poster, a package, or a printed page in a newspaper, magazine or book, is capable of adding values when combined with a camera, computer vision models that identify the page content and tools that extract related digital data. In conjunction with print, the accordance of AR systems delivers value above print or digital material.

11.7 Conclusion

In order to make the NER SDGs effective, intervention of advanced technologies in agriculture and allied activities is a must. Computer vision and machine learning (ML) tools along with adequate sensors and IoT devices, drones and other ancillary gadgets would ensure efficient soil and crop monitoring, enhance post-harvest value addition, and agricultural robots would not only help in implementing precision agriculture, which is so important in case of NER due to its varying weather conditions and immensely diverse ecosystem, but also in managing the crop in hostile terrain. Moreover, these tools may be used for surveillance too in this strategic geo-political region. Data analytics techniques are inevitable for monitoring waste or river water, so that timely intervention is possible to control hazards, such as contamination. Besides, initial results from the geospatial analysis of the river Brahmaputra indicates that the same technique may be applied in regular monitoring of river water using satellite imagery at strategic locations. In order to extract and preserve unique biological features, use of AI tools and data analytics in traditional knowledge documentation, taxonomy and bioinformatics is also proving to be quite beneficial, possessing huge scope for specific applications.

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Chapter 12
Sustainable Development Goals (SDG 3) "Health and Well-Being": What's Ailing North–Eastern States?

Mridul Kumar Sarma

Abstract The UN General Assembly sets Sustainable Development Goals (SDG) in 2015 and achieved by the participating countries by 2030 to have a better, peaceful and prosperous world by 2030. A total of 17 goals have been set. India also took a pledge to work towards the fulfilment of these goals. Among the 17 goals, "good health and well-being" is the one goal in which this paper will focus with special relation to the north–eastern states. Currently, India is at a very lowly position compared to other developed nations, and among all the states of India, north–eastern states (NE states) have so far done very poorly in many yardsticks used to measure the health goal to be achieved. The current COVID-19 pandemic has posed additional challenges in achieving the health goals in particular. From the health indicator point of view, various parameters need changes. Currently, India ranks 117 out of 166 countries in the sustainable development report. Among the states in India, the north–eastern states have ranked towards the bottom of the table. Assam ranked 30 in 2018 and 25 in 2019. Among the NE states, Manipur ranks the best, rank 12 in 2019 in the health sector. This paper will focus on the various health parameters that are being considered for the assessment of SDG 3. The reasons why NE states are not doing well in the health sector are the maternal mortality rates, various health indicators that need improvement, etc, the various disease and conditions like HIV, tuberculosis, malaria and diarrhoea among children, the rising trend of non-communicable diseases and the menace of substance abuse that are still prevalent among the population in the north–eastern states. The ever-increasing malignancies of the lung, gastrointestinal tract and blood are also a matter of great concern in NE states. This chapter will focus on the various health indicators and try to find a solution for the various problems ailing the north–eastern states. This study will also focus on the various causes leading to reduced utilization of the various healthcare services the state has to offer.

Keywords Sustainable development goal (SDG 3) · North–eastern states · Health indicators · Infectious and non-infectious diseases

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12.1 Introduction

There are seven states in the north–eastern part of India: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura; famously known as "the seven sisters". With a population of 45 million (Chandramuli 2011), the seven sisters have a 2.6 lakh km^2 of an area with mountains, jungles and plains making up its geographical structures. Numerous ethnicities and multiple dialects with different cultures and traditions of each state make up its population. Due to its remoteness and geographical conditions, the development of these states has been painstakingly prolonged. Education, health, infrastructure, transport and communication face significant hurdles in these states.

The UN General Assembly sets Sustainable Development Goals (SDG) in 2015 and achieved by the participating countries by 2030 to have a better, peaceful and prosperous world by the year 2030. A total of 17 goals have been set. India also took a pledge to work towards the fulfilment of these goals. The third goal in the list is the goals of the good health and well-being. These goals are to be achieved by the year 2030.

According to WHO, health is a state of complete physical, mental and social well-being and not merely the absence of disease (WHO 1948) or infirmity. Public health is the science and art of preventing disease, and its purpose is to reduce the suffering of the general mass as a whole, reducing human made disaster, environmental hazards, promoting better health behaviour and health education for prevention of communicable and non-communicable diseases.

The definition of health implies that to call an individual healthy, the person needs to be healthy both physically and mentally, and also he is at peace with his society. We all are aware of the various physical health issues, but a deeply under-recognized condition in our society is mental health. It may be due to various reasons. There is a taboo associated with mental health in our society. The family members of a troubled person usually overlook the problems the patient is facing, and at the same time, the person who is suffering is probably not in a condition to seek medical help by him/herself. Our society labels many of such individuals as mad or insane. However, in reality, most of them could have been cured had he got proper medical attention. Many times, we fail to recognize that depression is a disease and can very well be treated. Depression is a significant cause of loss of work in our society. Many people take sick leave from work just because they are having a low mood on that particular day. These missed days at work due to mental health issues can have a big impact on our economy.

Well-being can be measured by happiness index. Bhutan is the first country to develop the concept of gross national happiness index based on the nine domains of gross national happiness. These are psychological well-being, education, community vitality, ecological resilience, living standard, cultural diversity, health, good governance and time use.

Happiness Alliance took inspiration from Bhutan and developed the happiness index.

The happiness index is a broad survey device that assesses happiness, well-being and some aspects of sustainability and resilience.

To measure the health and well-being of a society, various parameters are used. These are the various health indicators as follows:

- Presence of various diseases (both communicable and non-communicable) and how well they are being managed.
- Social issues.
- Social well-being can be measured by looking into higher educational attainment, safe neighbourhoods, as well as economic sufficiency and stability. etc.

Currently, India ranks 117 out of 166 countries in the sustainable development report. Among the states in India, the north–eastern states have ranked towards the bottom of the table. Assam ranked 30 in 2018 and 25 in 2019. Among the NE states, Manipur ranks the best and 12 in 2019 in the health sector.

The structure of this chapter is as follows: first, the various health parameters will be discussed in relation to the north–eastern states. Secondly, the various diseases which are very much prevalent in the north–eastern states are mentioned. This section included both communicable and non-communicable diseases. This section also included the current situation of malignancy in this region, the menace of substance abuse, mental health issues and illness related to immunodeficiency condition. Finally, the various factors for non-utilization of healthcare services are discussed.

This chapter highlights the various burning health issues the north–eastern states are facing including the health parameters used to measure the Sustainable Development Goals, various communicable and non-communicable diseases, and this chapter will try to explain the reason for the current poor state of affairs regarding these problems and also will try to find solutions for the same.

12.2 Health Indicators of North–Eastern States

Infant mortality rate: The National Family Health Survey (NHFS-5) 2019–20 found that the infant and child mortality rates in Assam have witnessed a marginal decrease from the year 2015–16 to 2019–20. IMR in Assam in 2016 was 47.6 and in 2019–20 was 31.9 (NFHS-5, 2019–20) (NFHS-5, 2020).

The report shows that the neonatal mortality rate (NNMR-per 1,000 live births) has decreased from 32.8/1000 live birth to 22.5/1000 live births. (NFHS-5, 2020).

Maternal mortality rate: of Assam is 23.7 per million population in the year 2014–2016. The value was 480 in 2004–2006.

The health of a child is dependent on the health of the mother. That is why the improved maternal mortality is a good sign for the north–eastern states. Normally, women in general and their health have primarily been in a poor state in India. The health of women is very well linked with the health of children. Healthy mothers tend to bear healthy children and nurture healthy families. However, due to many factors

such as patriarchal society, gender discrimination, lack of access to proper health care to the female member of the family in society's lower socio-economic strata, the health of women continue to be in poor condition. Although the Khasi tribe of Meghalaya have matrilineal society, many women suffer from nutritional deficiency. Overall in India, women have anaemia to a large extent, to the tune of 50% in some areas. In these women with anaemia, maternal mortality is usually higher because pregnancy is a very stressful period in women's life.

The major causes of infant mortality are as follows: (1) pre-maturity in 35% of cases, (2) various infections in 33% cases and (3) congenital malformation in around 9% cases. The incidence of neonatal infections can easily be prevented by using proper sanitation measures in proper healthcare set-ups. In rural Assam and other north–eastern states, delivery by untrained midwifes (*dhais*) is common, leading to various infections in the neonates. Pregnant ladies should be given access to skilled birth attendants for better obstetrics care. This is extremely important to lower both maternal mortality rate and neonatal mortality rate.

The major causes of under 5 years of age mortality are mainly infectious, namely pneumonia, diarrhoea and malaria. Congenital disabilities constitute a small number of cases of under five mortalities. Usage of proper sanitation measures can prevent these infections.

In their studies, Barua and Kusre (Barua 2015) found that the prevalence of the various congenital malformations was 1.2% among the babies who were alive at birth. Babies with a high degree of congenital malformation die in utero, so that it was not taken into account. The various congenital malformations were seen more commonly in males (66.67%). Among the various organ systems, musculoskeletal system was found to be involved more commonly than other systems like cardiovascular system. Elderly mothers usually gave birth to babies with congenital malformations more frequently than their younger counterparts (Barua 2015).

12.3 Various Communicable and Non-communicable Diseases

12.3.1 Tuberculosis

Tuberculosis is an infectious disease caused by the bacteria Mycobacterium Tuberculosis. Tuberculosis is known to mankind since time immemorial due to its effects on the human body and also due to the various socio-economic problem it causes. Tuberculosis primarily involves the lung (also known as pulmonary tuberculosis), but it can affect almost any organ system (also known as extra pulmonary tuberculosis) in our body.

Even after thousands of years of suffering from this dreaded bacteria, tuberculosis is still a major killer of mankind. Various major organizations are making tremendous efforts to eliminate tuberculosis. United Nations (UN) is targeting the elimination

of tuberculosis from the world by the year 2030, and World Health Organization (WHO) has launched End TB Strategy targeting a reduction in the number of new cases to less than 20 per 100,000 population by 2030. (United Nations 2015; WHO 2015).

India has launched National Strategic Plan for Tuberculosis Elimination 2017–2025 to eliminate tuberculosis from India by 2030. India has tuberculosis control activities for more than 50 years now, yet TB continues to be a serious health crisis for India. An estimated 480,000 Indians die every year due to tuberculosis. This huge number does not include more than a million missing cases every year that are not notified and many of those missing cases die without receiving proper treatment. In 2016, India witnessed 2.79 million TB incident cases, among which 0.147 million incident cases of multidrug resistant tuberculosis (MDR TB) and 87 thousand incident cases of HIV-TB co-infection. (HFW 2017).

Tuberculosis is prevalent across the north–eastern states, and both pulmonary and extra pulmonary tuberculosis are seen frequently in all states. Pulmonary tuberculosis is particularly dangerous for society because of its potential for spreading to other individuals who are in close contact with the patient. In a poverty-stricken population in many north–eastern states, this creates a significant problem because the household usually does not have a separate room for the tuberculosis patient, and the patient usually shares the room with other healthy members of the family making them at risk for contracting the disease.

In states like Manipur where the incidence of HIV is high, the TB-HIV co-infection is a serious problem. A study done by Kayina TKP et al. in Manipur found that males were more commonly affected by tuberculosis in their study population. In their study, 6.5% of patients were HIV positive, and among the TB-HIV co-infected patients, 46.3% of the cases were Extra-Pulmonary TB (Kayina et al. 2019).

Three states from the north–eastern part of the country have a high prevalence of HIV as shown by National Aids Control Organization (NACO) 2019 data. (NACO 2019). These three states are Mizoram 2.32%, Nagaland 1.45% and Manipur 1.18%. Because of a strong association between HIV and tuberculosis, active tuberculosis case finding should be intensified in these areas. Active case finding can be carried out in the Integrated Counselling and Testing Centres (ICTC), antiretroviral therapy (ART) centres.

Tuberculosis is a considerable obstacle in achieving good health in the tea garden workers of Assam. Despite being a curable disease, many tea garden workers continue to bear the brunt of the once dreaded disease. The Government of India provides treatment of tuberculosis free of cost. However, due to lack of access to government-run hospitals or lack of knowledge of such health facilities, patients continue to suffer. Around 15% of tea garden workers in Assam are affected by tuberculosis. These workers usually stay in a crowded household with a very low per capita area. Tuberculosis spread through droplet infection, so it is very easy for the bacteria to spread from one person to another. Usage of masks can be very handy in these situations. When the household's earning member gets affected, it becomes difficult for the other members to have a decent living. Tuberculosis is a significant cause of

perinatal death in tea gardens of Assam. That is why it is very important that proper medical help is given to the patient with tuberculosis.

12.3.2 Diarrhoeal Diseases

Many children die of diarrhoeal diseases around the globe. The estimated death of children under five years of age is around 9% globally, translating to around 1600 children dying of diarrhoeal diseases per day in the year 2013. African countries and South Asia are the two regions that witness many children dying of diarrhoeal disease under two years of age (UN 2016). There is currently a decreasing trend of children dying of diarrhoeal diseases. From the year 2000 to 2012, the under five year age mortality has come down around 50%, from 1.3 million to 0.6 million in 2000. The Sustainable Development Goal (SDG) target for the under five mortality rate is 25 deaths per 1000 live births by 2030, but the under five mortality rate in 79 countries is above 25.

In the article published by Liu et al. (2016) in *Lancet* demonstrates that the under five mortality was 63.7 per 1000 live births in the north-east in 2015 the highest among all the other state of India. This is very unfortunate as the death due to diarrhoea can be prevented easily using proper sanitation measures and using purified drinking water. For the purpose of treatment, the World Health Organization (WHO) has recommended low osmolarity oral rehydration solution (ORS), regular breastfeeding and supplementation of minerals such as zinc (WHO 2006). Zinc supplements help boost the immunity in young children at dose 10–20 mg/day. It has been observed that these simple measures can cause a drastic change in the management of diarrhoeal diseases in under five-year-old children. The knowledge, attitude and practice of the mother are extremely important in the treatment of diarrhoeal diseases of children.

The north-east region is a hilly area inhabited by tribes of different cultural beliefs. There is great diversity in sociocultural traditions among the various tribes of this region. Apart from Manipur, Tripura and Assam, this region is mostly dominated by tribal population. Studies done by Sundarajan (2013) found that the tribal communities seek health care from a specific healthcare practitioner based on their cultural beliefs. Here, the head of the family's education level and his ties with specific community is an important determinant of healthcare utilization (Singh et al. 2015). The North-east India region has the lowest percentage of children whose parents or caregiver has sought treatment for diarrhoeal diseases.

In Assam, prevalence of diarrhoea in the 2 weeks preceding the survey (%) is 5.5 in 2020 compared to 2.9 in 2016 (NFHS-5 2020).

Non-availability of a nearby medical facility or non-availability of health practitioner at the health facility is the prime reason for this reluctance by the population for seeking health care. These factors can be rectified with some effort from the policymakers.

12.3.3 Malaria

Malaria is caused by an obligate protozoan parasite called plasmodium. It has four species, namely falciparum, vivax, ovale and malariae. In North-east India, infections with plasmodium falciparum and vivax are common. In India, the districts are divided into three categories 0, 1, 2 and 3 depending the annual parasite index (API).

National Framework for Malaria Elimination (2016–2030) and a National Strategic Plan (NSP, 2017–2022) have been placed into action by India's government for Malaria elimination. In the National Strategic Plan, districts are divided into three categories 0, 1 and 2 depending on the annual parasite index (API). These plans aim to eliminate malaria (zero indigenous cases) in all categories 1 and 2 districts by 2022.

Category zero includes 75 districts reporting no malaria cases in the last three years. Category 1 includes 448 districts having annual parasite index of less than 1 per 1000 population. In category 2, the API value is more than 1 but less than 2, and in category 3, the API is 2 or above. Categories 2 and 3 have 48 and 107 districts, respectively.

The API of Assam is 0.43, but Meghalaya and Mizoram have the highest number of Malaria cases among all the NE states.

In India, the API is consistently falling from 1·66 per 1000 population in 2006 to 1·37 per 1000 population in 2010 (WHO 2012). Similarly in Arunachal Pradesh, API decreased significantly from 59 per 1000 inhabitants in 1995 to 6 per 1000 inhabitants in 2012 (Mutheneni et al. 2014), but it is still much higher compared to the national average.

Despite a lot of efforts to eradicate malaria in the last few years, it continues to be a major public health problem in the north-east region. Only 4% of the total population of India live in north–eastern region, but it contributes 10–12% of total malaria cases in India each year (Patra 2004).

Most of the malaria cases in India occur predominantly from plasmodium falciparum (PF) or plasmodium vivax (PV). For the last several decades, PF cases are rising, and currently, PF cases constitue around 48.1% cases (Patra 2004).

Assam, Manipur and Nagaland see a lesser number of Malaria cases in comparison with other states.

All the peripheral hospitals in the NE region receive a lot of malaria cases in all kinds of severity. Many cases of cerebral malaria also come with patients usually in a state of coma. Prognosis can be much worse in such cases as cerebral malarial carries a high mortality. Malaria is an entirely curable disease with government-sponsored treatment given free of cost to all government-run hospitals across India. Despite that, many patients still die of malaria in NE states because patients fail to avail those facilities. In many occasions, the patients are not aware of the facilities being provided at the hospitals. The mass education system should be in place to make people aware of the hospitals' facilities. Some patients are so poor that they do not have any means to come to the hospitals. Although many free patient transport systems are in place, there are areas in NE states that are hilly and proper road is

not yet available, and for this reason, the vehicle provided by the government cannot reach out to the needy people.

One major problem with the malaria cases in NE states is the issue of drug resistance. Here the usual malaria drug chloroquine does not affect the parasite. Chloroquine can be administered orally in tablet form, but Artisunate needs to be administered in the drug-resistant cases but via the intravenous route. That causes an additional problem in some health settings.

12.3.4 Japanese Encephalitis

Japanese encephalitis virus (JEV) is caused by flavivirus. It is a mosquito-borne disease. Flavivirus is a RNA virus belonging to the family flaviviridae. This genus includes other important virises such as dengue, yellow fever and the West Nile viruses. Japan witnessed the first case of Japanese encephalitis in 1971.

Culex mosquito (maily culex tritaeniorhynchus) transmits the disease to humans. The virus maintains a cycle between mosquito and a vertebrate host (commonly pig). For this reason, this disease is common in areas where pig farming is commonly practised. Assam also has substantial pig population, the largest in the country accounting for 17.96% total pig population in India, and the state has witnessed a growth of over 6% in pig population (Sulabh 2017).

Assam is very vulnerable for spread of JE due to very high pig population coupled with abundant rainfall, making the area very ripe for mosquito proliferation.

Pig farming is very popular in Assam as pork meat is consumed by a vast majority of people of various ethnic groups in Assam. Japanese encephalitis is one of the differential diagnoses of acute encephalitis syndrome.

12.3.5 Immunodeficiency Diseases

Acquired immunodeficiency syndrome (AIDS) is a disease caused by a retrovirus human immunodeficiency virus(HIV). It attacks the immune system of the human body making the body vulnerable for many infections. HIV gets transmitted from human to human mainly through sexual route. Other routes of transmission being via blood transfusion and from mother to baby transplacentally.

In north–eastern states, Manipur has the highest number of cases per 100,000 population, the value being 36.86. AIDS damages the immune system leading to infection by various bacteria or viruses which would not have caused any problem in a person with a normal immune system. AIDS is also associated with a number of malignancy in the human body.

Sex education is extremely important in school level to the young kids for the practice of sex and choosing the right sexual partner in future. Sex education among sex workers is also tremendously important.

12.3.6 Respiratory Diseases

Lungs are the most vital organs in our body, circulating oxygen and expelling out carbon dioxide. Respiration being a passive process, we never really appreciate or understand its importance when we are healthy. Currently, respiratory diseases are increasing everywhere due to the ever-increasing pollution and cigarette smoking.

The various respiratory diseases cause great health burden in our society. Asthma and chronic obstructive pulmonary disease (COPD) are the two most common respiratory diseases. COPD is currently the third leading cause of death worldwide. The global prevalence of Asthma is around 3–5%. Some countries such as Australia and the Netherlands have a far higher incidence of asthma. The prevalence of Asthma in India is also approximately 5%. Worldwide around 200 million people have COPD.

Cigarette smoking is the prime cause of COPD, but in India biomass fuel exposure is a very important cause of COPD, especially COPD is expected in the female population.

Asthma and chronic obstructive pulmonary disease (COPD) are rising day by day. Lung cancer used to be rare 100 years back (Spiro GS 2005), but now lung cancer and cancer of oral cavity are the most common cancers among males in the India (Bray 2018). The main cause of lung cancer is cigarette smoking. Nowadays, it is very worrisome to see young children take up cigarette smoking. This will have profound impact on their overall health and psychological development.

In north–eastern states, a high percentage of population live below the poverty line. Among the north–eastern states, Manipur has the highest percentage of population living below poverty line(36.9%), followed by Arunachal Pradesh (34.7%). Meghalaya has the lowest number of people living below poverty line (11.9%) (Indian Government Census Data 2011).

In the rural areas of this region, many people use biomass fuel for cooking food at home as they do not have access to liquefied petroleum gas (LPG) cylinder at home. This biomass fuel is equally dreadful to lung health. Many women develop COPD because of this reason.

The prevalence of asthma is also increasing owing to the ever-increasing pollution in the major cities of North–East India.

12.3.7 Malignancies

Cancer incidence in north-east region is much higher than the national average. The national average of cancer is around 90–110 per lakh population but in places like Aizwal district has 269.4 cancer cases per lakh population for males and 214.1 per lakh population for females. These values are alarmingly high. Some regions, such as East Khasi Hills district, Kamrup urban, Mizoram state, Papumpare district, Meghalaya, witness very high number of cancer cases. Because of this high incidence of cancer, north-east is labelled as the cancer capital of India (Mathur 2020).

Lifestyle choices like excessive tobacco consumption can be blamed for this alarming number of cancer cases in this region. Tobacco consumption in the form of cigarette smoke, chewable tobacco, hucca, etc., is very common in various ethnic groups in this region. Taking raw betel nut is a major factor causing a high number of oropharyngeal cancer in the north–eastern states. Many of the inhabitants of this region have the habit of taking chillies, the Bhut jolokia is a famous product of this region.

It is very important to know the early signs of lung cancer. Mass education regarding the various symptoms can play a very important role in early diagnosis of cancer. Lack of awareness regarding the presenting symptoms of cancer is the prime reason why patients come to seek medical help in a very advanced stage of their disease.

The cancer problem needs urgent attention, and it should be a multidisciplinary effort. Combined efforts from government, healthcare workers, hospitals, administrative bodies, medical organizations, NGOs and more—to impart the right awareness and lifestyle guidance necessary.

12.3.8 Mental Health Issues

WHO definition of mental health is "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community"(WHO 2014). For humans to evolve, fruitful contribution of society cannot be over emphasized. Social and mental fitness both are needed to contribute socially.

There has been a steady rise in mental health problems in India, and same trend is also being seen in the north–eastern states. It has been observed in various studies that mental health issues are not only present in adults but also in adolescents. Harikrishna (2017) conducted a study among school children in ten schools and found that less than one-tenth of the participants have some mental health issue. Keyho (2019) conducted a study in Kohima, Nagaland, and concluded that mental health issues are prevalent in Nagaland, and emotional problems were present in majority cases (17.1%) followed by hyperactivity and conduct problems. Manipur ranks first with 14.1% of population having mental health issues. Many years of insurgency problems, ethnic clashes, human rights violation, crime against women and substance abuse have made the people in north–eastern states more frequently suffer from mental health issues. Haobam (2013) conducted studies in regional institute of medical science and observed the hospital admission patterns in the psychiatry ward. They found that males were having more mental health issues than the females, and alcohol dependence was the major problem in majority patients.

12.3.9 Substance Abuse and Addiction

Substance abuse is a serious problem everywhere around the globe. North-east India too has a major problem of substance abuse among the various ethnic groups. Cigarette or bidi smoking and smokeless tobacco products are seen in the population. Drug use is also becoming common in both men and women in this region.

Ahmed et al. (Nadeem 2009) in their study found that alcohol was the primary substance abused (21.4) followed by cannabis (3.0%) and opioids (0.7%) among men. Yadav et al. (2016) in their study found that prevalence of substance use was higher among younger age group as compared to youth and older. Similar findings were reported in others studies (Dhekale 2011; Kokiwar 2011).

Intravenous drug abuse is also on the rise in north–eastern states. The rising trend in the AIDS cases in this region can be associated with intravenous drug abuse. Educating the young children about the menace of substance abuse can go a long way in the prevention of the dreaded situation in this region.

12.3.10 Utilization of Healthcare Services

Although the state offers many facilities at its government-run hospitals, many facilities are not being enjoyed by the general public. There can be many factors, but the common ones are as follows: (1) there is no nearby facility, (2) facility timing is not convenient, (3) health personnel are often absent, (4) waiting time is too long, and (5) poor quality of care.

To achieve these health goals, the available resources to be utilized to the full extent.

(a) We need to invest in health workers to have people with motivation to work for the welfare of the people who need the best care. In India, we have the multi-purpose workers and anganwadi workers who work at the grass-root levels. Investment should be made in these peripheral workers who can deliver the healthcare services to the masses who actually need the care.

The north–eastern states are mostly hilly, and people living in the most peripheral areas have difficulty in accessing the healthcare services the state has to offer. That is why we need people who can reach out to these people to deliver the healthcare services where it matters.

(b) Providing good nutrition advice is also crucial to improve a society's health as a whole. Indulgence of alcohol and smoking has caused many diseases in the north–eastern states than many other places. The disease of lung is on the rise because of smoking. To improve the health indices, addiction has to be removed from society by giving good health advice. Young people suffer the most from alcohol addiction and smoking because they are the most productive people. That is why incorporating good health advice in school level is of immense

importance. Sex education is of great importance in preventing sexually transmitted diseases, especially HIV. Proper health advice will be a boon to north-east people because diseases like tuberculosis, malaria, dengue, diarrhoea and other communicable diseases can be prevented by using proper sanitation techniques. More recently, the importance of sanitation has been exemplified by the global pandemic of COVID-19. We have all realized that sanitizer and wearing masks can prevent the spread of the dreaded virus.

(c) It's very important to make health care affordable to the general population. There is no use having healthcare services if the more significant mass of the population cannot afford it. Here lies the role of good governance when north-east is concerned.

12.4 Conclusion

The north–eastern states are an part of India and have many potentials in human resources and natural resources. However, the nation cannot benefit from it unless it helps the people living in these states. If not paid attention in time, then the whole nation and the government will be dealing with a complicated situation in future. The government should invest more time, energy and money to bring these states at par to India's other states and money to bring these states at par to India's other states to improve the various parameters being measured for the Sustainable Development Goals.

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Chapter 13
Progress Made by the Northeastern States of India Towards the 2030 Health-Related Sustainable Development Goals (SDGs): Performance of the Health and Well-Being Indicators

Sahana Bhattacharjee

Abstract The Sustainable Development Goals (SDGs) are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030, which were adopted by 193 United Nations Member States at the UN General Assembly Summit in 2015. The third goal of the 17 SDGs is 'good health and well-being: Ensure healthy lives and promote well-being for all at all ages', accomplishing which is crucial for the very existence of humankind. Although many studies in the Indian context on SDGs have been conducted, none has particularly focused on how far or how close Northeast Indian states have been able to achieve the targets of the Sustainable Development Goals Agenda, especially in the context of SDG 3. This study is an attempt to carry out a data-based assessment of how far India and its northeastern states in particular have been able to achieve the targets set under Goal 3 of the SDGs to be achieved by 2030 with respect to some of the health and well-being indicators such as family planning services, child immunization and nutritional status of children and adults, maternity care and delivery care services available, tobacco use and consumption among adults, Under-five Mortality Rate (U5MR), Infant Mortality Rate (IMR), Maternal Mortality Ratio (MMR), Neo-natal Mortality Rate (NNMR). It is expected that this study will bring forth the gaps in the health sector which needs to be addressed for realizing SDG 3 for India and its northeastern region in particular.

Keywords Sustainable development goal (SDG) · Health · Well-being · Indicators · Northeastern states

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13.1 Introduction

The Sustainable Development Goals (SDGs) form a collective vision in terms of some well-defined goals which aim to eradicate poverty, preserve the planet for our next generation and provide all the inhabitants of the world with a peaceful and prosperous life by 2030, which were adopted by 193 United Nations Member States at the UN General Assembly Summit in 2015. It was adopted as a part of the 2030 Agenda for sustainable development where a detailed 15-year plan for successive achievement of the goals was laid out, and it came into effect from 1 January 2016 (The Sustainable Development Agenda, n.d.; What are the Sustainable Development Goals?, n.d.; Sustainable Development Goals (SDGs), n.d.). The agenda encompasses 17 SDGs and 169 targets and seeks to build on the success of the Millennium Development Goals (MDGs), to achieve what could not be accomplished by these. They aim to balance the three dimensions of sustainable development: the economic, social and environmental.

India, among all the other nations, has taken a lead in streamlining the SDGs, and its commitment towards achieving the SDGs is very well reflected in its convergence with the national development agenda as reflected in the motto of Sabka Saath Sabka Vikaas (Collective Efforts for Inclusive Growth) (Voluntary National Review 2020, India, n.d.). Prime Minister Narendra Modi spoke of India's development plans having conjunction with the SDGs in the Sustainable Development Summit of the United Nations, and in his words, sustainable development of one-sixth of humanity which calls India its home will be of great consequence to the world and our beautiful planet (Voluntary National Review Report on Implementation of Sustainable Development Goals, n.d.). India moved ahead of the other countries in implementing and measuring success in achieving the goals by construction of the SDG India Index by NITI Aayog, Government of India, which spans across 13 out of 17 SDGs (leaving out Goals 12, 13, 14 and 17) (SDG India Index, n.d.). The index was developed to be used as a yardstick of social, economic and environmental status of the country and its states and UTs and aims to measure the overall country's and its state-wise progress towards the SDGs for 2030.

Of the 17 goals of the SDGs, the third goal is 'good health and well-being: Ensure healthy lives and promote well-being for all at all ages'. However, there are other goals which ultimately converge towards ensuring good health for all, which are Goal 2 (ending hunger, achieving food security and improved nutrition), ensuring availability and sustainable management of water and sanitation for all (Goal 6) and ensuring access to affordable, reliable, sustainable and modern energy for all (Goal 7) (India and Sustainable Development Goals: The Way Forward 2016). The overall well-being of an individual across all ages is vital for sustainable development. Only if the mind and body of a person are fully fit will he be able to contribute towards the society by giving his complete efforts. Some of the targets that have been set under Goal 3 of the SDGs to be achieved by 2030 are—bringing down the global figures for Maternal Mortality Rate, Infant Mortality Rate, Neo-natal Mortality Rate, prevention

and treatment of substance abuse, achieve universal health coverage, reducing illness and deaths from epidemics and those from hazardous chemicals.

The Constitution of India states that it is the right of every citizen of India to attain the highest attainable standard of physical and mental health. The protection of life and fortification of personal liberty is assured by Article 21 of the Constitution of India (Mathiharan 2003). Further, Article 47 of the constitution directs the states that the highest standard of living, quality of public health and level of nutrition should be made available to its residents and the state should prohibit the consumption of intoxicating drinks and drugs that are injurious to health, except for when it is to be used for medicinal purposes (Article 47 in The Constitution of India 1949 n.d.). Despite the laws and provisions made to safeguard the best of health for its citizens, India has not been able to make considerable progress in the field of health. Also, in the fiscal year 2018, the public health expenditure by states and UTs together amounted to only around 1.28% of the country's GDP (Value of public health expenditure in India FY 2014–2018, 2020). India contributes to 15% of the global maternal deaths (Zodpey and Negandhi 2018). India is ranked 50 out of 222 countries with respect to IMR. India is globally ranked 1 for tuberculosis (TB), and 43% of Indian children are underweight today, which is higher than even some of the lesser developed countries such as Pakistan (32%). India's share in the global burden of diseases is 20%, which is quite high. About 5.4 million children die before reaching 5 years of age (SDG 3: Good Health and Well-Being, n.d.). Looking at the highlights of the SDG India Index 2018, it can be seen that most of the northeastern states have been tagged as either aspirant (having SDG Index value <50) or performer (having SDG Index value between 50 and 65) (SDG India Index, n.d.). Northeast is the easternmost region of India comprising of eight states–Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. About 45 million people reside in this part of the country, which comprises of 3.76% of India's population (Dikshit and Dikshit 2014). The Northeastern Region is characterized by a unique geographical location, uneven terrain, high rainfall, vast hilly region as well as forest areas, economic backwardness, insurgency, etc. and is home to a large number of diverse ethnic groups. Therefore, it is not a very homogenous territory for easily providing round the clock normal healthcare services to all the 47 million people belonging to the region (Medical and Health, n.d.). In the annual report of the Government of India, year 2015–16, some areas concerning the health sector in the northeastern states were identified, viz. shortage of trained manpower, effective and timely utilization of financial resources and services available, morbidity and mortality due to malaria, high level of tobacco consumption, large number of HIV/AIDS cases in Nagaland and Manipur and the increasing occurrence of these diseases in Mizoram and Meghalaya to name a few. Although many studies revolving around Northeast India have elaborated on its health status and healthcare infrastructure, none of them have focused on how far or how close Northeast India is from accomplishing the targets of the Sustainable Development Goals Agenda by the year 2030. This paper attempts to give the readers an insight into the current health scenario via the different health and well-being indicators of northeastern states of India in reference to some of the targets set under Goal 3 of the SDGs to be achieved

by 2030. The inter-state disparity among the northeastern states will also be analysed. This research paper intends to bring forward the success achieved so far as well as the gaps in the health sector which need to be addressed by the concerned authorities if they are to realize their dream of efficaciously achieving SDG 3 for this part of the country in particular.

13.2 Data and Methodology

13.2.1 Data Source

Data for attaining the objectives of this paper have been collected from multiple secondary sources. For gathering information on family planning services, child immunization and nutritional status of children and adults, maternity care and delivery care services available, tobacco use and consumption among adults, the state fact sheets/reports for India as a whole and for each northeastern state separately, of the National Family Health Survey-1 (NFHS-1) (1992-93), NFHS-2 (1998-99), NFHS-3 (2005-06) and NFHS-4 (2015-16), conducted by Government of India's Ministry of Health and Family Welfare, has been considered. Data on the various mortality indicators such as Under-five Mortality Rate (U5MR), Infant Mortality Rate (IMR), Maternal Mortality Ratio (MMR), Neo-natal Mortality Rate (NNMR) have been collected from the Sample Registration System Statistical Report for the years 2014–2018 and Compendium of India's Fertility and Mortality Indicators,1971–2013, published by the Office of the Registrar General, India, and available in the Census of India website (https://censusindia.gov.in/).

13.2.2 Methodology

The following methods have been used to fulfil the objectives of the paper.

13.2.2.1 Multiple bar Diagram

A multiple bar chart is used to display and compare the number, frequency or other measure (e.g., mean) on two or more sets of inter-related data for different discrete categories of data. The length of the bars is set in proportion to the magnitude of the values represented through the diagram. This graph facilitates comparison between more than one inter-related phenomena.

13.2.2.2 Descriptive Statistics

A descriptive statistic is a summary statistic which summarizes a given data set so as to extract meaningful information about the variables from it and also to highlight potential relationships between the variables. Descriptive statistics is popularly classified into two categories—measures of central tendency (values of the variable which is the representative of the entire data set, also known as an 'average' value of the data set) and measures of dispersion (values which indicate the skewness or scatteredness among the members of the data set).

13.2.2.3 Percentage Change

Percentage change is a simple mathematical formula which calculates the extent of change over time. It is calculated as

$$\text{Percentage change of a variable over two time points} = \frac{\text{Value of the variable at(Second time point} - \text{First time point)}}{\text{First time point}} \times 100\%$$

If the percentage change is positive, it means the value of the variable has increased over the time period under consideration.

If the percentage change is negative, it means the value of the variable has decreased over the time period under consideration.

13.3 Analysis and Results

This section contains the summary of analysis of the collected data.

13.3.1 Family Planning Services

The National Family Welfare Programme in India renamed as the 'Reproductive and Child Health Programme' aims at meeting the health concerns of women and children more completely, including all aspects of women's reproductive health throughout their lifespan. In regard to the family planning issue, the new approach promotes the use of contraceptives among eligible couples, allows the couples to choose from among some contraceptive methods including condoms, oral pills, IUDs and male and female sterilization and assures high-quality health care to them (Family planning, n.d.). The following table shows the residence-wise percentage use of any family planning method by currently married women in the age group 15–49 years.

Table 13.1 shows that the average percentage use of family planning services over the four rounds of NFHS is the least for the state of Nagaland (both for rural and urban areas) and is the highest for Tripura (both for rural and urban). Further, Mizoram and Assam fared better than India, both as a whole and for rural and urban areas, separately. Also, rural Sikkim is seen to fare better than rural India. However, the values corresponding to total as well as rural–urban areas are seen to decrease in NFHS-4 as compared to NFHS-3.

13.3.2 Child Immunization

The Expanded Programme on Immunization (EPI), the brain child of the Government of India, was established in 1978 with the aim to reduce morbidity, mortality and disabilities from six serious but preventable diseases, viz. tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis and measles by making free vaccination services easily available to all eligible children (Mortality, Morbidity and Immunization n.d.). Subsequently, the Universal Immunization Progamme was introduced in 1985–86 with the objective of covering at least 85% of all infants against the six vaccine-preventable diseases by 1990 and to achieve self-sufficiency in vaccine production. Figure 13.1 exhibits the percentage of children in the age group 12–23 months who have received full immunization (BCG, measles, three doses each of polio and DPT) in India and its northeastern states during NFHS-1 to NFHS-4.

Figure 13.1 clearly shows that except for Arunachal Pradesh, Assam and Mizoram, the percentage of children receiving full immunization (for which the value had dropped in the NFHS-2 and NFHS-3, respectively), all the other states have shown an increase in the percentage from NFHS-1 to NFHS-4. The average percentage of children receiving full immunization over these four NFHS rounds is found to be the highest for Sikkim (66.67%), followed by Mizoram (53.3%) and Manipur (46%), the only states which have averages higher than the all India average of 42%. Additionally, the variability of the percentage change is seen to be the highest for Meghalaya (413.05) and the least for Mizoram (25.75), both of which are greater than the variability of the all India data (17.95).

13.3.3 Maternal and Reproductive Health

Promotion of maternal and child health has been one of the most important objectives of the Family Welfare Programme in India. The Ministry of Health and Family Welfare, Government of India, included motherhood and child health services into the Reproductive and Child Health Programme, which integrated maternal and child health and fertility regulation interventions with reproductive health programmes

Table 13.1 Residence-wise percentage use of any family planning method by currently married women in the age group15–49 years

State/place	NFHS-1			NFHS-2			NFHS-3			NFHS-4			Average		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Arunachal Pradesh	23.6	39.5	20.8	35.4	47.3	33.3	43.2	47.3	41.6	31.7	26.5	33.3	33.475	40.15	32.25
Assam	42.8	62.3	40.1	54.7	68.3	53.4	56.5	66	54.5	52.4	54.9	52	51.6	62.875	50
Manipur	34.9	44.3	30.3	38.7	44.9	35.6	48.7	54.5	46	23.6	25	22.7	36.475	42.175	33.65
Meghalaya	20.7	31.9	18	20.2	45.3	13.8	24.3	43.7	18.4	24.3	32.8	22.4	22.375	38.425	18.15
Mizoram	53.8	57.1	50.5	57.7	65.1	49.7	59.9	64.3	54.8	35.3	38.5	31.6	51.675	56.25	46.65
Nagaland	13	20.6	10.9	30.3	46.7	26.1	29.7	41.9	24.8	26.5	31.3	24.1	24.875	35.125	21.475
Sikkim	NA	NA	NA	53.8	56.8	53.3	57.6	63.1	56.4	46.7	36.9	51.4	52.7	52.26667	53.7
Tripura	56.1	71.1	52.4	55.5	70	51.8	65.7	66.8	65.5	64.1	66.8	63	60.35	68.675	58.175
India	40.7	51.1	37.1	48.2	51.2	39.9	56.3	64	53	53.5	57.2	51.7	49.675	55.875	45.425

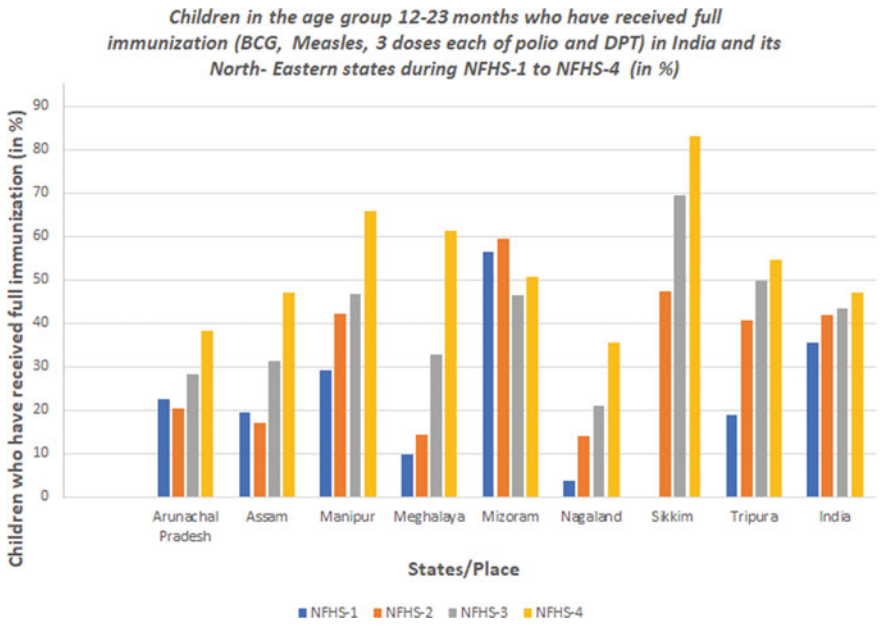

Fig. 13.1 Percentage of children in the age group 12–23 months who have received full immunization (BCG, measles, three doses each of polio and DPT) in India and its northeastern states during NFHS-1 to NFHS-4

meant for all adults (Maternal and Reproductive health n.d.). The important components of the programme with regard to the maternal and reproductive health include—provision of ante-natal care, encouragement of institutional deliveries or home deliveries assisted by trained health personnel, provision of postnatal care, including at least three postnatal visits, identification and management of reproductive tract and sexually transmitted infections. The following table shows the residence-wise percentage of institutional deliveries in India and northeastern states during NFHS-1 to NFHS-4:

It is evident from Table 13.2 that the average percentage use of institutional deliveries over the four rounds of NFHS is the least for the state of Nagaland (both for rural and urban areas) and is the highest for Sikkim (both for rural and urban). Further, only Tripura and Sikkim fared better than India as a whole as well as for the rural area. Further, urban areas of the states of Tripura, Sikkim, Meghalaya and Manipur have better percentages than urban India. However, the values corresponding to total as well as rural–urban areas are seen to increase from NFHS-1 to NFHS-4.

The following table shows the residence-wise percentage of mothers who received ante-natal care in India and northeastern states during NFHS-1 to NFHS-4:

It can be observed from Table 13.3 that the average percentage of mothers who received ante-natal care over the four rounds of NFHS is the least for the state of Nagaland (both for rural and urban areas) and is the highest for Sikkim (both for rural and urban). As compared to India, only the states of Manipur, Mizoram, Sikkim and

Table 13.2 Residence-wise percentage of institutional deliveries in India and northeastern states during NFHS-1 to NFHS-4

State/place	NFHS-1	NFHS-2	NFHS-3			NFHS-4			Average		
	Total	Total	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Arunachal Pradesh	19.9	31.2	31.7	64.1	19	52.2	81.5	44.1	33.75	72.8	31.55
Assam	11.1	17.6	22.9	59	18.6	70.6	92.7	68.2	30.55	75.85	43.4
Manipur	23	34.5	49.3	71.2	40.9	69.1	86.3	60.5	43.975	78.75	50.7
Meghalaya	29.6	17.3	29.7	75	20.4	69.1	86.3	60.5	36.425	80.65	40.45
Mizoram	48.9	57.6	64.6	89.8	39.1	79.7	97.2	61.4	62.7	93.5	50.25
Nagaland	6	12.1	12.2	32	6.6	32.8	56.3	24.3	15.775	44.15	15.45
Sikkim	NA	31.5	49	87.6	43.1	94.7	95.3	94.4	58.4	91.45	68.75
Tripura	30.7	45.2	48.9	75.7	44.8	79.9	92.6	75.7	51.175	84.15	60.25
India	25.2	33.6	38.6	67.4	28.9	78.9	88.7	75.1	44.075	78.05	52

Note The residence-wise data on percentage of institutional deliveries in India and northeastern states were not available for NFHS-1 and NFHS-2

Tripura are seen to have better percentages, both as a whole and for urban–rural areas. Further, for none of the northeastern states and for India, the percentages of mothers receiving ante-natal care are seen to increase steadily over NFHS-1 to NFHS-4. For Nagaland and Meghalaya, the percentage is observed to decrease, both as a whole and for rural–urban area from NFHS-3 to NFHS-4.

The following figure shows the residence-wise percentage of children who received postpartum checkup within two days/months of birth in India and northeastern states during NFHS-2 to NFHS-4.

It is clear from Fig. 13.2 that the percentage of children receiving postpartum checkup within two days/months of birth is the highest for India as well as for all the northeastern states as a whole and also residence-wise, for NFHS-3. All these percentages are seen to drop in NFHS-4. As far as the comparison of the states is concerned, Manipur during NFHS-2, Sikkim during NFHS-3 and Assam during NFHS-4 are seen to register highest percentages among the states, residence-wise as well as in totality.

13.3.4 Nutritional Status of Children

Nutritional status is a major determinant of the health and well-being of children. Inadequate or unbalanced diets and chronic illness are associated with poor nutrition among children. Inadequate nutrition also proves to be a hindrance in a child's physical and mental development. Nutritional status of children has three main indicators—underweight, stunting and wasting. In the present study, only the status of underweight children in India has been studied (Key findings n.d.). The following

Table 13.3 Residence-wise percentage of mothers who received ante-natal care in India and northeastern states during NFHS-1 to NFHS-4

State/place	NFHS-1	NFHS-2	NFHS-3			NFHS-4			Average		
	Total	Total	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Arunachal Pradesh	48.9	61.6	36.4	56.6	28.3	26.7	37.3	23.5	43.4	46.95	25.9
Assam	49.3	61.1	36.3	68.9	32.3	46.4	60.3	44.8	48.275	64.6	38.55
Manipur	63.4	80.2	70.1	85.9	64	69	81.7	62	70.675	83.8	63
Meghalaya	51.8	53.6	53.4	81	47.8	50	71.3	46.3	52.2	76.15	47.05
Mizoram	88.9	91.8	57.8	41.3	75.1	61.4	77.5	42.9	74.975	59.4	59
Nagaland	39.3	60.4	31.6	57.9	23.9	15	28.6	9.3	36.575	43.25	16.6
Sikkim	NA	70.3	69.4	96.1	65	74.7	75.6	74.2	71.46667	85.85	69.6
Tripura	64.9	70.8	58.7	72.5	56.5	64.3	77	59.9	64.675	74.75	58.2
India	63.2	43.8	50.7	73.8	42.8	51.2	66.4	44.8	52.225	70.1	43.8

Note The residence-wise data on percentage of mothers who received ante-natal care in India and northeastern states were not available for NFHS-1 and NFHS-2. Further, for NFHS-3 and NFHS-4, the % of mothers who received had at least 3 and 4 ante-natal care visits for the last birth, respectively, was considered

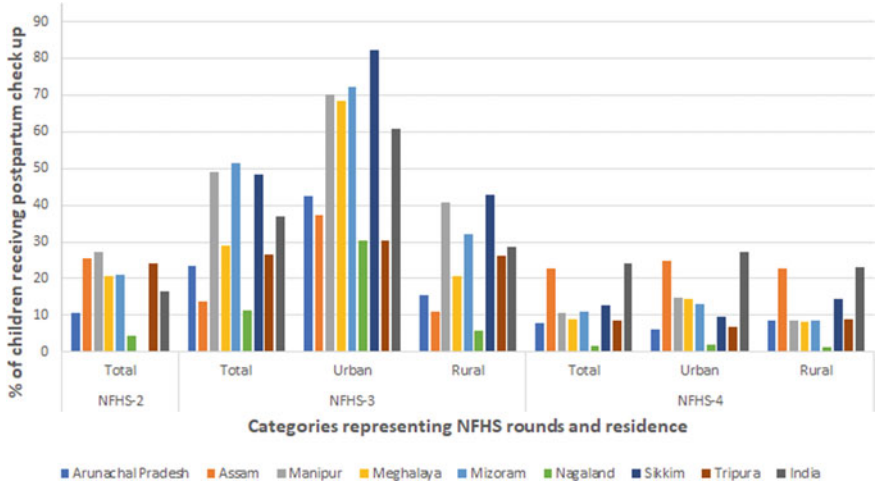

Fig. 13.2 Residence-wise percentage of children who received postpartum checkup within two days/months of birth in India and northeastern states during NFHS-2 to NFHS-4. *Note* For NFHS-1, data on postpartum check for both states and India are not available. For NFHS-2, the % of children who received postpartum checkup within 2 months of delivery was considered, and for NFHS-3 and NFHS-4, the % of children who received postpartum checkup within 2 days of delivery was considered

figure exhibits the percentage of underweight children under 3/4/5 years of age in India and northeastern states during NFHS-1 to NFHS-4:

It is evident from Fig. 13.3 that Mizoram has the lowest % of underweight children during all the four rounds of NFHS, whereas Tripura, Meghalaya and Assam on average have almost the same % of underweight children over the four rounds of NFHS. However, none of the states have % of underweight children higher than that in India during each of the NFHS rounds. Thus, compared to the overall undernutrition scenario in India, the northeastern states are placed in a marginally better position.

13.3.5 Nutritional Status of Adults

The Body Mass Index (BMI) is a measure of the nutrition in adults, which is calculated by dividing the weight in kilograms by the height in squared metre (Nutrition and the prevalence of anaemia). A threshold value of 18.5 kg/m^2 is used to define thinness or acute undernutrition in adults, and a BMI of 25 kg/m^2 or above indicates overweight or obesity. A BMI of 17.0–18.4 kg/m^2 would indicate mild thinness, and a BMI less than 17.0 kg/m^2 refers to moderately/severely thinness. A BMI of over 30.0 kg/m^2 simply means the 'obesity' condition. If a breast-feeding mother in particular is not properly nourished, her children will in turn not receive proper nutrition from her. Also, the extreme conditions of malnourishment or obesity in adults pose several

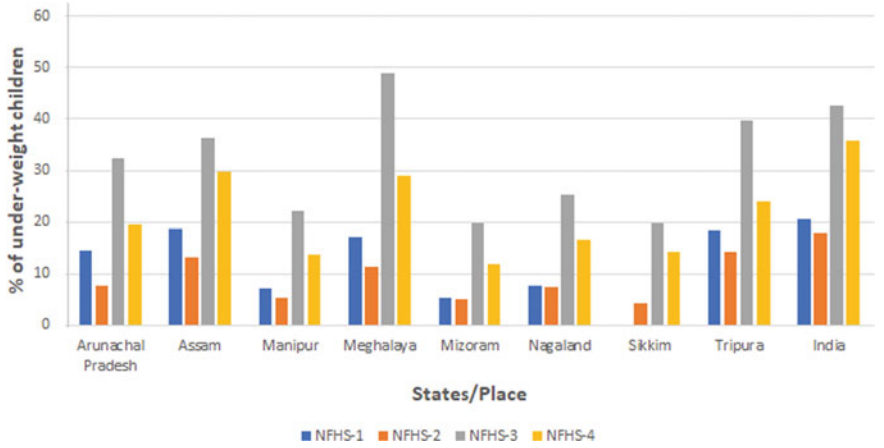

Fig. 13.3 Percentage of underweight children under 3/4/5 years of age in India and its northeastern states during NFHS-1 to NFHS-4. *Note* For NFHS-1, the % of children under 3 years of age was considered. For NFHS-2, the % of children under 4 years of age was considered. For NFHS-3 and NFHS-4, the % of children under 5 years of age was considered

health problems such as heart attack, infertility, difficulty in conception. Table 13.4 shows the percentage of adults (15–49 years of age) whose BMI is below 18.5 kg/m^2.

It can be seen from Table 13.4 that among the northeastern states, Tripura and Assam have the highest (greater than even the all India average) and Sikkim has the lowest percentage of both under-nourished male and female adults on average. It can

Table 13.4 Percentage of adults (15–49 years of age) whose BMI is below 18.5 kg/m^2 in India and its northeastern states during NFHS-2 to NFHS-4

State/place	NFHS-2	NFHS-3		NFHS-4		Average	
	Total	Female	Male	Female	Male	Female	Male
Arunachal Pradesh	10.7	16.4	15.2	8.5	8.3	12.45	11.75
Assam	27.1	36.5	35.6	25.7	20.7	31.1	28.15
Manipur	18.8	14.8	16.3	8.8	11.1	11.8	13.7
Meghalaya	25.8	14.6	14.1	12.1	11.6	13.35	12.85
Mizoram	22.6	14.4	9.2	8.4	7.3	11.4	8.25
Nagaland	18.4	17.4	14.2	12.3	11.5	14.85	12.85
Sikkim	11.2	11.2	12.2	6.4	2.4	8.8	7.3
Tripura	35.2	36.9	41.7	18.9	15.7	27.9	28.7
India	35.8	35.5	34.2	22.9	20.2	29.2	27.2

Note For NFHS-1, the data on % of adults (15–49 years of age) whose BMI is below normal were not available. For NFHS-2, the data on % of only ever married women (15–49 years of age) whose BMI is below normal were considered. For NFHS-3 and NFHS-4, the data on % of both men and women (15–49 years of age) whose BMI is below normal were considered

also be observed that the percentage of under-nourished male and female adults has decreased from NFHS-3 to NFHS-4.

13.3.6 Tobacco and Alcohol Consumption

Tobacco and alcohol usage is associated with many diseases, including lung and heart diseases, diabetes and arthritis (India Report 2017). In addition, women who use tobacco experience difficulty in conception and are at an increased risk of infertility, pregnancy complications, premature births, low birth-weight infants, still births, miscarriages and infant deaths. These two factors are also found fourth and fifth most important contributors to the global burden of diseases (Bonu et al. 2004). Figure 13.4 shows the gender-wise percentage of adults in the age group 15–49 years who consume tobacco.

It is evident from Fig. 13.4 that the % of male and female who consume tobacco is the highest in the state of Mizoram and the least for Sikkim, during both NFHS-3 and NFHS-4. Except for Manipur, tobacco consumption among females is seen to decrease from NFHS-3 to NFHS-4. As far as tobacco consumption among males is concerned, the % of consumers is seen to increase marginally in the states of Manipur, Meghalaya and Nagaland from NFHS-3 to NFHS-4, whereas for the other states as

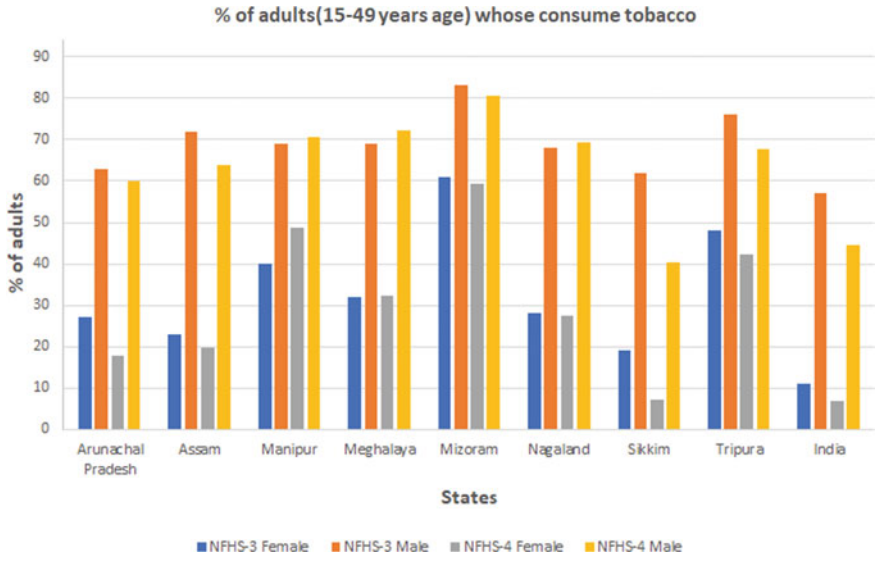

Fig. 13.4 Gender-wise % of adults in the age group 15–49 years who consume tobacco in India and its northeastern states during NFHS-3 and NFHS-4. *Note* For NFHS-1 and NFHS-2, the data on % of adults (15–49 years of age) who consume tobacco were not available

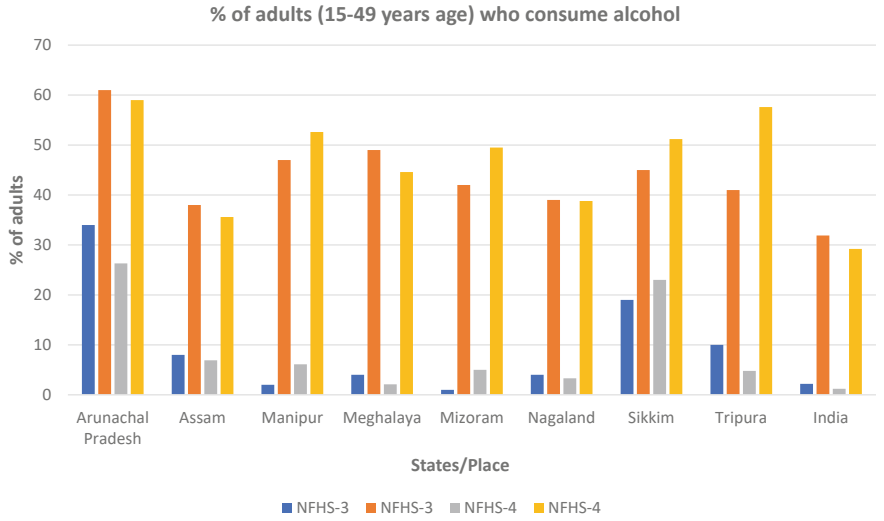

Fig. 13.5 Gender-wise % of adults in the age group 15–49 years of age who consume alcohol in India and its northeastern states during NFHS-3 and NFHS-4. *Note* For NFHS-1 and NFHS-2, the data on % of adults (15–49 years of age) who consume alcohol were not available

well as for India as a whole, it is seen to decrease. Fig. 13.5 displays the gender-wise percentage of adults in the age group 15–49 years who consume alcohol:

It can be observed from Fig. 13.5 that the highest percentage of adults who consume alcohol, both among males and females, hails from the state of Arunachal Pradesh. The all India average percentage of alcohol consumers is observed to be less than that of each of the northeastern states of India, both during NFHS-3 and NFHS-4. The average percentage of alcohol consumers among males is seen to be the least for Assam, and for females, it is the least for Mizoram. Table 13.5 shows the gender-wise percentage change of the percentage of adults in the age group 15–49 years who consume alcohol:

It is clear from Table 13.5 that for Arunachal Pradesh, Assam, Meghalaya and Nagaland, the % of alcohol consumers among both males and females has dropped from NFHS-3 to NFHS-4, whereas for Tripura, the % of consumers among males has dropped, but the % of females has increased by 40%.

13.3.7 Infant Mortality Rate

Infant Mortality Rate (IMR) is defined as the probability of death of children under one year of age per 1000 live births. IMR is widely used as a measure of population health and quality of health care, and a nation is believed to do well in terms of its

Table 13.5 Gender-wise percentage change of the % of adults in the age group 15–49 years who consume alcohol

States/place	% change from NFHS-3 to NFHS-4 for males	% change from NFHS-3 to NFHS-4 for females
Arunachal Pradesh	−22.6471	−3.27869
Assam	−13.75	−6.31579
Manipur	205	11.91489
Meghalaya	−47.5	−8.97959
Mizoram	400	17.85714
Nagaland	−17.5	−0.51282
Sikkim	21.05263	13.77778
Tripura	−52	40.4878
India	−45.4545	−8.46395

health if it has a fairly low IMR. Figure 13.6 shows the Infant Mortality Rate of India and its northeastern states during a period of 10 years, ranging from 2007 to 2016:

Figure 13.6 shows that out of the eight northeastern states of India, Assam is the worst-performing state and Manipur is the best-performing state over the period 2006–2017. The IMR of India as a whole has decreased gradually from 2007 to 2016, and except for Meghalaya and Assam, the IMR of the other northeastern states per year is lesser than that of India (barring 2007 in which Meghalaya had an IMR lesser

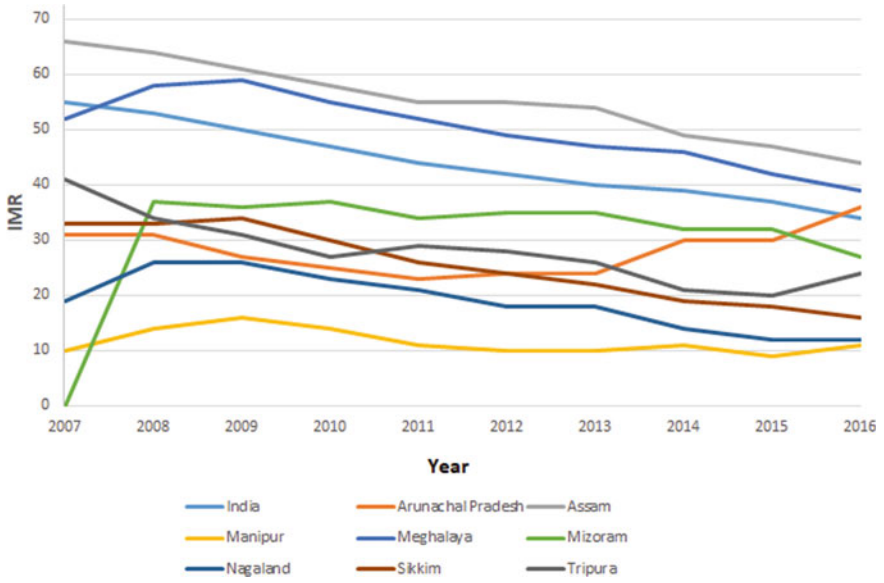

Fig. 13.6 Infant mortality rate of India and its northeastern states during the period 2007–2016

than that of India). It can further be seen that following a steep increase in IMR from 2007 to 2008, the IMR has more or less remained uniform from 2008 till 2016. For Nagaland and Sikkim, the IMR is seen to decrease after an initial increase in the IMR. For Tripura, there has been a decrease in IMR from 2007 to 2016, whereas for Arunachal Pradesh, after a decrease till 2013, the IMR is seen to increase.

13.3.8 Maternal Mortality Ratio

The Maternal Mortality Ratio (MMR) of a given place is defined as the number of maternal deaths occurring during a given time period per 100,000 live births during the same time period in that place (Series Metadata, n.d.). Maternal mortality is widely considered as a general indicator of the overall health of a population, of the status of women in society and of the functioning of the health system. Higher mortality ratio thus indicates lack of proper health facilities for women and also, gender inequalities to some extent. The drawback of this measure is that it does not throw any light on the cause of maternal deaths or interventions required for curbing maternal deaths. Figure 13.7 shows the Maternal Mortality Ratio of India, Assam and other states (including all NER states except Assam) for the period 2004-06 to 2016-18.

Figure 13.7 throws light into the fact that as compared to India and all the other Indian states, the MMR of Assam is the highest each year from 2004-06 to 2016-18, but the MMR is seen to decrease over these years, which is a very positive development. Also, as compared to India, the average of the MMR for all the other

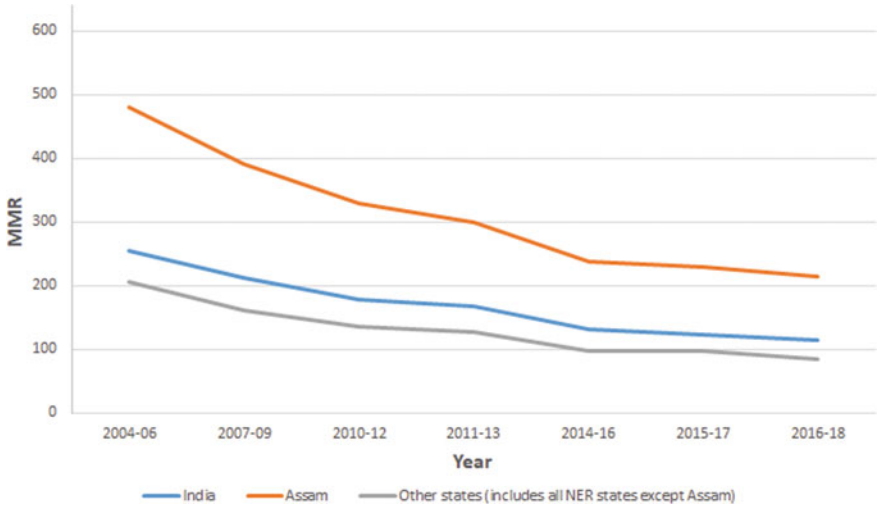

Fig. 13.7 Maternal Mortality Ratio of India, Assam and other states (including all NER states except Assam) for the period 2004–06 to 2016–18

states (except Assam) is seen to be lower for each year, and both have experienced a decreasing trend in MMR.

13.3.9 Under-Five Mortality Rate

Under-five Mortality Rate (U5MR) or Child Mortality Rate is defined as the probability of dying before age 5 years per 1000 newborns. U5MR is a leading indicator of the level of child health and overall development in countries. It reflects the impacts of complex health determinants such as high-risk fertility behaviour, extent of poverty and gender inequality, health infrastructure, effectiveness of delivery services (Awofeso and Rammohan 2012). Figure 13.8 shows the residence-wise Under-five Mortality Rate for India and Assam for the years 2011–2018:

It is evident from Fig. 13.8 that for India, the Under-five Mortality Rate is the highest in the rural areas as compared to only the urban areas in each year from 2011 to 2018 (except for the year 2015 where the U5MR for urban India was more than that of rural India). Also, the U5MR for rural Assam is seen to be higher than that of urban Assam for each year from 2011 to 2018. Furthermore, the U5MR for rural Assam, urban Assam as well as Assam as a whole is higher than that of rural India, urban India and India. The trend in the U5MR is seen to be decreasing over the period 2011–2018 (except for a peak in 2015 for urban India and a trough in 2015 for India).

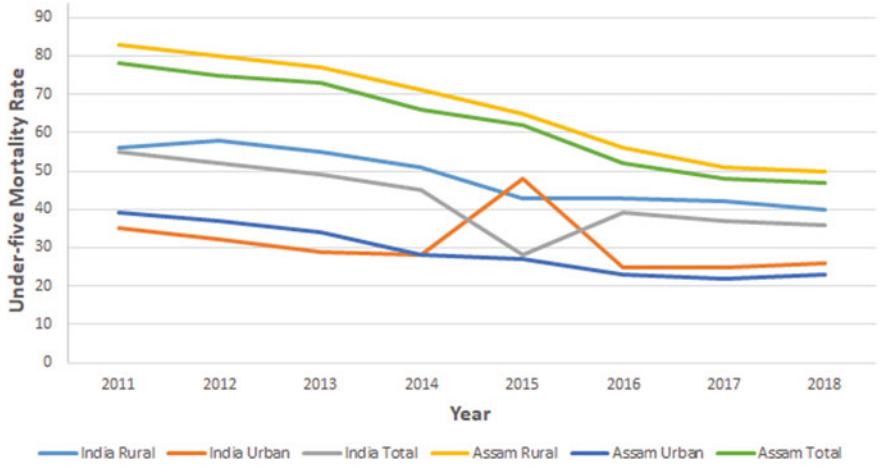

Fig. 13.8 Residence-wise Under-five Mortality Rate for India and Assam for the years 2011–2018

13.3.10 Neo-Natal Mortality Rate

The Neo-natal Mortality Rate (NMR) of a place is defined as the number of neo-natal deaths during a given time period per 1000 live births during that time period in the same place. NMR is a significant indicator of newborn care and reflects the quality of postpartum care and newborn healthcare assistance. It contributes the most to the IMR and U5MR. With about 0.75 million deaths of neonates in India annually, it records the highest NMR among all the countries of the world (Sankar et al. 2016). Figure 13.9 shows the residence-wise Neo-natal Mortality Rate for India and Assam for the years 2011–2018:

It can be seen from Fig. 13.9 that for both India and Assam, the NMR is the highest in the rural area as compared to the urban area for each year from 2011 to 2018. As compared to India, the corresponding NNMR of Assam (both for urban and rural areas) is less for every year during the period 2011–2018. Except for the NMR trend of urban Assam, which shows an increase from 2013 till 2015 and exhibits a nearly constant trend thereafter, all the other trends are seen to be decreasing over the considered time period.

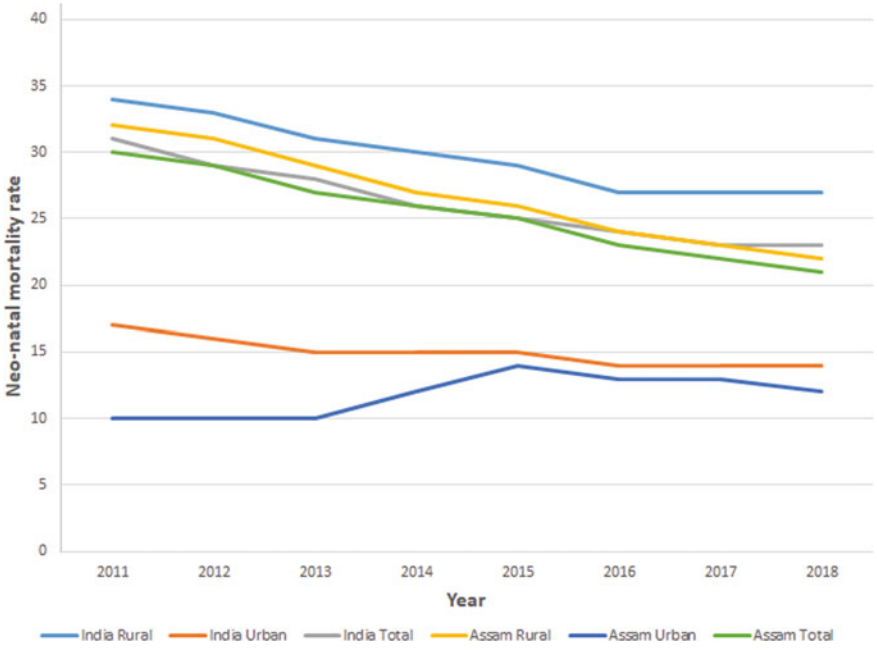

Fig. 13.9 Residence-wise Neo-natal Mortality Rate for India and Assam for the years 2011–2018

13.4 Summary and Conclusions

India is one of those developing countries of the world which has taken a lead in accomplishment of the SDGs by construction of the SDG India Index, an initiative taken up by NITI Aayog, Government of India. The northeastern states of India in particular are seen to underperform in respect of the SDGs, as reflected by their SDG India Index values. A humble attempt has been made through this paper to identify how far behind the northeastern states of India are in achieving the targets set under Goal 3 of the SDGs by the year 2030, with respect to some of the health and well-being indicators. Although it is aimed to reduce the global MMR to 70 per 100,000 live births by 2030, Assam and all other states (including NER states) recorded 215 and 85 maternal deaths per 100,000 live births in 2016–18, which is quite far behind the target. Assam registered 21 neo-natal deaths and 47 under 5 years death per 1000 live births in 2018, which is marginally behind the target of at least 12 neo-natal deaths per 1000 live births and at least 25 under-five age deaths per 1000 newborns globally by 2030. The average IMR of the northeastern states in 2016 is approximately 26 per 1000 live births, and infant deaths contribute the most to the neo-natal and under-five child deaths. A very few percentage women in the age group 15–49 years of the rural areas of the northeastern states of India use the family planning services, which has dropped from NFHS-3 to NFHS-4. The percentage of institutional deliveries in the northeastern states is far from 100%, although it has increased considerably from NFHS-1 to NFHS-4. Thus, it can be said that the northeastern states of India are yet to achieve the target of universal access to reproductive healthcare services. Most of the northeastern states (except for Mizoram and Sikkim) have less than 50% children in the age group 12–23 years receiving full immunization. Also, Arunachal Pradesh, Assam and Nagaland have less than 50% of mothers receiving ante-natal care. Furthermore, except for Manipur and Mizoram, for the remaining six northeastern states of India, less than the Indian average of 25% children are receiving postpartum checkup within two days/months of birth. These show that the Northeast Indian states are lagging far behind the target of achieving universal access to quality healthcare services and access to effective and quality vaccines. As far as the nutritional status of children in the Northeast Indian states is concerned, each of them has lesser percentage of underweight children over the four rounds of NFHS as compared to the national average of 29%. It has also been found that most of the Northeast Indian states have considerably low percentage (<32%) of under-nourished male and female adults. Although the % of adults in the northeastern states who consume tobacco has decreased from NFHS-3 to NFHS-4, the male consumers in these states (except Sikkim) still remain high (>50% and greater than the all India average). Manipur and Mizoram have almost 50% female consumers of tobacco. An overall conclusion can therefore be drawn that the northeastern states of India are far from the achievement of the global target of tobacco control in all countries. The percentage of alcohol consumers in each of the northeastern states of India is found to be less than the all India average, both during NFHS-3 and NFHS-4. There is a drop in the percentage of consumers from NFHS-3

to NFHS-4, which is a step closer towards the target of achievement of prevention and control of alcohol consumption. Sikkim is, thus, seen to be the Northeast Indian state which is performing well in respect of most of the health and well-being indicators, and Nagaland is seen to fare poorly in most of them. The Northeast Indian states are yet to achieve the targets of SDGs. To control the prevention of tobacco and alcohol consumption, awareness programmes informing about their ill effects can be conducted. Government should ensure that people of the northeastern states receive a regular supply of food products at a minimal cost so that even the economically backward sections of the society can have an access to the basic food requirement and the undernutrition of adults prevalent in this part of the country can be tackled. Also, measures should be taken so as to ensure that the health services, maternity-related services in particular reach the mothers and newborns of Northeast Indian region. This will help cope with less pregnant mothers and newborns receiving ante-natal and postpartum checkup, respectively. It is believed that India with the help of sustained efforts and its far-fetched vision will be able to realize the most of the targets of Goal 3 of SDGs by the year 2030.

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Chapter 14
Status of Gender Equality in the Northeastern States: A Pathway Towards Achievement of Sustainable Development Goal

Lovleen Gupta, Shubham Singhania, and Rohit Kumar Shrivastav

Abstract In this study, we tried to evaluate the status of gender equality of the northeastern states of the Indian Subcontinent. Gender equality is a prominent global issue owing to its effects on human rights and development priorities. The United Nations has embraced gender equality as a sustainable development goal because it foots for a peaceful, prosperous, and sustainable world. Since the group of Indian northeastern states holds very distinct and mostly cultural and social backgrounds in comparison with other parts of India, we have tried to analyze the same over several economic and social parameters. The status of gender equality of these states has been evaluated by studying variables like sex ratio, demography, education, political, social, and economic participation of women. Through this study, we tried to validate the conventional belief that women in the target states are likely to have equal status through the pieces of evidence from national and state statistics. We also tried to reason out the plausible causes for their existing status in various dimensions to make some lateral conclusions on the status of the women and the possible steps to be taken in the future context to enhance their role and participation for the achievement of the UN-based SDGs for a better and prosperous development worldwide.

Keywords Gender equality · Socioeconomic · Sustainable development goals · Northeastern states

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14.1 Introduction

'A woman is like a tea bag- you never know how strong she is until she gets in hot water.' Eleanor Roosevelt (Ghosh 2015). Over the last few decades, women empowerment and gender equality have taken a substantial rise not because she can give birth or has a hand behind some man's success, but because of her strength to meet circumstances with bravery, a female is considered the greatest type of living organism. But women are not getting what they deserve, in the family they are dominated by their fathers or brothers and in the workplace, they are disintegrated by getting low pay as compared to men. Gender inequality instead of getting narrower is becoming broader. Inequality is a thought of the human mind, and gender inequality has always been a critical issue of our society. Defining gender inequality, we can understand that it is the stage of conceptual progress when rights, responsibilities, and opportunities are not set upon considering the gender of an individual. Understanding the depth of gender inequality around the world, the first World Conference on Women was held in Mexico City in 1975 (UN 2020). Later, four womens' conferences were held, but the significant turning point came in the 1995 Beijing World Conference on Women where the fourth conference was held. Gender equality was introduced as a global agenda which was further termed as *'gender mainstreaming,'* according to which every nation must work on the extension of gender perceptions to all political and social codes of conduct, all policy making, lobbying, development, enforcement, and supervision. After the implementation of the gender equality agenda, 100+ nations have launched new programs to strengthen the status of women.

On the other hand, the United Nations Development Program established a separate fund as the United Nations Development Fund for Women (UNIFEM) in the year 1984 with a motive to provide access to women in terms of education, health, and employment. Following the fourth conference agenda, UNDP came up with more indicators in 1995: gender empowerment measure (GEM) and the gender-related development index (GDI). GEM focuses on women's political participation, economic participation, and control over economic wealth, while GDI measures the inequalities faced by women in fulfilling those that were very vital to human progress as a whole (Mahanta and Nayak 2013).

The United Nation Development Program (UNDP) on September 25, 2015, further established 17 goals plus 169 targets to achieve Sustainable Development Goals (SDG) which are to be accomplished over the globe till 2030 (Nandan and Mallick 2020). The fifth goal was related to gender equality which states that as a basic human right, every woman and girl should be given equal opportunity in every aspect as it is crucial for a sustainable future and to accomplish sexual orientation uniformity among women of all age by 2030 as to wipe out poverty and inequality and establish manageable improvement goals. Over both its programs and activism, UN woman works to inspire other women and children. Every part of the globe will make strides toward sustainable development by 2030 with greater action on gender equality, leaving no one behind. Many scholars state if a nation empowers its women and girls, it will help the economy to boost faster and magnificently. To withstand the

Table 14.1 India's ranking as per Sustainable Development Goals index

Years	Rank
2016	110
2017	116
2018	177
2019	115
2020	117

Source NITI Aayog, SDGs, 2021

UNDP, many constitutions were framed in India to provide each resident status of equality and establish a strategy for providing equivalent rights to men and women for living as well as equivalent compensation to both for the same work. Also, the performance of India in terms of the achievement of the Sustainable Development Goals is not very promising as represented in Table 14.1.

According to the 2019 United Nations Development Report, India stands at:

- Literacy rate among women is 65.46% as compared to 82.14% of men.
- Enrollment of girls in primary education is 100%, but 74.6% of women are not allowed or get access to higher education.
- Women hold only 11% of seats in Lok Sabha but 46% in Panchayati Raj Institutions.
- Out of the 48.5% population of women, only 27.4% are in the workforce.
- Child sex ratio is 919 for 1000 boys.

Despite this constitution, discrimination faced by a woman is still at its peak and effort done by the government is going in vain. Sexual discrimination starts even before birth as female feticide, which has brought about lower sex proportion in numerous conditions of India. Everywhere around the corner, women face inequality whether it is the workplace, in own family, or in the marketplace. In the work field, women face unequal pay as compared to men, and even family shows prejudice in terms of education or preference for sons in all dimensions (Agarwal 1994; Amartya 1990; Elson 1993; Murthi et al. 1995).

With the understanding of the concept of inequality and social rights, the thought of women empowerment and gender mainstreaming has steadily started increasing and has turned up as a global revolution in the deep-rooted patriarchal society (Mahanta and Nayak 2013). Social scientists, welfare economists, and many other subject experts have been developing models and theories both in quantitative and qualitative ways to estimate the levels of inequality in the preview of aspects like social contribution, economic contribution, literacy levels, social representation, etc. Measures of inequality are dependent upon the geography of the study, culture and background, demographics, etc. Therefore, different epistemological studies give us new horizons to have a better understanding and a new layer to this social problem.

As per the socialization theory, women are reliant financially on men in their life, be it their fathers or husbands. Also, the power of decision-making rests majorly in the hands of men for both the women and their children. But for the past few years,

women have battled to get equivalent with men in all spheres of life whether it is schooling, well-being, business, yet there exists a disparity in these areas (Sharma 2015). Gender disparity has arisen as one of the staggering obstacles in accomplishing the improvement targets.

14.2 Gender Inequality at International Level

Though many efforts are made globally to reduce gender inequality, it is not completely wiped out. Reports from 2005 to 2011 of the World Economic Forum (WEF) state that countries like Pakistan, Egypt, India, and Turkey hold the lowest positions/ranks in gender inequality, while countries like Denmark, Iceland, Sweden, and Norway top the list. These countries were driven by a relatively political democracy, with an excellent record of government openness and efficiency, and a robust safety net that provided protections for marginalized groups of people. In 2010, a critical snapshot of the output of 134 countries was given in which on average, results were narrowed, i.e., 96% in health, 93% in education, 60% in economic activity, and 17% in political empowerment. Countries which were successful in closing the gender gap were Iceland, Finland, and Norway (i.e., 80% of the gap), while the lowest country on the list was Yemen which was able to reduce the 46% of the gap. Even after one decade (i.e., 2020), this gap does not improve, Nordic countries dominate gender equality, and Iceland stands as the world's most gender-equal country, after Norway, Finland, and Sweden. Therefore, to accelerate gender parity, the process needs to be changed. For girls & boys and men & women, better and sufficient education would be needed to bring about attitudinal changes. Many scholars cited that in order to get parity, government needs to organize resources, direct leadership efforts, and contribute to priorities in the public and private sectors till the next decade instead of the next centuries (Padhi and Khan 2017). The business itself cannot contract the gender gap, though it must take measures to reach the virtuous loop of markets and cultures that equity produces.

14.3 Area of the Study

Social issues always take a new form when we look at them in the context of developing nations especially the areas that have distinct cultures and ethics, i.e., the Northeastern Part of India. Northeast India refers to the easternmost portion of India, comprising eight separate states, such as Assam, Tripura, Meghalaya, Nagaland, Mizoram, Sikkim, Arunachal Pradesh, and Manipur. Due to its international borders with Bangladesh, Bhutan, China, Myanmar, and Nepal, the NES regions are of strategic significance in the geopolitical situation. As they are dependent on each other, they are recognized as the land of seven sister states (excluding Sikkim). All these states are linked to India through the Siliguri Corridor. It is thus the only

way to meet the seven sister and only brother states. All these states have a diverse significant culture, traditions, beliefs, and historical identities quite different from the cultures of other parts of India. This fact is becoming a basis for the notion that women in North East India are enjoying much higher status compared to other parts of India. The general assumption is that women and men are treated as equal partners within various spheres of life. This conviction is rooted in the fact that unlike the other parts of India, the entire northeastern region is almost liberated from social evils and traditions such as dowry, sati pratha, feticide, and female infanticide. But we cannot generalize this whole fact easily, as we know the northeastern region consists of eight diverse states and the need of the hour is to focus on these states independently. However, various gender analyses show a completely different image. But there are still various conventions that prohibit women from taking part professionally and rituals and practices that women must blindly observe. A few of the social and economic issues faced by these women are illiteracy, drugs, poor health, education, household health, crime, disparity between male and female pay salaries, etc.

In the recent past, the people of northeast India have been faced with problems such as crime, violent repression, tribal wars, terrorism, law, and order. Sharma (2015) concluded in his paper that in certain northeastern states, the enrollment rate as well as nutritional rate among girls is lower compared to boys, and gender disparities in literacy status are also found to be striking. Singh (2018) stated that Mizoram has the highest literacy rate of 91.3% and Arunachal Pradesh has the lowest literacy rate of 65.4% in the last two censuses. States such as Nagaland, Mizoram, Arunachal Pradesh, Meghalaya, and Manipur perform better than the average of Indian equivalents in the Gender Index Fund, but states such as Tripura, Assam, and Sikkim in the same analysis stayed below the national average. It is because these areas are highly affected by riots, ethnic fights, Maoist insurgencies, etc. Due to undefined roles and responsibilities, women are the worst affected. Therefore, there seems to be a myth that the status of women is better in the northeast states as compared to the other states of India. So, in this study we scrutinize the position of gender equality in northeastern states on various economic and social parameters and measure the extent of achievement of sustainable development goal of gender equality.

14.4 Literature Review

Das (2013) examined the status of northeast women with the overall states of India. The study reveals that in the northeast states, the status of women was better only in some indicators as compared to the rest of the states in India. They also observed that in the northeastern states, women have a really low amount of independence of travel and a low degree of confidence over themselves. To study northeastern states, Padhi and Khan (2017) used poverty and inequality indicators. Anand and Sen (2007) concentrated on the use of metrics that are responsive to social equity and how to use

these indicators for the development of equality among the world. Wallace and March (1991) and Moser (1993) emphasize on the interconnection among gender equality, gender policy development, and the integration of gender planning and activities.

In her research, Nussbaum (1999) clarified that the world economy must be alert to gender inequality as a justice problem and, as a major concern, also concentrate on women's problems. Even Patel (1998) focused on gender equality and human rights, and with the opinion to bridge this gap, various interventions such as improving women economic capacity, providing awareness by using social media platform, and strengthening the policy related to violence against women were focused upon. Mahanta and Nayak (2013) attempted to explain the problem of women's access to the lack of fundamental rights including the right to safety, education and jobs, civil rights, and the right to work, in addition to problems such as domestic violence, while taking into account the specific sociocultural condition of the northeast. BUONGPUI (2013) concluded that even when several contributions are done by women economically still, they are lacking in an equitable position, though women are getting access to education still they are not allowed to be a decision-maker in social, economic, and political institutions. He also stated that most tribal societies treat women as 'second sex,' and these statements overlap with gender equality and empowerment of women. Himmelweit (2002) stated that both paid and unpaid labor, along with the interdependence of the sectors of the economy, must be taken into account for gender impact research to be successful. Nandan and Mallick (2020) consider gender equality as a path to achieve regional growth and income equality of 16 major Indian states over the period 1991–2017. It was concluded that the difference in gender disparity hinders the growth of the economy and widens the income gap.

The World Economic Forum's gender disparity studies examined the role of women in a diverse variety of countries. The Gender Gap Report was first established in 2005 with only 58 countries as a part of it, but now it has grown to 187 countries, and India secured 112th position as per the Global Gender Gap Index (World Economic Forum 2019). In Table 14.2, it is well represented that India's position in terms of gender quality has been deteriorating since last 4–5 years which is a cause of concern. Maintaining gender representations has been a huge problem for today's world. Gender equity and women's liberation have become means of reaching education for all children, a reduced death rate for children under five, improving women's mortality and a lower risk of HIV/AIDS (Mahanta and Nayak 2013). In several countries in the world, including India, gender equality has been part of the growth agenda. The nation would be strong and balanced where both the sex had equitable opportunities and wealth, had equal rights, and the capacity to expand skills and calibers. The National Human Development Report (NHDR) was used by the government in generating reports related to human growth, and every state actively took the initiative to build this report (Nayak 2011). According to the Government of Assam, UNDP, (2014) approximately one-third (30%) of the future, overall human growth is expected to be wasted due to the prevailing gaps that underlie successes in the fields of education, health, and wages. In the revenue factor, the loss due to inequality is the largest (about 44%), followed by health (32%) and then education (9%). The report also highlights that it is important to consider and

Table 14.2 India's ranking as per global gender gap index

Years	Rank
2010–11	112
2011–12	113
2012–13	105
2013–14	101
2014–15	114
2015–18	108
2016–17	87
2017–18	108
2018–19	108
2019–20	112

Source World Economic Forum, 2021

handle multiple diversities in the state for economic progress to convert into greater human development outcomes. Ghosh (2015) concluded in his paper that empowering women in the country is the way to gender equality by making schooling compulsory for all women, ensuring equal work opportunities for them, helping to set up their industries, supporting women in national politics, etc. Therefore, the above literature review demonstrates that numerous studies have been conducted at the global and national level on the topic of gender discrimination, but so far, no significant effort is made in respect of northeastern states. In this respect, the present paper is a constructive effort to fill the conceptual difference.

14.5 Theoretical Framework

To find out the reason for widening gender disparity, the authors tried to link various theories to identify the gap which weakens the economy of the world. Though the gender gap is not restricted to these theories, and many more can be formulated to identify the gap, the study focuses on some of the crucial theories highlighted in the extant literature.

14.6 Socialization Theory

The mechanism by which women and men are told about norms and behavior as associated with their sex is known as gender socialization theory. Theories of socialization describe the development of individuals in respect of the social environment as it demonstrates that individuals learn the vocabulary, information, norms, beliefs, and traditions that are required to engage in and incorporate into a society or culture

(Höppner, 2017; Hurrelmann and Bauer 2015). As a result, socialization affects the socio-structural arrangement of common life, while at the same time helps in achieving social and political stability (White 2017; Höppner, 2017). In the nascent stage of development, gender roles and gender norms are riddled with symbols and vocabulary (Walker 1999). For instance, girls are supposed to be clean and kind while boys to be messy and noisy. Gender stereotypes are becoming more evident in the style of dresses and preference for recreational activities as children grow older. Therefore, gender stereotypes are the consequences of gender socialization.

14.7 Double-Burden Syndrome

The workloads of women who intend to earn money but are overburdened with large amounts of unpaid domestic labor are termed as double money syndrome, and it is also referred as a double day or second shift. The responsibility of cumulative obligations has often been regarded as a double burden. Women's more typical domestic duties are stated to require regular care, sometimes at a set period (such as cooking), whereas men's responsibilities tend to be lower and more versatile (Dean 1992; Väänänen et al. 2004). Women substantially spend more number of hours than men on household chores and caring work which include taking care of an ill person or looking after the child. This finding is an outcome of gender disparity which still prevails in many parts of the world. According to (Brara and Brara 2017; Ghosh 2015), women of rural area in northeast states suffer from the same state as they first fulfill all the work of home and then go to the field for vegetation, or to do basket weaving, and on the contrast, men's work is limited to fieldwork only.

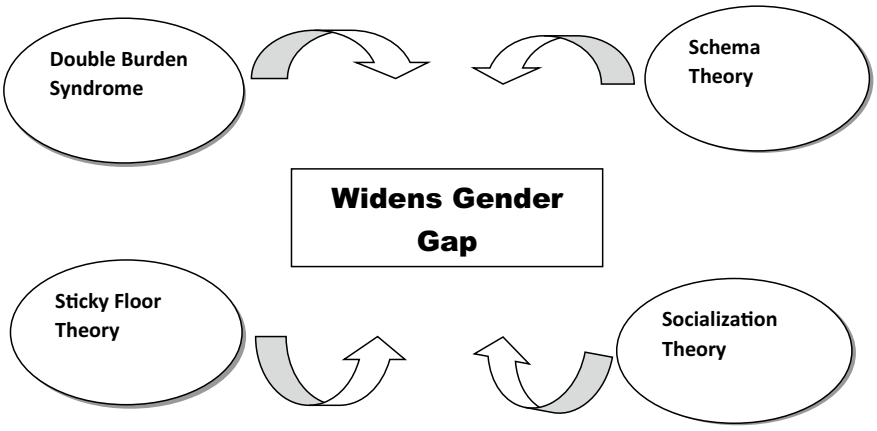
14.8 Sticky Floor Theory

Sticky floor theory is used to describe a discriminatory employment pattern that restrains certain groups of people at the bottom of the job. Floro (1995) stated that as women frequently earn less than the man, there is a belief that women should manage up with her paid job as well as the household chores. Because of this, women usually indulge in part-time jobs or employment in the informal sector to reconcile paid work with domestic work as they have many responsibilities, and this leads to gender inequality where women are contributing less to the economy. According to Johnson et al. (2014), women have to face considerable difficulties even in management roles as a result of their expertise being underestimated and thus their prospects being limited. Stereotyping behaviors were implied in the office which means females are evaluated not on their skills and willingness to perform a job, but on the assumed physicality and psychological functioning of their gender, culminating in disqualifying them from becoming competitive in managerial roles (Pichler et al. 2008).

14.9 Schema Theory

Schema theory is a study of cognitive science dealing with how brain information is organized. The scheme is an integrated unit of information for any topic or case. It is derived from previous knowledge and is used to direct present perception or intervention (Pankin 2013). In terms of psychology, 'schema' is described as a mental framework centering on a specific theme that helps us to organize social information. It will guide our actions and the processing of information relevant in those contexts. According to Lemme (2006), knowledge regarding the self is increasingly flowing into the system as a result of experience and social contact, and the self-schema theory will be continuously used during life. Sharma (2015) believes that women have been controlled by a patriarchal system of inheritance that led to women's social and economic dependency on men, and this further leads to the reduction of their status as compared to male members. While women have struggled to be equal to men in all facets of life (education, health, work, etc.) over the last few decades, disparity persists in these sectors.

14.10 Conceptual and Theoretical Framework Justifying Reasons for Gender Inequality



Source Authors own Conceptualization.

14.11 Data and Methodology

The whole research is primarily based on secondary data collection. The data has significantly helped to focus on the status of people residing in northeast states. Therefore, to study the gender gap of northeastern states, four main fundamentals areas are studied that is education, health, political participation, and economic contribution that are considered. The study of the data was further carried out based on individual expertise.

14.12 Gender Inequality in Employment

The word "Employment" refers to economic and development growth and is characterized as the proportion of people engaged in constructive activities in the economy. To analyze the gender inequalities, female's work participation rate is used as an indicator and presented in the table below. It was concluded that the difference was favorable for all northeastern states except Manipur; however, the gender gap in the rate of participation in work was comparatively higher in urban areas than those of rural areas. In urban areas, the situation in Assam and Tripura was adverse but still, gender disparity was above the national average. The rate at which rural women participated in work were relatively higher than that of women in urban areas. Except for Sikkim, Tripura, and Assam, the gender gap in rural areas was lower than the national average for all other northeastern states (Fig. 14.1).

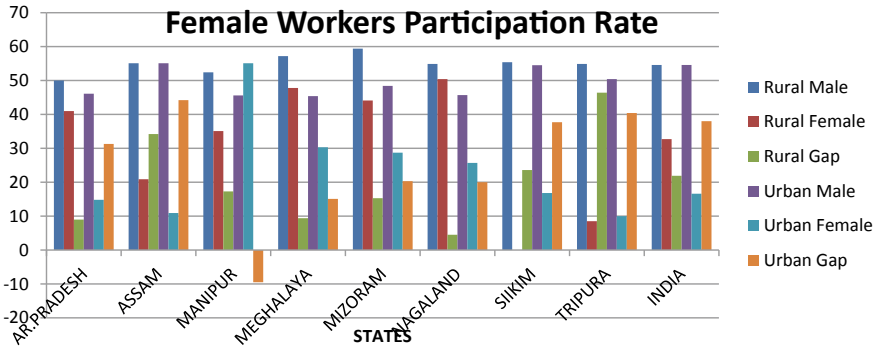


Fig. 14.1 Female workers participation rate in northeastern states. *Source* www.indiastat.com

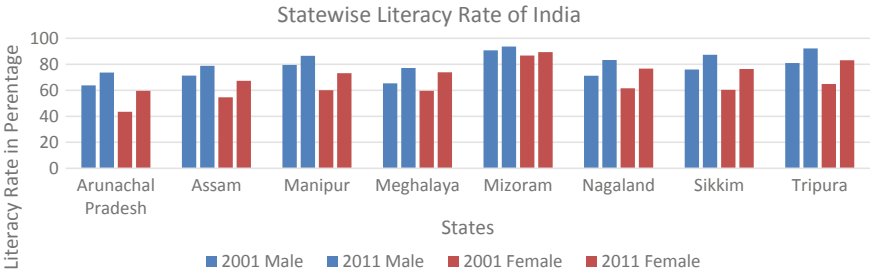


Fig. 14.2 Literacy rate in northeastern states 2001–2011. *Source* Census of India (2001, 2011)

14.13 Gender Inequality in Education

One of the essential aspects that decides the role of women is education. Talking about the literacy rate and the rate of registration at different stages of education, it is important to assess if there is inequality and the degree of discrimination that induces in a community over a given period. In the following paragraphs, the gender disparity in education in northeast India was examined using those metrics.

14.14 Literacy Ratio

The term literacy means the ability to read and write. The literacy rate among women is lower than men because of the conventional thinking that women are made to take care of the home only and men must go out and work. This lessens their role to add value to the economic activities. In 2001 and 2011, the gender difference in literacy rates was 21% and 16.68% which was smaller than the national literacy rates. For Mizoram, Meghalaya, and Nagaland, it was slightly smaller. The highest gender difference in literacy rates was in Arunachal Pradesh. However, there has been a substantial increase in the literacy rate in the last decade. Besides, for all states in the country except Assam, the gender disparity in literacy has been narrowed down (Fig. 14.2).

14.15 Enrollment Gap

Another factor in which gender differences are shown is the participation ratio at various stages of teaching. From the below table, it was stated that there is a gender difference in the registration distribution in all states for Classes 1–5. For Assam, the difference was the largest and for Sikkim, the lowest. Though, it was higher than the national average. The gender disparity was lowered in 2009–10. Though, the gender

difference in other states is larger than the national average but excluding Assam and Meghalaya. But in Classes 6–7, the enrollment rate for girls surpassed that of boys in some states. The enrollment of girls in senior education school was higher than those of boys in Meghalaya, Nagaland, and Sikkim, and the gender difference for other northeastern states except from 1999 to 2001 Assam was reduced as compared to the national average. Nonetheless, the gender gap was lowered in 2009–10. Assam and Tripura have been able to minimize the gender difference to an essential degree (Figs. 14.3 and 14.4).

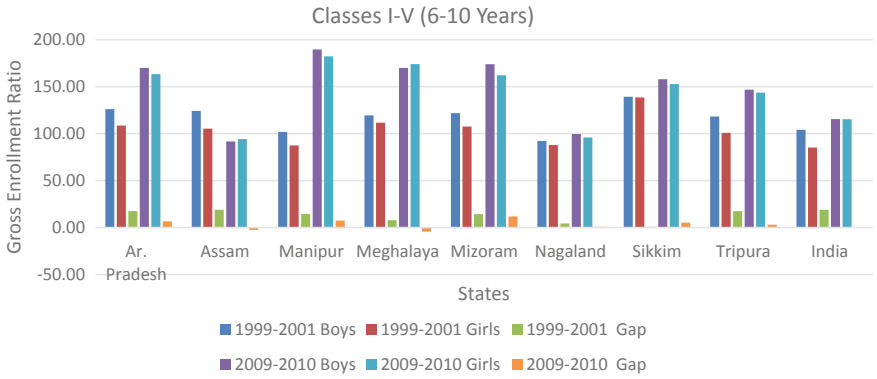


Fig. 14.3 Gender inequality in enrollment ratio of students in schools (Classes I–V). *Sources* www.indiastat.com

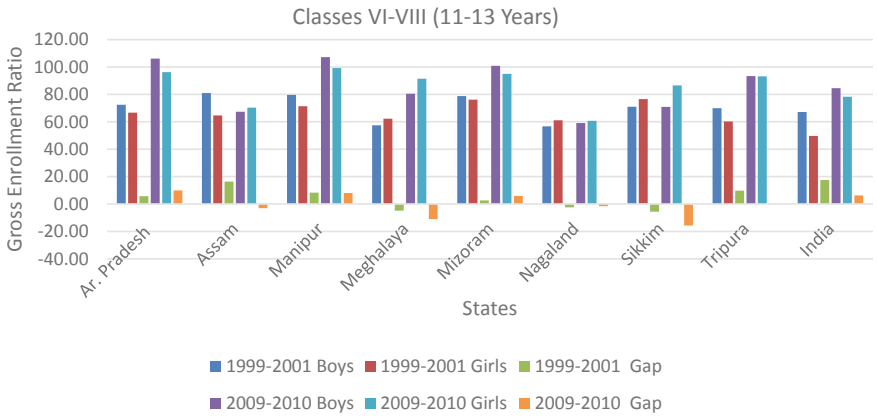


Fig. 14.4 Gender inequality in enrollment ratio of students in schools (Classes VI–VIII). *Sources* www.indiastat.com

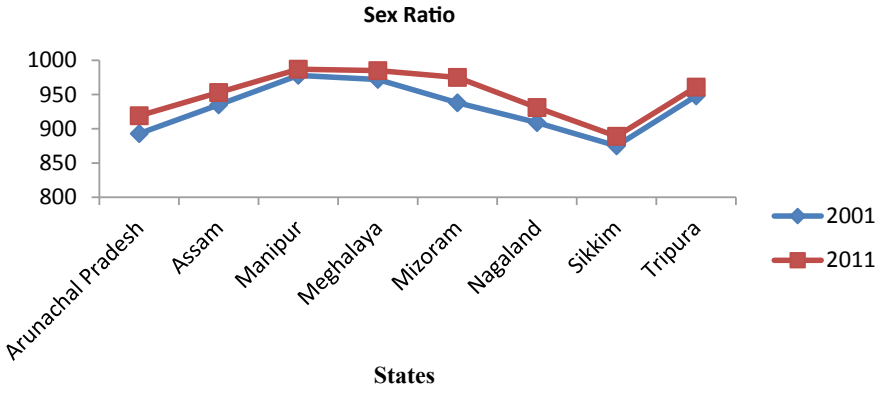


Fig. 14.5 Sex ratio in northeastern states 2001–2011. *Source* Census of India (2001, 2011)

14.16 Gender Inequality in Health

Health is one of the expansive indicators in which gender discrimination is seen everywhere in the world. Even when the women in this era are getting aware and intelligent, but the one thing they are ignorant about is their health. They are very much immersed in the process of taking care of their children that they forget about the diet intake which makes them physically weak and lack of their participation in activities. An improved sex proportion consistently shows a superior status of women in the public. Indicators like sex proportion, infant mortality rate, and life expectancy were used to examine the inequality in northeastern states.

14.17 Sex Ratio

It is defined as the number of women per 1000 men. A decrease in the proportion of women in the population of numerous nations on the planet has been seen throughout the long term. Except for Nagaland, Sikkim, and Arunachal Pradesh, in northeastern states sex ratio was higher in 2001 and 2011. States like Mizoram, Arunachal Pradesh, and Nagaland improvise within a decade. Still, in all states of the country, the sex ratio was not favorable for women (Fig. 14.5).

14.18 Life Expectancy at Birth

The term 'life expectancy' refers to the number of years a person can expect to live. Life expectancy of women is generally higher to that of men because of the absence of habits like smoking and drinking. This affects greatly the economic activities

performed by women. It is also the human growth index metrics, too. To depict the status, we now must rely on multiple studies to display a sketchy understanding as the table related to life expectancy for northeast states is unavailable. For women, life expectancy at birth was higher than for men, both at the national level and in various countries in the region. According to NITI Aayog in 2010, life expectancy in Assam is 65.5 years for females and for men is 62.7 years. However, states like Manipur (61.5 years) and Arunachal Pradesh (54.51 years) had a lower life expectancy of women at birth as compared to the national Fig. (63.3 years).

14.19 Infant Mortality Rate

Infant mortality is the death of an infant before his or her first birthday. It is mainly caused among illiterate women who do not know about the proper care that is to be given to their born. And later, it leads to their emotional disturbance. So, it is vital to be educated for women to reduce the infant mortality rate. But in the case of northeast states, the mortality rate is favorable. It was found that the difference between boys and girls is narrow except Assam which is 58:64. However, the rates of infant mortality between males and females were similar in Meghalaya depicting that no gender difference exists in this state (Table 14.3).

Table 14.3 Infant mortality rate in 2009

States	Infant mortality rate in 2009								
	Total			Rural			Urban		
	M	F	GAP	M	F	GAP	M	F	GAP
Mizoram	33	38	−5	–	–	–	–	–	–
Meghalaya	59	59	0	–	–	–	–	–	–
Mizoram	33	38	−5	–	–	–	–	–	–
Tripura	33	30	2	–	–	–	–	–	–
Manipur	14	18	−4	–	–	–	–	–	–
Arunachal Pradesh	31	34	−3	–	–	–	–	–	–
Nagaland	23	28	−5	–	–	–	–	–	–
Assam	58	64	−6	61	67	− 6	35	38	− 3
India	49	52	−3	54	56	− 2	32	35	− 3

Sources www.indiastat.com

14.20 Gender Inequality in Political Participation

The participation of citizens is the essence of stable democracy as it not only equals the level of participation but also incorporates the level of support from different parts of the group. Democracy requires fair representation from both the male and female population to be functional to be people's genuine voice. Equality of gender in politics is one of the basic facets that require equal participation of people in today's world. The status of women in eight states of northeast has a significant role in social and domestic works; however, their political participation is quite negligible. In some states of India, a system of 'women proxy' is used which is a short term used to depict women are elected in Panchayat bodies merely for 'proxies' or to serve as puppets in the hands of their family members, society, and Panchayat members, as their only role is to give their rights to the male dominant (Mahanta and Nayak 2013). Ahmed (2020) analyzed in his paper that female participation in the political sphere is just equal to zero. In states like Manipur, Mizoram, Nagaland, and Sikkim, no woman is elected as a Member of Parliament to Rajya Sabha. Even the participation of women in the state legislature is restricted to 5–6. He suggested in his paper to empower the women to actively take part in political activities, and the government must pass the pending Constitution Bill, 2008, which is also referred as the women's reservation bill which provided 33% reservation for women in the Lok Sabha and (SLA) State Legislative Assemblies.

14.21 Conclusions

In the above analysis, four indicators, namely education, health, political participation, and employment, are used to analyze the level of gender inequality in northeastern states in accordance with the Sustainable Development Goals. Gender equality is not just a universal human right, but an integral pillar to make society peaceful, stable, and healthy. To overcome gender disparity, even the United Nations formed 17 goals. Gender equality is one of the 17 goals which aims to end all types of prejudice against all women across the world in the form of domestic violence, prohibition against early child marriage, and ensure women's effective involvement and equal leadership opportunities at various dimensions of decision-making in terms of political, economic, and public life. To end gender disparity by 2030, immediate action is required to eliminate the root cause of discrimination that continues to curtail women's rights. Customizing laws related to equality among citizens is required to gender equality.

It is clear from the above study that the status of women in the NER states in certain metrics is greater than that of women in the rest of India. Though results are puzzling, contradictory exist. In field such as literacy rate, sex ratio, enrollment gap, political participation, and infant mortality rate, the gender disparity has been estimated. But we cannot deny the fact that the figures of northeast India are always

better than the national figure. But women empowerment and economic position were not up to the mark.

To promote the mechanism of achieving gender equality, a revolutionary shift in sociocultural ideals and behavioral trends is required. The government plays its role, and it is also the responsibility of people to consider and promote women's equal participation in the development of the northeastern states. There have also been several large women's movements in the northeast states that have contributed to greater alignment with mainland India and have also encouraged nationalism and democratic confidence along with mediation and political negotiation to put stability and prosperity in the region. And this postmodern era has taught women to come out and earn money. To conclude with, northeast women can be visible individually which will make them recognizable distinctly from the rest of India, or as soon as women believe like they have the potential to manage society at the same time as men, it will not remain a distant dream to attain gender equality.

14.22 Limitations and Future Scope

Like any other paper, this paper also includes certain limitations. One of the limitations is that the study focuses on the conceptual framework only rather than on empirical analysis which means the paper does not do proper justice to the topic.

To provide the right knowledge for successful preparation and execution of government policy, a thorough review of women's status is important, including at the district level. In this regard, future comparative studies focus on the empirical analysis for each social and economic indicator in respect of northeast states. We can also do analysis on each state independently to have a proper status to identify every root for the gender disparity.

14.23 Policy Implications

In today's era country like India where women are worshiped as goddesses, but we do not even value her as an individual. The word equality should not be misinterpreted as women should be equal to men because the very moment, we say this we are telling everyone that they are not equal. Governments in accordance with goals established by UNDP must focus on gender equality by providing easy access to everyone and providing awareness among the people related to equality. The government can also establish a rule in which at least there be one women's organization in each district to encourage leadership among women. Therefore, to promote gender growth and gender equality within its boundaries, every state government must indulge to overcome this hurdle. In other words, the state government in conjunction with the

central government frame policies to eradicate gender inequalities and enable women to advance social stability, economic development, and prosperity in India, remedial policy steps should be adopted urgently at each district level.

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Chapter 15
Change in Dominant and Deficient Functions of Rural Female Workers in North-Eastern Region of India: An Analysis

Ashu Rani and K. V. Chamar

Abstract The present research work is an attempt to analyse the change in dominant and deficient functions of rural female workers in north-eastern region of India. The village level census data of 2001 and 2011 has been used to find out the change in dominant and deficient at districts level. The districts boundary of 2001 has been re-arranged according to the districts boundary of 2011. The number of districts in 2001 was 72 which increased to 82 in 2011. The rural female workforce has been increased from to 26.11% (40.95 lakhs) to 27.45% (49.64 lakhs) during the period. Agriculture labourers and other workers have been increased by 3.92–7.23%, while cultivators and workers engaged in household industries have been decreased by 10.95% and 0.20%, respectively. The 'z score' technique has been used to find out dominant and deficient working force in a district. Further, dominant and deficient function of 2001 and 2011 in all the 82 districts has been classified into 18 sub-categories. High positive change is recorded in deficient functions in four districts in the category of agriculture labourers, while high negative change is observed in 11 districts in the category of normal functions. However, about two-fifth districts of the study area have no change in any category of functions during 2001 to 2011.

Keywords Occupational structure · Dominant and deficient functions · Rural female workforce

15.1 Introduction

Occupation is an economic activity, which is largely related to agriculture, industry and services. A distinction is often been made between total population and manpower, while total population refers to the entire populace inhabiting the area,

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and the manpower consists of only those persons who are engaged in economically gainful activities.

Chandna (2016) highlighted that, "the study of economic composition of population remains incomplete without its reference to the occupational structure of a population. The occupational structure of a society is the product of a number of intimately related factors. An analysis of a population's economic composition unfolds the diverse economic, demographic and cultural attributes of an area, which form the basis for region's social and economic development".

The definition of worker in India has been changing from census to census. Census of India (2011) defined that "any person whose main activity is envolved in any economic activities with or without remuneration of earnings by his physical or mental activities is classified as worker. It even includes temporary help or unsalaried work on farm, family business or in any other financial activity". The workers have been grouped into four broad categories that are cultivators, agricultural labourers, workers engaged in household industries and other workers.

The study of working force is not a new field, but each and every scholar has a different way of study. Working force as a broad theme has been studied by various scholars, such as educationists, economists, demographers and geographers. Geographers and other scholars have carried out many studies about workforce from time to time, like Krishan and Chandna (1974), Siddiqui (1975), Kaur and Chandna (1983), Kailash (1990), Siddiqui and Shafiqullah (2001), Bhattacharya (2002), Chamar (2006), Sharma (2012), Rai and Babita (2012), Thakur (2012), Pegu (2015), Bala and Chamar (2017) and Rani and Chamar (2018).

With a significant proportion of female population still residing in rural areas, agriculture labourers and other workers have been increased from nearly four per cent to slightly more than seven per cent during the period. The present study therefore endeavours to analyse the changing pattern of rural female workers in north-eastern region of India.

15.2 Objective of the Study

The main objective of the present study is to analyse the changing pattern of dominant and deficient functions of rural female workers in north-eastern region of India.

15.3 Study Area

North-eastern region of India commonly known as 'land of seven sisters' (excluding Sikkim) is situated at the north-eastern Himalayan sub-region of India. It accounts for 7.8% of the total geographical area of the country. The region is bounded by Bhutan and Tibetan part of China in the north, Myanmar in east and Bangladesh in south-west, while state West Bengal of India in the west. The study area consists of seven states

comprising 82 districts, 598 subdivisions and 44,538 villages in 2011. The district boundaries along with census location code numbers have been represented in the map (Fig. 15.1). The total rural population of north-eastern region is 36.91 million (81.73%) as per 2011 census, out of which male constitutes 18.83 million (51.01%) and female 18.08 million (48.99%). As per census 2011, the region has about one-third female population of scheduled caste and scheduled tribe in proportion to rural female population. The rural female literacy rate is recorded 65.03%. The average rural sex ratio is 985 females per 1000 males.

15.4 Data Source and Research Methodology

The district-wise data of 2001 and 2011 has been used. The number of districts increased from 72 to 82 during the period. The number of villages has also increased from 41,798 in 2001 to 44,538 in 2011. So the district boundaries of 2001 have been re-arranged according to the district boundaries of 2011. Further all the villages have also been re-arranged on the basis of district boundary of 2011. Initially, the district-wise rural female workers have been calculated in per cent in proportion to total rural female population. After that the percentage of four broad categories of rural female workers, viz. (i) cultivators, (ii) agriculture labourers, (iii) workers in household industries and (iv) other workers, have been calculated in proportion to total rural female workers in a district.

Further to find out a parameter of balance working force as compared to dominant and deficient working force of aforementioned four categories in a district, the 'z score' (data-mean/standard deviation) technique has been used. The z scores thus obtained was classified into three categories. It is believed that a value in the range minus 1 to plus 1 represents the normal or average workforce of a district. Values below and above the average are considered as deficient and dominant for all the 82 districts in study area. Finally, dominant and deficient functions in respect of total rural female workers of all the districts have been classified into 18 broad categories including normal functions in 2001 and 2011. The maps have been prepared with the help of Arc GIS 10 (Arc Map Version 10.1).

15.5 Changing Pattern of Rural Female Working Force

The rural female working force has been increased from 26.11 to 27.45% during the period 2001–2011. High positive change, i.e. more than 10%, is recorded in more than half of the districts of Nagaland and Kamrup district of Assam state. The category of moderate positive change (5–10%) confirmed to 11 districts, namely Upper Siang, Mokokchung, Kiphire, West Kameng, Tuensang districts of Arunachal Pradesh; Chandel, Tamenglong, Senapati districts of Manipur; Kamrup Metropolitan, Dhubri districts of Assam and West Tripura district of Tripura. On the other hand,

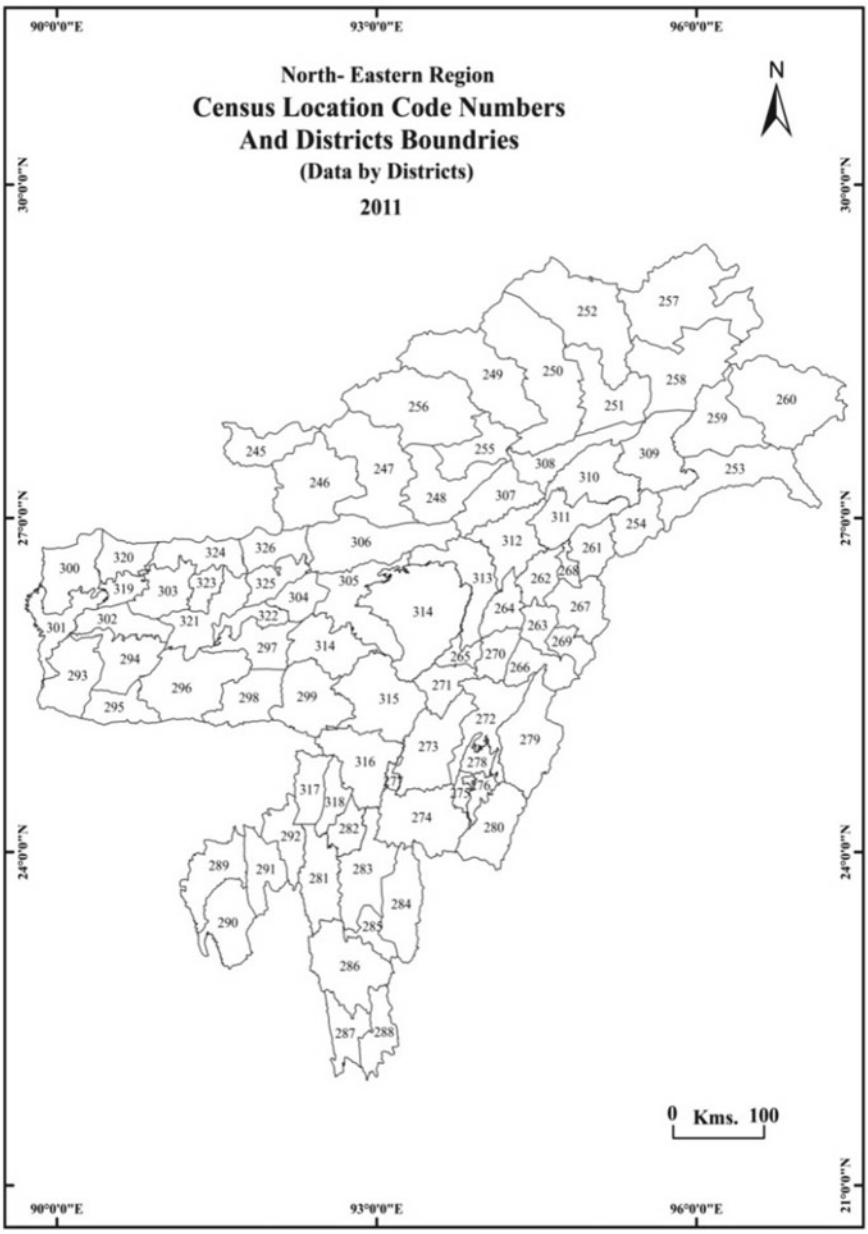

Fig. 15.1 Census location code numbers and districts boundries of north-eastern region. *Source* Prepared by Authors

low positive change, i.e. less than 5%, is observed in one-third districts, mostly found in the form of large continuous patches in the study area (Fig. 15.2). It may also be noted that the highest decline recorded is in Lakhimpur district (–22.47%) of Assam followed by Saiha (−19.11%), Aizawl (−16.48%) and Champhai (−15.19%) districts of Mizoram. The negative change was recorded in nearly two-fifth of the districts mostly confined to extreme southern and north-eastern parts of the study area. All districts of Meghalaya, Mizoram, more than half of Arunachal Pradesh and one-third of Assam come under the category of negative change.

15.6 Changing Pattern of Rural Female Cultivators

The rural female cultivators have decreased by nearly 11% that is from 50.45 to 39.50% during the period 2001–2011. The positive change is recorded in five districts, namely Senapati and Thoubal districts of Manipur; Tuensang and Kohima districts of Nagaland and East Khasi Hills district of Meghalaya. High negative change, i.e. more than 10% occurred in two-fifth districts, mostly located in the northern, north-eastern and some small patches in the southern part of the study area. The highest decline is found in Dimapur district of Nagaland followed by Baska, Saiha, Darrang, Tawang and Lower Dibang Valley districts which have more than 20% decline in the category of cultivators. On the other hand, the category of low negative change, i.e. less than 10%, covered about half of the districts, mostly confined to south-western and peripheral areas of the study region (Fig. 15.3).

15.7 Changing Pattern of Rural Female Agricultural Labourers

The rural female agricultural labourers have been increased from 17 to 21% during the period 2001–2011. It is observed that very high and high positive change, i.e. more than 6%, is confined to 20 districts in the form of small scattered patches in the study region. The highest positive change is recorded that Darrang (13.95%) followed by Zunheboto (11.90%), Udalguri (11.02%) and Lower Dibang Valley (10.33%) districts. The category of moderate change (3–6%) is covered by 19 districts including the 12 districts of Assam; Mon, Dimapur and Peren districts of Nagaland; Upper Subansiri and East Siang districts of Arunachal Pradesh; Kolasib district of Mizoram and West Tripura district of Tripura states, found in the form of small patches. The low change, i.e. less than 3%, is observed about in one-fourth districts, mainly confined to northern and peripheral parts of the study area. On the other hand, the negative change is recorded in 20 districts, mostly situated in south-western part of the study region (Fig. 15.4). The highest decline is observed in Senapati district (11.34%) followed by Jaintia Hills (8.98%), Imphal West (4.48%), Hailakandi (3.36%), Cachar (3.20%) and Kokrajhar (2.50%) districts, respectively.

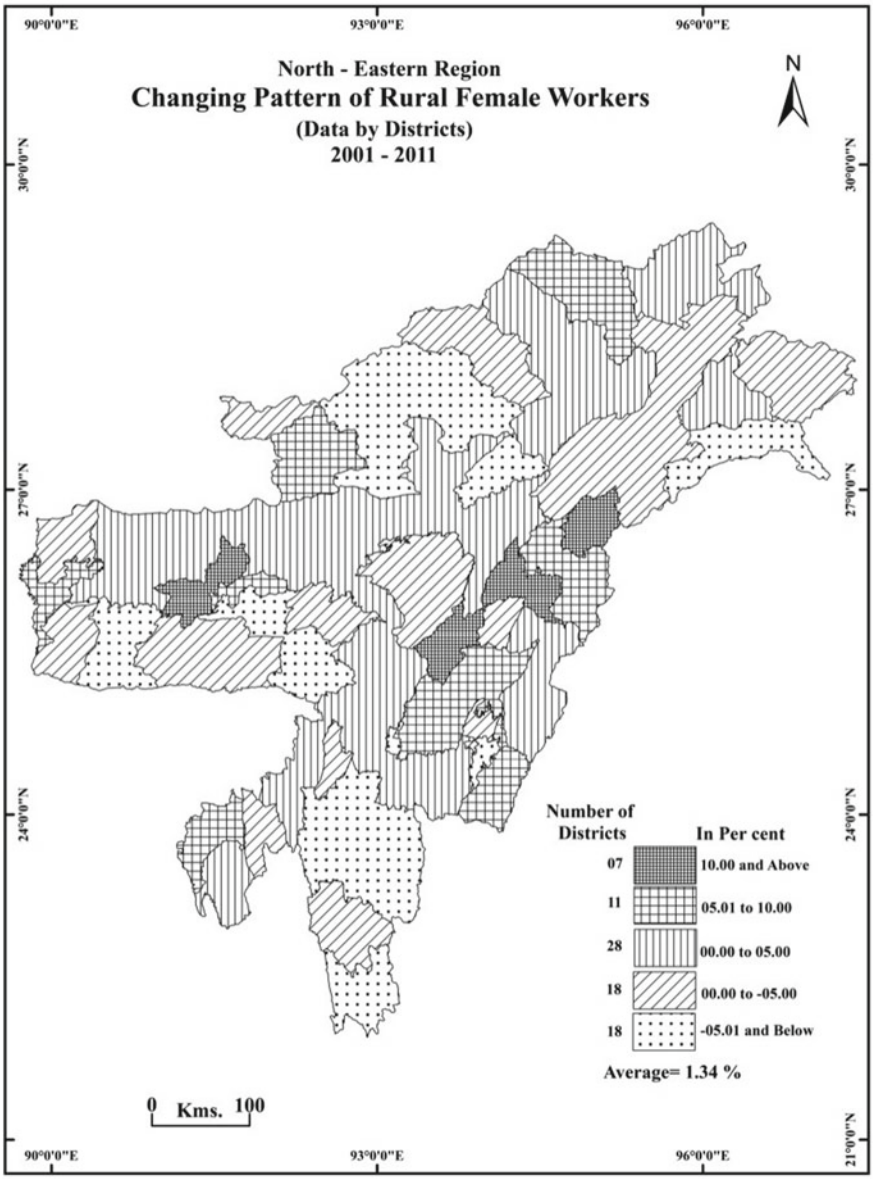

Fig. 15.2 Changing pattern of rural female workers. *Source* Prepared by Authors

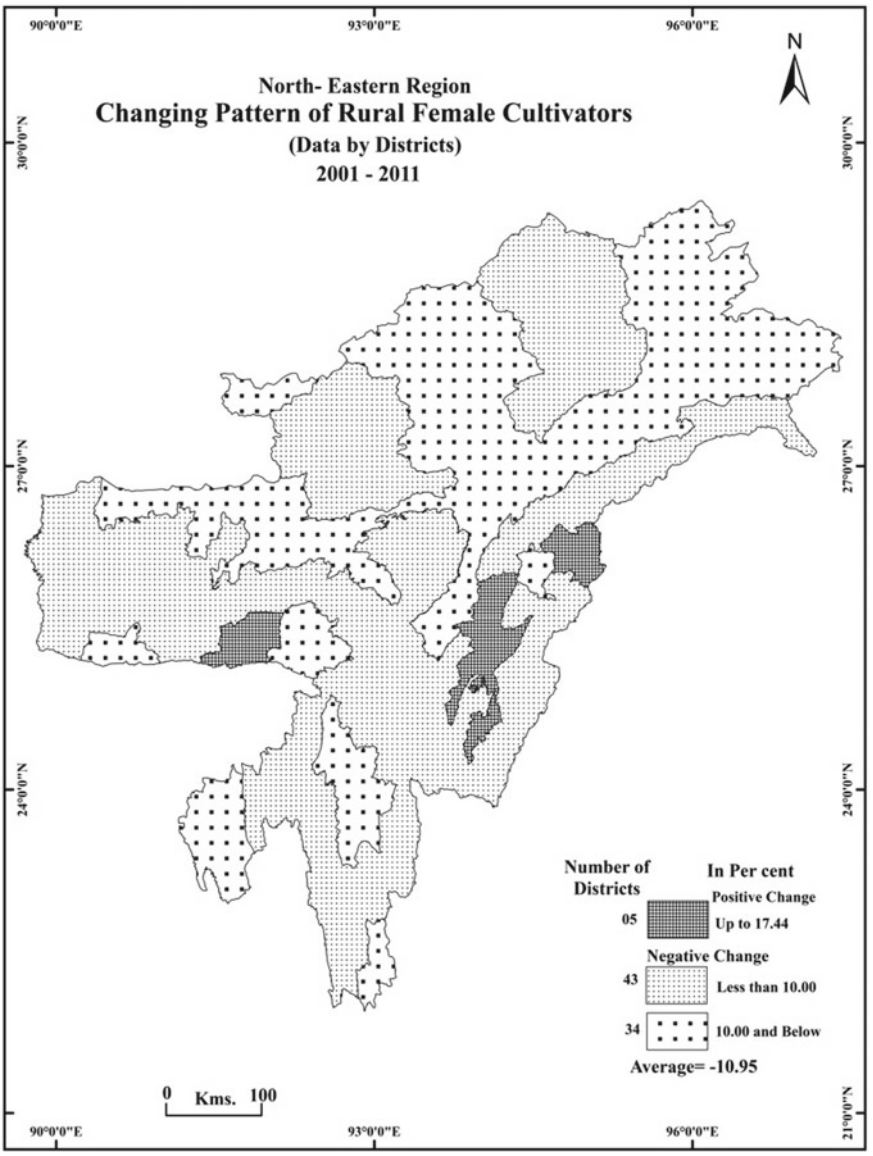

Fig. 15.3 Changing pattern of rural female cultivators. *Source* Prepared by Authors

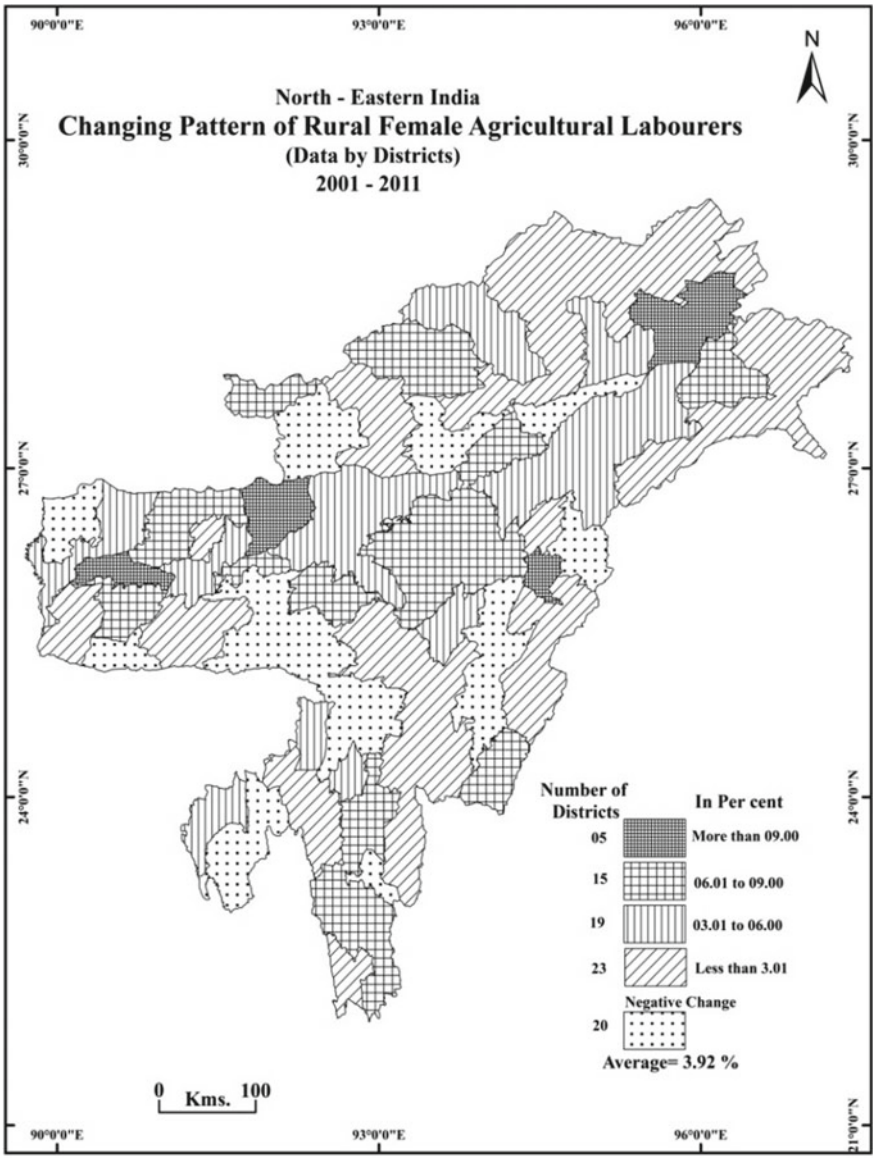

Fig. 15.4 Changing pattern of rural female agricultural labourers. *Source* Prepared by Authors

15.8 Changing Pattern of Rural Female Workers in Household Industry

The rural female workers engaged in household industries have been decreased from 7.24 to 7.04% during the period 2001–2011. The positive change is recorded in two-fifth of the districts, situated in half of the districts of Assam, Arunachal Pradesh and Mizoram. The highest positive change was recorded in Upper Siang district of Arunachal Pradesh (3.76%) followed by Jorhat, Cachar, Hailakandi and Kolasib. On the other hand, the negative change occupied by three-fifth districts is mostly confined to the central parts of the study area (Fig. 15.5). It may also be noted that the highest negative change is observed in Imphal East (7.19%) district of Meghalaya followed by Churachandpur, North Tripura, Senapati and Bishnupur districts.

15.9 Changing Pattern of Rural Female Other Workers

About seven per cent of rural female others workers have been increased during the period 2001–2011. Very high and high positive change, i.e. more than eight per cent, is observed in 28 districts, mostly located in small scattered patches in the region. The highest positive change is recorded in the district of Jaintia Hills (22.91%), followed by Dimapur, South Tripura, Saiha, Nalbari and Baska districts. The category of moderate positive change ranging between 4 and 8% is confined to nearly one-third of the districts, found in large scattered patches in the study area (Fig. 15.6). The low positive change, i.e. less than 4%, is observed in 24 districts, confined to the central and peripheral parts of the study area. On the other hand, negative change occurred in only five districts, namely Karimganj of Assam; Senapati and Thoubal districts of Manipur; East Khasi Hills of Meghalya and Tuensang of Nagaland during 2001 to 2011.

15.10 Pattern of Dominant and Deficient Functions of Rural Female Workers

Further z score value has been used to identify the dominant and deficient functions of above said four categories in a district. It is obvious from Tables 15.1 and 15.2 that the dominant and deficient functions including normal functions of all 82 districts in north-eastern region of India have been classified into 18 sub-categories in 2001 and 2011.

Table 15.1 shows the composite picture of dominant and deficient functions of rural female workers of a district in 2001 and also represented in the map (Fig. 15.7). It has been recorded that 14 districts have dominant functions such as Lohit district in Arunachal Pradesh is dominant by cultivators, while agricultural labourers are

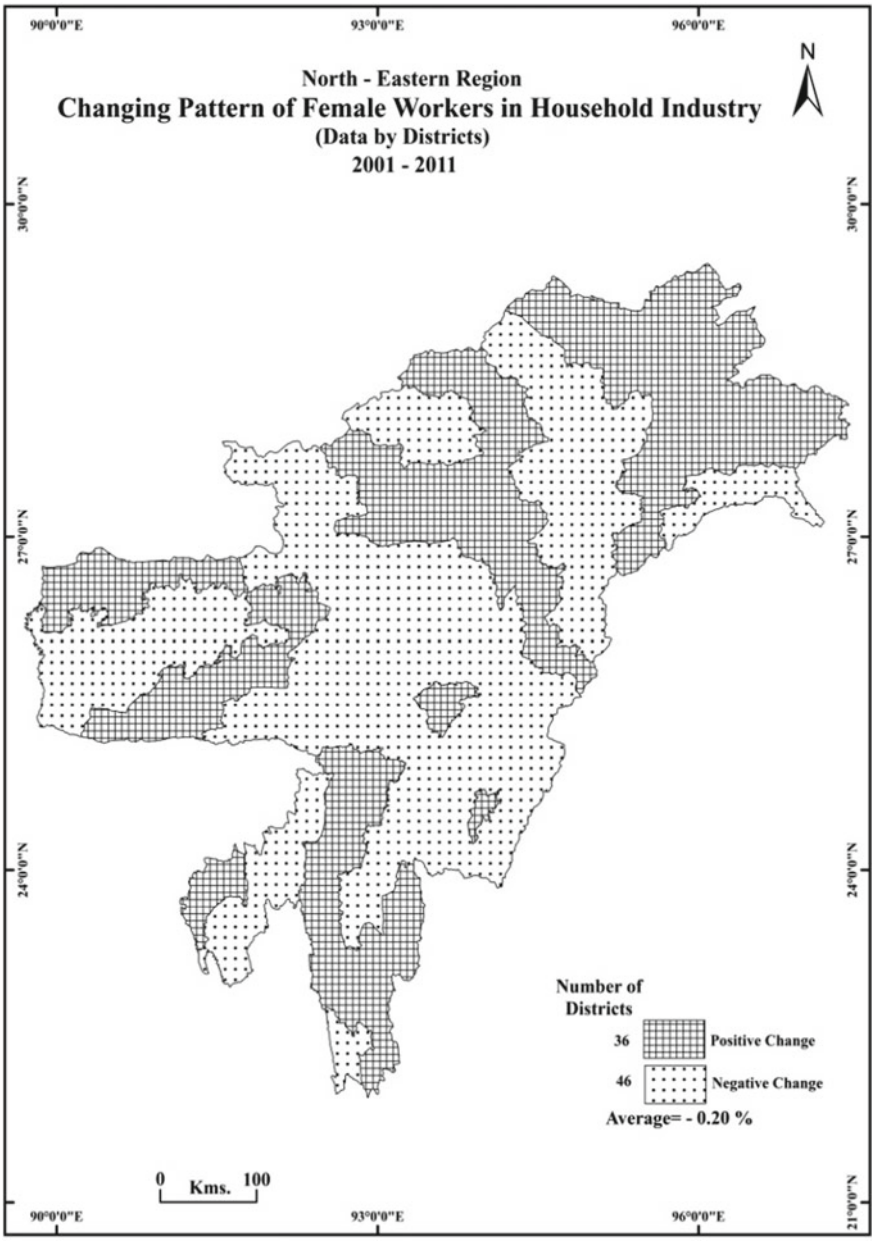

Fig. 15.5 Changing pattern of rural female workers in household industry. *Source* Prepared by Authors

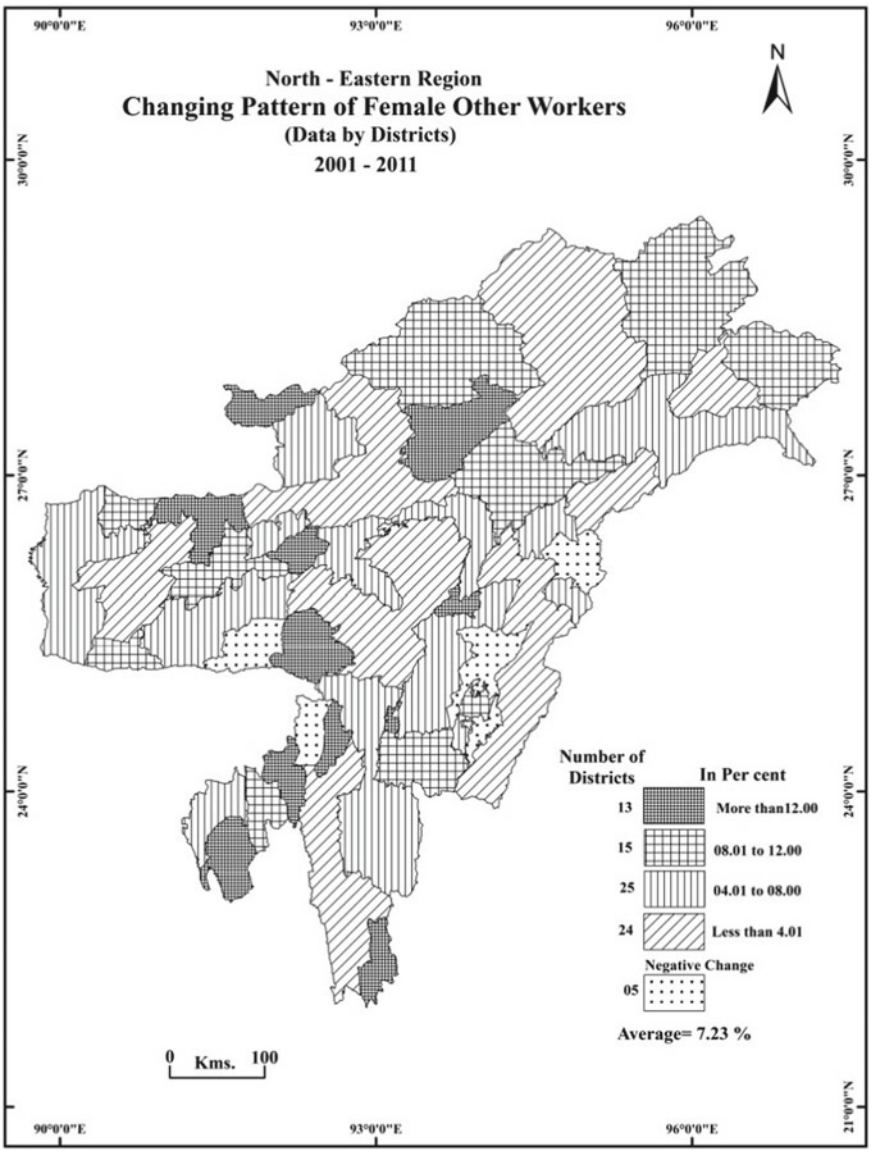

Fig. 15.6 Changing pattern of rural female other workers. *Source* Prepared by Authors

dominant in five districts, namely West Tripura, South Tripura and Dhalai of Tripura; Jaintia Hills of Meghalaya and Bongaigaon of Assam. On the other hand, workers engaged in household industries are dominant in Thoubal and Imphal West of Manipur and Kamrup of Assam. The category of dominant in other workers is recorded in Sonitpur, Tinsukia, Dibrugarh, Sivsagar and Uadalguri of Assam state.

Table 15.1 India: North-eastern region: dominant and deficient functions of total rural female workers, 2001

S. No.	Functions code	Functions	Name of the district with census code number	Total
1	A	Dominant in Cultivators	Lohit (259)	01
2	B	Dominant in Agricultural Labourers	West Tripura (289), South Tripura (290), Dhalai (291), Jaintia Hills (299) and Bongaigaon (319)	05
3	C	Dominant in HHI Workers	Thoubal (276), Imphal West (277) and Kamrup (321)	03
4	D	Dominant in Other Workers	Sonitpur (306), Tinsukia (309), Dibrugarh (310), Sivasagar (311) and Uadalguri (326)	05
5	b	Deficient in Agricultural Labourers	Dibang Valley (257)	01
6	d	Deficient in Other Workers	South Garo Hills (295) and West Khasi Hills (296)	02
7	bc	Deficient in Agri. Labourers and HHI Workers	Twang (245)	01
8	Ab	Dominant in Cultivators, Deficient in Agricultural Labourers	Kohima (270) and Ukhrul (279)	02
9	Ac	Dominant in Cultivators, Deficient in HHI Workers	Kolasib (282)	01
10	Ad	Dominant in Cultivators, Deficient in Other Workers	Lower Dibang Valley (255), Lower Subansiri, (258), Lawngtlai (287), East Garo Hills (294), Lakhimpur (307) and Dhemaji (308)	06
11	Ba	Dominant in Agricultural Labourers, Deficient in Cultivators	Dhubri (301)	01
12	Ca	Dominant in HHI Workers, Deficient in Cultivators	Bishnupur (275), Imphal East (278) and Nalbari (323)	03
13	Da	Dominant in Other Workers, Deficient in Cultivators	Cachar (316)and Hailakandi (318)	02
14	Abc	Dominant in Cultivators, Deficient in Agricultural Labourers and HHI Workers	Upper Siang (252)	01

(continued)

Table 15.1 (continued)

S. No.	Functions code	Functions	Name of the district with census code number	Total
15	Abd	Dominant in Cultivators, Deficient in Agricultural Labourers and Other Workers	Upper Subansiri (249), West Siang (250), Changlang (253), Kurung Kumey (256), Mon (261), Zunheboto (263), Wokha (264), Phek (266), Tuensang (267), Tamenglong (273), Aizwal (283), Longleng (268), Kiphire (269), Peren (271), Serchhip (285) and Lunglei (286)	16
16	CDa	Dominant in HHI Workers and Other Workers, Deficient in Cultivators	Barpeta (303) and Karimganj (317)	02
17	Abcd	Dominant in Cultivators, Deficient in Agricultural Labourers, HHI Workers and Other Workers	East Kameng (247), Triap (254) Anjaw (260) Mamit (281), Champhai (284) and Saiha (288)	06
18	Normal Functions	Neither Dominant nor Deficient	West Kameng (246), Papum Pare (248), East Siang (251), Mokokchung (262), Dimapur (265), Senapati (272), Churachandpur (274), Chandel (280), North Tripura (292), West Garo Hills (293), RiBhoi (297), East Khasi Hills (298), Korkrajhar (300), Goal Para (302), Morigaon (304), Nagaon (305), Jorhat (312), Golaghat (313), Darrang (325), DimaHasao (315), Baska (324), Karmup Metropolitan (322), Karbi Anglong (314) and Chirang (320)	24

Source Compiled by Authors

Similarly, deficient functions have been recorded in three districts like Dibang Valley of Arunachal Pradesh in the category of agricultural labourers and South Garo Hills and West Khasi Hills districts of Meghalaya in other workers in 2001. However, half of the districts covered either one or more in various dominant and deficient functions, while 24 districts are recorded as normal functions in 2001, mostly situated in central and western parts of the study area.

Table 15.2 India: North-eastern region: dominant and deficient functions of total rural female workers, 2011

S. No.	Functions code	Functions	Name of the district with census code number	Total
1	B	Dominant in Agricultural Labourers	West Tripura (289), South Tripura (290), Dhalai (291), Dhubri (301), Goalpara (302), Bongaigaon (319), Baksa (324) and Darrang (325)	08
2	C	Dominant in HHI Workers	Bishnupur (275), Imphal West (277), Imphal East (278), Barpeta (303) and Kamrup (321)	05
3	D	Dominant in Other Workers	Dimapur (265), North Tripura (292), Tinsukia (309), Dibrugarh (310), Sivasagar (311) and Kamrup Metropolitan (322)	06
4	b	Deficient in Agricultural Labourers	West Kameng (246), Lower Subansiri (255), PapumPare (248), Dibang Valley (257) and Churachandpur (274)	05
5	c	Deficient in HHI Workers	Tawang (245), Lower Dibang Valley (258) and East Khasi Hills (298)	03
6	d	Deficient in Other Workers	Chandel (280), West Khasi Hills (296) and Karbi Anglong (314)	03
7	cd	Deficient in HHI Workers and Other Workers	Lohit (259)	01
8	Ab	Dominant in Cultivators, Deficient in Agricultural Labourers	Mokokchung (262) and Kohima (270)	02
9	Ac	Dominant in Cultivators, Deficient in HHI Workers	Saiha (288)	01
10	Ad	Dominant in Cultivators, Deficient in Other Workers	Zunheboto (263), Kolasib (282) and East Garo Hills (294)	03
11	Cd	Dominant in HHI Workers, Deficient in Other Workers	Thoubal (276)	01
12	Da	Dominant in Other Workers, Deficient in Cultivators	Cachar (316) and Hailakandi (318)	02

(continued)

Table 15.2 (continued)

S. No.	Functions code	Functions	Name of the district with census code number	Total
13	Abc	Dominant in Cultivators, Deficient in Agricultural Labourers and HHI Workers	East Siang (251) and Anjaw (260)	02
14	Abd	Dominant in Cultivators, Deficient in Agricultural Labourers and Other Workers	Upper Subansiri (249), Upper Siang (252), Triap (254), Kurung Kumey (256), Wokha (264), Ukhrul (279), Phek (266), Longleng (268), Kiphire (269), Peren (271), Senapati (272), Tamenglong (273), Champai (284), Lawngtlai (287), Dhemaji (308) and Dima Hasao (315)	16
15	Acd	Dominant in Cultivators, Deficient in HHI and Other Workers	Aizwal (283) and Lunglei (286)	02
16	CDa	Dominant in Other workers, HHI Workers and Deficient in Cultivators	Karimganj (317) and Nalbari (323)	02
17	Abcd	Dominant in Cultivators, Deficient in Agricultural Labourers, HHI Workers and Other Workers	East Kameng (247), West Siang (250), Changlang (253), Mon (261), Tuensang (267), Mamit (281), Serchhip (285)	07
18	Normal Functions	Neither Dominant nor Deficient	West Garo Hills (293), South Garo Hills (295), Ribhoi (297), Jantia Hills (299), Kokrajhar (300), Morigaon (304), Nagaon (305), Sonitpur (306), Lakhimpur (307), Jorhat (312), Golaghat (313), Chirang (320) and Uadalguri (326)	13

Source Compiled by Authors

Table 15.2 indicates that 19 districts have dominant functions, 11 districts have deficient functions, while 39 districts covered either one or more in various dominant and deficient functions and rest of the 13 districts have recorded in the category of normal functions in 2011 (Fig. 15.8). It is observed that eight districts are dominant in the category of dominant in agricultural labourers, the districts, namely Dhubri, Goalpara, Bongaigaon, Baska and Darrang of Assam; and West Tripura,

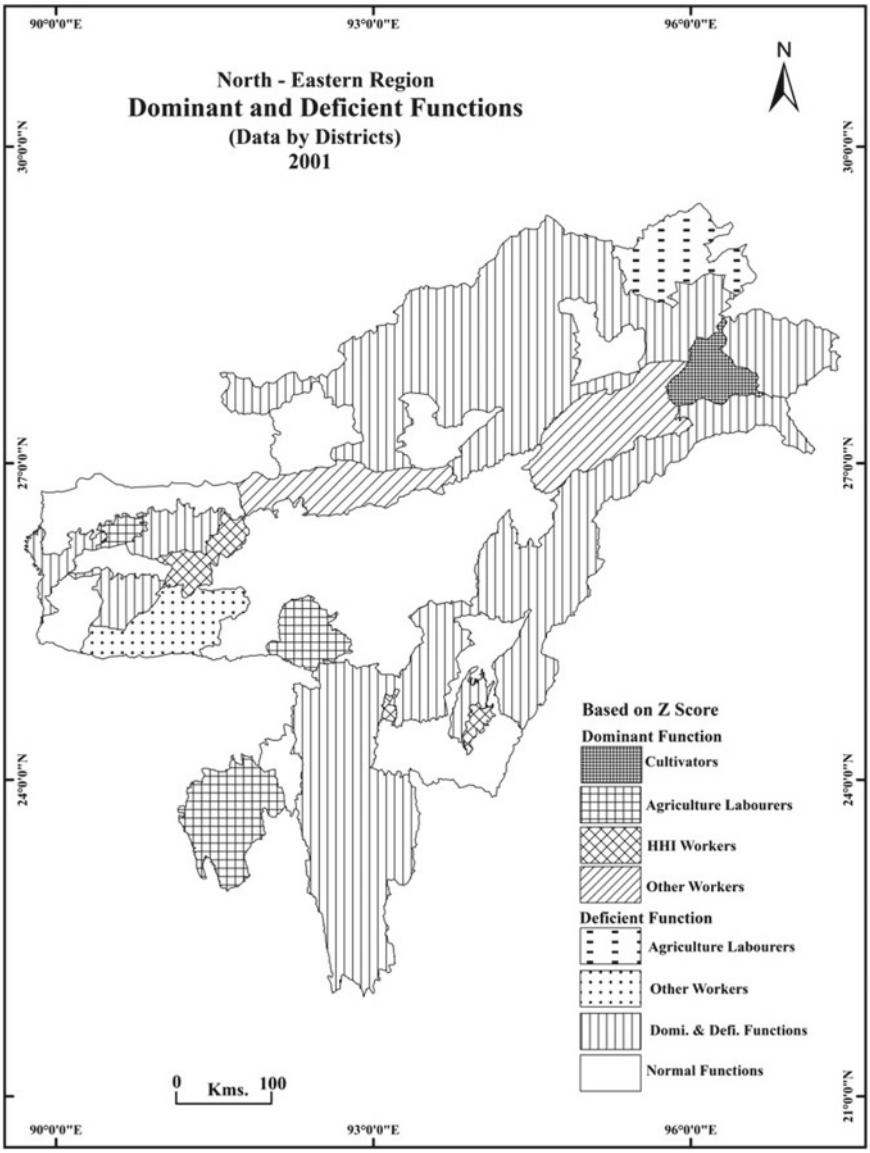

Fig. 15.7 Dominant and deficient functions in 2001. *Source* Prepared by Authors

South Tripura, Dhalai of Tripura which confined to western and south-western parts in the study region. Workers engaged in household industries are dominant in five districts like Bishnupur, Imphal West, Imphal East of Manipur; and Barpeta and Kamrup of Assam, while other workers are dominant in six districts, namely Dimapur of Nagaland; North Tripura of Tripura; and Tinsukia, Dibrugarh, Sivasagar, Kamrup

Metropolitan of Assam. Agriculture labourers are deficient in five districts belonging to Arunachal Pradesh and Manipur. Non-agricultural functions like workers engaged in household industries are deficient in three districts, namely Tawang and Lower Dibang Valley of Arunachal Pradesh; and East Khasi Hills of Meghalaya; and other workers are deficient in districts of Chandel, West Khasi Hills and Karbi Anglong, confined to the south-western part of the study area.

15.11 Change in Dominant and Deficient Functions of Rural Female Workers

Table 15.3 represents the change in various categories of dominant and deficient functions from 2001 to 2011. It may be noted that all the functions are classified into 22 categories including 14 sub-categories which have more than one functions.

The highest positive change is recorded in four and three districts in the category of deficient and dominant, respectively, in agricultural labourers. Likewise, three districts are also recorded deficient in the category of workers engaged in household (c). Further, the functions of sub-categories like dominant in workers engaged in household industries (C); dominant in cultivators but deficient in workers engaged in household industries and other workers (Acd) have also observed positive change. Similarly, the following functions dominant in other workers (D); deficient in other workers (d); deficient in workers engaged in household industries and other workers (cd); dominant in cultivators but deficient in agricultural labourers and workers engaged in household industries (Abc); and dominant in workers engaged in household industries but deficient in other workers (Cd) have positive change by one district.

On the other hand, the highest negative change is observed in the category of neither dominant nor deficient (normal functions) by 11 districts followed by three districts which are dominant in cultivators but deficient in other workers (Ad); dominant in household industries but deficient in cultivators (Ca). Further, the functions of sub-categories like dominant in cultivators (A); deficient in agricultural labourers and workers engaged in household industries (bc); dominant in cultivators but deficient in agricultures labourers, workers engaged in household industries and other workers (Abcd) have also recorded negative change by one districts.

15.12 Areas of No Change

The study reveals that about two-fifth districts have maintained their same status in various categories of dominant and deficient functions in both the census years that is 2001 and 2011. Further, it is also recorded that the various sub-categories of functions like dominant in cultivators but deficient in agricultural labourers (Ab);

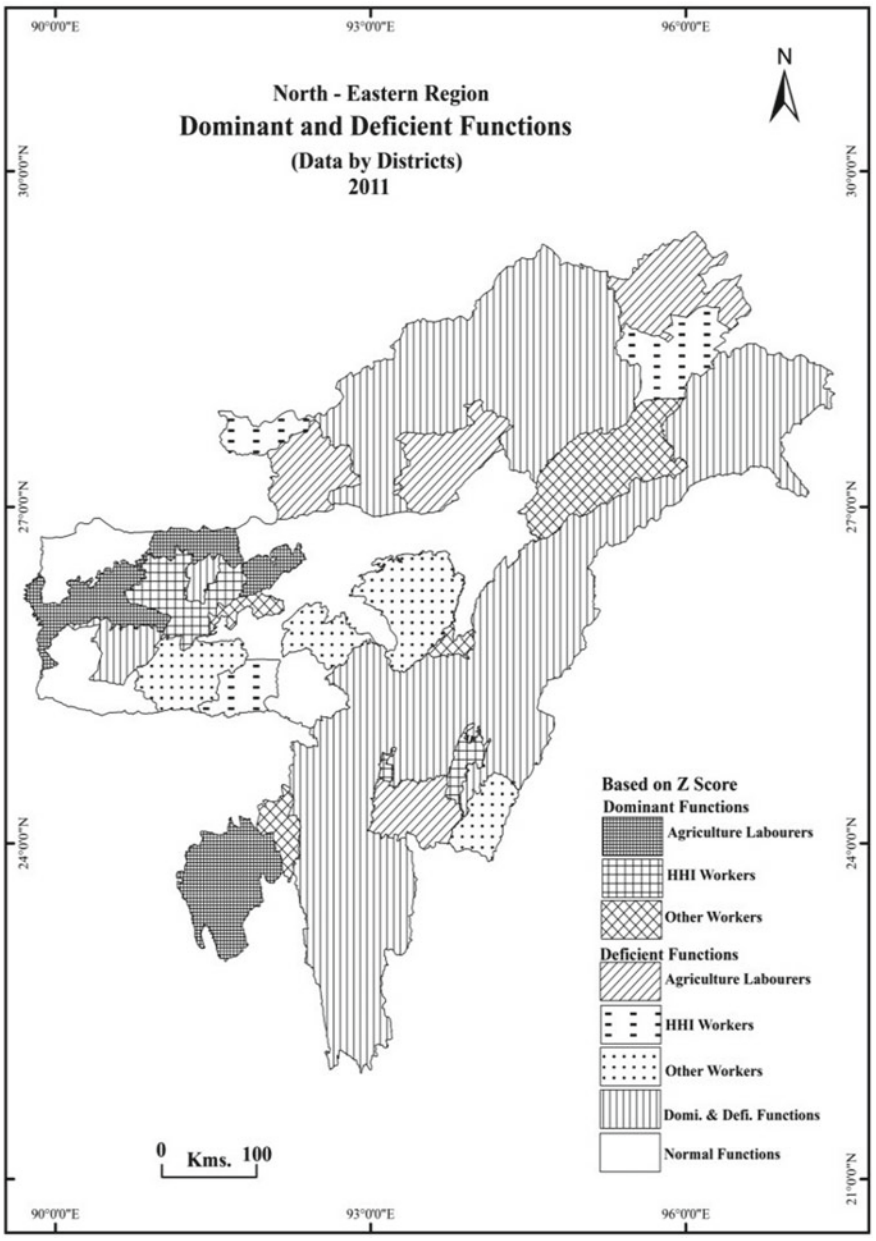

Fig. 15.8 Dominant and deficient functions in 2011. *Source* Prepared by Authors

Table 15.3 India: North-eastern region: change in dominant and deficient functions of rural female worker in 2001–2011

S. No.	Functions code	Functions	District census code number			Change in nos.
			2001	2011	No change in district	
1	A	Dominant in Cultivators	259 = 1	–	–	−01
2	B	Dominant in Agricultural Labourers	289, 290, 291, 299, 319 = 5	289, 290, 291, 301, 302, 319, 324, 325 = 8	289, 290, 291, 319 = 4	03
3	C	Dominant in HHI Workers	276, 277, 321 = 3	275, 277, 278, 303, 321 = 5	277, 321 = 2	02
4	D	Dominant in Other Workers	306, 309, 310, 311, 326 = 5	265, 292, 309, 310, 311, 322 = 6	309, 310, 311 = 3	01
5	(b)	Deficient in Agricultural Labourers	257 = 1	246, 255, 248, 257, 274 = 5	257 = 1	04
6	(c)	Deficient in HHI Workers	–	245, 258, 298 = 3	–	03
7	(d)	Deficient in Other Workers	295, 296 = 2	280, 296, 314 = 3	296 = 1	01
8	bc	Deficient in Agricultural Labourers and HHI Workers	245 = 1	–	–	−01
9	cd	Deficient in HHI Workers and Other Workers	–	259 = 1	–	01
10	Ab	Dominant in Cultivators, Deficient in Agricultural Labourers	270, 279 = 2	262, 270 = 2	270 = 1	–
11	Ac	Dominant in Cultivators, Deficient in HHI Workers	282 = 1	288 = 1	–	–
12	Ad	Dominant in Cultivators, Deficient in Other Workers	255, 258, 287, 294, 307, 308 = 6	263, 282, 294 = 3	294 = 1	−03
13	Ba	Dominant in Agricultural Labourers, Deficient in Cultivators	301 = 1	–	–	−01
14	Ca	Dominant in HHI Workers, Deficient in Cultivators	275, 278, 323 = 3	–	–	−03

(continued)

Table 15.3 (continued)

S. No.	Functions code	Functions	District census code number			Change in nos.
			2001	2011	No change in district	
15	Cd	Dominant in HHI Workers, Deficient in Other Workers	–	276 = 1	–	01
16	Da	Dominant in Other Workers, Deficient in Cultivators	316, 318 = 2	316, 318 = 2	316, 318 = 2	–
17	Abc	Dominant in Cultivators, Deficient in Agri. Labourers and HHI Workers	252 = 1	251, 260 = 2	–	01
18	Abd	Dominant in Cultivators, Deficient in Agricultural Labourers and Other Workers	249, 250, 253, 256, 261, 263, 264, 266, 267, 268, 269, 273, 271, 283, 285, 286 = 16	249, 252, 254, 256, 264, 279, 266, 268, 269, 271, 272, 273, 284, 287, 308, 315 = 16	249, 256, 264, 266, 268, 269, 271, 273 = 8	–
19	Acd	Dominant in Cultivators, Deficient in HHI Workers and Other Workers	–	283, 286 = 2	–	02
20	CDa	Dominant in Other Workers, HHI Workers and Deficient in Cultivators	303, 317 = 2	317, 323 = 2	317 = 1	–
21	Abcd	Dominant in Cultivators, Deficient in Agricultural Labourers HHI Workers and Other Workers	247, 254, 260, 281, 284, 288 = 6	247, 250, 253, 261, 267, 281, 285 = 7	247, 281 = 2	−01
22	Normal Functions	Neither Dominant nor Deficient	246, 248, 251, 262, 265, 272, 274, 280, 292, 293, 297, 298, 300, 302, 304, 305, 312, 313, 314, 315, 320, 322, 324, 325 = 24	293, 295, 297, 299, 300, 304, 305, 306, 307, 312, 313, 320, 326 = 13	293, 297, 300, 304, 305, 312, 313, 320 = 8	−11

Source Compiled by Authors, Name of the district is mentioned in Tables 15.1 and 15.2

dominant in cultivators but deficient in workers engaged in household industries (Ac) and dominant in cultivators but deficient in agricultural labourers and other workers (Abd) have no change in number of districts during the period in north-eastern region of India (Fig. 15.9).

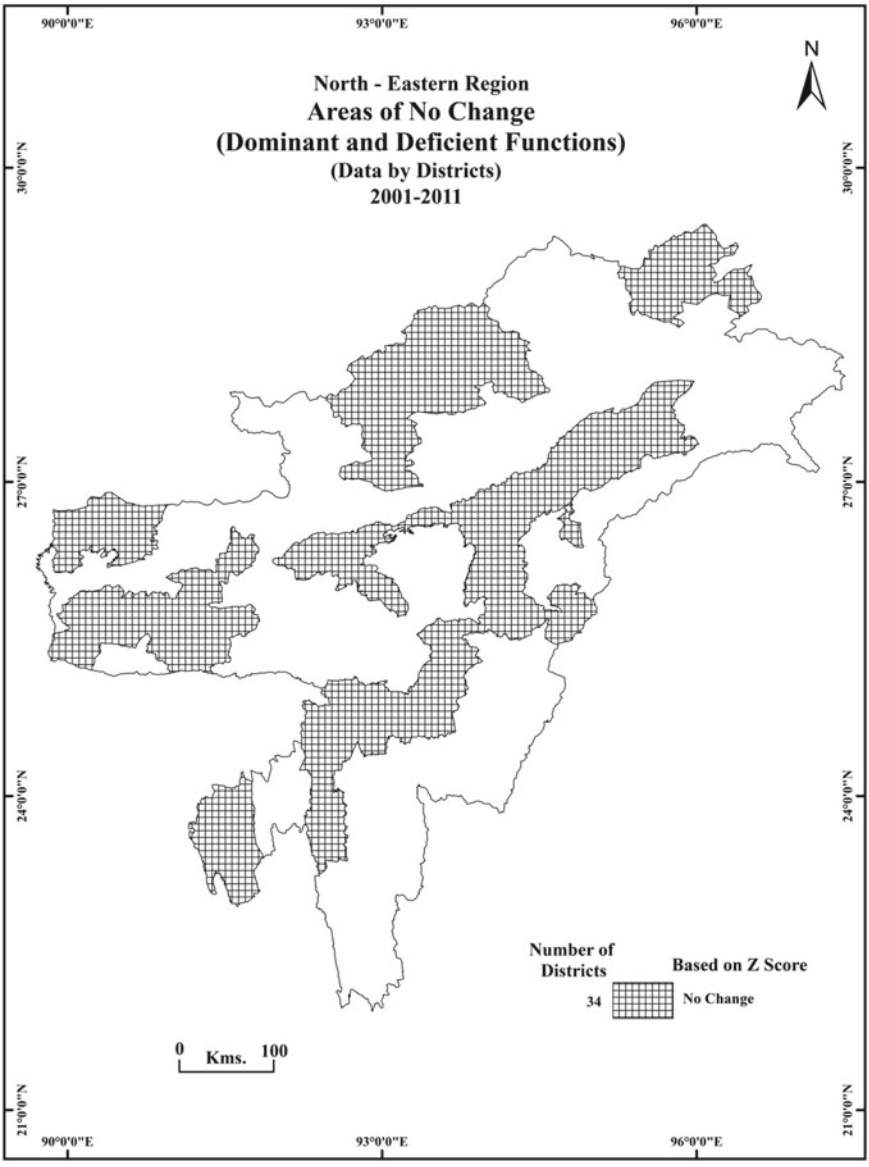

Fig. 15.9 Areas of no change in dominant and deficient functions from 2001 to 2011. *Source* Prepared by Authors

15.13 Conclusions

It is concluded that rural female agricultural labourers and other workers have also increased by 3.92% and 7.23%, respectively, during the period. On the other hand, rural female cultivators and workers engaged in household industries have decreased by 10.95% and 0.20%, respectively. Further, the dominant and deficient functions of all the 82 districts have been classified into 18 sub-categories including the category of normal function. It has been recorded that 14 districts of 2001 and 19 districts of 2011 have dominant functions, while three districts of 2001 and 11 districts of 2011 have deficient functions in all the four broad categories. Further, negative change is observed in the category of normal functions by 11 districts. It may be noted that about two-fifth districts have maintained their same status in various categories of dominant and deficient functions in 2001 and 2011 in north-eastern region of India. Besides variation in the topographical conditions, increase in urban area, demoralization of joint families in rural areas, fairly educational and transportation facilities and better employment opportunities in the urban areas are the responsible factors to increase the rural working force during the period 2001–2011 in north-eastern region of India.

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Chapter 16
An Evolving Paradigm of Cybersecurity in North Eastern India

Subimal Bhattacharjee

Abstract Over the last two decades, the cyberspace has become an integral part of our lives connecting people from all over the world and creates new models for business and communication. But the process of digitization comes with the rising threat of cyberattacks on our networks. Cyberattacks threaten everything from our critical infrastructures to our personal data and given the hyper speed of digital adoption, this threat is only going to grow over time. The scale and sophistication of the attacks have been increasing with the growing power of state sponsored hacker groups. In this paper, we examine the growing menace of cyberattacks and the cybercrime in the north eastern states of India and look at ways toward creating a strong cybersecurity mechanism that will help the region tackle the growing wave of cyberattacks in the coming times with increased digitization and universal adoption of digital payment systems through strong a public–private partnership and a graded approach to security.

Keywords Cybersecurity · North eastern India · Cybersecurity strategy · Cyberattacks · Cybercrimes

16.1 Introduction

Every day brings new stories about cyberattacks and with far higher frequency than just a couple of years back. But it is not just the frequency that is growing, but also the scale and sophistication of the attacks have evolved and grown. The recent case involving a retired bank officer from Silchar in Assam losing INR 18.93 lakhs (INR 3.14 lakhs from the savings account and INR 15.79 lakhs from fixed deposits) was the biggest cyber fraud in the state of Assam and the north eastern region ever. While we will retake a look at this case later in this paper, what is an established reality is that the hackers were upping the ante in the region with more structured stories and

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better coordination. The state of cyber resilience in the state is going to be tested to the highest level of stress.

The north eastern states have been luckier than the rest of the country that the absolute volume of cyberattacks has been far lesser, though that might be attributed to lower levels of digitization in the society. But the region cannot remain immune to the winds of change blowing across cyberspace as hackers across the world are hitting at any target that displays any vulnerability. The level of cyberattacks would go up proportionately in the near future as the region increases its participation in the digital economy unless serious steps are taken to shore up the cybersecurity preparedness of the states.

Before we take a look at the north eastern states of India in a focused manner, it would be pertinent to study the changing landscape of the cybersecurity mechanism in the global context, given that the last year has seen some of the most audacious cyberattacks. The SolarWind attack using vulnerabilities in its ubiquitous and very popular Orion system gained access to both federal and private networks in the US, one of the most advanced countries in digital readiness and usage. The attack was attributed to a Russian hacker group that had tacit backing from Kremlin (Temple-Raston 2021). Even before the dust settled on the hack, the world witnessed a global wave of cyberattacks when 4 zero-day exploits were found in Microsoft Exchange Server. The attack was unusual in its ferocity and has been confidently attributed to a Chinese backed hacker group known as Hafnium, and it is estimated that almost 750,000 servers were affected (Carlson 2021).

While both the above-mentioned hacks were humongous in scale, they had little impact on the common person. But then that was about to change soon with the Colonial Pipeline. Probably the costliest cyberattack in history to date, the incident brought into sharp focus that the severity and scale of cyberattacks were growing every day as critical infrastructures became more decentralized and connected. The attack on 9 May 2021 on the pipeline that catered to 45% of the energy needs of the east coast resulted in the company shutting down its operations as they grappled with the attack, resulting in a loss of almost 2.5 million barrels and pushing up Brent Crude by 1.5% and US futures by 3% (Greenberg 2021). The long lines at the gas stations were the optics that finally shook up the US administration. US President Joe Biden signed an executive order to encourage improvements in digital security standards across the private sector and better equip federal agencies with cybersecurity tools (Presidential Actions 2021).

The FBI has identified the DarkSide Group as the perpetrators, and there is enough circumstantial evidence to link this group to the intelligence community in Kremlin. But that is not enough to take on-ground action against Russia except imposing a few sanctions. As a matter of fact, the United States in April did impose sanctions against Russia for its alleged involvement in the SolarWind attack but nowhere was the response proportional (Helman 2021).

Before we look closer home, let us first delve a bit into the unique challenge we face in securing our networks, the core cybersecurity challenge.

16.2 Cyberattacks and the Evolution of Network Risks

Cyberspace has this unique aspect that the attack vectors and tools are almost the same whether the attack is perpetrated on an individual, an institution, or even a national network. The attackers range from individuals to organized groups and syndicates, non-state actors, and formal militaries of various nations. Even the motive for the attacks differs from thrill-seeking to disrupting networks, causing financial losses, and destroying critical infrastructure functions. The absence of geography in carrying out these attacks gives anonymity to the attackers who today execute their sinister missions involving multiple counties at the same time (Erikson 2008).

Networks have always been attacking vectors. In conventional attacks, these are the roads, railways, naval, and air routes. In the twenty-first century, digital networks are the attack pathways. The trend has been driven by universal digitization leading to global interconnectivity that raises the risks of cyberattacks.

The term "Internet" is a truncation of "internetworking", the original label for how multiple unrelated networks interconnect to form a common whole. This interconnectedness is the inherent strength of the network connecting seven billion people on this planet. It is also the same interconnectedness that creates the vulnerabilities that allow hackers to break the system.

The reason why cybersecurity is such a complex endeavor lies in the nature of the digital landscape, which can be thought of as a digital wild west where a person with a laptop and a data connection can cause more damage than a dozen men with guns. The low entry cost has been the primary reason why the cyber battlefield has seen a constant influx of hackers ready to take down the digital pathways of the world.

Over the last three decades, as the world came to terms with cyber risks, the majority of the hackers focused on some of the other forms of social engineering (phishing) (Aiken 2016) that allowed the hacker to obtain enough information from the target, which could be used to access the targets mail or social media accounts or alternatively target the victims' financial accounts and siphon off funds. The conflict zones saw more incidents of dedicated denial of service (DDoS) which required a large number of hackers working with established tools to ping a server and overwhelm the same. More complex hacking using malware was far less common.

In the past few years, one of the more certain trends emerging is the use of ransomware by hackers. This is connected to the rise of cryptocurrency, allowing the hacker to easily receive the ransom anonymously, a task that would have been difficult a decade ago. As a matter of fact, the majority of illegitimate transactions on the dark Web are powered through crypto transactions. As any law enforcement official will tell you, the toughest bottleneck in receiving ransom is the financial drop-off. Cryptocurrency has effectively solved this problem. Remember that in most data breaches in recent times, like the Mobikwik customer data that ended up on the dark Web, the payment demanded was in bitcoins (Myre 2021).

That does not mean that the less tech-savvy financial frauds have decreased. Rather, these numbers have soared, especially after the global lockdowns were implemented, resulting in the common man spending greater time online, thus giving a

larger window of opportunity to the hackers. It is just that we see far greater degree of sophistication and technical innovation in the present-day attacks. Remember, both the Microsoft Exchange hack and the Solar Wind hack exposed multiple zero-day exploits (SolarWinds Security Advisory 2021).

Most times, the system vulnerability is due to mundane and almost silly reasons like outdated hardware, disgruntled employee, or software that has not been updated. In the case of Lal Path Labs, which found its entire data up for sale on the darknet, it was discovered that the database did not even have the rudimentary protection of a password (Jamie 2020).

The future is going to get even more complex and probably scary. Much has been said and written about the potential impact of technological advancements like 5G, machine learning, AI, quantum computing, and the Internet of things. These are the critical transformative technologies that will determine global prosperity in future. But these technologies are giving sleepless nights to the security community as the world is not yet ready to face these incremental challenges (Castagna 2021).

The fact is that the impact of many of these technologies is not known, and no practical assessment has been done so far. What though is undeniable is that with an unprecedented growth in connected devices, the possibilities of unlawful access would also be an existential threat, and the new tech has the potential to overwhelm the defenses of global network security. Just imagine the Stuxnet or Zeus or CryptoLocker powered by ML and spreading through the IoT nodes to infect every device on the network. That is what a digital apocalypse would look like.

16.3 The Rise of State-Backed Actors

Since the first Gulf War, the world has witnessed the disturbing trend, wherein hacker groups have started receiving state backing. Both China and Russia have encouraged and supported hacker groups and made such groups part of informal state policy to wage asymmetric warfare. A college system with an emphasis on mathematics and computer science means that there is no shortage of recruits.

The transparent method of thwarting cyberattacks has always been raising the cost of penetration. Thus if an organization has solid cyber defenses, the possibility is that a normal hacker would be discouraged from mounting an offensive, given that they are always looking out for low hanging fruits. This does not apply to state-backed hackers who have unlimited funds and sometimes even access to human resources on the ground to take down the defenses of the target.

Most of the major hacks over the last few years can be traced to state-backed hackers who are working toward implementing the states objectives. For example, the DNC hack used to target Hillary Clinton and push Trump's candidacy was supported by a well-backed social media campaign using bots and sock puppets and can be considered as one of the most successful hacks and was pulled off by hackers with the backing of Russian State (Nakashima and Harris 2018).

16.4 Critical Infrastructures in the Cross Hair

When successfully attacked by a hacker, critical infrastructures scattered by geography can have a severe cascading effect on the economy and social fabric. We witnessed a small montage of this with the Colonial Pipeline incident. In November 2020, the grid failure in Mumbai severely disrupted normal life in the city that was still reeling from the effects of the pandemic. The energy minister had stated that the grid failure was due to a cyberattack originating from China, though the Central Government did not comment on the matter. Recorded futures, a US company, had independently corroborated that Chinese malware codes were flowing through the network and had put the Chinese hacker group, Red Echo, behind the intrusion. Observers have opined that the attack if it was so was to send out a message to Government of India after the skirmishes in the Galwan Valley that led to casualties on both sides (The Print Team 2021).

The increase in the digitalization of many critical infrastructures especially in sectors such as oil, gas, and other associated industrial systems is altering the nature of cyber risks in the country. According to the Global Risks Report (2021), cybersecurity failures are among the world-attacks' top mid-term threats. Critical infrastructures are also increasingly shifting to automated control to reduce the human interactions, and control is devolved to centralized computing systems. The growth of interconnected systems and networks makes the system more vulnerable to malicious attacks. Also the use of robotics, sensors, and AI only increases the points of attack.

In February 2021, a hacker made an attempt in Florida to tamper with the chemical levels in the city's drinking water supply (Tidy 2021). The hacker had gained access to the water system with the help of a control system of the plant using a remote access program after then he tried to increase the levels of sodium hydroxide which would have invited a dangerous kind of situation. A supervisor detected the attack monitoring the computer system that reversed the chemical levels as soon the hack was detected, averting a crisis. Today, almost 80% of critical infra companies are privately owned. They are facing intrusion challenges from state-backed actors with infinite resources making the battle terribly skewed.

16.5 The India Story

India has been the second most affected nation by cyberattacks. And the pace of attacks is increasing relentlessly. In the first few months of 2021, India witnessed significant data breaches reported by Air India and Dominos, as both the two companies' databases get posted on the darknet for a price. In another bizarre incident, when Mobikwik, the payment solutions company, had a data breach with customer data, including personal data posted on the darknet,the company brazened it out by not accepting the data breach, despite overwhelming evidence to the contrary.

This was utterly contrary to accepted norms that ensured companies urgently share information of breach with the customers.

In 2020, when India came under a harsh lockdown to contain the spread of COVID-19, our digital networks started seeing an unprecedented surge of attacks, with as many as 1,158,208 attacks recorded, a 300% increase (Nanda 2021). The majority of these attacks can be confidently attributed to hackers operating out of mainland China. The reasons for the growth in cyberattacks could be the increased time spent online by the citizens, making them more vulnerable to cybercriminals and shift to the work from home model that compromised organization security protocols. Most of the attacks took the form of financial fraud, but the latter part of the year saw a growing number of major data breaches and a possible attack on the power grid in Mumbai. One of India's largest data breaches has been the Aadhaar data breach, where 1.1 billion Aadhaar details got leaked through multiple government databases (Sapkale 2019).

Cyberattacks pose a clear and present danger to the nation, both strategically as well as economically. The current digital economy comprises around 14–15% of our country's total economy and is expected to reach close to 20% by the end of 2024. India has more than 120 recognized "data centers", and it is important to mention that although India was one of the first countries to introduce cybersecurity policy in 2013 not much was done for the upgrading of a mature and coordinated cyber and its security approach.

Countries like the United States, United Kingdom, and Singapore have a single organization dealing in cybersecurity, but India on the other hand has 36 central bodies which is headed by ministries deals with cyber issues, and almost all has a different problem solving structure. The state governments have their own Computer Emergency Response Team (CERT). While CERT-IN has responded to cyber threats, it has been late in conducting security checks and has often released advisories once an attack has occurred. In the case of WhatsApp and Pegasus malware, CERT-IN only came in after others had warned of the possibility of individuals being compromised.

There are multiple agencies operating in the national cybersecurity landscape. National Technical Research Organization (NTRO) handles the technical intelligence gathering functions around various sectors including aviation, space and telecom, data management, cybersecurity functions, encryption, and software systems. The National Critical Information Infrastructure Protection Center (NCIIPC) which operates under the NTRO is the national nodal agency for critical information infrastructure protection and is now also covered under the IT Act.

CERT-In is the premier agency that is responsible for the overall cybersecurity mechanism for the nation. This was the agency that had for the first time flagged security concerns for Android Jelly Bean and Kit Kat. Being the nodal agency, CERT-In receives operational intelligence from its situational awareness and threat intelligence systems. Whenever a breach or malware is discovered, the organization issues an advisory to the concerned parties. It also forecasts and alerts of cybersecurity incidents, provides emergency measures for handling cybersecurity incidents, and coordinates cyber incident response activities.

16.6 North Eastern India and Cyber Risk Evaluation

Looking at the complex challenges of cybersecurity and juxtaposing them on the north eastern region presents a unique set of challenges. The NFHS-5 survey has thrown up some very disturbing figures with Meghalaya (42.1%) and Assam (42.3%) at the bottom of the Internet usage chart in the country. Against that Sikkim and Mizoram are at the top of the charts with almost three quarters of the population online (NFHS-5 2021; see also, Chari et al. 2020). But these numbers are slated to rise diametrically. While we will go into the sustainable development program and its focus on cybersecurity a little later, it is essential to mention that of the 17 goals under the SDG program, 13 rely heavily on digitization and delivering governance through cyberspace (The 17 Goals n.d). This alone will probably increase the number of netizens in the north eastern region by 50% in a short space of time.

On the other hand, a quick look at the incidence of cyber frauds gives us a bleak picture. According to the report released by the National Crime Records Bureau (NCRB) in (2018), the rate of cybercrimes in the state of Assam is 6.5 (defined as the number of crime per one hundred thousand population), the third-highest in the list of all states and union territories. The potential explosion in cybercrimes can be well imagined by the fact that even with the second-lowest internet usage across the nation, the state ranks near the top in the rate of cybercrime.

A cybersecurity think tank had conducted several surveys in October 2020 in the state of Assam to figure out the public awareness with respect to cybersecurity and cyberattacks. Similar surveys were conducted in the other neighboring states, including Meghalaya. The data generated was hugely worrying as the majority of the respondents had not filed a police complaint despite facing some form of cyberattack, while only a meager 12% decided to approach the police (The Shillong Times 2021). Interestingly enough, almost 73% of the respondents stated that they faced some form of cyberattack. These are numbers that should give the law enforcement officials sleepless nights as that means the absolute number of cybercrimes happening in the state would be almost five times more than the reported number of cases. The other worrying fact is that the response mechanism has time and again failed the victim.

The recent case reported in Silchar involved an SBI officer losing INR 314,000 to cybercriminals as the officer was asked to pay a sum of INR 11 to bsnl.rechargecube in the process reveals his net banking details (Barakbulletin 2021). The victim was immediately locked out of his account, and despite rushing to the police station immediately to lodge a complaint, INR 3.14 lakhs had been siphoned off to two bank accounts and one PayTM account. The incident was newsworthy primarily because an ex-bank official ended up losing money and that too, a lot of money. But the aftermath of the story is what makes the case really interesting. Three days after the incident, the victim's wife checking on her husband's account realized that despite reporting the hack, the bank (SBI) had not restricted the victims net banking account resulting in an additional INR 1.579 million withdrawn from the fixed deposit accounts in the form of overdraft. This incident illustrates the level of apathy that becomes a boon for the cybercriminals allowing them to flourish. Of course, as per

the RBI circular released in 2017, a bank customer will have zero liability from the moment he has reported the incident, which means the victim in this case will not lose his life's savings, but that does not absolve the bank of gross negligence.

The region has also been witnessing a veritable explosion of QR code frauds. The eastern states in the country are witnessing high levels of online frauds through payment apps and online marketplaces. TrustCheckr, a software company, located in Bengaluru reported that states like West Bengal, Odisha, Bihar, Jammu and Kashmir, Himachal Pradesh along with all the north eastern states are facing frauds in KYC, cash-back offers, false digital wallets, fake-selling, QR codes, UPI phishing, and lottery scams. About 20% of the QR Code scams originate from the north eastern state Assam. In QR code frauds, most fraudsters posed themselves as a defense person selling. TrustCheckr identified over 1 million frauds in B2B and B2C, and the majority of the scams are around fraud in KYC, fraudulent cash-back, digital wallet theft, counterfeit, QR codes, UPI phishing, lottery threats, and money laundering on social networking sites. Most scams involved people purportedly from the armed forces advertising goods on electronic marketplaces. In the last 15 months, about 25% of scams have taken place in the know your customer (KYC) and 20% in QR codes, while the B2B scams were largely accomplished with 25% synthetic identity frauds and 30% fake identities (Sentinel Digital Desk 2021).

All indications are that the north eastern states are fast growing into hotspots for financial cyberattacks, and the law enforcement agencies are in a tizzy trying to figure out a way to control the spread of financial frauds through phishing (Hadnagy 2018). The problem is that cybercriminals are fast reinventing themselves and creating better and better scenarios. For instance, in the middle of the pandemic and the central vaccination drive, people started receiving OTPs ostensibly for vaccine appointments despite not having registered on the COWIN site. While no actual case has been discovered of a data breach or financial loss, the fluidity in creating new plays by the hackers should be of concern.

Apart from the usual financial frauds, some of the other major hacks in the region have been:

1. Manipur Government's Manipur.gov.in was infected with Japanese Keyword Malware as reported on February 2021. It was spamming Japanese scripts on the official site and had the ability to hijack all the key search results of the site.
2. In August 2020, the Nagaland Government's E-commerce Platform "Invest and Development Authority of Nagaland" was also infected by malware, redirecting the visitors to unwanted pop-ups and links. The Nagaland State Biodiversity Board Website was hacked in the same year, and the hackers displayed the Pakistan Army Zindabad message on the page.
3. In 2012, Mizoram Government's site Dpar.Mizoram.gov.in was hacked and defaced.
4. In January and February 2021, a series of Websites of the popular educational institutes in Barak Valley of Assam was hacked.
5. In February 2021, Gauhati University's Website was hacked, and a Valentine Message was displayed on the screen.

Most of these events have not involved deep penetration attacks using ransomwares or malwares and have been reasonably simple from a technological perspective. However, that does not reduce the concerns that are being witnessed in the region due to cyberattacks.

Financial frauds aside, the other area of concern is the spread of online misinformation in a structured fashion, intended to disturb the peace. The north eastern region of India comprising of the eight states—Assam, Nagaland, Manipur, Arunachal Pradesh, Mizoram, Tripura, and Sikkim had its issues around identity and conflicts. Many of the insurgency movements in the region have been resolved recently and as the government wants to bring lasting peace to the region by solving the remaining ones including the Naga insurgency movement, which started in the 1950s. The reasons for the respective conflicts are wide-ranging from separatist movements to inter-community, communal, and inter-ethnic conflicts (Bhattacharyya 2018, 2019; Bhattacharyya and Pulla 2020a, b). To add to the several problems of the region, malicious interference by Chinese backed actors has been constantly targeted at the region, which includes carrying out online misinformation campaigns to disrupt the local peace. The north eastern region of India happens to be one of the most violent regions in the country (Bhattacharyya 2018, 2019; Bhattacharyya and Pulla 2020a, b), and a concerted campaign of misinformation can cause severe repercussions in the region.

The spurt of violence in north eastern states after the Citizenship Amendment Bill was enacted as a law in December 2019 saw a huge misinformation (ANI 2019; Sarma and Bhattacharyya 2021) campaign authored by groups that probably had allegiance to international players, which aimed to exacerbate the situation. The indigenous population of the region were concerned about losing out elements of their culture due to the influx of outsiders while the so-called "outsiders" were worried about the violent ramifications of the new law. The spread of misinformation was targeted at both groups that raised fears and fueled further violence. The situation deteriorated fast, prompting the army to issue an official advisory to the citizens to be cautious of spreading fake news (ANI 2019).

Another long-running urban legend being pushed via social media and instant messaging apps is that a small group of outsiders are roaming the region and looking to kidnap small children (please see, Bhattacharyya 2017) for nefarious purposes. The fake news has already claimed two young lives in 2017 through mob lynching in Assam (Karmakar 2018), but similar stories are still getting circulated. The region is even now sitting on a power keg, with almost 1.9 million people being left out of the National Registrar of Citizens (Sarma and Bhattacharyya 2021); a concerted misinformation campaign can rekindle the insurgency in the region. The new Information Technology (Intermediary Guidelines and Digital Media Ethics) Rules have aimed to target the origin of such news as the cybercriminals behind these insidious campaigns have long hidden behind the veil stitched by the anonymity of end to end encryption. The need for attribution trumps the need for privacy, given that lives are being lost due to the spread of fake news.

Coming back to the Chinese interests in the region, we must remember that the Doklam crisis was the Chinese creeping closer to the Siliguri Corridor, a long-term objective to cut off the north eastern states from the mainland. China has also continued to claim Arunachal Pradesh as Chinese territory. As a matter of state policy, China has over the years kept the insurgency in the region alive by supplying the insurgent groups with arms and financial aid (Bhalla 2016). With growing digitization in the region, including ramped up digitization of the oil pipelines and power grids, the region is becoming hugely vulnerable to asymmetric warfare conducted by external hacker groups based out of Chinese soil.

The problem is that no independent assessment has been made of the vulnerabilities in the region's critical infrastructure, thus making any kind of predictions irrelevant. While most significant states facing organized cyberattacks have a state CERT, Assam and the other north eastern states are an exception. Given the region's strategic importance, local state CERTs or a common north eastern CERT must be set up to tackle the growing problem of cyberattacks and act as the regional nodal body to author the appropriate response. The Cyberdome project (Radhakrishna 2019) of the Assam government is a good initiative, but it has to be well structured to undertake CERT functions and do threat mitigation and train law enforcement authorities on cyber investigations and forensics. With almost 75% of the regional population expected to be online by 2025, the region can expect to start reaping the benefits of digitization, but it cannot be accomplished without developing strong cyber resilience as that would leave the region vulnerable to the worst of the worst cyberattacks. The region needs to develop a graded risk approach along with vulnerability testing to address the problem at hand.

16.7 The Current Response Model

The National Cyber Security Policy announced in the year 2013 was devised to give an umbrella approach for ensuring a safe and secure cyber experience to individuals and businesses alike and also help in capacity building around the overall cyber security ecosystem as well as fostering economic opportunities among youngsters and start-ups. Cybersecurity management was the key focus of the policy. It is this policy directive that determines our response to incidents in cyberspace.

The model has multiple lacunas, the primary being the communication between the public and private bodies. We must remember that the majority of institutions hit by cyberattacks are private organizations that most times do not even know who to call and report the breach. These private organizations are battling hackers with the backing of enemy states with almost infinite resources. And that is a battle that cannot be won. The security of our networks is too important to leave in the hands of the private industry.

In the north eastern states, the majority of the cyberattacks are directed at individuals or small mom and pop outlets and take the form of financial frauds. In this context, the greatest enemy is lack of awareness. The survey undertaken by the

Cyber Peace Foundation (PTI 2020) has clearly demonstrated that a majority of the population are unaware of online financial frauds through phishing. Even when the individual is aware of cyber frauds and the need to protect personal data, they are not very comfortable going to the law enforcement to report an act of data breach. This might also stem from the fact that local law enforcement in India does not actively investigate cybercrimes other than lodge a complaint unless the case is in the media's eye.

The other major problem with individual users is that they do not update their applications or apply security patches on a regular basis. Adobe Acrobat has been regularly releasing software patches, but most people using the Adobe softwares do not apply these patches regularly, resulting in intrusions through the software, a common occurrence in most small communication agencies. Obsolete hardware and software remain one of the most significant causes for the data breach.

The COVID-19 pandemic has driven people to work from home, resulting in an explosion of cyberattacks as the basics of cybersecurity are thrown to the winds. At the same time, the pandemic spurred the use of digital payments, which has also been a factor behind the increase in cyberattacks (Parent 2020).

It is also high time that cybersecurity compliance is made mandatory and regulations to handle data breaches. The passage of the Personal Data Protection Bill 2019 currently with a select parliamentary committee will address these issues. Take the case of Mobikwik (The Hindu BusinessLine 2021), who should have informed its customers about the data breach to enable the said customer to take protective action. Instead, the company has maintained innocence, probably as they are in the process of coming out with an initial public offering. CERT-In could has pushed through a third-party audit, but strangely that has not been ordered.

16.8 Cybersecurity Response Model for the Future

India faces one of its toughest challenges as we are subject to persistent and sophisticated malicious cyberattacks that threaten our institutions. North eastern states in particular will face the growing menace of cyberattacks as the government will look toward achieving universal digitization to improve the delivery of governance to the citizens. That will be accompanied by increasing risks. What we must realize is that the digital world has completely metamorphosed over the last seven years. The cyber threats today are far more complex, and this complexity will only grow with time. It is time to take bold decisions if we are to win this asymmetric war that has been fostered on us. Incremental changes will just not do. To tackle this menace, a structured approach and an institutional rethink are necessary. Here, I will try and list down some broad approaches that will help better respond in this digital battlefield as far as north eastern India is concerned.

1. ***Public Private Partnership***: Cybersecurity is too important and complex to be left to the private organizations. In the absence of a Personal Data Protection

Act in place, the companies have no real incentive to push for cybersecurity in their networks except for compliance. That has to change and change fast. The organizations have to be incentivized to consider cybersecurity as a key parameter of evaluation. That means either put punitive penalties for data breaches or the possibility of monetizing the data held by an organization. Today, organizational databases are sold for huge sums of money on the darknet but do not even have notional value when the same data is registered on the balance sheet. Secondly, we need an apex response body for cyber incidents, but the same body must have private members to eschew better coordination and communication. It is also extremely urgent that the law enforcement agencies work with various private and not for profit bodies to build awareness among the public on the nature and quantum of cyber risks and ways to negate the same. And this has to become an ongoing exercise if we want the citizens to be genuinely prepared to tackle the cyber threats.

2. ***Money, Money, Money***: Battles are won with resources and that takes money. The problem is that most organizations and even the government will pay lip service to data security but when it comes to actually doing something, monetary restrictions will crop up. On the other hand, the hackers at the other end have humongous resources and all the time in the world. This is a battle that can be won only with huge sums of money. The government made a start this year by allocating INR 1500 million to cybersecurity in the Union Budget (Union Budget 2021; see also, Mali 2021), but the sum is too insignificant to really make a difference. A budget has to be set aside for cybersecurity and network upgradation to tackle obsolescence at the state levels.
3. ***Weakest Link***: The commercial networks and public networks operate in an interconnected world as no network in the twenty-first century can be truly standalone. Therein lays the opportunity for the hacker who looks to target the weakest link in the chain. In the case of the SolarWind hack, the weakest link in the chain was the Orion system which could have been identified and protected better if the users could have done an honest analysis of the weakest chain. As work from home becomes an accepted part of life in the north eastern region, individual connections will need to be analyzed and strategies designed to lower risks.
4. ***Securing the Telecommunication Link***: In one of the most significant attacks of its kind in 2016, malware took control of the computing power of millions of video cameras connected to the Internet. These networked computing devices were harnessed to mount a massive DDOS attack and take down large parts of the Internet. The telecommunication chain is the most vulnerable part of the Internet. Huawei is not a part of the 5G test rollout because the company has often been referred to as an arm of the Chinese Communist Party and has been accused of using its devices to act as listening posts. But just removing Huawei from 5G rollout is not enough. The telecom link is often the most used node for entry into a system. Securing the chain is an important element of cybersecurity. Last year, the Department of Telecommunications in a bid to boost indigenization as well as improve the network security ruled that for future telecom supply, only trusted vendors whose list would be released by the government would be

acceptable (BS Web Team 2020). But this precluded existing contracts. Given the strategic nature of the north eastern states, it would be imperative to vet all existing contracts and secure the telecommunication chain at the earliest.

5. ***Data Protection Bill***: Without a legislative framework for personal data protection which penalizes data breaches, we cannot create a resilient cybersecurity model. It is indeed worrying that the Parliamentary Panel has still not approved the final bill to be tabled in the Parliament (PTI 2021). Delay in this matter can be calamitous.
6. ***Graded Approach***: The north eastern states need to apply the same graded approach to cybersecurity that is the accepted practice nationally. That means critical infrastructures will be at the top of the list of priorities. A complete evaluation of cyber risks should be at the top of the regional agenda to better prepare for the stormy times ahead.

16.9 Conclusion

The fast changing digital landscape is continuously throwing new challenges at network security, and both India as well as the narrow north eastern region will be targeted in future. If we do not prepare now, we will be putting our nation at grave risk. With the adoption of the Sustainable Development Goals (SDG) for 2030 as one of the key indicators, cyber capacity building and systematically linking these efforts with its development cooperation funds will become a key imperative. In the cybersecurity sector, the desired impact and the overall objective are to provide the citizens of the north eastern region an open, free, secure, resilient, and peaceful cyberspace. Reference to this can be found as a target under SDG 9 which states to "build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation", as well as under SDG 4 which states the introduction of "quality education", SDG 8 backs on "decent work and economic growth" and SDG 16 on "peace, justice, and strong institutions" (The 17 Goals n.d). Given the focus on SDGs in determining growth parameters, cybersecurity has to now take the center-stage. That will go a long way in ensuring a safe and resilient digital society in north eastern region.

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Part III
Case Studies

Chapter 17
Sustainable Development Goals and Assam—A Roadmap to a Better Future

Payel Saha, Syeda Fahima Shahnaz Sultana, Ankabehari Saha, and Madhushree Das

Abstract The Sustainable Development Goals (SDGs), with a set of 17 intertwined goals and 169 targets to fulfill, is a burning topic of the world now. Accepted and adopted as a part of the 2030 Agenda for Sustainable Development in 2015, the SDGs represent an ambition, a vision and a measure of sustainable development. Put simply, it's a target to achieve. The North-Eastern state of Assam became the very first Indian state to adopt the SDGs and set in motion a robust process to implement them. First with the adoption of 'Vision Assam 2030' and later with "Assam 2030: Our Dream, Our Commitment", the Government of Assam tries to implement the SDGs at the grassroot and localized level. This chapter tries to assess the impact of the SDGs in Assam and also further delves into the growing awareness, tries to evaluate the performance of the SDGs and attempts to draw a roadmap to improve the transparency of the local governmental activities in implementing and achieving SDGs. Based on secondary data analysis, the performance of SDGs in Assam is traced through the state-specific SDG indicators, SDG India Index score, budgetary allocation, CSR, NFHS data and so on. Sustainable development is the need of the hour for a better and inclusive growth, and this necessitates the evaluation of the SDGs, the rationality of adoption and the impact of the SDGs at the local level, and effective monitoring.

Keywords Assam · CSR · Growth · Impact · NFHS · SDGs

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17.1 Introduction

Sustainability is a concept of late 1980s. Brundtland Commission Report of 1987 made use of the term for the first time. Since then, the popularity of the idea is on the rise. Be it Earth Summit of Rio in 1992, Kyoto Protocol or other summits of various other times, sustainability and sustainable development has always been at the centre stage. The idea of sustainable development, while popular, had no definite measurement. No definite guidelines. As such, each country had their own idea of sustainability and went on with achieving the said sustainability in their own purview. This diversification hamstrung the successful implementation of the said idea. Thus, "Sustainable Development Goals", a unique idea to lead current global society towards sustainable and better future, was adopted on 25th September, 2015 in United Nations General Assembly. Representatives of 193 countries unanimously accepted and adopted the 169 targets spanned between 17 goals to promote global peace and prosperity. Sustainable Development Goals (SDGs) calls for eradication of poverty, increasing quality of life, zero hunger and malnutrition, climate change, easing economic inequalities and so on. The idea of SDGs was sown in the United Nations Conference on Sustainable Development at Rio de Janeiro, Brazil in 2012 and bore fruit in 2015. The focus hones on overall improvement of quality of life. However, the goals also stressed that no one would be left behind in quest of development. The goals are designed to improve life in a sustainable way, for the next generations to come. Core principles of SDGs encompasses Planet, People, Peace, Prosperity and Partnership.

India has played an all-encompassing role in formation of SDGs and spoke for developing countries in United Nations. India has defined the contours of SDGs through Addis Ababa Action Agenda, Agenda 2030 and so on. India officially committed herself to SDGs on 1st January, 2016. NITI Aayog is the national level coordinator for implementations of SDGs. Ministry of Statistics and Programme Department (MoSPI) has been tasked with regional indicators and coordination between states for achieving targets enshrined in SDGs.

Assam was the first state of India to accept and implement SDGs as the futuristic way to development. Official order 'Ref. No. PDP 55/2015/63 dated 28/12/2015' formally adopted SDGs as the pathway to development. Since then, Assam Government has tried numerous policies to adopt and adapt to SDGs. A dedicated Centre for Sustainable Development Goals (CSDGs) has been established in 2016 and is acting as the coordinator between various departments pertaining to SDGs in Assam, most notably, Planning and Development Department. CSDGs has also been in the forefront, emphasizing importance of SDGs in Assam. CSDGs further emphasizes on integrating and assimilating SDGs in existing planning and development programs. It has also played a vital role in preparing 7-year strategic plan and 3-year annual plan, budgets and is synchronizing state and district level affairs to suit SDGs. This Centre was asked

1. To spread knowledge, awareness, and understanding on SDGs to every group at every level of politics;

2. To study Assam's success rates for the implementation of MDGs and SDGs, and identify the barriers to this,
3. To synchronize all the Governmental activities related to the SDGs at all levels and;
4. For the purpose of contributing to SDG-related work and projects.

Govt. of Assam released a Vision Document 2030 on 10th February, 2016 in a conference where almost 250 stakeholders were present. Advisor to United Nations Secretary General on SDGs, Jeffery Sachs also was in the presentation. According to him "It is truly a milestone that Assam is first to produce the 1st SDG Vision Document in the world. SDGs are really a bold idea for sustainable development and your grasp of the SDGs is a bold addition and it is an inspiration to all. Adoption of SDGs in the state in mission mode will rejuvenate the whole world. Assam will become the world leader in sustainable development."

The present chapter tried to evaluate the status of SDGs in Assam. It has been almost 5 years since the alignment of the state development plans with that of the SDGs, and it is a high time to evaluate the performances of various departments pertaining to SDGs. The authors tried to assess the performance of Assam in moving towards the SDGs based on the factors identified and worked on by the Centre for Sustainable Development Goals (CSDGs).

17.2 Study Area

Assam, a gateway to the north-eastern India, is known for its picturesque landscape, hillocks, blue hills, red river, flora and fauna. Extending from 24° 10′ N to 27° 58′ N and 89° 49′ E to 97° 26′ E with an area coverage of 78,438 km^2 (app.), this state is bounded by Arunachal Pradesh and Bhutan in the north, Meghalaya, Tripura, Mizoram and Bangladesh in the south, Nagaland and Manipur in the east and West Bengal in the west. The presence of three out of six physiographic divisions of India enhances the beauty of the state, namely the Northern Himalayas (Eastern hills), the Northern Plain (Brahmaputra plain) and Deccan Plateau (Karbi Anglong). Assam is the largest north-eastern state of India in terms of population having a boastful population size of 3.12 crore (Census, 2011) distributed in 33 districts and population density of 398/km^2, whereas second in terms of area. Its literacy rate is 72.19% (Census, 2011). The state is connected with the rest of India via a narrow strip in West Bengal called the "Siliguri Corridor" or "Chicken's Neck". The capital of Assam is Dispur. The climate of Assam is attributed as "Tropical Monsoon Rainforest Climate" with high humidity and heavy rainfall. Majuli, the world's biggest river island in Assam on Brahmaputra river made the state more glorifying (Fig. 17.1).

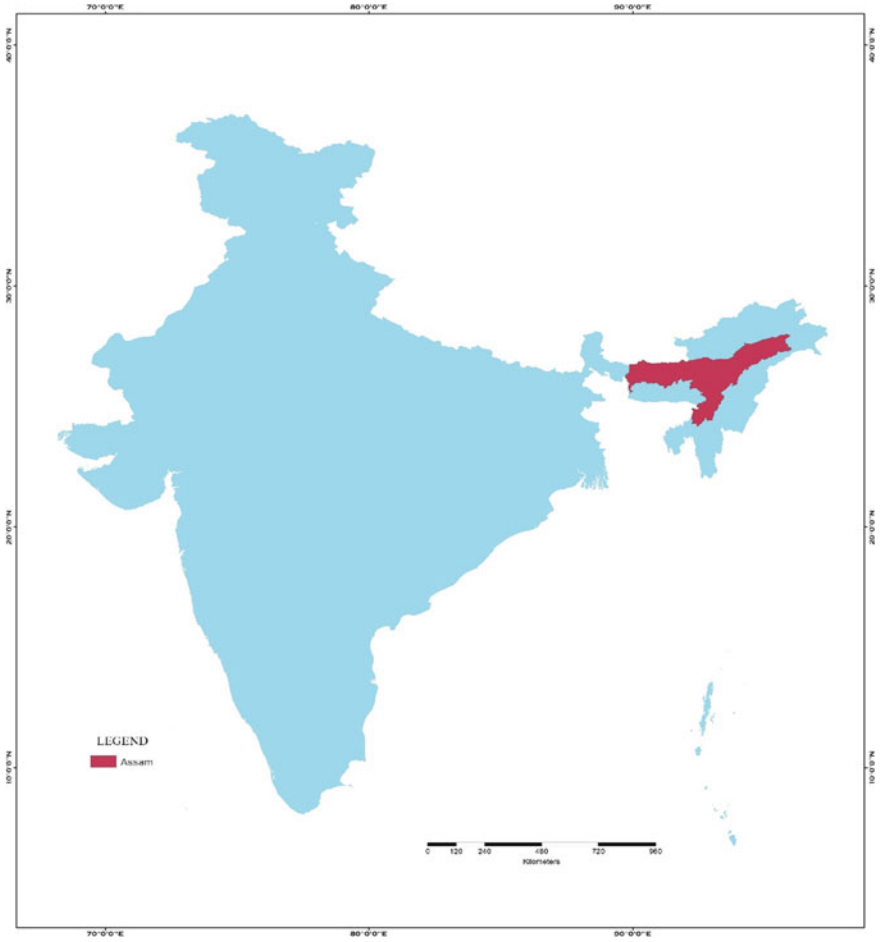

Fig. 17.1 Location map of the study area

17.3 Related Researches

The concept of SDGs while decades old, is formally introduced and accepted in 2015. But, the idea of sustainable development is decades old. Since 1972, sustainable development has been gaining popularity and was formally termed and introduced at 1987. SDGs are but a measuring stick of the efficiency of the policies and plans taken by govt. to achieve Sustainable Development through some selected goals and objectives. Bali Swain and Yang-Wallentin (2020), Costanza et al. (2016), Quoquab and Mohammad (2020), Lönngren et al. (2016) has discussed the concept, theoretical framework and workings of SDGs in length. Lönngren et al. (2016) specifically pondered the multidimensionality of the concept of SDGs. Kropp and Lein (2013)

discussed the multicriteria approach on SDGs, enabling it to perform to best of its abilities, whereas Falebita et al. (2020) dwelled on the perspective of social uncertainty in the face of potential socio-cultural changes brought on by SDGs. Isar (2017) emphasizes on cultural aspects of sustainable development and cultural policies that should be undertaken from a contrarian view. Swain (2018) had tried to critically analyse the concept and applicability of SDGs. True to the belief of Sustainable Development, "Stop and Go", a concept introduced by Griffith Taylor, is the theme in these articles. However, the concept itself cannot function without a scientific measurement. The need of assessment of SDGs is aptly broadcasted in Hák et al. (2016). On that note a further flurry of research articles followed in Robert et al. (2005), Parris and Kates (2003), Pearce et al. (1996), Kaye-Blake et al. (2019) discussing the indicators that can be used for evaluating SDGs and its fulfilment. Lyytimäki et al. (2013) stressed on the uses and misuses of the criteria selected to assess the performance of SDGs. The govt. policies and implementation of SDGs is very important for the SDGs to be successful. Fitsilis and De Vrieze (2020), Miola and Schiltz (2019) discusses quite in length about the impact of policies and procedures enabling Govt. to implement SDGs to the best of their abilities. Moran et al. (2008), Nagy et al. (2018), Cobbinah and Darkwah (2017), Maruatona (2012), Fung et al. (2020) concentrated on national, regional and even local level implementation of SDGs in various corners of the globe be it largescale at Africa or local metropolitan area of Romania. The theme of the articles basically is application of the existing knowledge into practical reality.

17.4 SDG India Index 2018 and Assam

The NITI Aayog constructed the SDG India Index 2018 as a means to assess the progress of the different States and Union Territories in achieving of the targets of the SDGs. Spanning across 13 out of 17 goals except Goals 12, 13, 14 and 17, the index evaluates the performance of the States and the UTs on a set of 62 Priority Indicators which measures the progress made on the outcomes of the interventions and schemes adopted by the Government of India.

Assam has scored a composite score of 49 in the SDG Index Score for Sustainable Development Goals which makes it an aspirant and is also the third lowest performer among all the states. The highest score as obtained by the state of Himachal Pradesh is 69 and the composite score for India is 57. In case of individual SDGs, Assam has been a leading state only in case of Goal 15 with a score of 100 in the SDG India Index and has been a "Front Runner" with a score of 75 in case of SDG 10. With a score of 53 for Goals 1, 2 and 16 each, a score of 54 for Goal 4 and with a score of 61 for Goal 8, Assam has been a "Performer" for five SDGs out of thirteen, and for six SDGs, Assam's score ranged between 18 and 42, making the state perform in the category of "Aspirant". Thus, despite being the early adherer of SDGs, Assam has slacked in achieving of the same (Table 17.1).

Table 17.1 Assam's performance in the SDG India Index 2018

SDGs	Achiever (100)	Front runner (65–99)	Performer (50–64)	Aspirant (0–49)
SDG 1			√	
SDG 2			√	
SDG 3				√
SDG 4			√	
SDG 5				√
SDG 6				√
SDG 7				√
SDG 8			√	
SDG 9				√
SDG 10		√		
SDG 11				√
SDG 15	√			
SDG 16			√	
Composite SDG				√

Source SDG India Index: Baseline Report 2018

17.5 SDG Indicators and Assam

The Government of Assam has identified and determined 59 state-specific core SDG indicators and benchmarks for fulfilling the SDG targets (https://transdev.assam.gov.in/portlet-innerpage/sdgs-implementation-status-in-assam). These indicators are assessed in this study to understand the current status of the Sustainable Development Goals in the state as-well-as the performance of Assam in the SDG India Index 2018 as shown above.

17.5.1 Goal 1: End Poverty in All Its Forms Everywhere

The first Sustainable Development Goal which aims at abolishing poverty from the world has been assigned seven targets which are to be achieved through the indicators fixed for each of the targets. The Government of Assam has identified one state-specific indicator to achieve the target of eradicating poverty by the year 2030 in the state (Table 17.2).

As recent data regarding the proportion of the population living below the national poverty line or the Poverty Head Count Ratio is not obtained yet for the state of Assam, the data of the baseline year 2011–12 is considered to be valid till the point.

The Poverty Head Count Ratio for Assam stands at 31.98% for 2011–12 which is a decrease against the previous 37.9% for 2009–10. The number living below the

Table 17.2 State-specific indicator and target—Goal 1

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
1.1 Poverty head count ratio	31.98 (2011–12)	22.1 (2011–12)	21.92 (2011–12)	0

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, MDG India Country Report (2015a, b), Sustainable Development Goals National Indicator Framework Progress Report (2020)

poverty line as estimated in 2011–12 using the Tendulkar Committee approach is 10.13 million (Handbook of Statistics on Indian States n.d.; Gaur and Rao 2020). The rural Assam has 33.89% of its population living below the poverty line while the urban, has 20.49%, thus indicating the prevalence of socio-spatial disparity between rural and urban Assam (Statistical Hand Book Assam 2019). Mahatma Gandhi National Rural Employment Guarantee Act (NREGA), National Rural Livelihood Mission, Deendayal Upadhyay Grameen Kaushalya Yojana, National Social Assistance Programmes (NSAP), etc., are some initiatives adopted by the State.

17.5.2 Goal 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture

The second goal which focuses on ending hunger, the achieving of food security and improved nutrition, and also the promotion of sustainable agriculture, has eight targets which are set to be achieved through 14 indicators. The Assam State Government has assigned three state-specific indicators to the achieving of the same.

As evident from Table 17.3, the proportion of underweight children within 5 years of age has increased by 3.00% between 2015–16 and 2019–20 for the state, whereas for the entire nation a decrease of 2.30% has occurred (Joint child malnutrition estimates n.d.). On the other hand, the proportion of women falling in the age group 15–49 years and who are anaemic has increased by 21.10% between 2015–16 and 2019–20 for Assam. However, the production of rice per hectare of land cultivated increased. Both, the increase in the number of underweight under-five children as-well-as the number of anaemic women of 15–49 years, reflect the performance of the state to be non-satisfactory with a score of only 53 in the SDG India Index 2018.

Some schemes adopted by the State Government of Assam for maternal and child nutritional development include POSHAN Abhiyaan, Integrated Child Development Services (ICDS), Assam Affordable Nutrition and Nourishment Assistance Yojana (Anna Scheme), etc., and certain schemes to increase the agricultural production, and help farmers of the state, are Assam Farmer's Credit Subsidy Scheme (AFCSS), Samagra Gramya Unnayan Yojana (CMSGUY), Pradhan Mantri Fasal Bima Yojana (PMFBY), etc.

Table 17.3 State-specific indicators and targets—Goal 2

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
2.1 Proportion of children within the age 5 who are underweight (%)	29.8 (2015–16)	19.9 (2015–16)	35.70 (2015–16)	0
	32.8 (2019–20)	21.5 (2019–20)	33.4 (2017)	0
2.4 Proportion of women within age 15–49 who are anaemic (%)	44.80 (2015–16)	38.6 (2015–16)	50.40 (2015–16)	0
	65.9 (2019–20)	46.01 (2019–20)		0
2.5 Average yield of rice (kg/ha) of land cultivated	2119 (2014–15)		2390 (2014–15)	4238
	2271 (2018–19)		2619.5 (2017–18)	4238

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, NFHS-5, Statistical Hand Book Assam (2019), Joint child malnutrition estimates (JME)

17.5.3 Goal 3: Ensure Healthy Lives and Promote Well-Being for All at All Ages

The third Goal which promotes healthy lives and well-being for all has 13 targets and 26 indicators. The Government of Assam has identified six state-specific indicators to achieve the targets defined (Table 17.4).

There has been significant decrease in the maternal mortality ratio, child (under 5) mortality rate, and infant mortality rate for Assam. Though both the three indicators are lower at the national average, the rate of decrease for the three is higher for Assam than the nation as a whole, thus, indicating improved child and maternal healthcare facilities in the state. The proportion of births attended by trained medical personnel has too amplified by 20.60% for the state between 2015–16 and 2019–20. No recent number of allopathic doctors has been able to be procured for the study. Janani SurakshaYojana (JSY), Janani Shishu Suraksha Karyakaram (JSSK), Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA), are some of the schemes run by the State for ensuring healthy lives of children and mothers.

The increase in road accidents caused fatalities for Assam while the decrease in the same for the entire country, arise questions on the road safety standards of the state. Numerous activities have been adopted by Government of Assam Public Works (Roads) (PWRD), under the aegis of Road Safety Management Component of World Bank aided Assam State Roads Project (ASRP) for improvement of road safety on its State Highways and Major District Roads. The Assam Road Safety Action Plan (ARSAP) too has accorded high priority to the achieving of improved road safety in the state. Actions as Identification and Mitigation of Black Spot, Safe Corridor Demonstration Program (SCDP)-I, II and III, have been undertaken.

Table 17.4 State-specific indicators and targets—Goal 3

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
3.1 Maternal mortality ratio (deaths per 100,000 live births)	300 (2011–13)		167 (2011–13)	70
	237 (2014–16)		130 (2014–16)	70
	229 (2015–17)		122 (2015–17)	70
3.2 Child (under 5) mortality rate (deaths per 1000 live births)	62 (2015)	35.7 (2015)	43 (2015)	25
	48 (2017)	30.3 (2019)	37 (2017)	25
3.3 Infant mortality rate (deaths per 1000 live births)	49 (2014)	29.6 (2015)	39 (2014)	18
	41 (2018)	25.1 (2019)	32 (2018)	18
3.4 Proportion of births attended by trained medical personnel (%)	74.30 (2015–16)		81.40 (2015–16)	100
	94.9 (2019–20)			100
3.5 Number of allopathic doctors (Government and NHM) per 100,000 population	12.0 (2014)		51.2 (2011)	100
3.6 Fatalities from road accidents (per 10,000 km of roads)	84.7 (2013)		317.0 (2013)	42.3 (by 2020)
	86.3 (2018)		284.8 (2018)	42.3 (by 2020)

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Sample Registration System Statistical Report (2018), NFHS-5, Road Accidents in India (2019), Sustainable Development Goals National Indicator Framework Progress Report

But despite the programmes and schemes adopted and implemented by the State Government, Assam's performance in the SDG India Index 2018 has been poorly reflected.

17.5.4 Goal 4: Ensure Inclusive and Equitable Quality Education and Promote Lifelong Learning Opportunities for All

The Goal 4 of the Sustainable Development Goals has 10 targets and 11 indicators which aim at ensuring inclusive and equitable quality education and facilitate learning opportunities for all. The Government of Assam has determined seven state-specific indicators for fulfilling the targets of the Goal 4.

Table 17.5 depicts an increase in the net enrolment ratio at upper primary, secondary, and higher secondary level of education in the state. The highest increase in the net enrolment ratio has occurred at the upper primary level for the state. There also occurs a notable decrease in the dropout rates at the primary level with the rate decreasing by 9.76% in a year period between 2015–16 and 2016–17. The dropout rate has increased at the secondary level of education in Assam by 0.54%.

Many schemes have been adopted by the State Government of Assam to ensure equitable, quality and inclusive education. AAROHAN, SAPTADHARA, waiving of Examination fees and centre fees for poor students appearing in HSLC and HSSLC examinations, scholarships, implementation of GUNOTSAV, waiving of school affiliation fees, introduction of Tele-Education through Virtual Classrooms, etc., are a few schemes and actions adopted by the State.

17.5.5 Goal 5: Achieve Gender Equality and Empower All Women and Girls

The Goal 5 aiming at achieving of gender equality and empowerment of females, has nine targets and 14 indicators. A total of five state-specific indicators have been identified and assigned by the Government of Assam to the achieving of the targets of SDG 5 (Table 17.6).

The female to male literacy ratio is higher for Assam than the national average. The current literacy rate in Assam is 85.9 as per the survey conducted by the National Statistical Organization (NSO). There thus is an increase in the literacy rate of the state as compared to the literacy rate of 73.18 in the Census 2011. The female literacy rate is 81.2, while the male is 90.1 for Assam (Household Social Consumption on Education in India 2017–18, 2020).

For the state, the ratio of female to male work participation rate is lower than the average for the country. If women empowerment starts by enabling gender inclusive education, its foci are the increase in gender inclusive work participation, increase in political visibility, and social and domestic freedom. The ratio of female-to-male work participation rate is lower in Assam, and the women representation in the state assembly is only 6.35%. Though there is increase in women getting married before the age of 18 within the cohort of 20–24 years, there is a slight decrease in the proportion of women of the age-group 15–19 being pregnant.

Table 17.5 State-specific indicators and targets—Goal 4

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
4.1 Net enrolment ratio at primary level (upper primary) (%)	76.07 (2015–16)	73.94 (2015–16)	100
	80.32 (2016–17)	72.69 (2016–17)	100
	84.11 (2017–18)	72.62 (2017–18)	
4.2 Net enrolment ratio at secondary level (%)	54.84 (2015–16)	50.80 (2015–16)	100
	58.28 (2016–17)	51.77 (2016–17)	100
4.3 Net enrolment ratio at higher secondary level (%)	26.68 (2015–16)	32.05 (2015–16)	100
	27.89 (2016–17)	30.95 (2016–17)	100
4.4 Net enrolment rate at pre-primary (ECD) level (%)	49.8 (2008)	42.9 (2013)	100
4.5 Dropout rates at primary level (%)	15.36 (2015–16)	4.13 (2015–16)	0
	5.60 (2016–17)	6.35 (2016–17)	0
4.6 Dropout rate at secondary level (%)	27.06 (2015–16)	17.06 (2015–16)	0
	27.60 (2016–17)	19.89 (2016–17)	0
4.7 Ratio of vocational enrolment to total secondary enrolment (%)	2.0 (2016)	(Not available)	25

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Sustainable Development Goals National Indicator Framework Progress Report (2020), U-DISE Flash Statistics 2016–17

National Mission for Empowerment of Women (NMEW) Scheme, Mission Poorna Shakti, Beti Bachao Beti Padhao, Maternity Benefit Programme (IGMSY), Vocational Training cum Rehabilitation Centre (VTRC), etc., are some of the schemes implemented and steps adopted by the State to facilitate gender equality within its territory. But despite the efforts, Assam has underperformed in the SDG India Index 2018.

Table 17.6 State-specific indicators and targets—Goal 5

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
5.1 Ratio of female to male literacy (15–24 years)	0.93 (2011)		0.91 (2011)	1.0
5.2 Ratio of female to male work participation rate	0.40 (2011)		0.45 (2011)	1.0
5.3 Proportion of seats in the state assembly occupied by women (% to total elected members)	6.35 (2016)		11.9 (2014)	33.3
			14.4 (2019)	33.3
5.4 Proportion of women within 20–24 years getting married before the age of 18 (%)	30.80 (2015–16)	19.1 (2015–16)	47.4 (2005–06)	0.0
	31.8 (2019–20)	18.5 (2019–20)		0.0
5.5 Proportion of women within 15–19 years who are mothers or pregnant (%)	13.6 (2015–16)	9.2 (2015–16)	16.0 (2005–06)	Halt and reverse
	11.7 (2019–20)	8.6 (2019–20)		Halt and reverse

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, NFHS-5, Census 2011

17.5.6 Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for All

With eight targets and 11 indicators, the Goal 6 of the Sustainable Development Goals ensures water and sanitation availability and a sustainable management of both for the entire populace. Two state-specific indicators have been fixed to monitor the targets of the Goal to be achieved (Table 17.7).

The recent National Family Health Survey-5 (2019–20) shows 86% of the households in Assam to have access to safe drinking water, of which 92.3% being urban households and 85.00% being rural. Moreover, the survey also indicates 68.6% of the populace of the state to be living in households with improved sanitation facility. The share was only 49% in NFHS-4 (2015–16).

The performance of Assam with respect to Goal 6 in the SDG India Index is far below satisfactory with a score of only 42. National Rural Drinking Water Programme (NRDWP), Minimum Need Programme (MNP), Accelerated Rural Water Supply Programme (ARWSP), Pradhan Mantri Gramodaya Jojna-RWS, Neer Nirmal Pariyojana, Swachh Bharat Mission, are few among the schemes adopted for facilitating safe drinking water and sanitation with rural being given high priority.

Table 17.7 State-specific indicators and targets—Goal 6

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
6.1 Proportion of households with access to safe drinking water (%)	85.9 (2012)		87.8 (2012)	100
	84.2 (2015–16)	82.7 (2015–16)		100
	86.0 (2019–20)	87.1 (2019–20)		100
6.2 Proportion of households without access to sanitation	12.0 (2012)		43.4 (2012)	0.0 (By 2020)

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, NFHS-5

17.5.7 Goal 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All

The Sustainable Development Goal 7 which focuses making energy sustainable, reliable, and available for all, has five targets and six indicators, and the Government of Assam has identified three state-specific indicators for the targets of the Goal 7 (Table 17.8).

The percentage of houses being supplied with electricity increased by 55.60% between 2011 and 2019–20 in the state. The percentage of households using clean

Table 17.8 State-specific indicators and targets—Goal 7

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
7.1 Proportion of households using electricity as the primary source of lighting (%)	37.0 (2011)		67.2 (2011)	100 (By 2019)
	78.3 (2015–16)	92.54 (2015–16)		
	92.6 (2019–20)	96.70 (2019–20)		
7.2 Proportion of renewable energy to total annual energy production by installed capacity (%)	2.5 (2015)		14.2 (2016)	15
7.3 Proportion of transmission and distribution loss to total energy produced (%)	21.0 (2014–15)		21.46 (2016)	5.0

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, NFHS-5

cooking fuel in the state is 25.10%, and the renewable share of installed generating capacity for the state is 8.29% (SDG India Index: Baseline Report, 2018).

Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Integrated Power Development Scheme (IPDS), projects funded by Trade Development Fund, Asian Development Bank, etc., are certain schemes and projects adopted and on-going to facilitate sustainable, reliable and affordable energy in rural and urban Assam and this will too help increase the score of the state in the SDG India Index for Goal 7 which is otherwise as low as 18, the second lowest among all Indian states and union territories.

17.5.8 Goal 8: Promote Sustained, Inclusive and Sustainable Economic Growth, Full and Productive Employment and Decent Work for All

The SDG 8 has 12 targets and 17 indicators for promoting sustained, inclusive and sustainable economic growth, opportunities and environment. Two indicators have been identified by the State Government for Goal 8 (Table 17.9).

The annual rate of growth of Gross State Domestic Product at constant prices (2011–12) for the state is 9.1% during the period 2015–16 to 2019–20. The state's SGDP at constant prices is estimated to grow at a rate of 8.5% in 2019–20 which is more than 5% GDP growth rate estimated for the entire country (Assam Budget 2020), thus indicating a favourable status of the state economy.

The periodic Labour Force Survey 2017–18, Assam has highlighted the unemployment rate of the state to be 8.1%, which is higher than the all-India unemployment rate of 6.1%. The female unemployment rate in Assam is 13.9%, and the unemployment rate in usual status (ps + ss) among the age 15–24 years is 36.2% for 2017–18 (Assam Budget 2020; SDG Progress Report 2020).

Assam has a relatively higher score in the SDG India Index 2018 for Goal 8. With a score of 61, Assam falls in the 'Performer' category. Many schemes and programmes

Table 17.9 State-specific indicators and targets—Goal 8

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
8.1 Annual rate of growth of SGDP (constant prices) (%)	7.88 (2014–15)	7.3 (2014–15)	10
	8.5 (2019–20)	4.18 (2019–20)	10
8.2 Total unemployment rate usual status (ps) (per 1000 population)	61 (2015–16)	50 (2015–16)	20

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Assam Fiscal Responsibility and Budget Management Act, 2005

are being implemented by the state to enhance the economy and reduce unemployment, Prime Minister Awaas Yojana-Gramin, Pradhan Mantri Mudra Yojana, Lead EAPs (Externally Aided Projects), etc., being a few.

17.5.9 Goal 9: Build Resilient Infrastructure, Promote Inclusive and Sustainable Industrialization and Foster Innovation

For the SDG 9 which aims to boost infrastructure, industrialization and innovation through eight targets and 12 indicators, the Assam Government has fixed five state-specific indicators (Table 17.10).

Communication is of utmost importance for fostering development and so is industrialization. The contribution of the manufacturing sector to the State GDP has increased immensely and has also become a strong source of generating employments. Assam State Roads Project, Fakuruddin Ali Ahmed Paki Path Norman Achani, Mukhyamantrir Pakipath Nirman Achani (MPNA), Boneej, Biponi, Swami

Table 17.10 State-specific indicators and targets—Goal 9

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
9.1 Total length of surfaced road (NH, SH and PWD) per 100 km^2 area	35.42 (2015)	35.51 (2013)	Ensure full connectivity
9.2 Total length of surfaced roads (NH, SH and PWD) per 100,000 population	89.03 (2015)	96.45 (2013)	Ensure full connectivity
9.3 Total (wireless + wireline) telephone connections per 100 population	53.95 (2015)	79.4 (2015)	100
	66.97 (2017)	93.01 (2017)	
9.4 Share of manufacturing sector in GSDP (at 2011–12 constant prices, %)	9.0 (2015–16)	16.05 (2015–16)	Triple
	16.77 (2018–19)	17.42 (2019–20)	
9.5 Share of manufacturing sector employment in total employment (%)	4.8 (2015)	10.5 (2015)	Triple
	6.7 (2017–18)	12.1 (2017–18)	

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, MOSPI: Statistical Year Book India, 2018, Sustainable Development Goals National Indicator Framework Progress Report (2020), Assam Fiscal Responsibility and Budget Management Act, 2005

Table 17.11 State-specific indicators and targets—Goal 10

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
10.1 Ratio of average size of holdings of small and marginal farmers to semi-medium, medium and large farmers (%)	16.1 (2010–11)	14.2 (2010–11)	Increase
10.2 Gini co-efficient of inter-district DGDP	0.16 (2014)	(Not applicable)	Reduce

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam

Vivekananda Assam Youth Empowerment (SVAYEM) Yojana, are a few schemes implemented by the state to facilitate communication and industrial development.

17.5.10 Goal 10: Reduce Inequality Within and Among Countries

With 10 targets and 11 indicators, the SDG 10 focuses in eradicating inequalities to promote economic development along with economic growth. The State Government has identified two state-specific indicators (Table 17.11).

Assam has been a "Front Runner" with a score of 75 in the SDG India Index 2018. The Government of Assam has implemented many successful schemes and programmes to minimize the inequalities-social, economic and spatial, within its borders. Mahatma Gandhi National Rural Employment Guarantee Act, Assam State Rural Livelihoods Mission Society (ASRLMS), Pradhan Mantri Awaas Yojana-Gramin, Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY), MNP (Minimum Need Programme) House Site Scheme, are some schemes implemented for the removing of inequalities.

17.5.11 Goal 11: Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable

The Goal 11 which focuses on cities and human settlements has 10 targets and 15 indicators. Three state-specific indicators have been identified (Table 17.12).

Urban areas are the engines of growth and take the nation in the path of progress. All the human settlements in general and the urban spaces in particular need to be sustainably developed for promoting inclusiveness, safety, opportunities and resilience. Credit Linked Subsidy Scheme, Affordable Housing in Partnership, Drum Composter, Beneficiary Led Construction, In-situ Slum Redevelopment, In House Composting Daily Dump Project, National Air Quality Monitoring Programme

Table 17.12 State-specific indicators and targets—Goal 11

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
11.1 Proportion of total urban population living in slums (%)	4.48 (2011)	17.36 (2011)	0.0
11.2 Proportion of municipal solid waste treated to the total municipal solid waste generated in the state (%)	6.3 (2012)	12.5 (2012)	100.0
11.3 Ambient air quality index of Guwahati (PM10) average for Guwahati monitoring stations (in $\mu g/m^3$)	257.8 (2013)	(Not applicable)	100.0

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam

(NAMP), Guwahati Smart City Project, are few schemes implemented by Assam Government to meet the targets of Goal 11. Assam's performance in SDG India Index however has been low with a score of only 32.

17.5.12 Goal 12: Ensure Sustainable Consumption and Production Patterns

The Goal 12 has 11 targets and 13 targets and aims at sustainable consumption and production. No state-specific indicators have been set by the Government of Assam for the same. National Clean Energy Fund, National Policy on Biofuels, National Bio Gas and Manure Management Program, etc., are Central initiatives adopted by the State to achieve the Goal 12 (SDG India Index Baseline Report, 2018). The post-harvest storage loss of rice and wheat for the state increased from 0.14% in 2017–18 to 0.47% in 2018–19, whereas the transit loss decreased from 0.69 to 0.63%, respectively.

17.5.13 Goal 13: Take Urgent Action to Combat Climate Change and Its Impacts

With five targets and eight indicators, the Goal 13 aims at combating climate change and its impacts. Three state-specific indicators have been identified by the State Government for the pursuance of the Goal (Table 17.13).

Climate change and its adverse impacts are a nightmare to the world and most of the governments around the globe, being part to the UNDP and the SDGs, are trying their best to minimize the effects. The proportion of cropped area and the people affected by flood increases each year in the State. National Action Plan on

Table 17.13 State-specific indicators and targets—Goal 13

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
13.1 Proportion of cropped area affected by flood to the total cropped area (annual average) (%)	8.1 (2014–15)	(Not available)	Halt and reduce
13.2 Proportion of people affected by flood (annual average) (%)	11.7 (2014–15)	(Not available)	0.0
13.3 Proportion of area degraded and wasteland (%)	5.83 (2010)	3.66 (2010)	Halt and reduce

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam

Climate Change (NAPCC), Rehabilitation Grant (RG), Ex-Gratia Payment, etc., are initiatives adopted by the State.

17.5.14 Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development

The Goal 14 having ten targets and ten indicators pursues the conservation and sustainable usage of the water bodies and marine resources. The Government of Assam has identified five state-specific indicators (Table 17.14).

The presence of coliform in water systems indicate a change in the integrity of the water system depicting contamination and quality degradation (Minnesota Department of Health n.d.). Though for most of the tributaries the coliform level has decreased between 2013 and 2018, but in case of the Bharalu river, an increase is observed thus denoting deteriorating water quality. The highest reduction of coliform is observed in the Kharsang river. National Plan for Conservation of Aquatic Ecosystems, National Water Monitoring Program, etc., are few initiatives of the Centre undertaken by the State.

Table 17.14 State-specific indicators and targets—Goal 14

Indicator	Assam baseline (Latest year)	Target (2030)
14.1 Mean of range of total coliform levels of Dhansiri at Golaghat (MPN/100 ml)	7500 (2013)	Halt and reduce significantly
	2150 (2018)	
14.2 Mean of range of total coliform levels of Bharalu at Guwahati (MPN/100 ml)	121,000 (2013)	Halt and reduce significantly
	122,650 (2018)	
14.3 Mean of range of total coliform levels of Disang at Dillighat (MPN/100 ml)	10,680 (2013)	Halt and reduce significantly
	6000 (2018)	
14.4 Mean of range of total coliform levels of Kharsang before confluence with Buridhing (MPN/100 ml)	120,000 (2013)	Halt and reduce significantly
	1050 (2018)	
14.5 Mean of range of total coliform levels of Barak at D/S of Silchar (MPN/100 ml)	11,250 (2013)	Halt and reduce significantly
	4650 (2018)	

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Statistical Hand Book Assam (2019)

17.5.15 Goal 15: Protect, Restore and Promote Sustainable Use of Terrestrial Ecosystems, Sustainably Manage Forests, Combat Desertification, and Halt and Reverse Land Degradation and Halt Biodiversity Loss

With 12 targets and 14 indicators, the Goal 15 is aimed at preserving the forests, animal lives and preventing the biodiversity loss. The State Government has identified four indicators for the same (Table 17.15).

The forest cover has increased in the state and so has the tiger population. Assam is one of the six Indian states to have achieved a score of 100 in the SDG India Index 2018 for the Goal 15. Some schemes and policies adopted by the State for achieving the Goal 15 are National Environment Policy 2006, National Agroforestry Policy 2014, Green Highways Policy 2015, State CAMPA, Social Forestry, Indian Rhino Vision 2020, etc.

Table 17.15 State-specific indicators and targets—Goal 15

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
15.1 Proportion of area under forest cover (%)	35.22 (2015)	69.7 (2015)	21.34 (2015)	Increase
	36.11 (2019)	68.6 (2019)	21.67 (2019)	
15.2 Growing stock of timber in notified forests and trees outside forest (million cubic metres MCuM)	176.7 (2015)	121.7 (2015)	5768.4 (2015)	320.00
	138.36 (2019)	117.8 (2019)	5915.76 (2019)	
15.3 Total area protected (national parks and wildlife sanctuaries) (km^2)	3817.9 (2014)		516,584.0 (2014)	Increase
15.4 Number of tigers in the wild	167 (2014)		2226 (2014)	Increase
	190 (2018)		2967 (2018)	

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Indian State Forest Report (2019), Tiger Status Report (2018)

17.5.16 Goal 16: Promote Peaceful and Inclusive Societies for Sustainable Development, Provide Access to Justice for All and Build Effective, Accountable and Inclusive Institutions at All Levels

The 12 targets and 23 indicators of Goal 16 of the SDGs, are set to achieve just, peaceful and inclusive societies for sustainable development as-well-as accountable, inclusive and effective institutions for the achieving of the former. The Government of Assam has six state-specific indicators for achieving the Goal 16.

Table 17.16 shows how the crime against women and children have increased manifold between 2015 and 2019. Though there is decrease in murders and trafficking per lakh population, many trafficking incidents and other crimes go unreported in the state. All these indicators reflect a not much strong law and order in the state as-well-as the sense of prevalence of justice among the populace. However, the decrease in the number of pending IPC cases at the Gauhati High Court indicates its effectiveness as an institution. Moreover, in the state 100% births are registered while only 65.9% of the deaths for 2017, and in 2019, 15.4% of the population are Aadhaar holders (Sustainable Development Goals National Indicator Framework Progress Report 2020).

Assam has a score of 53 in the SDG India Index 2018 and Integrated Child Protection Scheme (ICPS), Swadhar Greh, UJJAWALA, Financial assistance and

Table 17.16 State-specific indicators and targets—Goal 16

Indicator	Assam baseline (Latest year)	North East India average	India average (Latest year)	Target (2030)
16.1 Total violent crimes (all forms) per lakh population	47.1 (2015)		26.7 (2015)	Halt and reverse
	83.4 (2019)	34.3625 (2019)	31.2 (2019)	
16.2 Murders per lakh population	4.2 (2015)		2.55 (2015)	Halt and reverse
	3.6 (2019)	2.5875 (2019)	2.2 (2019)	
16.3 Cases of human trafficking per lakh population	4.6 (2015)	0.775	0.5 (2015)	Halt and reverse
	0.6 (2019)	0.375 (2019)	0.2 (2019)	
16.4 Crimes against children (all forms combined) per lakh children	23.8 (2015)	26.35 (2015)	21.1 (2015)	Halt and reverse
	55.6 (2019)	36.175 (2019)	33.2 (2019)	
16.5 Cases reported of crimes against women per lakh female population	148.2 (2015)	50 (2015)	53.9 (2015)	Halt and reverse
16.6 Pendency of trials of IPC cases at courts (%)	83.9 (2015)	78.125 (2015)	85.8 (2015)	Reduce
	54.003 (2019)			

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Crime in India 2019, Gauhati High Court Statistics 2019

support services to victims of rape, Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act 2013, Swahid Kushal Konwar Sarbajanin Briddha Pension Asoni, etc., are certain schemes and actions amongst few adopted by the State.

17.5.17 Goal 17: Strengthen the Means of Implementation and Revitalize the Global Partnership for Sustainable Development

For Goal 17, which has 19 targets and 25 indicators, the Assam Government has fixed two state-specific indicators (Table 17.17).

Table 17.17 State-specific indicators and targets—Goal 17

Indicator	Assam baseline (Latest year)	India average (Latest year)	Target (2030)
17.1 State's own tax revenue collection as a ratio of the state's gross state domestic product (%)	5.79 (2013–14)	7.74 (2013–14)	Increase
17.2 Share of SDG goals 1–17 in total expenditure budget (%)	55.6 (2017–18)	Not Available	Increase
	32.50 (2020–21)		

Source State Level Core Indicators for Monitoring the Progress of SDGs in Assam, Assam Budget (2020–21)

The state of Assam is among the first states in India to prepare an Outcome Budget which associates the budget sectoral allocations to the 17 Sustainable Development Goals (Budget 2017–18). The outcome budget measures, monitors and evaluates the achievable targets as well as the qualitative and quantitative output achieved. The budgetary allocations play a significant role as a financial resource in creating of an economically enabling environment for achieving of the SDGs. In the Assam Budget 2017–18, the total allocation made to the SDGs was INR 47,768 crores of which the highest allocation of INR 9748 crores was being made to Goal 10, while the least allocation which was only INR 3 crores was to Goal 14. Whereas, in the Assam Budget 2018–19, the total allocation for the SDGs was only INR 14,671.09 crores with the highest allocation of INR 5580.96 crores being made to SDG 1 and the lowest being nil to SDG 14. In the Assam Budget 2019–20, the allocation for the SDGs was over INR 13,000 crores with the highest allocation to SDG 4 and in the Assam Budget 2020–21, the total amount allocated for the SDGs is INR 26,904.19 crores. INR 9452.59 crores, which is the highest, has been allocated to Goal 9, while INR 35.28 crores has been allocated to Goal 5 which is the lowest allocation made (Figs. 17.2 and 17.3).

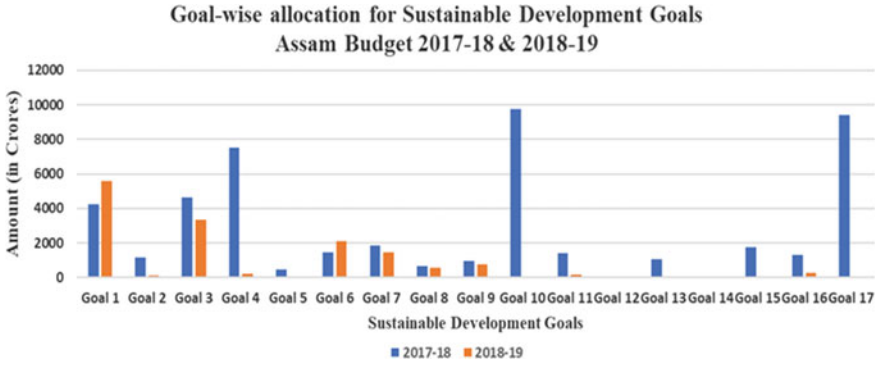

Fig. 17.2 Assam budgetary allocation 2017–18 and 2018–19. *Source* Assam budget 2017–18, 2018–19

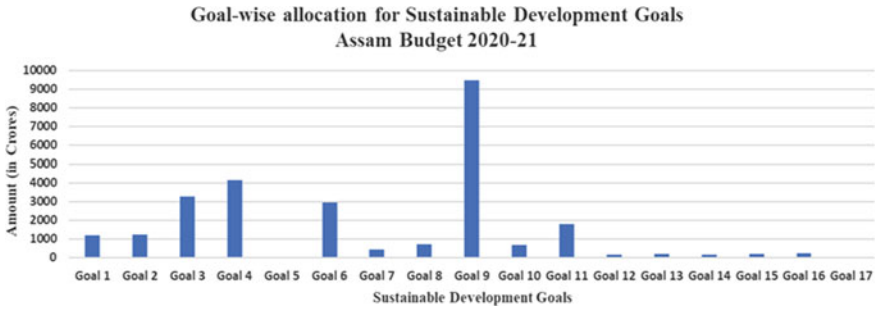

Fig. 17.3 Assam budgetary allocation 2020–21. *Source* Assam budget 2010–21

Next to budgetary allocations, of importance though not less, is the CSR. Corporate Social Responsibility (CSR) was made mandatory in our country by amendment of the Companies Act 2013, in 2014 and it being intertwined with the SDGs play a significant role by roping in the corporate sector into the scene of SDGs. In the state in the financial year 2019–20, INR 26.06 crores have been spent on developmental goals through CSR, though the amount has been much more in the preceding years (Fig. 17.4).

Fig. 17.4 Corporate social responsibility investments in Assam. *Source* https://www.csr.gov.in/statelist.php

17.6 Conclusion

Every state dreams of prosperity, which is inclusive of sustainable economic development along with growth, Assam is no different. With India being a part to the SDGs, the Government of Assam has tried its best to achieve the targets and set sail on a route of sustainability and progress. The State Government of Assam drafted the Vision document "Assam 2030: Our Dream, Our Commitment" to tune the developmental plans of the state with the Sustainable Development Goals adopted by India as being a member nation of the United Nations, on the 25th of September, 2015. Assam is the first state in India and also one of the first states globally to adhere to SDGs and introduce them into the policy discourse of the state. But despite being the first, the results are not always as expected. Assam has a long way to go to become an "Achiever" in all the Sustainable Development Goals in the SDG India Index and this is not possible without the equal participation of people, civil societies, and private bodies. Now is the time to make every step towards development, a sustainable one.

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Chapter 18
Measuring Gaps to Achieve the SDG 1 in Assam and Identifying the Causes

Barnali Gogoi and Swapnali Saikia

Abstract Poverty, with its multifaceted nature, is a complex social issue. After decades of efforts at the local, regional, and international levels to eradicate it, poverty persists, defying these all. Positioned at the third UN decade for eradication of poverty (2018–2027) with the Sustainable Development Goal (SDG) 1, it is time to analyze the progress at the local level. India has adopted the SDG framework and oriented its policies and programs toward achieving its goals. SDG India index has been developed to measure progress toward goals and targets at the district level. In this index, five indicators have been adopted to measure goal one, i.e., no poverty. In Assam, percentage of population below the poverty line is 31.98 in 2018, and the rate of poverty reduction is slower than many other states of India. In fact, the index for SDG 1 in Assam has dropped from 53 in 2018 to 48 in 2019. Moreover, with high infant mortality (44) and maternal mortality ratio (300), medium to low percentage of households with electricity (37), sanitation (64.9), and safe drinking water (54.8) multidimensional poverty is equally prevalent in the state. In spite of achievement of many targets of Millennium Development Goals (MDGs), the final report on MDGs (The Millennium Development Goals report, 2015) emphasized the monitoring and tracking at local level to prioritize the goals and for appropriate intervention. Considering the significance of analyzing at local level, this study attempts to find the variations at the district level in Assam in the path to be covered to achieve the goal in respect of the five indicators of the SDG 1 and to identify different socio-geographical factors affecting the implementation and success of the programs to eradicate poverty. A critical review of the programs is also attempted to assess long-term success in eradicating poverty. It is expected that assessment and analysis of factors will help orient the policies and the implementation strategies more appropriate.

Keywords Sustainable development goal · Poverty · Assam

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18.1 Introduction

The aim of Sustainable Development Goals (SDGs) of United Nations (UN) is a sustainable, equitable, and developed world. Since the adoption of the Agenda 2030, the 17 SDGs have been analyzed from different perspectives like quantifying the impacts of SDG and strategies to be adopted by different countries (Swain and Yang-Wallentin 2020), prioritizing and assessing gaps and linkages among SDGs (Allen et al. 2018), analyzing synergies and trade-offs among SDGs (Pradhan et al. 2017; Kroll et al. 2019) to cite a few.

SDG 1 'No Poverty' has synergetic relationship with five other goals, SDG 3 (good health and well-being), SDG 4 (quality education), SDG5 (gender equity), SDG 6 (clean water and sanitation), and SDG 10 (reduced inequalities) (Pradhan et al. 2017) and thus has a very important role in achieving other sustainable goals or vice versa. Achievement of SDG 2, 3 and 6 through welfare schemes will definitely reduce several dimensions of poverty, but achievement of SDG 1 will empower the poor to reduce different dimensions of poverty. India has adopted five specific indicators to assess and achieve the SDG 1.

Poverty is a result of complex interplay of factors ranging from individual to institutional. The UN has recognized that 'poverty is a specific, local and contextual experience' (UN 2004). In India, certain social groups like scheduled tribe and scheduled caste population are historically marginalized and are still striving to come out of perpetual poverty as a group. *Ben Ki Moon*, former Secretary General of the UN in his foreword to the Millennium Development Goals Report (2015), acknowledged that ethnicity is one of the factors hindering the attempts to reduce poverty. Besides, there are conditions that enhance social capital and generate economic opportunities which greatly assist in reducing poverty.

The study briefly addresses the evolution of the poverty concept, its measuring techniques, and the attempts of the UN to reduce poverty. The references given in this context are only a glimpse of the enormous literature on the topic, only to signify the importance given to it through different periods. Understanding the need of assessing progress at local level, the present study then attempts to measure the gaps in each indicator of SDG 1 in all the districts of Assam. After identifying the districts lagging behind or performing well in achievement of each of the indicators, finally it is attempted to find the important factors creating the variation in progress.

18.2 Poverty Concept and SDGs

Defining poverty has kept engrossed the social scientists for decades. Even its basic concept of lack of money implies lack of purchasing power to fulfill certain basic needs. That is why Hashim (1996) considered purchasing power in terms of per capita monthly expenditure as a powerful indicator of many forms of deprivations of

human being. Sutton (1968) commented that economic definitions of poverty disregard certain sociological characteristics of the poor. Poverty is more than an economic condition; 'it is a form of social injustice' (Haworth 1968) and 'a social exclusion' (Thomas 2000). Herrick and Hudson (1981) suggested six approaches for poverty assessment which included social indicators like housing, health, community facilities, and access to social and economic capital among others. The United Nations introduced the concept of 'human poverty' (UNDP 1997) to encapsulate different dimensions of poverty. There has been continuous attempt to develop measuring techniques of poverty like the Sen Index, the Thon Index, indices by Foster, Greer and Thorbecke to cite a few. The pioneers to construct multidimensional poverty index and multidimensional indicators were 'Peter Townsend in 1979, Joanna Mack and Stewart Lansley in 1985 and Tim Callan, Brian Nolan and Christopher T. Whelan in 1993' (DE n.d.). The multidimensional measurement methodology of Alkire and Foster developed in 2007 (Alkire et al. 2015) is the most used one at present. The global Multidimensional Poverty Index (MPI) report published annually by the United Nations Development Programme and Oxford Poverty and Human Development Initiative (OPHI) at the University of Oxford since 2010 is based on the MPI developed by Alkire and Foster (UNDP and OPHI 2020).

The UN dedicated an entire decade starting in 1997 to eradicate poverty followed by a second decade from 2008 to 2017, and now it is the third decade (2018–2027) with the theme 'Accelerating global actions for a world without poverty'. The conceptual and methodological developments in poverty and its measurements have greatly assisted to build frameworks of development by the UN. The Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) are based on the concept of multidimensional poverty. The aim of the MDGs was to address poverty in all its dimensions. The MDG 1 was to 'eradicate extreme poverty and hunger,' and achievement of the target to reduce 'by half the proportion of people living in extreme poverty' well ahead of time (UN 2015) was the best outcome. In the Agenda 2030 of the UN, the first seven SDGs address poverty and its different forms. 'The global MPI provides important information related to Sustainable Development Goal (SDG) 1—ending poverty in all its forms everywhere' (UNDP and OPHI 2020). The disaggregated MPI is assisting in identifying the groups and sub-national regions lagging behind in the path to achievement of SDG 1.

The national MPI for India is 0.123 and for Assam 0.162 which is less than only four states among 36 states and union territories of India in 2020. The MPI in all other states of Northeast India, Arunachal Pradesh (0.108), Manipur (0.085), Meghalaya (0.146), Mizoram (0.099), and Tripura (0.087) is less than Assam (OPHI 2020). There are thirteen indicators of sub-goals of SDG 1, but India at present is adopting only five indicators of three sub-goals (NITI Aayog 2019). The present study is concerned to the indicators adopted by India, although these are not enough to depict the disaggregated picture of poverty.

18.3 Data

Data for the indicators adopted by India in SDG India, Index and Dashboard, 2019–20 (NITI Aayog 2019) for SDG 1 are collected from the following sources (Table 18.1).

Other secondary data used in the discussion are collected from Economic Survey of the Directorate of Economics and Statistics, Government of Assam (2018) and Statistical Hand Book of the Directorate of Economics and Statistics, Government of Assam (2020a).

Table 18.1 Data sources used in the study

SDG global targets	Corresponding indicators in SDG India index and dashboard	Source
1.2 By 2030, reduce at least by half the proportion of men, women, and children of all ages living in poverty in all its dimensions according to national definitions	Poverty head count ratio	Economic Survey, 2017–18 Directorate of Economics and Statistics Government of Assam (GOA)
1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable	A household with any usual member covered by any health scheme or health insurance	National Family Health Survey, 2015–16
	Persons provided employment as a percentage of persons who demanded employment under Mahatma Gandhi National Rural Employment Guarantee Act, MGNREGA (%) (depending on data availability, the present study uses data measured at household level)	Economic Survey, 2017–18, Directorate of Economics and Statistics Government of Assam (GOA)
	The proportion of the population (out of total eligible population) receiving social protection benefits under maternity benefit	National Family Health Survey, 2015–16
1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership, and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services, including microfinance	Percentage of households with Kutcha houses	Assam Human Development Report, 2014 Planning and Development Department, Government of Assam, NITI Aayog, UNDP p 215 www.in.undp.org

18.4 Methods

The data of each indicator for all districts are presented in composite bars, to depict visually the gaps to achieve individual goals of the indicators. The index score is then computed for each district following the methods adopted by the NITI Aayog (2019) and presented in a map. The reasons for wide gaps to goal in some indicators are analyzed on the basis of the nature of the indicator.

18.5 Discussion

Poverty rate in India is 21.92 in 2011–12 (NITI Aayog 2020). The percentage of people living below poverty line in Assam (32.0) is higher than national rate and higher than all neighboring states of Northeast India except Manipur (36.9) (GOA 2020a). Poverty head count ratio is very high in all the districts of Assam and has long paths to be covered to reach the national target of 10.95% (GOA 2018). The only district that has achieved this target is Kamrup Metro, which is primarily an urban district (Fig. 18.1).

The target to cover households by any health scheme or health insurance for any member of the household is 100%. But Barpeta and Morigaon are the only two districts where more than 20% households have been covered till 2015–16. In all other districts, more than 80% households are yet to cover which is a long path to reach the target (Fig. 18.2). However, percentage of population provided employment under the *Mahatma Gandhi National Rural Employment Guarantee Act*, (MGNREGA) is quite high, more than 70% in all districts with small gaps to reach the target 100% (Fig. 18.3). Proportion of population availing maternity benefit is variable across districts, which is the minimum in the most urbanized district of the state, Kamrup (M) (Fig. 18.4). In some districts like Dhemaji and Morigaon, the percentage is quite high. Similarly, the percentage of households with kuthcha houses also varies across

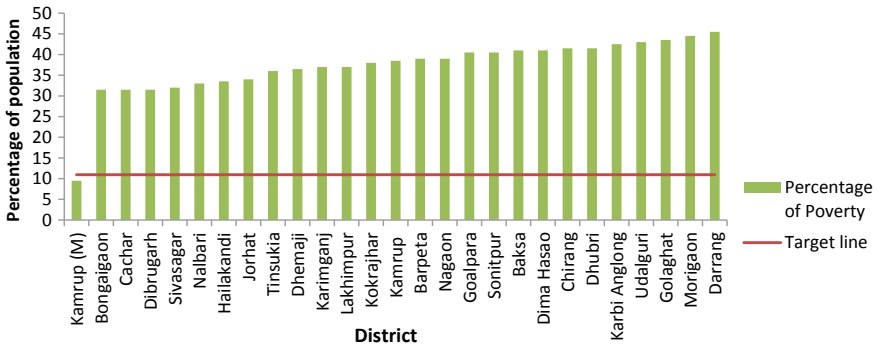

Fig. 18.1 District-wise poverty head count ratio in Assam, 2017–18

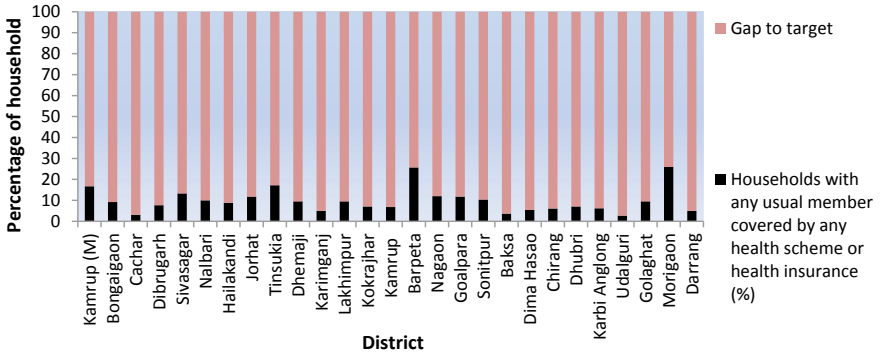

Fig. 18.2 District-wise percentage of households with any usual member covered by any health scheme or health insurance, NHS, 2015–16

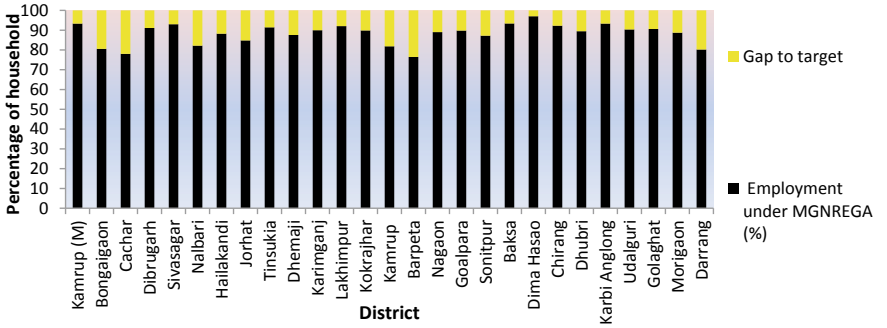

Fig. 18.3 District-wise percentage of households provided employment under MGNREGA, 2016–17

the districts (Fig. 18.5). The index score calculated on the basis of these indicators for the districts reveals that the index varies from 21.76 in Darrang to 53.74 in Kamrup Metro (Table 18.2), only Kamrup Metro district is in the performer category, and all other districts are in aspirant category as per the range adopted by the NITI Aayog (2019) to categorize the districts on the basis of SDG 1 index score (Fig. 18.6).

18.6 Understanding the Causes

The status of the districts of Assam in four out of five indicators is very low, and thus, each district is yet to cover long gaps to reach the targets. The two indicators—poverty head count ratio and households with Kutcha houses—demonstrate poverty status of an area, while the rests are related to measures (actions) adopted to reduce poverty.

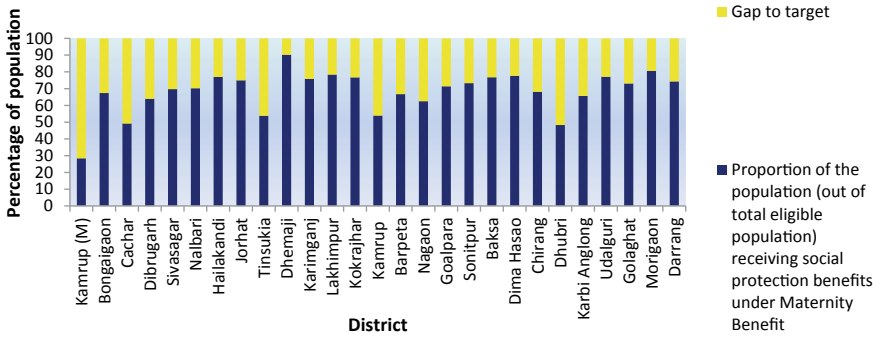

Fig. 18.4 District-wise proportion of the population out of total eligible population receiving social protection benefits under maternity benefit, NHS, 2015–16

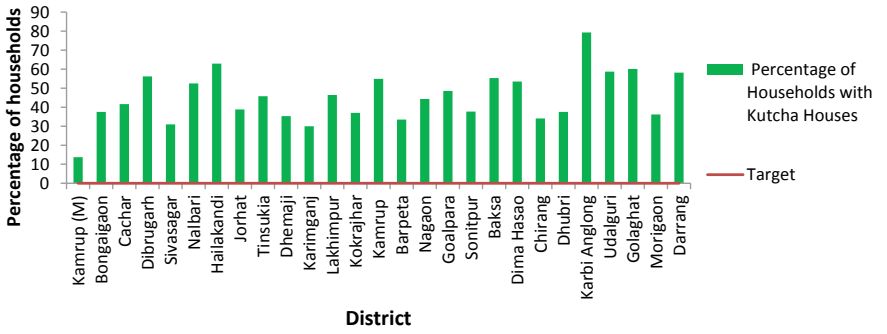

Fig. 18.5 District-wise percentage of households with Kutcha houses, 2013

Poverty is affected by a number of factors and areas dominated by scheduled tribe and scheduled castes are historically poor. The districts in Assam in which poverty head count ratio is high are also the districts in which percentage of scheduled tribe (ST) or/and scheduled caste (SC) population is high such as Dima Hasao (70.92), Chirang (37.05), Karbi Anglong (56.33), and Udalguri (32.14). However, Darrang, Morigaon, Dhubri, and Golaghat are exceptions where poverty is more, but ST/SC population is not dominant. In case of these districts, factors like high agricultural density (Dhubri and Morigaon), natural hazard (Morigaon and Dhubri), high population density (Darrang and Dhubri), and low levels of urbanization and industrialization have combined for the poverty status (Table 18.3). Factors for high poverty in Darrang and Golaghat are not easily discernable. Percentage of households with Kutcha house is to some extent related to level of urbanization, more urbanized districts having less Kutcha houses ($r = -0.47$), as rural people build their houses with locally available materials.

The three other indicators of SDG 1 are related to different welfare schemes launched by the government. Achievement in implementation of those is affected by

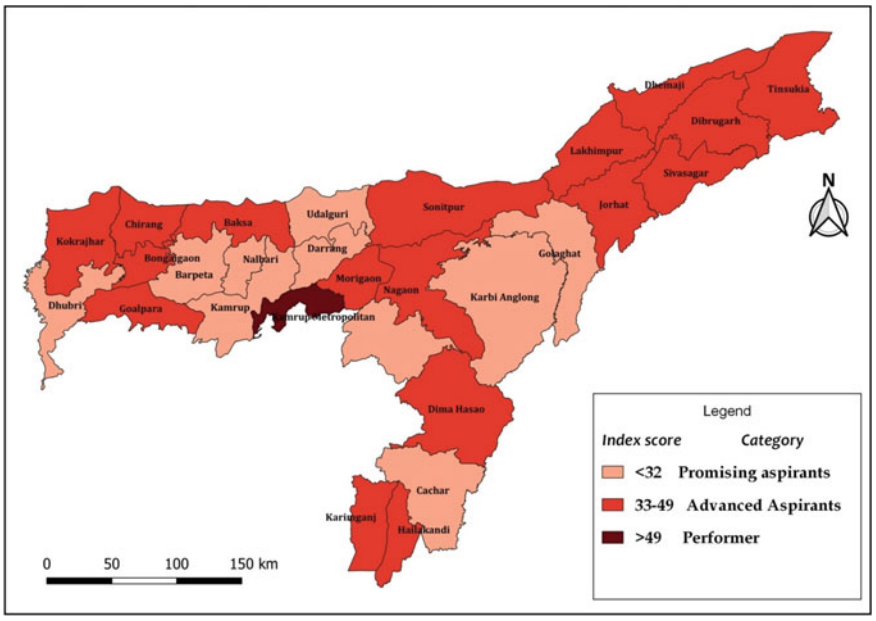

Fig. 18.6 Districts of Assam at different levels of progress in SDG 1

a number of factors like awareness of the targeted population, proper implementation mechanism, involvement at all stages, availability of fund, monitoring system, etc. Data of Janani Surakshsa Yojana have been used for the indicator 'Proportion of the population (out of total eligible population) receiving social protection benefits under Maternity Benefit'. This scheme was launched in April 2005 all over the country with special focus on the states where institutional child birth was low and one of those states is Assam. The implementation mechanism of the scheme is very effective due to the accredited social health activists (ASHA) who establish link between the government and the beneficiaries. The ASHAs have been very effective in creating awareness as both ASHA and the beneficiaries are financially benefited in the process. The highest achievement was made in 2013–14 and since then a declining trend has set in Assam as a whole and in all the districts (GOA 2020b). The schemes on the basis of which the indicator 'Households with any usual member covered by any health scheme or health insurance (%)' has been chosen are not specified. '*Atal Amrit Abhiyan*' (AAA) is a health insurance scheme started in April 2017 with one block each in only seven districts and subsequently extended to nine more districts. It is aimed to cover all the districts phase-wise. Another such health scheme in Assam is '*Arogya Nidhi*' introduced in November 2012. Assam *Arogya Nidhi* is a scheme that provides cashless treatment to those insured under *Pradhan Mantri Jana Arogya Yojana* (PMJAY) or AAA and reimbursement of medical expenses for others. Data of the indicator 2 (Table 18.2) based on such schemes reveal wide gap to reach the target. There may be several reasons like *Atal Amrit Abhiyan* started only recently

in 2017 and in selected blocks of selected districts. Reimbursement is not a feasible option for the very poor as they are unable to bear the initial expenditure. Moreover, approval committee to reimburse comprises top level bureaucrats due to which the process of reimbursement is time consuming. MGNREGA was introduced in Assam in 2006–07 in seven districts, and since 2008–09, all districts of the state are being covered by this scheme. The success of this scheme lies on the time duration it is in place, implementing agency being the local government—gram panchayat playing the most significant role and direct cash benefit received by the poor and the distress.

There are other factors that affect the implementation of such welfare schemes. Lack of awareness is a major cause of failure or slow progress in many welfare schemes. It has been found in a primary study that most people are unaware of such schemes (Saikia 2019). The geographical area of a district, total population, population density, and infrastructure like transportation and health center, and skilled personnel also determine the success rate in implementation of these schemes. Lack of motivation, accountability, absence of performance appraisal, absence of a system of incentives and penalties, understaffing, and poor working conditions are some other factors already identified (Planning Commission 2002).

18.7 Conclusion

The UN has suggested 13 indicators to assess the achievement toward Goal 1 (UN 2017). India has adopted only five indicators to achieve SDG global targets 1.2, 1.3, and 1.4 (NITI Aayog 2018). There is no indicator to assess the accessibility to basic services, economic and natural resources, technology, and financial resources which are indicators suggested in Global Indicator Framework for the targets 1.3, 1.4, and 1.5. Further, there is no segregation of poverty by sex, age and geographic location. There is sufficient information in national Health Surveys to grasp the different dimensions of poverty by age and sex, and some of these are used as indicators of SDG 2, 3, 5, and 7. As SDG 1 has synergetic relationship with many of the SDGs, targets achieved in respect of goals 2, 3, 4, 5, 6, and 10 (*Zero Hunger*, *Good health and well-being*, *Quality education*, *Gender equality*, *Clean water and sanitation*, *Reduced inequalities*) will reduce several dimensions of poverty.

There are as many as 67 centrally sponsored and central sector schemes relevant to the targets of SDG 1 (NITI Aayog 2018). Successful implementation of these schemes should help India and its states to reduce the percentage of population in poverty significantly.

The purpose of most of these schemes is to give social protection and relief from poverty. But to sustain a life out of poverty and to improve upon requires capacity building, empowerment, and skill enhancement. The umbrella scheme of skill development, Prime Minister Employment Generation Scheme (PMEGP), *Sarva Siksksha Abhiyan* and a few other schemes are there which are designed to build capacity and develop skill.

Table 18.2 District-wise indicators and index score of SDG 1

	Population living below national poverty line (%)	A household with any usual member covered by any health scheme or health insurance (%)	Households provided employment as a percentage of households who demanded employment under MGNREGA (%)	The proportion of the population (out of total eligible population) receiving social protection benefits under maternity benefit	Percentage of households with Kutcha houses	Normalized score	Normalized score	Normalized score	Normalized score	Normalized score	Index score
	1	2	3	4	5	1	2	3	4	5	
Kamrup (M)	9.5	16.7	93.32	28.4	13.7	100	14.39	71.6	0	82.72	53.74
Bongaigaon	31.5	9.2	80.57	67.4	37.5	40.52	6.68	17.39	54.47	52.71	34.35
Cachar	31.5	3.1	78.03	49.2	41.6	40.52	0.41	6.59	29.05	47.54	24.82
Dibrugarh	31.5	7.7	91.12	63.9	56.2	40.52	5.14	62.24	49.58	29.13	37.32
Sivasagar	32	13.3	92.98	69.7	31	39.07	10.89	70.15	57.68	60.91	47.74
Nalbari	33	10	82.16	70.2	52.5	36.18	7.5	24.15	58.38	33.8	32
Hailakandi	33.5	8.8	88.23	77	62.9	34.73	6.27	49.96	67.88	20.68	35.9
Jorhat	34	11.8	84.8	75	38.8	33.29	9.35	35.37	65.08	51.07	38.83
Tinsukia	36	17.2	91.42	53.8	45.8	27.5	14.9	63.52	35.47	42.24	36.73
Dhemaji	36.5	9.5	87.57	90.2	35.3	26.05	6.99	47.15	86.31	55.49	44.4
Karimganj	37	5	89.98	75.8	30	24.6	2.36	57.4	66.2	62.17	42.55

(continued)

Table 18.2 (continued)

	Population living below national poverty line (%)	A household with any usual member covered by any health scheme or health insurance (%)	Households provided employment as a percentage of households who demanded employment under MGNREGA (%)	The proportion of the population (out of total eligible population) receiving social protection benefits under maternity benefit	Percentage of households with Kutcha houses	Normalized score	Normalized score	Normalized score	Normalized score	Normalized score	Index score
	1	2	3	4	5	1	2	3	4	5	
Lakhimpur	37	9.5	92.03	78.4	46.4	24.6	6.99	66.11	69.83	41.49	41.81
Kokrajhar	38	7.1	89.88	76.7	37	21.71	4.52	56.97	67.46	53.34	40.8
Kamrup	38.5	6.8	81.86	53.9	54.9	20.26	4.21	22.87	35.61	30.77	22.75
Barpeta	39	25.7	76.48	66.7	33.5	18.81	23.64	0	53.49	57.76	30.74
Nagaon	39	12	89.02	62.5	44.3	18.81	9.56	53.32	47.63	44.14	34.69
Goalpara	40.5	11.8	89.82	71.4	48.5	14.47	9.35	56.72	60.06	38.84	35.89
Sonitpur	40.5	10.4	87.24	73.3	37.7	14.47	7.91	45.75	62.71	52.46	36.66
Baksa	41	3.7	93.38	76.8	55.3	13.02	1.03	71.85	67.6	30.26	36.75
Dima Hasao	41	5.4	97.06	77.6	53.5	13.02	2.77	87.5	68.72	32.53	40.91
Chirang	41.5	6.1	92.25	68.1	34.1	11.58	3.49	67.05	55.45	57	38.91
Dhubri	41.5	7.1	89.46	48.3	37.5	11.58	4.52	55.19	27.79	52.71	30.36
Karbi Anglong	42.5	6.2	93.33	65.6	79.3	8.68	3.6	71.64	51.96	0	27.18

(continued)

Table 18.2 (continued)

	Population living below national poverty line (%)	A household with any usual member covered by any health scheme or health insurance (%)	Households provided employment as a percentage of households who demanded employment under MGNREGA (%)	The proportion of the population (out of total eligible population) receiving social protection benefits under maternity benefit	Percentage of households with Kutcha houses	Normalized score	Normalized score	Normalized score	Normalized score	Normalized score	Index score
	1	2	3	4	5	1	2	3	4	5	
Udalguri	43	2.7	90.35	77.1	58.7	7.24	0	58.97	68.02	25.98	32.04
Golaghat	43.5	9.5	90.62	73.1	60.1	5.79	6.99	60.12	62.43	24.21	31.91
Morigaon	44.5	25.9	88.75	80.6	36.2	2.89	23.84	52.17	72.91	54.35	41.23
Darrang	45.5	4.9	80.2	74.3	58.2	0	2.26	15.82	64.11	26.61	21.76

Source Calculated from data sources mentioned in Table 18.1

Table 18.3 Factors affecting achievement of SDG 1

District	SC population (%)	ST population (%)	No. of registered MSME	Registered factories	Agricultural density	% of area flood inundation	Percent of urban population
Dhubri	3.61	0.32	32	94	1.08	44	12.73
Bongaigaon	11.2	2.54	43	76	0.71	30	14.86
Kokrajhar	3.33	31.47	16	42	0.73	10	6.19
Chirang	7.28	37.05	43	14	0.76	5	7.32
Baksa	7.69	34.84	4	22	0.87	16	1.29
Goalpara	4.47	22.96	58	27	0.85	36	13.69
Barpeta	5.62	1.61	195	73	0.88	68	48.80
Nalbari	7.8	3.02	80	37	0.44	51	10.72
Kamrup(M)	8.11	5.99	179	0	0.51	16	82.70
Kamrup	7.1	11.99	256	1658	0.87	40	9.38
Darrang	4.33	0.9	62	95	0.88	42	5.97
Udalguri	4.55	32.14	25	61	0.66	19	4.51
Sonitpur	5.67	12.06	99	505	0.73	31	10.86
Lakhimpur	7.85	23.93	38	76	0.83	50	8.76
Dhemaji	6.44	47.44	16	8	1.23	46	7.03
Morigaon	12.3	14.28	49	83	1.03	70	7.65
Nagaon	9.43	4.07	187	383	0.84	57	10.41
Golaghat	5.83	10.47	62	330	0.67	29	9.16
Jorhat	8.11	12.81	76	361	0.63	43	23.84
Sibasagar	3.67	4.26	151	408	0.44	51	11.60
Dibrugarh	4.43	7.75	306	508	0.53	38	18.37

(continued)

Table 18.3 (continued)

District	SC population (%)	ST population (%)	No. of registered MSME	Registered factories	Agricultural density	% of area flood inundation	Percent of urban population
Tinsukia	2.83	6.17	94	655	0.68	19	19.93
Karbi Anglong	4.7	56.33	30	54	0.74	5	14.38
Dima Hasao	2.02	70.92	0	28	0.64	0	29.18
Karimganj	12.85	0.15	20	121	0.92	32	8.92
Hailakandi	10.71	0.1	23	59	0.77	26	7.30
Cachar	15.25	1.01	33	343	0.54	27	18.16

Source Statistical Handbook, 2019: Economic Survey, 2017–18

The Government of Assam has launched several welfare schemes targeted at poor (*Anna Yojana, Atal Amrit Yojana,* etc.), females (*Indira Miri Universal Widow Pension Scheme, Minority Girls Scholarship Scheme,* etc.), old age (*Universal Old Age Pension Scheme*), youth (*Kalpataru Scheme*), students (*Gyan Deepika Scheme*), and disabled persons and most of these schemes are for the economically weaker section. *Deen Dayal Upadhyay Grameen Kaushalya Yojona* (DDU-GKY) and a similar one for urban area, National Rural Livelihood Mission (NRLM) and National Urban Livelihood Mission (NULM) are specifically for the skill development and capacity building of the poor. The implementation of some of these schemes is quite satisfactory across the state. The targets to achieve in terms of these schemes may not be very difficult if proper strategy, monitoring, and mechanism of implementation are evolved. But, at the end, multidimensional poverty index in 2030 will prove how successful these schemes are.

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Chapter 19
On Understanding the Drinking Water Treatment Requirements in Assam, India, During Emergencies

Rituparna Bhattacharyya, Bowen Tan, and Diganta Bhusan Das

Abstract At the heart of this review paper is about understanding the complex problem of drinking water shortage that most people in Assam, India, encounter during a crisis, e.g. floods, ethnic riots, droughts and others. Therefore, this systematic review aims at discussing the factors of drinking water treatment practices during an emergency with a view to developing a decentralised water treatment system (DWTS), and it stems from our reviews of both social science and engineering literature. Alongside, we have conducted a small pilot survey with the possible stakeholders for DWTS. The survey and secondary sources of literature have provided a better understanding of the state of drinking water treatment in the state of Assam during emergencies as well as for everyday living. We discuss these findings in this paper.

Keywords Drinking water treatment · Decentralised water treatment system · Affordable · Locally sourced membrane · Assam · India

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19.1 Introduction

Water, which is a prerequisite for every living being on this living planet, continues to be an important topic of research not only for the pure scientists and technologists but also for the social scientists including international institutions such as the World Bank and the United Nations (UN). Among the 17 Sustainable Development Goals (SDGs) of the UN, Goal 6 aims at universal, equitable and affordable access to safe drinking water and sanitation for all by 2030. However, the World Bank (2017) estimates that by the year 2025, approximately 66.67% of the world will live in water-stressed regions. Besides, the latest statistics retrieved from the UN suggest that 0.663 billion people still do not have access to improved drinking water while 1.8 billion people across the globe drink faecally contaminated water (Ahuja 2013; Lantagne and Clasen 2012).[1] Consequently, nearly 350 million people die every year due to a lack of adequate water supply access, sanitation and hygiene[2] and approximately 1000 children die each day due to diarrheal diseases (Lantagne and Clasen 2012; Narayan et al. 2020, World Bank 2017). These problems are found mostly in developing, transition and rapidly industrialising countries (Peter-Varbanets et al. 2009) including India (Bhattacharyya 2014, 2017; Narayan et al. 2020). Although considerable progress has been made with respect to improving access to drinking water from 76% in 1990 to 91% in 2015, 40% of the population (approximately 4 billion) across the globe suffers from absolute water scarcity (Hoekstra et al. 2012; Mekonnen and Hoekstra 2016; Bhattacharyya and Prasad 2020), while 80% population (in 2011, 5.6 billion people) are estimated to suffer from the threat to water security (Vorosmarty et al. 2010). In order to achieve improved access to drinking water free from microbial as well as organic and inorganic pollutants, the UN and the World Health Organisation (WHO) have called for targeted approaches to speed up the health gains for those lacking access to safe drinking water. One of the approaches of purifying water is the decentralised water treatment system (DWTS) (Libralato et al. 2012; Massoud et al. 2009; Semiyagaa et al. 2015; St-Onge et al. 2020). DWTS is not a certain piece of technology or kit, and it is simply a generic concept that defines water treatment using a stand-alone technology, for examples, flocculation, membrane-based filters, disinfection, boiling, application of microwave, reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), microfiltration (MF) and particle filtration (Libralato et al. 2012; Massoud et al. 2009; Semiyagaa et al. 2015; St-Onge et al. 2020). DWTS may include drinking water treatment of a single household (point-of-care systems) or a community (small-scale systems).

This review seeks to identify the practices that people use to purify drinking water during an emergency as well for their daily uses in Assam, India. We also carry out a brief review of the literature on gendered access to water wherein we review the issues linked to gendered water practices and try to connect it with interfaces of technologies

[1] Sustainable Development Goals: 17 Goals To Transform Our World, Retrieved 9 January 2017 from, http://www.un.org/sustainabledevelopment/water-and-sanitation/

[2] World Water Day, 2013, International Year of Water Cooperation, UN Water.org. Retrieved 03 December 2016 from http://www.unwater.org/worldwaterday/home/en/

of water engineering, especially the use of low-cost membranes to purifying water. This is followed by a discussion on the methodological issues deployed. This follows a discussion on the state of drinking water conditions in India, both for everyday and during emergencies.

19.2 Mapping Gendered Water Access

The journal publications of two special themed issues (1) Geographies of Water, guest edited by Mark A Fonstad in the *Annals of the Association of American Geographers* (Vol 103, No. 2, 2013), and (2) Scaling Down: Household Water Practices in *ACME: An International Journal for Critical Geographies* edited jointly by Dena Fam, Kuntala Lahiri-Dutt, Zoë Sofoulis (Vol 14, No 3, 2015) reflect the scale of the continued importance and dynamics of water, addressing the variegated social, cultural, environmental, political, economic and methodological terrains, which are often (re)shaped by human actions not only in the developing world but also in the developed world (Bakker 2013; Brown 2013; Escamilla, et al. 2013; Fem and Lopes 2015; Lahiri-Dutt 2015; Thornton and Riedy 2015; Sofoulis 2015; Swyngedouw 2013; Teh 2015). Obviously, the issues differ from place to place and region to region (Ahuja 2013, Arnold 2009; Bakker 2013; Brown 2013; Dinar et al. 1997; Dyson 2008; Eckstein 2009; Escamilla, et al. 2013; Fem and Lopes 2015; Gain et al. 2011; Gain and Giupponi 2015; Glennon 2005; Lahiri-Dutt 2015; Mekonnen and Hoekstra 2016; Hoekstra et al. 2012; Singh 2014, 2015; Teh 2015, Sofoulis 2015; Swyngedouw 2013; World Water Development Report 2015). Undoubtedly, water is a basic necessity, but the scholars of the occidental world are increasingly vouching for treating water as an 'economic good' by addressing the issues of freshwater scarcity and the 'need to supply water to the poor' (Bakker 2013; Eckstein, 2009; Mekonnen and Hoekstra 2016; Hoekstra et al. 2012). Amidst resistances and ever-burgeoning freshwater demands and impact of climate change (Eckstein 2009; Mekonnen and Hoekstra 2016; Hoekstra et al. 2012), scholars continue to argue for tackling potable water challenges by looking for answers via the lenses of equity, privatisation and economic marketisation (Bakker 2013; Glennon 2005), albeit the water quality regulations differ from country to country (Ahuja 2013). Triggered by the rolling out of neoliberalism (Harvey 2005) during the 1990s across the world including the Global South, the European water companies embarked on their mission to set up their companies in the developing world aimed at privatisation of water supplies (Bakker 2013). With the onset of the new economic reforms reinforced by structural adjustment programmes of India during the late 1980s (Bhattacharyya 2009, 2013), India too has liberalised its pro-privatisation water policies alongside building the requisite technological assistance to deliver new ways of high-quality water consumption to its citizens especially in the metropolitan cities (Lahiri-Dutt 2015). However, the country still reels under gendered access to water crisis (see, Bhattacharyya and Prasad 2020), where 77 million people fail to have access to safe drinking water

(the detailed drinking water conditions of India are discussed below.).[3] Evidently, even where there are provisions of improved water supply, those spatial locations too often suffer from mismanagement, poor governance, dilapidated/ageing/outdated water infrastructure and poor level of managerial and technical skills (Bhattacharyya and Prasad 2020; Gain and Giupponi 2015; Gain et al. 2011; Pulla et al. 2018). These phenomena are not unique to India alone but many developing countries continue to suffer from these problems (Escamilla et al. 2013). This review, however, aims to understand the key drivers of drinking water practices in an emergency, which should determine future water treatment solutions in times of an emergency. In doing so, this review aims to fathom the socio-economic conditions and technological interfaces (e.g. membrane materials) driving water practices in India.

It remains well documented that within the realm of water engineering too, there is a large body of literature on sustainable water practices (Chandrappa and Das 2014) through the development of DWTS including designing devices to disinfect water, desalination, etc. (Shamsuddin et al. 2015, 2016; Peter-Varbanets et al. 2009). Table 19.1 illustrates some of the low-cost water-purifying devices (including groundwater purification devices) developed by scientists using one of the membranes—ceramic, agro-based, slow-sand filtration and polymeric.

Most of these devices are however built using top-down approach with a lack of consultations with the locals/potential customers. While these devices are beneficial, they are often time-consuming for everyday maintenance and operations (Peter-Varbanets et al. 2009). In addition, the majority of these devices fail to be multi-purpose (i.e. not only cleaning pathogenic bacteria or viruses but also removing other contaminations such as salinity, fluoride, arsenic, iron and nitrate at the same time), user-friendly, mobile and without telemetric techniques. It is also evident from our survey that most rural areas use slow-sand filtration system which is of low efficiency and not suitable for emergencies. There is no developed water treatment device for emergencies, due to limited technology and cost. This provides a clear rationale for potential development of a low-cost DWTS using a bottom-up approach. In the following section, we discuss the methodological issues deployed.

19.3 Methodological Issues

The central aim of this review is to understand the factors underpinning drinking water practices in emergencies in Assam, located in North East India. For this reason, we have conducted a small-scale pilot survey among a list of selected academicians and possible future DWTS stakeholders residing in Assam, India, and the UK (willing to work in India). The survey was compiled in Survey Monkey. The title of the survey was *Provision of Clean Drinking Water in Humanitarian Crises* (https://www.surveymonkey.com/create/?sm=l40FLnrg4oRhfGhMYQyTOguTtQ3BPEOtnSGlJI3USxE_3D). It consisted of 10 questions comprising four close-ended and the rest open-ended questions (including questions

[3] The Water & Sanitation Crisis in India, Retrieved from, http://water.org/country/india/

Table 19.1 Summary of Low-cost water treatment materials for membrane filtration

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
India	Viruses	Waterborne viruses (i.e. enteroviruses, hepatitis E virus and rotavirus), Protozoa, Bacteria	New Delhi	Granular activated carbon	Granular activated carbon-based urea arginine phosphate buffer (GAC-UAPB)	Low cost	Jothikumar et al. (1995)
			Jodhpur	Ceramic membrane	Composite of hydroxyapatite, pond sand and sesame sawdust	Low cost	Choudhary et al. (2015)
		Bacteria, Protozoa, Viruses	Mumbai	Ceramic membrane	Kaolin and other local materials	Low cost	Das et al. (2016)
		Bacteria, Protozoa, Viruses	Sukabumi	Ceramic membrane	Kaolin and other local materials	Low cost	Fatimah et al. (2015)
			N/A	Rice-husk-ash	Rice-husk-ash-based composite membrane	Low cost	Malhotra et al. (2013)
		Microbes	N/A	Polyvinylidene fluoride (PVDF) and polyphenylsulfone (PPSu) hollow fibre membrane	Polyvinylidene fluoride (PVDF) and polyphenylsulfone (PPSU) hollow fibre membrane produced using manual spinning	Total cost per litre of water clarification 0.97×10^{-4} USD $/L	Praneeth et al. (2014)
	Chemical oxygen demand (COD)		Kolkata	Ceramic membrane	Alpha alumina and kaolin clay	0.0025–0.005 $ per litre treated water	Bhattacharya et al. (2016)

(continued)

Table 19.1 (continued)

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
	Dairy waste		Assam	Ceramic membrane	Tubular ceramic microfiltration membrane using low-cost natural clays (kaolin, quartz, ball clay, pyrophyllite, feldspar and calcium carbonate)	Low cost	Kumar et al. (2016)
	Chromate/chromium (Cr)		Rankem	Ceramic membrane	Locally sourced clay, sodium carbonate, sodium metasilicate and boric acid	Membrane cost \$19/m^2	Jana et al. (2010)
			N/A	Ceramic membrane	Ceramic composite membrane using local clay and baker's yeast biomass	Membrane cost \$61/m^2	Vasanth et al. (2012)
	Arsenic (As)		N/A	Rice-husk-ash	Rice-husk-ash-based composite membrane	Low cost	Malhotra et al. (2013)
			Maharashtra	Coating coal bottom ash	Coating coal bottom ash with ferric (hydr)oxide (bottom ash obtained from a coal-fired power plant in India)	0.00064 \$ per litre treated water	Mathieu et al. (2010)
	Fluoride (F^-)		N/A	Rice-husk-ash	Rice-husk-ash-based composite membrane	Low cost	Malhotra et al. (2013)

(continued)

Table 19.1 (continued)

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
			Jodhpur	Ceramic membrane	Composite of hydroxyapatite, pond sand and sesame sawdust	Low cost	Choudhary et al. (2015)
	Mercury (Hg)		N/A	Agro-based membrane	Agro-based waste materials (Mosambi peel, peanut husk, rice husk and coffee)	Low cost	Agarwal et al. (2010)
	Other heavy metals		N/A	Agro-based membrane	Agro-based waste materials (Mosambi peel, peanut husk, rice husk and coffee)	Low cost	Agarwal et al. (2010)
	Saline		Karnataka State	Cellulose acetate/polyamide fibrous membrane		Low cost	Raghuraman (1993)
			Haryana	Nanofiltration membrane	Nanofiltration reverse osmosis membrane	Low cost	Arora and Maheshwari (2011)
	Pesticides	Endosulfan	Orissa	Wood charcoal filtration		Low cost	Mishra and Patel (2008)
		Endosulfan	Kharagpur	Wood charcoal filtration		Low cost	Yedla and Dikshit (2008)
		Pesticides	N/A	Charcoal filtration	Indigenous charcoals, in collaboration with the Wood Energy Research Centre in Saraburi, Thailand	Low cost	Kearns et al. (2010)

(continued)

Table 19.1 (continued)

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
	Turbidity		N/A	Polyvinylidene fluoride (PVDF) and polyphenylsulfone (PPSu) hollow fibre membrane	Polyvinylidene fluoride (PVDF) and polyphenylsulfone (PPSu) hollow fibre membrane produced using manual spinning	Total cost per litre of water clarification $0.97X\ 10^{-4}$ USD $/L	Praneeth et al. (2014)
			Kolkata	Ceramic membrane	Alpha alumina and kaolin clay	0.0025–0.005 $ per litre treated water	Bhattacharya et al. (2016)
	Oil	Oil in wastewater	Guwahati	Ceramic/cellulose acetate composite membrane	Ceramic / cellulose acetate composite membrane system	Membrane cost $33.42/$m^2$	Mittal et al. (2011)
	N/A	Drinking water treatment	N/A	Ceramic membrane	Organic water purification system using clay pots and organic waste products such as tea, coffee and sawdust	Low cost	Sharma and Godbole (2012)

(continued)

Table 19.1 (continued)

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
			N/A	Slow sand filtration	Slow sand filtration (i.e. active carbon, cotton, sand) and copper wires	Low cost	Sudha et al. (2009)
Pakistan	Arsenic (As)		Balakot	Biomasses materials	Pine leaves as adsorbent	Low cost	Shafique et al. (2012)
			Northern Pakistan and India	Biomasses materials	Walnut shells, chickpea testa and chopped shavings of Blue Pine tree were used as adsorbent	Low cost	Saqib et al. (2013)
			Islamabad	Architectural waste materials	Hydrated cement, marble powder and brick powder as adsorbent	Low cost	Bibi et al. (2015)
	Fluoride (F^-)		Islamabad				
Nepal	N/A	Drinking water treatment		Ceramic membrane	Potter clay/colloidal silver	Low cost	Bogler and Meierhofer (2015)
China	Arsenic (As)			Amorphous zirconium oxide nanoparticles	Amorphous zirconium oxide nanoparticles as adsorbent	Low cost	Cui et al. (2012)
Africa countries	Viruses	Cryptosporidium parvum oocysts		Moringa oleifera seed		Low cost	Petersen et al. (2016)
		helminth parasite egg in irrigation water		Moringa oleifera seed		Low cost	Sengupta et al. (2012)

(continued)

Table 19.1 (continued)

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
	N/A	Earlier stage of water treatment		Moringa oleifera seed	Use Moringa oleifera seeds as water coagulant at earlier stage of water treatment	Low cost	Amagloh and Benang (2009), Baptista et al. (2015), Sengupta et al. (2012) and Nishi et al. (2012)
	Turbidity	Irrigation water		Moringa oleifera seed		Low cost	Petersen et al. (2016)
				Moringa oleifera seed		Low cost	Sengupta et al. (2012)
	Dye and heavy metal (i.e. Pb^{2+}, Ni^{2+} and chlorine)	Industrial wastewater	Egypt	Rice husk / mesoporous sludge filter	Adsorption of dye, Pb^{2+}, Ni^{2+} and chlorine in industrial water waste	Low cost	Shalaby et al. (2016)
Various countries	Viruses	Bacteria, Protozoa, Viruses		Ceramic membrane	Kaolin and other local materials	Low cost	Henry (2013)
	Arsenic (As)	Bangladesh, West Bengal in India		Dried water hyacinth roots powder		Low cost	Singh Thakur and Semil (2013)
	Heavy metal	Cadmium Cd^{2+}, lead Pb^{2+} Copper Cu^{2+}, Nickel Ni^{2+}, Zinc Zn^{2+}, Chromium Cr		Agricultural-based adsorbent	Banana peel, Agave bagasse, Cashew nutshell, mango peel waste, potato peel, rice shell		De Gisi et al. (2016)
				Industrial-based adsorbent	Industrial wastes, such as fly ash, red mud, activated slag and blast furnace sludge		

(continued)

Table 19.1 (continued)

Country	Pollutant	Comments	Area	Materials	Comments	Cost	Reference
				Sea materials	Sea materials, such as Chitosan, peat moss and Sargassum (Algae)		

entailing willingness to participate in the future research project with their respective contact details). We had sent the survey to approximately 50 participants. The survey link was emailed to various contacts as well as posted in the networking sites such as LinkedIn and ResearchGate. At the time of completion of the survey, we have received 18 responses. The findings of the pilot survey are discussed in the following section.

19.4 State of Drinking Water in India and Burden of Diseases

Geo-spatially, India is a tropical country and home to 1.34 billion people ranking second in the world after China.[4] Despite a faster pace of economic growth (Bhattacharyya 2009, 2013),[5] no cities in India have 24 × 7 access to piped water supply (Bhattacharya and Borah 2014).[6] Only 43.5% households are fitted with piped water (of which, 32% households receive water from treated sources while 11.6% from untreated sources); 11% from well (1.6% covered while 9.4% uncovered); 33.5% from hand pumps; 8.5% access water from tube well/borehole and 3.5% use other sources to drink water (Table 19.2; Census of India 2011). Table 19.3 illustrates a detailed breakdown of the status of availability of drinking water (rural and urban) (Census of India 2011). In addition, the country is well known to suffer from regular humanitarian crises, either natural (floods, storms, earthquakes) or man-made (community displacement via inter-ethnic violence, conflict zones, insurgent activities). The natural/man-made hazard(s) affecting the local areas of our participants are flood (93.75%), earthquake (62.50%), drought (37.50%) and ethnic riots (37.50%). Undoubtedly, these crises are regular phenomena occurring annually for 37.1%; once a year for 42.86%; twice a year for 21.43% and even thrice for 14.29% participants. These crises result in significant drinking water scarcity.

There are no adequate statistics as to how people manage drinking water in times of a crisis. In response to our question *How do the people cope during a crisis? And what is the extent of population affected?,* the majority of the participants confirmed that they are used to living with the crises as a part of their lives. The following narratives further demonstrate as to how people manage with their lives during a crisis.

1. During flood, some communities stay in their stilted houses and some others live in raised platforms inside their houses. Many of them store their crops in

[4] Population of India (2017 and historical). *Worldometers*. Retrieved 11 January 2017, http://www.worldometers.info/world-population/india-population/

[5] India Development Update—June 2016, *The World Bank,* Retrieved from, http://www.worldbank.org/en/news/feature/2016/06/20/india-develop.

[6] Urban Water Supply in India (4 July 2011). *The World Bank*, Retrieved from, http://www.worldbank.org/en/news/feature/2011/09/22/urban-water-supply-india.

Table 19.2 Main Sources of Drinking Water, 2001–2011, India

Country/States/Union territories	Total households		Tap water		Well water		Hand pump/Tube well		Other sources		Tap water (2011)		Well (2011)	
	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	Treated	Untreated	Covered	Uncovered
India	246,692,667	191,963,935	43.5	36.7	11	18.2	42	41.2	3.5	3.9	32	11.6	1.6	9.4
Jammu and Kashmir	2,015,088	1,551,768	63.9	52.5	6.5	5.6	12.8	12.7	16.7	29.2	34.7	29.2	1.9	4.7
Himachal Pradesh	1,476,581	1,240,633	89.5	84.1	2.9	4.8	4.2	4.5	3.4	6.6	83.9	5.6	1.5	1.3
Punjab	5,409,699	4,265,156	51	33.6	0.4	0.8	46.6	64	2	1.6	41.1	9.9	0.2	0.2
Chandigarh	235,061	201,878	96.7	91.9	0.1	0	2.6	8	0.6	0.2	93.7	3	0.1	0
Uttarakhand	1,997,068	1,586,321	68.2	65.9	1.1	1.2	24	20.8	6.7	12.1	53.9	14.3	0.7	0.4
Haryana	4,717,954	3,529,642	68.8	48.1	3	11.7	25	37.9	3.2	2.2	55.9	12.9	0.7	2.3
NCT of Delhi	3,340,538	2,554,149	81.3	75.3	0.1	0	13.7	21.9	4.9	2.7	75.2	6.1	0.1	0
Rajasthan	12, 581,303	9,342,294	40.6	35.3	10.8	24	37.5	32.9	11.1	7.9	32	8.5	1.2	9.6
Uttar Pradesh	32,924,266	25,760,601	27.3	23.7	4	11.6	67.9	64.1	0.9	0.6	20.2	7.1	0.6	3.4
Bihar	18,940,629	13,982,590	4.4	3.7	4.3	12.6	89.6	82.9	1.7	0.8	3.1	1.3	0.7	3.7
Sikkim	128,131	104,738	85.3	70.3	0.6	0.1	0.1	0.4	14.1	29.1	29.2	56.1	0.4	0.2
Arunachal Pradesh	261,614	212,615	65.5	67.8	5.7	4.7	13.1	9.7	15.7	17.8	26.4	39.1	1.4	4.3
Nagaland	399,965	332,050	47.2	42	25.7	34.9	6.7	4.5	20.5	18.6	6.1	41.1	6.6	19.1
Manipur	507,152	397,656	38.6	29.3	7.5	6.4	6.8	7.7	47.1	56.6	25.6	13	2.8	4.7
Mizoram	221,077	160,966	58.7	31.9	4.7	2	1.7	4	34.9	62	39.4	19.3	2	2.7
Meghalaya	538,299	420,246	39.3	34.5	25.4	27.4	5.4	4.4	29.9	33.7	27.8	11.5	6.9	18.4
Tripura	841,781	662,023	33.2	24.6	27.4	38.3	34.3	27.9	5.1	9.1	20.3	12.9	2.9	24.5
Assam	6,367,295	4,935,358	10.5	9.2	18.9	26.7	59.4	49.6	11.3	14.6	9.2	1.3	1.7	17.2

(continued)

Table 19.2 (continued)

Country/States/Union territories	Total households		Tap water		Well water		Hand pump/Tube well		Other sources		Tap water (2011)		Well (2011)	
	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	Treated	Untreated	Covered	Uncovered
West Bengal	20,067,299	15,715,915	25.4	21.4	6	10	66.8	67.1	1.7	1.5	21	4.4	0.7	5.4
Jharkhand	6,181,607	4,862,590	12.9	12.6	36.5	51.8	47.3	30.1	3.4	5.6	10	2.9	1.9	34.6
Odisha	9,661,085	7,870,127	13.8	8.7	19.5	28.6	61.4	55.5	5.2	7.3	10	3.9	2.2	17.3
Chhattisgarh	5,622,850	4,148,518	20.7	15.5	11.4	24.6	65.6	55	2.3	4.9	12.3	8.4	0.8	10.6
Madhya Pradesh	14,967,597	10,919,653	23.4	25.3	20	29	53.6	43.1	2	2.6	16.4	6.9	1.1	18.9
Gujarat	12,181,718	9,643,989	69	62.3	7.1	11.7	21.2	21.8	2.7	4.2	39.8	29.2	2.3	4.8
Daman and Diu	60,381	34,342	75.2	72.9	0.7	3.4	23.5	23.4	0.5	0.2	54.6	20.6	0.5	0.2
Dadra and Nagar Haveli	73,063	43,973	46.5	28.2	7.2	19.4	45	48.8	1.3	3.6	26	20.5	1.4	5.7
Maharashtra	23,830,580	19,063,149	67.9	64	14.4	17.8	15.5	15.8	2.1	2.4	56.3	11.6	2.2	12.2
Andhra Pradesh	21,024,534	16,849,857	69.9	48.1	6.4	16.5	20.6	32	3.1	3.4	49	20.9	0.5	5.9
Karnataka	13,179,911	10, 232, 133	66.1	58.9	9	12.4	21.5	25.7	3.5	3	41.2	24.8	1	8
Goa	322,813	279,216	85.4	69	11.1	26.1	0.3	1.1	3.2	3.8	82	3.4	4	7.1
Lakshadweep	10,703	9,240	20.3	3.1	71.7	93	2.5	1.6	5.5	2.4	9.1	11.1	6.9	64.9
Kerala	7,716,370	6,595,206	29.3	20.4	62	71.9	4.2	3	4.4	4.8	23.4	6	14.6	47.4
Tamil Nadu	18,493,003	14,173,626	79.8	62.5	5.1	10.6	12.8	23	2.4	3.8	55.8	23.9	1.2	3.8
Puducherry	301,276	208,655	95.3	89.3	1.9	2.7	2.5	6.6	0.3	1.4	90.8	4.5	0.1	1.8
Andaman and Nicobar Islands	93,376	73,062	85	76.2	7.3	16	0.5	0.5	7.1	7.3	68.8	16.2	0.7	6.6

Source Census of India (2011), Ministry of Home Affairs, Government of India, http://www.censusindia.gov.in

Table 19.3 Status of Availability of Drinking Water, 2001–2011, Rural and Urban Areas

Country/States/Union territories	Rural						Urban					
	Within the premises		Near the premises		Away		Within the premises		Near the premises		Away	
	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001
India	35	28.7	42.9	51.8	22.1	19.5	71.2	65.4	20.7	25.2	8.1	9.4
Jammu and Kashmir	35.5	17.1	35.1	50.9	29.4	32	84.8	74.7	10.2	19.2	5.1	6.1
Himachal Pradesh	51.9	27.3	37.9	58.4	10.2	14.3	84.7	73.3	11.7	20.4	3.6	6.3
Punjab	81.7	82	12.7	13.8	5.7	4.2	92.7	92.1	5.7	6.5	1.6	1.5
Chandigarh	85.4	69.3	13	27.8	1.6	2.9	86.2	78.1	11.6	18.7	2.2	3.2
Uttarakhand	45.4	32.7	34.5	46.9	20.1	20.5	88.7	82.1	7.8	12.7	3.5	5.2
Haryana	56.3	30.7	27.5	42.7	16.2	26.6	83.9	76	11	16.5	5.1	7.5
NCT of Delhi	64.1	62.3	25.5	20.6	10.4	17.1	78.8	75.8	15.2	18	6.1	6.3
Rajasthan	21	19.8	47.1	51.6	31.9	28.6	78.2	75.8	14.1	16	7.7	8.2
Uttar Pradesh	44.1	38.2	41.9	50.6	14.1	11.3	78.8	77	16	17.6	5.2	5.4
Bihar	47.1	36.3	40.4	51.1	12.6	12.6	75.5	70.5	17.5	20.9	7	8.6
Sikkim	42.1	40	35.1	39.1	22.8	20.9	78.8	85.6	15.7	11.6	4.5	2.8
Arunachal Pradesh	31.4	25.3	42.2	54.9	26.4	19.8	69.7	56.9	23.1	31.8	7.3	11.4
Nagaland	20.1	17.6	48.5	49	31.4	33.5	52.1	44.3	27.2	34.6	20.7	21.1
Manipur	8	7.5	51.3	58.9	40.7	33.6	31.8	24.9	36.2	52.5	32.1	22.6
Mizoram	6.4	5.3	61.6	56.8	32.1	37.9	53.5	33.4	33.2	47.2	13.3	19.4
Meghalaya	14.8	12.1	47.3	55.6	37.9	32.3	57.7	49.3	28.4	33.6	13.9	17.1
Tripura	24.5	13.6	35.9	55	39.6	31.4	69.6	58.2	16.7	32	13.7	13.9
Assam	50.4	33.6	29.3	41.9	20.4	24.5	78.8	63.2	12.8	26.3	8.4	10.5

(continued)

Table 19.3 (continued)

Country/States/Union territories	Rural						Urban					
	Within the premises		Near the premises		Away		Within the premises		Near the premises		Away	
	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001
West Bengal	30.5	23.4	37.9	56.2	31.5	20.4	56.2	53.4	27.8	34.7	16.1	11.9
Jharkhand	11.7	9.7	51.9	63.6	36.4	26.7	59.1	57.2	23.1	26.1	17.8	16.7
Odisha	16	13.7	45.5	53.9	38.5	32.4	56.9	52.1	24.7	27.1	18.5	20.9
Chhattisgarh	10.3	11.9	59.3	65.8	30.3	22.3	49.7	49.3	37.4	37.1	12.9	13.7
Madhya Pradesh	13	14	50.9	58.6	36.1	27.3	55.4	55.2	30.1	29.4	14.5	15.3
Gujarat	48.3	29.3	33.2	49.9	18.5	20.8	83.7	73.5	11.5	20	4.8	6.5
Daman and Diu	72.6	25.5	24.6	69.9	2.8	4.6	77.4	72.9	21.5	25.7	1.1	1.4
Dadra and Nagar Haveli	32.6	8.4	48.4	77.4	19	14.4	71.5	37.5	25.1	59.8	3.4	2.8
Maharashtra	42.9	38.9	37.5	43.9	19.6	17.2	79.3	73.3	15.6	21.1	5.2	5.7
Andhra Pradesh	31.5	22.8	44.6	55.4	23.9	21.9	67.9	57.2	21.8	29.3	10.3	13.5
Karnataka	26.6	18.5	48.6	55.4	24.8	26.1	70.9	56.6	20.6	29.6	8.5	13.8
Goa	71.2	54	20.6	31.7	8.2	14.3	85.1	69.6	12.3	22.4	2.7	8
Lakshadweep	79.8	87.6	19.9	8.1	0.3	4.3	84.9	77.9	12.6	15.2	2.5	6.9
Kerala	72.9	69.1	16.3	17.4	10.8	13.5	83.3	78.9	11.5	13.6	5.2	7.4
Tamil Nadu	17	12	74.8	74.7	8.2	13.3	54	48.3	40.2	41.3	5.7	10.4
Puducherry	60.7	39	37.2	56.3	2.1	4.7	85.1	71.9	14.2	24.4	0.7	3.8
Andaman and Nicobar Islands	47.1	32.5	35.3	48.5	17.6	19	83.9	78	12.8	18.7	3.4	3.3

Source Census of India, 2011, Ministry of Home Affairs, Government of India, http://www.censusindia.gov.in

stilted granaries. Others shift to safer places like embankments, nearest roads and railway lines or nearby high-rise platforms with livestock. They use boats and rafts made of trunks of banana plants for communication and transportation. In the study area, an estimated 3 million people are affected annually.

2. People generally manage their drinking water on their own by sourcing from available groundwater in nearby wells and hand pumps installed in villages and schools. Those residing in relief camps set up by Government generally in schools use the available groundwater from wells and hand pumps. Floods in Assam are annual features, and they affect nearly 1.5 million people annually inundating more than 1500 villages. They occur mainly due to overflowing of banks of the river Brahmaputra and its tributaries during the monsoon season.
3. People generally find it difficult to survive during and after the time of flooding as all tube wells in the affected area go under floodwater. They bring drinking water from far away where tube wells remain unaffected, maybe from school premises. Many times, the affected people are given water-purifying tablets to purify contaminated floodwater for drinking.
4. Poor households in floods are affected severely and become victims of polluted water. During drought, a section of the people buys potable water sold in cans by small operators, while the poor use unsafe ways of purifying the water. Those affected by flash floods in Hyderabad city manage by buying bottled water as the piped water is of no use for days. The people affected may be about 4 million.

One of the anticipated finding of our survey was that it is the young girls and women who mainly bear the brunt of collecting and purifying drinking water for everyday practice. Previous studies have shown that women in the remote and hilly areas of the country travel for miles to collect water and spend on an average of about 5–6 h daily (Dyson 2008; Singh 2014, 2015). This in turn affects not only the health of the women but also the school attendance of the girls.

Evidence from a study conducted in Tanzania suggests that if the distance to the water source was reduced from 30 to 15 min, it would increase the girls' school attendance by 12%.[7] This finding would of course be highly beneficial in developing a low-cost, affordable, compatible water-purifying device, while taking into account the human factors (or ergonomics) of the users. In simple terms, ergonomics is the science of designing a mechanism to fit the individuals who use them (Dul et al 2012; Karwowski 2005). Designing the interfaces of the device based on the perceptions of the women and girls is likely to reduce significantly the challenges they confront, and the amount of time they spend daily in collecting and purifying water.

The findings from our pilot survey further show that people use conventional methods such as boiling water, use of chlorine tablets and home-made water filters such as sand and charcoal to remove impurities to higher forms of purifying water using double lime-candled filters and aqua-guards (depending on the economic conditions of the households). Evidently, in times of a crisis, the poor households are severely affected and become victims of polluted water. While economically better

[7] Water and Gender, UN Water.Org Retrieved from http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/water_and_gender.pdf.

households buy potable water sold in cans by small operators, the poorer sections fall prey to unsafe water.

Notwithstanding, in 2012, the Ministry of Water Resources, Government of India, unravelled that the vast majority of Indians who depend on groundwater through hand pumps, tube wells and bore wells and which are perceived largely to be safe water suffer greatly from contaminations such as high salinity, fluoride, arsenic, iron and nitrate. Among the 639 districts, in 158 districts the groundwater pockets have become highly saline; excess fluoride contents are found in groundwater pockets of 267 districts; pockets across 385 and 270 districts, respectively, suffer from high nitrates and iron contents while 53 districts across the country suffer from high arsenic contents beyond the permissible levels as per the Bureau of Indian Standards (IS: 10500) (Sethi 2012). Arguably, this problem is going to escalate further with the growth of population, urbanisation and growing demand of water if proper measures are not taken. This observation bears resonance to previous literature on the problems of availability of freshwater (Ahuja 2013, Arnold 2009; Glennon 2005; Mekonnen and Hoekstra 2016; Hoekstra et al. 2012). However, it opens up deeper layers of questions regarding as to how to fix these challenges in order to provide improved and sustainable water (Chandrappa and Das 2014) to its citizens. While integrated and sustainable water management through fixing of leaky pipes and stringent metering for control and reduction of non-revenue water,[8] rejuvenation of the water utilities' capacities through allocation of sufficient budgets for operation and maintenance remains paramount; it is also important to promote behavioural changes and better affordable water tariffs covering quality services for all including the weaker sections. In addition, it is very important to generate public awareness on sustainable water usage and a greater 'willpower' at policy levels (World Bank 2017).

In yet another observation of the 68-page report prepared by Safe Water Network titled *Community Safe Water Solutions: India sector review*, India ranks, respectively, 120 (out of 122) and 133 (out of 180) with respect to water quality and water availability. In 1977, Bradley divided water-related diseases of the tropical countries, which embrace hot climates into four categories (Bradley 1977). They are *waterborne diseases* (caused mainly by pathogenic bacteria or viruses that could trigger typhoid, cholera, diarrheal diseases and amoebic and bacillary dysentery), *water-washed diseases* (caused as a result of very poor personal hygiene and using contaminated water that causes skin and eye diseases like scabies, trachoma, flea, tick-borne and also lice), *water-based diseases* (generates parasites in contaminated water, which in turn causes schistosomiasis, dracunculiasis and other helminths) and *insect vector-related diseases* (especially mosquitoes that breed in water and trigger malaria, filariasis, dengue, yellow fever, onchocerciasis and trypanosomiasis) (Bradley 1977).

[8] Non-revenue water is the amount of water, which cannot be charged but mostly is wasted through leaky pipes, overflows, metering fallacies, theft, etc. In addition, the water which is freely used, for example, to tackle a fire by the firefighters can also be considered under Non revenue water (Frauendorfer and Liemberger 2010).

As per WHO estimates, each year in India waterborne diseases affects 38 million people of which approximately 75% are children; typhoid affects 72,00,000; 15,00,000 are affected by viral hepatitis[9]; nearly 400,000 die of diarrhoea while about 780,000 simply die due to drinking of contaminated water. This observation echoes the findings of previous research on poor tube well water quality, latrine proximity and resultant diarrhoea in Bangladesh (Escamilla, et al. 2013). The findings of WHO nevertheless bear an adverse impact on the economic development of the country, which is, as calculated by Safe Water Network estimated to be a staggering loss of US$600 m annually and 73 million working days. Using a cost–benefit analysis, Pathak (2015) seemingly calculates the burden of drinking unsafe water and found that '1.5 million children under 5 years die each year due to water-related diseases, 200-million-person days of work are lost each year, and the country loses about Indian Rupees 366 billion [$5.37 billion] each year due to water-related diseases p.76'. Although there are differences in these calculations, the differences could be attributed to the methodologies entailed and the calculations unravel that the country continues to face serious drinking water crisis. The following table illustrates the impact of the water pollutants on health (Table 19.4).

In response to another question—*Is there any institutional support to cope with the natural/man-made hazard(s)?* we received 15 responses. The majority responded that while there are governmental, civil societies and local public supports for the population affected by a crisis; given the extent of the crisis at times, support remains highly inadequate and more needs to be done. The findings further suggest that there is a scope for development of a low-cost, affordable, user-friendly, mobile water treatment device to be used both during a crisis and for daily use especially by the weaker section of the population. The narratives of the respondents that fortify this observation are as follows:

1. Generally, economically weaker section of people who cannot afford water filters, etc., will be the potential users of such a system. We have been associated with water supply bodies so anything innovative will be interesting.
2. Areas having no access to municipality-piped water will certainly welcome the move. Drought-hit areas will also welcome. Devices capable of removing iron from drinking water at affordable cost are desperately needed in different places throughout Assam and North-East of India.
3. If any user-friendly device for purifying water is made available to flood-affected people in the times of crisis, people will be more than happy but we believe it has to be provided free as these flood-affected people are very poor and they would not come forward for anything which bears them a cost. Cost component may be considered by government or other voluntary organisations/NGOs if proposed at proper platform.
4. It would be of great relief for the people if such a system is actually developed. Residents of the locality would certainly use it. But there is a need of awareness in this regard which our NGO can comfortably manage it. Our NGO would be

[9] IS 10500: 2012 Drinking Water—Specification (Second Revision), Gr 6, Retrieved 12 January 2017 from, http://www.bis.org.in/other/DrinWatIS10500.pdf.

Table 19.4 Impact of the Contaminants on Health

Metal contaminants	Limits		Health impacts	Sources of water
	Acceptable (mg/L)	Permissible (mg/L)		
Arsenic	0.01	0.05	• Weight loss, • Lack of energy • Depression • Skin and nervous system toxicity • Cancer upon prolonged exposure	• Geological settings • Previously used pesticides in orchards • Improper waste disposal or product storage • Of glass or electronics
Fluoride	1	1.5	• Brownish discoloration of teeth • Bone damage • Fluorosis	• Geological settings • Industrial waste
Iron	0.3	No relaxation	• Imparts blackish colour • Rusty sediment • Bitter or metallic taste • Brown-green stains • Iron bacteria to food and beverages	• Geological settings • Leaching of cast iron pipes in water distribution systems
Nitrate	45	No relaxation	• Methemoglobinemia or blue baby disease in infants	• Natural deposits, decaying plant deposits • Livestock waste • Septic systems, fertilisers and household • Wastewater
Total Dissolved Solids	500	2000	• Objectionable saline taste to water, • May affect osmotic flow and movement of fluids • Could lead to kidney stones at very high levels	• Natural deposits, deep groundwater • Nature of soil and landfills

Sources Community Safe Water Solutions: India Sector Review, Safe Water Network, Indian Standard: Drinking Water—Specification, (Second Revision), IS 10500: 2012, Poison in India's Groundwater Posing National Health Crisis. *The Times of India*

very happy to help the people in our locality in helping them get low-cost purified drinking water and save them from various diseases. We would make sure about the sustained use of the system and, if possible, modify it for the better fitment of the situation in consultation with the provider.

19.5 Conclusion

Indeed, access to unsafe water is a travesty of democracy. This mini-review sets out to understand further the state of drinking water practices of the people of Assam in times of emergency. However, the findings are based on a pilot survey and systematic review of social science and engineering literature. This review not only extends our knowledge of the state of drinking water practices in India but also serves as a base for a further large-scale survey (in triangulation with qualitative interviews amongst the residents), while taking into account the user-centric perspective and the unique socio-economic, cultural standpoint, for a nuanced understanding of the problem that residents of the localities face during the times of a crisis.

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Chapter 20
Perilous Waters: Gendering Community-Based Disasters Management Practices from Floods—A Study of Majuli, Assam

Bikash Chetry

Abstract When a hazard unfolds as a disaster, local communities are not only '*first responders*' in the aftermath of disasters but also the '*first constituency*' to be affected by the deluge. The Sustainable Development Goals (SDGs) 5 (Sustainable Development Goal 5 aims toward achieving '*Gender Equality and empowerment of women and girls and eliminated all forms of gender based discrimination mended towards women*'. In this paper I have primarily used the major indicators of SDGs: 5.1, 5.2, 5.4 and then 5.1a, 5.2b, and 5.4c to decipher gender based discrimination in public and private spaces primarily to understand their participation and roles of community in Village Panchayat and Village Disaster Management Committees, etc. and the hegemonic culture of the community. Secondly, to understand the gendered roles of women in post and pre disasters as often the unpaid roles of women were perceived as extension of their gender roles and remained neglected. Thirdly, it was used to decipher the unequal distribution of resources in community and vulnerable population among vulnerable like Single-headed Household and widows being left out during the rehabilitation due to the ownership of resources being centered around men) and used SDG 10 (aims toward achieving to '*Reduce inequality within and among countries*'. In this paper, I have primarily used the major indicators of SDGs like 10.2 inclusion of everyone irrespective of their sex, age, race, etc., for their social, economic, and political empowerment and promotion and 10.6 to enhanced representation of voices of subaltern/ disadvantage section of the community in decision making process. Firstly, the goal was to study whether the Disasters Management programs at the community level are gender inclusive or not and to understand whether community-based practices during disasters addresses to reduce the gender inequalities if any at the community level. Secondly, these SDGs were used to understand and document the voices of vulnerable constituencies in disasters management and to check whether the gendered needs are addressed or not

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while relief and rehabilitation.) focussing on reducing gender inequalities by mainstreaming a more decentralized bottoms-up approach with more inclusive nature from state to the village level. However, the study was conducted in the Majuli district of Assam shows that the Community-based Disasters Risk Reduction (CBDRR) strategies or programs are disconnected from the gendered realities and tend to overlook social equity and inclusion of vulnerable constituencies in DRR. At the same time, lapses in good governance practices alienate their voices further, leaving virtually no room for vulnerable gender groups to meaningfully reduce their vulnerabilities. So, it is paradoxical to believe to have environmental justice without focusing on the differential needs and capacities of not only the binary gender groups but also non-binary gender. The community-based initiatives have to be more gender-neutral and egalitarian in their approach for fulfilling the priorities of SDGs and for the Sendai Framework for Disaster Risk Reduction (2015–2030) to make development plans more disaster resilient. This can be done by aiding the vulnerable communities to mitigate disaster impacts and to build back better. Hence, through this paper, I would try to locate the need for a gendered approach in CBDRR plans in island geographies like Majuli. Also how the prevailing interplays between power and hegemony is a key in understanding the CBDRR.

Keywords Flood · Gender · Developmental goals · Community-based disaster management practices · Disaster risk reduction

20.1 Introduction

Over the years, we have witnessed the growing paradigm shift in vulnerability, which has altered the way of disaster studies, policies, and programs. It has invalidated the claims of disasters being '*natural*' rather than looking at it as a phenomenon emerging out from the existing social and economic inequalities, unequal power distribution, resources, and information that impact the vulnerable constituency at the most. Hence, while addressing disasters it is vital to acknowledge the fact that even these marginalized groups or people should not be seen/treated as helpless '*victims*' of disasters.

The disasters and development nexus is a part of a circular process within which the impact of disasters on development or vice-versa needs to be analyzed. Disasters have not only disrupted the normal course of life of affected communities from Assam but also halted development efforts in the state. The development funds which are originally earmarked for new initiatives have to be transferred for relief, response, and rehabilitation work as the region is one of the most flood-prone regions in India. The average flood-prone area of Assam is 39.58% which is four times more than the national average of 10.2% and also due to the geographical location of the state in seismic zone V. As the region is home to young mountain ranges with active tectonics of Himalayan thrust plate, it has been the source of major earthquakes, floods and riverbank erosion and landslides in the region. Flood has been a perennial issue for

Assam post the great earthquake of 1950, and floods had a long-lasting impact on the traditional livelihood systems of women including pottery making, handlooms, animal husbandry, etc., have emerged as one of the key issues of flood in the island. At the same time, an identical narrative about the significance of Brahmaputra is visible through the Assamese/Amoxiya lens which marks it as an integral part of larger Assamese identity. This can be established by the work of the Assamese song-writer/poets Rupkonwar Jyoti Prasad Agarwala, some lines of poem/songs are as follows, '*Luitor parore aami deka lora moriboloy bhoi nai'* (we are the youths from the banks of Luit[1] and we don't fear death), the song further says, '*Luitore pani jabi o boi, joyare kiriti deshe bideshe, sohore nagare, phuribi koi'* which translates into English as '*O mighty river through your water, which flows through different lands, cities, and towns, through this water tell our stories of victories to people*'. Or for that matter, even Dr. Bhupen Hazarika who regarded the river as '*Mahabahu Brahmaputra*' presents the historical perspective of the river and used the Brahmaputra as a metaphor for unity and harmony for the people of Assam and discusses the precarious nature of the river. However, the flood has been a key issue for the state's development and despite the government's technocratic approach of flood mitigations, more than half of the state reels under flood every year. In this background, it is also important to understand that communities in Majuli have adapted themselves to '*live with flood*s' and devised a way of living by adopting a series of indigenous/local knowledge to cope with the deluge.

Disaster has been seen as 'levelers' as it affects everyone equally but the impact of disasters vary due to social-political norms developed in the society which leads to disproportionate effect on certain population more than others. The vulnerabilities of the community are not only because of their physical nature but also due to the arrangements in societies (along with gendered rolesGendered Roles, cultural practices, lack of access to resources, unavailability of social capital, livelihood opportunity, etc.) which leads to their susceptibility to disasters. '*Gender*' in particular is often used in a restrictive manner that is confined to binary gender groups and tries to put the non-binary gender groups in that box. However, the term has to be used in a more emancipatory way which needs to go beyond the normal definition of gender. Gender should refer to existing roles, responsibilities, needs, and interests of not only binary gender groups but also the non-binary genders as well. This area in disaster scholarship has been a misplaced priority as it focuses more on how disasters affect the male–female and at the same time neglect the non-binary genders.

It is often seen that women contribute more labor than men in agriculture and other allied activities, as it is believed that at some given point in time they had inherited the land. At the same time, the double burden of work especially after post-disaster limits the participation of women in the public spaces. Though in Assamese societies, women are actively engaged in Panchayat meetings and block-level meetings or other public forums. But at the same time, it is vital to consider the fact that only

[1] Luit is one of the name used for the only Male river in World '*Brahmaputra*' which mean '*son of Brahma*' as per the Hindu Mythology.

the presence of women in public space does not guarantee them to have decision-making power as the tribal or non-tribal Assamese societies are patriarchal and at the same time the customary practices or norms does not allow women to govern these bodies. They only attend the meetings and are not expected to be vocal about the gender needs which makes them nothing but '*second-class citizens*' and see them as mere '*spectators*' in these bodies and their needs or vocal intervention remains largely limited which results in the non-inclusion of pertinent issue of women and non-binary genders during disasters like sanitation and hygiene, potable drinking water, medical aid, during floods. Hence, it is in this context vital to generate and document based on the lived realities of communities whose lives and livelihoods are dependent on the Brahmaputra and study whether the prennial flooding and riverbank erosion in these areas have transformed their lives and livelihoods or not. And these narratives are required to be documented as the lives around these geographies often belong to marginalized groups like women as against men, economically and socially disadvantaged than rich, particularly in the case of Assam where there are different intersectionality that impacts women, in particular, more severely than others. And the groups have largely remained voiceless due to lack of agency/organization which could aid them in articulating their voices or perspective has been an challenged. Hence, the study is aimed to discover these voices and document their narratives and stories of communities about what it is like to be '*living with floods*', and focus on their lived realities. Also, the research will be informed by researcher own lived experiences of growing up in the Brahmaputra valley where monsoon or floods had different connotations for him and his brother. It meant nothing but gazing through the windows without worrying about the fear of losing lands, cattle, or homes to floods but this was nonetheless the same for his single mother who feared losing her cattle or crops that could feed the family for the entire year. Soon this childhood exhilaration dissipated with each passing year as researcherstarted understanding the larger impact of the flood on his family or Assamese women at large. This meant nothing but havoc and especially to women of my households with added drudgeries, loss of traditional livelihoods, disappearance of homes, etc., which are engulfed by the mighty Brahmaputra. Going by lived realities of such geographies, families had to spend at least fifteen days to months usually and sometimes, even more, to live either on embankments or on bamboo-raised platforms (which are called *Saang* in Assamese) or in relief camps. This lifeworld has not only shaped my understanding of flood and its associated loss or transformation caused to communities but also compelled him to do in-depth research to understand the varied phenomena associated with floods.

Hence, it will be paradoxical to believe to have environmental justice without focusing on the differential needs and capacities of not only male–female binary but also non-binary gender. The traditional flood control measure and policy promulgated by the nation-state have also been restored to focusing more on the hydraulic structure for flood control, and these strategies or programs are deemed to be disconnected from the gendered realities and their impacts during disasters. At the same time, lapses in good governance practices alienate the gender voices further, leaving virtually no room for vulnerable gender groups to meaningfully contribute toward the reduction

of their vulnerability combined with the patriarchal elements of society which further reduces their opportunity to overcome their vulnerability. Hence, this research would be an imperative endeavor to understand the '*Gendered differentiated impacts of Disasters*' on binary as well as a non-binary gender and explore and analyze their vulnerabilities through a gendered lens. By doing this, the research will contribute toward the disaster scholarship in adopting a more gendered approach to Disaster Risk Reduction.

Against these backdrops, the study discusses the concepts of Gender in Disaster studies and the imperative of gender in disaster scholarship. In the second section, the paper gives an overview of the field area and also about the epistemological/methodological tools used for the data collection. The third section of the paper discusses the prerequisite of examining disaster scholarship through a gendered lens and the need for Gender being a key analytical category in Disaster management. The fourth section of the paper discusses results and discussions, wherein I have not only looked into the gendered vulnerabilities of different gender constituency but also discussed the hegemonies spaces or gender in-exclusive early warning systems which aggravates their gendered risk and vulnerabilities in the study area. In the last section of the paper, it discusses the indigenized methods adopted to cope with disasters and the need of looking at disasters as a social phenomenon and moving away from the idea of seeing vulnerable groups as not only as '*Victims*' but also as an equal partner in disaster management and study their gendered vulnerabilities emerging out of the societal and gender norms.

20.2 Situating the Field Area of Study

The study area Majuli is located amidst the Brahmaputra River and about 630 km upstream from Bangladesh—Assam border. Also, the island is located in the broadest part of the Brahmaputra valley, wherein the river divides the island from Jorhat and Lakhimpur districts (Goswami 2001). The island lies between 26° 39′ 57.6″ and 27° 16′ 19.2″ N and longitudes 93° 34′ 12″ and 94° 42′ 3.6″E, and it is encircled by the Brahmaputra in the South and Lohit, Kherkatia Suti, Subansiri, in the North. The physiography of Majuli island is characterized by unique characteristics of having an extremely dynamic flow system, and the ecology of the island is unusual than other riverine islands as the island faces a constant threat due to flood and erosions. The island is formed by a significant landmass of alluvial flood plains of the Brahmaputra, which is profusely dominated by the profusion of depositional landforms including Chars and Chaporis[2] (sandbars, bed-forms, etc.) and not to mention vast lengths of wetlands (Figs. 20.1 and 20.2).

[2] Chars and Chapori' these two names were coined based on the topography of the Assam. The Raised land surrounded by water is locally called 'Char'. When 'Chars' get perpetually, then they are locally called 'Chapori'. In other words, after changing of the course of river if the 'chars' are connected with or linked to the original soil then the 'chars' are identified with 'Chapori'.

Fig. 20.1 Brahmaputra near Kamalabari Ghar in Majuli

Fig. 20.2 Erosion near the Salmora, Majuli

20.3 Methodological/Epistemological framework for the Research

The research study was conducted as a part of M.Phil. research in Majuli district of Assam. It was qualitative in nature to get an in-depth understanding of '*Gendered differentiated impacts of Disasters*' on binary as well as a non-binary gender and explore and analyze their vulnerabilities through a gendered lens. By doing this, the researcher contributed toward the disaster scholarship in adopting a more gendered approach to Disaster Risk Reduction. The research followed a Descriptive cum exploratory research design as it intended to study the diverse aspects related to the gendered needs during disasters and the interplay between power and hegemony which shapes the CBDRR plans. The study was located in two blocks of Majuli: Majuli Development Block (Kamalabari) and Ujani Majuli Development

Block (Jengraimukh) as the universe for the research, the blocks being perennially affected by floods. The blocks consist of 248 revenue villages out of that 4 villages (Salmora, Jengrai Gaon, Moulal Kalita Gaon, and Dakhinpat Kumar Gaon) were selected using the Purposive Sampling method which was also based on the secondary literature which shows the higher impact of floods on these villages and due to the proximity to the Brahmaputra, lacks resources to cope and impacts of floods on the livelihoods of the communities due to twin process of floods and riverbank erosions.

For the research, explorative interviews has been used with the key informants from the community and the participants included men and women primarily as there were no other gendered constituencies in the study area, local scholars and elderly and representative from village councils, etc. were also selected for the research. The data collection was done through key informant's interviews, and a checklist[3] was used for the interview (Semi-structured questions were used to interview members of flood-affected households whose livelihoods were impacted due to flood and riverbank erosion). FGDs as a tool were used as 'it encourages a range of responses from respondents, their attitudes, behavior, opinions, or perceptions of participants on the research issues' (Hennink 2007). Focus Group Discussions (FGDs) were used to uncover men's and women's experiences and examine whether the communities' pre-existing patterns of discrimination might have enhanced their gendered difficulties post-disaster or not. FGDs were conducted in four villages in mixed population and individuals as well in which 15 members from the community participated in each FGD. The categories of respondents selected for the study are as follows:

- Men, Women, Elders of the communities, Community members.
- Members of Village Council (Gaon Panchayats), Community leaders (village head), Block Development officer
- Academician, Members of Community-Based Disaster Management Committees/Task Forces, SHGs, etc.

As the majority of the respondents from the sites/village selected for the study speak Assamese, the tools for data collection were first prepared in English and later it was translated into Assamese to collect data smoothly from the field. Also, as the researcher is from Assam, the interviews and FGDs were conducted in Assamese. Since most of the data collected or recorded responses were in the form of text and audio hence, I used descriptive and theoretical analysis to interpret/analyze the collected data. Firstly, all the interviews, focus group discussions, etc., were transcribed into English from vernacular languages (Assamese) to avoid loss of data, misinterpretation of information, etc. After that all the data was transcribed, it was read thoroughly and data was coded as text based on the theories and themes which emerged out of the objectives of the research. I have used varied theoretical tools

[3] Some of the key points of the checklist were as follows: types of disasters and hazards affect in the area, impact of disaster on traditional livelihoods (Block level, GP level and community level), indigenous knowledge and practices to cope from disasters, role of institutions in disaster risk management, and strengths of the community, etc.

and integrated vulnerability theory, Genderscape and Hegemony, and other socio-political and cultural theories to describe the gendered impacts of the disaster, their vulnerabilities, and unequal distribution of power and resource among binary and non-binary gender constituencies. The data collected using FGDs was meticulously transcribed considering all the themes which emerged based on the existing theories, and objective of the research a framework was developed to arrange and analyze it.

To unpack the hegemonies spaces or dominance of one group/gender over the other in vulnerable geographies like Majuli wherein flooding is perennial, Gramscian concept of '*Hegemony*' was used. Gramsci defines Hegemony as an approach of exerting power or control by the dominant bourgeois class on the vulnerable communities through the medium of knowledge which is based on acquiescence rather than force/coercion (Gramsci 1971). This merely reflects the consent of the ruling class secured by popularizing their world view; in the Marxist view, it was a means of controlling the production by certain group or section (Bates 1975). However, knowledge echoes power relation, both power and knowledge are interlinked as the precondition of excreting power is by instituting a body of knowledge (Foucault 1975). Hegemony is commonly understood as the 'political dominance of one group/state over another' as voiced by Lenin as something which is leadership exercised by the dominant over the dominated. For this research, I have also employed the theoretical concept of '*Genderscape*' (Krishna 2009) to understand the gender space relations (physical spaces) with the river in the context of studying the impact of rivers on women, intending to meaningfully contribute toward the larger framework of gender and disasters. In this context, I have used measurable indicators like men and women participation in different phases of disasters as well as employment guarantee schemes of the Government of India like MNREGA, workspaces, the share of women cultivators, property and land ownership, in the region. At the same time how the participation of women is challenged by the traditional and customary practices of Assamese societies, the burden of work at home, gender and caste intersectionality, decision-making power in public and private sphere, or state and national policies have dealt with gender issues, etc. The gender divides are very high in the societies being patriarchal since these intersectionalities are significant to look at the gender impact of disasters.

20.4 Revisiting Disasters Through a Gendered Lens

In social science research, the varied roles of community, individual and their gendered roles in the flood-affected area or around water have been well documented, conventionally if we looked at water management per se it is predominantly dominated by men, who were either even colonial cartographer, geographers or engineers. And the dominant approach to disaster management largely ignores the gender perspective which perceives disaster management being male-centered, and the dominance of men and masculine culture has been posed essentially to the

prevalent discourse (Morrow and Enarson 1996). The dominance of men and masculine culture has posed a threat to women and other vulnerable groups. Hence, these practices of water management have largely been disconnected from the gendered realities or needs of people who were traditionally dependent on water and natural resource and women being by the virtue of their gendered roles and their relationship with the environment play a vital role in this time. As rightly documented by Bina Agarwal about how the rural poor, especially women, and their occupation are shaped by the environment, at the same time, they are mostly the victims of environmental degradation as well. While on the other hand, women in India have been the prominent actors of movement around environmental protection and regeneration. Hence, there are varied vulnerable groups that can be categorized based on their ethnicity, gender, class, age, etc. If any disasters strike in the community, it does not have any particular discriminatory impacts on a particular gender, rather it affects all gendered constituencies equally. However, the social-political norms developed in the society have discriminatory impacts which leads to the varied coping mechanism of the communities. In a disaster context, the vulnerability of the community is the result of poverty and marginalization as they are more likely to live in vulnerable areas due to lack of choice, social capital, etc., and they are often at more risk of disasters.

Gender is a prevalent division that affects all societies, and takes the social and economic resources away from women and brings it toward men (Blaikei et al. 1994). Gender should refer to existing roles, responsibilities, needs, and interests of not only binary gender groups but also the non-binary genders as well. Vulnerability theorists agree that the women population are the most at risk when hazardous conditions unfold as disastrous events yet, a large majority of poor women in India, face gender-based discrimination or differences during disasters (Enarson 2001). Often these communities are forced to live in inhabitable areas (like areas prone to erosion, flood plains, slums, or marginal agricultural lands like Chars and Chaporis), and the communities living in these geographies have a lack of access to information and also relatively less fallback position or resources to invest to reduce their vulnerability. So the different groups manifest different vulnerabilities depending upon their background characteristics and their coping capacity. One such vulnerable group is women and transgender communities—due to their socio-economic status, education status, lack of decision-making power, etc. For the most part, vulnerability theorists agree that women are the population that is at more risk when hazardous conditions unfold as disastrous events. They observe gendered vulnerability in disaster context is deeply embedded in patriarchal values and the social production of gender within different social structures, which locates women subordinate to men.

Women in disaster-prone communities are more vulnerable to men, and disasters tend to have more impact on them compared to males. For instance, several studies have shown that the mortality rates for women during disasters are often several times higher than men. The combination of social, economic, cultural, and political factors further weakens women and increases their vulnerability. Women are further disadvantaged when they are pregnant, lactating, or are in the elderly bracket and they are

also more at risk, as far as the injury, loss, and deaths are concerned. This is imperative in the context of Assam as well wherein women are continued to be constructed in the role of reproducers, nurturers, and disseminators of tradition, and caregivers, and their work in the agriculture field is often seen as an extension of their domestic responsibilities, rather than as a separate economic activity. These have been deeply embedded due to patriarchal values and through the social production of gender within the social structural position where women and non-binary gender are being treated inferior to men. This further results from their political marginalization and increases their dependence on men during disasters, which shows the hegemonic relation in disasters context. Having said that even the coping capacity of men and women also differs which implies their vulnerability and capacities of both (Ariyabandhu 2005). In the country context of disaster, relief efforts are only confined to meet the immediate needs rather than addressing and lessening the effects of vulnerability. Therefore, to reduce the gendered impacts of a disaster, both women, men, and a non-binary gender groups must be given equal opportunities, resources, relief, and rehabilitation. Also, their voices need to be heard while making policies.

20.5 Understanding the Prerequisite of Gender as an Analytical Category in Disasters Management

Disasters are not social levelers but their impacts are felt in certain social and historical contexts through the boundaries of class, race, and gender among others (Fordham and Enarson 2001). The impact of disasters is unskewed due to the pre-existing social and economic conditions (social position in community and family, restriction, taboos, and cultural values, etc.) which are discriminatory toward a gender group compared to another. The existing gender role learning, misogyny, and gender identity formation have made women accustomed to accept the perpetuated violence without any objection. Even during the relief and rehabilitation, the household vulnerabilities often play a significant role as it gets blended with the external and internal factors (Chambers 1983). As per the structural paradigm of Bolin 1988, societal pre-existing inequalities exacerbate the differential impact of disasters in relief and rehabilitation which leads to susceptibility toward vulnerable groups (Jackson 2003). One such vulnerable constituencies are women who are considered to be '*Vulnerable within the Vulnerable*' (Ariyabandu and Foenseka 2006).

Vulnerability is often linked with poverty most of the time, and due to globalization, a lot of feminization of poverty has been acknowledged. Women as a group have less scope as compared to men despite not portraying women as a victim group (McDowell 1999). They are often committed to others which in turn makes them compromise their ability for them. Around the globe with certain variations, women tend to play multiple roles: reproduction, production, and community management/activism etc. The role and essence of women are hidden behind common-sense notions of what is '*natural*' for women and men to do and be and

they must sort out with less educational and employment opportunities, diminished political power and representation, and civic freedoms. The extensive patriarchy limits women to get equal opportunities. These factors make some women vulnerable in certain locations, times, and situations. Depletion can make women even more vulnerable which is largely concealed. Conventional economic analyses portray the informal sector as marginal whereas on the contrary majority of women in the developing economies (over 80% of women in South Asia) work in the informal sector. The income generated by these women becomes a major component of the household budget.

Despite prevalence in lower-status positions, women are depreciated in positions of power and responsibility in pre- and post-disaster decision-making committees and organizations (Enarson and Morrow 1997; Neal and Phillips 1990). Thus, women gradually become vulnerable through the disaster process. Women's material conditions are subjected to a common specimen in their everyday lives which includes domestic and reproductive labor, caregiving, and vulnerability to abuse and violence. These specimens enable women a unique vision when natural and man-made disasters impact communities (Fordham and Enarson 2001). While addressing gender inequalities, it is easy to tag women and girls as 'special needs' however, it is vital that we move from this narratives and shift the narratives to women's rights rather than women's needs (Enarson and Fordham 2002). Though women's rights have been specifically acknowledged in the 1993 Convention to End Discrimination against All Women (CEDAW), such laws, treaties, and guidelines remain an empty talk rather than action. Hence it is significant that we changed our narratives to women's rights rather than women's needs (Enarson and Fordham 2002).

20.6 Factors Influencing Gendered Vulnerabilities in Disasters

The impact of disasters varied between women belonging to different age (elderly, infants) and social groups (Mehta 2007). The age difference also determined their coping mechanism, livelihoods changes in post-disasters as elderly and children have heightened exposure due to their dependency on others due to their health and limited mobility. Also, middle-aged women are more at risk due to the added drudgeries of not only being caregivers but also as they take up the role of an earner in the family. Gender in our society has largely shaped the coping capacity as well as the vulnerability during floods. Women are seen as active and resourceful in the disaster management cycle but often they are regarded as the helpless '*victims*' of disasters. Women are considered to be more vulnerable constituency during disaster not because of their physical position but due to socio-economic position and they have specific needs in pre, during and post-disasters scenario. Several causes are primarily responsible for the vulnerability of people as far as the occurrences of disaster are concerned and these are discussed in Table 20.1.

Table 20.1 Causes influencing the Gendered vulnerability during disasters

Vulnerabilities	Causes
Material/Economic vulnerability	Unequal access to resources
Social vulnerability	The disintegration of social patterns, family/social ties, and loss of family
Ecological vulnerability	Dwindling resources and livelihoods due to degradation of the environment
Organizational vulnerability	Lack of gendered participation at the community level
Education vulnerability	Unequal access to information and knowledge
Attitudinal and motivational vulnerability	Lack of awareness
Political vulnerability	Limited access to power and representation in village/panchayat and household
Cultural vulnerability	Beliefs and customs
Physical vulnerability	Gendered roles and added roles

Source The table was developed based on the analysis of field data

20.7 Gendered Roles

Women due to their gender roles and responsibility in the family inclusive of bearing, nurturing, rearing children, caring for the elderly and sick, etc., which are done voluntarily without getting any economic remunerations. These roles of women are linked to their reproductive roles which places men in the more public and powerful areas, and they get social recognition and economic rewards which makes women more vulnerable due to their inability to participate in the disaster management programs (Wickramasinghe 2000). Thus, the role of women remains as the secondary caretakers and is largely been overlooked. In a disaster like the 2005 Kashmir earthquake, women were largely affected because when the disaster struck in the area many women were inside doing household chores which resulted in the loss of life od a large number of women (Parker and Halvorson 2007). Often, it is seen that post-disaster women recover slowly as compared to men as women are not as mobile than men because of their gendered division of labor. It is seen in a disaster situation where men often migrate and women are left behind because of their gendered division of labor.

While growing up, I observed that disaster relief and rehabilitation processes are carried out without incorporating women and their needs. The roles and responsibilities of mother and grandmother in post-disaster management are merely seen as the extension of their pre-existing gender roles, while it was opposite in the case of men from researchersy household. Often, the addition of new roles with their existing roles leads to more overburden on women in the family that makes the case for the overwhelming importance of understanding the differential impact of a disaster on women and the need to configure their specific vulnerabilities and special competencies in the formal and informal initiatives of disaster management. The differential

impact on men, women, and the transgender community is not taken into consideration while responding to these disasters. Hence, the research would try to look at the impact of a disaster on women and the transgender community and this cannot be analyzed in isolation without taking into consideration the impacts on another gender as well. Therefore, to draw the comparison between the impact of disasters on men, women and transgender community in different phases of disaster management the analysis would be looking at the specific roles during these phases in disaster management.

20.7.1 Gender Role of Men and Women in Different Phases of Disaster Management

Women's contribution to extra labor is often obscured or even denied during disaster management. In Pre-disaster conditions in many societies, women were not recognized for the work they carry out (Motsisi 1994). This renders women and children more vulnerable to disaster than men (Cain et al. 1979). Almost 63% of the respondents both men and women expressed that women play an active role in disaster management programs. Women from the community mentioned that they are always hit hard by disasters and the existing social inequalities like lack of resource and ownership of land further increase their vulnerabilities to disasters. Due to lack of decision-making power and gender-biased oppressions, lower economic, social and political status in the community, they tend to be more vulnerable and likely to suffer the loss of life and property compared to men. The researcher observed that, due to their gendered role of ensuring household food security, their dependence on natural resources is more compared to the other and hence the impacts of disasters on women are seen larger. More than two-thirds of women respondents expressed that post-flood loss of livelihood makes women fend for their families which causes them to assume greater responsibility on their shoulders. Post-disasters women tend to become more vulnerable than their counterparts as it expands their care-giving roles. The hardships induced by the floods often have an impact on their physical and mental health.

> My daily routine starts from wee hours from 5.30 am taking care of children, elderly, cooking food, animal rearing, working in the paddy field, collecting fodder, etc. sometimes I feel like I must have committed some kind of sin in the past life that I had to work so much without getting any monetary value out of it. Post the onset of floods further adds to my problem as I not only have to perform my existing role but new roles get added to that which makes our life more miserable than men'.[4]

The gendered role cannot be analyzed in isolation without taking into consideration the role of men and women in the process of disaster management. Therefore, to draw a comparison between both constituencies in different phases of disaster management it is imperative to look at their specific roles. Table 20.2 shows the

[4] Excerpts from FDGs conducted in Molual Kalita Gaon and expressed by Monisha Das.

Table 20.2 Gendered roles before floods

Disaster phases	Done by whom
Before floods	W > M
1. Prepare all household belongings and make them ready for moving before the flood	This work includes preparation for packaging belonging, the family's legal document, and keeping them in safer places. The majority of them expressed that this is primarily done by women
2. Fetching and storing water	During flood on normal situation, majority of women expressed that the fetching and storing drinking water during floods are done by women
3. Preparing food for the family thrice a day	None could claim their roles except women, male respondents also expressed that this work is majorly done by women. For the family who is farmer, majority of the women are involved in agriculture as they mill rice grain by hand and keep it for cooking. But for the family that does not have rice paddies, buying is the only option and this puts immense pressure on women to make sure that food is available when the family is broke during floods.
4. Storing the food items (rice, tea, pumpkin, lentils, etc.) and basic medicine for flood	Women play a significant role in disasters by storing the food before the onset of flood and also by taking good care of their family members' health, ensuring that there is available medicine at home before the disasters.
5. Collect fodder for animals	More than half of the women respondents expressed that this is done by the male members of the family.
6. Building a stilt house (Chang Ghar[5]) or Strengthening it	The majority of women respondents acknowledge that building stilt house or repairing it to store materials or rice seeds, etc., are done by men. They make sure that this doesn't collapseduring floods. In case the family has to be evacuated temporarily, men get some assistance from women, to rebuilt temporary shelters.

Note <> is measured in terms of more times spent for each activity and many activities done in a day/season by a single woman and man (through 24 h-livelihood and floods activity calendars), but not by income.[6]

role of men and women in different phases of disaster management. Both men and women play a significant role during the different phases of disaster management but the majority of women respondents expressed that they are made to shoulder many

roles and responsibilities in the different phases of disaster management which impact their physical and mental health and hinder their participation as well.

More than half of the respondents both men and women expressed that women have more responsibilities than men before the floods and there were several reasons to claim this. Normally, women were already occupied due to their gender roles, but to be prepared for the forthcoming floods at a certain time of the year, women work harder and more intensively. Women from the community expressed that they share the majority of the work in their households and play a very important role in preparing for a flood by storing food for the whole period of the flood as they are the one responsible to ensure that food is available to other members during the flood. Both women and men respondents expressed that, before the flood, women get much busy in collecting and preparing assets or belongings to move them to safe places and making sure that they were not seriously damaged or washed away by floods. Social norms had structured the roles of women in building their expertise in dealing with household management. As reported by the participants of focus group discussions and local authorities, more women participated in the Disaster Risk Reduction dissemination meetings organized by the local disaster management committee and NGOs. While the role of the men was to ensure the safety of the house, they were involved in building a stilt house (Chang Ghar) or repairing it to store food for floods. Women expressed that the majority of the male members are involved in collecting fodder for the cattle before floods. The analysis of the discussion with men and women respondents reflects that before floods women have more roles and responsibilities compared to men, and these roles further augments women's vulnerability during disasters (Table 20.3).

In this phase of the disaster, men were seen to be more proactive compared to women; however, many roles were shared by women too. During the flood, women tended to work lesser than men in the other flooding phases—pre and post, because their normal activities get delayed; but this did not mean that their workload or responsibility was reduced. The number of activities that women could perform was reduced, but the weight of the existing chores was even heavier and sometimes even dangerous. On the other hand, women also share roles with men like preparing rice seeds for farming after the water recedes, looking for safe places to keep cattle safe from being washed away during floods. Sometimes, they even engage actively in productive work in addition to their existing gender roles at home (cleaning house, cooking, caring or nurturing children, etc.) (Table 20.4).

More than one-third of the respondents both men and women expressed that women have more responsibility than men post-floods. Women become extremely occupied with many little assignments like cleaning the households, taking care of sick and elderly, and helping men in moving the household assets back to their

[5] Kare Okum (Mising Language) or Chang Ghar in Assamesse are houses built on bamboo stilts, bricked or wodden poles beneath which water are easily passed without any restriction these are used for living, or acts as granaries or to cattles shelter.

[6] Source: The table was developed based on the field data collected.

Table 20.3 Gendered roles during floods

Disaster phases	Done by whom
During floods	W < M
1. Move all belongings to safe places and build a temporary shelter	Women expressed that this was mostly done by men as they feel more energy and strength is needed however, women do contribute as well. In case of a bigger floods, people need to move out of their houses to safer places. The majority of men and women respondents from the community reported that men are largely involved in moving all belongings, animals, etc., but women also take part in it.
2. Food Collection	Almost one-fourth of women respondents expressed that the menfolk go fishing and collect vegetables during the flood. If the family is evacuated to safe places, women also take part in this role.
3. Income generation	Mainly done by men; however, both men and women are active in income generation during the flood period. One-fifth of the respondents expressed that men often migrate in search of employment in urban areas and women are left out in the villages with a limited source of income like weaving and pottery making
4. Take care of children and elderly	The majority of men and women both expressed that this is done by women. In the relief camps, women spend too much time looking after children and elderly due to their gender roles.
5. Take care of the property and belongings in relief camps from their flooded house	Women are less movable than men due to their gendered roles and they claim most of this responsibility. More than one-third of the men respondents expressed that women mostly take care of such properties including household materials, animals, and other belongings in the relief camps and flooded houses.
6. Rescue of the family and other Community Members	Men are involved in rescuing family members though women have also played important role in rescuing family members during floods

Source The table was developed based on the field data collected

house. On the other hand, men were observed to migrate out for income, leaving all household responsibilities again on women.

> Post-flood it is hard to live in makeshift camps due to safety and security for women in these camps. I have to feed a family of five: two children, an elderly ailing mother, and I tried to fulfill their demands for food, water with whatever relief materials we could from aid agency while distributing it equally among the family members. As due to household chore and lack of knowledge about relief distribution my husband goes to get relief but he needs alcohol more than food. Last year he sold one-fourth of reliefs which included (rice, dal, and sugar)

Table 20.4 Gendered roles post floods

Disaster phases	Done by whom
After floods	W > M
1. Cleaning of house and moving the household's assets back	One-third of male respondents expressed that women are primarily involved in cleaning their houses and premise, and reinstall the belonging back to their houses
2. Repaired the damage house	The majority of women respondents expressed that after floods house are majorly repaired by the men.
3. Borrow money, seeds, etc., to meet the immediate cost of the flood on families	More than one-sixth of respondents both men and women expressed that women are largely responsible for these. Women-headed households that have an agricultural field borrow seeds on credits from Seed banks of NGOs. Mishing women reported that as they do not have agricultural land they borrow money for buying cattle, poultry, etc., from the money lenders to feed their families.
4. Take care of sick and elderly	More than one-fourth of respondents both men and women stated that women are primarily responsible for taking care of the sick and elderly after floods. Women also raised the concern about the burst of diseases when the water receded. This included dengue fever, diarrhea, or flu. Women were the only caregivers in the families and they had to do this single-handedly.
5. Restore and Rehabilitate the agriculture	Both men and women from the community expressed that they equally contribute to this. Post-flood both men and women equally contribute in preparing the field, harvesting, threshing, winnowing, milling, etc. In a women-headed household, these are entirely done by women.
6. Raising animals for livelihood	A large number of male respondents (i.e., two-third) expressed that this is entirely done by the women folks In the island. Post-flood they are responsible for taking care of the livestock or arranging fodder for animals. Some of the women mention that they take loans to buy animal husbandry like pigs, poultry, etc
7. Sell labor	More than two-thirds of the respondents both men and women expressed that this work is majorly done more by men. When the water recedes, they work in other community members fields to earn a livelihood.

Source The table was developed based on the field data collected

> for alcohol and we had handed to mouth situation and I was forced to sell my phone to get bare minimum food for the family'.[7]

Women expressed that to survive post-flood they get involved in livelihood generation by rearing cattle, pottery making, weaving, etc., along with their usual gender roles. Women from the community also expressed that they tend to engage in many things from homecare to earning income after the water recedes. Some of the women respondents mentioned that they had to work on their farms (i.e., plowing, transplanting) without getting any help from their spouses as they migrate to different places for livelihood. Collecting fodder, firewood, cooking, and many other activities were all handled by women, which were time-consuming, tiring, and unpaid and led to stress and anxiety among them. The majority of the women expressed that men from the communities are majorly involved in repairing the damages in the house or they sell labor to support their family. The analysis of the discussion with men and women respondents reflects that after floods the roles and responsibility of women increase as compared to their male counterparts and makes them more susceptible to injuries and loss post floods. Pre-flood and post-flood women expressed that they were very proactive in preparing and responding to the possible risks that would occur but during flood men tend to play an active role. If we compare the roles and responsibilities of men and women in a disaster situation, women tend to have more roles in disaster management as compared to men. There are certain new roles and responsibilities added after the disaster which makes women overburdened and which makes them vulnerable during disasters.

20.8 Changing Roles of Women and Their Vulnerability Due to Added Roles

Disaster tends to change women's role in the family from being caretaker to wage earner which often increases the burden on women as the new roles get added to their existing roles. One-fourth of the respondents expressed that floods lead to an increase in drudgery/ household chores and it becomes the woman's responsibility to take care of family, children, and elderly. Women from the community expressed that

> We are majorly involved in the cleaning of houses, collecting fodder, moving the household assets and other valuable goods to a safer place which restricts their mobility and makes them vulnerable to mental and emotional stress'.[8]

In disaster generally, new roles get added to the women's existing roles which makes them vulnerable to disaster. A study on Rajasthan drought (2005) shows that a large number of men migrated to other areas for jobs while most of the women stayed behind in the villages due to which women were overburdened especially

[7] Excerpts are from FDGs conducted in Jengrai Gaon and expressed by Bonita Pegu.

[8] Transcripts of field notes as expressed by village leader of Jengraimukh Chapori.

due to the unavailability of adequate nutrition and clean drinking water. It is often observed that disaster decreases women's chance to involve in paid work because of their increased workload at home (Kafi 1992). Though women try to 'cope' with the disaster, their attempt to survive through the disasters takes a lot of personal sacrifices. The multiple roles of women in the home front curtail their presence in the public sphere, while it places men prominently in decision-making processes (Wickramasinghe 2000).

> As the island reels under flood for at least two-three months and it takes time to recedes water, hence it becomes difficult to earn livelihoods, therefore, whatever we saved in forms (money or rice) from last year harvest has to been used to cope from floods. Often men are forced to migrate for employment so it becomes our responsibility to fend for our families without any economic or financial support. Also, it becomes a problem for us to access the financial assistance due to the gendered and added role of being the caretakers and provider for the family'.[9]

Post-flood it is largely seen that women due to their added roles, these factors create hindrances in their participation in disaster planning and also while receiving the relief packages which position men predominantly. Also, data from the field shows how the Community-based Disasters Management programs primarily relief distribution has failed to be gender inclusive and also failed to address the gendered voices to reduce the existing gendered inequalities.

> A woman from the Mishing community responded 'We have been displaced three times from our village as it was washed away due to floods, we don't have cultivable land so we survive by working on others land or by working as a daily wager. But due to flood every year, our only source of livelihood is also lost hence, we are entirely dependent on the remittance received from the aid agency which is not enough for our survival especially when it last for two–three months and relief distribution primarily headed by men become non-inclusion of loss incurred by women in forms of loss of livelihoods (cattle, poultry, savings from pottery making, handlooms, selling their personal belongings, etc.) which are often neglected or not taken into consideration'.[10]

20.9 Hegemonies Spaces and Gender Vulnerabilities

The coping efforts of women are often severely challenged by gender relationships and handicapped by power structure both within the household as well as within the community, despite having provisions for inclusion of women representatives in (local) governance processes, i.e., Panchayat Raj System which gives 50% reservation to women in the state of Assam as well as other 19 states of India. But the gender relationship have a bias toward males and does not allow women to meaningfully participate in these decision-making fora. To which, I would like to quote an excerpt from the FGDs conducted in three sites with women folks in Majuli

[9] Excerpts are from interviews with Ronita Baruah from Dakhipat Kumar Gaon.

[10] Excerpts are from interviews with Lima Basumutary from Salmora.

> Researcher: Do you have decision-making power in the Gram Panchayat or the Village Disasters Management committees?
>
> Respondents: Our societies are male-dominated, where the head of the household is largely men and they take the decision in the family as well in the communities, women and other members have to follow their decisions. She further asserted, if a woman doesn't have decision making power in her house, how we can expect them to decide the Gram Panchayat or village disaster management committees, which are largely male-dominated irrespective of having a provision of women reservation.[11]

Lapses in good governance practices alienate women's voices further, leaving virtually no room for women to meaningfully contribute toward the reduction of their vulnerability. The patriarchal elements of society further eliminate women's opportunities to overcome their vulnerability. Also, the predefined household structure of most of the family is male-headed wherein they are seen as breadwinners or providers for the family and they have dominance or control over resources. As men often migrate for livelihood making women as head of the household which added to women vulnerabilities not only due to new roles being added but also due to them being excluded as beneficiaries prepared by the Gaon panchayats, the patriarchal nature of these fora fails to recognize women as the head of households. At the same time, most of the relief and rehabilitation process is largely focused on the materialistic support being provided to people. Rather than addressing the psychological impacts of disasters, gendered vulnerabilities have not been given much importance, this is important for the long-term survival of women and other marginalized groups in the area. The review of literature also shows that disaster management policies and legislation in the country context have failed to incorporate gender perspective or have been blind toward gender in all areas of disaster management both in practice and policies. Resilience building from disasters demands inclusive gendered empowerment (inclusive of binary and non-binary gender groups) in all aspects of life: physical and mental, social, economic, political, and cultural. The State must assume responsibility to remove common and known barriers toward empowering women.

20.10 Unequal Access to Resource and Power Dynamics

Gender analysis makes it clear that women are vulnerable not because it is their physical nature to be weak but because of the arrangements in societies that result in their poverty, marginalization, and dependence on men (Enarson and Morrow 1998a, b). The analysis of data shows the unequal participation of women in not only village disasters management committee, family but also at all sphere of social order including community level as well. Women are viewed as '*spectators*' or victims of disasters compared to their counterparts as they are subjugated and dispossessed within their community. As per Gender Polarization Theory, the dominance and

[11] Excerpts from the M.Phil Thesis 2016.

control of male head in the household in terms of decision-making power combined with the lack of access to resources in pre and post-disasters leads to increased women's dependency on men (Bem 1983; Ikeda 1995). The dual burden of being a caregiver (reproductive role) and wage earners make them susceptible to disasters. They reported that these dualities in their role lead to exclusion from relief programs and often men are considered as the '*head of the households*' and the ownership/property rights belong to men so while receiving the relief women often faced difficulties in accessing due to lack of awareness. The intersectionality of caste, ethnicity, economic status, etc., also leads to further subjugation of women (Lewis and Lockheed 2007). The eroding island (Moduli) witnesses that women coping efforts are often challenged by the gender inequalities and handicapped by the unequal power relations both within the households as well as within the community. Respondents mentioned that they could not participate in the disaster management meetings or awareness and training camps due to household chores and personal factors which make them vulnerable during floods. Women stated that

> Despite having the provision of inclusion of women in local decision making bodies, the gender relationships having a bias towards males who do not allow women to meaningfully participate in the decision making fora which further increases their vulnerability leading to lapses in good governance practices alienating women's voices further, and leaving virtually no room to meaningfully contribute towards the reduction of their vulnerability'.[12]

Women became more susceptible to injury and loss due to their lack of control over means of production, low access to resources and control over it, less access to information and participation thus making them vulnerable to various disasters. They believed that they are largely considered as the beneficiary in the village disaster management committee as the majority of men are the head of gram panchayats or village disaster management who decides on women behalf. Women further add to that due to failure of proper rehabilitation, the disparity in the society is created by pushing them into the margins. Taking a look into the economic consequence of the affected women from disasters, issues like landlessness, joblessness, loss of access to common property, and food insecurity come up more evident from the island.

20.11 Lack of Healthcare Facilities

One of the key issues that emerged out of the island is the lack of healthcare and hygiene facilities for women. More than one-fifth of the respondents mentioned that women's health had been adversely impacted due to the recurrent floods. Lack of healthcare facilities has caused problems for all the people especially for women on the island. During medical emergencies or even for small ailments as well, they have to either travel to Lakhimpur or Jorhat. As the island is encircled by water during floods, people get trapped without any medical help.

[12] Transcripts of field notes as expressed by female respondent from Dakhinpa Kumargaon.

> Majuli people face a lot of problems during the flood but health care has been the major problem. For a population of closely 2 lakhs, we have only one doctor and few nurses who are always overburdened, and most of the time hospital runs out of medicines on the island. In most of the cases, we have to take the patient either to Guwahati or Dibrugarh for treatment and many a time people die on the way to hospitals'.[13]

The vulnerability of women of Majuli is further escalated due to this lack of adequate healthcare and medical facilities available in the isle. As the island is mainly connected by the Brahmaputra, during the floods it becomes an uphill task to get any medical aid. For a population of approx. 2 lakhs, only two ambulance boat were available in the island (excerpts from official of SDO, Majuli). But the vulnerability of women is further divided based on their state as pregnant and lactating mothers and the elderly are more vulnerable during any disaster as the impact of disasters is seen more on them compared to any other respondents in the community.

20.12 Gendered Exclusive Early Warning System and Responses in CBDM

The interrogating concerns of early warning systems being permeated and disseminated across the gendered lines are vital to reduce gendered vulnerabilities and risk of community to assess whether these early warning systems are accessed and understood by the community or not. As in the case of Majuli, this information percolates and is accessed by communities based on the predefined gender norms, or inequalities that exist due to intersectionality of age, education, caste, class, and ethnic belongingness of a particular gender.

The analysis of the field data based on the daily activities of different gender groups indicates that women have been assuming the role of reproducers, nurturers, and disseminators of tradition, caregiver of the family is often seen as an extension to their domestic responsibilities, while on the other hand men are seen as a provider or breadwinner of the family who would often go out and become part of the power centers like Panchayats and Blocks offices, that gives them more access to resources but also information/early warning systems. Women tend to be less exposed to these sources of information about early warning or Disaster Risk Reduction bodies as the gender roles restrict their mobility. As expressed by women folks from Salmora.

> We get the early warning about disasters mostly from men of the households as they frequently interact with the patwaris, SDO officer, gaon budda (Headmen) as they interact and meet them on regular basis in a monthly or weekly meeting at Gaon Panchyat (village councils meeting), markets, etc. So they are more likely to receive the information about early warnings from them as they have their numbers so they contact mostly the men from the community. While on the other hand, very few women from the community interact with these people especially if they are members of village councils, etc. however, they don't meet them daily as there were many times they couldn't attend the meeting due to household drudgeries. She further added that though the early warning is passed on through the ham

[13] Transcripts of field notes as expressed by 39 year male respondent.

radio, radio, etc. which are controlled or managed by men of the household or the women expressed they had very little time to access the information through these means due to their gendered roles'.[14]

It is important to discern how different gendered groups are prepared, cope to withstand the impact of flood on communities in areas like Majuli, and to see whether the early warning is disseminated to people and they react to these early warnings which ultimately percolate into more gendered inclusive community-based response plans. Often the communities living in vulnerable geographies like in Assam or Majuli, in particular, being patriarchal their disaster responses have been informed based on the cultural and social constructed gender norms wherein each gender group has been seen through the lens or enactments of either being feminine or masculine. And this gender stereotyping has been often produced and (re)produces through the different popular public and institutional discourses and media through it reports limiting women are '*Victims*' of such disasters who are waiting to be rescued or emancipated by the opposite gender (Zarqa 2014). Hence, one group being idyllically portrayed as feminine limits them as a victim of disasters who are dependent on men for their emancipation and at the same time the gendered imposed femininities of women (particular being a caregiver, provider of the family or securing food for the children and elderly) which restricts them and further aggravates their vulnerabilities more than the former.

Often women from the island have relied upon men for the early warning and measures which push their vulnerabilities further and impacts them more over the other. Hence, it is significant that these power centered has to be more gendered neutral in their approach as see women and and other vulnerable groups needs to be seen not only as 'victims' of disasters but as a partner in disasters management. While at the same time take the gender needs needs to be taken into consideration which in turn would pave the path toward a gender-inclusive disaster risk reduction approach.

20.13 Women Resisting the Everyday Precarity in Majuli

Literature reveals that in many communities women are not seen as equal partners in disaster management, it lacks integrating women during disaster mitigation, planning, and decision-making, and gender concern or needs are largely been overlooked during the relief and emergency response. Women have been the backbone of the rural subsistence economy in Assam so their respective role in the family which is produced in nature makes the family more sustainable but these roles are largely not acknowledged or not getting any economic remuneration for this creates more susceptibly. So the impact of disaster on the community is not natural rather it is manifested due to these norms, practices, role that women does in the family and community. Also, the roles of women are seen as the extension of their reproductive

[14] Excerpts are from the interview conducted in Salmora.

role and even their work in the agriculture field has often been seen as an extension of their domestic responsibilities, rather than a separate economic activity. Due to the gendered production, the role of women in Assamese society is to secure food, water, and fuel (in some sites) during floods because of their closeness to nature or due to dependency on nature for firewood, food, and other essential things. This is when the men are found to exercise their power and control over the others in the family, pertinently the women.

The ability to cope with the temporary variability in the environment requires the communities to develop their strategies or approaches to withstand these disasters. Data from the field shows that in most of the household in Assam and particularly in Majuli, women due to their performative gender roles take the responsibility of accumulating certain resources, which are '*Buffer Household Assets*' (primarily Rice, bottle gourd, sugar, pumpkin, tea, and other food reserves) or savings in bank accounts, cattle, or falling back to traditional methods of survival, are examples of coping strategies from the variability in the environment. The majority of the respondents expressed that to prepare the households for disasters most of the community who has economic resources store food grains (like rice, pulses, pumpkin, bottle gourd, tea, biscuits, salt, and jaggery).

> Flood has been a perennial phenomenon since the 1950 earthquake and most of the people on the island are well aware of it so most of the families have devised their preparedness plan for the flood. Like a large number of constituencies including the tribal and non-tribals in Majuli make stilt houses (Chang Ghar) used for living by tribal communities like Mishing and 'Bhoral/Bharal' (storage for grainery) or sheltering cattle among the Assamese community. Often these houses are used by some non-tribals communities as well to relocate their belongings or taking shelter during disasters. As added by a male from Salmora and Dakhipat Kumar Gaon, the women from the community have been storing non-perishable food items like (Rice, Dal, Pumpkin, bottle gourd, tea, biscuits, salt, jaggery, Sugar, etc.) every year and a large number of household used these to cope from floods, at the same time some families rely on their savings as well from the harvest, pottery making, etc. to sustain the monsoon seasons due to depletion of the traditional livelihoods'.[15]

However, these resource varies from family to family depending on their income and resources. At the same time, the community-owned solution is limited or restricted to certain groups of people especially women groups, and elders from the communities hence it would be wrong to put everyone in the same blanket about their coping abilities and vulnerabilities as larger section of migrant labourer, displaced community are left to fend for themselves during disasters. Often post-disasters research studies have acknowledged women's utmost attempt to survive through these disasters that involves a lot of personal sacrifice and compassion as well as accepting psycho-physical burden like in the case of Majuli as well as women folks were forced to sell the personal belongings, savings, and even utensils in some case to sustain floods.

[15] Excerpts are from interview conducted with traditional potters and farmers from Salmora and Dakhinpat Kumar Gaon.

20.14 Way Forward

Disaster Management programs have been state-driven which follows a more technocratic approach/building hydraulic structure that is developed outside the communities without integrating the issue pertinent to gender concern or by understanding the vulnerabilities of communities. It has failed to acknowledge community voices and livelihood changes of different gender groups which creates more inequalities, and this results in less adaptive capacity of the community. As argued by Lefale, climate change adaptation needs to look beyond the debates of scientific knowledge or following a technocratic approach (Lefale 2008). Rather, it is vital to look at disasters as a social phenomenon that emerges from the social injustices or due to widening coping gaps emerging out due to social and economic capital to withstand the floods.

Although everyone is equally vulnerable to disasters, the pre-existing societal and gender norms render women as '*vulnerable within the vulnerable*'. It further heightens due to different criteria like age, caste, and socio-economic position as one constituency is impacted more than another due to underlying factors. Hence, it is vital for the relief providers and policymakers to understand and acknowledge the role and participation of all gender group in disasters management and take measures to address the needs for recovery and reconstruction phases of disasters but at the same time in doing so, it is vital to look at the relationship between those who are governing or managing water and those who are being governed by them. It is significant to have a gendered perspective while analyzing vulnerability, also it is incomplete without an equal focus on the capacity of people, and the state-driven programs need to be gender aware. Hence, to attain a gendered approach in community-based disaster management practices it is important to have participatory ways of working which would lead to being more nuanced approach in addressing disasters by inculcating not only capacities and vulnerabilities of different gendered groups but also gendered needs, voices during disasters in management or decision-making which are done by international lobbies then in those cases it is paradoxical to believe to have environmental justice or to think that it can be sustainable. Empowerment of women is necessary to incorporate measures to improve women 's status in society as it is a sophisticated, multidimensional phenomenon which are like a ladder with many steps in it, e.g., education, economic independence; political power, equal opportunities decision-making, etc., and all these steps are needs to be climbed by women to achieve empowerment (Enarson and Morrow 1998a, b).

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Chapter 21
Rejuvenating Geographies of Manas Through People's Participation: A Success Story of Community Conservation

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Abstract The Manas National Park (MNP) is one of the country's wealthiest reservoirs of flora and fauna. However, the Park has faced several ups and downs due to sociopolitical unrest, poaching, and illegal encroachment. It has been observed that 20.47 km^2 area of the Park has been encroached from 1991 to 2004 due to the sociopolitical unrest in the region. As a result of this, in 2003, Manas lost the glory of the World Heritage Site. However, on February 10, 2003, the Government of Assam, the Central Government of India, and the Bodo Liberation Tigers (BLT) signed a memorandum of settlement on Bodoland Territorial Council (BTC) in New Delhi has enlightened peace and security to the region. Immediately, the conservation

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fraternity, including the Department of Environment and Forest, BTC (now BTR—Bodoland Territorial Region), NGOs, local organizations, and fringe villagers, took the initiative to protect and conserve the bioresources of MNP, taking the community conservation and livelihood generation approach. The fringe villagers were actively involved in the rejuvenation process of Manas through community participation and livelihood generation for the sustainable well-being of the biodiversity-rich area. In 2011 finally, Manas regained its World Heritage status. This study depicts a success story of biodiversity and bioresource conservation through people's participation in maintaining the sustainable livelihood by the people of fringe villages of MNP.

Keywords Biodiversity · Bioresources · Livelihood · Land cover change · Manas National Park · Assam

21.1 Introduction

The central purpose of this study is to demonstrate the accomplishments of sustainable livelihood in the fringe areas of Manas National Park (MNP), geospatially located in Assam, India, and showcase the success stories of biodiversity and bioresource conservation using people's participation.

There is a large literature displaying the pressure of development alongside the unprecedented growth of human population and exploitation of bioresources for commercial purposes, which are the prime causes of habitat fragmentation, range reduction, and shrinkage of forest lands near the protected areas (Jha et al. 2014; Joshi et al. 2011; Medhi and Kar 2016; Meena 2015) as well as increasing the conflicts between wild animals and human (Barua et al. 2010; Bhuyan and Kar 2018; Kushwaha et al. 2004; Panja and Mistri 2018; Riebsame et al. 1996; Sarma et al. 2009; Sharma and Sarma 2014; Theobald et al. 1997; Sukumar 1991; Walpole and Linkie 2007; Yadav et al. 2020). Biodiversity is everywhere. Biological diversity or biodiversity refers to the diversity of living organisms in that particular area, region, or country or on Earth. In other words, biodiversity refers to the wide variety of ecosystems and living organisms: animals, plants, habitats, and genes. The breadth of the concept of biodiversity reflects on the interrelationship of genes, species, and ecosystems (Scoones 1998). Currently, biodiversity and its conservation constitute a significant concern globally due to the rapid destruction caused by anthropogenic activities. Of the 17 Sustainable Development Goals,[1] we argue that biodiversity is directly or indirectly linked to all of them. Importantly, biodiversity is a vital ingredient of the Paris Agreement, 2015, which pledges to curb carbon footprint below 2°, preferably to 1.5°.[2]

[1] The 17 Goals. United Nations: Department of Economic and Social Affairs Sustainable Development. https://sdgs.un.org/goals.

[2] The Paris Agreement. *United Nations Climate Change*. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

India is a mega diversity area under the wide range of agro-climatic and sociocultural conditions prevailing in the country (Srivastava et al. 1996).

The state of Assam is one of the richest reservoirs of flora and fauna and has a significant stronghold of biodiversity in the country. The significance of biodiversity of Assam is relatively high, as out of thirty-six biodiversity hotspots in the world,[3] two biodiversity hotspots are located in Assam. The Eastern Himalayan Biodiversity hotspot, covering Brahmaputra valley and the Indo Burma Biodiversity hotspot covering Barak valley of the state are the breeding ground of several endemic species of plants and animals. Thus, this region can be addressed as the geographical 'gateway' for endemic flora and fauna. To qualify as a biodiversity hotspot, a region must meet two strict criteria: it must contain at least 0.5% or 1500 species of vascular plants as endemic, and it must have lost at least 75% of its primary vegetation (Myers et al. 2000). The second criteria indicate that the state of Assam is a conservation priority site as 75% of the primary vegetation cover of the region has already been lost due to anthropogenic causes.

Bioresources refer to all kinds of naturally occurring resources of biological origin. This indicates that biodiversity generates bioresources. Biodiversity and bioresources play a significant role in the functioning of ecosystems which provide us with products and services, without which we cannot survive. The critical role that biological resources play in sustaining human life has received considerable attention in the last two decades. In 1992, a broad framework for the conservation and use of the world's biological resources—the Convention on Biological Diversity (CBD)—was agreed by the United Nations Conference on Environment and Development (the Earth Summit). Despite increasing recognition, the world's biological resources continue to be on the verge at an alarming rate, particularly in developing countries where many of the remaining resources are concentrated. The state of Assam is also not exceptional. The reasons for the loss of biodiversity and bioresources in Assam are related to habitat conversion and agricultural intensification brought about by demographic and market-driven pressures (Pagiola et al. 1997). The immediate land managers in Assam are the farmers, livestock keepers, forest dwellers, and rural people, both men and women, whose livelihood is closely dependent upon the availability and productivity of biological resources. Their situations are not similar, but different stakeholder groups have different interests in bioresource exploitation and management. Some of them have livelihoods closely associated with the conservation and sustainable use of wild resources, while others are driven by market opportunities and investment in converting the natural systems to productive agriculture. A significant challenge the government and other organizations faces is accommodating ecological concerns in rural development policies and programs where conservation is not the primary aim. Bioresources play a critical role in the livelihood systems of many of the world's impoverished, even in highly modified or degraded landscapes. Sustainable natural resource management is the primary source of livelihood in many

[3] Biodiversity Hotspots Defined.

Critical Ecosystem Partnership Fund. Protecting Biodiversity By Empowering People. https://www.cepf.net/our-work/biodiversity-hotspots/hotspots-defined.

developing countries. Protected areas can and should be managed to serve human development, poverty alleviation, and livelihood needs without compromising the value and integrity of the resource base. In effect, this approach requiring regional and landscape management must integrate social, cultural, economic, and institutional concerns with biodiversity outcomes and values and that the relevant institutions cooperate to achieve this (Standwith and Lockwood 2006). Hence, biodiversity, bioresources, their management and livelihood systems are complex and interrelated. This study attempts to understand the relationship between biodiversity, conservation, bioresources, and livelihood in and around the MNP of Assam, India. The study's findings demonstrate how the community conservation approach and livelihood can be synchronized and remain sustainable. The results depict the success stories of biodiversity and bioresource conservation through people's participation in maintaining the sustainable livelihood by the people of fringe villages of MNP.

This study begins with a description of the study area. It then goes on to discuss the materials and methods deployed for this study. Following this, it discusses the findings of this study.

21.2 Study Area

This is a highly under-researched study on MNP, which was declared a National Park (NP) in 1990. MNP is geospatially located at the foothills of the Himalayas (locally addressed as Bhutan Himalayas) and geographically falls within the Baksa and Chirang districts of the Bodoland Territorial Region (BTR), Assam (Fig. 21.1). The Park is jutted between 26°35′–26°50′N and 90°45′–91°15′E. Although MNP covers an area of 519 km^2, the Park embraces the core area of the Manas Tiger Reserve, bearing an area of 2837 km^2, altitude, which ranges from 50 to 200 m above the mean sea level. Indeed, Manas bear a legacy of being a biodiversity hub since time immemorial. Declared as a Reserved Forest in 1905, Manas was one of the few Protected Areas (PAs) to house as many as 21 scheduled species as listed under the Wildlife (Protection) Act, 1972. On October 1, 1928, Manas was declared a wildlife sanctuary, and later in 1973, it was declared a Tiger Reserve and a biosphere reserve. In 1985, Manas accomplished the highest recognition from the UNESCO as the world heritage site.

Interestingly, toward the northern part of the river Manas, the flow of the forests continues and remains juxtaposed with Bhutan's Royal Manas and the Black Mountain National Park (Rodgers and Panwar 1988), thereby abutting an extensive area of 'virgin landscape' which more or less remains undisturbed even in the twenty-first century. Indeed, this entire biogeographic zone falls under the Northeast Brahmaputra Valley (9A) biogeographic site (Rodgers and Panwar 1988). The eastern part of the Manas Reserve Forest, adjacent to MNP received an additional 350 km^2 on August 20, 2016, to extend the conservation initiative in the periphery. Notably, the first author of this study prepared the GIS map of the "First Addition to Manas National Park." He also prepared the GIS map for the newly recognized (on June 5,

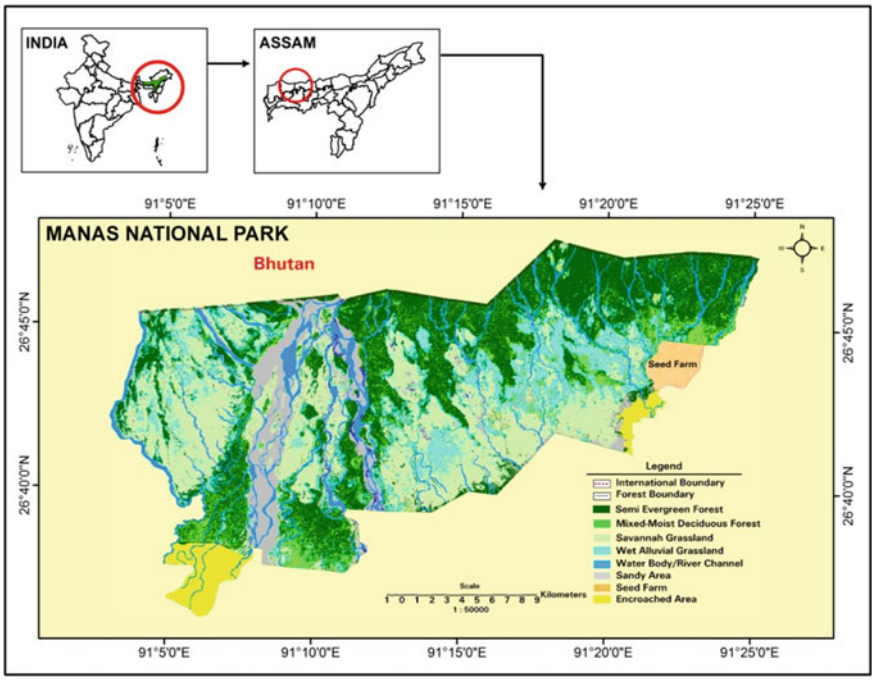

Fig. 21.1 Location map of Manas National Park. *Source* Created by the authors

2021) Raimona National Park, the sixth NP located across Gossaigaon and Kokrajhar subdivision of Kokrajhar district, Assam, covering 422 km^2 notified in June 2021 by the Government of Assam. The Bodoland Territorial Council and Department of Environment and Forest, Assam, recognized his contribution on August 15, 2021 (the 75th Independence Day of India).

Known for its spectacular scenic beauty and various types of habitat supporting a wide range of flora and fauna, MNP, by virtue of its geographical location, enjoy a tropical climate with average annual rainfall between 3000 and 4000 mm. However, ethnic disturbances (Dutta 2018; Mahanta 2013) in the recent past have caused severe lapses in MNP management, paying a heavy toll in the form of extinction of several local species, including the unicorn—the pride of the state—the Great Indian one-horned rhinoceros. In addition, several other highly endangered species such as pygmy hog (*Sussulvanius*) and Bengal florican (*Houbaropsis bengalensis*) became far more vulnerable. It is important to note here that the entire region of Northeast India is known to the outside world for its turbulence and disquiet by various insurgent movements for almost seven decades now. The demands of these movements range from sovereignty to the creation of independent nation(s) within India or the demand for better lives (Bhattacharyya 2018; Goswami 2015; Mishra 2014). Of the various insurgent movements, Naga National Movement is one of the

oldest (Bhattacharyya 2019; Bhattacharyya and Pulla 2020a, b; Mishra 2014). All these insurgent groups engage in sporadic violence.

In the backdrop of being backward and feeling of being alienated and importantly, for fear of losing their identity, several organizations of Bodos—All Bodo Students Union (ABSU), National Democratic Front of Bodoland—Progressive (NDFB-P), National Democratic Front of Boroland—D.R. Nabla faction, People's Joint Action Committee for Boroland Movement (PJACBM)—co-jointly launched the Bodoland movement in the 1980s in parallel with the historic Student Movement of Assam against illegal immigration from Bangladesh (Bhattacharyya 2009, 2013; Sarma and Bhattacharyya 2021). The demand of the Bodoland movement has been for a separate state within the Union of India. For this, their demand constituted the districts of Assam where a significant number of the Bodo population are found—Kokrajhar, Baksa, Chirang, Udalguri, Lakhimpur, Sonitpur, and Dhemaji of Assam. In the wake of a 1993 agreement, the Bodoland under the Sixth Schedule of India's Constitution embracing an area of 8795 km^2 became an autonomous administrative unit under the Bodoland Autonomous Council, known as the Bodoland Territorial Autonomous District (BTAD) or Bodoland (with the incorporation of the districts of Kokrajhar, Chirang, Baksa, and Udalguri). In 2003, BTAD was transformed into the Bodoland Territorial Council (BTC), which is discussed below.

Further, on January 27, 2020, a peace agreement was signed between the Union of India, Government of Assam and the Bodo organizations under the leadership of NDFB, the All Bodo Students' Union and United Bodo People's Organization, thereby augmenting more executive and legislative powers, and it is now known as Bodoland Territorial Region (BTR). The Bodoland has, however, been mired in infrequent violence or sociopolitical unrest. For example, in 2012, the districts of Kokrajhar, Chirang, Baksa, Udalguri, Dhuburi and Bongaigaon engaged in heinous ethnic conflicts between Bodos and non-Bodo indigenous people of Assam (especially the immigrant Muslims) where over hundred thousand people were obliterated and 4,85,921 faced displacement (Mahanta 2013; see also, Bhattacharyya 2013). The violence again erupted in December 2014, killing nearly 78 people, mainly women and children (Goswami 2014). So, one can imagine that MNP located within the region fell victim to the Bodo insurgent activists (discussed below). This study demonstrates that despite ethnic disturbances, how MNP faces geographies of restoration through peoples' participation.

21.3 Materials and Method

This study is based on the secondary data collected from multiple sources—Office of the Field Director, Manas Tiger Reserve, Wildlife Trust of India, *Aaranyak*: a scientific and industrial research organization, Wildlife Area Development Trust, local NGOs and community organizations. In addition, this study is also based on the literature (journal articles and books), archival materials, and newspapers depicting the Bodo movement and biodiversity, bioresource conservation, and livelihood issues

from different databases worldwide. To generate the map, we have deployed the Arc GIS 10.3 software.

21.4 Discussion

The people of the fringe areas of MNP largely depend on forest and natural resources available in the area for their livelihood, agriculture, food, and other commodities like fuel wood. However, increasing political unrest (Dutta 2018; Mahanta 2013) and human population in the fringe areas have led to encroachment and illegal hunting and tree felling within the protected area during the 90s. Even now, people residing in the fringe areas are in many ways dependent on the Park for their livelihood, such as livestock grazing, fodder, and fuelwood collection. These findings bear resonance with the observations of similar other studies conducted elsewhere in Assam—Kaziranga National Park (Das 2017; Hazarika and Kalita 2019) and Gonbina Reserved Forest in Goalpara district of Assam (Medhi and Kar 2016).

As already discussed above, Manas is a world heritage site and one of the major wildlife habitats for several critical species like Asian Elephant (*Elephas maximus*), Royal Bengal Tiger (*Panthera tigris tigris*), Greater one-horned rhino (*Rhinoceros unicornis),* etc. From 1992 to 2003, Manas encountered the worst time—civil unrest, political instability, terrorism, and ethnic violence were extensively experienced in the BTAD area (Dutta 2018; Mahanta 2013). As stated earlier, the root cause behind this ethnic violence was mainly the ethnic identity crisis of the Bodo people and their demand for separate Bodoland out of the territory of Assam. The civil unrest in the 1980s and early 1990s had a tremendous impact on the wildlife and its habitat in MNP. Several militant groups and timber mafias were engaged in illegal logging and poaching to raise funds for their activities. The Greater one-horned rhino became extinct from Manas during that period, and a large number of swamp deer and wild buffaloes were poached too during the period of unrest. According to statistics retrieved from the Forest Department of Assam, between 1991 and 1993, 36 rhinos were poached in MNP. Table 21.1 shows the trend of rhino poaching in MNP from 1962 to 2016.

Rhino poaching, however, is not an MNP specific problem; it is a pervasive problem in other national parks and sanctuaries of Assam, too—Kaziranga National Park, Orang National Park, Pobitora Wildlife Sanctuary, and Laokhowa Wildlife Sanctuary. And the causes of poaching more or less remain the same—illegal/mafia trading.

Notwithstanding, due to the massive destruction of forests and wildlife, Manas lost its glory as a world heritage site in 2003. During that time, protection and wildlife habitat management and conservation practices in Manas were not sufficient; as a result, 20.47 km^2 of the Park was encroached (Sarma et al. 2008). Similarly, the wildlife habitat of the Park witnessed disturbance due to improper habitat management practices. Evidently, the satellite images of MNP show the changes in habitat patterns from 1991 to 2004 and from 2004 to 2020. Table 21.2 illustrates the changes

Table 21.1 Trend of rhino poaching in MNP, 1962–2016

Year	Rhino poaching
1962	1
1963	1
1965	1
1971	1
1976	4
1978	1
1981	2
1982	1
1983	3
1984	4
1985	1
1986	1
1987	7
1989	6
1990	2
1991	3
1992	11
1993	22
2001	1
2011	1
2012	1
2013	5
2014	1
2016	2

Source Office of the Field Director, Manas Tiger Reserve

in wildlife habitat in MNP during the period of unrest. There is a massive decrease in woodland habitat from 1991 to 2004. It was mainly due to the illegal cutting of the trees during that period. Seemingly, the alluvial grassland habitat (which is considered as best habitat for many species, including rhino and swamp deer) also plummeted from 94.38 to 44.31 km^2.

21.5 A New Beginning, A New Hope

To put an end to the Bodo problem, since March 2000, a series of negotiations were held between the Government of India, Government of Assam, and Bodo Liberation Tigers (BLT). And as discussed above, on February 10, 2003, at New Delhi,

Table 21.2 Forest cover changes in MNP from 1991 to 2004

Land cover types	1991 (Area in km^2)	2004 (Area in km^2)
Woodland	241.18	233.21
Savannah grassland	120.86	161.97
Alluvial grassland	94.38	44.31
Water body	8.88	4.99
Sandy area	23.79	35.97
Encroachment	0	20.47

Source Office of the Field Director, MNP

the trio signed the Memorandum of Settlement on Bodoland Territorial Council (BTC). Accordingly, the accord arrived at a consensus of building a self-governing body within the state of Assam for those areas under Bodo jurisdiction, as already discussed above, comprising four districts of Assam—Kokrajhar, Chirang, Baksa, and Udalguri. The BTC jurisdiction extended over 3082 villages and was bestowed with legislative powers in over 40 subjects per this accord. The Executive Council consisting of 12 Executive Members, including a Chief and a Deputy Chief, was approved in the agreement alongside an appropriate representation of the state's non-tribal population. In tandem with the Government of Assam, the Government of India has been developing symbiotic efforts to execute the aspirations of the Bodo people linked to their sociocultural identity, development of education, language, and overall economic development of the region.

This accord had staggeringly transformed the region's sociopolitical scenario. It brought peace, security, and stability, albeit spasmodic violence is witnessed, for example, the 2012 and 2014 ethnic conflicts between the Bodos and the immigrant Muslims (Mahanta 2013; Goswami 2014). Nevertheless, in the aftermath of this political settlement, the conservation fraternity, including Government Departments, Non-Government Organizations (NGOs), local youths and most importantly, the women of the fringe villages of Manas, decided forthwith to revive Manas and bring back its lost glory. But the process of rejuvenation of Manas was not straightforward. It was already established that without the good faith of the fringe villages of Manas, it is not possible to re-establish Manas and restore its dead fame.

Therefore, it became apparent that the conservation of Manas is almost impossible without the participation of the local stakeholders—the fringe villagers. Increasingly, all stakeholders recognize that all plans must be grounded in the two critical principles of Ecological Security and Livelihood Security for sustainable development and effective biodiversity and bioresource conservation. Arguably, in a developing country like India, the vast majority of the rural population are (in)directly dependent on natural resources and biodiversity elements (Bhuyan and Kar 2018; Das 2017; Hazarika and Kalita 2019; Meena 2015; Medhi and Kar 2016; Panja and Mistri 2018). Ecological security is critical because it provides the survival of tens of thousands of species of plants and animals and the fundamental ecosystem services upon which

human food, health, water, and cultural security are dependent. The heightened interrelationship between livelihood and ecological security makes the study area's rural population the primary stakeholders in biodiversity conservation with sustainable use.

Moreover, the findings of this study demonstrates that communities dwelling in this biodiversity affluent region have obtained rich indigenous knowledge in ecology and bio-conservation from previous generations via their interactions with local ecosystems, through which they have built and shaped their cultures, lifestyles, and livelihoods. Therefore, community-based natural resource management (CBNRM) is an integrated approach to enabling biodiversity conservation and supporting local livelihoods (Adams and Hulme 1998; Grimble and Laidlaw 2002, Grimble and Wellard 1997). Considering all these aspects, the conservation fraternity had decided to motivate the local people through the NGOs and create mass awareness to conserve and protect Manas. The different NGOs—Wildlife Trust of India (WTI), *Aaranyak*, WWF, Manas Maozigendri Ecotourism Society, Bodoland Forest Protection Force, Manas Souchi Khongor Ecotourism Society, Manas Bhuyanpara Conservation Society, Manas Agrang Society, etc., had come forward to motivate people and protect and conserve the biodiversity and bioresources of MNP and its surrounding areas.

The conservation body adopted a community conservation approach to conserve the Park and uplift the livelihood pattern of the fringe villagers of Manas. The main reason for prioritizing community conservation was the area's remoteness, and the people living in the vicinity of the forest have lower incomes and have less access to education, health care, and developmental opportunities. There remains a link between poverty and environmental degradation, both reinforcing each other. Thus, the most pressing challenge is to conserve biodiversity and bioresources and, at the same time, improve the communities' livelihoods dependent on forests (Das 2017; Meena 2015; Medhi and Kar 2016). To minimize the dependency on forest resources sustainable alternative livelihood initiatives were planned and introduced to the fringe villages of Manas. The conservation organizations conducted a massive survey of the fringe villages, where information like village name, household number, the population of the village, ethnicity of the population, and their livelihood was collected. After collecting all the information of the fringe villages, self-help groups (SHGs) consisting mainly of women were formed in the fringe areas through series of consultation workshops taking a radius of 1 km buffer from the park boundary covering the fringe villages. These SHGs were trained to work on piggery, beekeeping, vermicomposting, weaving, food processing and preservation, fishery, stitching, dairy farming, goat farming, and mushroom cultivation.

The NGOs—WTI, *Aaranyak*, WWF, had played an active role in community mobilization, networking with other government and non-government agencies like National Institute of Rural Development, State Institute of Rural Development, Krishi Vigyan Kendra, Northeastern Council to establish the market linkages with other market players in retailing the products generated by the SHGs. In 2004 WTI launched a vision of creating a more prominent "Greater Manas Conservation landscape" encompassing an area of nearly 1500 km^2 to maintain the ecological integrity

and functionality of the entire landscape. WTI's work centered around three strategies—(1) to bring increased areas in the landscape under protection, (2) augmentation of the numbers of animals and enhance their protection, and (3) involve local communities in conserving this landscape. Manas Tiger Conservation Program (MTCP), led by *Aaranyak* in partnership with the Forest Department, BTC, and Wildlife Conservation Trust, is initiating change among the people living in the fringe areas of the Park, by helping them choose alternate livelihoods. For example, the SHGs around the Park received market linkages in 2014 when these SHGs participated in the International Agri Fair 2014, held at Guwahati from Feb 08 to 11, 2014, bearing market linkages with Vietnam, Myanmar, and Thailand. Similarly, the tourist lodges in and around the Park have been contacted for selling of SHGs' products during tourist seasons (October–May). In addition to this, nearby towns like Barpeta Road, Patshala, Barama, and Bijni have also been targeted for marketing. A local livelihood exhibition cum sale is organized regularly at Bansbari, the central location, around the Park, which helps the SHGs exhibit the various products prepared by them.

Interestingly, Northeastern Development Finance Corporation Ltd (NEDFi), a Public Limited Company and National Bank For Agriculture and Rural Development (NABARD) have come forward to support the SHGs in selling their products in major cities of Northeast India. Besides, the Northeastern Council (NEC), the nodal agency for the entire Northeast region's economic and social development, has also enhanced the market linkages. Few significant achievements of these SHGs led by women that remain paramount to be mentioned here are that it won the best stall and first prize in Food products preservation in the 17th All Assam Agri-horticulture show in 2011. Again in 2012, it won the best women entrepreneur in Northeast Agri Fair 2012 (Figs. 21.2 and 21.3).

Similarly, the wildlife habitat of Manas also revived from 2004 to 2019. As per the Park authority's recent data, the woodland of the Park has increased to 238.81 km^2 in 2019 from 233.21 km^2 in 2004. The water bodies of the Park also grew from 2004 to 2019 from 4.99 to 11.78 km^2. This increase of water bodies in the Park has created the necessary environmental conditions for the growth of alluvial grassland.

Fig. 21.2 Bringing back Manas, Initiatives by the NGOs. *Source* Created by the authors

Fig. 21.3 Weaving by local women, SHGs are targeting tourists buy their products. *Source* Created by the authors

The alluvial grassland is the prime habitat for the Greater one-horned rhino in the Park, and it had expanded from 44.31 in 2004 to 71.5 km^2 in 2019. However, the dry savannah grassland, which is in transition between grassland and woodland due to natural succession, has decreased in the Park from 161.97 to 119.51 km^2 from 2004 to 2019. Table 21.3 displays the changes inland cover patterns in the Park from 2004 to 2019. The most significant change that has been observed in the Park is the reduction of encroachment area from 20.47 to 19.12 km^2, which has brought positive vibes among the frontline staff and conservation fraternity working for the conservation of MNP.

We argue that from 2003 onward, the scenario of Manas and its fringe areas have changed gradually. The villagers of the fringe areas took the initiative to protect Manas, and they realized the real potentiality of Manas and its importance in their life and livelihood. The drastic change in the living standard of the women associated with SHGs had also encouraged others to join the movement and initiate the conservation of Manas and its bioresources. The MNP authority continues to take initiatives along with the NGOs to facilitate some exposure trips of the fringe villagers to look at the scenic beauty and biological diversity in the Park and make them aware of the need to conserve the bioresources of the Park. After achieving the stability and

Table 21.3 Land cover change of Manas from 2004 to 2019

Land cover types	2004 (Area in km^2)	2019
Woodland	233.21	238.81
Savannah grassland	161.97	119.15
Alluvial grassland	44.31	71.5
Water body	4.99	11.78
Sandy area	35.97	39.73
Encroachment	20.47	19.12

Source Office of the Field Director, MNP

security of the Park, in 2008, the Greater one-horned rhino was translocated to MNP from Pobitora Wildlife Sanctuary under the program of Indian Rhino Vision 2020, supported by the International Rhino Foundation in collaboration with the International Fund for Animal Welfare (IFAW), *Aaranyak*, WTI, WWF, and local NGOs. This has tremendously boosted the morale of the forest staff, fringe villagers, and the conservation fraternity, who continuously try to revive and protect MNP.

The reintroduction of rhino in the Park has brought a boost to the tourism sector too by significantly escalating the tourist flow in the Park. Looking at the increased tourist inflow, the local NGOs like Maozigendri Ecotourism Society, Bodoland Forest Protection Force, Manas Souchi Khongor Ecotourism Society, Manas Bhuyanpara Conservation Society, Manas Agrang Society have started ecotourism establishments, and infrastructure in the fringe areas, and it has created new livelihood opportunities for the local youths of the area. Table 21.4 presents the trend of increase of tourist inflow in MNP from 2003 to 2020.

Finally, in 2011, after facing many impediments, Manas regained its world heritage site status from UNESCO. The story of MNP will always remain a success story in the history of conservation. Today MNP is the proud legacy of the state of Assam. It is one of the most beautiful and biodiversity-rich places in the world. Despite facing diverse obstacles, Manas continues to hold the highest tags as a Tiger Reserve, Biosphere Reserve, National Park, Elephant Reserve, and a World Heritage Site. Now the fringe villagers, especially women, have emerged as the real

Table 21.4 Tourist flow in MNP

Year	Domestic tourist	Foreign tourist	Total visitors
2003–04	215	88	303
2004–05	13,648	234	13,882
2005–06	24,596	289	24,885
2006–07	11,760	69	11,829
2007–08	9546	239	9785
2008–09	17,774	139	17,913
2009–10	9734	503	10,237
2010–11	16,867	129	16,996
2011–12	24,030	177	24,207
2012–13	18,328	91	18,419
2013–14	22,840	325	23,165
2014–15	9786	475	10,261
2015–16	40,559	614	41,173
2016–17	36,201	351	36,552
2017–18	37,592	480	38,072
2018–19	42,340	650	42,990
2019–20	44,422	721	45,143

Source Office of the Field Director, Manas Tiger Reserve

protectors of Manas. Their service for Manas is now 24 × 7. In November 2020, MNP authority received the prestigious Global Tiger Conservation Excellence Award for their proactive actions to conserve tigers and their habitat in Manas; similarly, in 2021, Manas received the Hem Chand Mahindra Foundation Wildlife Warrior Awards and International Union of Conservation of Nature and Natural Resources (IUCN), WCPA-International Ranger Award under the leadership of the fourth author of this paper. In 2016, Dr. Bibhuti P Lahkar of *Aaranyak* also received the award of Heritage Hero from the IUCN for his prodigious efforts to transform MNP from its dark age to new hope. Currently, Manas is all set to revive its forgotten glory. Arguably, the economy has transformed from a mafia economy to a local economy, which bears the potential to become a global economy in the foreseeable future. This is largely because domestic and international tourist flow to MNP has been continuously rising since 2011. Infrastructural facilities in and around MNP are also developing gradually, bringing new livelihood options for the youth of the fringe villages of MNP. This markedly signals that proper planning and systematic implementation of the conservation projects remain essential to ensure ecological and livelihood security of any biologically resourceful area. Manas set an example of how biodiversity, bioresource conservation, and livelihood can move together in a synchronized manner toward sustainable well-being. There is a ray of hope that the recent signing of the BTR agreement in January 2020 will indeed open more doors to intensify the conservation of Manas further, bearing the stupendous possibility of opening new livelihood opportunities for the people of the region, including the fringe villagers of MNP.

21.6 Conclusion

This is one of the first studies demonstrating how MNP revived post-2003 after signing the agreement from where BTAD became BTC. The MNP sets an example of biodiversity and bioresource conservation and livelihood generation through government initiatives and people's participation. Though the Manas is now well protected and well managed, threats are always there from poachers, illegal tree cutting, and habitat destruction. Therefore, continuous monitoring of the community participation and awareness among the fringe villagers is very much essential. Local NGOs are now taking the initiative to generate livelihood among the youth of the area, and they are also assisting the forest department to protect and conserve Manas. Eco-Development Committee (EDC)s were formed among the fringe villages near First Addition to Manas NP. The EDC prepared the micro-plan for their respective villages where conservation actions were linked to their sustainable livelihood by reducing the gap between the park authority and the local community. Soil health cards are being distributed with support from Krishi Vigyan Kendra, promoting bio-pest management in agricultural practices, health checkup camps for livestock, information dissemination, and linking government schemes to the fringe villagers by involving the EDCs are also parts of ongoing interventions by the organizations

in the landscape. The authors firmly believe, "*At the end of our society, we will be judged not by what we have created but by what we have refused to destroy*" and Manas is an excellent example of this.

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Chapter 22
Ephemeral *Char* Ecosystems and Mitigation of Flood-Induced Vulnerability Along River Brahmaputra

Nazifa Ahmed

Abstract Every water community has unique lived experiences but the common feature in eastern and North-eastern India is the disruptive impact of embankments, dykes and dams on riparian lives. The existing literature on riverine islands engages with the colonial and post-colonial political economies without much engagement with the traditional knowledge and strategies which are used in a traditionally flood-dependent agrarian regime. The *char* (shifting riverine islands) dwellers or *charuas* in Assam have seen a shift from flood-dependancy to vulnerability, as river infrastructuring has ruptured the Brahmaputra River's natural flow and siltation cycle. In this article *charuas* who inhabit the downstream Brahmaputra and have ancestral linkages to erstwhile East Bengal have been studied. The presence of embankments and other colonial river control methods and energy extractive economies have only exacerbated issues of erosion, flash floods and reduced siltation along levees. It has presented a fractured landscape fraught with disputes when mismanaged and disaster resilience and mitigation when common resources are well managed. This paper is based on field observations and personal interviews of *charuas* who see themselves fighting this annual crisis alone—the intensity and frequency of which has exacerbated in time—with their innovative common property management, housing methods on raised plinth, cropping phenophases, using *kaisha* grass and reliance on solar technology, which holds great potential for sustainably averting the intensification of vulnerabilities in hydraulic regimes if applied well.

Keywords Hydrosocial lifeworlds · Embankment · Cropping phenophases · Flood · Erosion · Risk mitigation · Riverine islands

22.1 Introduction

The dynamic braiding characteristics of the River Brahmaputra give birth to shifting riverine islands locally called *chars*—thus offering new insights into the discourse

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on South Asia's diverse riparian environments. Such complex geographies have garnered complex theorizations from scholars such as 'hybrid' scapes (Lahiri-Dutt and Samanta 2013) and 'environmental hinterlands' (Chakraborty 2012) which have aimed at shelving delta discourses under 'transdisciplinary imagination', that which defy land-water binaries. These *chars* (also called *diaras* in the mid-Gangetic plains) undergo processes of diluviation and alluviation and are 'slippery and ephemeral' as Law (2004) puts it about various geographical regions which change like "a kaleidoscope", thus inspiring cultural geographers and environmental historians to shed rigid assumptions in their ontological inquisition.

Much like the fluid nature of these islands, the identities of its inhabitants hang between citizenship and statelessness. It can also be said that such fertile spaces which lay at the mercies of erosion, flood submergence and periodic re-emergence have seen and attracted the most hardworking but non-state-affiliated and flood-displaced masses time and again due to the social remoteness it provides along with environmental precarity. In the context of political refugees, it is obvious in the case of the *chars* in Bangladesh wherein the Rohingyas have been settled in Bhashan *char*—an ungovernable, borderless and migrating space, both politically and environmentally untenable.

This paper has been written based on primary interviews with *charuas* of Barpeta district (Assam) in Chenga, Jania and Baghbar districts, and on the basis of secondary literature on *chars*. The study involved deductions from interviews based on random sampling of 70 households and its village headmen.

The insecurity faced in choosing shelter and/or livelihood, wherein the question of security loses its conventional definition, and the need for migration as a means of adjustment through a complex social set-up has been left out as it is beyond the scope of this paper.

22.2 A Brief History of River Management

Chars are fraught in its history of increased disasters owing to constructions of embankments to control the turbulent Brahmaputra especially since the colonial times. The history of transplantation of indentured labour (Guha 1977; Prakash 1990) and cultivators from erstwhile East Bengal (now Bangladesh) to improve the overall agricultural productivity in these regions under the colonial government put the onus of environmental risk management and adaptation upon these communities completely, something which continues to be seen to date. Even today, the communities living in chars are primarily defined by *pykasht*[1] (migratory occupancy) as compared to *khudkasht*[2] (settled occupancy) whether it is in Assam, Bengal or Bihar, and Bangladesh. Even in the post-independence era legal and economic planning done for these regions follow such outdated frameworks which result

[1] Sinha (2016).

[2] Ibid.

in myopic planning strategies thus failing at attaining sustainable development goals. This strengthens the argument that the discipline around Assam's *char*land studies are in dire need of decolonisation in the hands of geographers. Much of such work has been done by environmental historians with reference to West Bengals' *chars* very recently and forms a bedrock for other disciplines to expand upon.

To provide a background into the setting up of flood management in River Brahmaputra, one needs to look at the history of cultivation in Brahamputra's *chars* and levees. During the colonial period the seasonal nature of hydraulic 'volatility' led to unreliable revenue collections and made variable the efforts of the East India Company, to extract revenue. As such, hydraulic structures were erected to sheathe floodplains from river spills. The colonial logic was to protect profitable land at all costs and to tame the unruly river and its tributaries. The aim was to turn 'wastelands' into profitable land based on Locke's philosophy which in turn borrowed its tones from Christianity and lacked an ecological understanding in its land use categorisation schema (Hilaly 2016).

D'Souza's (2016) work on the transformation of these densely populated flood dependant spaces to flood-vulnerable zones since the intervention of the British via material manifestation of control (like dams, dykes and embankments), to this day provides one with a background for the many issues faced by the *charuas* or *char* dwellers of the Mahanadi river and the many groups of people who are annually displaced by floods and erosion. The colonial idea to control the flood and inundation effects on the river however failed as the mighty River Brahmaputra spilled from its now narrowed channel and caused even more inundation, as was found out during the River Mahanadi surveys conducted by military engineer Lieutenant J.C. Harris. Shift from flood dependency to flood vulnerability due to hydro-energy extractive and flood control engineering was a part of colonial capitalism, as pointed out by D'Souza. It caused the rise of capitalist private property in a bid to control rivers and 'enable administrative certainty' even at the cost of destruction of a fine ecosystem dependent on silt and water. This also pointed to a general discourse where deltaic lands were seen as productive based on their use value added to swathes of 'wastelands' and 'fetid morasses', by migrant labourers (Hilaly 2016; D'Souza 2006). The initial attempts of the British only saw a mounting cost of repair and maintenance owing to large-scale corruption of the bund *daroghas,* as was cited instead of an acceptance of their inefficiency (D'Souza 2006; Bhattacharyya 2018; Mukherjee 2019). By the 1940s, the cost of upkeep of embankments and dykes and its accumulated financial, social and ecological costs were widely recognised by the Empire and it could not be dismantled without causing significant disasters. Matters further worsened ever since dam construction began to be seen as a progressive developmental activity to 'harness' flood waters in the post-independence era.

The contradictory nature of the Empire's policies was visible in the fact that they believed that a mighty system such as the Brahmaputra's drainage networks could be managed through embankment construction for efficient agricultural land management and revenue collection, while also understanding that their actions were exacerbating floods in the regions downstream as well as provoking erosion in the floodplains and deltaic plains. The onset of flood control through technological artefacts

like embankments, dams and dykes is an extension of capitalist mode of production of deltaic flooding (Smith 1984) which is packaged from a misogynistic outlook of controlling elements of nature such as floods to the advantage of masculinist colonial operations. To further envisage the point, the reproduction of technocratic solutions to manipulate nature creates capital while also redefining the economic and societal relations of the people whose fate hang by a thread—the cycles and rhythms of the river and its hybridscapes. It is mainly women, children and other marginal groups such as backward tribes—the very people who maintain lives here and understand the complexity of these spaces, that are most affected by it.

In a bid to create sustainable island living, meso-level hydrological structures such as embankments and dykes (let alone macro-level structures like dams) can not be the only model which can be relied on. After observing the large-scale shift in the balance of such ecosystems arising from erecting cognate structures along the river's flood plains and basin, approaches have to be tailor-made from one *char* space to another, as not every *char* region is similar. The focus on the grain and market *chars* serve also needs to adopt a more humane approach if sustainability is at the heart of the development paradigm. This offers one the need to shift from a political-economic approach which had shoehorned the stories of displacement of the *charuas* into a narrative of 'land hungry' settler colonialists, born from sub-nationalist anxieties. An indulgence in an interdisciplinary approach with decolonisation at the core of our understanding will offer insights for creating sustainable development in these densely populated fertile spots of the Global South. Anthropological, geographical, historical, social and economic modules can intersperse in such unique ecological niches to create a discourse on ephemeral spaces along with its ephemeral people in the decolonial tradition. To reclaim these spaces sustainably, one needs to integrate both socio-political movements as well as traditional know-how of dwelling/indigenous communities who inhabit dynamic land-waterscapes and deploy time-tested methods of adjustments such that they can figure a way out to adapt and make living less vulnerable.

22.3 Precarity as a perennial feature of life

According to noted Bangladeshi artist, Sharmin Hossain, owning land access denotes caste and or class privilege. The '*birodari system*' (i.e. brotherhood) is a patriarchal system wherein the '*poribar*', '*bongsho*', '*gushthi*' or kinship ties consolidate power and elitism. Very much like Bangladesh's *chars*, even in Assam's *chars gushti*-dominance is observable in the form of land ownership and land appropriation practices. Land struggle becomes acute especially in the winter months when *char* lands which had submerged during floods re-emerge downstream in the channel.

This is where the question of primitive accumulation and rent-seeking comes in the picture. Even the practices of settling in *chars* after being dispossessed are found to be dependent on whether one had linkages to and the support of *mattbars* (power poles) in the island (Baqee 1998). As such, the months marked by an accretion of

land is fraught with an increase in the level of violence in *chars* with various power poles who fight to make claims over said lands. As these lands do not come under the purview of the Permanent Settlement Act, the Bengal Alluvion and Diluvion Act (BADA) of 1825 had been enacted which has since been amended with new sub-clauses to outline the use of *char*lands. These colonial legal interventions continue to persist till date and any dispute in these migratory lands is still settled on the basis of *bichar* or local conventions, wherein the support of the wealthy families who hold positions of power and money can buy off judgements and land documents in their favour. Thus, colonial legal intervention systems, informal local institutions and the 'volatilities' of erosion and land emergence downstream play a huge role in maintaining a level of remarkable precarity over the lives of *charuas*. In some cases, precarity and land fertility defined the stereotypes attenuated by the main-landers with regard to *char* living even though there was very little knowledge of the land-based resource struggles and the outcomes of regular internal displacement owing to riverine erosion. For instance, Internally Displaced Persons (IDPs) often lost official artefacts due to floods and untoward climate events or due to internecine land conflicts and lost claim to shelter and cultivation lands. Sometimes, rich peasants could overnight be rendered landless owing to the volatile hybridscape and have to wait for their lands to re-emerge downstream for years. Though most of the rich peasants have properties in the mainland and alternate means of livelihood in the current times, unlike the poorer *charuas* their loss in some ways in not remotely comparable to the precarious lives led by the latter group.

22.3.1 Response to Vulnerable Conditions

As land and its rights are mostly non-permanent even in the more stable[3] *chars*, the forces of erosion and flood inundation have forced people to partition resources based on the rhythms of nature and their understanding of their milieu mainly helped them cope with its uncertainties. Some of the strategies used are:

Sharecropping in Tune with Cropping Phenophases and Land Struggle In *char* areas, a varied basket of grains and vegetables are grown in different flood and post flood seasons—the most important crops being *ahu, aman, aus* and *boro* paddy, as well as groundnuts, jute and sweet potato. The sowing season varies between November to March when accretion of *chars* takes place. Understandably, the violence ensues in a bid to acquire these finite land plots. Observations from field suggest that these months are full of activity in the *chars* and as such respondents were hard to catch hold of. As per a summation of an 18-year period (1972–1990) from Iqbal's study, the violence occurs at the rate of one episode every 21 days and rises to 16 during harvest period in the *chars* of Bangladesh. Bangladesh shares cultural and institutional proximity to the *chars* of Assam. His study also observed

[3] Classified as stable based on field classification to denote the *chars* which have existed for up to 20 years.

that the southern *chars* faced more violence due to higher accretion in the southern part. As such, cropping phenophases offer a solution for food securitisation in the drier months irrespective of the background of violence leading up to land-grabbing practices by *mattbars*—mainly practised in the lands allocated by the government for displaced persons. Even if the southern parts of the islands may be closely monitored by a local body and redistributed among farmers on a rotation basis to work on lease (as cultivators on others' land) once they are rendered landless due to erosion, this does not offer a clear solution in terms of proportionate allocation of land for cultivation, grazing and sometimes even in shelter, as most of these concepts are based on fixity of land.

Baqee (1998) chalks out various forms of sharecropping prevalent in Bangladesh which involves:

1. *Kamla*: Harvesting of crops by hiring daily wage labour.
2. *Barga*: Sharing of yields between the tiller and the landowner, and
3. *Chukti*: A short contract, which can be divided into:

   (a) *Thika*: Tiller has to relinquish a fixed quantity of harvest against the plot size they are allowed to cultivate. *Aadhi* is a popular form of *thika* contract where half (*aadha*) the produce had to be handed over by the cultivator to the land owner.
   (b) *Lagani*: The landowner is paid in advance by the tiller for a given plot and the contract lasts for a stipulated period. It is generally common in the early stages of *char* occupancy and is riskier if the crops fail.

In Assam the *aadhi* was the most common form of farming management due to the skewed position of land ownership. The rich farmers sometimes owned so much land that they could not cultivate on it. Though a relatively smaller proportion, the poor peasants would also sometimes rent out land due to a lack of ploughs or bullocks and cultivation may not be viable for them, as a result. Most of these transactions however were conducted in kind or favours rather than in cash, which is elusive to an outsider but seemed to work for some villagers due to the unique social configuration of their societies.

During the flood season, adjustments are made depending on the rainfall and flood intensity. Standing crops, if ripened, are harvested in groups, while animals are left in embankments. Most of the poultry and ducks are sold for cash before floods as they inevitably do not do well in disasters. To reduce the lapping of flood water, bamboo stakes are placed at equal intervals against the plinth of the house. Mix cropping of flood-resistant and flood-sensitive rice is also practised as a way to deal with anomalies of weather based on speculation of monsoon arrival. Farmers often cropped *aman* rice in rainfed conditions as it survives 7 to 14 days underwater, as a safe exercise. Lessons on this matter can also be drawn from north western parts of Bangladesh wherein flood-tolerant rice varieties have improved the climate resilience of communities, and increased profitability and household consumption (Bairagi et al. 2021). Baqee, also notes from his field experiences, the use of floating seed beds during flood retreat season, wherein farmers spread water hyacinth over

banana rafts. As soon as the hyacinth rots, earth is sprinkled and seeds are allowed to germinate on it. This complicated process is accomplished by fewer farmers, while richer farmers, with links to the river banks, grow seedlings there or buy saplings from the market. In Assam, most farmers relied on buying fertilisers and seeds from the market owing to seed damage in the present times, which more or less added to their dependence on non-traditional seed varieties and fertilisers. Floods often destroyed granaries and seed banks in the parts surveyed for this study.

Housing and Drinking Water The indigenous knowledge of peasant communities which was brought from erstwhile East Pakistan by its migrants involved building houses on plinths as pointed out in the earlier passage. These plinths are usually as high as the highest flood water level, or sometimes slightly higher. Land is dug out from the adjoining areas to build the mound such that the dugout portion turns into a pond and the highly raised land becomes the plinth on which houses are constructed to avoid storm surge waters and floods from entering. To make the plinth erosion-proof, a local variety of creeper called *lata ghash* may be grown on the top slopes, along with *kaisha* grass on the lower slopes submerged under water. Other methods of plinth maintenance were likely not necessary every year but its maintenance required minimum effort with cost-effectiveness. Any maintenance of the plinth was usually done with a plaster of paste made of mud, jute and husk. Likewise, it helped to dig wells on raised plinths so that safe drinking water was accessible even during floods. Often tubewells at a lower elevation would yield contaminated water during flood events. During intense rainfall, bamboo stakes are placed at the plinth bottom, which barricades it from the impact of running water. Nowadays, most *char* house walls are erected with corrugated tin sheets and thatch/tin roofs; hence, repairs are not required every year, barring the poorer households still using less durable building materials like thatch and mud.

Abdul Baqee learns from his five-year-long stay in the *chars* of Bangladesh that structural adjustments to safeguard the plinth and household goods may not be required every year if the flood intensity is low for consecutive years. However, some preparations and adjustments are made during high-intensity monsoons and floods. Apart from making adjustments to the plinth and reinforcing it, people pile cots and put away seeds in earthen pots. *Machans* or bamboo platforms on stilts are used to raise cots upon, as measures of staying above flood water level. Sometimes, the false bamboo ceilings are used as *machans*, with the roof opened on one side. In times of crises, the *mattbars* would help out people in the village by allowing them to use their boats, bamboo and other resources available with them at the moment. It was observed that only fewer households with some degree of influence had boats, whereas most of the others had to rely on hiring boats or making banana trunk rafts to stay afloat during floods. Boat making is a lost art in some of the *chars* which I had investigated. This is mainly happening due to a transition in employment choices among the youth, wherein most men often out-migrated to satellite towns and market centres to make a living, thus causing limited engagement with traditional skills.

Optimal use of Flora: Kaisha Grass and Jute In the formation stage (0–3 years) of a *char* when gradual alluvial deposits form sandy plains, a grass called *kaisha* or

sun grass is abundantly seen growing. It is widely used for feeding cattle especially in the flood season. *Kaisha* is sometimes used in thatching roofs of mud huts but so are jute sticks from previous crop cycles reused in housing and in making transitory roads along the sandy *chars*, so that cyclists and two-wheelers can ride on the sand without skidding. Such flora is native to wetlands and is a solution to low-cost housing construction. As a natural resource, it is pervasive and instrumental in the upkeep of grazing cattle, especially during floods, as this resilient grass can withstand inundation of both fresh and brackish water. At present even though most *charuas* had increasingly found themselves reliant on bamboo and corrugated tin sheets for building homes, bamboo often had to be transported from the mainland at great cost and so was also the case with tin sheets. The optimal use of local resources with a little handholding from the state and NPO agencies could go a long way in renewal of housing by these communities to lessen their struggles as well as take off some of their collective emotional load of vulnerability and disaster risk mitigation.

Solar Energy The islanders were often found to have small solar panels, as they were reliant on renewable sources of energy for electrification. The ever-morphing land-waterscape did not allow for power grid set up and as such solar technology has a bright future as coming to the aid of people. Most dwellers used small electronic goods and consumed very little by way of energy, hence reliance on DC current was seen useful. However, the downside of setting up costs impacted most of the poorer families who had to rely on the burning kerosene lamps. As part of living in these places the community aspirations were pinned on buying solar panels with savings, and as such most families were beginning to have some form of solar electrification, when they were not in fact beneficiaries of soalr electrification schemes by the government. Thus, almost 90 per cent of the energy requirements (barring cooking needs) were fulfilled from solar energy which also meant that it was non-functional during the lengthy overcast monsoon season.

Weed Species and Its Impact on Rice and Jute Cultivation in the Chars In Assam and Bengal, the pervasive presence of water hyacinth is a serious impediment to inland navigation, *aman* paddy growth, fishing and jute cultivation. In a riparian region conducive to jute and paddy cultivation, the choking presence of this weed had often been attributed to malarial epidemics, closure of waterways and also as one of the 'most pressing problems' impeding agricultural operations (Iqbal 2010). Sudhir Chandur Sur[4] (1939) elucidates how the growth of this weed is associated with the obstacles to the current of rivers—from standing cross-roadways, railway embankments and railway bridge pillars—by deterring the river to transport large amounts of organic and inorganic matter to the sea via bigger rivers. This led to the deposition of weeds like the hyacinth which found stagnant waters to multiply in. Iqbal argues that the water hyacinth and railways together have had serious implications on the great Bengal famine, by impacting agrarian well-being and engulfing large swathes of rice-growing submerged fields and choking freshwater bodies. Nonetheless, it needs to be emphasized that the accelerated invasion of water hyacinth had much

[4] Sudhir Chandur Sur, ABP, 14 April, 1939, pp 16. *In* Iqbal (2010:157).

less bearing on the Bengal fmaine, as compared to other economic and political causes of the time.

The weed was also responsible for the retardation of water inflow, due to the matted presence of water hyacinths, and for the spread of water-borne diseases.

In 1914, the first working proposal towards utilisation of water hyacinth was done by to turn it into manure when dried and burnt to ash. In the context of the First World War, which had restricted global access to potash, the country recognised the potential it held. The Water Hyacinth Act (1926) was passed in Assam to deal with the debate of destruction or utilisation of the weed and for many years the deal was kept in suspension.

The connection of the weed to lowering agricultural productivity on one hand and the paradoxical position of being excellent manure when burnt to ash points at historical mismanagement in both colonial and post-colonial time periods. Regional planners can thus focus on this weed to look for answers to manage it as a resource suited to traditional practices of cultivation specific to the char and its adjoining levees called *chaporis*. The 'extraordinary biological strength' of the weed to pervade and invade large spaces, reduce waterway mobility for islanders by promoting random patches of siltation (making boat travel of islanders dangerous and difficult) and destroying fish production has still not been seen by the community as big a problem as was considered by the colonial governments.

In many parts of Assam's *chars* water hyacinth fibres may be extracted for use or it is decomposed and used as fertilisers especially around flood season, nonetheless it presents a possibility for vector-borne diseases to spread especially in the flood-receding period and needs to be dealt in sustainable ways such that such communities are able to depend on it as a sustainable source of fertilisers rather than depending on chemical fertilisers available against microloans.

22.4 Hydrosocial Agents at the Centre of Sustainability

lifeworld or the world as experienced by the subjects collectively is the most important basis of all epistemological enquiries. As we are discussing inhabitants in riparian environments, Krause's (2017) hydrosocial lifeworlds can help us lead to an investigation of humans as 'hydrological agents, and as inhabitants of wet places', thus linking the social to the hydrological cycle. To put it simply, this school of thought often maps the ways in which water flows may 'mirror' political institutions, kinship, social movements and economic power, therefore shaping the subjective opinions of the corresponding water communities whom it affects and is affected by.

Harris[5] (2018) outlines three 'moments' in the study of this hydrosociality. He states that the first way to know a river is to swim in it, second is to encounter its people and the third is to acknowledge rivers as persons. Khan[6] (2018) makes a

[5] Krause (2018). Delta Methods: Reflections on Researching Hydrosocial Lifeworlds, pp. 7.

[6] _____Ibid., pp. 18–21.

similar case that human existence is determined by varied interwoven elements and in the braided river deltas of the Brahmaputra-Jamuna, it is a being which is constantly shifting and reorganising geological, biological and socio-economic systems. Khan pursued the idea that many rivers in a braided channel bear different socialities, even those adjacent to it. Her study states that the rivers alone are not milieu-producing and the proposed approaches to study braided river island ecosystems were very helpful.

Context and contextualisation are gravely important in the sense of human adjustments as no conventional theorisation can be applied to explain the complexities and the diversities of nature-human interactions across Assam's *chars*. As Lahiri-Dutt and Samanta (2013) put it, *chars* cannot be reduced to a 'fixed set of rules and people's lives may be different from one *char* to another'. Likewise, intersectionalities matter in numerous ways than one, making a one-size-fits-all planning approach primed towards failure- the women (and by default their children) do not form a homogenous group and they are affected at multiple levels than meets the eye whether it is because seasonal differences (flood), or daily life experiences (erosion), perceptions of insecurity of life, unequal burden of rehabilitation post displacement over and above class and income differences.

The *char* community of Assam has mostly centred their daily activities around disaster response and relief practices as opposed to 'building back better' (Jagnoor et al. 2020), the bulk of the onus falling upon the womenfolk to manage the homestead. This lack of long-term critical engagement as part of rehabilitation makes sense when one is faced with the ground realities of what is an annual occurrence for the *charuas,* which shapes lifeworlds in the hydrosocial context of Assam's *chars.* As such empowering women in *chars* in a guaranteed way towards sustainability promotion. This is not to shift the entire burden on the women for a community's development but previous research shows the role of women. The char communities in Assam had a propensity to accept community youth as the vehicles of change, however the role of women's participation should in no way be undermined in this respect, as supported by experiences across the globe. A more active role of women in decision making help communities move assuredly towards sustainability in economic, political and environmental sense, all of which are equally important aspects of development (Akume et al. 2015). Thus, the need to see women as not just community drivers but also hydrosocial agents forms a rather important connotation for these communities.

In conclusion, water has to be a prime factor alongwith its hydrosocial agents which will define varying degrees of environmental crises and human responses in the context of climate action. The undertaking of SDGs (Sustainable Development Goals) in the context of climate crises forces one to integrate the local-ecologic like the *chars* with the global, as these regions are at the forefront of climate change impact and duress. The development question in Assam's chars has almost never attained a transregional emphasis and therefore communtiies here have been left to fend for themselves at most times of disaster or peril. When looking at the environmental history of *chars* one key figure that emerges is the personification of *chars* in folk culture and the emotional attachment people held to it; the rivers shifting and shaping

chars provide a narrative to understand the ways in which people devise adaptation (Paul 2017), mitigate risks and perform 'acts of resilience'. Likewise, the perceptions of vulnerability and security are linked to how they viewed their milieu which mainly came from the river flow variations. The life-giving Brahmaputra according to the *charuas* took away annually only to give back in return. This could be a major motivator for a community to live and adapt with their milieu, however, it may not suffice in the face of fast changing forms of nationalism, climate crises and economic transitions. As such the need of the state at such a moment is paramount in devising fluid infrastructures which can withstand the ephemeral nature of these geographies while taking caution not to arrest erosion and floods by controlling the river to free up more land as Saikia (2019) would put it. Bora (2015) states the epistemic and political category of the nation-state has emerged as a foundational inequality in India's northeast thus deterring affirmative political action. Thus, the role of the state would be paramount in facilitating a dialogue with local communities in the long term while providing fluid infrastructures as a solution in the short term. The latter can provide ease of access to safe spaces, provide access to mainland-situated markets thus cushioning *charuas* from economic shocks during floods, provide ease of access to school and health facilities- all of which are deeply intertwined with overall feelings of well-being and in its ability to alleviate disaster risk. The role of state and non state agencies coupled with the efforts coming from within the community will prove to be a solid base for attaining at least the bare minimum SDGs within the next ten years- like poverty eradication, zero hunger, and well-being- which continue to remain a distant dream for the *charua* communities of Assam till date, let alone other kinds of goals like climate action, access to good health and education.

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Chapter 23
Making Unpaid Work Visible—The Key to Removing Gender Inequality: A Study in the Urban Households of Assam

Chandrama Goswami and Manisha Bhattacharyya

Abstract Inequality acts as an obstacle to development. It can take different forms; and all these forms of inequality have a gender dimension. One such form is in the definition of 'work'. Work usually means gainful employment for pay or profit. This definition of work suffered from many drawbacks because many activities do not have a price. The definition of work has changed over time. Since around the 1920s, people of both sexes have been putting emphasis on the economic value of unpaid work. Unpaid work is now captured through time-use surveys. The main objective of this paper is to look into the how the definition of work has changed over time. It also looks into why and how unpaid work has been incorporated in the Sustainable Development Goals (SDGs). Gender equality and women's empowerment is a pre-requisite to attain the SDGs. Based on a time-use survey of 100 women in Guwahati, Assam, another objective of the paper is to study how unpaid work restricts women's entry into labour markets and livelihoods through which women gain access to economic resources. The third objective of the paper is to study the impact of unpaid work on labour market performance of women. In case of female labour supply, it is found that time allocation for the labour market is affected by the size of the family and support from spouse/father. Lack of sleep/leisure time along with health problems are the most important factors affecting women due to heavy burden of unpaid work. For women to join the paid labour force, it is essential to improve child care facilities and other basic service facilities. For instance, increasing single working women's housing, making public transport safer and modifying public programmes to cater to women's needs can pave the way for more women to engage and remain in the labour force, reducing gender inequality leading to economic empowerment and achievement of the SDGs.

Keywords Unpaid work · Subsistence production · Labour market · Time-use survey · SDGs

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23.1 Introduction

The productive efforts in an economy (in other words, work) include not only market production but also household non-market production. This, however, is not reflected in the official statistical system. Much of the work done at home, i.e. non-market production, is done by women, and is not included in the accounting framework of the System of National Accounts (SNA). This is mainly because the work done at home (though requires substantial efforts and time and has utility), does not have a market price. This brings up the interesting discussion on the concept of 'work'. The indicators and definitions of work have changed over time. Work has been defined as gainful employment for pay or profit in 1956 by the United Nations National Accounts System. In other words, work means a person gets a wage/salary. In case of a self-employed person, the goods or services have to be sold for money. For example, a person working on one's own/family farm would be defined as work if the produce was sold for a profit. This definition of work excludes subsistence production like collection of water, firewood and fuel, domestic and care work. This definition of work suffered from various drawbacks. Many of the activities in Third World countries do not have a price as it does not enter into the market. In 1966, this definition of work was expanded which led to inclusion of goods and services which could be sold (Sarma 2009). That is, according to this definition, the concept of work included production of those commodities/services which had a market. This definition of work was expanded again in 1993 to include all activities that could be produced in a monetized economy (like gathering fuel and water). This definition excluded production of all services from own final consumption in the households except paid domestic services and owner occupied housing. Work done in the household (i.e. domestic and personal services of households) is not meant for the market and so it is difficult to find a price to value such services. And, if services by members of households for own final consumption is included, all persons engaged in these activities would become self-employed. This would make it appear that unemployment does not exist.

Two concepts usually used in economic analysis to measure work/activity are gross domestic product (GDP) and gross national product (GNP). GDP is defined as 'all goods produced and services rendered by residents and non-residents of a country'. GNP does not include income gained from economic activity and property held by foreigners and non-residents in a country. In measuring output, it takes into account all the goods and services produced during the period, whether these are exchanged for money, (i.e. marketed) or exchanged for other goods and services (i.e. bartered) or used for self-consumption. What needs to be looked into is that production of any particular item is not counted twice. The problem comes in the use of the word 'all' in the definition of GDP. The word 'all' is misleading because in case of work, it includes only those economic activities which have money value. Though all goods and services (whether marketed, bartered or used for self-consumption) are taken into account, however, certain activities are excluded in the estimation of GDP, like illegal activities (which include smuggling, black-marketing, prostitution,

etc.). It also excludes the value of subsistence work, as well as the work required for daily maintenance of the labour force.

The following list includes those domestic and personal services for which there are no entries in the SNA accounts when they are produced and consumed for the household (para 6.20. SNA 1993)

i. The cleaning, decoration and maintenance of the dwelling occupied by the household including small repairs of a kind usually carried out by tenants as well as owners;
ii. The cleaning, servicing and repair of household durable or other goods, including vehicles used for household purposes;
iii. The preparation and serving of meals;
iv. The care, training and instruction of children;
v. The care of sick, infirm or old people; and
vi. The transportation of members of the household or their goods.

As women are heavily involved in these works and in the maintenance of not only themselves but also other members of the family, women's economic contribution is the single largest item which is not counted in national economic indicators (Bhattacharyya 2009, 2013; Kulshreshtha and Singh 1999; Sarma 2009; Singh 2014).

Domestic and personal services have been excluded from the production boundary of SNA 1993 mainly because—(i) for statistical purposes, it is difficult to measure household production and to value its products; (ii) core estimates of national accounts and time series of those estimates have established methods of application that have been developed without household products; and (iii) household production is relatively isolated from and independent of market activities (Pandey 2001).

It is the payment for work that sets cash value on it; the intrinsic value of the work remains the same. This makes it necessary for unpaid work to be a factor in the cash economy having an equivalent value. Recognition of this concept will lead to an accurate and fairer assessment of a country's economy and ensure gender equality.

Since around the 1920s, people of both sexes have been putting emphasis on the economic value of unpaid work in families. In acknowledgement of work done in World War II, pressure increased for public acknowledgement of all women's work as part of a general movement to raise women to economic, social and political parity with men (Lewenhak 1992). A number of studies were carried out to study the economic value of unpaid work at that time. The year 1975 was declared as International Women's Year by the United Nations, and this was followed by the United Nations Decade for Women, 1976–1985. Studies during this period also showed the economic value of unpaid work with contribution from the International Labour Organisation. The UN's agenda for the 1985 World Conference to Review and Appraise the Decade for Women claimed that domestic work (i.e. the work required to maintain homes and families) cannot be measured. By 1985, research studies from different countries of Africa, Asia and Latin America pointed out to the importance of unpaid work; though they received little publicity. However, at the World Conference held at Nairobi, Kenya to mark the end of the Women's Decade, the Commission on the Status of Women was forced to accept the document 'forward looking

strategies', which stated that concrete steps should be taken to quantify the unremunerated contribution of women to agriculture, food production, reproduction and household activities. The momentum generated by the UN Decade for Women was kept up by women's organizations and other international bodies which succeeded in including 'unpaid family workers' among its main work categories. However, due to the difficulties faced in establishing internationally acceptable bases for assessing the economic value of unpaid work, the document 'forward looking strategies' has not been implemented in practice.

After the discussion on how the how the definition of work has changed over time, the paper looks into why and how unpaid work has been incorporated in the Sustainable Development Goals (SDGs). Gender equality and women's empowerment is a pre-requisite to attain the SDGs. Based on a time-use survey of 100 women in Guwahati, Assam, another objective of the paper is to study how unpaid work restricts women's entry into labour markets and livelihoods through which women gain access to economic resources. The third objective of the paper is to study the impact of unpaid work on labour market performance of women.

23.2 Unpaid Work and Sustainable Development Goals

Inequality acts as an obstacle to the attainment of Sustainable Development Goals (SDGs). It takes different forms which include income inequality, inequality in access to and control over property, inequality in access to civil and political rights and unequal access to social, cultural and economic rights. All these forms of inequality have an inherent gender dimension (Abdourahman 2017). Women doing a major part of the unpaid work in most societies are not a matter of free choice; it is imposed on women as a social construct. Women thus remain invisible from mainstream economics due to their heavy burden of unpaid work. This has led to the inclusion of unpaid work in the Sustainable Development Goals. It can be said that gender equality and women's empowerment is a pre-requisite to attain the Sustainable Development Goals (SDGs). Equal rights and opportunities of women and girls become necessary for a life free of violence and discrimination. Equality and empowerment of women is one of the 17 SDGs, which is essential for inclusive and sustainable development (SDG 5: Achieve Gender Equality and Empower all Women and Girls). Targets of Goal 5 are (i) To put an end to all forms of discrimination against women/girls; (ii) To eliminate all forms of violence, including trafficking and sexual and other types of exploitation, against women/girls, both in the public and private spheres. Gender equality by 2030 requires elimination of the root causes of discrimination that curtail women's rights in private and public spheres.

Being engaged in unpaid work at home leaves the womenfolk of the household having less time for rest, leisure, self-care, education, political participation, etc. Less education leads to lower income. Also engagement in unpaid work results in less time to acquire skills to engage in remunerative works.

The importance of addressing the burden of unpaid work to achieve gender equality and women empowerment in the SDG framework comes as SDG 5.4 which states 'Recognise and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate'. Indicator of SDG 5.4: proportion of time spent on domestic and care work, by sex, age and location. To achieve this goal, it is necessary to make time-use surveys a part of the national statistical systems. However, time-use surveys suffer from many drawbacks and are still done in an ad-hoc manner in many countries and very few are carried out regularly to allow for trend analysis. Moreover, caring for children, elderly and the sick often overlaps with domestic work, making accurate person-to-person care statistics difficult to capture (UN Women: Progress towards the Sustainable Development Goals (E/2017/66).

23.3 The '3 R s'

The '3 R' approach was first suggested by Diana Elson in 2008. This concept was brought in to integrate unpaid work into macroeconomic policies, which was expected to lead to a sharing of the burden of unpaid work. The 3 R s' stand for recognize, reduce and redistribute.

The importance of the '3 R s' has also been recognized by the United Nations Secretary-General's High Level Panel on Women's Economic Empowerment, established in September 2015, and accepted them as the key drivers of women's economic empowerment (United Nations 2017; UN 2017).

Both men and women are engaged in different unpaid work; however, unpaid work is usually viewed as 'women's work'. Cross-country analyses of national time-use surveys, undertaken since 1990s (Budlender 2010; Miranda 2011) have proved that men dominate paid work and women dominate unpaid work—both in terms of participation and time spent. Another finding of their study is that the gender gap is greater in unpaid work. There are mainly two causes for this. First, it has been found that more time is spent by women in unpaid work and more women than men are engaged in both paid and unpaid work. Secondly, the amount of unpaid work declines when a woman enters the labour market, but it is less than proportionate because the woman usually makes up for the decline in unpaid work by foregoing leisure, sleep, personal care, education, etc. Action Aid Report 2016 estimated that globally a young woman works on an average four years more than her male counterpart over her lifetime, due to her involvement in both paid and unpaid work.

It is necessary for the society and individuals to give importance to unpaid work and value the ones involved in providing care (Razavi 2007). At the same time, it is necessary to expand women's opportunities, choices and freedom to enable them to participate in paid work. The burden of unpaid work carried by them should be recognized, reduced and redistributed to make them equal partners in the growth process.

Recognition: It is important to recognize the importance of unpaid work. Only when due recognition is given, it will become a part of national policy as a developmental issue. A gender sensitive macroeconomic policy is likely to reinforce social protection for unpaid workers. Paid maternity leave and child care leave are examples of social protection policy that recognizes working women's care responsibilities. These leaves enable a woman to recover from the effects of pregnancy and child birth; at the same time proving income and job security to mothers. It not only offers income and job security to mothers, but also allows them time to recover and rest from the effects of pregnancy and childbirth. It has now become essential to encompass women in the informal sector within the purview of maternity and child care leave so that they do not need to drop out from the labour market at the time of pregnancy or child birth. A strong database with information on different aspects of unpaid work and workers is required for an effective gender sensitive macroeconomic policy. Such a system is likely to force governments to rethink how they visualize the economy and how they prioritize the allocation of public resources (Action Aid 2013).

At the same time, it is required to break down the entrenched cultural norms regarding the gender division of labour. The education system can help in this regard by making more opportunities available for women and promote gender equality.

Reduction: It refers to the reduction of drudgery and time stress of unpaid care and domestic work. This can be done through public investment in physical infrastructure (like provision of clean water and sanitation, clean and affordable fuel within the household and public transport); and in social infrastructure (like care services, health services). Improving technology and making it user friendly, particularly women friendly (invention of light women friendly agricultural equipments) is another example of reducing workload and time stress of unpaid work. Access to clean water and sanitation cannot be taken for granted and women and girls, especially in rural areas, have to spend a lot of time in the collection of water and fuel. A considerable amount of time is devoted by women to look after the elderly, both in rural and urban areas. Public investment in non-medical services will lead to a reduction of the unpaid care load to a great extent.

Redistribution: Redistribution means a more equitable sharing of unpaid work between men and women within the household. Vacancies or job opportunities would have existed in the mainstream economy; but they are hidden as they are filled up by unpaid work in the household mainly in the areas of childcare and care of elderly, sick and disabled (Antonopoulos and Fontana 2006). According to a UN policy brief, investing 2% of GDP in the care sector could increase employment rates by 4–7% points with women filling between 59 and 70% of the newly created jobs (UN 2017). Provision of public and affordable childcare has the double benefit of giving young women time for continuous participation in the labour force and increases their earnings; and at the same time contribute to the early development of children.

The main stakeholders involved in the 3 R's include individuals, households, communities, employers and government. Among them, the state has the most important role. However, state interventions alone may not result in desired changes within the specified timeframe; however, they can be the first steps towards a genuine change

for women and a means of institutionalizing a gender-equitable mindset (UN Women 2017a, b).

The International Labour Organization (ILO 2018) has recently proposed an extension of the '3 R s' framework to '5 R s' and has included **reward** for care workers and their **representation** in social dialogue with employers and the state.

These recent commitments are built on the 1995 Beijing Declaration and Platform for Action, which recognizes reducing the unequal distribution of paid and unpaid work between men and women to achieve gender equality (OECD 2020).

23.4 Unpaid Work and Performance of Women in the Labour Market

Unpaid work acts as the key constraint on women's participation in activities outside the household, including paid work (Bhattacharyya 2009, 2013; Razavi 2007; Sarma 2009). Engagement in unpaid work leaves a woman with less time to involve in paid activities. In addition, it leaves them with less time to acquire the skills for paid work. The challenge is more in developing countries due to the lack of basic infrastructure facilities and public services (like day care centre, and the lesser responsibility taken by men in carrying out unpaid work.

For women's empowerment, it is necessary to distribute unpaid work evenly. Gender inequality in unpaid work has to be done away with to move towards women empowerment. This can be achieved, to some extent, through flexible working time arrangements, subsidized child care, paid parental leave for men/women (Ferrant et al. 2014; Folbre 2018; ILO 2018).

Given the time and opportunity, women can equally participate in the labour market. This is possible only with even distribution of unpaid work. As people engaged in unpaid activities are not considered 'economically active', women remain outside the formal labour market (Bhattacharyya 2009, 2013; Goswami and Bhattacharya 2014; Sarma 2009; Singh 2014). To increase female participation, there should be an even distribution of unpaid work. Women's socially ascribed roles makes them concentrated in works which have poor remuneration, part-time, casual and irregular.

Based on the survey of 100 women in Guwahati, the main determinants which restrict women's entry into the labour market are shown in Table 23.1.

As can be seen from the table, unpaid work plays the most important in restricting women to participate in the formal labour market. In addition, size of family, family support and timing of job also restrict women's participation in the labour market, perpetuating gender inequality. Patriarchal system still prevails in many regions of the world and women and girls are allotted time-consuming responsibilities, which overburden them with work in the reproduction, production, household and community spheres. All these tasks are low-status activities, and women who spend most of their time performing these tasks are often considered as 'not working'.

Table 23.1 Labour market performance of women

S. No.	Variable	Category	Percentage
1	Age of respondents	18–30 years	22
		30–50 years	54
		Above 50 years	24
2	Level of education	Illiterate	10
		Functionally literate	22
		Primary–high school	57
		Class 12–graduation	11
3	Worked for a salary	Fixed timing	94
		Flexible timing	06
4	Type of job	Private job	12
		Self-employed	58
		Family business	21
		Govt service	09
5	Nature of job	Permanent	09
		Temporary	91
6	Leave	Paid leave	21
		Unpaid leave	79
7	Paid holidays in a week	Yes	09
		No	91
8	Time spent daily in unpaid work at home (hours)	Cleaning	03
		Washing	01
		Looking after children/elderly	02
9	How often are you engaged in unpaid work at home	Always	62
		Frequently	34
		Sometimes	04
10	Type of family	Joint	78
		Nuclear	22
11	Support from spouse in unpaid work	Always	36
		Frequently	37
		Sometimes	10
		Never	17
12	Support from other family members in unpaid work	Always	25
		Frequently	18
		Sometimes	57
13	Reasons for not engaged in formal job market	Looking after children	39
		Looking after elderly	23
		Transferable job of spouse	21

(continued)

Table 23.1 (continued)

S. No.	Variable	Category	Percentage
		Uneducated	17

Source Field study

As discussed above, many women need to drop out of the labour market due to the uneven distribution of unpaid work. The ILO (2018) estimated that 606 million workers or 41% of inactive people are not in the labour market due to unpaid care responsibilities which has an impact on economic growth and development (OECD 2020). According to Ferrant et al. (2014), women's unequal share of unpaid work has led to less participation in labour market along with a widening of the gender wage gaps and the access to quality of jobs. According to them, this is the reason why a reduction in the gender gap in education has not led to a better participation of women in the labour market (Bhattacharyya 2009, 2013; Sarma 2009).

Table 23.2 shows the health issues caused due to heavy burden of unpaid work. Due to lack of sufficient sleeping hours along with heavy burden of unpaid work, women face several health problems, back pain and headache being the most common. As a major percentage of women do not have time for leisure, mental stress is high among them.

Table 23.3 shows the infrastructural facilities which can improve the conditions of women to a great extent and enable them to participate in paid work.

23.5 Case Studies

The following case studies also show how unpaid work acts as a barrier for women to enter into formal paid work; or at times to continue their work in the formal labour market.

Tulshi works for a living. Her husband is a truck driver, so his income is not sufficient to meet expenses of the family. First, she got a job in Delhi Public School, Guwahati for looking after students of lower class. She did her job very sincerely. Her income depended on the whims of the Proprietor. Her actual work schedule was only for 2 h. However, she had to move around for about 5 h in the school bus along with the students. Many times, she had to face many threatening remarks and insults from Guardians for petty issues. She left the job and joined Manpower Outsourcing Organization which engaged her for rendering service in different households. In return, she got a monthly wage which was a small part of the total amount which was charged from the customer. This was a form of economic exploitation. Later, she left this organization and approached different families in her own area which required household services. Since the last three years, she has been continuing her part-time work to support different families. Now, she is free from any middle man. The important point to be noted here is that any worker (that too with families to

Table 23.2 Health issues of women

S. No.	Variable	Category	Percentage
1	Frequency of taking leave because of health problem	Once a week	12
		Once a month	40
		Not usually	48
2	Cause of health problem	Work in paid service (standing, driving)	09
		Unpaid work at home	71
		Lack of proper food	12
		Irregular food habits	08
3	Nature of health problem	Mental stress	38
		Back pain	07
		Headache	17
4	Access to health care	Yes	41
		No	59
5	Time for leisure	Yes	15
		No	45
		Sometimes	40
6	Time of rest/sleep	More than 5 h	12
		Less than 5 h	88

Source Field study

Table 23.3 Infrastructural facilities for ensuring gender equality

S. No.	Variable	Category
1	Leave facilities	Paid
		Unpaid (if for long period)
2	Required facilities in the work place	Creche
		Health facility
		Women's hostel
3	Time frame	Shift duties
		Work from home
4	Access to credit	Bank credit
		Workplace credit
5	Recognition of unpaid work	Spouse
		Other family members

Source Field study

look after) faces health issues and requires leave at times. However, in most cases, if any leave is required, then it is treated as absence leading to wage deduction. At present, there seems to have no provision for legitimate leave for this working class. It is urgently required to provide minimum wage for this working class with proper leave rules.

Mrs Rita Sharma (name altered) is a highly qualified lady. After her M.A in Pol. Sc and L.L.M., she taught at the primary, high school, under graduate and post graduate level in different education level. She worked in SBI Officers Association School, NERIM, USTM in different periods. In spite of having a law degree, she is much more passionate to teaching profession and dedicated her service to different educational institutions with nominal remuneration. At home, she has to look after her two children, and her mother-in-law who stays with her in Guwahati. Her husband has to spend maximum time out of home due to his transferable job and spends time with the family after long intervals. She has to manage everything right from her children's education and other household activities. Moreover, she has to look after her own mother also as her brother stays abroad. Even after having a brilliant academic career, she had to compromise it for her family responsibilities. In the presence of child care facilities and facilities to look after the elderly, she could definitely have gone ahead in her career.

23.6 Valuation of Unpaid Work

Household maintenance, management and shopping, care of children and of the old, disabled and sick persons, community services, etc., are examples of unpaid work which do not enter the market. They can be termed as non-market household production. These activities are of two types, viz., activities which are normally performed by household members only (such as cooking, shopping for the family, per care, etc.) and activities which are frequently provided by market producers also (such as repairs, interior decoration, child care, etc.) (Bhattacharyya 2009, 2013; Hirway 2000; Sarma 2009).

The economic value of the productive activity of a household needs to be calculated for the estimation of household production. However, difficulty arises with unpaid housework because there is no market value of this work as there is no wage rate, and thus no monetary value is attached to it. Moreover, this unpaid work involves emotions, love, care and a sense of responsibility (which cannot be measured in monetary terms and has no profit motive). This makes its real value much more than market value.

There are two main approaches of evaluating unpaid work in households—(i) through the value of output of unpaid work, or (ii) through value of input (time) spent in unpaid work. In the first approach, activities such as food preparation, washing, cleaning, etc., which are unpaid are divided into different types of work which is based on market availability. Market rate is then taken to price these activities. This approach requires detailed information on the products produced by the households

and in the market; and is thus not usually used to evaluate unpaid work of women. In the second approach, time required to perform unpaid work is given a monetary value. This means that the value of unpaid work is imputed through an indirect way. Time-use survey is usually used to collect the data by the second method. After women's activities at home are collected through a time-use survey, a monetary value is put on these activities.

The methodology of imputing the monetary value is done either by the (i) opportunity cost approach or by the (ii) market rate approach/replacement cost approach. The opportunity cost approach assumes that the person has foregone some income in the labour market by doing work at home. The market rate/wage rate approach evaluates unpaid work at the wage of a 'general' worker or as a 'specialist'. A 'general' worker can do everything—cleaning, cooking, helping children with their homework, nursing the sick and elderly, etc. A 'specialist' worker on the other hand, treats different activities as different works, with a special market wage for each work.

All the approaches mentioned above have a certain bias in their estimation and imputation of a monetary value of unpaid work due to different methodological and empirical shortcomings. In spite of these shortcomings, the market rate approach is used to provide monetary estimates of unpaid work as these estimates are less biased than that given by the opportunity cost approach.

Time-use survey can be used to give visibility to the unpaid work of men and women. Here, an in-depth analysis is made of participation of work on men and women on different SNA, non-SNA activities. However, time-use survey has been carried out in only a few countries till now (e.g. Australia, Japan, Maldives, Myanmar, Bangladesh, India and China).

23.7 Problems/Limitations of Time-Use Survey Data

Although time-use data is now widely used in the study of unpaid work, there are many problems with time-use data which makes it difficult to make a correct assessment of unpaid work.

First, time-use data ignores the efficiency aspect of the workers while collecting data on time spent in different activities. Efficiency is related to time and productivity. An unemployed person may put in more time for a particular work whereas another person engaged in some other work may do the same unpaid work in less time. Accurate data on the value of work done is thus difficult to collect, taking into consideration only the time factor. If this is done, valuation of time spent on unpaid work in a poor household will exaggerate the income of the household.

Second, time-use data do not take into consideration the conditions under which the work is being done. Whether the work is done at leisure, by compulsion or under harsh conditions is not taken into considered while collecting time-use data.

Third, time-use data makes no differentiation between unemployment, underemployment and leisure. In other words, it does not distinguish between forced inactivity and voluntary inactivity. A particular unpaid work may be done during

leisure hours, which actually gives satisfaction to the person involved. Same work may be done under compulsion. This difference is not considered in collecting data through time-use survey.

Fourth, seasonality is an important factor, especially in rural areas, which is not taken into account in collecting time-use data. As the activities of men and women differs during harvest time, sowing time, off-season, etc., it becomes difficult to assign the number of working hours of a person involved in unpaid work.

Thus, conceptually, it is not very easy to compute the value of unpaid work by multiplying the unpaid work by a wage rate discussed earlier. If this is done, it is necessary to conduct time-use studies on a fairly regular basis, say after every three to five years. And secondly, it will also be necessary to standardize the concepts, methods and classification of activities for time-use studies at the global level (Hirway 2000).

23.8 Conclusion

Gender inequality in the division of unpaid work is a universal phenomenon but it is more so in developing countries. From the discussions made above, we can conclude that

Proper valuation of unpaid work is an absolute necessity for achieving gender equality. Only with proper valuation of unpaid work, due recognition will be given to the people engaged in these works. The concept of inclusive growth is now an agenda of development in most countries. For example, the African Development Bank (2013) has conceptualized inclusive development as a larger section of people (across countries/regions) getting access to sustainable socio-economic opportunities, while protecting the vulnerable, all being done in an environment of fairness, equal justice and political plurality. The Eleventh Five Year Plan in India envisions inclusive growth as a key objective. And the Twelfth Plan talks of 'more inclusive growth'. Inclusive growth has been defined as the growth process that reduces poverty faster that is broad based and labour intensive, reduces inequalities across regions and across different socio-economic groups, opens up opportunities for the excluded and marginalized not only as beneficiaries but also as partners in the growth process. It is not a goal that can be achieved in the short run through the process of inclusion should start first without waiting for a certain level of growth and redistribution to take place. This implies that everyone, including women and the marginalized sections of the society are to be encompassed in the growth process. To make this objective a reality, women who constitute half of the world's population need to have access to their full socio-economic potential. This is, in fact, the pre-requisite of inclusive development. Proper valuation and due recognition of unpaid work is also necessary to achieve the SDGs. This can be achieved only when the work done by them gets due recognition, bringing in gender equality.

For proper valuation of unpaid work, time-use-based valuations have been the best possible methodology that have been carried out till now. But the methodologies used in time-use surveys in different countries have been different. A standard methodology is yet to be developed to collect data across countries. Each country till now has their own methods which make comparisons difficult. Moreover, many countries have collected data through time use at a point of time. But for proper estimation, regular collection of data becomes necessary. Thus, a standard method of valuation should be developed which can be used to collect data across regions and across time. Once unpaid work is appropriately valued, it is likely to reduce gender inequality by giving due recognition to the work done at home, the burden of which is being borne by women in most countries.

Steps should be taken to enable more participation of women in the labour market, especially in the formal sector. This will go a long way in reducing gender inequality with more women getting access to facilities like equal wages, maternity leave, direct money transfers to the beneficiaries of government programmes, etc. This will make women equal partners in the growth process. Participation in the formal labour market will also reduce women dropping out of the labour force during times of pregnancy and child birth. Policy interventions for provision of paternity leave, investments/innovation in labour saving technologies, expansion of public services (like healthcare and childcare facilities), etc., are some steps which can go a long way in bringing in gender equality. Facilities like single women's housing, safe public transport, childcare facilities at the workplace, etc., should be made available for women to become active participants in the growth process, empowering them in the process and bringing in gender equality.

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Chapter 24
Wildlife Habitat Dynamics and Sustainable Development: Revisiting Pabitora Wildlife Sanctuary of Assam India

Pranjit Kumar Sarma, Bibhab Kumar Talukdar, Pradipta Baruah, and Mukul Tamuli

Abstract Pabitora Wildlife Sanctuary (WLS), located in the state of Assam, India, is a prime habitat for Greater One Horned rhino (*Rhinoceros unicornis)*. With a population of 102 rhinos as of 2018, Pabitora WLS have the highest density of Indian rhinos in the world. The satellite images of 2008, 2013, 2016 and 2020 have been analyzed to understand the changes in rhino habitat in Pabitora WLS. Habitat suitability condition for rhino, distribution of invasive plant species in the sanctuary has also been analyzed here in this current research. The finding shows that there is an increase in the woodland from 44.74% in the year 2008 to 54.71% in the year 2020. This has been accompanied by an increase in alluvial grassland from 21.36% in the year 2008 to 23.71% in the year 2020. The transformation of wildlife habitat in Pabitora WLS is largely because of the natural succession process, massive flood in the year 2004, along with impacts of invasive plant species, local livestock grazing and proper grassland habitat management. The current research also focus on how developmental activities in and around the sanctuary have directly and indirectly influenced the rhino habitat in the area. This study suggests some measures and protocols for the restoration of key habitats in Pabitora WLS to mitigate the anthropogenic pressure and initiate sustainable development approach in the area.

Keywords Rhino · Habitat change · Suitability · Remote sensing · GIS · Pabitora Wildlife Sanctuary · Assam · India

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24.1 Introduction

Sustainable development as defined by the Brundtland Report of 1987 is a form of development meeting the current generation's needs without failing to compromise the future generations' abilities and demands. Put in the new globalized order,[1] sustainable development is the integration of economic, social and environmental development considered the inter-dependent and mutually reinforcing pillars that operate at the local, national, regional and global levels (Bennett 2004; Bhattacharyya 2019). Biodiversity is considered as an essential element for sustainable development and human well-being. It provides and supplies food, water, shelter, and fiber; in addition, biodiversity contributes to alleviating resilience in climate change and thereby, in(directly) support human health and provide job opportunities in agriculture, forestry, fisheries and many other sectors (Austin et al. 2017). We argue that all the 17 Sustainable Development Goals are linked to the geographies of biodiversity. Without adequate measures to conserve biodiversity and sustainably use its components (Bhattacharyya 2019), the 2030 Agenda for Sustainable Development will not be achievable. However, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report unfolds that despite the crucial role played by biodiversity in sustainable development, there has been staggering degradation of biodiversity and ecosystem services at unprecedented rates (Garda et al. 2010).[2]

The state of Assam is no exception, and severe loss of forest cover and biodiversity has been recorded in the state due to anthropogenic causes. As per the Global Forest Watch, from 2001 to 2020, Assam lost 269 kha of tree cover, equivalent to a 9.8% decrease in tree cover since 2000. The key species which are facing severe threat due to loss of forest cover and wildlife habitat (Medhi and Kar 2016; Meena 2015) are the Greater one-horned (GoH) rhino (*Rhinoceros unicornis*), Royal Bengal Tiger (*Panthera tigris tigris*) and Asian Elephant (*Elephas maximus*). The GoH rhino is also known as Indian Rhino (*R. unicornis*) has been facing diverse threats in Assam, India, in the form of poaching for its horn (Das 2017; Hazarika and Kalita 2019), deforestation, fragmentation and degradation of its habitat due to the impact of invasive plant species in last couple of decades and also possible disease which is yet to be ascertained through better scientific analysis of each rhino found dead for reason other than poaching. Assam is one of the last habitats of Indian rhino (Das 2017; Hazarika and Kalita 2019) and has the proud legacy of the highest population of GoH rhino in the world, with a total population of 2654 wild rhinos as of 2018, estimated by the Forest Department, Government of Assam. Pabitora WLS is one of the prime rhino bearing areas of Assam, with a total population of 102 rhinos in the year 2018. Therefore, habitat evaluation and habitat suitability analysis of one-horned rhino in Assam are of utmost necessity to conserve this species for the future generation.

[1] Forest Monitoring Designed for Action. *Global Forest Watch*. https://www.globalforestwatch.org.

[2] Chapter 2. Global biodiversity loss and the international context. OECD iLibrary. https://www.oecd-ilibrary.org/sites/34988850-en/index.html?itemId=/content/component/34988850-en.

Conservationist and protected area managers need various tools ranging from classical analyses to specific high-tech infrastructures and tools to tackle the increasing threats to biodiversity (Caughley and Gunn 1996). Among these tools, habitat suitability models in association with geospatial tools have emerged as a relevant and scientific technique to assess wildlife habitat suitability pattern (Berryet al. 2002).

Similarly, geospatial technology has emerged as an essential and new tool for the evaluation of wildlife habitats and also their suitability analysis. Geospatial technologies have been used to gather information on the wildlife habitats' physical parameters and geospatial modeling for habitat evaluation and suitability analysis. The current research focus mainly on evaluation of habitat pattern, its spatiotemporal changes, habitat suitability pattern of GoH rhino in Pobitara WLS. The sanctuary is surrounded by human habitation in all directions; hence, this study also emphasizes on the conservation of rhino and its habitat in the sanctuary using a sustainable development approach.

24.2 Study Area

The Pabitora WLS is located in the Marigaon district of Assam, India. The latitudinal and longitudinal extension of the sanctuary is respectively 26°12′ N–26°15′ N and 91°57′ E–92°50′ E. The sanctuary experiences a hot and humid climate with an average annual rainfall ranging from 2000 to 2300 mm. The average winter temperature is 8 °C, and the average summer temperature is 34 °C. The area's relative humidity ranges from 60% in the winter season, which rises to 95% in the summer season. The physiographic condition of the sanctuary is primarily flat with a gentle slope from the east to the west direction. The Burha-Mayong hillock is the only elevated area of the sanctuary. Pabitara is extensively a flood plain area created by the river Brahmaputra. The soil type of Pabitara WLS is alluvial, which helps grow alluvial grassland in the area. Pabitara is an ideal habitat for greater one-horned rhino and migratory waterfowl. Figure 24.1 shows the geographical location of the sanctuary.

24.3 Dataset and Methodology

The methodological steps of this study are outlined in Fig. 24.2. For this study, the dataset which were used is multi-dated satellite images of Digital Globe provided by Google Earth Pro for the year 2008, 2013, 2016 and 2020, Survey of India (SOI) topographical maps at 1:50,000 scales, ground control points (GCPs) and data related to rhino and its habitat. An extensive ground survey was carried out from June 2019 to November 2019 for the collection of real-world data of Pabitora WLS. This is the first time a drone (*Dji Phantom*) has been used to assess and collect the habitat characterization data and develop a habitat classification scheme of Pabitora

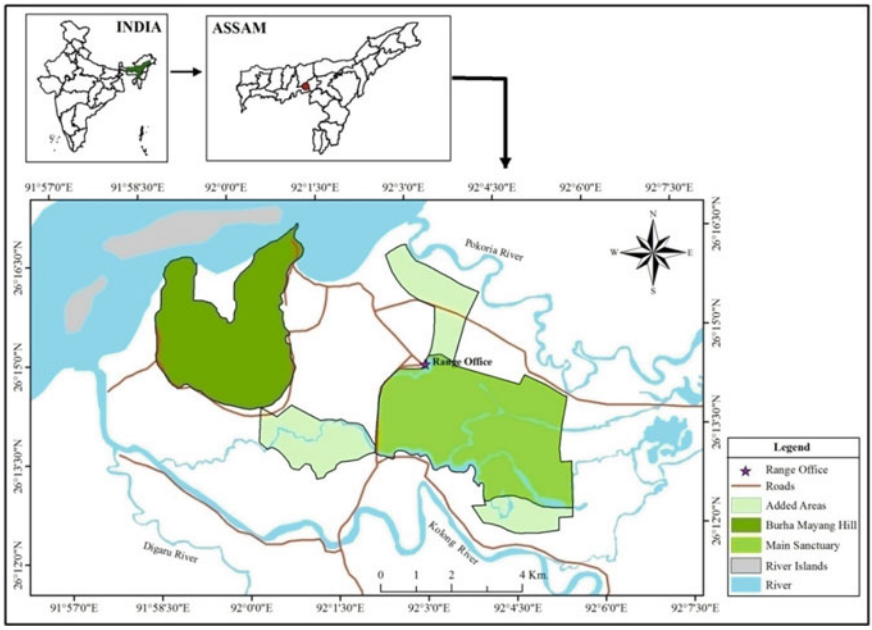

Fig. 24.1 Location map of the study area. *Source* Created by the authors

WLS in order to assist the divisional forest officer of the Pabitora WLS to prepare the management plan for the WLS. The Arc GIS 10.3 and ERDAS Imagine 9.3 software was used for this study. The satellite images of digital globe acquired from Google Earth Pro was used to assess the habitat changes in Pabitora WLS. The images were downloaded using Google Image downloader at HD resolution. The main advantage of using Google Image downloader is that it can mosaic the image tiles with geometric correction, which means that the images were automatically geo corrected in terms of geographical latitude and longitude. Subsequently, the images were transformed into UTM ZONE 45 N projection system using WGS 1984 datum, using ERDAS Imagine 9.3 software. Subset operation of the images were done using the vector layer of the forest boundary acquired from the already geo corrected topographical sheets of the sanctuary. A reconnaissance survey of the park was done using a state of the art drone named as Dji Phantom (enabled with GPS) by flying about 100–130 ft from ground level to get the real-time images of the park at very high resolution and also to collect the GPS coordinates of various habitat types in the sanctuary. After initial processing of the satellite images, a classification scheme of habitat types was developed using the drone images and the satellite images. After that, a supervised classification method was adopted to classify the images of 2008, 2013, 2016 and 2020. Supervised classification is defined as a process where the image analyst supervises the pixel categories of the images and relate them with the land use/land cover categories available in a satellite image (Sarma et al. 2011). Researchers of different fields have been using supervised classification

techniques to delineate and identify the features from the remotely sensed imagery; as in supervised classification technique, the user can categorize the pixels on the basis of its spectral and spatial characteristics and can be classified the image into better defined categories in terms of its similarity (Sarma 2010; Fortin and Dale 2005; Ibisch et al. 2003; Dudeni and Debba 2008). Training sets were collected using drone images and GPS points of different habitat types. The drone images were also used to identify the distribution of the invasive species in Pabitora WLS. The results of the classification process are the habitat maps of three different years for the years 2008, 2013, 2016 and 2020. To detect the land cover changes in Pobitara WLS, post classification comparison of classified images of 2008, 2013, 2016 and 2020 has been done. The method consists of overlaying multiple images using a cross operation. The two images need to be compared based on the previously classified image. This cross operation allows the analyst to know the extent and nature of the changes observed, in other words, the transition between different habitat classes and the corresponding areas of change (Sarma 2010). Implementing this technique, finally the rhino habitat change analysis of Pabitora WLS was done. Here in this research, an attempt has also been made to assess the rhino habitat suitability in Pabitora WLS using the geospatial tools. A grid-based approach was adopted to judge the suitability condition for rhino habitat in the sanctuary. The drone was used to collect the habitat parameters for rhinos, such as the types of habitats, water availability, human settlement location, elevation from mean sea level, distance from different modes of transportation and their impacts on distribution of rhinoceros, distribution of invasive species, etc. Based on each grid's collected information, each grid's hypothesis, condition/rules, and confidence value was assigned using the knowledge engineer tool available in ERDAS Imagine 9.3 software (Hazarika 2005). Confidence values are associated with each condition and these are always assigned by the knowledge engineer depending upon the importance of the input data. If the input data is important, a high confidence value is given (Sarma et al. 2010). Table 24.1 shows the hypothesis, conditions/rules and confidence values for each rule to prepare the habitat suitability map of Pabitora WLS.

24.4 Results

24.4.1 Habitat Change

The satellite imagery of digital globe acquired from Google Earth Pro for the year 2008, 2013, 2016 and 2020 was used to assess the habitat changes in Pabitora WLS. The results reflect a substantial increase in woodland from 17.36 km^2 (44.74%) in 2008 to 20.11 km^2 (51.82%) in 2016. This growth trend continues till 2020 and has risen up to 21.23 km^2 (54.71%). The trend of growth of woodland continues from 1977 onwards. In 1977 the total area covered by woodland was 11.1 km^2 (28.56%). This shows that a total 10.13 km^2 (26.10%) of woodland habitat has increased in

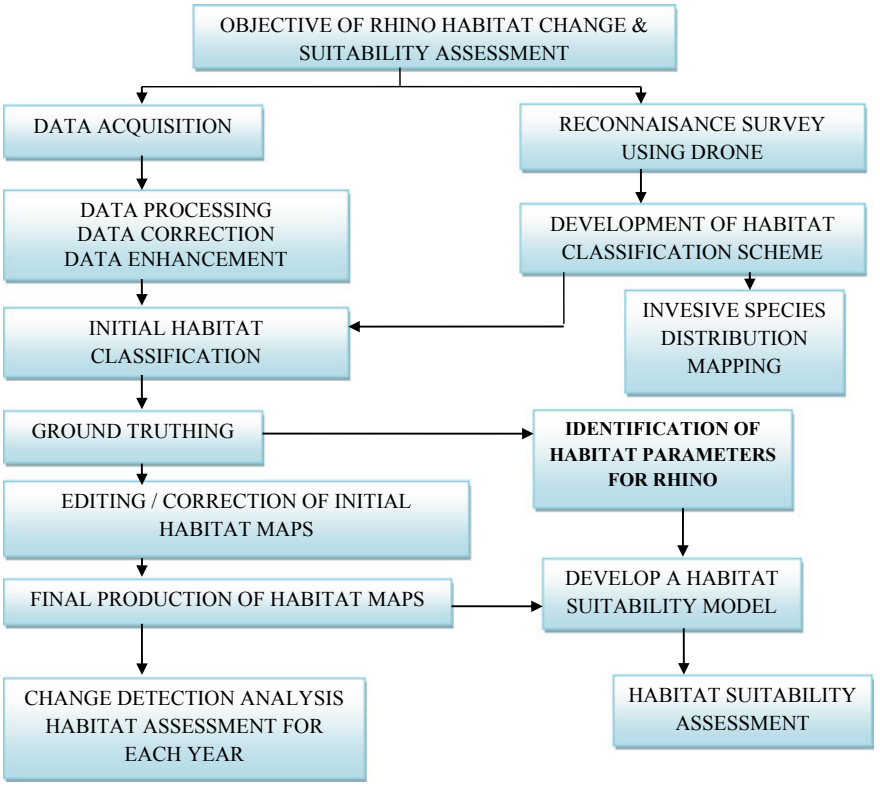

Fig. 24.2 Methodology of the study

Pabitora WLS from 1977 to 2020. This growth of woodland is mainly due to the natural succession from grassland to woodland. If this succession continues, it can adversely affect the quantum of grassland habitat needed for rhinos in this WLS. The most positive and remarkable change observed through this study is the growth of alluvial grassland. The trend of growth of alluvial grassland was negative from 1977 to 2004. In 1977 the total area covered by alluvial grassland was 16.25 km^2 (41.80%) which reduced to 5.2 km^2 (13.37%) in 2004. But from 2008 to 2020, there is positive growth of alluvial grassland in the sanctuary. In 2008 the total area covered by alluvial grassland was 8.29 km^2 (21.32%), and in 2020 it rises up to 9.2 km^2 (23.71%). This positive growth is mainly due to the impact of a massive flood in 2004 and the proper management of alluvial grassland in the sanctuary by the authority. Another important change observed through this study is that there is a decreasing trend of dry grassland habitat in the sanctuary from 2004 to 2008 and till 2020. In 2004 the total area covered by dry grassland was 6.51 km^2 (16.74%), which reduced to 4.29 km^2 (11.05%) in 2020. This decrease of dry grassland is mainly due to the increase of alluvial grassland habitat in part and the increase of invasive species like *Ipomoea, Mikania, Chromolaena*, which are commonly seen roadsides

Table 24.1 Hypothesis, rules/conditions and confidence value used in the classification of conservation status of Pabitora WLS

Hypothesis	Rules/conditions	Confidence value
Highly suitable	Excellent habitat quality	0.90
	Abundance of water	0.90
	No invasive species	0.90
	Low human influence/livestock grazing (less than 10%)	0.80
Moderately suitable	Good habitat quality	0.70
	Low water availability (less than 50%)	0.70
	Presence of invasive species (less than 30%)	0.70
	Moderate human influence/livestock grazing	0.60
Less suitable	Poor habitat quality	0.50
	Less water availability (less than 20%)	0.50
	Presence of invasive species (more than 50%)	0.50
	More human influence/livestock grazing (more than 50%)	0.40

and dry places in the sanctuary. The water body in the park remains almost constant from 1999 till 2016, but it slightly reduced in the year 2020. The fallow land in the sanctuary also shows a decreasing trend from 2008 to 2020, and it is mainly due to the increase of alluvial grassland in the sanctuary (Figs. 24.3, 24.4 and Table 24.2). The accuracy of the land cover classification was 94%, and kappa (κ^) statistics value was 0.9099. The kappa statistics is calculated using the following equation.

$$\kappa^{\wedge} = \frac{\text{Observed accuracy} - \text{chance agreement}}{1 - \text{Chance agreement}}$$

24.4.2 Invasive Plant Species

The grassland areas of India are gradually reducing due to anthropogenic causes like the expansion of human settlement, haphazard urbanization, unplanned burning of grassland, livestock grazing, irrigation and construction of dams. Now, most of the grassland areas of the Indian subcontinent are confined only in protected areas like national parks and wildlife sanctuaries. Further, the establishment of invasion by some invasive species in grasslands, especially in rhino bearing areas, is a significant challenge in terms of wildlife habitat conservation (Lahkar et al. 2011; see also, Bhuyan and Kar 2018). The Pabitora WLS is also facing tremendous pressure from invasive species. The presence of species like *Ipomoea* is a major threat to the rhino habitat in Pabitara WLS. The growth of this species is faster than the other grassland

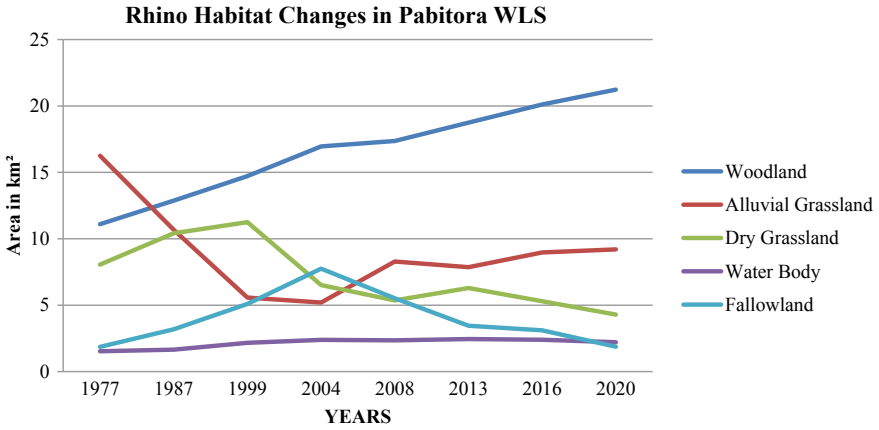

Fig. 24.3 Habitat Change from 1977 to 2020. *Source* Created by the authors

species, and it rapidly captures the grassland habitat area. The other dominant invasive species available in the sanctuary are *Mikania and Chromolaena.* The growth rates of these species are rapid compared to other grasses, and it is gradually capturing the rhino habitat of the sanctuary. Figure 24.5 shows the distribution of these invasive species in the sanctuary. The total area covered by these invasive species is 2.06 km^2 in the sanctuary. These invasive species are mainly distributed in the dry grassland and the elevated regions of the sanctuary (Fig. 24.6).

24.4.3 Habitat Suitability

Wildlife habitat suitability analysis is considered an essential criterion for conserving and managing wildlife habitat (Kushwaha et al. 2000). Habitat evaluation is the assessment of the suitability of land or water as habitat for specific wildlife species (Sarma et al. 2011). A wildlife habitat suitability map is defined as a map displaying the suitability of land or water as a habitat for a specific wildlife species (Lui 2001). To achieve this one we need a model to predict the suitability of land in a given particular set of land conditions. Such model is called a habitat (environmental) suitability model (Sarma et al. 2011; Leeuw and Albricht 1996). There are varieties of biological and geographical factors that directly and indirectly impact the species and its distribution. As discussed above already, the factors like habitat types, habitat quality, distance from roads and railways, availability of water, distance from water sources, topographic condition, and anthropogenic influence directly impact the species distribution and habitat utilization pattern. To understand the habitat suitability pattern of any species, it is essential to understand the relationship between these biological and geographical factors and the species distribution in a landscape. There are different techniques to understand the species—environment relationship,

Table 24.2 Changing trend of rhino habitat in Pabitora WLS

Land use classes	Years														
	Area in km^2								Net change						
	1977	1987	1999	2004	2008	2013	2016	2020	1977–1987	1987–1999	1999–2004	2004–2008	2008–2013	2013–2016	2016–2020
Woodland	11.1	12.87	14.72	16.95	17.36	18.75	20.11	21.23	1.77	1.85	2.23	0.41	1.39	1.36	1.12
Alluvial grassland	16.25	10.67	5.57	5.2	8.29	7.86	8.97	9.2	−5.86	−5.1	−0.37	3.09	−0.43	1.11	1.11
Dry grassland	8.06	10.42	11.25	6.51	5.36	6.29	5.3	4.29	2.36	0.83	−4.74	−1.15	0.93	−0.99	−1.01
Water body	1.53	1.65	2.17	2.39	2.35	2.45	2.4	2.21	0.12	0.52	0.22	−0.04	0.1	−0.05	−0.19
Fallow land	1.86	3.19	5.09	7.75	5.52	3.45	3.11	1.87	1.33	1.9	2.66	−2.23	−2.07	−0.34	−1.24

Data of 1977 to 2004 are based on prior study done by the authors in the year 2009 and published in Pachyderm, vol. 46, pp. 18–24. (Sarma et al. 2009)

Table 24.3 Suitability status of rhino habitat

Suitability categories	Area in km^2	% of area
Highly suitable	2.52	6.49
Moderately suitable	18.51	47.72
Less suitable	17.77	45.79
Total area	38.8	100

among them mostly used techniques are regression analysis, correlation analysis, discriminate analysis and artificial neuron network (Sarma 2010; Pereira and Itami 1991; Buckland and Elston 1993; Osborne and Tigar 1992; Walker 1990; Skidmore et al. 1996; Andrieset al. 1994; Skidmore et al. 1997). In this current research, a grid-based approach has been adopted to understand the species (rhino) environment relationship in Pabitara WLS. Rhinos of Pabitara WLS have been observed directly, and based upon the primary observation, some habitat parameters were identified. The parameters include human interference, habitat types, and elevation from mean sea level, distribution of invasive plant species, livestock grazing and availability of water. Based on these biological and geographical parameters, the habitat suitability model has been prepared. The result shows that 5.42% (2.1 km^2) of the total geographical area of the sanctuary is highly suitable for rhinos. The moderately suitable area covers 29.69% (11.52 km^2) of the sanctuary. Most interestingly, 64.89% (25.18 km^2) of the total geographical area of the sanctuary is less suitable for rhinos in Pabitara WLS. This shows that only 35.11% (13.62 km^2) area of the sanctuary is highly or moderately suitable for 102 rhinos available in Pabitara WLS. Figure 24.7 and Table 24.3 shows the distribution of habitat suitability zones in Pabitara WLS.

Wildlife suitability maps and models and their underlying importance have been criticized because of their poor accuracy level and insufficient validation with the reality, though this has clearly mentioned and advised in the habitat evaluation procedures (Norton and Williams 1992; Stoms et al. 1992; Williams 1988; USFWS 1981). The accuracy of wildlife suitability models and maps completely depends on how the output of the model is associated with the reality (Sarma et al. 2011). Here in this current research two different approaches were adopted to assess the accuracy of the habitat suitability model for rhino in Pabitara WLS using geospatial tools.

24.4.4 Accuracy Assessment of Suitability Model Based on Animal Presence and Absence

An accuracy assessment of the rhino habitat suitability map of Pabitara WLS has been done based on rhino presence and absence in different habitat suitability categories. The sighting locations (79) of rhino were overlaid into the habitat suitability map using the Arc GIS platform. The overlay result shows that out of 79 rhinos, 44 (55.69%) rhinos were found in the highly suitable habitat, 31 (39.24%) rhinos were found in a moderately suitable area, and the rest 04 (5.06%) were found in the less

suitable habitat of the sanctuary. Similarly, the results also show that even the most suitable area in the sanctuary is only 2.52 km^2 but maximum rhino was sighted in that area, whereas only 4 rhinos were sighted in a less suitable area (17.77 km^2).

It indicates that the model prepared for assessing rhino habitat suitability in Pabitara WLS has its validation with reality. It shows that rhinos preferred the most and moderately suitable habitats than less suitable ones in the park. Figure 24.8 shows the distribution pattern of rhino in different habitat suitability categories, the comparative assessment of habitat suitability area, and the number of rhino sightings in Pabitara WLS.

The accuracy assessment of the suitability map shows that the model is well associated with the ground reality and the authors recommend that same kind of modeling approach can be applicable in other rhino bearing areas of the state of Assam.

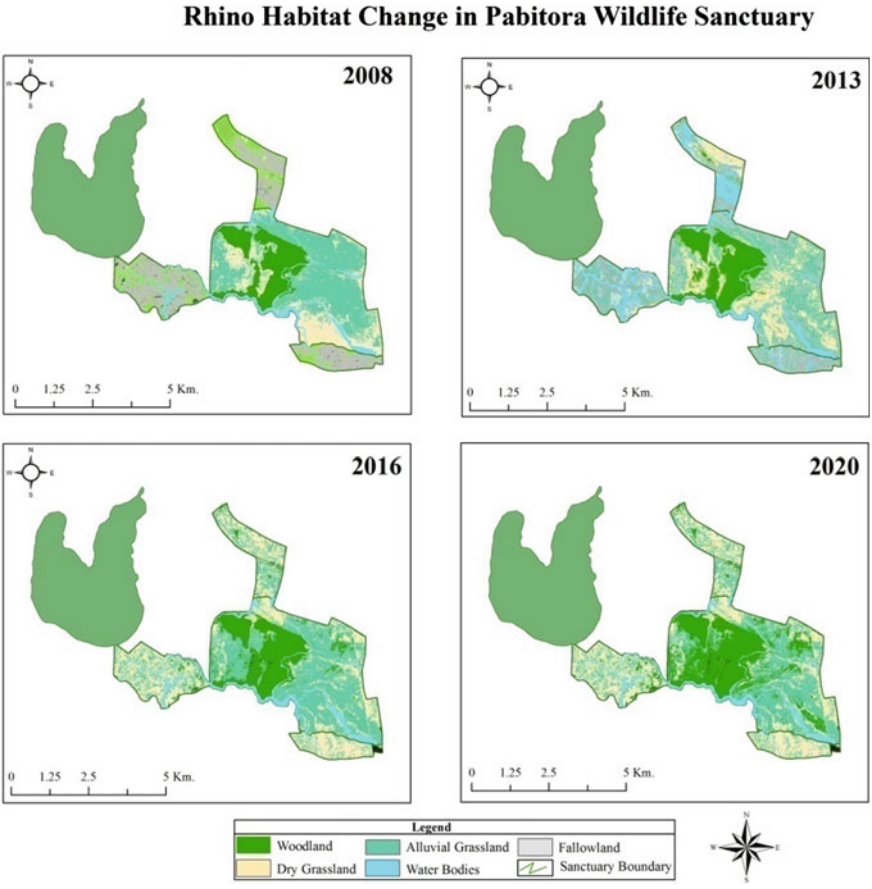

Fig. 24.4 Changing pattern of rhino habitat. *Source* Created by the authors

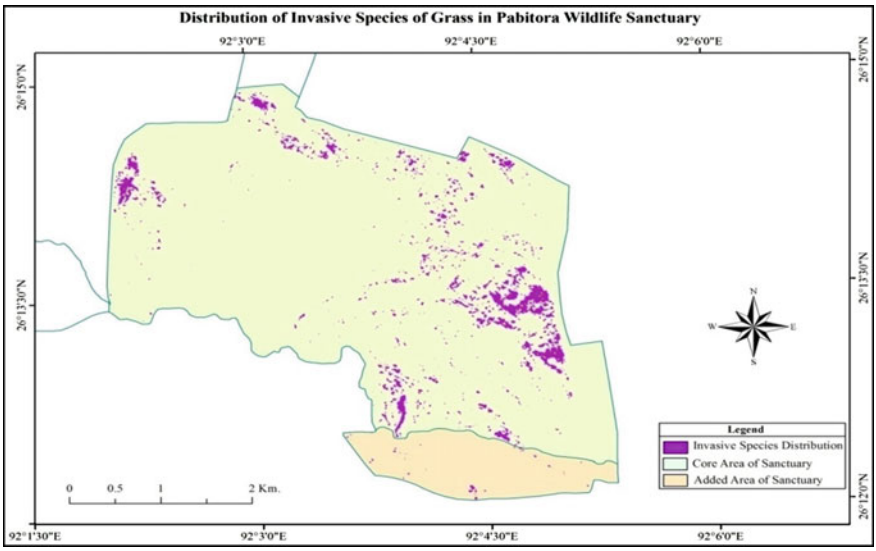

Fig. 24.5 Distribution of invasive plant species. *Source* Created by the authors

Fig. 24.6 Invasive plant species. *Source* Created by the authors

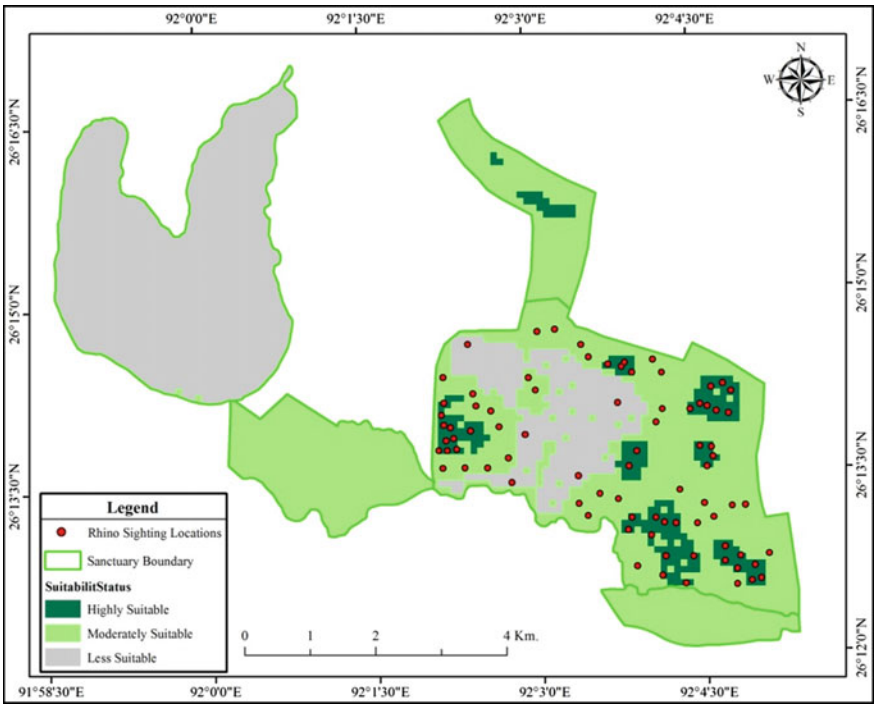

Fig. 24.7 Rhino habitat suitability status. *Source* Created by the authors

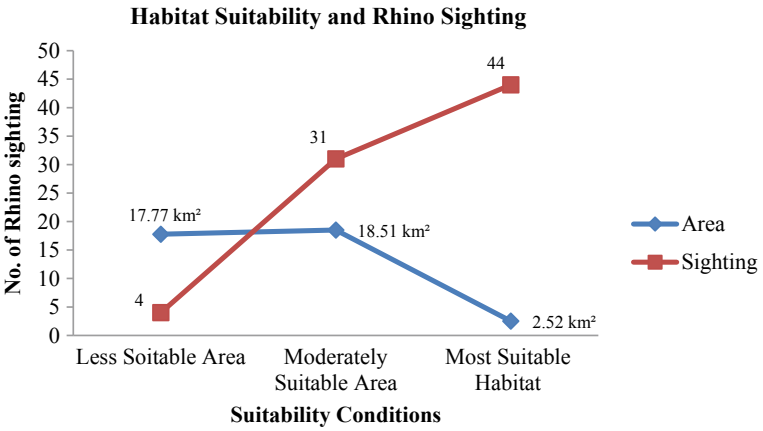

Fig. 24.8 Comparative assessments of habitat suitability and rhino sighting. *Source* Created by the authors

24.5 Conclusion and Recommendations

The study shows the gradual succession of woodland in the sanctuary, and it has gradually seizing the grassland habitat and reducing the ideal habitat for rhino in the sanctuary. This will create severe problems for rhino conservation efforts in the sanctuary. Proper management of woodland and grassland habitats is of utmost necessity at this moment. To check unwanted growth of tree species, especially *Bombax ceiba* girdling can be practiced as a management tool to prevent the spread of *B. ceiba* along with manual uprooting of woodland plant species or patch burning practices of grassland by the authority for proper management of rhino habitat in the sanctuary. The growth of invasive plant species is a significant threat to rhino habitat in the sanctuary, which have remained not as visible as rhino poaching. The long-term application of efforts alongside constant monitoring and investigation is required to handle this problem. The rhino habitat suitability status of the sanctuary is also not up to the mark, as only 6.49% of the total geographical area is highly suitable in the sanctuary.

Measurement should be taken to convert the moderately suitable habitat into a highly suitable habitat in the sanctuary, and a proper understanding of hydrology flow in and around WLS may add value to further improve rhino habitats in the WLS. To achieve this goal, scientific habitat management practices should be adopted as early as possible. Like any other national park or wildlife sanctuary, even Pabitora WLS is also surrounded by human habitation (Das 2017; Hazarika and Kalita 2019; Medhi and Kar 2016; Meena 2015). Hence the authorities should take necessary action to protect the wildlife habitat from the other domestic grazing animals like cows, goats and buffalos. This current research also recommends forming Eco-Development Committee (EDC)s in and around the WLS. The EDC should prepare the micro plan for their respective villages where conservation actions can be linked to their sustainable livelihood by reducing the gap between the sanctuary authority and the local community. This will stimulate the rhino conservation efforts in the sanctuary collectively. There is tremendous potential for eco-tourism in and around the Pabitora WLS; local villagers and youths can take the initiative along with the sanctuary authorities and tourism department of the government of Assam to make it a sustainable livelihood option. This will surely encourage the rhino conservation efforts in the sanctuary. Proper wildlife habitat management inside the sanctuary and involve the fringe villagers in protection and conservation through sustainable livelihood options will surely bring a positive change in Pabitira WLS in the near future. The current research has exclusively used remote sensing and GIS tools to detect the rhino habitat change, the impact of invasive species and rhino habitat suitability status of Pabitara WLS.

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Chapter 25
Prospects of Tourism Sector in Assam to Achieve Sustainable Development Goals

Shikha Yadav, Gautam Kakaty, Usha Rani, and Vaibhav Anand

Abstract Assam a state of North-East India is a naturally beautiful place with plains and hills. Its agro-climatic condition with a strategic geographical location bears a significant attention in the growth agenda of the tourism area of the state and the country as well. In this forest covering area, different species of rare plants, animal and birds are found. So its rich biodiversity draws the attention of the national and international tourists. Apart from this, Assam is very much rich with a different socio-cultural back ground as the state is a place of different linguistic of plains and hill tribes which carries another importance for tourists. Some of the important tourist spots are Kaziranga and Manas National Park, Majuli, Kamakhya Temple and historical monuments in Sivasagar. Looking into its diverse potentiality, prospect tourism industry is very high if required infrastructure with security of life, better transportation and hospitality, the future of tourism industry will be bright. In this chapter an effort has been made to focus the prospects of tourism sector in Assam to achieve sustainable development goals by compound growth rate. In 2018–19, 60.27 lakh domestic and 0.41 lakh foreign tourists visited Assam (Statistical Handbook of Assam, 2019). In spite of having immense scope of tourism sector, the state has to do a lot in creating more income and employment opportunity to achieve the desired goal of sustainable development of tourism industry.

Keywords Tourism · Sustainability · Biodiversity · Income · Employment · Assam · Majuli · Kaziranga · North –East

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25.1 Introduction

Assam, a state of North-East India is a naturally beautiful place with plains and hills. Its agro-climatic condition with a strategic geographical location bears a key attention in the development agenda of the tourism of the state and the country as well. Its natural biodiversity with mighty river Brahmaputra and its tributaries has made Assam a land of rivers. On its banks covering hills and plains, nature has created a green cover with thick and dark forests as it falls under heavy rainfall zone. In this forest covering area, different species of rare plants, animal and birds are found. So its rich biodiversity draws the attention of the national and international tourists. Apart from this, Assam is very much rich in diverse socio-cultural back ground with different linguistic of plains and hill tribes which carries another importance for tourists. Different ancient religious spots and its annual cultural functions linked with aboriginal identity at different point of times are also a source attention for tourists. The state also occupies top position in tea production. The beautiful green tea gardens are also recognized as a tourist spots. It attracts national and international tourist. Looking into its diverse potentiality for tourism industry, its prospect is very high if required infrastructure with security of life, better transportation, fooding and lodging can be made up to date, the future of tourism industry will be bright.

Tourism could be a potential mean to expedite development across the Sustainable Development Goals (SDGs). This sector has the ability to create generous employments for a continuous development, eradication of poverty and also it offers encouragements for conservation of environment—a triple-win to assist countries shift to more comprehensive and resistant economies. Nevertheless, lacking any safety measures, development of tourism market would surge unnecessary burden over biological diversity along with ecosystems upon which the livelihoods of so many people and local communities depend. Therefore, to attain the UN Millennium Development Goals, the World Tourism Organization (UNWTO) offers the private sector facilitate to deal with these international challenges and also to maximize the positive impacts of tourism. In this perspective, UN declared 2017 as 'the International Year of Sustainable Tourism for Development. In the 2030 Agenda for Sustainable Development SDG target 8.9, aims to 'by 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products'. The significance of sustainable tourism is also mentioned in SDG target 12.b. which plans to 'develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products'. This sector is most commonly connected with SDGs 8, 12 and 17 inVoluntary National Reviews (VNR) on the SDGs.

Assam tourist department has specified certain places as tourist spots with good road linkage on the back drop of the above observations. It includes, five national parks, two of which (Kaziranga famous for one-horned rhino and Manas National park) are designated as World Natural Heritage Sites by UNESCO, the Simhasana Hill in the Karbi Anglong district for adventure and mountaineering, *Satras* of Assam in Majuli district (Vaishnavite culture founded by Sankardeva), Kamakhya temple

in Kamrup district, spots with historical monuments viz., *Rangghar*, Siva Temple, *Talatal Ghar* or 'underground palace' located at Sivasagar district, etc. (Bhaskar et al. 2010).

A study on impact of tourism in generating employment opportunities in Assam was carried out by Paul and Sahu (2011). They opined that this is the major industry in the world having abundant employment opportunities. Although, Assam is wealthy in human resources, however this resource is still unutilized or underutilized. The state has almost 20 Lakhs educated unemployed at present. They opined that tourism sector has immense scope in generation of employment and income for this unemployed youth directly or indirectly.

Baruah (2011) mentioned the impact of tourism on environment. He viewed that generally tourists prefer to see natural sites and items in a state. If Government takes proper care for these sites, it will certainly help in environmental degradation.

Rahman (2011) conducted a study in Kaziranga National Park which is world famous for one-horned rhinoceros. This park is famous for conservation, preservation and protection of wild life in its 100 years journey. Based on primary and secondary level data, the author examines the development of this area through tourism.

Chowdhury (2017) in her paper 'Prospects of Tourism in Assam: A SWOT Analysis' viewed that tourism is most important sector for economic development in the state. The state has enormous scope to attract domestic and international tourist. To overcome the constraints associated with this sector, formulation proper policy and implementation of different policies may lead this sector as this sector has huge potentialities to contribute to the State Gross Domestic Product.

Table 25.1 depicts the trend of arrival in terms of Compound Annual Growth Rate (CAGR) of domestic and foreign tourist in Assam from 2004 to 2019 (Fig. 25.1).

The Govt. of Assam collected revenue from the tourist lodge to the tune Rs. 30.31 lakh during the year 2018–19 and numbers of tourist lodge and tourist hotel in Assam stood at 98 and 270 respectively during this period. There are only 14 tour operators recognized in the state (Statistical Handbook 2019, Govt. of Assam). The compound annual growth rate of domestic and foreign tourists since 2004 to 2019 were 2.93% and 4.47%, respectively.

In spite of having immense scope of tourism sector, the state has to do a lot in creating more income and employment opportunity keeping attention to achieve the desired goal of sustainable development of tourism industry. In the backdrop of above observations, an effort has been given in this chapter to focus the prospects of tourism sector in Assam to achieve sustainable development goals.

25.2 Sampling Framework

The study is mainly based on both primary and secondary level data. To capture the holistic objectives of the study, two key tourist spots of Assam viz. Kaziranga National Park (KNK) and Majuli were selected purposively. From each tourist spot, 50 tourists covering 25 domestic and 25 foreign and 50 respondents living in the

Table 25.1 Trend of arrival of domestic and foreign tourist in Assam

Tourist arrival	Domestic tourist	Foreign tourist	Total
2004	2,286,630	7285	2,293,915
2005	2,467,656	10,782	2,478,438
2006	3,268,657	11,151	3,279,808
2007	3,436,484	13,105	3,449,589
2008	3,617,306	14,426	3,631,732
2009	3,998,706	14,533	4,013,239
2010	4,050,924	15,157	4,066,081
2011	4,339,485	16,400	4,355,885
2012	4,511,407	17,542	4,528,949
2013	4,511,407	17,542	4,528,949
2014	4,684,527	17,638	4,702,165
2015	4,835,492	21,725	4,857,217
2016	5,491,507	24,673	5,516,180
2017	5,642,950	26,320	5,669,270
2018	5,934,791	31,739	5,966,530
2019	6,027,002	41,209	6,068,211
CAGR (%)	2.93	4.47	2.94

Source Statistical Handbooks of Government of Assam, 2019, and Directorates of Tourism, Assam

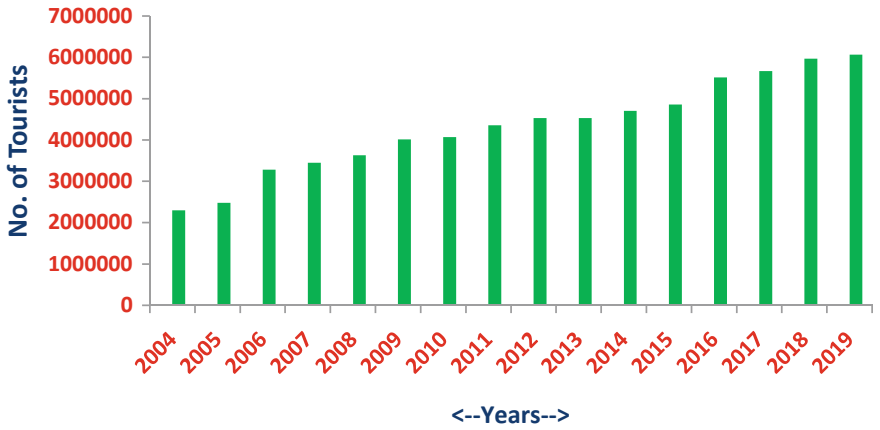

Fig. 25.1 Trend of arrival of domestic and foreign tourist in Assam

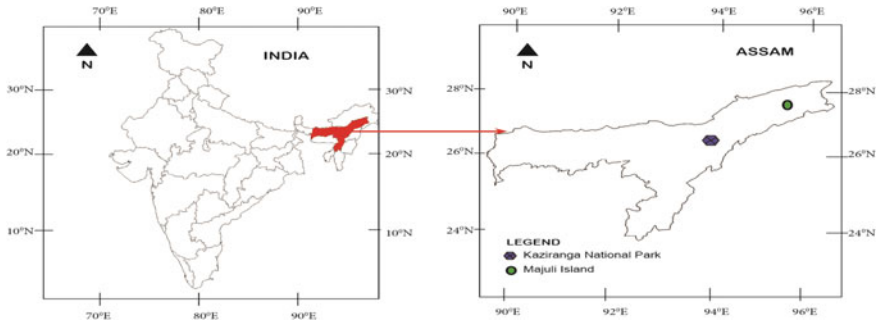

Fig. 25.2 Map of Assam-Kaziranga National Park and Majuli Island. *Source* Prepared by the authors

neighbourhood of tourists places were also taken whose livelihood depend on tourists. Similar pattern of sampling design was also followed for Majuli spots. In aggregate, the study covered 200 sample respondent 100 samples from each tourist spot. Samples were taken on random sampling technique during the peak season of tourist arrival in October/November 2019 to March/April 2020. The primary data were collected through a well-structured schedule to draw inference on the laid objectives of the study. The secondary data were collected from various published sources like Statistical Handbook 2019, Assam and Economic Survey2019–20, Directorate of Economics & Statistics, Government of Assam.

25.3 Profile of the Study Area

The state of Assam has ample scope for the development of tourism sector. The present study is focussed on two tourist points of Assam viz. Kaziranga National Park and Majuli Island. Figure 25.2 depicts the selected tourist spots for the study.

25.4 Kaziranga National Park (KNP)

KNP is important tourist destinations of central Assam. KNP, a branded worldwide name is famous for one-horned rhinoceros. It offers habitation for a number of endangered local species and migratory birds. KNP covers three districts of Assam, i.e. Nagaon, Golaghat and Sonitpur Districts of Assam. The park is situated on the north of mighty Brahmaputra and on the south of Karbi Anglong Hills. The Park is bounded by mighty Brahmaputra on the north and verdant Karbi Anglong hills on the south. There are four ranges of KNP viz. Kohora, Bagori, Burapahar and Agartoli. There are different Government and private Hotels/lodges and restaurants in Kaziranga for the tourist. *Aranya*, *Bonani*, *Banashree* and *Kunjabn* are four Government loges

Table 25.2 Trend of arrival of domestic and foreign tourist in KNP

Tourist arrival	Domestic tourist	Foreign tourist	Total
2007–08	53,640	6106	59,746
2008–09	100,384	5767	106,151
2009–10	105,264	7580	112,844
2010–11	112,392	7447	119,839
2011–12	117,308	7521	124,829
2012–13	93,747	7418	101,165
2013–14	119,289	6922	126,211
2014–15	123,360	7994	131,354
2015–16	162,799	11,417	174,216
2016–17	159,669	7383	167,052
2017–18	475,061	8467	483,528
2018–19	168,738	7443	176,181
CAGR (%)	5.71	1.35	5.48

Source Statistical Handbooks of Government of Assam, 2019

in Kaziranga. *Borgos*, *Wild Grass*, *G.L.* Resort *Bonhabi* Resort, *Kaziranga* Lodge, *Dhansiri* Lodge, *Iora*, *Alohi Ghar*, *J.S.* Resort, *Florican* Lodge, *Greenland*, *Park* Hotel, *Namdang* Guest House, *Shanti* Lodge, *Rhino* Guests Home, *DR*L, *Jupori*, *Prashanti*, Nature Hunt Eco Camp, Emerald, etc. are the private hotels and Lodges. Elephants and jeep safaris are available in the park. Table 25.2 shows the trend of arrival of domestic and foreign tourist in Kaziranga National Park from 2007–08 to 2018–19 (Figs. 25.3 and 25.4).

25.5 Majuli Island

Majuli Island is situated in Majuli district (newly created in 2016) of Assam. This Island is considered to be the largest River Island of the world and is bordered by the mighty Brahmaputra. At present total area of the Island is 352 km^2 which was 1255 km^2 in 1901. The main reason of area decline of this Island is due to heavy soil erosion (Sarma and Phukan 2004). Majuli is the host of so many '*Satras*' which are rich in original cultural heritage of Assam. Around fifteenth century, the great Assamese saint Srimanta Sankardeva and his disciple Madhavdeva introduced *neo-vaishnavite* philosophy in Assam. Majuli is bestowed with internationally famous *Satras (vaisnavite* memorials), i.e. *Auniati*, *Dakhinpat*, *Garamurh*, *Kamalabari*, *Uttar Kamalabari*, *Bengena-ati*, *Samaguri,* etc. These *Satras* are the treasures of many precious books written on '*Sachipat*', i.e. the bark of *sashi* tree hundreds of years ago. Various antiques weapons, utensil, jewellery and other items of Ahom kingdom are preserved in these Satras which attract the domestic and foreign tourist towards this holly place. These Satras are acting as a gem house of Saint Srimanta

Fig. 25.3 Pictures of KNP. *Source* Collected by the Authors in November, 2019

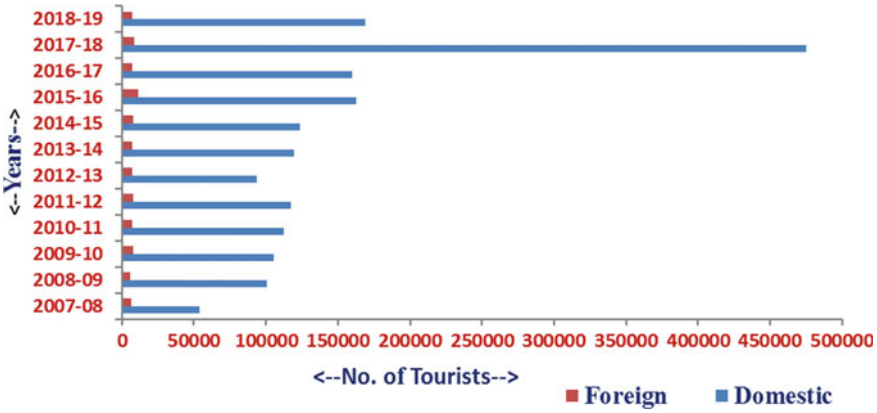

Fig. 25.4 Trend of arrival of domestic and foreign tourist in Kaziranga National Park

Sankardeva's unique creation, i.e. *Borgeet*, *Chali*, *Dasavatar Nritya Matiakhara, Notua, Satriya Nritya*, *Sutradhar*, etc. which established the foundation stone of a united Assamese society (Saharia et al. 2013). With the beautiful landscape in the lap of the mighty Brahmaputra, Majuli has tremendous potentiality to enhance tourism sector. The colourful culture of the tribes, ethnic foods, migratory birds from

different parts of the world, the *Ali-ai-ligang* (spring festival of mishing tribe) and *Raas* festivals during the autumn season, cover making, *paal namm* anniversary, exotic homespun masks crafts, etc. are the other segment of tourist attraction in Majuli (Fig. 25.5).

Table 25.3 shows the trend of arrival of domestic and foreign tourist in Majuli from 2010–11 to 2018–2019.

Table 25.3 shows that number of foreign tourists came down drastically with the negative CAGR at 20.08%. It might be happened as a large number of tourists do not feel it to be important to inform the local tourist offices authority as they have

Fig. 25.5 Pictures of Majuli Island. *Source* Collected by the authors in February, 2020

Table 25.3 Trend of arrival of domestic and foreign tourist in Majuli

Year	Domestic tourist	Foreign tourist	Total
2010–11	37,897	6267	44,164
2011–12	39,947	6849	46,796
2012–13	41,963	7376	49,339
2013–14	43,732	7973	51,705
2014–15	46,768	8031	54,799
2015–16	305,675	2645	308,320
2016–17	325,440	2857	328,297
2017–18	382,699	4295	386,994
2018–19	8010	652	8662
CAGR (%)	11.63	−20.08	9.41

Source Statistical Handbooks of Government of Assam, 2019

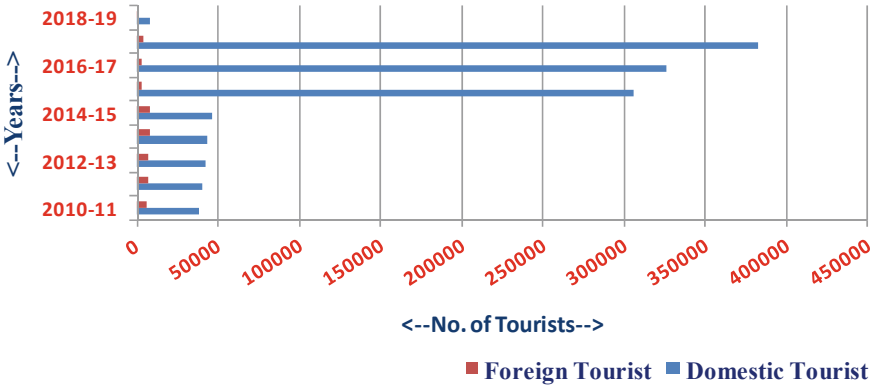

Fig. 25.6 Trend of arrival of domestic and foreign tourist in Majuli

already recorded their name in the first visiting place. On the other hand, some of the tourists do not stay in the registered tourist lodges and hotels; they use to stay in the residence of the local people for which such tourists do not come under the preview of tourist offices. At the same time law and order situation of the state and the country also determine the flow of tourists as a whole (Fig. 25.6).

25.6 Effect of Tourism in Economic Growth

Perspectives of sample respondents living in the neighbourhood of tourist places on effect of tourism in economic growth have been analysed with the help of chosen 8 economic indicators. Table 25.4 depicts effect of tourism in economic growth of the people live in the neighbourhood of tourist's places in Kaziranga National Park (Fig. 25.7).

The average ratings were considered by addition all the proportions in each column multiplying with dissimilar totals and the total was separated by hundred. The average scores indicated in Table 25.4 represent the perspective of sample respondents on impact of tourism in economic development in Kaziranga National Park as the highest score of 3.12 was found contrary to the statement 'contribution to overall assets creation and the lowest rating was recorded against 'Help in the removal of Poverty' (2.40).

Perspectives of sample respondents living in the neighbourhood of tourist places on impacts of tourism in economic development in River Island Majuli are presented in Table 25.5. The average ratings designated in Table 25.5 depicts the perspective of sample respondents on impact of tourism in economic development in Majuli as the highest rating of 1.54 was found against the statement 'provision of market for local produce' and the lowest rating was recorded against 'Help in the removal of Poverty' (1.15) (Fig. 25.8).

Table 25.4 Perspective of sample respondents living in the neighbourhood of tourists places on impact of tourism on economic development in Kaziranga National Park

Variables	High	Moderate	Low	No impact	Average rating	Ranking	SD
Improvement in the standard of living	8	21	19	2	2.70	5	0.50
Help in the removal of poverty	3	14	33	0	2.40	8	0.60
Contribution to overall assets creation	24	13	8	5	3.12	1	0.81
Increase in income	10	18	16	6	2.64	6	0.40
Provision of market for local produce	11	28	9	2	2.96	2	0.72
Creation of employment opportunities	13	17	16	4	2.78	3	0.45
Scope for self-employment	7	24	19	0	2.76	4	0.59
Improvement of Infrastructure	10	14	20	6	2.56	7	0.35

Source Primary data of field survey, October 2019–March 2020

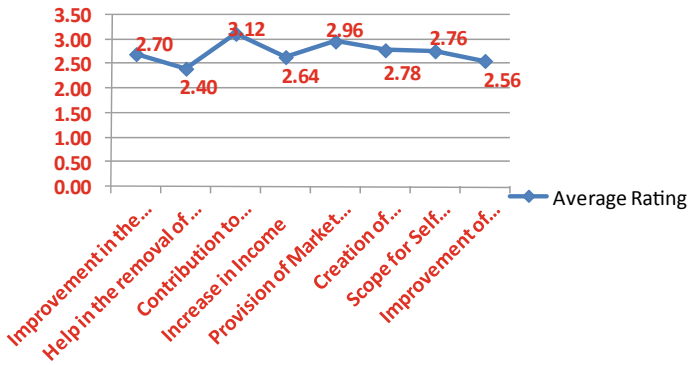

Fig. 25.7 Average rating of respondents on impact of tourism in economic development in Kaziranga National Park

Table 25.5 Perspective of sample respondents living in the neighbourhood of tourist's places on impact of tourism in economic development in River Island Majuli

Opinions	High	Moderate	Low	No impact	Average rating	Ranking	SD
Improvement in the standard of living	12	13	17	8	1.29	7	0.34
Help in the removal of poverty	3	14	28	5	1.15	8	0.48
Contribution to overall assets creation	21	10	16	3	1.49	2	0.68
Increase in income	9	17	23	1	1.34	7	0.45
Provision of market for local produce	16	24	8	2	1.54	1	0.69
Creation of employment opportunities	12	15	21	2	1.37	4	0.43
Scope for self-employment	15	15	20	0	1.45	3	0.51
Improvement of infrastructure	12	17	16	5	1.36	5	0.42

Source Primary data of field survey, October 2019–March 2020

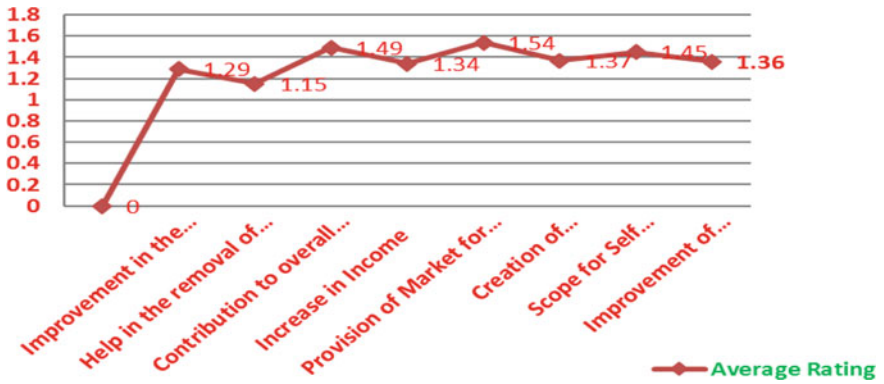

Fig. 25.8 Average rating of respondents on impact of tourism in economic development in Majuli

Table 25.6 Multiple reasons of attraction of tourists for visiting National Park Kaziranga (NPK) (interaction based on 25 tourists for each group)

No. of reason	Reasons of attraction	Foreign tourists (25)	Domestic tourist (25)
1	To see the world famous one-horned rhino	100	88
2	To enjoy the biodiversity of the Kaziranga through jeep and elephant safari	93	95
3	To enjoy the natural beauty of NPK	85	83

Source Primary data of field survey, October 2019–March 2020

Multiple Reasons of attraction of tourists for visiting National Park Kaziranga (NPK) based on opinions of foreign and domestic tourists is shown in Table 25.6. For visiting NPK, the reason 1 was the main attraction for the entire foreign tourist (100%) and it was 88% in case of domestic tourists. The point of attraction for both the groups were found at above 90% against the season 2 as it was considered as an extra special experience in life. Man by nature loves to enjoy natural beauty which reflected from the views of the tourists against the reason 3, was found at more than 80% for both tourists' groups.

Attraction of tourists by different reasons for visiting River Island Majuli is presented in Table 25.7. Table is based on multiple choices of opinions of the tourists. It has been observed that the main reason of attraction for river island for its age old ancient religious culture linked with Hinduism. The highest 68% of the foreign tourist viewed against the reason of attraction 4 followed by the reasons 8, 7, 1, 6, 2, 3, 5 and 10, respectively. All interviewed foreign tourists were found silent for visiting the island for any official purpose. In case of domestic tourists, the views of reasons of attraction were different from foreign tourist. However, they had similar reasons of attractions with a variation of opinions. The highest attraction 84% of the domestic tourists opined in favour of the reason 4 followed by the reasons 6, 3, 2, 5, 7, 1, 9, 10 and 8, respectively.

25.7 Constraints of Tourism Sector in Assam

Based on the observations and interactions with the sample respondents, the main constraints of tourism industry to achieve SDGs in Assam are identified as lack of air connectivity to majority tourist destinations in Assam, inadequate existing infrastructure for tourist such as good hotels and lodges with uncontaminated and hygienic food, insufficient reasonable and trustworthy communication, poor promotional measures to develop tourism sector, improper coordination with line departments, inadequate well organized tour operators and owing to heavy floods and soil erosion for four to five months from June to October in Assam, the major tourist spots

Table 25.7 Multiple reasons of attraction of tourists for visiting River Island Majuli (interaction based on 25 tourists for each group)

No. of reason	Reasons of attraction	Foreign tourists (25)	Domestic tourist (25)
1	To see the greatest river island in the world	48	24
2	To see the way of livelihood and culture of the people of the island	32	43
3	To see the unique basnavite religious *Sattriya* culture founded by Maha Purush Sankar Deva through the Philosophy Lord Krishna	28	48
4	To see the unique Rash Mahutsava during November and December	68	84
5	To see the ancient epical drama performed through mask made by local artisan in Samaguri *Satra*	24	36
6	To see the scenic beauty of the River Brahmaputra linked with ancient epical history of India	44	72
7	To see the natural biodiversity of the island	52	32
8	To have an refreshment for some days avoiding busy life	64	18
9	Official purpose	0	19
10	Educational and research	8	20

Source Primary data of field survey, October 2019–March 2020

in Assam particularly Kaziranga National Park and Majuli (sample tourist spots) suffer badly (Jha 2014). It damages all road and rail connectivity to the important tourist spots in the state.

25.8 Conclusions and Policy Implications

1. There should be coverage of air connectivity to the major tourist destinations in Assam.
2. It needs a proper attention on existing infrastructure for tourist to develop it as per satisfaction of the tourist.
3. More priority should give on promotional measures to improve tourism sector in Assam.
4. There must be proper coordination with line departments to achieve the SDGs in tourism sector in the state is utmost necessary.

5. Adequate numbers of well-structured tour operators are very essential to promote tourism sector in the state.
6. Proposed animal corridor in Kaziranga National Park should start without delay.
7. To save Majuli Island from soil erosion, Government should implement and execute all soil conservation measures' properly.
8. An awareness programme is essential amongst the people who live in the neighbourhood of the tourist spot because tourism sector develops a social relationship between local people and tourists.

The tourism industry in Assam has performed moderately well in some parameters. Looking into diverse potentiality, the future of tourism sector is very bright for achieving SDGs if all need base infrastructure of the state can be built up.

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Chapter 26
Sustainable Ethnic Tourism Development in Arunachal Pradesh

Parijat Borgohain and Barnali Patowary

Abstract Sustainable tourism is a new paradigm of development that thrives to conserve and sustain the natural, social, cultural and built environment by involving the local community, which in return contributes to their economic upliftment. This concept of planned tourism can be applied in presenting the ethnicity of local communities as tourism product for special interest tourists. Arunachal Pradesh, a state in the north eastern India, is the home to around 26 major tribes and over 110 sub-tribes with rich ethnic and cultural diversity. One of the unique features of the tribal people of Arunachal Pradesh is their close relationship with nature which is imbibed in the cultural beliefs and their indigenous traditional knowledge of conservation and management. This chapter tries to assess the viability of the sustainable lifestyle of the state's two major tribes, namely, the Monpa tribe and the Apatani tribe, as tourism product, who are part of the key tourist circuits of Arunachal Pradesh, namely, Tezpur-Bhalukpong-Bomdila-Tawang and Itanagar-Ziro-Daporizo-Along-Pasighat. To examine the relationship between sustainable tourism development and community participation, data have been collected through secondary and primary sources and a mixed method, including both qualitative and quantitative approach, is used in the study. It is found that ethnic tourism has great potential for the conservation and preservation of cultural and traditional expressions of these communities by making the showcase of ethnic resources economically viable.

Keywords Sustainability · Community participation · Ethnicity · Development · Tourism

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26.1 Introduction

Tourism in Arunachal Pradesh is one of the key industries among others like agriculture and forest-based industries, art and craft, handloom, horticulture and power. An assessment of the destination attractions and the elements of the state reveal that along with the exotic flora and fauna, the ethnicity of the local tribes is the strength of the destination appeal to attract both domestic and international tourists.

Although a number of studies and investigations have been carried out on socio-anthropological aspects and agriculture system and the natural resource utilization by the indigenous tribes, but little research has been done on ethnic tourism potentialities of the same. The present study will try to provide an insight into the prevailing traditional practices and beliefs of the Apatani tribe and the Monpa tribe and their viability as potential sustainable tourism products. As tourism is still in its infancy stage in the state of Arunachal Pradesh, it is imperative to study and identify the sustainable tourism principles so as to preserve the inherent ethnicity thereby making it economically beneficial for the local community. The study would also fill the gap in the literature, as while there is substantial literature on the ethnic tribe; little research has been done on ethnic tourism development prospects. As of now, few scholarly studies about indigenous ethnicity in North East India in general exist to help guide researchers and tourism developers.

The study is addressed by the following two questions:

(i) What are the strengths and weaknesses of the community that need to be addressed to assess its potentiality as one of the successful sustainable tourism destinations?
(ii) What is the perception of the local community toward impacts of tourism development in the study area?

26.1.1 Sustainable Tourism

With the travel and tourism becoming one of the largest industries in the global market in the post-war years (Sezgin and Yolal 2012), the industry was marked by the influence of 'Mass Consumerism'. Like any other industry, the tourism seller were also 'selling as much as produced', rather than designing specific products based on customer preferences. Although at the initial phase mass tourism lured economic benefits, it was in the early twentieth century that the negative impacts of the same were felt. The unplanned growth of the industry had exerted tremendous pressure on the available resources and intense environmental pressure (Sharma 2004). This had necessitated the realization for a controlled growth and development of the industry. Also the trend slowly shifted from the demand for the cheap and affordable packages to new tourism experiences which subsequently brought changes in the travel needs and demands of the tourists.

Swarbrooke and Horner (1999) has made an attempt to distinguish sustainable tourism and unsustainable tourism. It points out that while sustainable development is

slow and long term, unsustainable tourism is about rapid development, uncontrolled and short term. The study includes the concepts of carrying capacity assessment and de-marketing, and community involvement and local control as essential strategies for sustainable development.

According to Mowforth and Munt (1998), although the concept of mass tourism has not displaced in the third world countries, the new idea of alternative tours has been seen growing among the responsible tourist segment. It is the demand for real or authentic cultural experiences seen in the Third World nations under siege from global capitalism and western values.

The most widely accepted definition of sustainable tourism is the one given by the United Nations World Tourism Organization (UNWTO) which defines it as the 'tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities.'

According to the 2030 Agenda 4 it is believed that tourism can play a critical role in achieving 3 of the 17 SDGs. These 3 goals are 'Life Below Water' (SDG 4), 'Decent Work and Employment' (SDG 8) and SDG 12 'Responsible Consumption and Production' (SDG 12) (Soundararajan et al. 2019).

This chapter begins with the understanding of the concept of sustainable and ethnic tourism, and the importance of community participation in the development process. The discussion is followed by the identification of the ethnic resources in the study area. The subsequent section presents the participation of local residents in tourism activities and analyses their attitudes toward tourism development. The chapter concludes with a discussion of the future implications of sustainable tourism as development strategy for the local communities in North East India in general.

26.1.2 Ethnic Tourism

Ethnic tourism is one of the new forms of tourism which has developed to attract the special interest tourists. While cultural tourism is about viewing the cultural expressions of any community in the form of performance of dance and music or any kind of art and craft; ethnic tourism is about experiencing the same while living and directly interacting with the locals. Parmer (2008) at a conference on Inclusive and Sustainable Growth has defined ethnic tourism as 'travel motivated by search for the first hand, authentic and intimate contact with people whose ethnic/cultural background is different from the tourist'.

Ethnic tourism offers an opportunity to the traveler to have a first-hand interaction with the local people and learn from them, their way of life, culture, tradition and beliefs, by way of observing or participating in the festivals, rituals, dances and other celebrations. As a result, it has been observed that tourism can help in reviving the pride and interests of the local people in their own ethnic traditions and culture and they can be motivated to conserve and preserve the same.

Smith (1989) has mentioned the relation of tourism with nature in the simplest definition of ethnic tourism 'The approach to Nature through Her People is Ethnic Tourism'. It states that the combination of nature, culture and history is ethnic tourism.

However, the studies of ethnic tourism have often criticized loss of authenticity as one of the accompanying factors while marketing the cultural identity of people as a tourist product (Cohen 2000). Commoditization and loss of authenticity are the negative impacts of development of ethnic tourism that can destroy the cultural uniqueness of a community (Xie 2011). Hence, it is imperative that the new concept of independent travel and sustainable tourism has to be adopted, which has multifarious benefits for the society as a whole.

26.1.3 Community Participation as a Tool for Sustainable Development

Tourism is an industry involving host communities and tourists, which as a result has a direct and indirect impact on the people who live at the destination. It has been emphasized by the World Tourism Organization that the local community need to be involved in tourism planning, implementation and evaluation. Since the host community is the owner of the resources which would be developed and promoted for tourist consumption, it is natural for the locals to expect to be informed and involved in any decision taken for such developments.

Bopp et al. (2000) have mentioned that there are many facets to the aspect of community participation in tourism development and planning. Sometimes, it is seen that tourism ventures are undertaken keeping in mind the benefits of the local people but they are halted by the complete lack of interest on the part of the local community. In such cases, much of the time is consumed in the efforts of trying to educate the people and convincing them of the benefits that are involved in the venture for them. Researchers critically analyzed arguments for greater community involvement in decision-making in the broader context of development in general, and concluded that proponents of community-based decision-making processes were often naive about existing political structures.

26.1.4 Scope for the Development of Ethnic Tourism in Arunachal Pradesh

North East India is a land which is distinctly different from rest of the country for its diverse ethnicity, linguistics, lifestyle and culture. It has been agreed that North-east India, which has always been lacking behind in marketing itself as a mass tourist destination due to infrastructural or other reasons, has huge scope in terms of a potential niche tourist destination. There are around 26 major tribes and over 110

sub-tribes in Arunachal Pradesh. Among the major tribes, the most prominent ones are the Nyishi, Adi, Tagin, Apatani, Mishmi, Khampti, Tangsa, Nocte, Wangcho, Monpa, Aka and Miji (Human Resource Development 2005).

The varied community culture in Arunachal Pradesh is marked by heterogeneity in terms of language, customs, traditions and lifestyle. It is found that as many as 42 different languages are spoken in the state among which almost all of them, except Assamese and Nepali, belong to the Tibeto-Chinese family (Human Resource Development 2005). Absence of own written scripts of many languages is another distinctive characteristic of tribal communities of the state. Till today, many of them are using Assamese, English or Roman script for written communication.

One of the unique features of the tribal people of Arunachal Pradesh is their close relationship with nature which is imbibed in the cultural beliefs and their indigenous traditional knowledge of conservation and management which has been carried forward from generation to generation.

The state has an immense scope for the development of rural and ethnic tourism. What is required is a tourism policy based on responsible tourism for identifying new unexplored regions of the state without compromising the environment, and in achieving the Sustainable Development Goals (Soundararajan et al. 2019).

26.2 Study Setting

The present study explores the tourism potentiality of the Apatani tribe and the Monpa tribe of Arunachal Pradesh. These two tribal communities form a very important part of the key tourist circuits of Arunachal Pradesh, namely, Tezpur-Bhalukpong-Bomdila-Tawang and Itanagar-Ziro-Daporizo-Along-Pasighat.

Ziro valley, located in Ziro Block I in the Lower Subansiri District, is home to the Apatani tribe, who are one of the most advanced tribes of North East India. Ziro is popularly known as the 'Rice Bowl of Arunachal Pradesh', for its high agricultural productivity. The valley is bounded with the areas traditionally belonging to the neighboring Nyishi and hill-Miri tribes except in the south-eastern region by Assam. There are mainly seven traditional villages in Ziro known as Hong, Hari, Bulla, Hija, Dutta, Mudang Tage and Bamin Michi, which together form the Ziro valley, drained by the Kile River and its tributaries.

The indigenous Apatani tribe has a unique tradition of nature conservation and natural resource management, which has attracted the United Nations Educational, Scientific and Cultural Organization to propose the Ziro valley as a World Heritage Site. The Apatanis practice permanent wet rice cultivation which is unique among the hill tribes of the region. Moreover, it is integrated with pisciculture which makes it purely organic in nature. They even plant trees on private land, which are not only the source of fuel, fodder, food and timber, but also a part of socio-cultural and ritualistic purpose (Dollo et al. 2009). The cultural and historical background of the tribe is also very interesting. The study covered community members from five of

the villages of Ziro valley namely; Hong, Hari, Siro, Tajang and Dutta. A total of 460 questionnaires could be collected which were completed.

The Monpa tribe are the inhabitants of western Arunachal Pradesh concentrated mainly in the west Kameng district and the Tawang district. The tourist circuit covering these two districts have been popular mostly among the domestic tourists who come here to enjoy the natural attractions as well as for visit to the Buddhist monasteries. Another significance of the region is the Kameng Protected Area Complex (KPAC) consisting of Pakke Tiger Reserve, Nameri National Park, Sessa Orchid Wildlife Sanctuary and Eaglenest Wildlife Sanctuary, covering an area of 3500 km^2. with an altitude ranging from 100 to 3300 m (Sondhi and Athreya 2010). Also the western Arunachal Landscape has a total of eight community conserved areas with the total area of protected forests of 1500 km^2 (www.wwfindia.org). These are the habitat for the endangered red panda, Himalayan goral, serow, takin, small cats, etc. (Mongabay 2020). The Community Conserved Areas (CCA), which are predominated by the Monpa tribe, has adopted community-based tourism (CBT) as one of the viable sustainable livelihood option.

The Monpas are known for their architectural skills in house building, yak rearing, terrace cultivation, paper and candle making and above all for their warm hospitability. Dr. Verrier Elwin describes them as 'gentle, friendly, courteous, industrious, good to animals, good to children, you see in the Monpa the influence of the compassionate Lord Buddha on the ordinary man' (Norbu 2008). They also have a strong tie with nature and have also recognized that their culture, which conditions use of natural resources, must be maintained to assist in the management of natural resources.

The present study covered 65 community members from Tawang, Urgelling, Zemithang, Gispu, Muchuk from Tawang district, Sera, Bomdila and Dirang, who were randomly selected.

26.3 Material and Methods

The present research employed both qualitative and quantitative data collection and analysis methods. After the selection of the topic of study, information from secondary sources was collected, enabling the researcher to get background data and an understanding of the study area. The data has been collected from journals, published books, newsletters, brochures and the Internet as well as earlier research works.

Ten questions related to participation in tourism were put in the questionnaire designed for the local community. These questions are meant to determine the participation level of local community in tourism, the income from tourism activities, the participation in tourism planning and development. Another question was posed to identify the attitude of the local community toward the tourism industry. Factors included awareness of the importance of tourism to the community and the need of

participation in tourism planning. Also questions on objectives of tourism development that the community wishes to achieve through tourism, their suggestions and recommendations are included.

An in-depth semi-structured interview guide has been formed before visiting the field area which covered questions about community participation in tourism, particularly in the decision-making process, benefit sharing and tourism's contribution to development and economic upgradation as well as conservation.

Participatory observation included activities that the researcher conducted with community members during important festivals, as well as visiting tourist attraction sites in the study area. Non-participatory observation included activities that the researcher did not take part in, such as, visits of tourists, and daily activities of the community members.

26.4 Results

26.4.1 Scope for Development of Ethnic Tourism in the Study Areas

In ethnic tourism, exotic culture is the main attraction and the most vulnerable resource, which requires a specific cultural consideration in the planning process.

26.4.1.1 Ethnic Background of Apatani Tribe

The colorful Apatani tribe and its unique sustainable way of lifestyle intricate with nature, makes it a living cultural landscape. Table 26.1 presents the cultural identity of the Apatani tribe in Ziro valley.

26.4.1.2 Ethnic Background of Monpa Tribe

In Arunachal Pradesh the term 'Monpa' refers to a particular ethnic group inhabiting the Dirang administrative circle lying north of Bomdila, the Khalaktang administrative circle in the south-western part of West Kameng district and the entire Tawang district (Norbu 2008). They are said to be of Mongoloid descent and are the followers of the Tibetan Buddhism (Table 26.2). They mostly are the inhabitants of land at the altitude ranging from 2000 to 4500 m neighboring to Bhutan and Tibet.

Table 26.1 Cultural identity of the Apatani tribe

S. No.	Tourism resources	Current conditions	Unique style
1	Language	No written language till now	Tibeto-Burman language
2	Religion	Donyi-Poloism	Worships sun and moon
3	Tradition	Oral tradition	Reflected in performance of three-four week long festivals
4	Houses	Traditional bamboo houses	Housing patterns are long and are at elevated platforms
5	Society	Patriarchal and class endogamy	Society is divided into two classes—*Gyutii*, the Patrian and *Gyuchi*, the Plebeian
6	Costume	Elaborate and colorful dress, yet simple in style	*Jilañ*, the traditional dress of the priests has recently been made into a five rupee Indian postal stamp
7	Fair and festivals	Dree, Myoko, Murung and Yapung are major festivals	Festivals celebrated for better cultivation and for the welfare of the society and friendship
8	Administrative system	Traditional village council known as '*Buliyang*'	Three tier *Buliyang*, *Akha Buliyang, Yapha Buliyang* and *Ajang Buliyang*
9	Economy	Hunting, fishing, forestry and agriculture	Traditional ecological knowledge
10	Cuisine	Rice, meat, fish and vegetables	Organic and garden fresh
11	Culture	Animist-Shaminist	Believe in the world of spirits and deities

Source Primary survey, 2014–2016

26.4.2 Participation of Respondents in Tourism

Considering the nascent stage of tourism development in Ziro valley, it can be said that the community participation has been satisfactory as 24.1% of the total 460 respondents in the sampled villages have indicated to be engaged in the industry, either directly or indirectly. Among the many sectors of the tourism industry, maximum participation (10.2% of the total respondents) has been found in the accommodation sector, whether in the form of homestays, hotels or resorts. Further, the farmer groups and the self-help groups have been benefitted by offering their services as local tour guides and providing items for tourist consumption.

Tourism so far has been mainly a supplementary source of income for the local community, as the proportion of income attributable to tourism is just 25% for most of the participants (31.5%). The study also shows the result that the average time given by the participants to tourism activity is just 1–2 h per day, which indicates that they mainly take it as an alternate occupation.

Table 26.2 Cultural identity of the Monpa tribe

S. No.	Tourism resources	Current conditions	Unique style
1	Language	No written language till now	Bodic group of Tibeto-Burman language
2	Religion	Mahayana Buddhism	Worships Lord Buddha
3	Tradition	Oral tradition	Reflected in Tibetan epic
4	Houses	Frameworks of wooden posts and beams, walls of cut stones and white washed	Monpa houses (khyem) are rectangular in shape and double storeyed. Monpas are the best architects in designing and building houses
5	Society	Mostly nuclear and patriarchal family	Polyandrous and polygynous marriages
6	Costume	Distinctive way of clothing, well adapted to the environment	Influenced by Tibetan style
7	Fair and festivals	Losar, Saga Dawa, Dukpa Tse-shi, Lhabab Duechen, Gaden Ngam Choe, Choekor, Torgya and Tseb-Chu are some of the major festivals	Festivals have religious background and have significance of its own
8	Administrative system	Self-governing institutions	Self-governing unit headed by a man known as *Tso-Tsorgan*
9	Economy	Animal and agriculture	Subsistence economy based on primitive type of agriculture supplemented by animal husbandry
10	Cuisine	Millet, rice, maize, vegetables, meat of pork, beef, yak, butter tea, fermented cheese	Organic and garden fresh
11	Culture	Beliefs and practices of Buddhism followed by the Tibetan Mahayana School	Believe in existence of Gods and spirits

Source Primary Survey, 2020

Among the Monpa community, out of the total 65 respondents, only 17% have responded positively about participation in tourism. Also it is seen that their involvement has started only recently as the average year of participation is 2 years and the average time of engagement in tourism activities is only 4 h per day. Out of the total participants, 100% have responded that tourism is providing 25% of their annual income.

The involvement of the host community in tourism planning and development have been analyzed by questions relating to their participation in tourism meetings, about the issues that were being discussed in such meetings and their views on opinion of local communities being incorporated in planning of tourism. Among

the 460 respondents of the Apatani community, only 22.2% have participated in tourism-related meetings, while 61.1% did not participate and another 16.7% denied knowledge of such meetings being held in their community. The result reveals that more awareness about tourism and its significance has to be communicated among the community members. The study results also show that in the tourism-related meetings, marketing and promotion of tourism is the main issue of discussion, as indicated by 15.7% of the respondents. Only 0.9% indicated benefit sharing issue being discussed in the tourism meetings.

The study result shows that only a few people (9.6%) have been asked about their opinions on tourism many times in the tourism meetings of the total respondents from the surveyed villages. They are of the view that the major decisions concerning tourism in their community are made primarily by people outside the community such as the government officials, tour operators, non-government agencies, financial contributors. Opinion about the involvement about the whole community in decision-making was held by only 5.4%. When asked about the views of the villagers being incorporated in all planning decisions of tourism development in Ziro valley, out of the total respondents, 43% of the respondents indicated that their views have been considered, while 48.3 of them responded negatively.

Among the respondents from the Monpa community, none of the respondents have participated in tourism meeting. However 17% of them have responded that they have been asked about their opinions on tourism once by those who plan tourism development in their community. When asked about the major decisions concerning tourism taken in their community, 23% of the respondents have indicated that people outside their community take decisions, 41% have however responded that the whole community is involved in taking decisions regarding tourism. Also 20% have indicated that a group of people in their community take the major tourism decisions and the remaining 16% did not respond on the question. This indicates that a majority of them are unaware about the industry and its socio-economic benefits. Also many of the respondents have indicated that major decisions concerning tourism development in the community have been taken by either a group of people or people outside their community.

26.4.3 Local Residents' Attitudes Toward Impacts of Tourism Development

The local residents' perception and attitudes on impacts of tourism development have been studied by many researchers for assessing participation and support for tourism in their community (Rasoolimanesh and Jaafar 2016; Muresan et al. 2016; Brida et al. 2011). It has been argued that tourism as an industry can have both positive as well as negative impacts on a destination. Sustainable development of the same calls for minimizing the negative impacts while maximizing the positive impacts for

the host community as well as the environment that itself is an important element of tourist attraction.

26.4.3.1 Attitudes of Apatani Community on the Impacts of Tourism Development—An Exploratory Factor Analysis

Ziro is an upcoming tourist destination. Hence it is yet to realize a major change in its social, cultural, economic and environmental aspects, whether positive or negative. The destination marketers and tourism planners can learn from the experiences of other tourist destinations in the country which have been through the different phases of destination life-cycle, and adopt models that are able to deliver goals like poverty reduction, local economy multipliers, community participation and conservation of heritage.

The data has been analyzed using exploratory factor analysis (EFA), which is a quantitative method that analyses large set of variables by identifying the common sets of variances called factors or components (Rani 2013).

Two principal component analyses (PCA) were conducted in the study to reduce the number of variables that represents the attitude of the local community toward the economic, social, cultural and environmental impacts of tourism.

The PCA with varimax rotation of the 12 variables resulted in a four-component solution (Table 26.3). Varimax rotation is used to maximize the differences between the derived components. The eigenvalue is a measure of how much of the variance of the observed variables a factor explains. It determines the overall strength of relationship between a factor and the variables. Any factor with an eigenvalue ≥ 1 explains more variance than a single observed variable. The relationship of each variable to the underlying factor is expressed by the so-called factor loading. Rani (2013) states that factor loadings in excess of 0.71 (50% overlapping variance) are considered excellent, 63 (40% overlapping variance) very good, 0.55 (30% overlapping variance) good, 0.45 (20% overlapping variance) fair and 0.32 (10% overlapping variance) poor.

Twelve statements relating to assess the impacts of tourism development and community participation provided by local residents in the sampled villages have been analyzed using principal component analysis with Varimax rotation, which resulted in four-component solution.

Three attitude variables ('Better understanding and more education is needed', 'Tourism creates new markets for our products' and 'Tourism provides employment opportunities') were loaded in the first component, labeled positive economic impacts and support for sustainable tourism development, with the cross-correlation coefficients of 0.762, 0.897 and 0.875 (Table 26.4).

The second component consists of four variables ('Tourism is a way of preservation of age-old tradition and culture', 'Meeting tourists promotes cross-cultural exchange', 'Tourism is protecting the environment' and 'Tourism planning needs local participation') with the cross-correlation coefficients of 0.835, 0.831, 0.847 and

Table 26.3 Factor analyses of impacts of tourism development total variance explained

C	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.086	25.719	25.719	3.086	25.719	25.719	2.772	23.100	23.100
2	2.630	21.918	47.637	2.630	21.918	47.637	2.657	22.138	45.238
3	1.724	14.370	62.007	1.724	14.370	62.007	1.785	14.875	60.112
4	1.490	12.420	74.427	1.490	12.420	74.427	1.718	14.315	74.427
5	0.783	6.526	80.954						
6	0.725	6.038	86.992						
7	0.520	4.336	91.328						
8	0.444	3.700	95.028						
9	0.222	1.849	96.877						
10	0.162	1.350	98.227						
11	0.131	1.091	99.319						
12	0.082	0.681	100.000						

Extraction method: principal component analysis. C—Component

Table 26.4 Factor analyses of impacts of tourism development rotated component matrix (a)

	Component			
	1	2	3	4
Tourism can be a means of income for many households in my community			0.646	
Most tourism services are provided by local people				0.778
Tourism is a way of preservation of age-old tradition and culture		0.835		
Meeting tourists promotes cross-cultural exchange		0.831		
Tourism is protecting the environment		0.847		
Tourism planning needs local participation		0.520		
The current level of local participation is good			0.588	
Better understanding and more education is needed	0.762			
Tourism funds have been significantly used to improve basic infrastructure in the community			0.772	
Tourism creates new markets for our products	0.897			
Tourism deteriorates the natural and cultural environment				0.816
Tourism provides employment opportunities	0.875			

Extraction method: principal component analysis. Rotation method: varimax

0.520 (Table 26.4). This factor was labeled positive socio-cultural and environmental impacts and need for planning.

The third component consists of three variables, labeled support for community-based tourism, ('Tourism can be a means of income for many households in my community', 'The current level of local participation is good' and 'Tourism funds have been significantly used to improve basic infrastructure in the community') with the cross-correlation coefficients of 0.646, 0.588 and 0.772 (Table 26.4).

The fourth component consists of two variables, labeled negative environmental impact and support for local participation ('Most tourism services are provided by local people' and 'Tourism deteriorates the natural and cultural environment') with the cross-correlation coefficients of 0.778 and 0.816 (Table 26.4).

The positive perceptions of the local community toward tourism impacts indicate their willingness and support for the development of sustainable tourism. As tourism is an emerging industry in Ziro, the residents believe that tourism can provide employment opportunities and increase the standard of living by involving in the conservation work. The findings regarding residents' positive attitudes and their support for tourism development are consistent with the previous studies (Rasoolimanesh and Jaafar 2016; Muresan et al. 2016).

26.4.3.2 Attitudes of Local Monpa People—A Descriptive Analysis

In order to assess the perception and attitudes of respondents from Monpa community toward tourism impact, a descriptive statistics has been presented (Table 26.5). A higher mean score indicates a high respondents' rating of the item after recoding the order of the measurement. Among the twelve variables, the statement 'Better understanding and more education about local participation is needed' scored the highest mean value of 4.06 with SD 0.583. The statements 'Meeting tourists promotes cross-cultural exchange' and 'Tourism creates new markets for our local products' scored the second highest mean value of 3.83 with SD 0.574 and 3.76 with SD 0.824, respectively. Further the statements 'Tourism can be a means of income for many households in my community' and 'Tourism is a way of preservation of age-old tradition and culture' scored mean value of 3.73 with SD 1.349 and 3.69 with SD 0.789, respectively. This indicates that although the respondents are aware of the positive impacts of tourism, they feel that more awareness has to be created to generate knowledge about the importance of the industry.

Regarding participation of local people in tourism, the respondents want that more participation should come indicating with the statement 'The current level of local participation is good' scoring mean value of 3.56 and SD 0.865. Analyzing the economic impacts of tourism, 'Tourism provides employment opportunities' has scored the mean value of 3.55 with SD 1.287. 'Tourism funds have been significantly used to improve basic infrastructure in the community' scored mean 3.4 with SD 0.844 and 'Tourism planning needs local participation' with mean 3.2 and SD 1.148.

The statements on environmental impact received a mixed response with the statement 'Tourism is protecting the environment' have the mean value of 2.67 with SD 1.047 whereas 'Tourism deteriorates the natural and cultural environment' has a mean value of 2.98 with SD of 0.976.

The statement 'Most tourism services are provided by local people' scored the lowest mean of 2.69 with SD 0.827, meaning the host community does not agree with the statement. Hence, a better planning and decision-making regarding participation of local youths and unemployed people and efficient management of fund raised by the industry to improve infrastructure and facilities has to be taken.

26.5 Discussion

In Ziro valley, the concept of community-based tourism came to force since 1996, when the objective of developing the sensitive locations in rural parts of the country was initiated (Mize et al. 2016). However, one of the first actors to be involved in the initial phase of tourism development is the Future Generations Arunachal (FGA), a non-government organization which joined hands with the Ashoka Trust for Research in Ecology and the Environment in the year 2010 for starting community-based projects in the valley. FGA collaborated with an apex community-based organization named Ngunu Ziro, and the Rural Tourism Development Committee (RTDC) for

Table 26.5 Descriptive analysis of impacts of tourism development

S. No.	Variables	Mean	Standard deviation (SD)
Economic and infrastructural impact			
1	Tourism can be a means of income for many households in my community	3.73	1.349
2	Most tourism services are provided by local people	2.69	0.827
3	Tourism funds have been significantly used to improve basic infrastructure in the community	3.4	0.844
4	Tourism creates new markets for our local products	3.76	0.824
5	Tourism provides employment opportunities	3.55	1.287
Socio-cultural impact			
6	Tourism is a way of preservation of age-old tradition and culture	3.69	0.789
7	Meeting tourists promotes cross-cultural exchange	3.83	0.574
8	Tourism planning needs local participation	3.2	1.148
9	The current level of local participation is good	3.56	0.865
10	Better understanding and more education about local participation is needed	4.06	0.583
Environmental impact			
11	Tourism is protecting the environment	2.67	1.047
12	Tourism deteriorates the natural and cultural environment	2.98	0.976

Measurement scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither disagree nor agree, 4 = Agree and 5 = Strongly agree

ground handling the tourism projects which involved start-up of homestay units to imparting various training program for creating awareness and capacity building.

The participants who are actively engaged in tourism in the sampled villages consist of the members of the non-government organizations, the families offering homestay facilities to tourists, the resorts, the local tour guides and the tour operators and the members of the self-help groups (SHGs). The SHG members mainly consist of women participants who supply food items like fish, meat, vegetables and handicraft and handloom products. Besides, they also arrange cultural performances for the entertainment of tourists. It is said that community-based tourism has been a tool for villagers to seek additional income and is not initially aimed for high income generation (Strasdas 2005).

The study has revealed that for exploring the Monpa community tourism, there are two well recognized villages namely Thembang village in Dirang CD Block and Zemithang village in Tawang district. Thembang village is primarily the first Community Conserved Areas (CCA) in the state under the management committee

known as the Thembang Bapu Community Conserved Area Management Committee (TBCCAMC). The project had been started by the WWF-India for the scientific management of the area and socio-economic development of the local community. They had considered community-based tourism as the most viable sustainable livelihood options. By introducing sustainable practices like engaging locals in providing services like homestay facilities, home restaurants, guiding and craft making, the project aimed for minimizing unsustainable practices like changes in traditional management systems, extension of grazing areas, overutilization of forest resources, bordering issues to name a few.

Zemithang valley in the Tawang district has been considered as one of the best examples of community-based tourism to show how cohesiveness or sharing of a common goal by the community members is of utmost importance for attaining success in the projects undertaken (Dodds et al. 2016). In Zemithang, a community leader is appointed by the villagers known as *Kanchen*, who then appoints four villagers to take responsibility for the events and ceremonies taking place at the village. Also the WWF-India had initiated the conservation work by engaging the village elders and youths in the management of their forests and the endangered red pandas, musk deer, serow, goral, Himalayan black bears, Siberian weasels, leopards and others.

Besides these two villages, there are many other villages which are Monpa dominated and have started adapting the successful Community Conserved Area model namely, Mandla, Phudung, Domkho, Morching, Sangti valley, Pancheng valley to name a few. Many of these villages have stories to share about the conservation of vulnerable Red Panda found in the Himalayan forests. Homestay tourism has been considered a viable livelihood option in the villagers to offer an experience of the local lifestyle as well as an understanding of the traditional management system of their forest resources.

As ethnic tourism is at nascent stage Arunachal Pradesh, the participation level of the local community is satisfactory and their involvement in the industry as a supplementary occupation is in the line of sustainable growth of the same. However, more awareness about the significance of the industry and their involvement in planning and decision-making is required for a better and efficient management for the long term sustainability of tourism. As stated by Butler (1980), 'without increased knowledge, local enterprises are at risk of being overtaken by more tourism savvy outsiders'.

An impact assessment of tourism has been done on three aspects, namely, economic, socio-cultural and environment. The assessment has been based on the perception of the respondents from the surveyed villages. The results show that there are positive impacts on the economy as tourism provides supplementary income. However, the respondents have stated that funds from tourism have not been used for improvement of local infrastructure.

Regarding the socio-cultural aspects, the results show that the local people have agreed that tourism can help in preserving and promoting their traditional and cultural heritages. They have also agreed that tourism is a way of cultural exchange and a

medium of learning new things. However the local people agree that more participation of the local residents in the tourism planning is required for sustainable development of the same. However better management of the funds from tourism is required to improve the basic infrastructure in their community.

26.6 Conclusion

Sustainable ethnic tourism is a way of providing a niche experience to tourists by integrating natural resources with the local lifestyle of the indigenous communities. Hence, participation of the local community is encouraged by way of strengthening the local organizations, creating more awareness among the people, engaging them in economic activities and arranging capacity building programs. What is required is a proper planning which is integrated in the tourism development process to enhance the role of local people. In order to invite responsible tourists to the community, it is imperative to create a network of the non-government organizations, social enterprises, travel agencies, tour operators as well as government bodies, who can together take the initiative in developing their community as a successful ethnic destination.

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Chapter 27
SDG 3 in Manipur: A Story of Hill-Valley Divide?

Esther Ngaihte and Anushruti

Abstract In Manipur, the successful achievement of SDG 3, 'health and well-being for all' shall depend on whether the state government can increase investments in, as well as bridge the hill-valley divide in, the provisioning and access of, healthcare services. The NFHS 5 findings seem to point towards a reversal in the progress made so far and this should not be ignored. The government should identify where the gaps lie and undertake necessary steps for effective redressal.

Keywords SDG3 · Health disparities · Supply and demand factors · NFHS 4 · NFHS 5 · Hill-valley divide · Manipur

27.1 Introduction

India is committed to ensuring equitable and inclusive health and well-being for all by 2030 as a signatory to the Sustainable Development Goals (SDG). The SDG 3, 'ensuring healthy lives and promoting well-being for all at all ages' is a continuity and broadening of the Millennium Development Goals on health. The achievement of SDG 3 will crucially depend on the performances of Indian States since they are at different stages of demographic transition (Kumar 2014) and have differing levels of attainment in health status. Significant progress has been made in various States in both the provision of and access to healthcare, but much remains to be done.

The north-eastern state of Manipur is a small state of 22,327 km^2 area with a population of 28.56 lakhs (2011 census) and having 9 (nine) districts. It is geographically divided into a central valley area (comprising about 10% of the total area), and a hilly terrain with 60% of the population residing in the valley districts and 40% in the hill districts. The hills are subdivided into five districts, whereas the valley is organised into four districts. The population of Manipur is divided ethnically as tribal and non-tribal with the tribal living predominantly in the hills and the more politically and economically powerful non-tribal (Meitei) living in the valley areas.

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According to the Population Census (2011), 70.79% of the total population in the State are settled in rural areas while 29.21% reside in the urban areas. About 92.70% of the population in the hill areas are concentrated in the rural areas compared to the valley region which has around 54.40% (Economic Survey, 2019–20). Population density in Manipur is 128 person per square kilometre. In the hills, it is 61 as against 730 in the valley. Out of the 28.56 lakh population, 3.41% are scheduled castes communities and 40.88% are of scheduled tribes (Census, 2011). According to the Economic Survey Manipur (2019–20), "*there is apparent disparity in the level of income and consumption between the rich and the poor, between the urban elite and the rural poor, between the haves and have-nots and between the public living in the hills and in the valley*".

According to 68th Round of NSSO (2011–12), 38.8% of the population in rural areas and 32.59% in urban areas are estimated to be living below poverty line in the state. The Gross State Domestic Product (GSDP) of Manipur for 2018–19 (Projected Estimates) at current prices is estimated to be Rs. 25,870 crores as against Rs. 23,167 crores in 2017–18.

Various studies have also shown the differences in health outcomes between rural and urban areas in the state. The infant mortality rate (IMR) in Manipur is estimated at 25 deaths with the rate being much higher in rural areas (31.1) than in urban areas (12.2) (NFHS 5, 2020). The neonatal mortality and the under five mortality rates for the State are 17.2 and 30, respectively (NFHS 5, 2020). Following a trend like IMR, variances in rural and urban averages were observed which points towards a distinct hill-valley divide in terms of health outcomes.

The marked socio-economic and political differences and widespread differences in development between the rural and urban areas in Manipur have been studied as the hill-valley divide (Singh 2007; Phanjoubam 2005). This divide in Manipur has been documented in literature as the regional imbalance between the valley areas and the hill in both socio-economic and political terms. In many key 'development' indicators-administration, employment, poverty, health, and infrastructure, the marginalisation and economic underdevelopment of the hills can be seen (Arora and Ziipoa 2020). The failure to respond to these issues by the post-colonial and state government policies (Sharma 2019) has led to the quest for tribal identity (Kipgen and Chowdhury 2016). It is also studied as the source of identity formation due to the association between land and ethnicity due to the *exclusive use of land as a symbol of discrete identities and ethnic homeland* (Haokip 2018) and, therefore, as a *site of conflict* (Suan 2009). The said marginalisation and the quest for identity has led to many ethnic based insurgency groups (Shimray 2001).

In India, problems in public service delivery have been seen as one of the important causes of the persistent inequality in human development (Datt and Ravillion 2010). This along with concentrated poverty and the widening disparities between and within urban and rural areas can act as a hindrance to the achievement of SDG objectives. Various factors which are central to the process of development such as poverty, gender inequality, education and human rights have a bearing on the health performances and health access. Inequities in health performances can be due to historical inequities, socio-economic inequities and differences in health provision

and access (Baru et al. 2010; Balarajan et al. 2011). The extent to which these differences in access exist may be due to both supply and demand factors (Ensor and Cooper 2004; O'Donnell 2007). Supply side factors relate to the provision of good quality effective healthcare i.e., aspects inherent to the health system that hinder service uptake by individuals, households, or the community. Demand side factors include aspects which affects the utilisation of healthcare services. Andersen (1968), framework on healthcare utilisation helps us understand individual's healthcare utilisation through the interaction between three factors—(i) individual predisposition to use services like their socio-cultural characteristics, demography, health beliefs etc., (ii) factors that enable or impede use such as means and know-how to access care and (iii) their needs. James et al. (2006), argued that access barriers on both demand and supply side may not always be mutually exclusive and may interact and influence each other.

To achieve the targets for SDG 3 in Manipur, it is important to identify the factors that are crucial determinants of heath outcome and those that could act as deterrents. With medical facilities in the State mainly provided by the State Government, it is important to understand whether there exists a rural–urban disparity in health performance and access and if so, the factors behind it. Any district wise disparity in health indicators could act as a hindrance to achievement of SDG 3 in the State. The chapter provides a comparative analysis of the health performances of the nine districts in Manipur. It also attempts to explore any inequities in health that might exists between the hill and valley districts and whether those can be understood from the supply and demand factors of access thereby enabling the identification of feasibilities and constraints.

27.2 Sustainable Development Goal 3

The SDG or Global Goals, are commitments which were adopted by the member states of the United Nations in 2015 with the aim of ending poverty, protecting the planet, and ensuring peace and prosperity by the target year of 2030.

Given that there exist linkages and spill over effects, that is, actions taken in one area impact outcomes in another, 17 goals have been emphasised upon so that socio-economic and environmental sustainability is ensured in the process of development (undp.org n.d.)

Of the 17 SDG targets, SDG 3 is of particular importance. Poor health is one of the most fundamental and basic deprivations that has long lasting impact on the well-being of not only individuals but also, households and societies. Even today, an increasing proportion of the incidence of child deaths persist in the most backward regions of the world namely sub-Saharan Africa and South Asia (in.undp.org n.d.) Although, at the global level, the incidence of infectious diseases such as TB and HIV AIDs has been falling, emergence of new diseases such as the Covid-19 make the entire exercise a continuous and ongoing battle. Universal access to affordable healthcare is still elusive.

SDG 3 targets to achieve the following sub-goals by 2030:

1. Reduce to less than 70 per 100,000 live births, the global average for maternal mortality ratio.
2. End the preventable deaths of new-borns as well as children under 5 years of age. Towards this end, the neonatal mortality should be reduced to 12 per 1000 live births and under-5 mortality to 25 per 1000 live births.
3. End the epidemics such as AIDS, tuberculosis, malaria, similar neglected tropical diseases and, combat hepatitis, water-borne diseases, and other communicable diseases.
4. Premature deaths from non-communicable diseases should be reduced by one third through prevention and treatment.
5. Promotion of mental health as well as strengthening of the prevention and treatment of substance abuse, narcotic drug abuse, etc.
6. Number of deaths and injuries from road traffic accidents at the global level, should be halved (by 2020).
7. Ensure the provision of universal access to sexual and reproductive healthcare services (including family planning) as well as information and education on reproductive health along with its integration into nations' policies and programmes.
8. Provide affordable access to safe and good quality essential medicines, vaccines, and health care services so as to achieve universal health coverage and financial protection to health risks.
9. Achieve substantial reductions in death and illness due to air, soil, water pollution, and hazardous chemical contamination.
10. Ensure more effective implementation of the WHO Framework Convention in Tobacco Control across countries.
11. Encourage R&D of and access to vaccines and medicines particularly for diseases that affect developing countries specifically.
12. Help LDCs, developing countries and small island developing nations to substantively increase health financing and recruit, train, and retain health care workforce.
13. Capacity building for systems of early warning, risk mitigation and management of national as well as global health risks across countries of the world.

27.3 Manipur

27.3.1 Relative Performance in Health: India and Manipur

Provision of healthcare to such a geographically divided population as in Manipur is a gigantic task. The provision of health services in the State is primarily under the government sector, with a few private hospitals/nursing homes. The health system is organised at three levels of primary, secondary, and tertiary care, each level supported

Table 27.1 Manipur health outcomes in comparison to all India averages

Indicators	Manipur (SRS 2018)	All-India average (2018) (SRS)
CBR	14.3	20.0
CDR	4.5	6.2
TFR	2.2 (NFHS 5)	2.2
Life expectancy at birth	–	69.7
Sex ratio	985 (census 2011)	899
Dependency ratio	533 (census 2011)	571 (census 2011)
IMR	11	32

Source SRS Bulletin 2018

by a referral centre. As per the Economic Survey, Manipur (2019–20) there are 553 hospitals/dispensaries with a total manpower of 919 doctors and 2081 nurses, midwives, and dias. In terms of per capita availability of health workers, in 2017–18, there is one doctor per 41,000 population and one nurse, midwives and dias per 15,800 population. As per the DLHS-4, there are two tertiary healthcare centres, seven district hospitals, 59 primary health centres (PHC) and 148 sub health centres (SHC). 76.4% of villages have a PHC within 10 km and 75.2% of villages have a SHC within 3 km.

Table 27.1 gives an understanding of the health profile of the state as compared to the all-India figures.

Table 27.2 illustrates Manipur's health profile. The indicators used and targets are reproduced from the SDG India Index 2.0.

According to SDG India index 2.0, Manipur has an SDG 3 Index score of 62 and is considered a performer. Looking at the specific indicators, the state has a long way to go in terms of its performances in parameters other than U5MR and total physician, nurses, and midwives per 10,000 population. However, comparing the SDG index 2.0 with NFHS 5, Manipur saw an improvement in the proportion of institutional deliveries, percentage of children fully immunised, and in the use of modern methods of family planning. The state's performance deteriorated in U5MR. In most of the indicators it has performed better than the All-India average.

27.3.2 District-Wise Performance

Given that performance in various health parameters depends critically on factors such as its population size, demographic profile, average per capita incomes, inequality and poverty, the Government's finances, share of public spending on welfare schemes in the budget etc., whether SDG 3 targets will be met or not shall

Table 27.2 Manipur health profile

Indicator	SDG India Index 2.0 (actual) (1)	SDG India Index 2.0 (target) (1)	NFHS 4 (2)	NFHS 5 (2)
Proportion of institutional deliveries	58.7	100	69.1	79.9
Under 5 mortality rate per 1000 live births	26	25	25.9	30
Percentage of fully immunised children in the age group of 0–5 years	75.1	100	65.8	68.8
Total case notification rate of TB per 1 lakh population	97	0	–	–
HIV incidence per 1000 uninfected population	0.58	0	–	–
Percentage of currently married women aged 15–49 years who use any modern method of family planning	12.7	100	12.7	18.2
Total physicians, nurses and midwives per 10,000 population	44	45	–	–

Source (1) SDG India Index 2.0 (Niti Ayog) and (2) State Factsheet: NFHS rounds 4 and 5

be influenced substantially by the inter district variations in health outcomes of the State.

We use data from the district-wise factsheets of NFHS 5 to compare inter-district performance with a particular focus on the hill-valley divide if any.

The first sub-goal under SDG3 targets maternal mortality. Various studies have found that investment in women's and children's health not only secure high health, but also, social, and economic returns. Investment in packages for maternal and newborn health, child health, immunisation, family planning, nutrition, etc., is cost-effective, increasing health expenditure by dollar 5 per person per year up to 2035 in 74 high-burden countries is found to yield up to nine times that value in economic and social benefits (Stenberg et al. 2014) Amongst individual interventions that have the highest impact on maternal deaths, provision of contraception; management of labour and delivery; care of preterm births; treatment of severe infectious diseases, including pneumonia, diarrhoea, malaria, and neonatal sepsis; and management of

severe acute malnutrition are found to be most effective in achieving substantial reductions (Black et al. 2016).

Since data on maternal mortality is yet to be published, we can draw some indirect inferences by considering variables that capture the status of maternal health (Table 27.3).

According to Table 27.3, there have been improvements in maternal health outcomes between the two successive rounds of the NFHS (rounds 4 and 5, respectively) in both hill and valley districts. Despite improvements, average OOPE per delivery has also increased between the two rounds for all the districts. Since the cost of delivery remains to be a key factor that influences mothers' decision to opt for institutional deliveries, greater public spending by the state to reduce OOPE on account of deliveries will go a long way in reducing unwanted deaths. The valley districts seem to be performing much better than their hill counterparts if we look at the various parameters of maternal health.

The second sub-goal under SDG 3 targets reductions in neonatal and under 5 child mortality. The diagrams given below illustrate child mortality for Manipur as a whole, for rural and urban areas as well as between the two rounds of the NFHS (district-wise data on child mortality is yet to be published).

There seems to be a reversal in progress made with regards to child health between the two successive rounds of the NFHS for the State if we look at the data for the various child mortality parameters (Fig. 27.1). This reversal can have catastrophic consequences for successful attainment of SDG 3. As per NFHS 5, IMR is higher for rural areas than urban areas in Manipur (Fig. 27.2) Neonatal Mortality and Under 5 Mortality follow similar trends (Fig. 27.2).

Safe births, timely post-delivery care, complete vaccination, and adequate diet go a long way in reducing premature deaths. Adequate nutrition ensures that children wo survive the first year of their births, develop immunity and disease resistance as well as are at lesser odds of developing cognitive impairment which has long term consequences lasting even in adulthood. Children in India have been noted to be wasted and stunted on account of rampant child undernutrition. Table 27.4 looks at the various parameters of child health in terms of the hill-valley districts as well as the district-wise performance between the two rounds of NFHS.

The valley districts perform better than their hill counterparts when it comes to post-natal care, immunisation, and institutional care. In terms of adequate diet, children in the hill districts are marginally better off. Despite better nutrition, children in the hill districts are more stunted, exhibit greater wasting and weight imbalances than their counterparts in the valley districts. The only exception to this trend is the finding that a greater percentage of children in the valley districts are found to be anaemic.

Institutional deliveries and immunisations have improved between the two rounds of NFHS however, the decline in percentage of children receiving adequate diet is a worrying reversal. The percentage of children who were stunted have fallen but the percentage that are waste and severely wasted have increased for all the districts of the state between the two rounds.

Table 27.3 Maternal health (Manipur)

S. No.	Variable	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
1	Women age 15–24 years who use hygienic methods of protection during their menstrual period (%)	Bishnupur	76	80.1	76.3	83.2	Valley districts (average)
		Thoubal	69.8	81.6			
		Imphal East	79.4	76.4			
		Imphal West	80	94.6			
		Chandel	79.9	79.7	74.9	80.6	Hill districts (average)
		Churachandpur	76.5	87.4			
		Senapati	71.7	84.4			
		Tamenglong	67.1	71			
		Ukhrul	79.5	80.6			
2	Mothers who had at least 4 antenatal care visits (%)	Bishnupur	87	77.4	81.9	87.0	Valley districts (average)
		Thoubal	79.7	89.9			
		Imphal East	82.1	87.1			
		Imphal West	78.8	93.4			
		Chandel	42.9	66.6	40.4	57.6	Hill districts (average)
		Churachandpur	60.1	61.3			
		Senapati	39.5	64.9			
		Tamenglong	32.7	56.4			
		Ukhrul	27	38.8			
3	Mothers who consumed iron-folic acid for 180 days or more when they were pregnant (%)	Bishnupur	12.8	30.5	19.5	36.1	Valley districts (average)
		Thoubal	18.8	45.3			
		Imphal East	16.5	31.9			

(continued)

Table 27.3 (continued)

S. No.	Variable	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
		Imphal West	29.9	36.7			
		Chandel	9.3	21	6.0	14.0	Hill districts (average)
		Churachandpur	4.8	11.9			
		Senapati	5	15.6			
		Tamenglong	6.5	9.9			
		Ukhrul	4.6	11.7			
4	Mothers who received postnatal care from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of delivery (%)	Bishnupur	83.8	79	76.0	82.7	Valley districts (average)
		Thoubal	68.9	75.6			
		Imphal East	72.8	85.4			
		Imphal West	78.4	90.8			
		Chandel	39.3	55	39.9	49.6	Hill districts (average)
		Churachandpur	56.8	58.2			
		Senapati	37.4	37			
		Tamenglong	32.3	52.7			
		Ukhrul	33.6	44.9			
5	Average out-of-pocket expenditure per delivery in a public health facility (Rs.)	Bishnupur	8657	16,362	10,574.8	15,564.3	Valley districts (average)
		Thoubal	10,827	13,144			
		Imphal East	11,084	18,578			
		Imphal West	11,731	14,173			
		Chandel	7725	10,920	8051.6	11,150.8	Hill districts (average)
		Churachandpur	6119	10,646			

(continued)

Table 27.3 (continued)

S. No.	Variable	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
		Senapati	9764	12,254			
		Tamenglong	8507	8744			
		Ukhrul	8143	13,190			
6	All women age 15–49 years who are anaemic (%)	Bishnupur	26.8	35.8	27.9	30.7	Valley districts (average)
		Thoubal	28.3	24.2			
		Imphal East	27.3	35.9			
		Imphal West	29.1	26.8			
		Chandel	23.5	27.3	22.4	27.2	Hill districts (average)
		Churachandpur	20.3	32			
		Senapati	25.1	27.4			
		Tamenglong	27	27.3			
		Ukhrul	16	21.9			

Source NFHS 5 District Factsheets (Manipur)

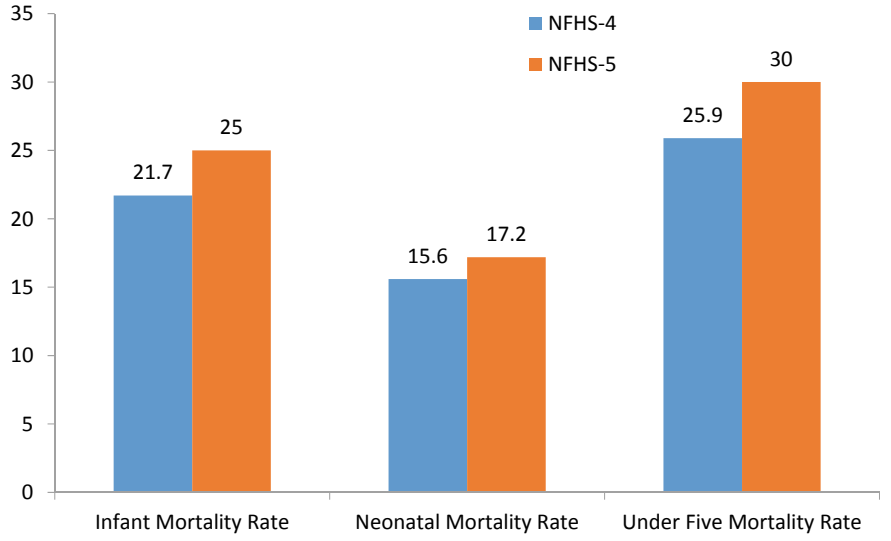

Fig. 27.1 Mortality rates (children) NFHS 4 and 5 (Manipur)

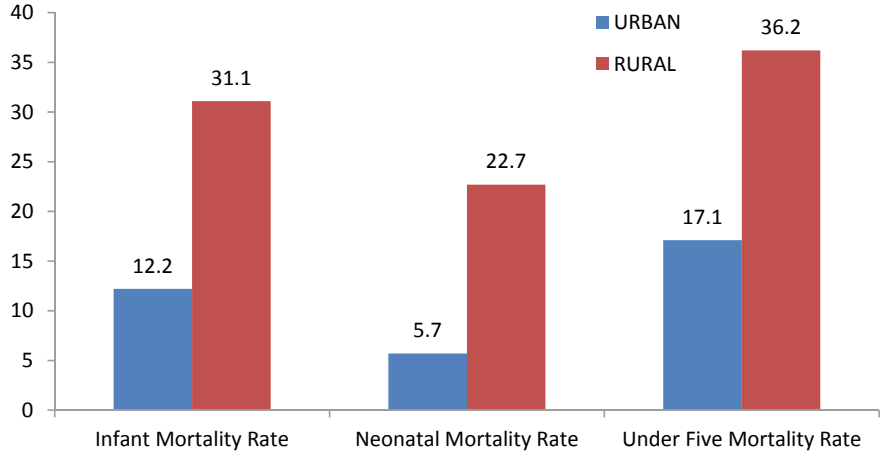

Fig. 27.2 Child mortality Manipur—rural urban (NFHS 5)

These findings mirror the trends in child nutrition parameters at the all-India level. Several States have seen a worsening or a stagnation between 2015 and 2019. According to the Indian Express article (2020), this means that children born between 2014 and 2019, of 0 to 5 years age, are more malnourished than the previous generation. It is a cause of concern since such reversals are unheard of in growing economies with stable democracies. Worsening child malnutrition, increasing levels of anaemia in women, and expecting mothers implies that in the last 5 years, children born

Table 27.4 Child health (Manipur)

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
1	Children who received postnatal care from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of delivery (%)	Bishnupur	na	65.3	0.0	77.8	Valley districts (average)
		Thoubal	na	73			
		Imphal East	na	81			
		Imphal West	na	91.7			
		Chandel	na	51.1	0.0	47.6	Hill districts (average)
		Churachandpur	na	56.8			
		Senapati	na	36			
		Tamenglong	na	49.2			
		Ukhrul	na	44.8			
2	Institutional births (%)	Bishnupur	86.5	89.5	83.1	91.2	Valley districts (average)
		Thoubal	73.5	87.8			
		Imphal East	80.8	91.7			
		Imphal West	91.4	95.7			
		Chandel	38.2	55.5	41.3	55.3	Hill districts (average)
		Churachandpur	63.2	72.9			
		Senapati	38.2	45.8			
		Tamenglong	33.3	57.7			
		Ukhrul	33.7	44.6			
3	Children age 12–23 months (about 2 years) fully vaccinated based on information from either vaccination card or mother's recall (%)	Bishnupur	77.2	66.6	74.5	72.8	Valley districts (average)
		Thoubal	65.4	74.2			
		Imphal East	72.7	76.2			

(continued)

Table 27.4 (continued)

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
		Imphal West	82.8	74.1			
		Chandel	50.6	55.5	49.6	58.4	Hill districts (average)
		Churachandpur	52.2	64.9			
		Senapati	58.7	65			
		Tamenglong	44	67.4			
		Ukhrul	42.4	39.4			
4	Total children age 6–23 months (about 2 years) receiving an adequate diet (%)	Bishnupur	17.4	21.1	19.8	19.1	Valley districts (average)
		Thoubal	17.4	22.9			
		Imphal East	17.6	19.2			
		Imphal West	26.7	13			
		Chandel	11.6	14.2	16.7	20.3	Hill districts (average)
		Churachandpur	11.5	23.6			
		Senapati	14.2	21.9			
		Tamenglong	25.2	26.5			
		Ukhrul	21.2	15.3			
5	Children under 5 years who are stunted (height-for-age) (%)	Bishnupur	24.7	15.5	25.5	20.3	Valley districts (average)
		Thoubal	30.1	31.5			
		Imphal East	26.2	18.4			
		Imphal West	21	15.6			
		Chandel	36.1	34	35.3	28.1	Hill districts (average)
		Churachandpur	35.7	25.1			

(continued)

Table 27.4 (continued)

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
		Senapati	35	27.3			
		Tamenglong	37.1	27.1			
		Ukhrul	32.7	27.1			
6	Children under 5 years who are wasted (weight-for-height) (%)	Bishnupur	6.9	7.9	6.6	9.3	Valley districts (average)
		Thoubal	7	8.3			
		Imphal East	7.8	11.7			
		Imphal West	4.7	9.3			
		Chandel	7.5	8.3	7.5	10.5	Hill districts (average)
		Churachandpur	6.6	12.1			
		Senapati	8.2	10.7			
		Tamenglong	8.2	9.6			
		Ukhrul	7.2	11.6			
7	Children under 5 years who are severely wasted (weight-for-height) (%)	Bishnupur	2	2.1	1.9	2.6	Valley districts (average)
		Thoubal	1.7	2.9			
		Imphal East	2.4	2.4			
		Imphal West	1.3	3.1			
		Chandel	3.1	3.2	3.0	4.6	Hill districts (average)
		Churachandpur	2.5	5.8			
		Senapati	2.5	5.5			
		Tamenglong	3.9	3.2			
		Ukhrul	3.2	5.3			

(continued)

Table 27.4 (continued)

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
8	Children under 5 years who are underweight (weight-for-age) (%)	Bishnupur	13.7	11.7	14.3	12.8	Valley districts (average)
		Thoubal	17.9	14.9			
		Imphal East	17.1	14.4			
		Imphal West	8.4	10.2			
		Chandel	13.2	14.7	13.3	14.5	Hill districts (average)
		Churachandpur	11.3	9.8			
		Senapati	14.7	12.9			
		Tamenglong	16.3	19.3			
		Ukhrul	11.1	16			
9	Children under 5 years who are overweight (weight-for-height) (%)	Bishnupur	2.1	3.1	2.4	2.8	Valley districts (average)
		Thoubal	3.1	4.9			
		Imphal East	1.5	0.5			
		Imphal West	3	2.6			
		Chandel	4.1	8.7	4.2	4.7	Hill districts (average)
		Churachandpur	3.1	4.5			
		Senapati	6.2	6.7			
		Tamenglong	4	1.6			
		Ukhrul	3.5	2			
10	Children age 6–59 months who are anaemic (<11.0 g/dl) (%)	Bishnupur	21.4	42.4	24.1	43.6	Valley districts (average)
		Thoubal	24.9	39.7			
		Imphal East	20.8	50.3			

(continued)

Table 27.4 (continued)

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
		Imphal West	29.3	41.8			
		Chandel	28.4	42.4	23.5	40.7	Hill districts (average)
		Churachandpur	17.5	41.1			
		Senapati	22.8	48.5			
		Tamenglong	22.9	37			
		Ukhrul	26.1	34.6			

Source NFHS 5 District Factsheets (Manipur)

are likely to suffer from both cognitive and physical deficiencies. Between NFHS-3 (2005–06) and NFHS-4 (2015–16), significant reductions in child malnutrition were achieved due to interventions such as nutrition missions, ICDS, MGNREGA, and expansion of Public Distribution System. So, this means that in terms of health, the country has taken a turn for the worse since 2015 despite improvements in availability of clean drinking water and sanitation. This will pose severe challenges to the achievement of SDG targets.

The sub-goals 3, 4, 5 and 10, target epidemics, premature deaths from non-communicable diseases and communicable diseases as well as strengthening of the prevention and treatment of substance abuse, narcotic drug abuse and the implementation of tobacco control. Table 27.5 illustrates information on disease burden as per the district-wise factsheet of NFHS 5. More people in the valley districts suffer from the burden of non-communicable diseases and problems of substance abuse.

The disaggregated achievements at the district level provide a mixed picture and their implications on SDGs particularly, SDG 3, is discussed in further detail in the next section. Overall, the valley districts seem to be preforming better than the hill districts. There seems to be a clear hill-valley divide in the health status of Manipur. Figure 27.3 illustrates the percentage of children under 5 years of age who are stunted for the various hill-valley districts. Similarly, Figs. 27.4 and 27.5 portray the divide in terms of wasting, and severe wasting, respectively which is confirmed by Fig. 27.6. Figures 27.7, 27.8 and 27.9 illustrate a similar divergence in terms of maternal health and disease burden. The better performance of valley district in maternal and child health parameters could be on account of higher per capita spending on and consumption of health services, better provision of health infrastructure and personnel in the valley regions which have a greater political and economic presence and have historically been favoured in policymaking and resource allocation.

The divergence in the performances of the hill and valley districts in health outcomes will not only act as a hurdle to the actualisation of SDG 3 but also, overall SDG goals apart from slowing down the process of human development of the people of Manipur. These gaps, if allowed to persist will create further intensification of ethnic strife, polarisation, and socio-economic conflict in the State which will drag down its economic growth and prosperity eventually.

27.4 Challenges to the Achievement of 'Health and Well-Being for All' in Manipur

The achievement of SDG3 objectives in Manipur will depend on both, the demand (affordability and accessibility) for healthcare and supply (availability) of healthcare. As much as the provision of healthcare by both the state and private player, i.e. the availability is important, the affordability and accessibility of healthcare by the households also plays a vital role in meeting the healthcare needs. A range of

Table 27.5 Manipur disease burden

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
88	Blood sugar level—high or very high (>140 mg/dl) or taking medicine to control blood sugar level (%) (female)	Bishnupur	na	13.4	0.0	14.1	Valley districts (average)
		Thoubal	na	10.6			
		Imphal East	na	15.9			
		Imphal West	na	16.6			
		Chandel	na	13.4	0.0	11.3	Hill districts (average)
		Churachandpur	na	13.5			
		Senapati	na	9.8			
		Tamenglong	na	11.7			
		Ukhrul	na	7.9			
91	Blood sugar level—high or very high (>140 mg/dl) or taking medicine to control blood sugar level (%) (male)	Bishnupur	na	15.8	0.0	17.3	Valley districts (average)
		Thoubal	na	12.9			
		Imphal East	na	18.5			
		Imphal West	na	21.8			
		Chandel	na	14.5	0.0	13.0	Hill districts (average)
		Churachandpur	na	15.2			
		Senapati	na	10.9			
		Tamenglong	na	12.7			
		Ukhrul	na	11.7			
94	Elevated blood pressure (systolic ≥ 140 mm of Hg and/or diastolic ≥ 90 mm of Hg) or taking medicine to control blood pressure (%) (female)	Bishnupur	na	23.6	0.0	24.1	Valley districts (average)
		Thoubal	na	23.2			
		Imphal East	na	21.9			
		Imphal West	na	27.5			
		Chandel	na	21.7	0.0	20.1	Hill districts (average)
		Churachandpur	na	16.3			
		Senapati	na	18.7			
		Tamenglong	na	21.5			
		Ukhrul	na	22.3			
97	Elevated blood pressure (systolic ≥ 140 mm of Hg and/or diastolic ≥ 90 mm of Hg) or taking medicine to control blood pressure (%) (male)	Bishnupur	na	31.3	0.0	34.8	Valley districts (average)
		Thoubal	na	33.4			
		Imphal East	na	36			
		Imphal West	na	38.4			
		Chandel	na	28.2	0.0	27.2	Hill districts (average)
		Churachandpur	na	25.2			
		Senapati	na	28.2			
		Tamenglong	na	29.4			

(continued)

Table 27.5 (continued)

S. No.	Variable name	District	NFHS 4	NFHS 5	NFHS 4	NFHS 5	
		Ukhrul	na	25			
101	Women age 15 years and above who use any kind of tobacco (%)	Bishnupur	na	48.8	0.0	43.6	Valley districts (average)
		Thoubal	na	47.9			
		Imphal East	na	39.6			
		Imphal West	na	38			
		Chandel	na	47.9	0.0	41.2	Hill districts (average)
		Churachandpur	na	62.1			
		Senapati	na	46.1			
		Tamenglong	na	17.2			
		Ukhrul	na	32.9			

Source District Factsheet NFHS 5

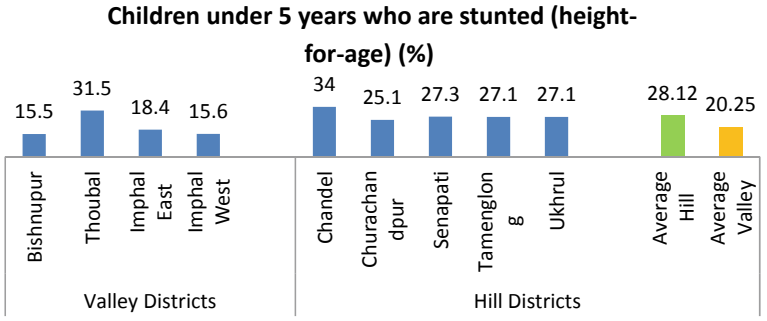

Fig. 27.3 Hill-valley divide (stunting)

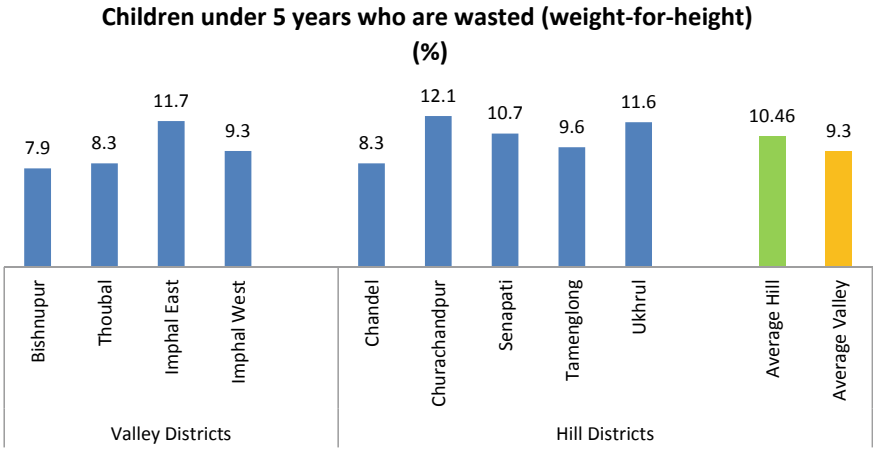

Fig. 27.4 Hill-valley divide (wasting)

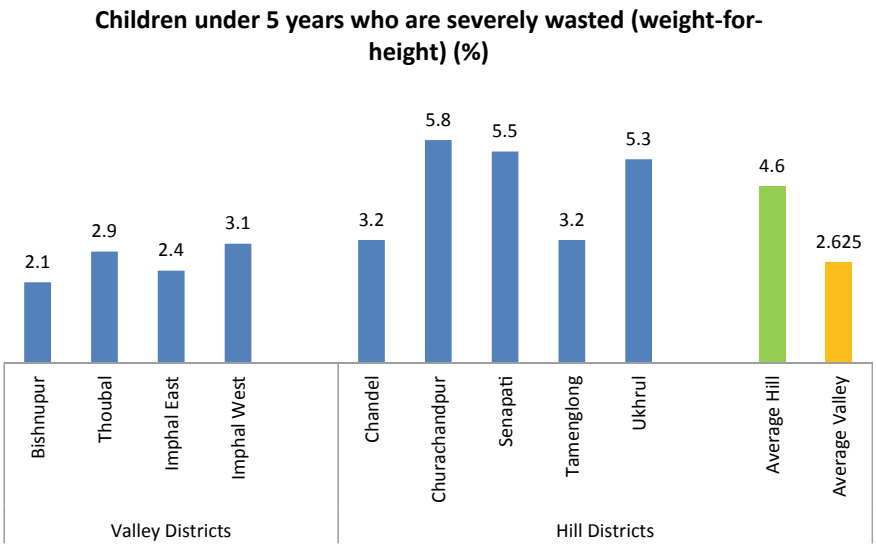

Fig. 27.5 Hill-valley divide (severe wasting)

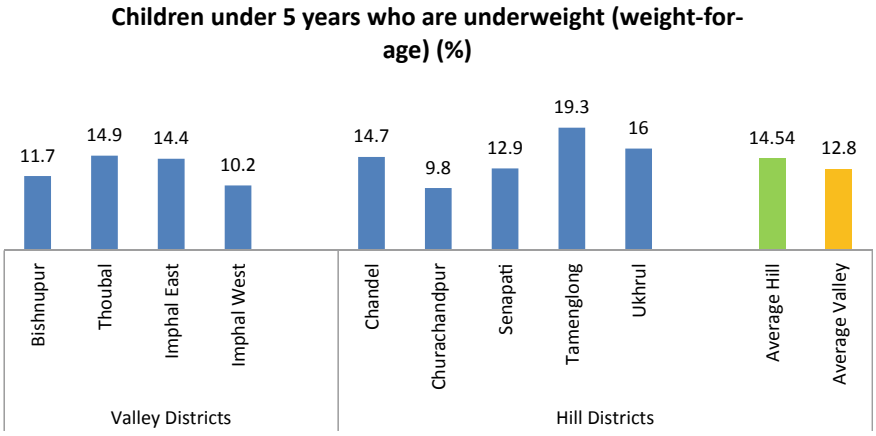

Fig. 27.6 Hill-valley divide (underweight children)

factors from both supply and demand side which can act as a barrier in achieving the objectives of SDG 3 and whether the hill-valley divide shall act as an additional constraint needs to be examined.

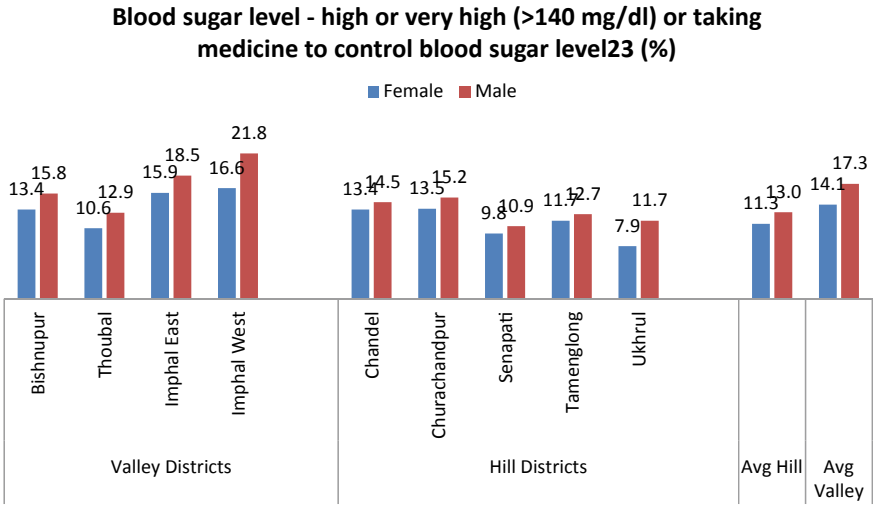

Fig. 27.7 Chronic diabetes in the districts of Manipur (female)

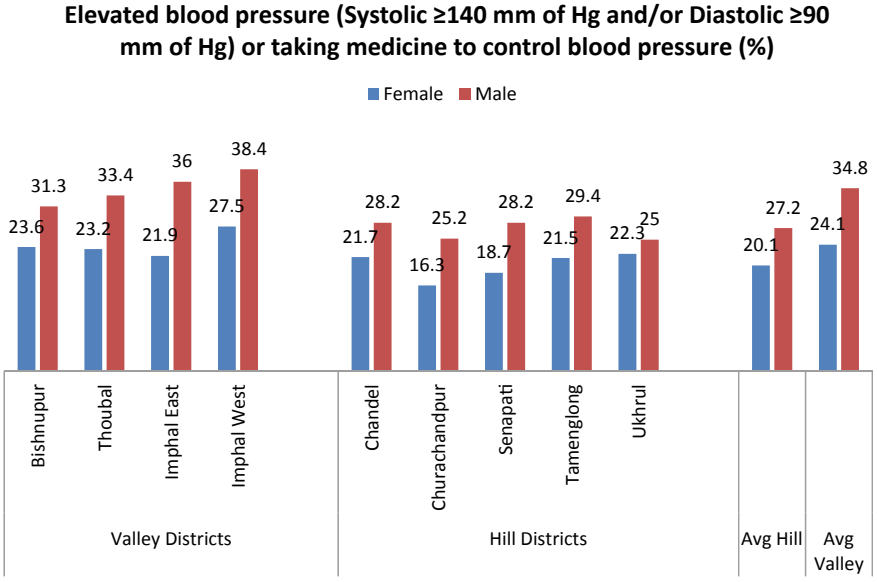

Fig. 27.8 Hypertension

27.4.1 Health Financing

The importance of public health financing can be seen in its role in not just in provision of better healthcare for people but also, in terms of protecting its citizens

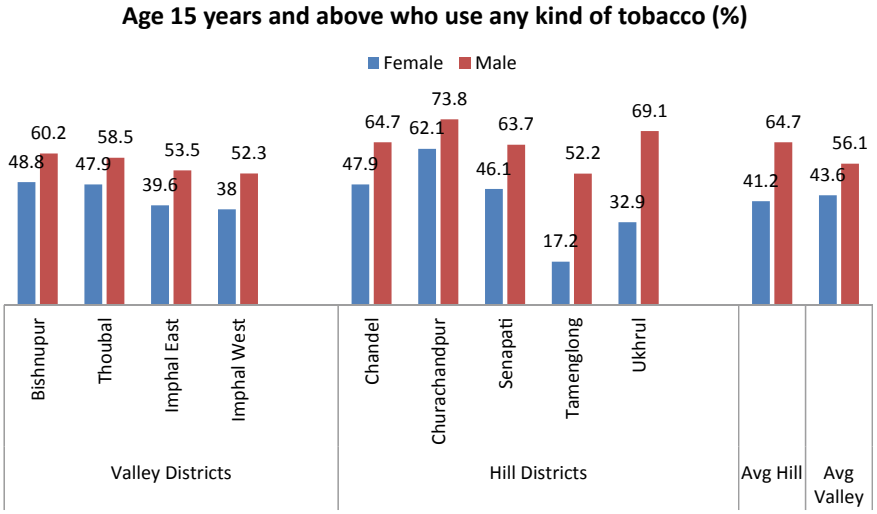

Fig. 27.9 Use of harmful substances-tobacco (female)

from impoverishment due to catastrophic health expenditures. According to budget estimates for fiscal year 2018 (BE) 1.28% of India's GDP was spent on public health, amongst the lowest in the world. According to Baru et al. (2010), in India '*the low public investment in health services over the last six decades has been a significant cause for the poor functioning and utilisation of public services.*' The low public health spending has led to not only high OOPE by households but is also believed to be one of the important causes of impoverishment in India (Berman et al. 2010).

Table 27.6 shows that the per capita expenditure on health by Manipur is higher than both the all-India average as well as that of Kerala (NHP 2019). The North Eastern States have higher public spending on health than the national average. Public expenditure per capita on health in Manipur is higher compared with all India and Kerala.

Although Manipur's public expenditure on health is not low compared to other states in India, it is still extremely low compared to the developed countries (United States: 16.3%, WB 2018) The low level of public financing in healthcare will hinder

Table 27.6 Comparison on the extent of public health financing between India, Manipur, and Kerala (the 'best performer' State in the SDG health rankings)

Indicator	India	Manipur	Kerala	NE states
Per capita public expenditure (Rs.)	1657	2061	1463	2878
Public expenditure as a % of GSDP	1.28	2.79	0.93	2.76
Health expenditure as a % of total state expenditure	–	5.45	5.85	6.30

Source NHP (2019)

Table 27.7 OOPE in Manipur (amount in rupees)

Indicators	Manipur rural	Manipur urban	India rural	India urban
OOPE per hospitalised case (Rs.)—All	5743	9731	14,473	21,985
OOPE per child birth (Rs.)—All	6488	10,116	5518	11,033
OOPE per non-hospitalised ailing person (Rs.) in last 15 days—Public	1369	1292	404	395
OOPE per non-hospitalised ailing person (Rs.) in last 15 days—Private	1719	1045	649	778

Source NSSO 71st Round: Social consumption on health January–June 2014

the achievement of the SDG 3 objectives since it will restrict the availability, accessibility, and affordability of healthcare. Households and individuals tend to rely on private facilities in the absence of publicly provided healthcare which increases their out-of-pocket expenditure on healthcare.

The OOPE per childbirth and per non-hospitalised ailing person in last 15 days-both public and private are much higher than the India average (Table 27.7). Given that public expenditure per capita in Manipur is higher than India average, the higher OOPE expenditure could be due to higher spending on non-medical component due to poor availability of sound, easily accessible infrastructure. The rural–urban differential in OOPE per non hospitalised ailing person in the last 15 days in private sector may be an indicator of the same.

27.4.2 Infrastructure

Although the correlation between physical infrastructure and health outcomes is not fully established (Datar et al. 2007), the existence of sound healthcare infrastructure is considered one of the important factors in determining the child and maternal health. The availability of rural health infrastructure in the north eastern states is said to be one of the poorest amongst the regions of the country with acute shortage of health centres (Saikia and Das 2016).

The Annual Report of Ministry of Health and Family Welfare, Government of India (2014–15) listed the various problems in the heath sector in the north eastern states as '*shortage of trained medical manpower, provision of access to sparsely populated, remote, far flung areas, improvement of governance in the health sector, including improved quality of health services rendered and effective, timely and full utilisation of existing facilities.*' In North-East India, the average availability of health worker such as total number of government allopathic doctors and total number of registered nurses and midwifes are minimum with respect to the other Indian states (Table 27.8).

Table 27.8 Availability of doctors at PHCs in Manipur in 2019

Area	Required	Sanctioned	In position	Vacant
Urban	9	NA	18	NA
Rural	90	238	208	30

Source HFW statistics in India 2019–20

In Manipur, the shortage of infrastructure provision can be seen also in the unavailability of various health care facilities in SHCs. Hossain (2015) noted that Manipur is one of the few states with lower percentage of PHC with labour room and no facility of operation theatre. It is also the worst performing in terms of unavailability of electricity, regular water supply and no ANM living in staff quarters. In most of the districts, specialist care providers were not posted in the community health centres (CHCs) except one obstetrics/gynaecologist in Bishnupur-Imphal (East), one paediatrician each in Thoubal and Imphal West and one anaesthetist in Ukhrul. There are only two functional operation theatres in all the CHCs of the state, one each in Senapati and in Imphal East (DLHS-4). Manipur however is a better performer than the national average in terms of many PHCs located on approachable, motorable road.

The more widespread shortage of health infrastructure in the hilly districts of Manipur compared to the valley district can be seen from the differences in proportion of assisted births between the hill and valley districts. The number of assisted births by a skilled health professional in two valley districts of Imphal East and Imphal West are 93% and 98%, respectively, compared to the hilly districts of Tamenglong and Ukhrul, which stand at 69.9% and 54.3% (NFHS 5).

The other indicator for the shortage of infrastructure and the differences in the availability of healthcare infrastructure between the hill and valley districts is the percentage of institutional births. The lower percentage in all the hill districts compared to the valley districts could be due to the poor availability of resources such as labour room, new-born care services, referral services for delivery, in the PHCs of hill districts compared to the valley (DLHS 4) (Fig. 27.10).

Another indicator which can be used to examine the availability, accessibility and affordability of maternal healthcare is the ANC visited and completed and the post-natal care accessed (Table 27.9).

There is a slight improvement in maternity care accessed from NFHS-4 to NFHS-5. The hill-valley disparity can be seen in the lower proportion of women completing 4 ANC visits (Fig. 27.11) and receiving post-natal care within two days of delivery (Fig. 27.12) in the hill districts. The percentage of mothers receiving post-natal care within 2 days of delivery is lower in all hill districts compared to valley district, especially in Senapati and Ukhrul. The reason for this could be the complete absence of PHCs having newborn services and referral services for delivery in Senapati, Ukhrul and Chandel. There is no delivery referral service in Churachandpur as well (DLHS 4, MoHFW).

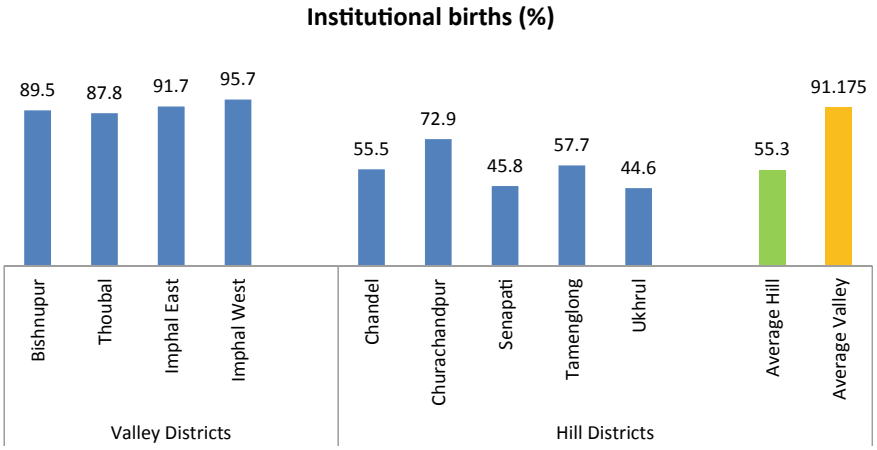

Fig. 27.10 Institutional deliveries

Table 27.9 Maternity care accessed

Indicator	NFHS 5	NFHS 4
Mothers who had an antenatal check-up in the first trimester (%)	79.9	77
Mothers who had at least 4 antenatal care visits (%)	79.4	69
Mothers who received postnatal care from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of delivery (%)	73.4	64.6

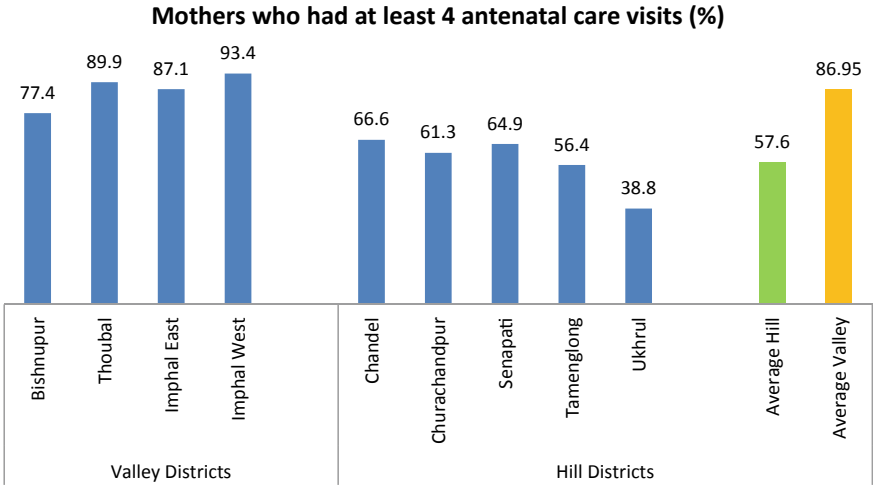

Fig. 27.11 Antenatal care

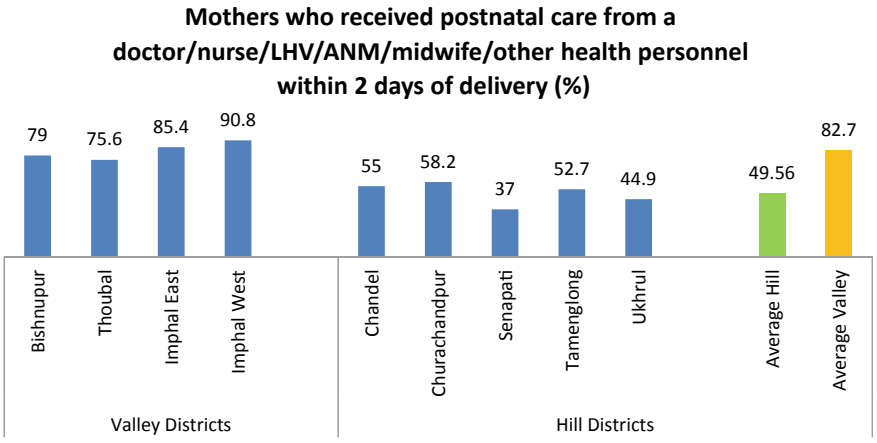

Fig. 27.12 Postnatal care

The availability and accessibility of healthcare for children can be seen from children being given post-natal care after birth and extent of completed immunisation. The hill-valley differential is depicted in Figs. 27.13 and 27.14, respectively.

The performance of the hill district in receiving postnatal care and achieving full vaccination for children is again worse than the valley districts. The hill districts' poor performance reflects either the shortage of infrastructure in the hills, better awareness in the valleys or the differences in out-of-pocket expenditure incurred on non-medical items in the hills due to transport constraints.

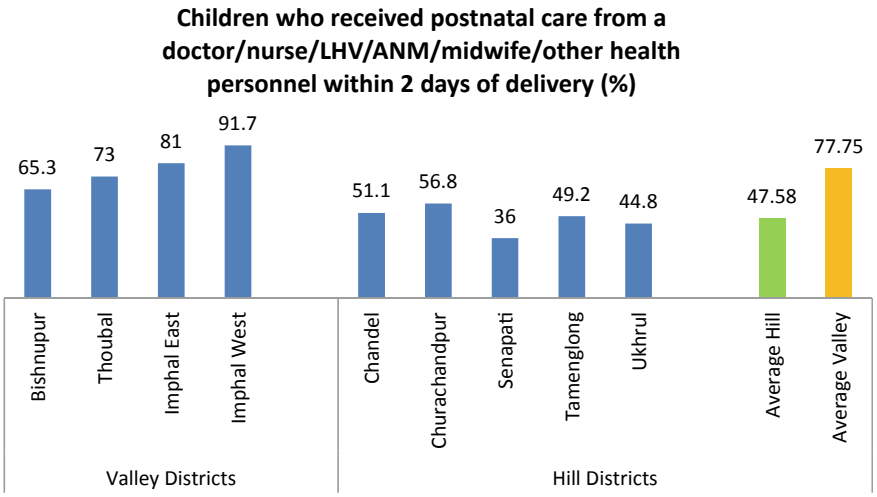

Fig. 27.13 Postnatal care (children)

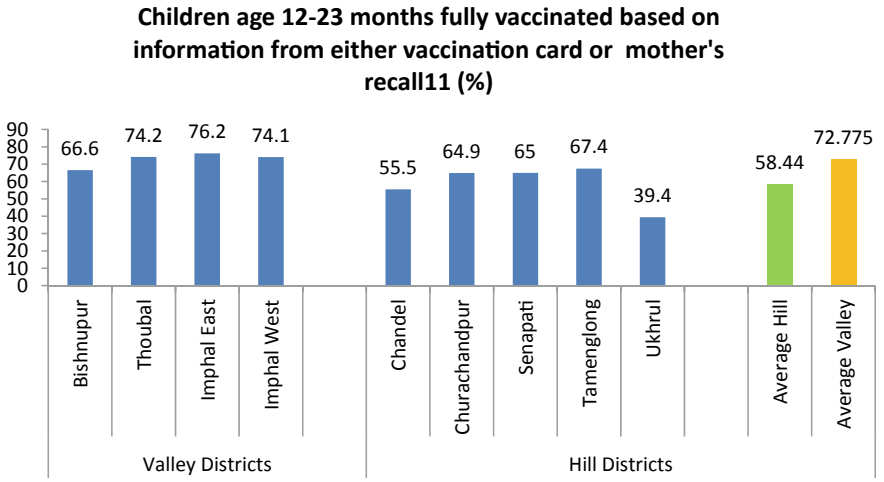

Fig. 27.14 Complete immunisation

Poverty is both a cause and a consequence of poor health and healthcare. Various studies have shown the link between ill health and poverty (Van Doorslaer et al. 2006; Noponen and Kantor 2004; Heltberg and Lund 2009). Poverty limits the economic access to health care and poor health decreases the productivity and income earning potentials of the individuals and households. The growing incidences of catastrophic expenditure due to health-care costs are one of the major contributors to poverty. Resorting to unsustainable methods of financing healthcare by household can lead to poverty. Studies have argued that specifically the debt for healthcare has robust associations with poverty creation (Das Gupta et al. 2009; Krishna 2006). The percentage of households with any usual member covered under a health insurance/financing scheme is extremely low for the state at 14.2% which is much lower than the all-India average (NFHS 5).

Table 27.10 shows the inter-district differences in the percentage of households with members covered by health insurance. The percentage in two valley districts of Bishnupur and Imphal East are extremely low although the differences in the hill-valley average is not too large.

In the absence of health insurance and extremely low public expenditure on health, OOPE will increase, which are often financed through savings or in extreme cases, selling assets, borrowing money, and reducing expenditure on other basic needs. Existing literature has shown that these strategies may jeopardise household livelihoods and push people to current or structural poverty, especially for those more vulnerable (Kipp et al. 2006; Ngatula et al. 2002; Piot et al. 2007).

The absence of or low existence of health insurance could also be due to factors such as low awareness, unavailability of products in the market or poverty. In extreme cases poor households with no health insurance and financing could also refrain from seeking medical treatment. This will act as a barrier to the achievement of the SDG 3.

Table 27.10 Households with any usual member covered under a health insurance/financing scheme

Variable name	District	NFHS4	NFHS5	NFHS 4	NFHS 5	
Households with any usual member covered under a health insurance/financing scheme (%)	Bishnupur	4.2	9.3	4.5	12.8	Valley district (average)
	Thoubal	4	19.1			
	Imphal East	6.1	7			
	Imphal West	3.7	15.7			
	Chandel	1.1	16.1	1.5	16.7	Hill district (average)
	Churachandpur	2	18.2			
	Senapati	0.6	15.4			
	Tamenglong	2.6	16.8			
	Ukhrul	1.1	17			

Source District Factsheet NFHS 5

The data on Unmet need for family planning amongst currently married women age 15–49 years (Fig. 27.15) and iron-folic acid consumption amongst expecting mothers (Fig. 27.16) can also be another indicator of the demand–supply mismatch used to capture low availability of healthcare services.

New et al. (2017), study on 'estimations and projections of levels and trends in family planning methods found Manipur to be amongst the states with greater need of attention amongst the states to achieve the SDG target of the use of modern contraception of 75% by 2030.

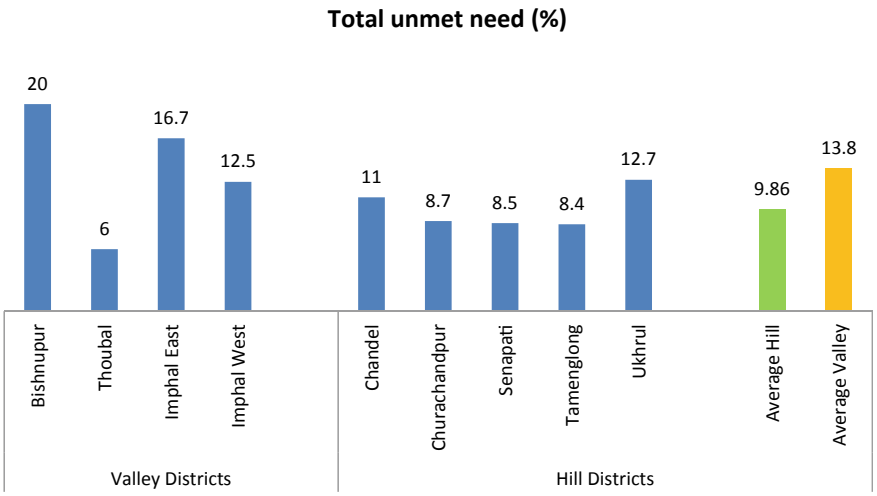

Fig. 27.15 Unmet need for various modes of contraception

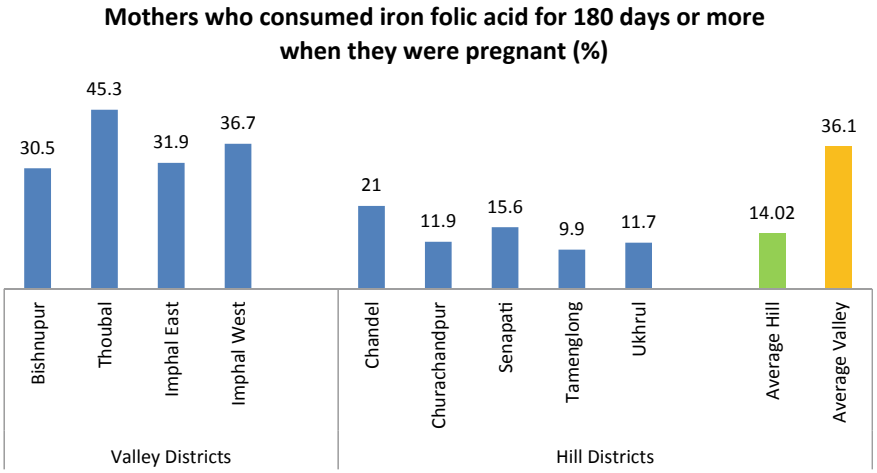

Fig. 27.16 Consumption of supplements in pregnancy

27.4.3 Other Challenges

There can be other factors beyond institutional inadequacy which might lessen healthcare provision in Manipur such as shown by Sinha et al. (2013) findings of a small but steady rise in violence against health workers and health institutions impeding health services in Manipur's pervasive violence. The challenges posed by COVID-19, in terms of shifting priorities of the health systems, restricting the capacity to provide certain services (Khetrapal and Bhatia 2020) as well as the impact on source of livelihoods (Harris et al. 2020) could worsen the health especially of women and children. The demand for resources and the huge financial implications for the achievement of SDG objectives could also be an added challenge.

27.5 Conclusion

Manipur's performance in SDG India Index 2.0 and the hill-valley differences in various health indicators highlights the need for greater investment in health as well as, the need to identify and bridge various gaps in provisioning and access of healthcare services. The State has made significant progress but much still needs to be done. The recent findings of the NFHS 5 then seem to point towards a possible reversal in the progress made thus far. The neonatal mortality between rounds 4 and 5 of the NFHS has risen from 15.6 to 17.2 deaths per thousand live births, the value for rural areas reaching as high as 22.7. Similarly, infant mortality has risen to 25 deaths per thousand live births from 21.7 in the previous round. For rural areas, the figure is a high 31.1 deaths per thousand live births. The TFR in the urban areas has fallen

below replacement levels however, the state average is still above it at 2.2 due to high fertility in the rural areas. These figures are indicative of the hill-valley divide as well as a rural–urban gap since much of the hilly regions of the state are rural in nature.

Further compounding the health disparities is the long persisting problem of infrastructural bottlenecks in the region. The demand–supply side mismatch and the acute shortfalls on the supply lead to problems of availability, accessibility, and affordability of healthcare services. This is avoidable and unfortunate since right to health is an individual's basic right.

Since the objective of good health cannot be gained in isolation, it is important to understand the effect that all the other goals have on health with some of them being proximate and direct social determinants. It is important for the government to understand where the barriers are coming from and thus taking the necessary steps for redressal. Coordination amongst different departments and stakeholders is key. Perhaps, the government can tap into locally influential groups and NGOs to realise success on the ground. A long road lies ahead as far as the realisation of SDG 3 targets is concerned.

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Chapter 28
An Analytical Study on the Inseparable Relations Between Food, Population, Arable Land and Economy in Manipur from the Perspective of Sustainability

Irom Luckychand Meitei and Gurumayum Jadumani Sharma

Abstract Sustainability becomes the very need of the hour as it is the ripe time to examine whether the present trend of various human activities of their own in Manipur, be in favour of sustainable development or not. Various unjust and unscientific anthropogenic phenomena have seen and known to be occurring for many years in the state. The unavoidable relationship between land, people and economy are not good from the perspective of sustainable development. Topographical features of Manipur is nice to look at but the distribution and density of population is not good, notwithstanding it is highly unreasonable as maximum population is settled in the minimum land. This leads congestion, pollution and loss of valuable arable land. Haphazard expansion of urban area mainly in the central valley of the state, migration towards this small valley from all sides, fast trend of conversion of paddy land and homestead arable land to built-up areas, rapid population growth and population density, insufficient crop production and productivity, unemployment due to lack of industries, low per capita income and bad connectivity with outside states and foreign nations and deforestation in the hilly areas, etc., have been emerging as major impediments in the path of sustainable development. If such hindrances are not removed the people of Manipur cannot survive well and good in future. Reallocation of population uniformly all over the state is a must to bring in sustainable development. Immediate checking and banning of intrusion to paddy land, to improve connectivity both internally and externally are highly needed as much as possible. Manipur being a tropical monsoon state has opportunity to conserve, harvest water to be used in lean season and other areas where water is not sufficient through irrigation. We should try these good activities as far as possible with a hope for overall development in the lines of sustainability.

Keywords Sustainability · Migration · Population · Arable land · Man-land ratio

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28.1 Introduction

The sustainable development goals (SDGs) are also called the global goals. The member states of all United Nations adopted it in 2015 as a universal call to action mainly to eradicate property, protect the planet and ensure that all people enjoy peace and prosperity by the year 2030 (SDG, n.d). There are 17 sustainable development goals just to change our world some of which are concerned with poverty, hunger, health and well-being, quality education, clean water and sanitation, affordable and clean energy and decent work and economic growth. Other goals are industry, innovation and infrastructure, reducing inequality, sustainable cities and communities, responsible production and consumption, climate action, life below water, life on land, peace and justice strong institution and partnership to achieve the goals. People, prosperity, planet, partnership and peace also known as SPs of 2030 Agenda of sustainable development (SDG, n.d).

Sustainability is the foundation of sustainable development, which is made up of three pillars viz. the economy, society and environment, sometimes informally treated as profit, people and planet (3 Pillar, n.d).

Manipur is a hilly small state located in the north-eastern part of Indian mainland. The geographical area is 22,327 km^2extending from 23° 51′ N to 25°41′ N latitude and 93° 02′ E to 94° 47′ E longitudes, respectively (Sanajaoba, 1988). Most parts of state belong to hilly topography while a small central portion is almost plain with small hillocks (Fig. 28.1). The central fertile valley portion represents about 10% of total geographical area of the state. As many as 20,089 km^2 represents the hill ranges and their small valleys. Even though the central valley is small in its areal extent, it is very fertile plain from which maximum basic agricultural production is achieved (B. K. n.d.). This small area supplies almost all the requirements of people who are inhabited in the state. Nearly 70% of the total population depend their livelihood on agriculture and its allied activities.

Climatically, the state enjoys subtropical monsoon climate which is favourable for cultivation of paddy and other sub-tropical crops (Modern Climate. n.d.). Paddy represents the dominant crop as it is consumed by all the inhabitants in Manipur (Bidyapati and Kaushal 2020). In fact, rice is the soul of everyone without which no one can live in the sense not only that for eating but also for acquiring other basic requirements such as purchase of clothes, utensils, building materials, vehicles and expenditure for education, health care and luxury items, etc. In the meantime, the number of population has been increasing. Unfortunately, the process of urbanization is not a systematic as the urban area is expanding haphazardly. The rate of urbanization is very high in central valley due to many pull factors.

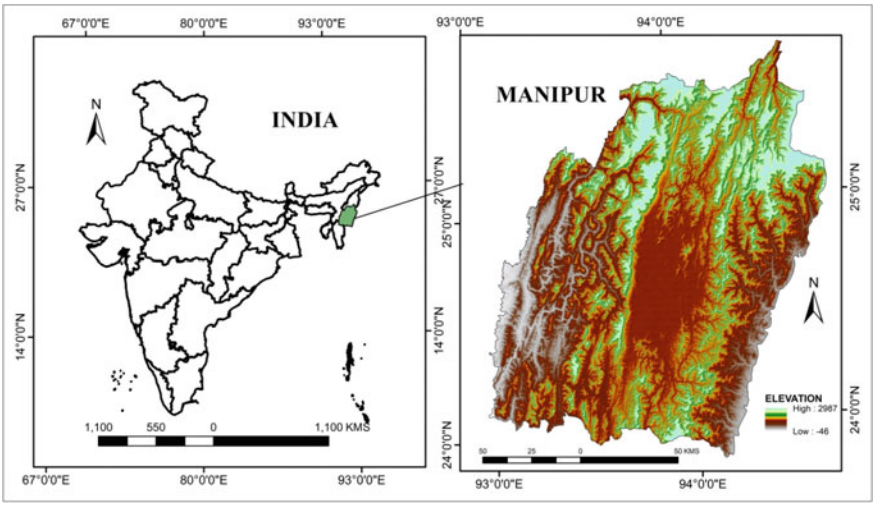

Fig. 28.1 Study area

28.2 Inseparable Relations Between Food, Population, Arable Land and Economy

Some vital pull factors of the central valley include the fertile plain area, nature of its topography, better health care facilities, better job opportunities, better infrastructure, concentration of major government offices and institution, good accessibility. In fact, the central valley is the state's growth centre where almost all kinds of activities exist. Because of having all such factors here in the central valley the rate of urbanization is very fast. All types of migration are even though found herein, the highest rate of migrations is rural to urban migration and hilly to valley migration (*Census of India: Migration.* n.d.). The MLR & LR Act of 1960, intends to bring about uniformity in distribution of land throughout the state, however, Section 2 of the Act says, 'it extends to the whole of the state of Manipur except the hill areas there of'. Non-tribal people of Manipur are not allowed to settle in hilly areas due to this provision (Sec—2 of MRL & RL).

On the other hand, tribal of hill area can settle both in central valley and hilly areas of the state (Kipgen, 2018). This is really concerned with politics of the state. If we viewed from the perspective of geographical aspect, it may be quite unfortunate as about 90% of the state's total geographical area belongs to hilly areas while only about 10% represents valley area in the heart of Manipur (Table 28.1 and Fig. 28.2).

According to 2011, census of the valley (around 10% total area of Manipur) supports 57.2% of the total population of the whole state which is less than half, i.e. 42.8% of the total population of the state spreads inappropriately over larger hilly areas (about 90% of the total land surface area of the state). Such type of situation

Table 28.1 Geographical area and district-wise population of Manipur

District	Area		Population	
	km^2	% to total	'000	% to total
Senapati (Hills)	3271	14.7	479	16.8
Tamenglong (Hills)	4391	19.7	141	4.9
Churachandpur (Hills)	4570	20.5	274	9.6
Chandel (Hills)	3313	14.8	144	5.0
Ukhrul (Hills)	4544	20.3	184	6.5
Imphal East (Valley)	709	3.2	456	16.0
Imphal West (Valley)	519	2.3	518	18.1
Bishnupur (Valley)	496	2.2	237	8.3
Thoubal (Valley)	514	2.3	422	14.8

Source Office of the Registrar General of India

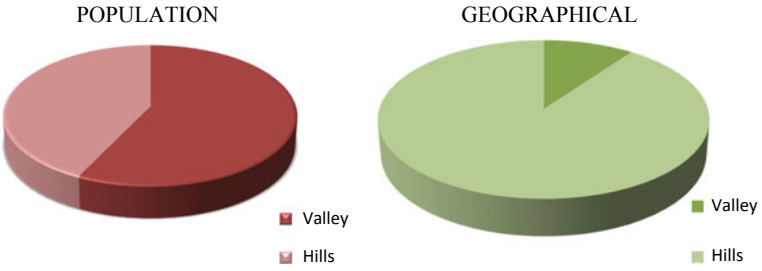

Fig. 28.2 Comparison of population and geographical area between hilly and valley region of Manipur

has been creating a lot of unbearable pressure on the very small fertile area of the central valley.

In the meantime, population growth in the state is also high. In 1961, the population of Manipur was only 780,037, but in 2011 it rises up to 28 55,704. However, the aerial extend of the land surface is not increased (Table 28.2).

Hence, man-land ratio becomes higher giving heavy pressure on land. Almost everyone all over the world especially in developing part is not fully aware of the environment which supports us consistently. For instances, many forests have been destroying ever since the dawn of industrial revolution (Rafferty, n.d.), most of the fertile arable lands have been covered with build-up areas, water has been polluted at a very fast rate, and we human being have exhausted so many non-renewable resources without any care for future, etc. In most of such things, there are problems of food shortage and scarcity which creates starvation, malnutrition, etc., in the developing and underdeveloped countries (Kramer and Allen 2015). In this respect, most of the rich people involved in food wastage recklessly. It ultimately leads to social turmoil and it expands up to state and national levels and sometimes up to

Table 28.2 Population growth of Manipur

Year	Total decadal increase of population (lakhs)	Decadal growth (%)
1961	7.80	–
1971	10.73	24.80
1981	14.21	24.66
1991	18.37	23.85
2001	22.94	21.56
2011	28.56	17.70

Source Office of the Registrar General of India

global level. Poverty, food shortage, unemployment and haphazard urban growth are the common burning issues in Manipur which are quite related with sustainability (Sharma, 2016,).

Except a few, Manipuris are poor people on an average. There is no big industry which provides jobs to large population. The projected per capita income of the people of the state at current price in 2019–20 is found to be Rs. 79, 296 only (Department of Economic and Statistics, 2020**).** It is only around half of the national value and much below the average of the developed countries of the globe. Most people eat rice, fish, meat and vegetables and pulses (Kumar, 2012). They do not fully follow the items of balance diet daily especially rice and one or other curry is consumed.

Manipur for its survival depends heavily upon neighbouring and different far-flung states and countries which is a distinct expression of non-sustainability. Starting from kitchen items including foods to various items such as clothes, paper and stationary items, oil and other items such as petroleum products, hardware, software, scoter, car, jeep, heavy vehicles, heavy machine and electronic items have been imported mainly from outside. Industrial development is almost negligible in the state, leading to mass unemployment. Consequently, an overlapping small business comes up within a short span of time which gives them small returns. The oldest and the largest economic activity in the state are the agriculture and its allied activities on which largest number of people earn their livelihood for years and years. At present time, also it becomes the main source of income for survival both in valley and hilly areas.

The other unfortunate situation here reflects in relation to the ratio of land and people. The density of population is increasing day by day due to both natural increase and migration (Table 28.3). Both urban and rural cultivable land are being changed into built-up land since the urban-sprawl is taking place in suburb areas and along the national and state highways and also both sides of district and inter-villages roads.

In spite of imposing restrictions by the government, some people still continue to construct various houses and business buildings like school, malls, workshop, restaurants, gardens, brick fields, sports complex, private hospitals and car show room and big buildings of various departments of state and central government, etc. (Fig. 28.3).

In the olden days, the state has enough land in and around a house and such land have been using for cultivation of different seasonal crops and vegetables and other

Table 28.3 Population density of Manipur (2011)

District	Area km^2	Population (lakhs)	Density (person/km^2)
Senapati	3271	4.79	146
Tamenglong	4391	1.41	32
Churachandpur	4570	2.74	60
Chandel	3313	1.44	44
Ukhrul	4544	1.84	40
Imphal East	709	4.56	643
Imphal West	519	5.18	998
Bishnupur	496	2.37	479
Thoubal	514	4.22	821

Source Population Census of India, 2011

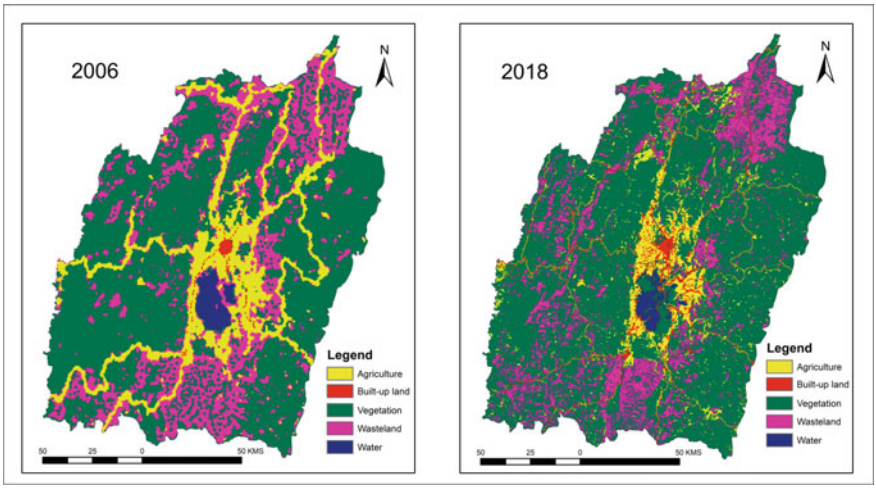

Fig. 28.3 LULC of Manipur

horticultural plants just to support the owner's day to day requirements, sometimes the surplus are sold off to neighbours. Such lands are now devoted for the construction of dwelling places and other buildings to be used for business. In fact, the earlier sparse settlement pattern has turned to compact and semi compact pattern which brings the two houses so close to each other and also two towns or villages so nearer at present. So all the needs of kitchen garden items are to be purchased from far-flung areas outside of the state. It shows the decrease of the degree of sustainability of the region (Fig. 28.4).

There were not much food problems in Manipur in early nineties as the population density was low or in other words both the homestead arable lands and paddy fields were large enough to support the meagre population. But there has been existed food

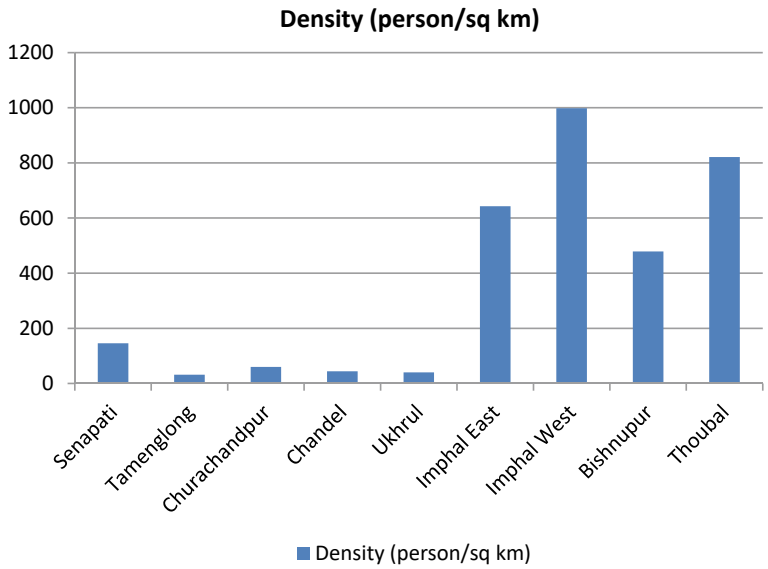

Fig. 28.4 Population density of Manipur

problem since the late nineties and this becomes worsen day after day due to rapid increase in population on the one hand and fast shrinkage of arable land in the central valley areas.

Since then the people of Manipur have not been able to produce their own food requirements and they now have started to depend on import of shortage quantity of food. Manipur being a landlocked state there is no cheap and fast mode of transportation such as good water transport system. Road transport system plays the vital role for the import of goods and other food items.

As encircled in all sides of the central valley by hill ranges, road transportation system is not good and fast movement is not allowed. Movement of trucks and buses consumes more time and fuel and also facing high risks, this automatically enhances the prices of the commodities when they reach the valley of the state. This extra increase in price exerts burden to the poor people and affects their livelihood adversely.

In the midst of such a worse situation, losing of arable land will create more problems. The economy of Manipur is primarily dependent on agriculture, in the hills jhumming or shifting cultivation and in the central valley areas single or double cropping, broadcasting or transplantation type is common. Arable land is by and large marginal and therefore agriculture had persistently been on subsistence mode in Manipur. Agriculture sector contributes a major share to state domestic product (SDP) (Table 28.4).

As many as 52.81% of the total workers are cultivators and agricultural labourers according to 2011 census. In fact, the state domestic product fluctuates depending

Table 28.4 Cropping area of Manipur ('000 ha) for the year 2018–19

District	Net sown area	Area sown more than one	Total cropped area
Senapati	17.53	25.20	7.67
Tamenglong	30.48	38.66	8.18
Churachandpur	36.41	44.21	7.80
Chandel	14.92	23.52	8.60
Ukhrul	13.64	22.27	8.63
Imphal East	35.66	53.70	18.04
Imphal West	32.53	56.91	24.38
Bishnupur	25.01	48.99	23.98
Thoubal	26.36	51.02	24.66

Source Department of Agriculture, Govt. of Manipur

on the performance of agricultural sector. This instability in the agricultural activities is caused mainly due to irregular and erratic behaviour of monsoon along with inadequate irrigation facilities. Even today agriculture becomes a living proposition. From the perspective of employment and per capita income, agriculture plays a very crucial role in the economy of Manipur.

In such a crucial juncture, the agricultural land holding in the state is generally small and marginal. Obviously, the arable land is very limited here in Manipur (Fig. 28.5). The area of operational land holding is about 172 thousand hectares operated by 151 thousand farmers as per the agricultural census of 2010–11. The average size of operational holdings for the whole state is only 1.14 ha in 2010–11.

Total cropped area of the central valley of the state is about 91,000 ha, whereas in the hilly areas it becomes only about 40,000 ha which shows that maximum agricultural products comes from the central plain of the state. Permanent cultivation

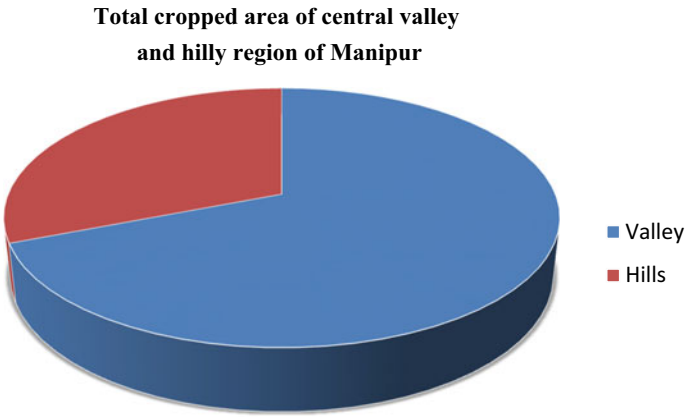

Fig. 28.5 Total cropped area of central valley and hilly region of Manipur (2018–19)

is generally practiced in the central valley and terrace and jhum cultivation are seen in some pockets of the hilly region of Manipur. Rice being main food of Manipuris grows both in plain and hills. Agricultural pattern is almost mono-crop with rice accounting nearly 95% of food-grain production. During 2017–15, the food-grain production excluding pulses was 52,065 thousand tonnes. The estimated requirement of food-grains for human consumption excluding livestock, poultry, seed, etc., in Manipur was 649.30 thousand tonnes in 2017–18. From this values, the food-grain requirements of the people are more than that of the actual produced values, the deficient amount being 128.655 thousand tonnes in same year mentioned above.

During the time of food storage in the state, the fast increasing population is a big problem in connection with human sustainability. Increasing population demands more land for the construction of dwelling places in the state. People movement in connection with migration is towards the centre, wherein many pull factors are existed. The central valley being the growth centre of the state attracts many people from all sides of it irrespective of distances. In this process, many lakes, wetlands, small hillocks, fertile land and paddy land were changed into built-up areas for dwelling purpose and business matters. The central part of the city which is called Keishampat was once a lake, in Manipur 'pat' means lake. Most part of the Lamphel pat are also occupied by big buildings and other small houses or business plots and Loktak lake, the largest fresh water lake in the NE-India is also now at the verge of being shrinked.

The Chinga hillock in Singjamei (Fig. 28.6a) was changed into super market (Fig. 28.6b) and other hillocks became smaller due to digging out of soil and rocks continuously. A large extent of farmstead land and paddy land was no more as they have been converted into settled area for various purposes in the state. Some of them are flooding due to the construction of dams and Loktak project. In fact, the cultivable land becomes too small to support the increasing population in Manipur. Such things have been common phenomena in other parts of the country too.

So a time will come when people suffer to large extent regarding food problems in the state. When looking back to history, Manipur faced a big crisis of starvation

Fig. 28.6 **a** Singjamei Chinga Hillock, **b** Singjamei Super Market. *Source* Manipur times (2020)

in 1939. In general cases, maximum people could not afford either lunch or dinner a day in the olden time.

In order to survive, people in olden days consumed banana tree, arum and oat after boiled instead of rice without curry. Such difficult days may come again in the state if we do not conserve our farmland and paddy land properly. The prices of basic food commodities are very high. Most of the people cannot afford it because of their poor economic conditions (Table 28.5).

To earn livelihood in Manipur is not an easy task in fact. It leads many youths in the path of drug or anti-social activities frequently. Many man and woman have spent their live without marriage since they are really scared how to support wives or husband and their children after they have entered their couple live. Such big issues in the society lead to many crisis within the state.

The estimated production, requirements and short fall of food-grains particularly the cereals are shown in the following Table 28.6. From the year 2012–2013 to 2017–2018, the production of cereals is not increased in a faster rate to make up the shortage quantity.

In the year 2013–2014, cereals deficit comes down to about 88,000 tonnes from 127,000 tonnes of 2012–2013. However, it increases up to 2015–2016 and again gradually falls down up to 2017–2018. Beyond this also it is likely to be fluctuated

Table 28.5 Per capita income of current price of Manipur and India

Year	PCI of Manipur	Annual growth rate	PCI of India	Annual growth rate
2011–12	39,762	–	63,462	–
2012–13	41,230	3.69	70,983	11.85
2013–14	47,798	15.93	79,118	11.46
2014–15	52,717	10.29	86,647	9.52
2015–16	55,447	5.18	94,731	9.33
2016–17	59,345	7.03	103,870	9.65

Source Department of Economic and Statistics, Govt of Manipur

Table 28.6 Estimated production of cereals, requirement of household consumption (‘000 tonnes) and short fall quantity (‘000 tonnes)

Year	Production of cereals	Requirement of cereals (‘000 tonnes)	Short-fall quantity (‘000 tonnes)
2012–13	437.60	564.68	127.08
2013–14	488.60	577.08	88.48
2014–15	493.57	589.73	96.16
2015–16	444.03	602.64	158.16
2016–17	504.78	615.82	111.04
2017–18	520.65	629.27	108.62

Source Department of Economic and Statistics, Govt of Manipur

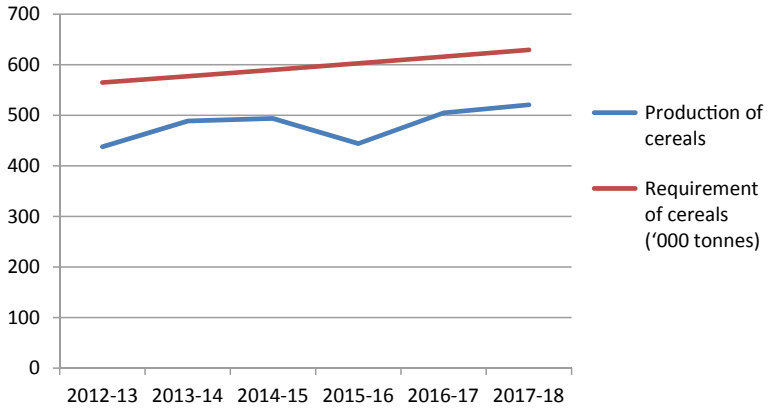

Fig. 28.7 Estimated production and requirement of household consumption of cereals ('000 tonnes) of Manipur

and the shortage of food-grains is still persisted as has been indicated by the import of huge quantity from outside through roadways every day.

If the rate of increase of food-grains is compared with the rate of increase of population, the later is much faster. This is not a good sign in connection with the sustainable development in Manipur. The total population of Manipur has been increasing very fast since 1961 onwards till date from 780,037 to more than 350,000 which is almost four times of 1961's value. From this, it is obvious that population pressure on the land becomes heavier and heavier day after day. It also implies that the haphazard urban expansion is also very rapid, ultimately farmland and paddy land started converting into build-up land (Fig. 28.7)

28.3 Conclusion

From the perspective of sustainable development, an uniform distribution of population over the entire state is highly required in order to conserve the small diminishing fertile land in the central valley which is the stomach of Manipur. The present migration pattern should be changed, now it should be from central valley to surrounding hilly areas. It must be possible if the government provides good facilities which are found in central valley with road improvements and after amending the present law of land. Good accessibility will bring people closer, ultimately will love each other and becomes the bases of peaceful coexistence. Again, good accessible roads are the artery and veins of economic development of a place. This system can reduce density of population in the central valley, pressure on land, traffic volume, various problems in the cities, etc. On the other hand, the efficiency of activities in the city will be increased, health conditions of city dwellers will also be increased. In the whole, there must be an equal development in both central valley and hilly areas.

Along with the conversation of the paddy field and homestead land many steps must be taken up to increase production. Most of the arable land does not have a good irrigation system and hence double or triple cropping is very rarely done. So, irrigation must be provided in order to increase production and productivity. As much as possible farmers should be encouraged and helped so that food self-sufficiency will be there in Manipur after some years. Without food we human beings cannot survive, therefore, we must be very careful in all the production activities of food.

Manipur being a monsoonal state has received enough rainfall to be used both for agricultural purposes and other purposes such as domestic consumption and small scale industrial purposes. Unluckily there is no any feasible project to harness rainwater properly during the south west monsoon season where maximum rainfall is occurred. So we need to take up such project to conserve the water during this season so that it can be utilized during lean season or dry season both in the fields and houses. The adoption of HYV seeds or IVs of crops will raise the production and productivity, however, the adoption of such crops become successful when water is provided timely and adequately.

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Chapter 29
Application of Remote Sensing and GIS Techniques for Landslide Hazard Zonation in Tamenglong District of Manipur, North East India

Lunghim Rongmei, Irom Luckychand Meitei, and Ekta Raman

Abstract Landslides are considered the real calamity in the rugged regions and are incited commonly every piece well and exacerbated by human activities. Landslide hazard assessment includes mapping, identifying and investigating the controlling variables and parameters affecting danger inception, event and portrayed the future unsafe zones. The present study centers around the utilization of remote sensing (RS) and geographic information system (GIS) tools to make thematic layers for the evaluation and the estimation of landslide risk zones in Tamenglong region of Manipur. Different remote sensing information, such as ASTER GDEM, GeoEye-1, TRMM, topographical and geological maps, are connected to break down terrain features, land use, rainfall, local geology and road network the area. For exact estimation, latest landslides were watched, 308 landslides, which happened in 2015–2016, are taken as tests and that example are accepted as a sign of the power for a landslide to come in the great beyond. A few contributing elements and parameters of a landslide, for example, as slope gradient, slope aspect, geology, land use, drainage, rainfall, road and fault lines buffering are used to create thematic layers by using ARC GIS 10.2. Initially, it investigated the relationship of the landslide recurrence and different factors to allot the palatable weighted value. After which, landslide susceptible index (LSI)/rating was resolved for entire classifications of every factor, with the use of landslide rate per sq. km of that class. Finally, GIS-based overlaying the entire susceptible layer to get the landslide hazard map. This technique can altogether upgrade the adequacy of a notice framework by keying out the inclined zone and at last cut the threat of landslides in mountainous regions.

Keywords Landslides · Remote sensing and GIS · Landslide susceptible index · Weighted · Thematic layers

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29.1 Introduction

Landslides are a standout among the most across the board land dangers on Earth, in charge of many death and billions of dollars in property damage every year. Zones inclined to landslides should, in this way, beset ahead of time to diminish such harm. Landslide hazard mapping can give a great part of the fundamental data basic for peril alleviation through appropriate task arranging and usage (Dai and Lee 2002a, b). Landslides are mind-boggling characteristic wonders that are difficult to demonstrate and mimic (Pandey et al. 2007). Landslides are as often as possible activated by rainfall in areas affected by a monsoon climate and this is in charge of an assortment of human and natural effects. Slope instability and landslides are serious troubles in the Tamenglong district of Manipur, as the region is arranged in youthful fold mountain of tertiary age, besides got an overwhelming rainfall (300 cm) during the monsoon season. The recurrence of maximum landslide events matches with the most astounding force of rainfall, i.e., May to October. In the study area, the landslide mainly occurred along the roads and shifting cultivation areas. The National Highway-53 passes the area, which is the help of the strong place where there is Manipur and moving development is the fundamental profession and wellsprings of sustenance in the domain. Huge scale anthropogenic exercises like structure and broadening of the road and vibrating produce by utilizing overwhelming vehicles, quarrying for the construction material, delicate lithology, complex geological structures, quick deforestation and substantial rainfall are the essential drivers of landslides in the region (Okendro et al. 2010). The region is encountering fast deforestation and formative works, for example, railroad and road infringed into temperamental territory that is vulnerable to landslides.

The development and abuse of regular assets require landslide peril zonation maps that set going to part up to the landscape into safe and unsafe zones, as per the frequency of landslides and different mass movement (Varnes 1981). Such maps can fill in as a base for land-use planning and the advancement of fitting medicinal measures (Bhandari 1987). Henceforth, to expedite a landslide peril zonation map and distinguished an exact area which is defenseless against landslides is the sole targets of the review. It includes point-by-point geological and geomorphological investigations in the field just as satellite image analysis and understanding for the evaluation of different elements that impacts or controls slope stability (Sarkar et al. 1995).

Arrangement of the landslide hazard map is in any case dependent on the coordination of remote sensing and GIS through the investigation of geo-ecological variables and parameters like lithology, structure, slope characteristics, hydrological conditions and land-use and land-cover patterns. It incorporates: (i) arrangement of facets, (ii) planning of thematic maps, (iii) reclassify and assignment of weightage, rating and summation and (iv) landslides hazard zonation mapping.

29.2 Study Area

The zone under scrutiny is a standout among the most in reverse regions of northeast India. The region is depleted by the Barak River and its tributaries and made a separating highlight of young landforms, which are inclined to slope instability and landslides. The examined territory is situated between 24° 30′ N and 25° 27′ N latitudes and 93° 10′ E and 94° 54′ E longitudes covering a region of around 4490 km^2. The investigation territory is physiographically intricate. Its high relief distinguishes gently inclined plains and rugged steep mountains that range in elevation between 135 and 2075 m, respectively, above the sea level. The landmass in the region is accepted to have been shaped because of the natural development during the Cretaceous and Eocene period. The main rock formations are sandstone, shale and sediment. Due to the feeble and delicate nature of rocks and high inclination of the hill slope, the landslide is a typical marvel in the area during the rainy season.

When all is said in done, the territory under scrutiny is described by the subtropical type of climate. The investigation territory meets an overwhelming rainfall over 300 cm in a year from the southwest monsoon (Thilagavathi et al. 2015). The mountain ranges of the area arrange in north–south alignment that incites solid orographic driving force. Most of the rainfall occurs from May to October and the remaining months are dry spell with high humidity and foggy (Fig. 29.1).

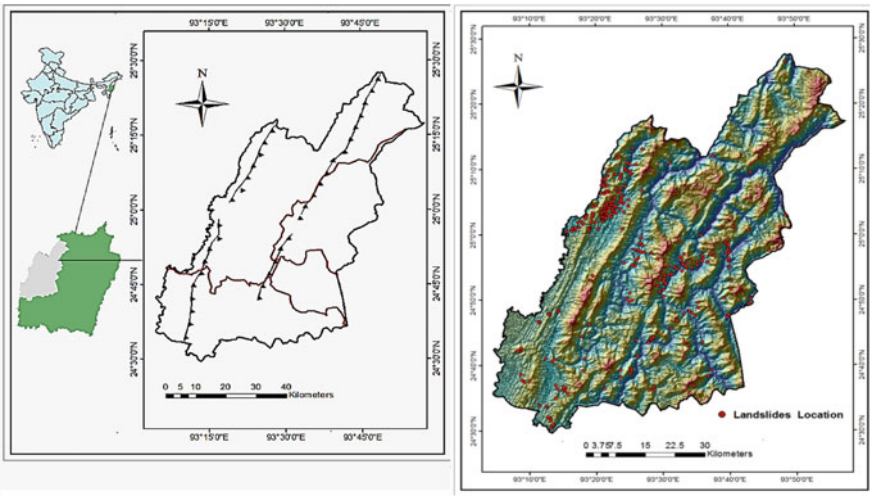


Fig. 29.1 Location and DEM of the study area

29.3 Objective

To zonate the landslide susceptible area using remote sensing and GIS.

29.4 Materials and Methods

In the momentum look into, a few materials, strategies and mapping procedures have been utilized for forming the ecological landslide hazard mapping. For the most part, remote sensing data and GIS tools have been utilized in parliamentary methodology to effective and reliable landslide hazard appraisals of Tamenglong region of Manipur. Right off the bat, so as to comprehend the terrain condition of the examination zone, advanced spaceborne thermal emission and reflection radiometer global digital elevation model (ASTER GDEM) data with a resolution of 25 m are utilized to make digital elevation models (DEM) and decide the topographic highlights, for example, slope gradient, slope aspect, drainage network and other geomorphologic attributes of the landscape. High-resolution GeoEye-1 satellite imagery of 1.65 m goals of natural just as infrared colors are utilized to key out the landslide area and land-use classification. At that point, detail perception has been played in a satellite image to find the locales of landslides and measure the region by counting the pixel and pursued by field verification. The landslide range of 100–300 m^2 with an aggregate of 308 ongoing landslides is taken as an example in the entire region, which will accept as an indicator for future landslides.

For land-use classification, data is based on the interpretation of GeoEye-1 satellite imagery by adopting supervised classification with 10–15 classes in each land-use class for analysis. Despite the fact that 10 land-use types were mapped, these were simplified into five classes for the reasons for this study: (1) dense forest, (2) open forest, (3) shifting cultivation, (4) shrubs and (5) settlements/cultivated field.

Topographical and geological maps were utilized to evaluate the geological and fault line setting and road connectivity in the district. Geological data are also obtained with a scale 1:25,0000 from the Geological Survey of India. The map covering the subjected area depicts the three geographical gatherings, for example, Barail, Surma and alluvium in which four fault line are given together a role as parallel in the north–south arrangement and made a buffering of 500 m along the fracture and road courses.

Three years monthly average accumulation Tropical Rainfall Measuring Mission (TRMM) 3B42v7 gridded information (March 2014–September 2016) is utilized to study the correlation of rainfall intensity and landslide frequency. In light of the TRMM information, the region under scrutiny covers four pixels of various rainfall zone zones which are assigned as low (34–85 mm), medium (85–153 mm), high (153–221 mm) and extremely high (221–255 mm) zones.

After the required data are assembled and contributing maps are readied, a comparative analysis was performed to see the relationship of landslide recurrence and

contributing variables. At that point field observation and affirmation have been directed to get a handle on the relative significance among the components to adjust the weighted value. After which a numerical weighting is adjusted based on relative significance to seven factors that add to slope instability: slope gradient, slope aspect, geology, vegetation, rainfall and proximity to faults, drainage density and road network. Every one of the seven components was gathered into 4–9 categories. In the wake of relegating the weighted value, the zone of the landslide region is determined and landslide susceptible index (LSI)/rating was resolved for entire categories of each agent, with the utilization of landslide percentage per km^2 of that class and the weightage doled out to it. The landslide susceptible index (LSI)/rating is calculated as follows:

$$\text{Landslide Susceptible Index (LSI)} = \frac{\text{Landslides}\%/\text{km}^2}{100} \times \text{weightage}$$

In the wake of ascertaining the landslide susceptible index (LSI)/rating, the various classes of thematic layers are allotted the corresponding rating value as attribute information in the GIS and an "attribute mapping" is brought forth for each data layer. The summation and overlay of these attribute map in Arc GIS 10.2 for mapping of the final landslide hazard zonation.

29.5 Results and Discussion

29.5.1 Local Geology

Landslides are generally controlled by the geology, slope morphology, soils and moisture conditions. Geology is the critical component in landslide hazard assessment and mitigation. Specific factors related to the cause of landslide can be identified in the geology such as low strength rock or soil, fault or bedding plane and hydrostatic pressure (Hammond 2007). The local geologic criteria to be sought in landslide investigation include material type, geomorphic landform, geological structure, etc. These criteria are required to estimate the boundaries of landslide and to assess the susceptibility and incident of the landslide. The geological formation that exposed in the study area belongs to Barail and Surma group of late Cretaceous to Miocene age (Krishnan 2010). Most of the study areas are occupied by rugged and dissected hilly terrain except a few depressions that are covered by alluvium deposit (Tewari 2010). The hill ranges of the region evolved as a result of a continent–continent collision of the Indian Plate with the Myanmar Plate forming an integral part of the Indo-Myanmar Ranges (Mandal and Mondal 2019). Figure 29.2a indicated those Barail groups are exhibited mainly in the easterly portion of the study area which is overlaid by Surma and exposed in the central (Kanungo et al. 2006) and southwest portion of the area. The Barail sandstones are older and are thickly bedded to the

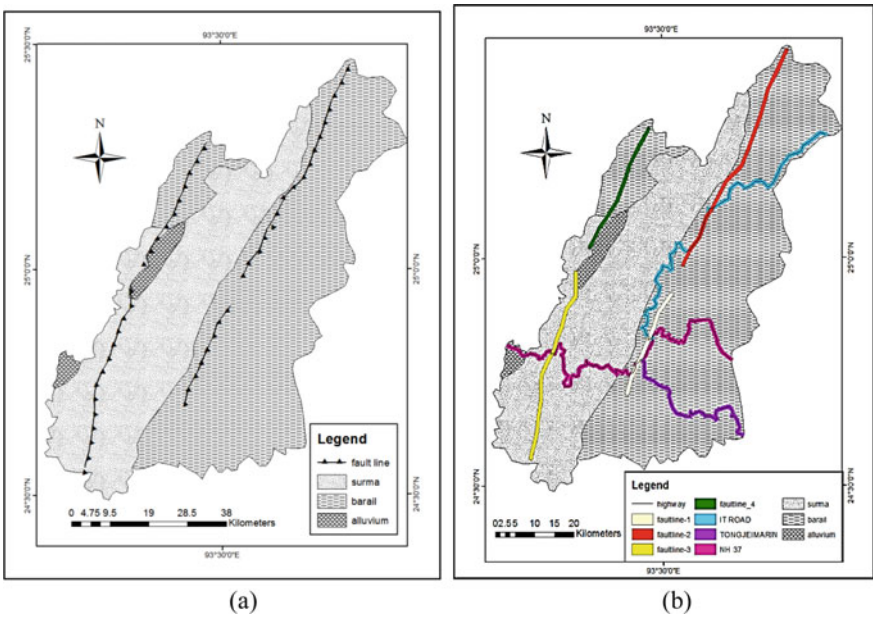


Fig. 29.2 **a** Geological map, **b** fault lines and road buffering (after Singh et al. 2013)

massive, hard and compact in nature. As a consequence, they are comparatively more resistant than Surma and alluvium with respect to erosion as well as a landslide.

However, Surma group represented by light gray to brownish colored medium-grained sandstone with reddish colored shale intercalations lies unconformable above the Barail group. At some place, the contact between Barail and Surma is marked by the presence of thin bands of the intra-formational conglomerate. All these difference geological setting contributed varied degree in soil erosion and landslide in the region.

There are four fault lines and three major roads in the study area, which are assumed as factors for landslides. Buffering along the fault line and the major road has been done only within 500 m as there no high correlation between fault, road lines and landslide. Out of 308 landslides samples, only 14 landslides are found inside the radius of 500 m in four fault lines and 13 are located along the three highways, which is, old Cachar road, NH-53 and IT road. But buffers were used for two reasons: (1) faults weaken surrounding rocks and material and (2) vibration produced by the heavy vehicle aggravated landslides. By and large, as the distance from faults and roads increases, landslide frequency decreases (Sarkar et al. 1995).

Geomorphologically, the area still is in its youthful stage characterized by deep, narrow gorges and steep-walled river valleys, a culmination effect of elements like heavy rainfall, toe erosion by rivers, slope instability, fragile rock unit and complex structures render the area highly susceptible and prone to slope failures and landslide occurrences (Okendro et al. 2010).

29.5.2 Slope Gradient and Aspect

Slope gradient has a great influence on the susceptibility of a slope to land sliding (Pareek et al. 2013). On a slope of uniform, isotropic material increased slope gradient correlates with an increased likelihood of failure. Yet, variances in soil thickness and intensity are two elements which alter over a wide range for both failure and non-failure sites. To quantify the relative frequency of landslides in different slope gradients, it is necessary to consider the distribution of the slope gradient categories using the available digital elevation model. The slope was modeled by using an ASTER GDEM data in a GIS raster environment. Slope gradient was derived from the DEM by calculating the maximum rate of change in elevation from a cell to its neighbors. To study the slope condition of the terrain, the area has been divided into six classes of slope (Fig. 29.3a): < 5, 5–10, 10–15, 15–20, 20–30 and < 30. These vary the degree of slope gradient contribute difference density of landslide.

Figure 29.3b shows correlations between landslide frequency and slope gradient, an examination of landslide frequency with the corresponding slope gradient categories shows a sudden increase from 5 to 10 with maximum frequency and the gradual decrease in the > 30 slope category. Out of 308 samples, only five landslides are found in the slope gradient of 0–5 category and abruptly rise to 115 in slope category of 5–10 and decrease to 109 in 10–15, 54 in 15–20, 22 in 20–30 and only three landslides are located in slope degree of < 30. In the wake of the correlation between slope gradient and landslide frequency, the rating has been done accordingly to the six categories of slope gradient.

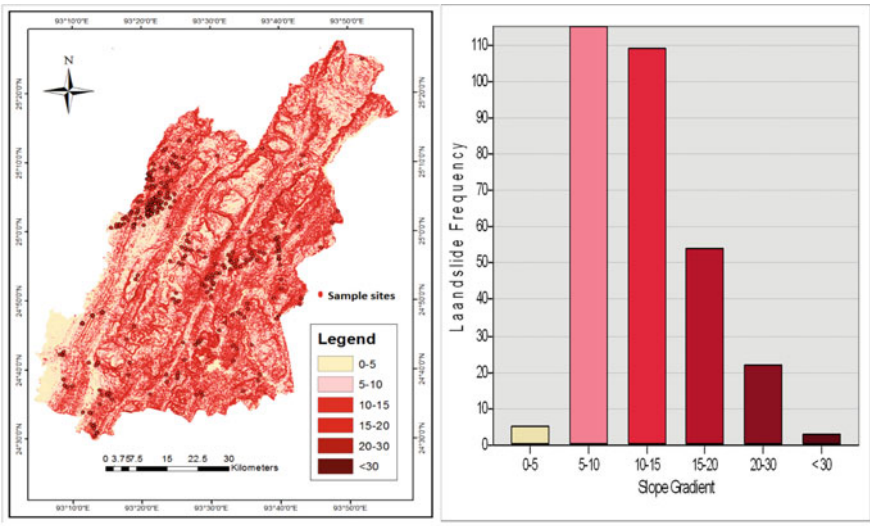


Fig. 29.3 **a** Slope map, **b** correlations between landslide frequency and slope gradient

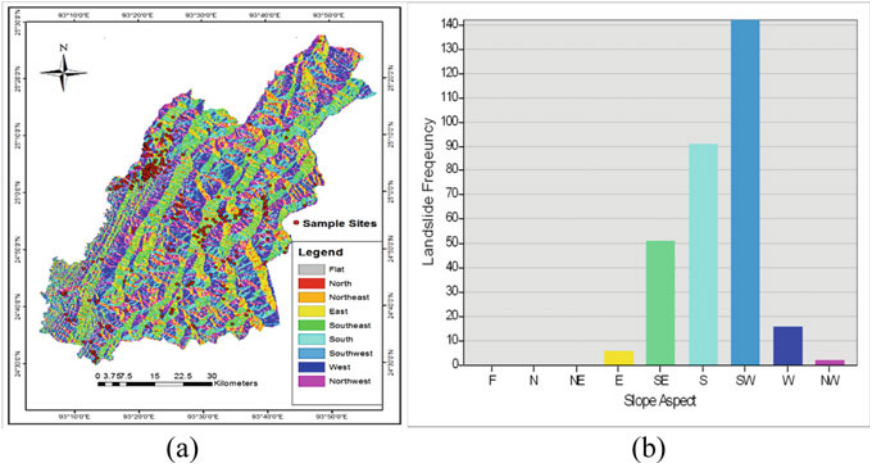
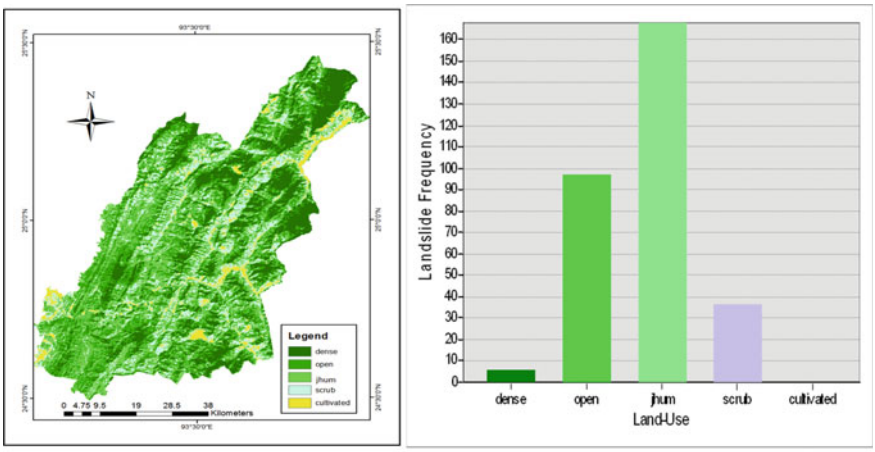


Fig. 29.4 **a** Slope aspect, **b** correlations between landslide frequency and slope aspect

The aspect of a slope can influence landslide initiation. Moisture retention and vegetation are reflected by the slope aspect, which in turn may affect soil strength and susceptibility to landslides. On the off chance that rainfall has an articulated directional segment by the impact of a predominant wind, the measure of rainfall falling on a slope may shift contingent upon its aspect (Wieczorek Gerald and Guzzetti 1997). The study area is received southwest monsoon rain which is influenced by southwest propagated wind direction. To investigate the relative relationship between landslide frequency and slope aspect, the DEM was used to calculate the aspect of a slope and divided into nine categories of slope aspect within the study area as flat, north, northeast, east, southeast, south, southwest, west and northwest. The distribution of aspect among the mapped landslides is shown in Fig. 29.4a.

The study area has a high correlation between slope aspect, rainfall and landslide frequency, based on the field observation most of the landslide occurs during the monsoon season, that is, June to September and the region is received a varied amount of rainfall indifference slope aspect. As mention earlier, the region is received southwest monsoon; hence, those slopes which are facing southwest orientation have a higher volume of rain which in turn highest frequency of landslides. In respective instances, the storms that strike the area have triggered many shallow landslides (soil slip-debris flows). Commonly, rainfall contributes to the tripping of the landslides by means of infiltration into the slipcover (Abuzied et al. 2016), which induces an increment in the pore pressure value and a diminution in the soil suction value (Giannecchini 2006). It can be seen that from Fig. 29.4b, out of 308 landslide samples, there is not a single slide is found in the flat, north and northeast-facing slopes. Again, the landslide frequency is comparatively low in east and northwest with a sample of 6 and 2, respectively. All things being equal, it increments with the direction of southeast (51), south (91) and achieving the most extreme along the southwest (142) confronting slope with the direction of monsoon rainfall.



(a) (b)

Fig. 29.5 **a** Land use/land covers, **b** correlations between landslide frequency and land cover

29.5.3 Land Use

Deforestation by human activities, such as shifting cultivation (jhum), timber extraction and other formative expansion are quickened the process of landslides. Extensive investigations have shown that land use or vegetation cover, especially of a woody type with strong and large root systems, helps to improve stability of slopes. Vegetation provides both hydrological and mechanical effects that generally are beneficial to the stability of slopes, however, sparsely vegetated slope is most susceptible to bankruptcy. So to establish the correlation of vegetation cover and landslides frequency, the study area was divided into five categories of land use such as dense forest, open forest, scrub, jhum/shifting cultivation and wet cultivated/settlement (Mani and Saranaathan 2017). The correlation between land-use types and landslide frequency is shown in Fig. 29.5b. It may be very well comprehended that the landslide recurrence on jhum/shifting cultivation land is the most elevated with an example of 168 landslides, trailed by open and scrub woodland. So far, in that, regard is no proof of landslides alongside the wet cultivated and settlement areas and a couple of landslides are inspected in the thick vegetation in the study area.

29.5.4 Drainage Density

Because of the heterogeneity of the geologic structure, lithological types and heavy downpour of rainfalls that are prevailed over the area. The number of streams is developed and many drainage networks which cut their way on the rocky surface

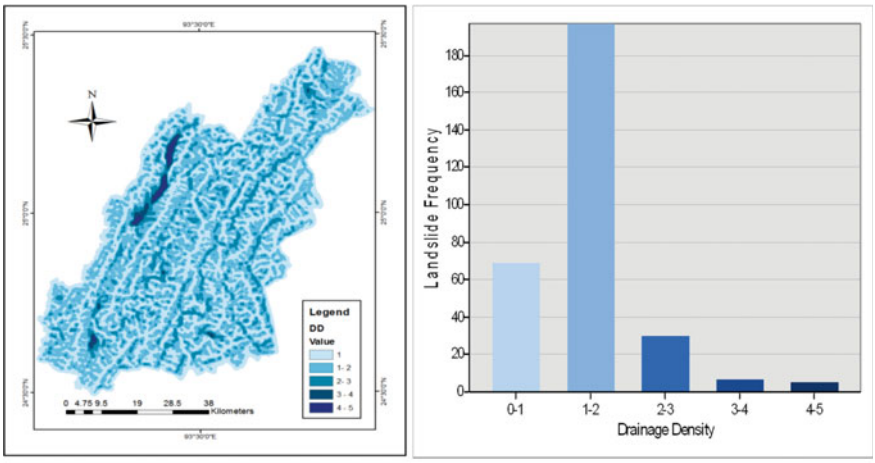


Fig. 29.6 **a** Drainage density, **b** correlations between landslide frequency and drainage density

with high drainage density values and leading to the formation of steep slope. As per the field observation, this steep slope is hardly used for shifting cultivation; the vast majority of the steep slope area has harmonized with a higher density of vegetation and drainage network and lower recurrence of the landslide. Just on certain occasions, higher densities of drainage confine in the field where there is high sinuosity of the river and lower velocity of water, which hindered the slope susceptibility. Some drainage basins with most minimal drainage density have the most noteworthy recurrence landslides in light of the high rate of percolation. In the examination zone, it is by all accounts a negative relationship of drainage density and landslide recurrence, (Fig. 29.6b) however, when it is compared with the number of landslides and level of landslide per square kilometer, landslides increment with an expansion of drainage density. In this way, the hypothetical centrality of the distance from drainage line increases, landslide frequency, for the most part, diminishes has been very acknowledged for this situation of study. Stream headward erosion is the principle impact the enlistment of landslides and terrain modification in the subjected region. As an outcome, the greater part of landslides is found just next to the water divide ridges.

29.5.5 Rainfall

Landslides are triggered by several factors such as heavy rainfall, seismic activities and construction of hill slope (Larsen and Simon 1993). The leading case of a landslide in Tamenglong district is intense and/or prolonged rain. Preferably, estimations of rainfall would be made with chronicle gadgets situated at the landslide sites. Since such estimations are uncommon and there is just a single rainfall estimating

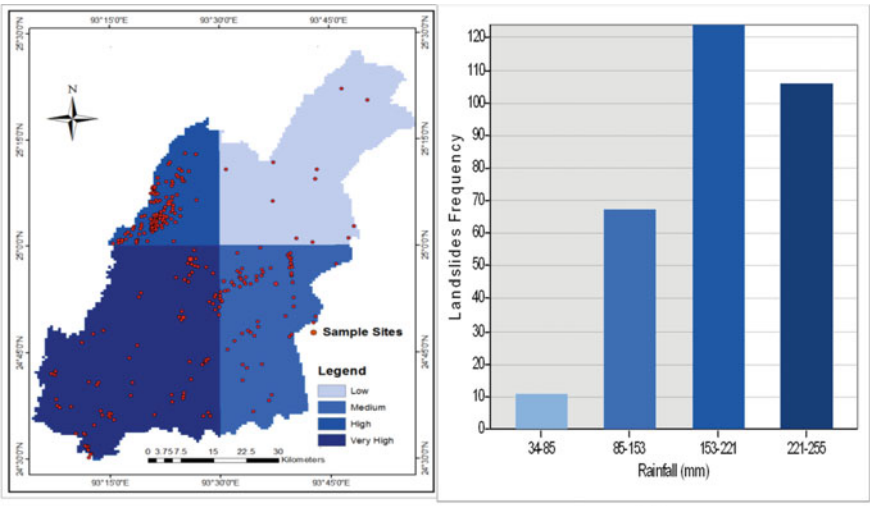


Fig. 29.7 **a** Rainfall, **b** correlations between landslide frequency and rainfall intensity. *Source* The Tropical Rainfall Measuring Mission (TRMM)

station situated inside the investigation territory. Hence, monthly average-three year accumulated (March 2014–September 2016) TRMM 3B42v7 gridded data has been applied to examine the correlation of rainfall and landslide frequency.

The Tropical Rainfall Measuring Mission (TRMM) data demonstrated the transformation of four rainfall zone, which are assigned as low (34–85 mm), medium (85–153 mm), high (153–221 mm) and high (221–255 mm) in the subject area. To show the rainfall intensity and landslide frequency, various landslides are tallied inside the diverse zone of rainfall and delivered in Fig. 29.7a. Figure 29.7b demonstrates the random correlation of rainfall intensity and landslide recurrence. It tends to be seen that landslide frequency increments with the ascent of rainfall aside from on the account of zone three.

29.6 Landslide Hazard Mapping

The primary aim of the landslide hazard mapping is to indicate and zoning the areas which are anticipated to take place in the hereafter. When evaluating the probability of land sliding within a limited period of time and within a given area (Pourghasemi et al. 2012), recognition of the conditions that caused the side to become unstable and the operations that triggered the movement is of principal importance. It is well known that many factors play an important role in engineering slope failure (Varnes 1984). There are various genes leading to slope failure at a specific site, thus it is terribly

complicated and onerous to assess confidently. Therefore, RS data can be applied to map factors with GIS integration processes, which are coupled to the occurrence of landslides, such as lithology, faults, road network, slope gradient, aspect, drainage density, rainfall, vegetation and land use/land cover. These thematic layers thought of main parameters that are accustomed to prepare and turn out multi-hazard maps. Therefore, in order to do an effective and reliable assessment and mapping, the quantitative approach has been adopted. A numerical weighted value was assigned to each of the factors based (Raghuvanshi et al. 2015) on the relative importance and the conditions of the terrain. In this area, the slope is taken into account the foremost necessary issue and has been assigned a weighted value of 25. Field evidence clearly incontestable that land use/land cover is one of the most important driving forces of slope instability in the survey region; therefore, the weighted value of 20 was specified. The influence of slope aspect is extremely important when we watched from the samples of landslide frequency, hence it allotted a weighted value of 15. Geologic structure, proximity to fault lines and road networks are combined as composite layers and assigned the weighted value of 15. Most of the landslides are triggered by the storm or prolonged rainfall in the region under investigation. There is a high significance of landslides incidence and intensity of rainfall because most of the slides are occurring during the monsoon seasons, therefore, a weighted value of 15 was given. Although the hydrological factor is really important in landslide occurrence, in the present study, only drainage density was taken; this is also comparatively not extremely significant, hence a weighted value of 10 was passed.

After assigning the weighted values, a landslide susceptible index (LSI)/rating was determined for whole categories of each agent, with the application of landslide percentage per km^2 of that class and the weightage assigned to it. The landslide susceptible index (LSI)/rating is calculated as follows:

$$\text{Landslide Susceptible Index (LSI)} = \frac{\text{Landslides}\%/\text{km}^2}{100} \times \text{weightage}$$

The results summarized in Table 29.1 indicate the areal coverage of various geological units and road network and the distribution of landslides within each one. Landslide frequency (number of landslides per km^2) and percent frequency for each unit have been estimated. Landslide susceptible index (LSI) values were calculated using these data. It is evident that alluvium and Barail are more susceptible to landslides than other geological units.

The outcome of the landslide susceptible index indicated that even the lowest slope gradient is prone to landslide in the neighborhood. It infers that slope angle of the order of 20–300 is most affected and the slopes degrees of below and above that are inclined in landslide tendency with a least affected in slope degree > 50 which are summarized in Table 29.2.

The outcome of the landslide susceptible index, which is demonstrated in Table 29.3 shows that jhuming cultivation area is the highest susceptible to landslides

Table 29.1 Landslide susceptible index for geology and road network (Weightage 15)

Geology	Area (km^2)	Number of landslides	Landslides/km^2	Landslides%/km^2	LRI/rating
Alluvium	120.90	56	0.5	45.4	6.8
Surma	1633.98	84	0.05	4.5	0.6
Barail	2360.32	141	0.5	45.4	6.8
Fault and road buffer	375.23	27	0.07	6.3	0.9

Table 29.2 Landslide susceptible index for slope gradient (Weightage 25)

Slope gradient	Area (km^2)	Number of landslides	Landslides/km^2	Landslides%/km^2	LRI/rating
0–5	872.68	5	0.005	1	0.25
5–10	1724.69	115	0.06	12	3
10–15	1199.77	109	0.09	18	4.5
15–20	511.96	54	0.1	20	5
20–30	153.21	22	0.14	28	7
30-above	28.02	3	0.1	20	5

follow by open and scrub forest while dense forest and wet cultivated and settlement are then far less vulnerable to the landslide. In the case of slope aspect; flat, north, northeast-facing sides are so far no incidence of landslide whereas west and southwest-facing slopes are a higher risk of landslide base on the data of samples and landslide susceptible indexes which was resumed in Table 29.4 (Table 29.5).

In this current research, drainage density and landslide frequency are extremely important. Landslide incidences increase with an increase in drainage density, which suggests that the erosional action by streams also play a role in increasing the slope instability. Further, high drainage density is encountered in steeper slopes (Ram Mohan et al. 2011).

Table 29.3 Landslide susceptible index for land use/land covers (Weightage 20)

Land-use categories	Area (km^2)	Number of landslides	Landslides/km^2	Landslides%/km^2	LRI/rating
Dense forest	971.45	6	0.006	2.6	0.3
Open forest	1280.39	97	0.07	30.43	6
Jhum	1309.18	168	0.12	52.17	10
Scrub	740.66	37	0.04	17	3.4
Wet cultivated/settlement	189.12	0	0	0	0

Table 29.4 Landslide susceptible index for slope aspect (Weightage 15)

Slope aspect	Area (km^2)	Number of landslides	Landslides/km^2	Landslides%/km^2	LRI/rating
Flat	256.4	0	0	0	0
North	522	0	0	0	0
Northeast	526.2	0	0	0	0
East	597.6	6	0.01	1.9	0.2
Southeast	542.8	41	0.07	13	1.9
South	565.8	91	0.16	30.7	4.6
Southwest	572.9	142	0.24	46.1	6.9
West	634.9	26	0.04	7	10
Northwest	268.2	2	0.007	1.3	0.1

Table 29.5 Landslide susceptible index for drainage (Weightage 10)

Drainage density	Area (km^2)	Number of landslides	Landslides/km^2	Landslides%/km^2	LRI/rating
0–1	1842.8	69	0.03	5.4	0.54
1–2	2024.52	197	0.09	16.3	1.6
2–3	560.76	30	0.05	9	0.9
3–4	37.57	7	0.18	32.72	3.2
4–5	24.67	5	0.2	36.36	3.6

It is well known that rainfall is the most important and frequent trigger of landslides, in general, and of shallow landslides, in particular. Commonly, it contributes to the triggering of the landslides by means of infiltration into the slope cover, which causes an increase in the pore pressure value and a decrease in the soil suction value (Giannecchini 2006). The outcome of the landslide susceptible index (Table 29.6) shows that landslide incidence increases with the advance of the rainfall.

Table 29.6 Landslide susceptible index for rainfall (Weightage 15)

Rainfall (mm) monthly average	Area (km^2)	Number of landslides	Landslides/km^2	Landslides%/km^2	LRI/rating
34–85	1265.15	11	0.008	2.2	0.33
85–153	989.83	67	0.06	16.6	2.4
153–221	496.80	124	0.24	66.6	9.9
221–255	1738.36	106	0.06	16.6	2.4

29.7 Result

The aftereffects of this appraisal are presented as the landslide hazard map of Tamenglong districts in Fig. 29.8 and area of the category wise in Table 29.7; which uncovered that a noteworthy extent of the region is under serious hazard of landslides. The evaluation demonstrates that 9.5% of the region incorporated into the high-hazard zone of landslide with a zone of 427.18 km^2. This high-hazard zone agrees with a zone of the higher slope gradient-southwest-facing slope shifting cultivation was done with short jhum cycle and existing soil conditions are truly plausible to make further genuine landslide issues.

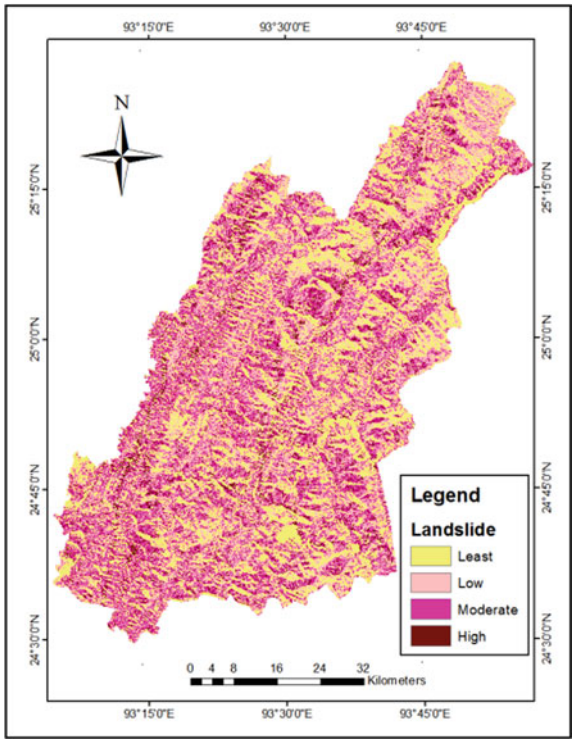


Fig. 29.8 Landslide hazard map of Tamenglong district

Table 29.7 Area covered by different zones of landslide

Landslide risk category	Area (km^2)	Percentage
Least	1493.62	33.26
Low	1469.41	32.72
Moderate	1100.52	24.51
High	427.18	9.51

The moderate zone spreads everywhere throughout the district with an area of 1100.52 km^2. In this zone, combination of the agents may adversely influence slope stability. The low class displays spatial dissemination emphatically portrayed by scattering pattern. This category holds a moderate potential for landslide occurrence and is portrayed gentle slope gradient and essentially found in the lower region and moderate slope adjoining a mountain peak. Roughly, 32.72% of the areas are falling under this class. Albeit steep slope represents a noteworthy landslide threat, many steep regions, which are made of bedrock, impeded the likelihood of landslides. This clarifies the moderate landslide list that portrays in some area in the investigation zone.

It was identified that least zone is fortuitously confined to valley area, gentle plain, settlement and agricultural area, north and east-facing slope at the top of high mountains characterized by flat and relatively gentle gradients. All these sites are generally stable and not prone to landslides. Zones of "least" susceptibility are relatively dispersed; the combination of factors is not very likely to adversely affect slope stability, and the chances that landslides will occur are small. This zone occupied a large area with a total 1493.62 km^2, which is 33.26% of the total area. Physical characteristics and the land use in the steep slope make large areas are more vulnerable to slope instability in the region.

29.8 Conclusion

The landslide hazard mapping of the Tamenglong district was meted out with the used of remote sensing data of different sources and agencies. These data are analyzed and accurately measure in the GISenvironment. Based on the result of landslide hazard index, the study area is divided into four levels of hazard zone, such as least, low, moderate and high, which were created by the combined factors of slope gradient, slope aspect, geology, distance from faults and road network, drainage density, rainfall and land use/land cover. The report has discovered that the physical character, significant rain and the effects of human development and over-exploitation of the forest resources are among the causes of the raised vulnerability of landslides. Hence, to mitigate the speed of landslides, it is not possible to vary the physical or phenomenon, however, individuals ought to amendment their activities to cut back the speed of landslide the subsequent recommendation has been made:

1. Restricting development in landslide-prone areas—Land-use planning is one of the most efficient and frugal ways to reduce landslide losses by avoiding the hazard and minimizing the danger. This is accomplished by removing or converting existing development or discouraging or regulating new development in unstable areas. Any development work should be permitted only after the assessment of land suitability by identifying safe and unsafe terrain.

2. To reduce the rate of deforestation, it needs to change the present stem cutting shifting cultivation system to traditional pruning system which will enhance the forest to regrowth very quickly and retain the stability of slopes.
3. The community field selection system needs to reintroduce to reduce the field of forest burnt by the fire in shifting cultivation.
4. Afforestation and public awareness programs about land degradation and future impacts should be discussed with active peoples' participation.

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Chapter 30
Analyzing Development Induced Trade-Offs: A Case Study of Loktak Multipurpose Project (LMP) in Manipur

Himani Tiwari and Harshita Tiwari

Abstract Sustainable development inherently involves trade-offs. The Loktak Multipurpose Project constructed with the goal to boost the economy of Manipur, a state in North-East India also acted as a breeding ground for the new and cascading risks. This study uses a novel analytical framework to (a) understand the impact of the project on the dynamic aspects and (b) explore the interactions (positive and negative) between the various parameters in order to facilitate an understanding of the generation of trade-offs. This retrospective analysis of the trade-offs shows that the negative consequences of the hydropower project greatly outweighed its benefits. Furthermore, the framework has the potential for a more concise trade-off analysis in a developmental context as it offers enough scope for changing the parameters, refining them, adding others, and exploring different methods of interactions.

Keywords Sustainable development · Trade-offs · Loktak Multipurpose Project · Manipur

30.1 Introduction

There is a strong yet a complex relationship between development and disaster risk. Developmental processes may negatively or positively affect vulnerability and exposure of the elements at risk like people, infrastructure, etc. Disasters may result in insurmountable losses, hence undoing the developmental gains (Thomalla et al. 2018). This linkage is indispensable through a lens of sustainable development highlighted in the Sendai Framework, 2015 (Kapucu and Liou 2014). Climate change experts and disaster managers across the globe although having their differences over the topic of sustainable development; to a large extent have a general accord on one

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thing that development is the leading cause of transforming most common hazards into disasters of mega proportions (Pelling 2012).

The North-Eastern region of India comprising of Assam, Arunachal Pradesh, Sikkim, Meghalaya, Manipur, Mizoram, Nagaland, and Tripura contributes to about 40% of the country's hydro potential owing to the existence of perennial rivers and streams (Thakur 2020). Despite this, several developmental challenges like accessibility, transportation facilities, unemployment, shortage of electricity, and many others exist in the region. To address these developmental challenges and exploit the immense hydel potential, construction of large hydropower plants became a part of government's official development plan. Hydropower has several advantages like it is renewable, pollution free, efficient, flexible, and cost-effective, but it can also have a negative impact on the ecology and the livelihood of the locals (Handique and Dutta 2014). These negative consequences bring to light the existence of trade-offs. Sustainable development inherently involves trade-offs (Tuhkanen and Han 2018) which can be defined as the decisions involved in achieving one outcome at the expense of the others. For example; development initiatives that support one goal, like the construction of hydropower projects to provide affordable and clean energy may exacerbate socio-economic vulnerabilities, increase disaster risks, and cause ecological imbalance (Cernea 2004; Sharma et al. 2007; Kumar Sharma and Thakur 2017). Trade-offs are predominantly found at all levels, but it is highly visible in situations involving large-scale projects and a number of stakeholders. The idea of trade-offs has been explored in several fields (Tuhkanen and Han 2018). Antle and Crissman (1998) used a quantitative approach to assess the trade-offs in environmental policy analysis. Trade-offs between conservation of biodiversity and well-being of humans were analyzed by McShane et al. (2011). Similarly, it has been explored in fields like ecosystem services (Howe et al. 2014), business (Hahn et al. 2010), finance (Fama et al. 2007), and many others. Tuhkanen and Han (2018) developed a typology framework using five key dimensions, viz. aggregation, risk, equity, participation, and time to assess the trade-offs between development and disaster risk reduction. Trade-offs' transparency and its identification in decision-making process were considered important for resilient and sustainable development by Thomalla et al. (2018).

Majorly, two types of trade-offs, viz. procedural and substantive have been predominantly discussed in the researches (Glasson 1999; Morrison-Saunders and Pope 2013). Procedural trade-offs are a reflection of a decision-making process where choices have to be made considering 'resources' and 'time' constraints (Morrison-Saunders and Pope 2013). Wood (2003) identified procedural trade-offs in the process of environmental impact assessment (EIA) between prediction and evaluation, facts and values, urgency and in depth information, certainty and uncertainty, and simplification and complexity. However, politically-inclined examples of trade-offs associated with the distribution of resources between interest, knowledge, and the various activities were also cited. In contrast, substantive trade-offs involve positive and negative results whilst weighing competing outcomes like the trade-off associated in an economic activity at the expense of socio-ecological outcomes. These trade-offs

may also supplant or substitute impacts over time or place like the habitat restoration, supplanting traditional lands of fishing, hunting, etc., into recreational or profitable activities (Gibson et al. 2005). Bio-physical and socio-economic categorization were further classified into negotiable and non-negotiable impacts, and these were considered crucial for facilitating decision-making for issues of sustainable development (Sippe 1994; Sadler 1996). Procedural trade-offs may also give rise to substantive trade-offs (Morrison-Saunders and Pope 2013). Bennett et al. (2009) developed an analytical framework to study the trade-offs induced by interactions between the ecosystem services. Wiréhn et al. (2020) applied the same framework to analyze substantive and procedural trade-offs in adaptation decision-making within an agricultural context.

Although trade-offs should be considered as an indispensable part of decision-making yet it is an extensively under-looked aspect especially in the development of hydropower project. In the light of this, the present study is a retrospective compilation of procedural and substantive trade-offs using a novel analytical framework in the context of the development of Loktak Multipurpose Project (LMP) in Manipur.

30.2 Study Area

Loktak Lake situated in between 24° 25′–24° 42′ N latitude and 93° 46′–93° 55′ E longitude lies in Bishnupur district of Manipur state, at an elevation of 768.5 m. It encompasses an area of 246.72 km^2 with watershed area of around 5040 km^2 (Khwairakpam et al. 2020; Singh et al. 2010) and is the largest fresh water lake of North-East India. The lake has a very dynamic ecosystem with its famous floating island commonly known as phumdis and is a subject of National and International importance under Ramsar Convention (1990) (Das Kangabam et al. 2019). It is also home to the World's only Floating National Park called as the Keibul Lamjao National Park. The area experiences an annual rainfall of 1500–1700 mm with the minimum and maximum temperatures ranging between 2–21 °C and 23–36 °C, respectively (Meitei and Prasad 2013). The lake possesses great socio-economic importance as it serves as a source of drinking water supply, irrigation, and hydropower generation and supports around 52 settlements and 12 towns with a population of 2,20,017 lying inside and in its periphery (Das Kangabam et al. 2019). On the downstream of Manipur river, the Ithai barrage is constructed at the confluence of Khuga and Manipur river and is a part of Loktak Multipurpose Hydro Electric Project which provides hydropower to its neighbouring states (Bijaya et al. 2015). Figure 30.1 shows the study area.

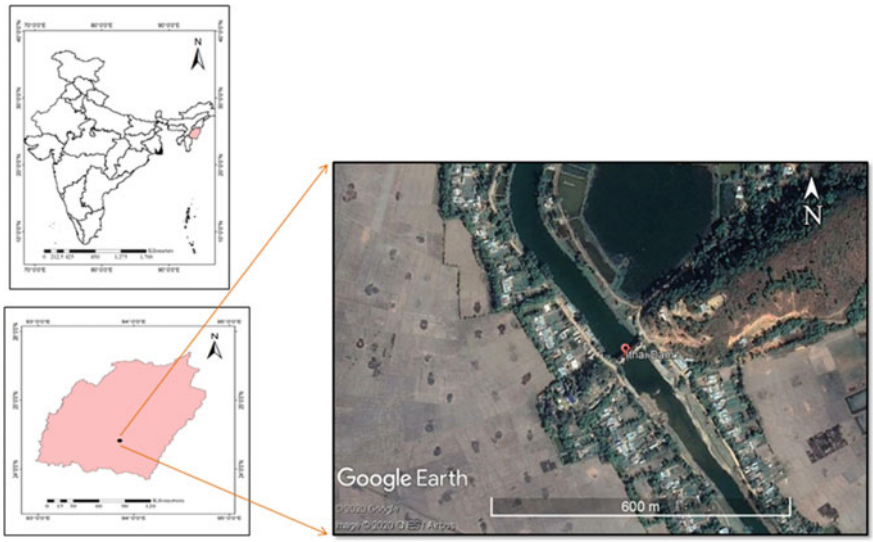

Fig. 30.1 Study area showing Ithai Barrage, Manipur using Google Earth Imagery

30.3 History of the Loktak Multipurpose Project (LMP), Manipur

Loktak Multipurpose Project (LMP) was proposed in 1971 by the Ministry of Irrigation and Power, Government of India, and for its execution, it was commissioned to National Hydro Electric Power Corporation (NHPC) in 1983 (Singh et al. 2018). Ithai Barrage is the artificial reservoir constructed and is an important and a major part of the project. The project envisioned and aimed at the following, viz. irrigating about 24,000 ha of land area with the generation of 105 MW of electricity; flood control in Imphal city and around the periphery of the lake and setting up 132 kV of transmission line for Manipur, Assam, and Nagaland (Singh 2017). The underlying vision of the project was to improve the living of the inhabitants and boost the economy of the state. But owing to its adverse socio-economic and the ecological impacts in the region, it was so severely criticized that the Government of Manipur requested the Union Government to decommission it (Saikia 2017).

30.4 Methodology

The present study is completely based on the secondary data collated from the research articles, newspapers, newsletters, and government reports. Extensive literature review on the subject of Ithai Barrage, Manipur was conducted. Following, various parameters or themes were identified which were further characterized as

procedural or substantive trade-off supported by the literature review (Table 30.1). A novel analytical framework shown in Fig. 30.2 is further used to (a) understand the impact of the project on the dynamic aspects and (b) explore the interactions (positive and negative) between the various parameters in order to facilitate an understanding of the generation of trade-offs. The 'parameters' here refer to the dimensions, factors, or themes in the socio-economic and ecological system that either affect decision-making or is a direct result of the development. In the present study, a total of 11 parameters have been identified.

30.5 Analysis and Results

Inserting all the parameters in the framework brings to the surface an interesting analysis (Fig. 30.3). The construction of the project resulted in generation of 105 MW of electricity, providing employment opportunities directly as staff, preserving the lake water and reduction in land encroachment. All these parameters no doubt boosted the economy of the state. However, procedural trade-off involving an ill-conceived planning, the absence of Memorandum of Understanding between the NHPC and the Government of Manipur had given rise to many substantive trade-offs like the disruption of the natural flow of water and natural drainage system which had further changed the breeding cycle of fish, forcing the local residents to use more pesticides. These compounding effects have resulted in increased water pollution. Also, its construction at a low height and the constant maintenance of the lake's water level has led to siltation and sedimentation accumulation processes in the lake, which has further caused devastating floods, loss of agricultural fields, and food insecurity in the state. Loss of biodiversity when coupled with these factors reduced the employment opportunities for the indigenous communities. These parameters when combined with others like unaccountability to the local community, lack of participation of the communities, etc., (rooted in the decision-making process) have given rise to local resistance/protest. These protest and the negative consequences of the barrage persuaded the Government of Manipur to request the Union Government to review and take the necessary steps regarding decommission (hence further affecting the decision-making process).

30.6 Discussion and Conclusion

The importance of sustainable development has been heavily recognized in the contemporary world. However, the analysis of trade-offs remains a limited topic. The Loktak Multipurpose Project constructed with the goal to boost the economy of the state also acted as a breeding ground for the new and cascading risks. Hence, to reduce such risks and to facilitate an informed, accountable, and liable decision-making, the inclusion of 'trade-offs' should be a prerequisite. This study is an attempt to identify

Table 30.1 Identified parameters of trade-offs supported by secondary data

S. No.	Parameters	Procedural	Substantive
1	Haphazard planning	Research shows that the site-selection for the construction of the Ithai Barrage was quite random and unscientific as it was constructed after a point where the Manipur and Khuga River meet at a height of 760 m, indicating high vulnerability of the submergence of the agricultural area (Ranjan 2014; Singh 2018a, b)	The construction of Ithai Barrage following the poor developmental planning tremendously deteriorated the ecosystem of the Loktak lake. This had slowed down the natural flow of water affecting the natural drainage system of Manipur and leading to the siltation of the lake. About 90.52% of the total 6,57,436 metric tonnes of sediments carried by the rivers, get deposited in the Loktak lake every year (LDA 2002; Meitei 2002; Ranjan 2014; Singh 2018a, b)
2	Absence of an MoU	Research shows that Memorandum of Understanding (MoU) between NHPC and Manipur Government was absent; guidelines for the operation of Ithai Barrage along with a detailed description of its possible long-term impacts were not delineated properly. The non-existence of a MoU was accepted by the NHPC in response to a RTI filed by a local activist in May, 2017 (CRAM 2017; Centre for Research and Advocacy, Manipur 2017; Yumnam 2017)	
3	Power generation		The project led to the production of 105 MW of electrical power in three phases of 35 MW each. One-third of the total electricity generated has been utilized for the state of Manipur whilst the remaining has been sold to the nearby states, generating annual revenue of about 21–22 crores. The year 1991–92 earned an income of Rs 30 crores from the project itself (Singh 2018a, b; Mohanty 2020)
4	Water preservation		The constant maintenance of Lok Tak Lake's water level at 768.5 m helped in the preservation of water and reduced the encroachment of land (Singh 2018a, b)

(continued)

Table 30.1 (continued)

S. No.	Parameters	Procedural	Substantive
5	Floods		The constant maintenance of Lok Tak Lake's water level at 768.5 m (much higher than the lake level) along with the increased siltation in the lake due to the construction of the Ithai Barrage, resulted in devastating floods; affecting thousands of hectares of the agricultural land (Ranjan 2014; Singh 2018a, b; Mohanty 2020). About 50,000–80,000 ha of land (cultivable and habitable) were submerged due to the floods (WWF 1994; Lukram 2017). Since the commissioning of the project in 1983, Manipur has suffered annual losses worth 300 crores rupees for example in 2017, the state suffered losses of 358.23 crore rupees owing to the flooding of lands (Singh 2018a, b; Samom 2018)
6	Pollution		Pollution in Loktak lake has become a major concern ever since population increased in the Nambol catchment. Domestic and non-degradable waste like plastic bags carried by the other rivers; hazardous nitrates washed from the agricultural lands polluted the Loktak lake. However, the blockage induced due to the construction of the Ithai Barrage worsened the pollution of the lake by obstructing the natural outflow of water to the Manipur river through Khordak Channel. Moreover, the reduced fish breeding led to an increased use of pesticides by the locals (Trisal and Manihar 2004; Singh 2015, 2017; Singh 2018a, b)

(continued)

Table 30.1 (continued)

S. No.	Parameters	Procedural	Substantive
7	Employment		The construction of the Ithai Barrage absorbed more than 500 people as staff, provided employment to about 2000 people after the mushrooming of small-scale industries; however, employment opportunities in the agricultural sector, livestock farming, and fishing were severely affected in the region (Singh 2015, 2017; Singh 2018a, b). Due to the maintenance of the high water level of Loktak Lake, the nearby well-cultivated agricultural fields that earlier had also served as grounds for livestock rearing have now transformed into marshlands or have inundated. The failure of the Loktak Lift Irrigation (LLI) scheme that was supposed to irrigate 23,000 ha of land incurred huge losses to the state. Before the construction of the barrage, 34,75,920 quintals of rice that used to be produced from 20,000 ha of land through double cropping techniques helped earn additional income (about 30–40 crore rupees) for the farmers even in the off-season (Joykumar 1993). But now, the loss of agricultural lands has contributed to food insecurity, with the state in need of 1–1.5 tonnes of rice to fulfil its demands (Sharma 2009). Moreover, an increased pollution and disappearance of various aquatic plants and indigenous fish varieties have further economically impacted the local people

(continued)

Table 30.1 (continued)

S. No.	Parameters	Procedural	Substantive
8	Loss of biodiversity		The damming of Ithai Barrage has severely impacted the flora and fauna of the lake. Indigenous and migratory fish that used to come to breed like Tharaak, Ngaton, Ngaatin, Pengba, etc., are not being predominantly found now (Romi Singh 2002; Trisal and Manihar 2004). Equally devastating is the impact on the indigenous flora owing to an increased water level of the lake due to the barrage, hence resulting in a decrease in its production and loss of its commercial essence. About 23 indigenous varieties of aquatic plants like Tharo, Loklei, Thaangjing, etc., have decreased. Moreover, phumdis' natural cycle has been affected. Phumdis play an indispensable role in phyto-sanitation; flood control, absorption of nutrients possess extreme social-economic, and cultural value and have multi-purpose use like medicine, handicrafts, fuel, fodder, etc. Also, phumdis are home to the rarest species, Shangai. (Meitei and Prasad 2013; Laithangbam 2017; Singh 2018a, b)

(continued)

Table 30.1 (continued)

S. No.	Parameters	Procedural	Substantive
9	Accountability	Since the beginning, the NHPC was not accountable to the people despite the negative consequences of the operation of the Ithai Barrage. In1994, the affected people filed a writ petition to avail compensation for the incurred losses; however, the NHPC showed no responsibility and diverted it towards the Government of Manipur (Mohanty 2020)	
10	Lack of participation of the communities	The indigenous communities were neither given any rights nor there exist an informed consent regarding the management of the Loktak Lake. This was also the reason behind the increasing protests (Schertow 2011)	
11	Protest	The socio-economic impacts of the Ithai Barrage and the steps taken to restore the lake became a precondition for the protest. To address the issue of the deterioration of the Loktak Lake, Loktak Development Authority (LDA) comprising of local MLAs, HODs of NHPC and line departments, etc., was constituted in 1986, and after the enactment of Loktak Protection Act (2006), LDA was given the prime responsibility for the restoration of Loktak lake. In response to this, massive displacement and expulsion of the indigenous communities residing in the floating huts on the phumdis; several restrictions on fishing and other activities were imposed as the local communities were being blamed for unsustainable fishing practices and mushrooming of phumdis. About 700 families living in phumdis were being evicted, with a mere compensation of Rs 40,000 per family (Satam 2017; Mohanty 2020)	Following the notices issued for the forced eviction from the phumdis, about 11 Meiti women were severely injured by the police, and there were appeals of inhumane action against the protesters by the use of batons, tear gas, and ammunition on December 29, 2011; about 1147 floating huts on the phumdis and fishing equipment's were burnt without their consent (Schertow 2011; NCHRO 2012)

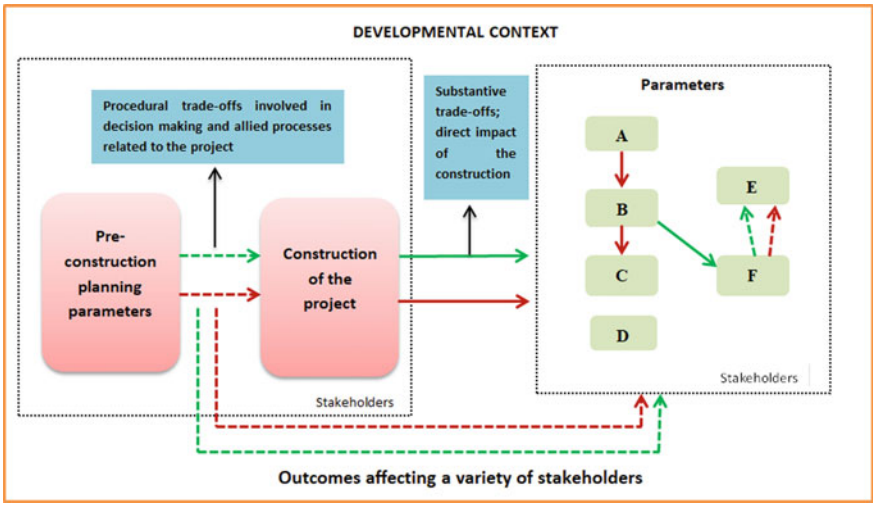

Fig. 30.2 Analytical framework for development induced trade-offs. Solid and dotted arrows represent substantive and procedural trade-off type, respectively. Red and green colour denote the negative and positive interactions, respectively. A, B, C, D, E, F, etc., are the various 'parameters' subjected to change depending on the developmental context

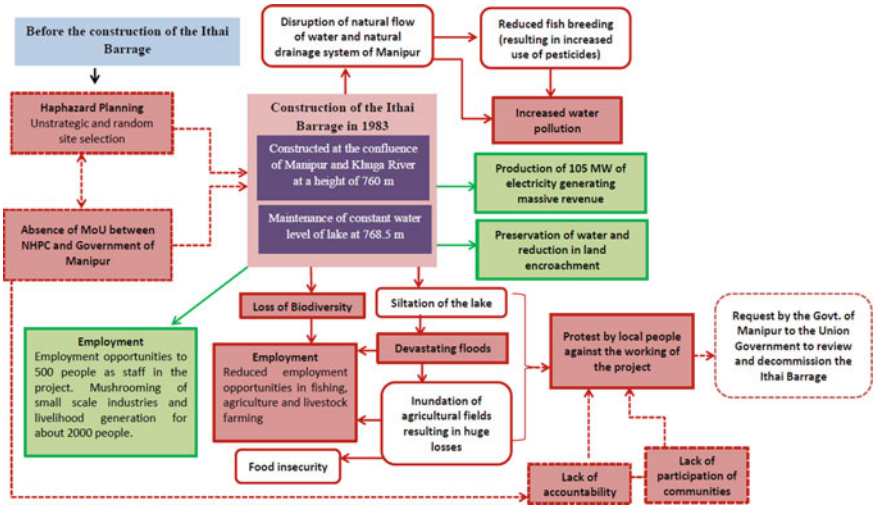

Fig. 30.3 Analytical framework applied in the context of Loktak Multipurpose Project (LMP), Manipur. Solid and dotted arrows represent substantive and procedural trade-off type, respectively. Red and green colour denote the negative and positive interactions, respectively

and explore the interactions between the parameters characterized as 'procedural trade-off' or 'substantive trade-off' through a novel analytical framework applied in the developmental context of the Loktak Multipurpose Project in Manipur. In this study, the negative consequences of the hydropower project (also rooted in the pre-planning phase) greatly outweighed its benefits. Procedural trade-offs have given rise to substantive trade-offs which in turn has also resulted in cascading risks. However, the use of only secondary data is a major limitation. Also, ideally, trade-offs should be prospectively considered to ensure an effective decision-making yet this retrospective compilation is indicative of the various parameters that one should consider whilst making such crucial decisions.

The framework used for this study can act as a base for a more concise trade-off analysis in a developmental context as it offers enough scope for changing the parameters, refining them or adding others and exploring different methods of interactions. Finally, since sustainable development inherently involves trade-offs; a thorough analysis of trade-offs is priory needed to measure this 'crucial' yet complex 'aspect' of sustainable development.

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