Water Resources Development and Management

Girish Chadha
Ashwin B. Pandya *Editors*

Water Governance and Management in India

Issues and Perspectives, Volume 1

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Water Resources Development and Management

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Editors and Contributors

About the Editors

Girish Chadha is a New Delhi-based business journalist-cum-entrepreneur. His engagement with water sector runs across several dimensions. He has written extensively on global water issues in leading foreign publications and is the Editor of India Water Review, a multi-media news platform on water in India. Girish also overlooks efficient water usage practice for a fast-growing global organic foods company with projects across several geographies.

Ashwin B. Pandya is the Secretary-General of International Commission on Irrigation & Drainage (ICID). An M Tech in Structural Engineering from IIT-Delhi, Pandya has been a former Chairman of Central Water Commission. In his long distinguished career encompassing all aspects of water resources sector, Pandya has provided mentorship and led the large water resources engineering community towards a sustainable and rational development regime. Pandya has been engaged with several state governments, many countries and the World Bank in various capacities and is an advisor to the Indian Government on several flagship projects.

Contributors

Mohammad Alam Rivers, Wetlands and Water Policy Division, WWF India, New Delhi, India

Robert Alexander Speed Badu Advisory Pty Ltd, Brisbane, QLD, Australia

Suresh Babu Rivers, Wetlands and Water Policy Division, WWF India, New Delhi, India

Anamika Barua Department of Humanities and Social Sciences, IIT-Guwahati, Guwahati, Assam, India

J. Chandrashekhar Iyer Ministry of Water Resources, Government of India, New Delhi, India

Arundhati Deka Department of Humanities and Social Sciences, IIT-Guwahati, Guwahati, Assam, India

Vishaka Gulati Department of Humanities and Social Sciences, IIT-Guwahati, Guwahati, Assam, India

Nitya Jacob New Delhi, India

Nitin Kaushal Rivers, Wetlands and Water Policy Division, WWF India, New Delhi, India

Indira Khurana Jal Jan Jodo Abhiyan, New Delhi, India

T. S. Mehra Ministry of Water Resources, Government of India, New Delhi, India

Arjit Mishra Rivers, Wetlands and Water Policy Division, WWF India, New Delhi, India

Ashwin B. Pandya International Commission on Irrigation and Drainage (ICID), New Delhi, India

Tanusree Paul Centre for Women's Studies, Visva-Bharati University, Santiniketan, West Bengal, India

N. N. Rai Central Water Commission, New Delhi, India

Romit Sen Rivers, Wetlands and Water Policy Division, WWF India, New Delhi, India

Introduction

Unlike any other natural resource, water occupies a vital place for sustenance and development of life as we know in modern times. The livelihoods, prosperity and sheer survival depend upon the deployment and management of water. Since it pervades the political economy of the country, there are multifaceted issues which come up when deployment and management of water towards betterment of the society is examined.

Along with its life and economy sustaining features, its shortage and surplus also are causative factors of disasters. Ensuring its supply in the right quantities at the right times is the key to water management. It is seen that addressing the challenges of water management is inversely proportional to the economic and social status of the country. Developing countries like India are yet to overcome the challenges though the political and social economies have been striving to this effect since some time.

India has been bestowed with 17% of the world's population but just 4% of the water resources to sustain ever-expanding demands from growing population as it makes transition from a subsistence-level society to a middle-income country with significant economy and achieves its goal of poverty elimination. Water management in India presents multifaceted challenges in the form of providing sustainability of the solutions, dealing with adversities and ensuring equitability as per the needs and demands of various sectors. All this has to be attempted in a highly skewed resource availability scenario in which the entire annual supply is provided within a short span of around 100 days, while supplies have to last for the entire year.

This is especially so in times when the availability is the least from natural precipitation. Over historical times, India has been ravaged by floods and droughts at regular intervals leading to loss of livelihoods, life and general disruption of social fabric under the stress of adversities. Often times, the floods and droughts exist in the country concurrently along with pockets of sustained supplies. While one part of the country experiences floods, at the same time, many other parts undergo drought-like conditions. Even the same area which has undergone flood damages also sometimes faces droughts in the subsequent parts of the hydrological

year. These issues will assume greater importance in near future when coupled with climate change effects, which will have greatest impacts on availability and distribution of water amongst different groups of the society.

There are many aspects of water management in line with its multifarious uses and requirements. The book attempts to examine some of the key aspects of water management in India in the context of the three scenarios of water availability, namely droughts, where the availability in a region is seriously impaired; floods, where the consequent inundation may bring up the needs of structural and non-structural measures for appropriate and timely disaster management; and thirdly, the beneficial aspect of water as a source of energy and livelihoods.

Apart from physical aspects of water management, an overwhelming requirement of social management of the infrastructure and interventions created assumes the form of next great challenge for the country, which has achieved at least partly the assets required for management. The book, therefore, also includes the social aspects of management in the form of gender-specific issues and participatory management initiatives at various locales.

Societal management requires apportioning and sharing the available water resources amongst various stakeholders, with each group holding specific demands and opportunities. More often than not, political and social boundaries intersect the hydrological boundaries, sometimes even leading to transboundary issues of water sharing. Water is not merely required by the human life alone but is also a key to environment sustainability of almost all the life forms. Issues arising out of interventions for development and their impacts on the rest of the biosphere are also an important aspect as we continue to garner more and more resources towards our requirements.

Each of the areas described above holds the potential of an in-depth inquiry and is also an independent subject in its own right in a multidisciplinary scientific inquiry. Indeed, much has been researched and written on them. The present works provide a glimpse of issues involved which are under active debate and possible solutions to some of them. The chapters sample relevant aspects of management and deployment of water in the context of India in its various geographical regions. Chapters are oriented towards providing a glimpse of issues involved and solutions being thought about for the long term.

The book comprises of seven invited chapters from authors of repute in different areas of management and disasters related to water.

In Chap. 1, Dr. Indira Khurana presents a historical perspective of droughts in India. A large part of India is naturally prone to drought. Drought is insidious and affects millions. It disrupts the social fabric and affects economic and social development in ways that are intergenerational, miring those affected in a perpetual cycle of poverty. It affects health and nutrition, education, and food security and creates a climate for continuation of social evils.

The author recommends that an effective institutional mechanism, backed by a legal framework for creation of an enabling regulatory environment for water, be put in place. Also, capacity building, development of contemporary forecasting and early warning systems and encouraging mitigation measures based on

state-of-the-art technology and environmental sustainability are suggested. There are examples of communities successfully drought proofing their villages through afforestation, rainwater harvesting and judicious use of water. Such efforts need to be scaled up through linkage with government resources.

With more than two-thirds of the country prone to droughts, the author underlines the need to look beyond several existing prevention and mitigation measures and stresses on larger community participation, quoting several instances in which such community-based initiatives in Andhra Pradesh, Gujarat, Rajasthan and Maharashtra have led to water harvesting and watershed management and drought proofing of areas. She takes a hard look at the existing government institutions and mechanisms, including in the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and the National Water Policy, to deal with the debilitating effects of droughts.

Coupled with the monsoon systems based intense rain spells and a relatively flat alluvial plain topography, floods have been a prime cause of distress since time immemorial. Floods have been a chief cause of loss of livelihoods and lives and pose a serious threat to sustained economic development of the most populated areas of the country. Ganga and Brahmaputra basins combined comprise the majority of the flood-prone area of India and suffer extensive flood damages almost every year. In Chap. 2, N. N. Rai et al. take up the issue of flood management based on extensive studies of the two largest river basins in India—Ganga and Brahmaputra. While examining the measures to alleviate the flood damages, it is necessary to have a close look at the hydrologic and hydrodynamic phenomena affecting the generation, propagation and dissipation of flood waves in the basins.

The authors draw attention to two key aspects relating to flood moderation in Ganga and Brahmaputra river basins. In Ganga Basin, the role of meteorological phenomena of cyclonic circulations and their path over Gangetic plains in the western parts of basin is highlighted. Similarly, in case of Brahmaputra Basin, the role of major sub-basins in Upper Brahmaputra Basin is examined with the effect of combinations on the floods in lower Brahmaputra valley around Guwahati, where major population centres are located. The flood peak pattern analysis and the estimate of flood storage requirement in different sub-basins of Ganga and Brahmaputra are provided.

With the regulated releases, the provision of other structural measures like embankments and non-structural measures like disaster advance warnings and pre-emptive management of disasters can become more effective. The authors argue that integrated development of reservoirs and storage projects could play a key role in moderating flood peaks and bringing relief from flood devastation in the two basins.

In the Chap. 3, Ashwin B. Pandya builds a case for development of the hydropower sector to address the issue of water security as well as sustainable energy needs of the country. The author underlines the fact that the current policy climate in the country is beset with misconceptions and creates hurdles rather than providing support for hydropower development.

Pandya suggests a host of interventions going beyond mere policy tinkering for faster growth of the sector. He suggests involving the local communities as stakeholders in projects and bringing in tariff-related interventions too. Segregating the Himalayan region comprising north and north-eastern parts of India and Peninsular India, the author presents region-wide issues that plague development of the sector and presents several suggestions to tide over most issues.

"It will not be possible to tinker with any one aspect and expect the sector to revive and take its pride of place in the development agenda of the country. Especially a consistent and global approach in terms of environmental and social assessments and finality of the decisions made is considered necessary for setting up a favourable investment and implementation scenario", Pandya concludes.

From the primarily scientific and managerial visions of water management, the book moves to sociological aspects of water issues plaguing the development of the sector.

With the increasing demands in line with the growth of population and the economy, issues of water sharing amongst the co-basin entities like the provinces and nations are coming up very fast. With increasing competitive federalism, the issues are also assuming greater intensities and are proving a strain on the fabric of society and national integrity. There are now more incidents of water conflicts than cooperation at a state or basin level. In its geopolitical setup, India finds itself in all the three roles that of an upper, middle and lower riparian entity, which makes the policy formulation very complex and difficult. Transboundary challenges with India's neighbours are also on the rise, each one with its own dynamics.

In Chap. 4, Dr. Anamika Barua et al. describe the parallels and interdependencies between interstate water conflicts within India and the transboundary ones with its neighbours, emphasising on the Brahmaputra River Basin.

While India has been able to negotiate on transboundary water issue with other riparian countries through treaties and other forms of agreements, resolution of internal disputes within the federal structure has been rather poor. Distributed federal nature of water governance with lack of dialogue affects the national development strategies and also makes the dialogues on water at international level more complex.

There is an amount of basin-wide coordination between India and its neighbours, like sharing of hydrological data with China during monsoon and hydropower development in Bhutan by India and arrangements for water sharing with Bangladesh in case of Ganga. In case of Indus Basin, the specialised nature of the basin and the treaty, the developments on the same are contentious and legalistic.

Management of water quality, especially in the lean season in the rivers, forming the central feature of the basin is becoming increasingly important. Increasing utilisation pressures from agriculture and pollution load from increasing urbanisation in various river basins have thrown up considerable issues of quality management and sustenance of the riverine flora and fauna. In the Chap. 5, Robert Alexander Speed et al. present a basin management plan that uses a hybrid—top-down and bottom-up—approach and engages with various stakeholders in the Ramganga River Basin.

The authors, including a team from WWF-India, draw upon the experience and efforts undertaken as part of the "Rivers for Life, Life for Rivers" programme of WWF-India, to outline measures for developing, protecting and harnessing the resources of the Ramganga Basin.

The chapter makes for an engaging discourse on how such a plan evolved at the end of a long process of dialogue with all stakeholders. "Different groups have different views on how water resources should be allocated, used and managed. Getting them to discuss and agree on a common vision for River Ramganga was tedious job. It involved a long drawn process of generating and sharing information, consultations and making users realise the benefits of such an exercise", the authors note.

Similar exercises may not have been carried out for all river basins, but many of the suggestions put forth by the authors can find acceptance in plans for reviving several other river basins and ensuring their continued health and safety.

Water management at states level is highly compartmentalised, and interinstitutional cooperative mechanisms are not well defined. Differing developmental levels of various states make for differing coordination and management sophistication.

Role of communities in the management of local water bodies and water facilities is of utmost importance when the local level issues are required to be tackled. State machineries often lack sensitivities and resources for setting up initiatives for ensuring the sustainability of the local water bodies in a rapidly changing urban environment. The water bodies, which are facing rapid urban expansion in their catchments or around their periphery, face a growing challenge of maintaining their water quality and quantity regimes. Local communities around them are the polluting agents as well as victims of the poor health of the water body both at the same time.

In Chap. 6, Nitya Jacob proposes people-led initiatives in cases where the state machinery has failed in its duty to provide even lifeline water supply. Weaving his arguments through various examples—from Hussain Sagar in Hyderabad to Neela Hauz in New Delhi where people-led movements saved local water bodies from disappearing in the wake of municipal apathy—the author stresses on the need to build local institutions and empowering leaders at the grassroots levels in matters of local water management.

Stopping short of saying that local water governance should be handed over to village panchayats or communities, Jacob asks for state or local government's tacit as well as explicit support in capacity building and harnessing the bandwidth that willing local NGOs possess. He also underlines the fact that water management at the local level would need to look beyond just watershed restoration or changing crop patterns. Since most watershed development programmes at the very basic level—village and block—have the potential to create social transformation, the author calls for equitable and inclusive representation of women, minorities and even the disabled in them.

Jacob's view is pertinent that for success of local water programmes, local leaders are more important than local bureaucracy as the former are unlikely to

move out of the area and remain heavily invested in their communities and local projects.

Gender issues in on-farm water management as well as fulfilling the consumptive needs of rural households are very important. It has been observed that with increasing migration of male skilled and unskilled labour towards urban centres, women have come to play important roles in maintaining the agricultural and drinking water securities of families and livestock.

However, with the existing power structures in society, the decisions on the initiatives to be taken and improvements to the practices are in the hands of male members in the rural communities. Gender involvement in the water management practices is, therefore, becoming more and more urgent. In the Chap. 7, Dr. Tanusree Paul looks at and beyond the issue of equitable representation of women in matters related to water governance and management and asks for a better understanding of interlinkages between empowerment and participation.

She is able to bring forth the sharp contrast between India and some of its neighbours in the subcontinent and other countries elsewhere in equal representation of women in water-related institutions as well as on ensuring gender equity in water allocation. The water policies in India have fallen short of equipping and empowering women in the true sense. Women have to be capacitated to function as empowered individuals in the waterscapes.

All in all, this book may be treated as an amalgamation of various world views of the water management scenario of the country. Various chapters and different world views expressed for different aspects of water management and governance provide the reader a glimpse of the spectrum of scientific and sociological areas that need to be negotiated for finding a path towards development. It is hoped that the publication will be able to bring contexts to policies being proposed and debated.

The book is an attempt to coalesce insightful opinions on the current water scenario in India and provide guidelines for management of the resource. With its expansive views and perspectives, it is hoped the book will be an effective guide for researchers, policy makers and stakeholders for the breadth of knowledge and ideas that it has generated.

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December 2018

Girish Chadha
Ashwin B. Pandya

Chapter 1
Dealing with Droughts

Indira Khurana

Abstract A large part of India is naturally prone to drought. Unfortunately, droughts have now become more frequent due to development interventions, deforestation and climate change. Drought is insidious and affects millions. It disrupts the social fabric and affects economic and social development in ways that are inter-generational, miring those affected in a perpetual cycle of poverty. It affects health and nutrition, education, food security and creates a climate for continuation of social evils. There are government mechanisms and institutions in place to deal with droughts, yet over the years, evidence indicates that clearly much more needs to be done. There are examples of communities successfully drought proofing their villages through afforestation, rainwater harvesting and judicious use of water. Such efforts need to be scaled up through linkage with government resources. Addressing drought can no longer be ignored, given the water crisis that the country faces as it stares at an ever-widening gap between demand and supply. This chapter informs about major droughts in India, devastation due to drought, government institutions and mechanisms, prevention and measures for drought mitigation and community efforts. The chapter suggests a roadmap for the way forward.

Keywords Drought · Bundelkhand · Community participation · Health · India · Mitigation · Water conservation

Acronyms

APDAI	Andhra Pradesh Drought Areas Initiative
APFAMGS	Andhra Pradesh Farmers Managed Groundwater Systems
BIRDS	Bharatiya Integrated Rural Development Society
CGWB	Central Ground Water Board
DDMA	District Disaster Management Agency

I. Khurana (✉)
Jal Jan Jodo Abhiyan, New Delhi, India
e-mail: dr.indira.khurana@gmail.com

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DDP	Desert Development Programme
DM	Disaster Management
DPAP	Drought Prone Areas Programme
DRDA	District Rural Development Agency
EGoM	Empowered Group of Ministers
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
IAEP	Integrated Afforestation and Eco-development Programme
IMD	Indian Metrological Department
IWDP	Integrated Watershed Development Programme
IWMI	International Water Management Institute
LTA	Long term average
MDWS	Ministry of Drinking Water and Sanitation
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
NDMA	National Disaster Management Agency
NDRF	National Disaster Response Force
NGO	Non-governmental Organisation
NRAA	National Rainfed Areas Authority
NRDWP	National Rural Drinking Water Programme
NRMC	National Remote Sensing Centre
NWDPRA	National Watershed Development Programmes for Drought Prone Areas
PRI	Panchayati Raj Institutions
RBI	Reserve Bank of India
SDMA	State Disaster Management Agency
SOP	Statement of Purpose
WASSAN	Watershed Support Services Network
WDPSC	Watershed Development Programme for Shifting Cultivation
WRG	Water Resources Group
WRM	Water Resources Management

India is not new to drought, with around 68% of the country prone to drought.

What is new is the increase in frequency and areas faced by drought. With rising water demands, poor water management and superimposition of climate change-related monsoon patterns, the situation calls for concerted action on various fronts.

A study conducted by the Water Resources Group (WRG) states that there will be a 50% gap by 2030 between demand and supply because of :

- The population increase from 1.2 billion in 2010 to 1.6 billion in 2030;
- Increased urbanization from 30 to 50% tends to change lifestyle and consumption patterns;
- Increase in the agriculture water footprint and will increase by 5%;
- Rise in the domestic sector consumption by 197%;
- A 283% increase in demand for water by the industrial sector in 2050 as compared to 2000;
- Growth in India's GDP, leading to a per capita income increase from $468 to $17,366 by 2050. Increase in per capita income will result in lifestyle changes that tend to increase per capita water consumption.

(*Source*: *Ranjit Barthakur and Indira Khurana, (eds) 2015. Reflections on managing water: Earth's greatest natural asset, Balipara Foundation*).

Water scarcity risk is further exacerbated by mismanagement, weak governance and by the absence of a multi-disciplinary and multi-stakeholder approach to natural resource management. Pollution, over-extraction of groundwater, and the degradation of freshwater ecosystem are a direct consequence of this mismanagement.

1.1 The Water Crisis: Cause for Alarm

We need water for survival, agriculture, industry, transport, culture, recreation, peace and much, much more. Only 2.5% of water is freshwater: The rest is saline and so mostly unusable. The question to ask is: Are we doing enough?

The alarm is not unfounded. Globally, agriculture is the largest user of water, accounting for around 70% of freshwater withdrawals. Lack of water has a domino effect on food security: Food output must grow by 60% to feed nine billion by 2050. But, by 2030, the world will confront a water supply shortage by 40%.

By 2025, 1.8 billion people will be living in regions or countries with absolute economic water scarcity. Already 1.2 billion are living with physical water scarcity.

With 263 trans-boundary river basins in the world, the potential for cooperation—or conflict—is tremendous. Desperation is leading to refugees within and between countries.

Lack of access to water has implications for equitable development, world peace and stability. No wonder, that Water Crisis was recognized as the third risk amongst the top ten risks in terms of impact according to the Global Risk Assessment Report, 2016, published by the World Economic Forum. A global risk is an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years.

(*Source*: *Ranjit Barthakur and Indira Khurana, (eds) 2015. Reflections on managing water: Earth's greatest natural asset, Balipara Foundation*).

1.2 Drought in India: A Historical Perspective

The Indian subcontinent experiences two monsoons: The southwest or the summer monsoon (June–September) accounting for 70–80% of the annual rainfall over major parts of South Asia and the northeast or the winter monsoon.

Drought is a normal, recurrent climatic feature occurring in all climatic regimes, usually characterised in terms of its spatial extension, intensity and duration. Conditions of drought occur when the rainfall is deficient in relation to the statistical multi-year average for a region, over an extended period of a season or year, or more.

Droughts in the Indian region are primarily due to failures of rain from the southwest monsoon. A drought year is defined by the Indian Meteorological Department (IMD) as one where the overall rainfall deficiency is more than 10% of the Long Term Average (LTA) value and more than 20% of its area is affected by drought conditions, either moderate of severe, or a combination of the two (Anon 2009a, b, c, d, e, f, g).

Drought is classified into three major types: meteorological, hydrological and agricultural drought (see Box below).

Box: Types of drought

Meteorological drought usually precedes other kinds of drought and is defined as the lack of precipitation from expected or normal levels over a period of time. It is further classified as *moderate* drought if the rainfall deficit is 26–50% and *severe* when the rainfall deficits exceeds 50% of the normal.

Hydrological drought is defined as the deficiencies in surface and subsurface water supplies leading to a lack of water for normal needs.

Agricultural drought is usually triggered by the above two, it occurs when soil moisture and rainfall are not sufficient during the crop growing season thus causing extreme crop stress and wilting.

Source: Anon (2009a, b, c, d, e, f, g).

Around 68% of the country or 329 million hectares is prone to drought, across arid, semi-arid and sub-humid areas (see Fig. 1.1). Drought-prone areas are often water stressed areas, and host a large population of India's poor. In these areas, the link between water scarcity and poverty is pronounced.

Of this 68%, nearly 33% of the area has a chronic drought problem while another 35% is drought prone. Most of India's very poor (officially defined as those subsisting with less than 75% of poverty line or having an expenditure capacity of Rs. 8 or $1.25 per day) inhabit the drought prone areas. Around 134 million people, dependent on agriculture, reside in chronic drought prone areas (Mahapatra et al. 2010a, b, c, d, e).

On average, drought afflicts these areas every third year. Taking into consideration the data of the rainfall in the last 100 years, there has been a severe drought every eight to nine years. India faced 22 major droughts during 1871–2002 (see Table 1.1).

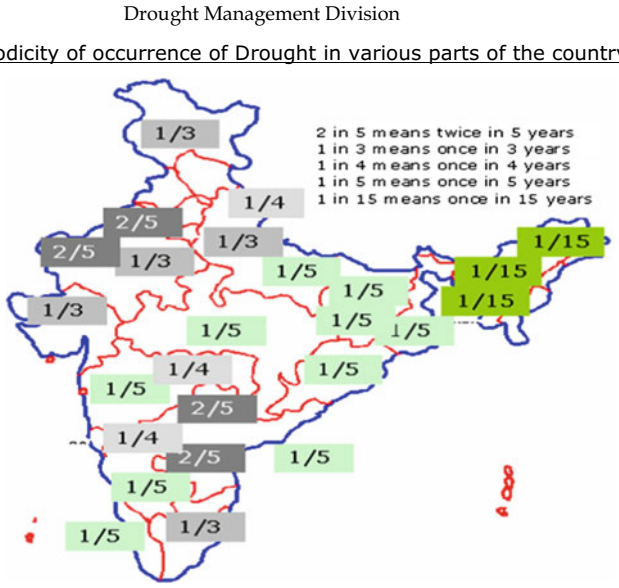

Fig. 1.1 Periodicity of drought occurrence across India. *Source* Anon (2012)

Some information on the 2013 drought in Maharashtra state is given in the box below (Box 2: Maharashtra drought 2013).

The Belgium-based Centre for Research on the Epidemiology of Disasters estimates that droughts have affected nearly 1,061 million people and killed 4.25 million people in India during 1900–2006 (Mahapatra et al. 2010a, b, c, d, e).

1.3 Examples of Recent Devastating Droughts in India

In early 2013, (monsoon sets in June), Maharashtra faced one of the worst droughts in recent memory, with key politicians stating that that this year's drought was worse than the one in 1972, which was termed as a 'famine'. Could this entirely be ascribed to monsoon failure?

Maharashtra is not new to drought. Climatologically, the state can be divided into four regions each with their own frequency of drought occurrence that range from once in three years to once in twelve years (http://cgwb.gov.in/CR/atlas.htm#drought).

Almost 20% of the state was affected: 11,801 villages across 15 districts were declared as drought-affected. Acute drinking water scarcity was faced in 1,779 villages and 4,709 smaller habitations. Some of the villages were facing drought for the second consecutive year. In March, 1,454 towns and 4,100 villages were supplied

Table 1.1 Major droughts in India between 1900 and 2000

Year	Area affected by drought	Losses (figures in parenthesis give loss in monetary terms)
July/2002	Uttar Pradesh (UP), Madhya Pradesh (MP), Rajasthan, Punjab, Haryana, Delhi, Karnataka, Kerala, Nagaland, Orissa, Chhattisgarh, Himachal Pradesh, Gujarat, Maharashtra, Andhra Pradesh (AP), Tamil Nadu (TN)	300,000,000 people affected ($ 910,721,000)
May/2001	New Delhi, Rajasthan, Gujarat, Orissa	20 deaths
April/2000	Gujarat, Rajasthan, Madhya Pradesh, Andhra Pradesh, Orissa, Maharashtra	90,000,000 affected ($ 588,000,000)
March/1993	Bihar, Orissa, Andhra Pradesh, Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Karnataka, Orissa	1,175,000 affected
1987	Gujarat, Rajasthan, Orissa, Madhya Pradesh, Andhra Pradesh, Maharashtra and four Union Territories	300 deaths/300,000,000 affected
April/1983	Kerala, Tamil Nadu, Rajasthan	100,000,000 affected
1973	All India drought	($ 50,000,000)
1972	All India drought	100,000,000 affected
1964	All India	166,500,000 affected
1942	Kolkata, Bengal region	1,500,000 deaths
1900	Bengal	12,50,000 deaths

Source Samra (2004a, b)

with 1,850 tankers of water. Drinking water supply was fast drying up and estimates indicated that use of tankers could increase up to 2100.

Big dams like Jayakwadi, Ujani and Koyna were running dry and the dead water stock was used for supplying water. Marathwada region had the worst statistics of water levels, with only 9% of the total capacity remaining as compared to 30% in 2012. According to the state's Groundwater Surveys, 195 of the 1,531 watersheds were critically depleted, 73 already 'over exploited'. (http://www.ibtl.in/news/exclusive/2079/maharashtra-drought-2013/).

In Ahmednagar district, lack of irrigation destroyed cotton, wheat, grape and sweet lime plantations, and would impact sugarcane production. (http://www.ibtl.in/news/exclusive/2079/maharashtra-drought-2013/). A 10–15% decline in India's sugar output was expected due to reduced cane availability from Maharashtra due to the drought (*Business Standard, Apr 8, 2013*).

With 70% of the water going for sugarcane cultivation and some being diverted for drinking water, dams had little to offer for other farming. (http://www.thehindu.com/todays-paper/tp-national/maharashtra-drought-manmade-says-study/article4579555.ece).

Analysis of the situation by some civil society groups ascribed the cause of the drought situation to poor water management, water-intensive cropping patterns (sugarcane for example), absence of a long-term view to manage water and drought, neglect of local water management systems, diversion of water resources to non-priority uses and absence of a long-term view to manage water and drought With 70% of the water going for sugarcane cultivation and some being diverted for drinking water, dams had little to offer for farming. According to researchers unless drastic counter measures were taken urgently, almost 30 million people could be affected. And, this would happen in that state which contributes 13.3% of GDP.

In March 2014, an Empowered Group of Ministers (EGoM) on drought headed by the Agriculture Minister approved a Rs. 12.07 billion ($0.185 billion) relief package for Maharashtra. Other measures announced included:

- 25% of the budgetary fund allocation in 2013 for long-term water conservation measures and drought- relief schemes;
- State to open animal shelters on 'zero deposit';
- Implementation of schemes worth Rs. 227 billion ($3.47 billion) for agriculture, irrigation and water conservation.

Thankfully in June, the monsoon arrived on time in Maharashtra bringing huge relief to areas reeling under serious drought situations. By June 13, the state had received 36.6% of the average rainfall for June and of the 355 talukas[1] in the state, 177 had already received 100% rainfall for the period. With the timely rain, pre-sowing operations started in full swing. (http://nidm.gov.in/PDF/DU/2013/June/13-06-13.pdf).

Source: *Ranjit Barthakur and Indira Khurana (eds), 2015. Reflections on managing water: Earth's greatest natural asset, Balipara Foundation.*

1.4 Drought Devastation

Drought is a complex, slow-onset phenomenon of ecological challenge that affects people more than any other natural hazards by causing serious economic, social and environmental losses.

Droughts cause the death and displacement of more people than cyclones, floods and earthquakes combined, making them the world's most destructive natural hazard. Yet, while droughts are expected to increase in frequency, area and intensity due to climate change, effective drought management policies are missing in most parts of the world.

According to a joint statement issued by Luc Gnacadeja, Executive Secretary of the UNCCD, Michel Jarraud, Secretary General of the World Meteorological

[1]Taluka: A subdivision of a district comprising of a group of villages organized for administrative purposes.

Organisation and Jose Graziano de Silva, Director General of the Food and Agricultural Organisation, "Droughts have scarred human history since ancient times. While lacking the drama of earthquakes or hurricanes, droughts cause more deaths and displace more people than any other kind of natural disaster." (www.wmo.int/pages/mediacentre/press_releases/pr_969_en.html).

Drought impacts include economic, environmental and social impacts, while affecting the local and national economy in various ways, directly and indirectly.

Direct impacts are usually physical/material and include reduced agricultural production, increased fire hazard, depleted water levels, higher animal mortality—both livestock and wildlife, and damage to livestock and wildlife habitats. When these direct impacts have a multiplier impact on economy and society these are known as indirect impacts. The latter are often so diffuse, that is becomes difficult to arrive at financial figures to estimate actual losses.

Economic impacts include production losses in agriculture and other sectors, which rely on surface and groundwater. Agricultural production losses result in a decline in income and purchasing power of the farmers. All industries that are dependent on agricultural produce as raw material also suffer economic losses. This also leads to price increase. If the drought is at a national level, then the macro-economic indicators are also affected (Anon 2009a, b, c, d, e, f, g).

Major droughts in India were followed by recession with serious impacts (see Box below).

Box: Impact of monsoon on Indian economy

In India, agriculture and allied sectors like forestry, logging and fishing account for 17% of the GDP (2011 estimate), employs 52.1% of the total workforce, and despite a steady decline of its share in the GDP, is still the largest economic sector and a significant piece of the overall socio-economic development of India. (http://en.wikipedia.org/wiki/Economy_of_India).

Considerable electricity is produced by hydroelectric power plants, which are driven by water collected during the monsoons. Electricity powers hospitals, schools, and businesses that help the economies of these areas to develop. This is the major reason for the economic growth of India to depend on monsoon season. If the monsoon is good, it boosts up the economy of the country and helps in maintaining GDP growth.

A good rainfall tends to boost agricultural productivity, reducing prices and bringing down inflation. Increased agricultural productivity enables export. A good rainfall enhances ground water levels and replenishes reservoirs. This improves the potential of irrigation hydroelectricity power generation. The flip side is that floods associated with stronger than normal monsoon can cause inundation of low lying areas and cities leading great damage to crops, property and life.

An analysis of the variation of the GDP and the monsoon has revealed that the impact of severe droughts on GDP is between 2 and 5% of GDP. Due to

the 2002 drought, agricultural contributions to the GDP dipped by 3.1% and agricultural income losses were estimated at Rs. 39,000 crore. Governments supplied 1.5 billion litres of water every day for close to four months using tankers, trucks and trains (Mahapatra et al. 2010a, b, c, d, e).

The large impact of droughts on GDP (despite the substantial decrease in the contribution of agriculture to GDP) is attributed to the indirect impact on the purchasing power of the large fraction of the population dependent on agriculture. Hence if the monsoon turns out to be a 'normal' monsoon, the nation heaves a sigh of relief and carries on with business as usual. If it turns out to be a drought, there is a significant impact on agriculture and the economy, and major drought relief programmes are launched (http://www.imd.gov.in/section/nhac/dynamic/lrf_backgroudnote_apr13.pdf).

The then Reserve Bank of India (RBI) Governor D. Subbarao stated that the performance of monsoon would be an important factor in determining the central bank's policy in the next three months reiterated this fact on June 7, 2013. "We also chase monsoon like millions of farmers across the country. So, monsoon outlook and monsoon performance is going to be an important factor in determining the bank's policy in the next three months," he said.

(*Source*: http://headlinesindia.mapsofindia.com/business-news/rbi/monsoon-an-important-factor-in-rbi-policy-d-subbarao-137090.html) and taken from *Ranjit Barthakur and Indira Khurana (eds), 2015. Reflections on managing water: Earth's greatest natural resource, Balipara Foundation).*

Environmental impacts include lower levels of water in reservoirs, lakes and ponds and reduced flows in spring and streams, leading to reduced availability of drinking water for humans, fish and animals. It may also cause loss of forest cover, migration of wildlife and greater mortality. A prolonged drought may increase stress on endangered species and cause biodiversity loss. Reduced stream flows may cause wetland loss, salinity ingress, aquifer loss, decline in water quality and productivity of the landscape (Anon 2009a, b, c, d, e, f, g).

Some of the impacts of drought on drinking water are given in the box below.

Box: Drought and drinking water availability

Drought affects the availability of surface and groundwater. To begin with, sources like dug wells and ponds dry out or store less water. This affects drinking water availability for people who depend on surface sources, which contributes around 15% of total drinking water needs in rural areas in India. More critically, less water in surface water structures leads to less recharge of groundwater. This has a direct impact on the drinking water availability as 85% of India's rural drinking water demand is met from groundwater. Hand pumps run dry. This makes accessing drinking water an expensive affair, thus keeping

large number of poor population without any provisions for drinking water or having to pay unaffordable amounts. As groundwater level dip, it becomes expensive to install deep tubewells solely for drinking water purposes. Fetching water from far away surface sources also makes drinking water transportation expensive.

Of the three types of drought described previously in the chapter, two of them—meteorological and hydrological—have an impact on availability of surface water availability, thus on groundwater recharge. In drought-prone areas drinking water becomes a problem from March and the problem becomes acute around May-June. In case of consecutive drought, the problem is felt around December-January that continues till June, when hope revives for a normal monsoon.

Making drinking water available to a large population during drought has been the most pressing aspect of India's drought emergency works. For instance, during the drought of 2002–03, 18 states reported severe drinking water shortages (11 of them continued to experience problems during 2003–04 as well). The Government had to make emergency provision of drinking water for 120,000 rural habitations and 500 towns. Tankers made more than 40,000 rounds in the four peak summer months to the affected villages carrying 116 million kilolitres of water in a day. According to government estimates, the exercise reached over 110 million people, including 22 million in urban areas. In addition to this massive scale of operations to augment drinking water supplies, 2.9 million kilolitres of water were supplied through rail to certain pockets of Rajasthan and Gujarat. Some, 2,40,700 hand pumps were repaired between July 2002 and June 2003. Over 22,000 new hand pumps were installed, and 2,250 new tubewells commissioned. Some 24,895 traditional sources of water were also revived.

The drinking water crisis doesn't end with a drought. Often the problem continues for two to three years even if the monsoon is normal. Depletion of groundwater adds to this problem, increasing the vulnerability of people to water drought. This recent example of consecutive drought impacting long-term drinking water availability is in the Bundelkhand region. Though in 2008 the monsoon was good, groundwater levels had not improved substantially. Migration continued during the summer of 2009 due to non-availability of adequate drinking water.

Source: Mahapatra et al. (2010a, b, c, d, e).

Social impacts arise from lack of income causing migration of the population from the drought-affected areas. There are several coping mechanisms adopted in India: Migration to cities to work as labour on construction sites, withdrawal of children from schools, postponement of marriage, selling of assets such as cattle and land. In addition to all this is the loss of social status and dignity. Inadequate food supply can lead to malnutrition. Shortage of water for drinking and agriculture leads

to social conflict and disruption. Inequities in distribution of the available water add to the social tension (Anon 2009a, b, c, d, e, f, g).

Health impacts of drought can be inter-generational. Drought restricts access to nutritious food and clean water, increasing susceptibility to malnutrition and disease.

Available data indicates that the short-term effects of drought on human health include those caused by water shortages and concomitant food shortages and by contaminated water. Dehydration caused by insufficient liquid intake, and diarrhea are major causes of infant mortality. In pregnant women, inadequate intake of calories and micronutrient malnutrition, resulting from food and mineral shortages, compromise maternal health and fetus development. Malnutrition in turn compromises the immune system, increasing susceptibility to infection.

The potential long-term effects of malnutrition in utero and early childhood include stunting and metabolic diseases such as diabetes and hypertension (UNISDR 2013).

1.5 Effect of Drought on Children

In May 2016, Nobel Laureate Kailash Satyarthi wrote a letter to Prime Minister Narendra Modi, drawing his attention to pitiable condition of 163 million children living in severe drought-affected areas of the country. Satyarthi, who shared the 2014 Nobel Peace Prize with Pakistan's Malala Yousafzai, has been working for child rights for many years and heads the *Bachpan Bachao Andolan*, a Delhi-based non-profit. The organisation has demanded that children be given top priority in all kinds of relief and rehabilitation work in view of the prevailing drought.

"Children are (the) silent victims of natural disaster(s). This natural disaster has increased child labour, child trafficking, and child marriages in (the) drought-prone areas," Satyarthi said. "More than half of the total child marriages and child labour cases in India (were reported) from these 10 droughts-affected states," he stated. Around 7.5 million children were forced into labour and 10.5 million child marriages were reported from these states.

He also quoted the Ministry of Home, informing that more than 22,000 children were reportedly kidnapped and around 36,000 missing from 10 drought-affected states across the country. He also warned that, "Owing to drought condition in these states, in the coming months the (number of) missing children may increase manifold" (http://www.downtoearth.org.in/news/children-worst-sufferers-in-drought-hit-areas-says-satyarthi-53823).

Scant literature is available to assess how drought affects children. Drought makes the rural population vulnerable as agriculture and consequently money dries up. Vulnerability increases and life becomes a daily struggle. Children are often forced to drop out of schools and this makes them vulnerable to traffickers.

"We have not done any study regarding (the) impact of drought on children. But our preliminary assessment says that 40% of (the) total (number of) children in drought-affected regions are vulnerable. The National Commission for Protection

of Child Rights can take the initiative to document all facts in drought-hit areas," Satyarthi added (http://www.downtoearth.org.in/news/children-worst-sufferers-in-drought-hit-areas-says-satyarthi-53823).

1.5.1 In Utero Exposure to Drought

A growing literature finds that in utero exposure to adverse environments may negatively affect the health and educational attainment later in life (Almond et al. 2009; Banerjee et al. 2010; Lin and Liu 2014; Maccini and Yang 2009; Neelsen and Stratmann 2011). These studies clearly demonstrated that early childhood conditions including the in utero period have a long lasting impact on life expectancy, adult earnings, adult health, and cognition development (Santosh Kumar, Ramona Molitor and Sebastian Vollmer, 2014, Children of Drought: Rainfall Shocks and Early Child Health in Rural India, http://www.shsu.edu/academics/economics-and-international-business/documents/wp_series/wp14-07_paper.pdf).

David J. Barker, a British physician and epidemiologist, was the first who argued that nutritional deprivation of pregnant women impacts the fetus and leads to impaired fetal development with long lasting consequences that continue to persist after birth and even through adulthood (Barker 1990, 1995).

Kumar and others studied the medium-term effect of drought in the year before birth (in utero) and in the year of birth on the health outcomes of children younger than 60 months living in rural India and found that children exposed to drought in utero had adverse effects on early child health and were more prone to undernutrition: They proved that exposure to droughts in utero is associated with lower weight-for-age z-scores and increased probabilities of being underweight.

Given the dependency of rural lives on rainfall, a negative rainfall shock in a year is likely to affect the household income due to reduction in agricultural production as well as food availability which in turn may affect the maternal and fetal nutrition. For developing countries, there is enough evidence to confirm that family income does affect the nutritional status of children (Duflo 2003; Jensen 2000).

A number of studies examined the long-term effects of rainfall on health and schooling of children. For instance, Maccini and Yang (2009) noted that higher rainfall in the year of birth leads to improved health, schooling, and socioeconomic status for Indonesian women but not for men and discount the importance of in utero exposure to higher rainfall. Similarly, Shah and Steinberg (2013) assess the effect of rainfall variability in India on human capital accumulation and found that children exposed to droughts in utero or between birth and age four score significantly worse on literacy and numeracy skills, were more likely to repeat a grade, and less likely to ever enroll in school.

Santosh kumar et al. found that exposure to a drought in utero has adverse effects on early child health. Children exposed to a drought in utero have an increased probability of lower weight-for-age z-score, and a higher likelihood of being underweight

and severely underweight. Nonetheless, they did not detect any significant effect of drought on anemia incidence among 0–5 years old children.

1.6 Evolution of Drought Management in India

As far as drought management is concerned, independent India continued to follow the systems and practices from the colonial era. These were relief based approaches, which were inadequate to drought proof the people and geographies.

The current preparedness, quick response, relief, recovery, mitigation and management systems have evolved out of the experience of 17 major droughts, five severe droughts and technological advances since 1871 (Mahapatra et al. 2010a, b, c, d, e). Some of the major shifts as a result of drought are highlighted below:

- Initially administration concerning drought evolved famine codes, manuals and response procedures to minimise starvation deaths. During the colonial period, droughts often turned into famines, leading to colossal loss of human lives. Post-independence in 1947, no famine has occurred due to the measures undertaken.
- In 1965–66, the drought resulted in a response of a public distribution system to ensure physical availability of food.
- In 1972, the priority was economic access to food through employment generation for the drought-affected population. In the early 1970s the Drought Prone Areas Programme (DPAP) and the Desert Development Programme (DDP) were conceived and implemented (Mahapatra et al. 2010a, b, c, d, e).
- As an outcome of increased drought relief expenditure during 1969–70 and 1970–71 as compared to planned expenditure, the Planning Commission appointed a committee in 1973 under the chairmanship of BS Minhas. The Minhas committee emphasised that 'While a significant expenditure from the national exchequer on drought relief operations has been repeatedly incurred, an adequate impact has not been stabilizing and upgrading the economy in drought prone areas. The committee suggested that the main thrust of a long-term strategy should be in the direction of restoring the ecological balance. It demanded an integrated approach to the development of drought prone areas and argued that a mere collection of sub-projects would not aggregate to an integrated development. The DPAP emerged as a means of implementing the recommendations of the Minhas Committee. It was launched in 1972 with an allocation of INR 700 million ($10.73 million) for 54 districts in the country. DPAP covers 972 blocks of 183 districts in 16 States. (Andhra Pradesh, Bihar, Chattisgarh, Gujarat, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttaranchal and West Bengal).
- Monitoring of the 1979 drought underpinned the need of resilient and stable farming systems and livelihood opportunities. It also brought about the key organisational/institutional arrangements like the Cabinet Committee on Drought, Committees of Secretaries and the Crisis Management Group.

- A Task force under the chairmanship of Dr. MS Swaminathan reviewed the impacts of the DPAP and stressed the role of planning, implementing a long-term strategy and integrating all schemes in the area to develop it. Dr Swaminathan observed, "If our achievement, notwithstanding the massive investment made since the commencement of the Rural works programmes in 1970–71, has not been significant, it is because we have been more concerned with registering expenditure than with developing a resource management system appropriate to areas where droughts are more frequent and where desert conditions are more pronounced". The task force reiterated the need for a watershed approach, which it felt, was neglected over the years. It moved away from the conventional approach of having district as a unit of planning.
- The 1987 drought ushered in watershed management for mitigating adverse impacts on livelihood, cattle and trees and as a long-term approach for drought proofing. The DPAP and the DDP programmes were redrafted making watershed as a unit of drought proofing. Other programmes were also launched: the National Watershed Development Programme for Rainfed Areas (NWDPRA), Watershed Development Programme for Shifting cultivation (WDPSC), Integrated Watershed Development Programme (IWDP), Integrated Afforestation and Eco-development Programme (IAEP).
- The 2000 drought helped in consolidating the institutional and capacity building infrastructure.
- The severity of the 2002 drought called for the setting up of special task forces, additional monitoring systems and responses. The policy makers and development practitioners realised that drought was indeed perpetuated by human induced factors like neglect of water harvesting capacity. Since then rainwater harvesting, specifically revival of traditional systems, has got priority in drought management.
- In 2005 the Government of India government enacted the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) that guarantees 100 days of manual employment to any rural resident who demands employment. The Act's core objective is to regenerate the village ecology thus making them free from not only drought but also from other natural calamities. The Act gives considerable importance to local water conservation and drought proofing.

1.7 Disaster Management in India

Concerned with the increasing frequency and magnitude of natural disasters, the Government of India passed the Disaster Management (DM) Act, 2005 under which National Disaster Management Authority (NDMA) was created at the national level, headed by the Prime Minister and similar authorities at the state and district levels.

1.7.1 The National Disaster Management Act 2005

Disaster management is defined in the Act as a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary for (i) prevention of danger or threat of any disaster (ii) mitigation or reduction of risk of any disaster or its severity or consequences (iii) capacity building (iv) preparedness to deal with any disaster (v) prompt response to any threatening disaster situation or disaster (vi) assessing the severity or magnitude of effects of any disaster (vii) evacuation, rescue and relief (viii) rehabilitation and reconstruction (http://ndmindia.nic.in/OM-NDMC-170413.pdf).

The salient features of the National Disaster Management Act 2005 include: Shifting the focus to preparedness, prevention and planning from the earlier response and relief centric approach. The legislation is in the concurrent list of Constitution, permitting States to enact their own legislation on disaster management. The Act provides for establishment of (a) National Disaster Management Authority (NDMA), (b) State Disaster Management Authority (SDMA)(c) District Disaster Management Authority (DDMA) and (d) Establishment of National Institute of Disaster Management and National Disaster Response Force.

The Act also provides for the Constitution of Disaster Response Fund and Disaster Mitigation Fund at national, state and district levels and stresses on non-discrimination (http://mha.nic.in/pdfs/DM_Act2005.pdf).

From the earlier relief-centric response, the DM Act 2005 covers all aspects from prevention, mitigation, preparedness to rehabilitation, reconstruction and recovery. It gave rise to the initiation of formal mechanisms to deal with disasters at various levels and with dedicated funds. Some of the institutions and their functions are given below.

1.7.2 National Disaster Management Authority

NDMA is the apex body for disaster management in the country set up with the vision 'to build a safe and disaster-resilient India by developing a holistic, proactive, multi-disaster and technology-driven strategy for DM through collective efforts of all government agencies and Non-Governmental Organizations' (http://ndma.gov.in/ndma/index.html).

The Prime Minister heads the NDMA, and the State Disaster Management Authorities (SDMAs) are headed by respective Chief Ministers to spearhead and implement a holistic and integrated approach to disaster management. (http://ndma.gov.in/ndma/evolution.html). The PM is assisted by a Vice Chairman and a group of members, each of who is assigned particular disasters and states.

A Cabinet Committee on Management of Natural Calamities has been constituted. In addition, High Level Cabinet Committee and Inter Ministerial groups are in place.

The functions of NDMA include:

- Developing policies on disaster management;
- Approval of the National Plan;
- Approval of plans prepared by the Ministries or Departments of the Government of India in accordance with the National Plan;
- Developing guidelines to be followed by the State Authorities in drawing up the State Plan;
- Laying down guidelines to be followed by the different Ministries or Departments of the Government of India for integrating measures for prevention of disaster or the mitigation of its effects in their development plans and projects;
- Coordinating the implementation of the policy and plan for disaster management;
- Recommending provision of funds for the purpose of mitigation;
- Providing support to other countries affected by major disasters as may be determined by the Central Government;
- Taking such other measures for the prevention of disaster, or the mitigation, or preparedness and capacity building for dealing with the threatening disaster situation or disaster as it may consider necessary;
- Laying down broad policies and guidelines for the National Institute of Disaster Management (http://ndma.gov.in/ndma/rolesrespons.html).

1.7.3 National Institute of Disaster Management (NIDM)

NIDM is the nodal national agency responsible for human resource development, capacity building, training, research, documentation and policy advocacy for disaster management. It works in tandem with the NDMA, and Central, State and Local governments and various other stakeholders for disaster resilience, by developing and promoting a culture of prevention and preparedness. The Institute supports the setting up of Disaster Management Centres in the state Administrative Training Institutes.

The Institute also hosts the SAARC Disaster Management Centre (SDMC) for the eight Member States of the South Asian Association of Regional Cooperation (SAARC), namely Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. The Centre has developed a Regional Framework on Disaster Management in South Asia and facilitated development of different road maps on different aspects of disaster risk reduction in South Asia, based on which a series of projects have been taken up (http://www.mdws.gov.in/sites/upload_files/ddws/files/pdfs/DM_Directory_310712.pdf).

1.7.4 State Disaster Management Authority (SDMA)

In the states, the SDMA, chaired by the Chief Minister is responsible for coordinating all disaster management related activities. The state governments are mandated to establish a District Disaster Management Authority (DDMA) in each district, headed by the District Magistrate. This Authority functions as the planning, coordinating and implementing body for disaster management for the district.

The role of the local authority is to (a) Ensure training of its officers and employees (b) Maintain resources so as to be readily available for use in the event of a disaster (c) Ensure that all construction projects under it conform to the standards and specifications lay down. It also carries out relief, rehabilitation and reconstruction activities in the affected area within its jurisdiction.

1.7.5 National Disaster Response Force (NDRF)

The DM Act, 2005 made a statutory provision for the constitution of the National Disaster Response Force (NDRF) for the purpose of specialized response to natural and man-made disasters. NDRF is under the direct control of the NDMA. It is a specialist force, capable of dealing with all types of natural and man-made disasters.

A National Disaster Response Fund and State Disaster Response Fund have been created to address the component of response.

1.7.6 National Policy on Disaster Management

There is a national policy on disaster management in place for enabling a holistic and pro-active approach for prevention, mitigation and preparedness for disaster management to be adopted; which calls for measures addressing of vulnerability reduction, preparedness and mitigation in all government departments, ministries, programmes and schemes. Emphasis is laid on community involvement and awareness generation, particularly the vulnerable population and women, for sustainable disaster risk reduction. Communities are the first responders to disasters and, therefore, unless they are empowered and made capable of managing disasters, any amount of external support cannot lead to optimal results. It also calls for the building up of institutional structures, standard operating procedures and adoption of construction norms.

However, the above policy has little focus on drought (http://ndmindia.nic.in/NPDM-101209.pdf).

1.8 Institutional Drought Management Cycle: Current Practices

Preparing for a drought requires action on several fronts: The setting up of constitutional, legal and institutional frameworks for monitoring, early warning systems, declaration of drought based on identified indicators, relief measures, financial and economic support and dedicated financing. In all of this coordination between different arms of the administration, technical institutions and the people, and flow of information is key. Responsiveness is required at different levels and a strong institutional framework to provide timely and adequate response is needed for this. In case of India, these levels are the Central, state, district and panchayat/village.

National level institutions: The National Disaster Management Authority, National Institute of Disaster Management, Indian Meteorological Department, Central Water Commission, National Centre for Medium Range Forecasting, National Remote Sensing Centre, National Rainfed Area Authority, Ministry of Water Resources, Ministry of Agriculture, Ministry of Drinking Water and Sanitation

State level institutions: Disaster management departments, departments of agriculture, water resources, public health engineering, local authorities, etc.

Drought management is a measure of responsiveness and resourcefulness of governments at different levels and requires a strong institutional structure to monitor and provide a timely response. While drought management is primarily the responsibility of state governments, the Government of India also plays an important role. The institutional framework for drought management is given in the diagram below. Details of the roles of various stakeholders are given in the Manual for Drought Management, Department of Agriculture and Cooperation, 2009, pp 94–100 (http://drought.unl.edu/portals/0/docs/international/GovtIndiaDroughtManual.pdf) and in Fig. 1.2. In case of drought, the responsibility lies with the Ministry of Agriculture, Government of India who coordinates the necessary action across ministries and departments.

The current approach to drought planning, monitoring, management and mitigation includes early warning and forecasting, monitoring, response, and mitigation (see Fig. 1.3 and the following sections). The system requires coordination between all: the Government of India, state governments, scientific institutions and the people.

A. Drought Early Warning Systems

Drought monitoring and early warning systems are central to drought management followed by drought preparedness and mitigation. Broadly early warning systems function at three levels:

- Receiving forecast, early warnings and advisories from scientific institutions;
- Monitoring key drought indices at the national and state levels; and,
- Developing composite index of various drought indicators.

Early warning systems (a) Provide accurate, timely and integrated information on drought condition (b) Detect drought early (c) Provide information on all the

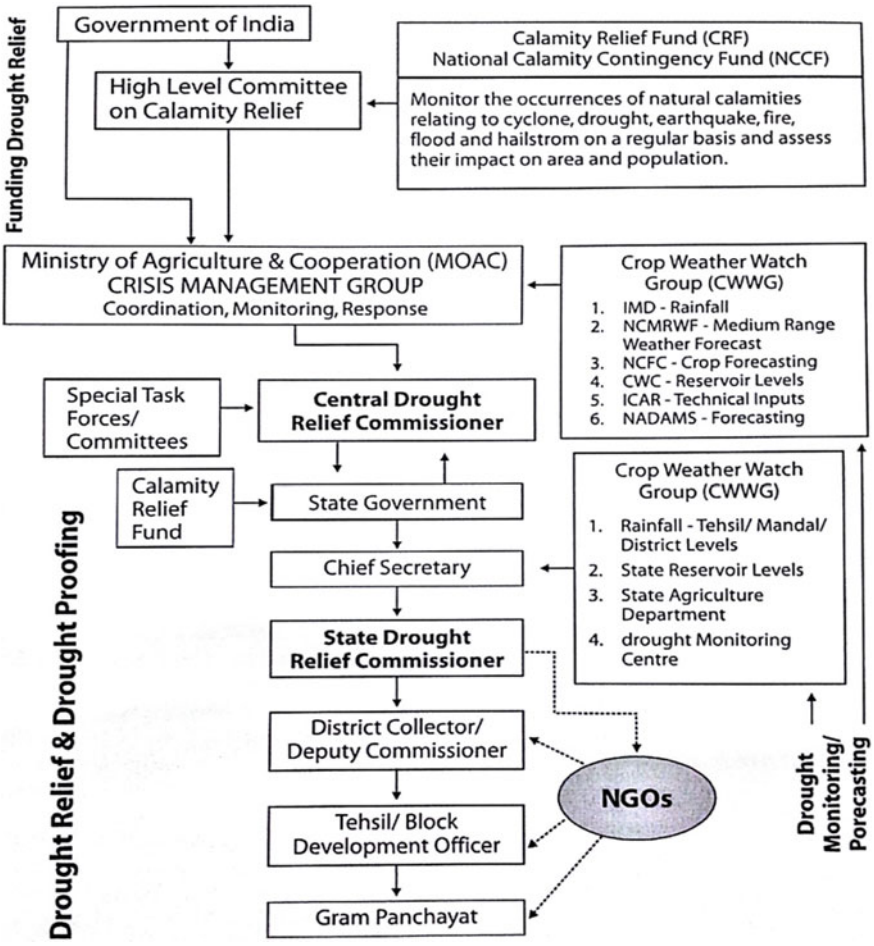

Fig. 1.2 Institutional framework for drought management. *Source* Anon (2009a, b, c, d, e, f, g)

drought parameters to all stakeholders (d) Require gathering and integration of data and seeking data from state and national networks.

Institutes providing monitoring and early warning systems include the India Meteorological Department (IMD), Agricultural Meteorology Division, the Drought Research Unit of IMD and the National Centre for Medium Range Weather Forecasting. In addition there are other institutions that provide information develop technologies and indices and offer advisories (Anon 2009e. *Manual for drought management, Department of Agriculture and Cooperation, 2009, pp 27–32*).

While these institutional mechanisms exist, the capacities of these institutions need to be strengthened, given the frequency and impact of drought (Samra 2013, *personal communication*).

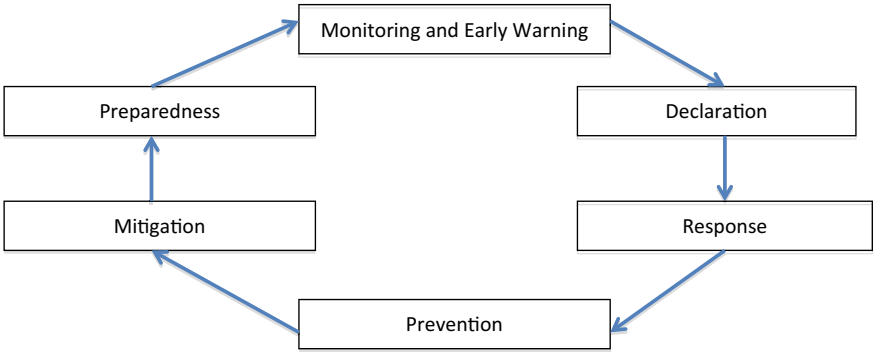

Fig. 1.3 Schematic representation of a drought management cycle. *Source* Samra (2004b). *Review and analysis of drought monitoring, declaration and management in India. Working paper 84, IWMI, page 3*

B. **Drought Monitoring**

Before the onset of monsoon an inter-ministerial group headed by the Agriculture Secretary is formed to review and monitor the monsoon. This group meets every week in the monsoon season.

Being a country with a federal system of governance, drought monitoring is the responsibility of the state and federal governments.

The Indian Meteorology Department (IMD) carries out drought monitoring and forecasting functions in the federal government, monitoring meteorological and agricultural droughts. IMD prepares aridity maps on weekly basis and has a continuing updating mechanism for sharpening and adjusting such forecasts. It also compiles weekly rainfall summaries, giving figures of precipitation at the district level.

In addition, National Remote Sensing Centre (NRSC), Hyderabad monitors drought in India through remote sensing methods. The key indicators that are used to monitor for drought are given below.

1.8.1 Key Droughts Indicators

State governments monitor droughts based on key indicators that include information on rainfall; reservoir/lake water levels; surface water/groundwater; soil moisture and sowing/crop conditions. This information collected at pre-determined intervals of time presents a reliable indication on be extent and severity of the drought.

Other indicators that are monitored include an assessment of fodder supply; drinking water supply; demand for employment in public works; unusual movement of labour in the affected areas in search of employment; current agricultural wages compared to normal times; supply of food grains and price control of essential commodities (Anon 2009a, b, c, d, e, f, g).

C. **Drought declaration**

Drought is declared by the states through a formal notification for the drought response to commence.

It is the primary responsibility of the states: The central government only aids or facilitates financial and institutional processes. Forecasting of arrival dates of monsoons and rainfall deviations with respect to normal by IMD and monitoring at state level initiate the process of drought declaration. States also monitor rainfall at lower administrative levels, gather information from remote-sensing agencies and on the parameters mentioned above.

Drought declaration signifies the beginning of government response to a drought situation. The Government of India sends a monitoring team only after a drought is declared and a memorandum is sent by the state governments to assess the requirements for relief and release assistance (Anon 2009a, b, c, d, e, f, g).

Ideally given that most of India receives rain from the South West monsoon between June-September, drought should be declared in October. By then, the total rainfall received is known, a final picture of crops sown is available and the water levels in the reservoirs are known. However there are delays in declaration, give the political ramifications (Samra 2013, *personal communication*).

D. **Drought relief**

Following drought declaration, planning and implementation of drought relief and response measures are initiated. Some of the measures include (a) Contingency crop planning (b) Support to farmers in the form of agriculture input, energy and extension support (c) relief employment (d) Water resource management (WRM) (e) Food security (f) Gratuitous assistance (g) Relief through tax waivers and concessions (h) Cattle camps and fodder supply and (i) Health and hygiene. Since this paper is focused on water, only the WRM is described briefly below.

1.8.2 Water Resource Management (WRM)

Efficient water management is an important yardstick for measuring the effectiveness of relief operations, since WRM in drought-affected areas is a critical factor in relief operations. A steady supply of drinking water is perhaps the most important responsibility for the government at all levels. This requires a host of measures such as augmenting water supply, rationing of water use, efficient utilisation and management of water resources. Planning for water management includes:

(a) Estimating the demand for water at district level; (b) Reservoir survey and management, including prioritising of water use based on availability of water; (c) Repair and augmentation of existing water supply schemes; (d) Fund supply; (e) Special measures for areas with drinking water scarcity by development of a contingency plan; (f) Construction of temporary piped water supply (g) Construction of bore wells (h) Supply through bullock carts, tankers, trains; and, (i) Waivers of water and electricity charges.

Drinking water should be the first priority and irrigation of crops the next. It is important to estimate the water demand in the area. The district administration can do this exercise on the basis of population data in the area and the demand from drinking, agriculture, industry and service sectors. All the measures aimed at conservation and augmentation can take place only once the estimates are known. Further details can be availed of from the Manual for drought management, Department of Agriculture and Cooperation, 2009, pp 70–77.

Ministries involved in WRM include the following:

At national level: Ministry of Water Resources, Ministry of Drinking Water and Sanitation, Ministry of Irrigation, Ministry of Rural Development, Central Water Commission, Central Ground Water Board, Ministry of Railways, Ministry of Water Resources.

At state level: State government departments of public health ad engineering, rural development, irrigation and relief, district administration.

All Central Ministries/State Governments are mandated to prepare detailed Standard Operating Procedures (SOP) in consonance with the national SOP, national policy and various guidelines issued by National Disaster Management Authority (NDMA) for their sectors.

For instance, the Ministry of Drinking Water and Sanitation (MDWS) keeps aside 2% of its funding under the National Rural Drinking Water Programme (NRDWP) for assisting the States to mitigate drinking water problem in rural areas in the wake of natural calamities. It has also prepared an SOP.

The SOP lays down the institutional mechanisms at national, state, district, block and village level. It lays down the specific actions required at these levels in responding to natural disasters of any magnitude and dimension and brings out the roles and responsibilities of various stakeholders in providing water, sanitation and hygiene services during different phases of disasters. It is meant to guide the administration at various levels to respond better in maintaining the basic services of drinking water and sanitation during natural disasters. In case of drought, this specific action could include development of a detailed contingency plan for drinking water supply, identification of habitations in need of emergency drinking water supply, identification of water sources which can be tapped, rejuvenation of ponds and other water bodies, deepening of tube wells, arranging for tanker water supply and repair of hand pumps.

It lists the actions to be undertaken by the individual officers (for example Executive Engineer, Assistant Executive Engineer, Assistant Engineer and Junior Engineer) before, during and after disasters. This will enable the officers at all levels to be better informed and equipped to prepare for, respond to and recover from the impact of disasters.

State governments are also encouraged to prepare their own State SOP for Rural Drinking Water and Sanitation.

In case of drought, the key responsibilities of the engineer include (a) prepare a detailed contingency plan for supply of drinking water in rural areas with technical help from the Central Ground Water Board (CGWB) and utilising, if need be the rigs and other capital equipment from the CGWB (b) Identify habitations/villages

indicating the month from which they are likely to face water scarcity (c) promote rainwater harvesting (d) work closely with NGOs (e) set up a toll-free helpline.

(*For details of the SOP refer to Standard operating procedures for responding to natural disasters: Rural Drinking Water Supply and Sanitation, Ministry of Drinking Water Supply and Sanitation, 2011*).

E. **Drought mitigation**

While drought relief and management are extremely important and help people to cope with drought conditions, it is necessary that there is a shift in public policy from drought management to drought mitigation. Mitigation is action that can be taken before or at the beginning of drought to help reduce impacts of drought.

1.8.3 Implementing Drought Mitigation Plans for Water Conservation

The objectives of these mitigation measures are to reduce soil erosion, augment soil moisture, slow down rainwater drainage and improve the efficiency of water use. This is possible either through (a) artificial recharge of groundwater, or (b) traditional methods of water collection and harvesting.

Artificial recharge of groundwater is possible through contour bunding, contour trenching, contour cultivation, bench trenching, graded bunding, gully plugging, check dams/nallabunding construction, gabion structure, stream bank protection, farm ponds, percolation tanks, *anicuts*, sub-surface barriers and injection wells.

Traditional methods of water harvesting and conservation include dug well recharge, village pond/tank, hill slope collection common in hilly areas with good rainfall (e.g. Arunachal Pradesh, Meghalaya) spring water harvesting, and rooftop rainwater harvesting.

In addition to water harvesting, state governments should encourage the use of water saving technologies in farming and other sectors and develop a long-term irrigation management strategy. Afforestation is an effective drought-resistant measure as well.

There are various soil and water conservation programmes that can be tapped for this work, such as the DPAP, watershed programmes, and the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA).

The National Rainfed Area Authority (NRAA) in the Ministry of Agriculture was set up to address the issue of drought mitigation on a long-term basis. The institute aims to bring conversion between numerous ongoing water conservation and watershed development programmes and monitor their implementation (Anon 2009a, b, c, d, e, f, g). The mandate of the institute is to (a) Evolve common guidelines for all schemes for development of rainfed/dryland farming systems (b) Identify rainfed areas which need priority attention (c) Identify gaps in input supply, credit, dissemination of technology (d) Develop capacity building plans and (e) suggest modalities to improve national and state institutions.

The areas of focus include (a) networking with the key ministries of agriculture, rural development, water resources, environment and forests and panchayati raj, (b) convergence, coordination, value addition, capacity building and monitoring and evaluation (d) meeting emerging challenges of policy, economy, social issues and technologies, (e) enabling institutions for effective service delivery and pilot projects (http://nraa.gov.in/).

1.9 Drought Mitigation Measures

Mitigation defines the actions that can be taken before or at the beginning of drought to help reduce impact. These are not stand-alone programmes but are part of development planning. Most of these measures are related to integrated soil, water and forest management and form part of soil conservation, watershed development and forestry programmes. Recommendations for drought mitigation include:

(a) Setting up mission/task force for drought mitigation;
(b) Conducting drought risk and vulnerability assessment;
(c) Identifying and implement programmes and measures for drought mitigation;
(d) Promoting education and awareness of mitigation policies and measures;
(e) Encouraging community level plans for drought mitigation;
(f) Implementing drought mitigation measures with respect to WRM, which include: (i) Water harvesting and conservation; (ii) Long term irrigation management; (iii) Setting up water user associations; (iv) Conjunctive use of surface and groundwater; (v) Completion of irrigation projects to increase storage capacity; (vi) Integrating small and large reservoirs;(vii) Integrated river basin planning; and (viii) Inter-basin transfer of water.
(g) Afforestation;
(h) Crop insurance; and,
(i) Community participation in drought mitigation by (i) Building on micro level experiences; (ii) Innovating on community based institutions; (iii) Community consultations through gram sabhas; (iv) Strengthening women self groups; and (v) Empowering panchayati raj institutions.

Consecutive/frequent and severe droughts call for concerted multi-year progammes that involve huge resources and a multi-dimensional approach to address socio-economic development. The Bundelkhand package is one such drought mitigation package programme that is jointly supported by the Central and state government across the states of Madhya Pradesh and Uttar Pradesh (see Box below).

Box: The story of Bundelkhand

Jhansi railway station, 5 am, June 2009. It was difficult to set foot on the platform: Everywhere, on the platforms and the approach leading to the railway

station, men, women and even children along with their parents were found waiting, resting, sleeping. Weary from struggling against a failed monsoon, these people were waiting for trains to take them out of their misery, to cities such as Delhi, Gurgaon, Mumbai and Bangalore, so that they could escape, to less water dependent and hence more secured future. This was one year when the people were forced to migrate because they were not getting drinking water. So great was the de cit.

Jhansi is one of the thirteen districts that fall under the Bundelkhand region, six of which are in Madhya Pradesh and the rest in Uttar Pradesh.

2009 was the fourth year of consecutive drought. A wall painting *Gaon ka har bacha Hindustani maang raha hai paani paani* (every Indian child in the village is asking for water) appeared as a silent appeal. This situation, in a region historically known for its traditional water harvesting systems of bundela and chandela tanks built by the erstwhile kings (Indira Khurana, 2009*, personal observation*).

Bundelkhand has a strong patriarchal society. Even in the peak summers, when temperatures are in the mid-forties, while passing the menfolk, women remove their footwear and carry these on their head. There is an ancient phrase coined here, *Ghagrichahe toot jayee, matkinaphute* (My husband may die, but my water pot should not break). Perhaps nothing can be more eloquent than this old saying in a region riddled by caste and patriarchy, where women status is low and that of widows, virtually non-existent. Over and above, the struggle to quench thirst.

The Bundelkhand region is spread over around 69,000 km^2 in seven districts of Uttar Pradesh—Chitrakut, Banda, Jhansi, Jalaun, Hamirpur, Mahoba and Lalitpur and six districts of Madhya Pradesh—Chhatarpur, Tikamgarh, Damoh, Sagar, Datia and Panna. These districts are amongst the most backward in the country.

Bundelkhand is a complex, rain-fed, socio-economically heterogeneous region. A hard rock area with limited inadequate ground water resources, it lacks infrastructure and access to improved technologies.

Historically, Bundelkhand region used to have one drought in 16 years, which increased three fold during the period 1968–1992. Between 2005 and 2009, the region witnessed a continuous drought (Inter Ministerial Central Team 2009).

The 2009 drought in Bundelkhand impacted 16 million people: 40% farms were not sown, bringing down food production by 30%, while 70% of ponds and tanks dried up (Mahapatra et al. 2010a, b, c, d, e). For perhaps the first time, people were migrating because of a shortage of drinking water (*Indira Khurana, personal visit, 2009*).

The causes of the crisis included:

- Increased deforestation in the historically dense forest Bundelkhand region which led to environmental degradation. This in turn led to reduced soil moisture conservation and decreased recharge of groundwater. The inter-ministerial central team reported that in UP side of Bundelkhand the forest area was a mere 7.75% whereas in MP side of Bundelkhand, the area under forests had declined to 26.2% from nearly 40% in the 1950s. (Mahapatra et al. 2010a, b, c, d, e);
- A decline in the traditional water harvesting systems;
- Over exploitation of groundwater;
- Moderate to severe meteorological drought due to the rainfall deficit. Hydrological drought was evident from 15 to 47% decline in the filling of reservoirs in MP, 28 to 64% in UP over three years, 70% dried up tanks, ponds, dug well and steep fall in ground water table (*Drought Mitigation Strategy for Bundelkhand Region of UP & MP by Inter Ministerial Central Team, 2009*);
- Primarily rain-dependent agriculture in the region aggravated by extreme weather conditions, like droughts, short-term rain and flooding in fields;
- Scarcity of water in the semi-arid region, with poor soil and low productivity thus causing a problem of food security. Depletion of ground water left thousands of hand-pumps defunct;
- Climatic uncertainties, leading to extended and frequent spells of drought thus leading to reduced agricultural yields. (http://www.devalt.org/bundelkhand-Critical-Conditions.aspx)

This led to acute poverty due to lack of employment opportunities; increased indebtedness, increase in number of farmer suicides and increase migration of the local population due to insecurity of livelihoods (*Indira Khurana, personal visit, 2009*).

Even in the peak drought some villages had enough water to drink and for agriculture. This was because they rallied around and began harvesting rainwater, whatever they were fortunate to receive. For example,

(a) In Rajpura village in Jalaun district, the villagers dug two ponds: one with local government funds and one with their own resources and placed a recharge pit in the middle of the ponds. This enabled recharge of the groundwater that charged up the hand pumps with drinking water. In Himmatpura village it is mandatory that each household harvest rooftop water, even from the thatched roof. Each and every house here has laid pipes that harvest rain- water from the slopping tiled roofs and direct that to an abandoned tubewell. The drinking water problems are solved with

water gushing out form the hand pump and the tube well (Mahapatra et al. 2010a, b, c, d, e).

There are few key lessons that emerge from the above efforts:

- The villages have taken up short-term and long-term measures to address the drinking water crisis.
- An integrated approach has been adopted in all the villages. Recharge and overall local ecological regeneration have been given priority.
- These villages have set up strong community level institutions that are both practical and effective.

Thus, in addition to the funds, the arresting of the downward spiral of the drought-prone region requires robust and resilient systems of livelihoods and enterprises, which need to be developed alongside solutions for regenerating the local environment and conserving water. Some of these could be:

- Revival and protection of the traditional water harvesting systems;
- Participatory integrated watershed management for conservation of rainwater;
- De-silting, repairs of dams, deepening, recharging of dug-wells;
- Intensification of crop diversification with innovative cultivation practices;
- Promoting low water consuming horticulture crops that increase the income of the farmers;
- Greater emphasis on tree plantation in the region; and,
- Setting up of industries that are not water intensive.

B. Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)

According to Government of India, Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) launched in 2006, is perhaps "the largest and most ambitious social security and public works programme in the world." MGNREGA is recognised as an ecological Act that aims to create sustainable livelihoods through regeneration of the natural resource base of rural India. In the process, it expected to provide resilience and adaptation to climate change and the vagaries of nature.

The Act was notified in 200 rural districts in its first phase of implementation (with effect from February 2006). It was later (in 2007–08) extended to additional 130 rural districts. Since 2008, MGNREGA has covered the entire country with the exception of districts that have a 100% urban population.

With an outlay of INR 1,725 billion (USD 28.75 billion) and an expenditure of INR 1,665 billion (USD 27.75 billion) during 2006–2012, it is estimated that about 23 million rural structures have been taken up. Of these about 60% are completed during this period. What is interesting is the fact that about 51% structures (about 12 million) are related to water conservation which includes, ponds, traditional water bodies, irrigation canals and so on (see Table 1.2). Since MNREGA spans across a spectrum of activities linked to life and livelihoods, water, land and agriculture, it provides an excellent opportunity to have an integrated approach to drought proofing. It also has components of afforestation and agro-forestry, which support and assist

Table 1.2 Water conservation works implemented under MGNREGA between 2006–12

Sr. No	Type of works	Total number of works completed from FY 2006–2007 to 2011–2012 (in million)	Ongoing works (in million)	% of total works taken up from FY 2006–2007 to FY 2011–2012
1	Water conservation and water harvesting (e.g. farm pond, percolation tanks etc.)	1.95	3.64	25
2	Flood control and protection (e.g. checkdams, culverts, etc.)	0.39	0.59	4
3	Drought proofing (e.g. afforestation/tree plantation, agro-forestry, etc.)	0.52	1.3	9
4	Irrigation canals (macro and micro-irrigation works, etc.)	0.57	0.95	7
5	Renovation of traditional waterbodies (e.g. desilting of tanks, etc.)	0.66	0.98	7
	Total water conservation and water related works	4.09	7.46	52

Source Ministry of Rural Development, Government of India, *MGNREGA Sameeksha, An Anthology of Research Studies on the Mahatma Gandhi National Rural Employment Guarantee Act, 2005, 2006–2012*. Edited and compiled by Shah et al. (2012), Orient BlackSwan, New Delhi, India

soil and water conservation, both of which are essential components of drought proofing.

Such an approach is important, as India's dependence on groundwater is phenomenal. Over the last few decades, India has emerged as the largest groundwater user in the world. With over 30 million wells India's groundwater usage is estimated to be around 230 cubic kilometers per year, which is more than a quarter of the global total. The most conservative estimate put the economic value of groundwater

irrigation in India in 2002 at US$8 billion per year, which is four times the annual public investment in irrigation projects and more than all government expenditures in India on poverty reduction and rural development programs (Shah 2007). Over two-thirds of India's agricultural land is rainfed and is irrigated by groundwater. Also, as mentioned earlier, the significance of groundwater for domestic water supplies is similarly marked, with 85% of the rural water supply schemes in India relying on groundwater sources. Given the variability of rainfall from year to year, any strategy to drought proof India will need to look at groundwater management. It is in this context that the water conservation initiatives under the MGNREGA offer a great potential for drought proofing.

Various reports have presented different perspectives on the impact of MGNREGA. Some that amidst all its drawbacks, MGNREGA is contributing to drought proofing the country. However, others state that the asset creation works are incomplete and are of inferior quality making MGNREGA a wasted opportunity. However, few studies have been able to quantify the impact (Shah et al. 2012; Box 6). The list of benefits that can environmental benefits that can accrue from MGNREGA work is given in Table 1.2.

Some of the expected environmental services from MGNREGA activities are given in the table (Table 1.3).

Since provision of water for agriculture is vital for ensuring food and water security in rural India, MGNREGA is a very important programme as far as drought proofing is concerned. Research conducted by various agencies for the Ministry of Rural Development suggests that water-related assets created under MGNREGA have increased the number of days in a year water is available and also the quantity of water available for irrigation. For instance, a study in the Sidhi, Betul, Jhabua, Shivpuri and Rajgarh districts of Madhya Pradesh noted that 70% of the irrigation structures under *Kapildhara* scheme ensured perennial water across agricultural seasons for beneficiaries. In the districts of Ujjain and Dhar, the irrigated land area increased by 26% and 19% respectively. In Chhindwara and Panna, the increase in irrigated area was even higher, i.e. 35% and 30% respectively, due to MGNREGA works. There are also reports that indicate that in certain places the reduction in distress migration has been reversed due to improper implementation of MGNREGA processes.

Box: MGNREGA outcomes: Preliminary findings

Preliminary findings indicate that MGNREGA works have led to a rise in groundwater, improvement in soil quality and reduction in vulnerability of production systems to climate variability (by strengthening livelihood and water security). However, some literature also points out that the extent and kind of impact MGNREGA works have on the environment depends on the scale of the activities undertaken, the technical design, the quality of assets created, and ownership and use of the physical structures constructed. There are only a few studies on the subject.

Table 1.3 List of MGNREGA activities and its expected environmental services

MGNREGA activities	Local environmental services	Regional and global environmental services
Water conservation and harvesting	Groundwater recharge, soil moisture retention, and protection (erosion control), flood control (reduced risk), providing irrigation and drinking water and improving soil quality (nutrient recycling)	Water conservation
Irrigation provisioning and improvement	Providing irrigation, improved agriculture and livelihoods, increased crop production	Reduce the need for methane producing large farms
Renovation of traditional water bodies	Improved storage capacity, irrigation availability, groundwater recharge, soil quality (nutrient recycling), biomass production and crop production	Water conservation
Land development	Land reclaimed for agriculture, improved irrigation availability, hance agriculture and livelihood improvement	
Drought proofing	Soil moisture retention, protection (erosion control) and soil quality (nutrient cycling), flood control (reduced risk), biomass production (fuel wood) and local climate regulation	Water conservation, carbon sequestration, biodiversity conservation
Flood control	Better drainage, higher land productivity (erosion control) and flood control (reduced risk)	Water conservation

Source Ministry of Rural Development, Government of India, *MGNREGA Sameeksha, An Anthology of Research Studies on the Mahatma Gandhi National Rural Employment Guarantee Act, 2005, 2006–2012*. Edited and compiled by Shah et al. (2012). Orient BlackSwan, New Delhi, India

Source: Ministry of Rural Development, Government of India, *MGNREGA Sameeksha, An Anthology of Research Studies on the Mahatma Gandhi National Rural Employment Guarantee Act, 2005, 2006–2012*. Edited and compiled by Shah et al. (2012). Orient BlackSwan, New Delhi, India.

These are important stepping-stones towards drought proofing despite the drawbacks of a massive government programme. As in many government programmes, there are concerns regarding democratic planning processes, transparency in financial transactions and more importantly the quality of structures. In one of the review notes by the Ministry of Rural Development, it was observed that absence of technical skills on water conservation structures were found to affect the quality and durability of structures created.

C. National water policy 2012

The water policy 2012 states several options for drought management as indicated in the box below.

The policy recognizes that water is a scarce resource is fundamental to life, livelihood, food security and sustainable development and the challenges in India with respect to water related natural disasters (flood and drought), equity in availability, access and distribution and water quality. It acknowledges the impending challenges related to global warming-induced climate change. Importantly it also acknowledges that water resources management and associated governance has been inadequate.

The policy recommends the need to develop a water framework law as an umbrella statement of general principles governing the exercise of legislative and/or executive (or devolved) powers by the Centre, the States and the local governing bodies.

For the management of droughts, the policy states that emphasis should be on:

(a) Drought preparedness with coping mechanisms as an option;
(b) Rehabilitation of natural drainage system;
(c) Land, soil, energy and water management with scientific inputs from local, research and scientific institutions to evolve different agricultural strategies and improve soil and water productivity to manage droughts. Integrated farming systems and non-agricultural developments may also be considered for livelihood support and poverty alleviation.
(d) Community involvement in preparing an action plan for dealing with drought situations.

(http://mowr.gov.in/writereaddata/linkimages/DraftNWP2012_English9353289094.pdf).

One of the other biggest weaknesses of the National Water Policy is that it doesn't talk about ecological water allocations, though ecological water needs are acknowledged. This becomes an important issue during the onset of drought/lean season when

competition for scarce resources is severe. Moreover, in absence of an implementation framework, such references remain only on paper, as was clearly demonstrated in the Maharashtra drought of 2013.

An analysis by Down To Earth showed that the drought-affected areas in Maharashtra received 60–70% rainfall against the state average of 90–92%. This is deficient but not deficient enough to cause drought of this magnitude. Therefore the reasons for this scenario cannot be attributed to low rainfall alone, but bad water management.

First and the fore most, in case of Maharashtra, the recommendations of the second Maharashtra Water and Irrigation Commission 1999 suggesting a cap on new sugar factories in water-deficit river basins, and shifting of sugar factories out of drought-prone areas have not been adhered to. As a result, sugar cane was grown in water stressed areas leading to more vulnerability and more inequity.

Second, the prescription under the Maharashtra Water Resources Regulatory Authority (MWRRA) Act, 2005, suggesting equal distribution of water to all projects in a river basin during water crisis was not implemented. Maharashtra also clearly brought out the need for having clear water allocation policies and the need for having hydrology as a non-negotiable parameter in crop planning.

1.10 Community Participation in Drought Mitigation

Community participation is an essential feature of drought mitigation programmes where community-based institutions play an important role (see section). For this, there is a need to

- Build on micro-level experiences (at the habitation/village level) to achieve at scale drought mitigation;
- Develop community-based institutions for collective planning, implementation and equitable resource use. Women self-help groups could also be involved;
- Organise community-based consultations through gram sabha, which can be compared to the 'general body meeting' of a company, to enhance transparency, equity and ownership;
- Empower Panchayati Raj Institutions (PRIs), which are the mandated local self-governance units at the lowest level. An empowered PRI improves the delivery mechanisms of programmes leading to a reduction in the impact of drought (Anon 2009a, b, c, d, e, f, g).

1.11 Community Initiatives

There are several community based models available across the country where local communities have taken up water harvesting and watershed management to drought

proof their areas and also manage with the water resources that they have. Some of these are given below.

I. Involving the People in Groundwater Management in Drought-Prone Regions

The Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS) project was implemented in seven drought-prone districts of AP state. The goal of the project was to enable farmers to manage their groundwater systems and adopt suitable agricultural options.

Over 9,000 farmers residing in 638 habitations voluntarily took several steps to reduce groundwater pumping for tiding over the problem of groundwater depletion. The project was funded by the Royal Netherlands Embassy, New Delhi, and the implementation guided by Food and Agricultural Organization (FAO). The NGO Bharatiya Integrated Rural Development Society (BIRDS) implemented the project through a federation of nine NGOs.

APFAMGS was designed to stimulate farmers' innovation in the assessment and analysis of groundwater, and fine tune initiatives to optimize water-based livelihoods. The knowledge was used to help the farmers and other vulnerable communities deal with the depleting groundwater and its effect on agriculture. Community institutions took responsibility for assessing groundwater availability for a micro unit, and used the understanding to plan groundwater resources sustainably for their agriculture and livelihood pattern. Overall, the effort was also to ensure that there is no attempt to dilute the science just because the community handles it.

The project (i) Offered local solutions in managing groundwater distress; (ii) Reduced groundwater pumping along with an increase in wealth creation; (iii) Enhanced recharge initiatives and consequent rise in water level; and (iv) Diversified the cropping system matching with availability of water.

For the first time, the issue of water was not compartmentalized on the basis of individual farmers, habitations and villages. Water was looked at comprehensively at the micro-basin level with all competing interests brought to a common platform and the needs prioritized scientifically and equitably.

The farmers also worked out ways to reduce ground water pumping through changes in cropping, crop diversification, improved water use efficiency, improved pump efficiency, regulating new well construction and reviving abandoned wells as recharge structures.

Outcomes included: (a) A significant change in the cropping system; (b) Increase in crop diversity from 14 to 32, largely in favour of low water consuming and low risk crops; and, (c) Substantially reduced irrigation (ranging from 20 to 60%) in the cultivation of high water consuming crops like paddy, sugarcane, banana, turmeric, and mulberry. Food security and improved nutrition were never compromised while changing the cropping systems.

The core message of the project, that groundwater abstraction over the long term needs to be aligned with water availability, is taking hold. This is suggested by the emerging positive correlation between water availability and water use in 48 out of the 58 project hydrological units. The project also indicated how enabling communities

to generate and handle scientific input can result in solutions that are acceptable to all.

(http://www.mdws.gov.in/sites/upload_files/ddws/files/pdfs/Towards%20Drinking%20Water%20Security.pdf).

II. The Andhra Pradesh Drought Adaptation Initiative

Andhra Pradesh (AP) has the third largest drought-prone area amongst states in India: Mitigation of drought is a key focus area of the state government.

In collaboration with the World Bank, the state government launched the Andhra Pradesh Drought Adaptation initiative (APDAI) for deepening integration of climate considerations with local action, by packaging drought adaptation measures into existing institutional frameworks. The overall objective was to enhance the drought-adaptation capacity of affected communities and reduce their vulnerability towards drought risks.

The project focused on natural resource-based production systems and envisaged the development of a package of tested measures for drought adaptation. Therefore, a number of pilots were started under APDAI to cover agriculture production systems, livestock, natural resources, livelihood of vulnerable groups and economic support tools for different livelihood groups.

The programme was implemented through the women self help group (SHGs) which are federated at different levels. In AP, SHGs have been formed in every village and have built up considerable human, social and financial capital. Technical support was provided by Watershed Support Services and Activity Network (WASSAN).

The areas of intervention under the project included agriculture production, livestock production, natural resource management (groundwater and common property resource management and economic support tools. Most of these had an impact on water availability, its use and management.

The specific areas of intervention and the rationale behind implementing these are given in Table 1.4.

The groundwater pilot was designed to encourage farmers to come together to utilise the available groundwater resources by pooling the water from all the existing bore wells for collective sustainable use and management of water. Implementation was delayed due to factors such as arranging for electricity connection (2 villages). Of the five villages, collective use of water began in four villages. However, the pilot did not make much headway in one village. Implementation was delayed due to factors such as arranging for electricity connection (2 villages), reluctant farmers (one village), and process involved in organising entire village (heterogeneous) community (one village). Some of the results of this pilot were:

- One of the bore wells brought under collective use dried up due to lack of rains and as a result, the water level in the other four bore wells also declined. Yet, none of the farmers sunk new bore wells.
- Water pumped per season was reduced with the introduction of pipelines and sprinklers. There was also reduction in time spent by farmers in watering.

Table 1.4 Activities and their relevance to drought

Sr No	Activity	Relevance to drought
1	Diversified farming systems	• Saves crops during short and long dry spells • Provides additional fodder, fuel and food • Reduces the risk of total failure of the production system due to prolonged drought and continuous years of drought
2	System of rice intensification (SRI)	• Reduces risk of crop loss due to water scarcity and higher input costs
3	Plough bullock	Timely sowing reduces the crop failure due to pest and disease attack by 30–50%
4	Seed bank	• Helps in timely sowing and minimizes crop failure due to non-availability of seed
5	Nursery	• Generates employment • Plants help in protection of soil from wind erosion; assured income during drought years
6	Livestock vaccination	• Protection of animals from exposure to contagious diseases and epidemics (due to low resistance) during drought
7	Fodder bank	• Prevents distress sale of animals due to fodder scarcity • Availability of additional fodder during drought for preserving nutrition
8	Backyard poultry	• Provides employment and subsidiary income to cope with lack of agricultural income during drought
9	Chick Rearing Centre (CRC)	• Creates livelihood/employment opportunities during drought
10	Breed improvement in Sheep	• Promotes breeds that can survive on meagre vegetation and resistance to diseases
11	Ram-lamb rearing	• Making available locally suitable breeding rams would lead to propagation of drought resistant progeny and reduction risk among sheep rearers
12	Groundwater management	• Promotes water saving • Ensures critical irrigation during drought • Prevents overexploitation of ground water
13	Common land development	• Provides income generating activities, inputs to agriculture/home, environmental services and safety nets for people in drought years
14	Leased land development	• Reduces the risks and vulnerabilities of the women belonging to the poor, landless and women headed households
15	Goat rearers CIG (Common interest group)	• Provides support to sustain goat population, which is an important resource to cope during drought

Source APDAI evaluation report, Poverty Learning Foundation (2009), table modified by the author

- The farmers diversified cropping pattern that included fodder and vegetable cultivation.

Strong institutional frameworks based on common interest at the community level are required for optimizing groundwater initiatives. This enables better crop planning, crop-water budgeting and ground water monitoring. Linkages with agriculture department and research stations are imperative.

It is important to note that the minimum time required to complete total cycle of this pilot (including processes related to collective use of water such as crop-water budget, use of rain gauge station, etc.) is 4–5 years. At the time of the evaluation, the pilot had still not completed its total cycle in a majority of the villages.

Source: APDAI evaluation report, Poverty Learning Foundation (2009).

III. **Raj Samadhiyala**

In 2002, Raj Samadhiyala village in Gujarat got around 80 mm of rainfall. It was the severest drought year for the state. Despite this, the wells in the village had water and the water supply scheme was supplying water for close to 8 h a day. This was probably the only village that did not report out-migration.

Raj Samadhiyala is an example of integrated water resource management backed by good water governance that resulted in water security. For the last 30 plus years, since 1978, the village has been harvesting rainwater. It is more than 20 years that the village last received drinking water through tankers, which is in stark contrast to surrounding villages. Irrespective of drought, villagers here have been taking up three crops a year using the harvested rainwater. In 2002, while the state reported a crop loss of 60%, the annual estimated earnings from agriculture in this village were around Rs. 3 million ($45,984).

Raj Samadhiyala was a severely water scarce village in 1970s. Village women used to walk five to seven kilometers for fetching drinking water. Irrespective of rainfall, water scarcity remained the biggest problem. An irregular water tanker was the only hope for getting water at the village. The groundwater level dipped to 250 m.

In 1978 the villagers took up extensive rainwater harvesting measures and established a village development committee that took over water management and laid strict rules for water use.

To start with, the village development committee planned out in detail how to harvest the 500 mm average rainfall it gets, for optimal uses.

Between 1978 and 2003, Rs. 25 million ($383,200) from the available District Rural Development Agency (DRDA) government funds was spent on water harvesting, through the construction of45 check dams, percolation tanks and farm ponds over an area of 1,090 hectares. Run off rainwater was directed into sub-surface percolation structures using satellite maps that indicated old dried water channels. To treat the catchments, 60,000 trees were planted to help regulate water runoff and enhance water conservation.

In 1992 the village stopped getting water through tankers. All the water conservation works resulted in recharging of groundwater: The water level went up, from 250 m in 1985 to 15 m in 2004. A 70 feet deep well, earlier completely dry, is now

exclusively used for supplying drinking water to 300 households. The well has 60 feet of water, even when monsoon fails. Water is pumped to a surface tank and from there supplied to households through taps. It appears that the village has reached a sustainable level where groundwater recharge and surface water use are balanced (Mahapatra et al. 2010a, b, c, d, e).

IV. **Hiware Bazar**

Hiware Bazar village in semi-arid Ahmednagar district of Maharashtra state is one of the few villages in the country that undertakes an annual water budgeting exercise, which it has been doing since 2004. The district's groundwater department is a key partner in the village's tryst with water security. It has been more than a decade that the village stopped having a seasonal drinking water problem.

Once a prosperous village, the scenario changed after the 1972 drought, one of the worst of the 20th century. First forests vanished, triggering soil erosion and groundwater depletion. Traditional water harvesting structures collapsed. This affected water availability, both for drinking and irrigation. There was virtually no water after the monsoon. The impacts of droughts were also becoming severe, compounded by ecological degradation.

In 1989 the village took the first step towards water security by adopting an integrated model of water management. The village used all available government funding resources, while retaining decision-making power with the village institution that had representation from all constituencies in the village. Voluntary labour participation by residents became mandatory. To begin with the village regenerated the 70 ha of village forests, the catchment for the wells. With government money and voluntary labour participation 40,000 contour trenches around the hill to conserve rainwater and recharge groundwater were built. Between 1995 and 2005, the entire development money was spent on water conservation. The 70 ha of afforestation helped in treating the catchments for most of the wells, the contour bunding stopped run off and saved farms from silting, and around 660 water harvesting structures of various types captured rainwater.

In early 1990s, the wells had water for more than eight months. By 1995–96, the village got drinking water throughout the year from local sources. The water table has gone up in village wells. With rising water level, the number of wells has also gone up—from 97 in 1990 to 217 in 2007. The village also reaped a rich harvest, providing an increase in agriculture income: In 2006 the agricultural income was Rs. 24.70 million (USD 378,601; Mahapatra et al. 2010a, b, c, d, e).

Every year, the village measures the total amount of water available in the village, estimates its uses and then prescribes the agricultural cropping pattern to be taken up. The idea is to strike a balance among all water uses. The villagers decide on the crops to be grown consensually. Borewells have been banned to safeguard aquifers.

The audit begins with monitoring the groundwater level of the six observation wells in the village, along with the amount of total rainfall received measured by the village's three rain gauges. The sum of rainfall and groundwater is the water available. The villagers then budget water for the village. Water for drinking (for humans and

animals) and other daily uses gets priority. Seventy per cent of the remaining water is used for irrigation. The remaining water is used to recharge groundwater.

The water audit has been very useful in ensuring sustainability of both agriculture and water availability for drinking purposes for humans and livestock in the village. During 2003–04, there was a drought in the district and there was a drinking water scarcity, Hiware Bazar did not need tankers. That year, the villagers did not cultivate any major crop and switched to drip irrigation for crops like tomatoes and onions.

V. **Laporiya**

Nine droughts between 1997 and 2007 and still Laporiya in Rajasthan state did not need a water tanker. Its wells had enough water for drinking purposes, its soil had enough moisture to support a good harvest of fodder to sustain a livestock population that yielded Rs. 3.7 million ($56,713) a year from milk sale.

The village got a good monsoon of 700 mm in 1997 and since then, till 2007, the rainfall ranged from 100 to 238 mm. Yet this village did not require aid in the form of water tankers for drinking purpose when all the nearby villages suffered from lack of water. Over 189 families here traveled the journey from drought and thirst to self-sufficiency, by reviving traditional rainwater harvesting systems. And on the way, it has inspired 250 more villages to take the same path for a water secured future.

The village, once well networked with traditional water harvesting structures, slipped into an abyss of ecological degradation. After Independence in 1947, embankments of its most reliable water source, the Ann Sagar breached. Nobody cared to repair it for the next 20 years. Being the main recharge point for numerous dug wells used for drinking purposes, it impacted overall groundwater level. Gradually the village became water scarce. In spite of there being rain, the land was completely dry. There was no moisture in the soil. All rainwater ran off into the river. By the 1970s, the government described the village as ‘barren with highly saline landscapes and denuded pasturelands, capable of producing only one low-value monsoon crop’. During summer months, 40% of the population migrated to the cities in search of jobs and, due to lack of fodder, some 75% of livestock moved to nearby states.

In 1991, the village began digging 50 new wells, three large natural tanks, and a unique dyke system called the ‘chauka’ to capture rainwater in pasturelands. The number of tanks excavated in the village and surrounding areas in 1991 alone was worth Rs. 2.5 million. The first impact was felt in availability of drinking water. The village for the first time got drinking water round the year. Water table levels in the village rose to just 15 feet below the surface, from a depth of 60 feet in 1991. Its 100-odd wells got back life—the major sources of drinking water. Availability of water ensured a bumper harvest. Villagers grew wheat in Laporiya for the first time in 20 years. The amount of irrigated land area increased to 741 acres (300 ha) and the village’s agricultural production increased more than 12 times. Laporiya’s efforts to conserve land and water are an integrated and multi-pronged approach that requires villagers to make interventions and changes at every step.

Laporiya model is now being adopted in 250 neighbouring villages in Rajasthan ensuring drinking water security to some 42,000 families. As a result, at least 40

Table 1.5 Stage-wise attainment of water security

Stage I	Stage II	Stage III	Stage IV
Water budgeting in the village making assessment of demand and availability. Development of drinking water security plan	Drinking water distribution takes precedent as to begin with water must be judiciously used	Drinking water need completely met. There are village rules and regulations to manage	Village in higher trajectory of economic growth fueled by drinking water security initiative
Extensive water conservation and revival of traditional systems leads to overall increase in water availability	Ecological regeneration starts giving benefits like more fodder and fuelwood as well as water availability for irrigation	Increased water availability and ecological regeneration give the villages assured irrigation and alternative sources of livelihood	Village institution in firm control of all resources and in all aspects
Drinking water sources like tubewells and wells get water	Local institutions are proactive in water governance	Increase in village income means rising confidence and commitments of the village institutions for water conservation	Village's capacity to invest on water related works high so system becomes sustainable
Treating catchments for ecological regeneration in the village makes water sources secure	Village institutions play a major role in equal distribution of water including for the weaker sections of the village society	Village is a complete ecological economic unit with self-sufficiency in water resource	Water resources are sustainable
Village institutions in place to monitor conservation and make people part of the efforts			Water resources are sustainable
1–2 years	2–4 years	5–10 years	Above 10 years

villages have moved out of the government status of 'drought-prone'. If rainwater harvesting measures would not have been adopted, the villagers would have been searching for drinking water for themselves and their livestock, living a life in penury.

1.12 What Community Efforts Teach

Based on the examples cited in this paper, a village usually goes through four stages before attaining sustainable security (See Table 1.5).

Table 1.6 Investments made by Government of India on drought proofing

Programme	No of states	Area treated in hectares	Total investments since inception of the programme in Rs. million (and million $)
DDP	7	457,949	15,687 (261.45)
Drought Prone Areas Programme	16	745,914	20,95,336 (34,922)
Total	23	1,203,863	2,111,024 (35,185)

1.13 Financial Mechanisms

The governments had been investing huge sums on both drought proofing and drought relief. Despite these investments large tracts of the country remain vulnerable to droughts.

A report by Down To Earth-a science and environment fortnightly, shows that Maharashtra which is considered as a pioneering state in watershed development which has conserved, regenerated and judiciously managed water resources in 12.6 million hectares (ha) of the state's 24.1 million reeled under severe drought during 2013. Over the last decade Rs. 600 billion (USD 10 billion) was spent in watershed development in the state. Despite watershed development work in 42% of the area Marathwada region remained the worst affected by drought. This is just a case in point.

Government of India had been investing regularly on drought proofing through two key programmes—Desert Development Programme (DDP) and Drought Prone Areas Programme (DPAP). A total of 1.2 billion hectares have been treated with an investment of Rs. 2,111 billion ($35.18 billion; Table 1.6).

Drought relief: This is arranged largely through the Finance Commission through a scheme of financing relief expenditure, which is available at district level. Once a drought is declared automatically these funds become available to deal with the providing relief. Funds are available from the Central National Calamity Contingency Fund. The expenditure made on drought relief during 2002–13 is given in Table 1.7.

In addition, the state governments can reorient development programmes for drought relief; for example, programmes such as MGNREGA and other water conservation programmes, for generating employment and for building assets that conserve and store water.

Table 1.7 Drought relief during 2002–2013

Drought year	No. of states	Relief assistance demanded (in Rs. billion and billion USD)	Relief assistance approved (in Rs. billion and billion USD)
2002–2003	17	353.53 (5.42)	37.48 (0.57)
2003–2004	5	107.75. (1.65)	13.97 (0.21)
2004–2005	11	251.04 (3.85)	18.83 (0.29)
2005–2006	5	37.37 (0.57)	4.29 (0.07)
2006–2007	2	15.50 (0.24)	1.55 (0.02)
2007–2008	2	21.03 (0.32)	0.70 (0.01)
2008–2009	2	22.43 (0.34)	1.41 (0.02)
2009–2010	15	923.97 (14.16)	50.80 (0.78)
2010–2011	4	121.21(1.86)	34.16 (0.52)
2011–2012	3	102.94 (1.58)	17.49 (0.27)
2012–2013	2	109.04 (1.67)	13.04 (0.2)
Total		2065.81 (31.66)	193.72 (2.97)

1.14 Drought Proofing in India: Lessons Learned and the Way Forward

Water resources constitute a country's vital assets. Yet consensus is lacking on how much utilisable water India really has. Database on how many rivers, lakes and other surface water bodies is not available. Rivers are unhealthy, reduced to meandering sand and polluted stretches. Groundwater is fast depleting, given that the country is the largest groundwater extractor in the world. Quality is suspect. Future projections indicate that India is moving towards water scarcity. With life revolving around water, this natural resource is heading towards the intensive care unit, with the residents in tow *(Ranjit Barthakur and Indira Khurana (eds), 2015. Reflections on managing water: Earth's greatest natural resource, Balipara Foundation).*

1. Water, drought risk and vulnerability assessments
2. Hydrology as an integral part of land use planning
3. Integrated policy framework on water and drought management
4. Convergence of programmes and schemes on water for drought proofing
5. Institutional strengthening and Community engagement in water resources management and drought proofing.

Even during severe drought, rainwater captured from 1 to 2% of India's land can ensure as much as 100 L of water per day for every citizen. Rainwater must be captured wherever possible and whenever possible, following safety measures that are already available in the public domain. India has a rich and diverse menu of ecological region-traditional rainwater harvesting systems that were developed over centuries. While there are some policy and implementation efforts at reviving these

methods keeping in mind the contemporary environment, such efforts need to be augmented and scaled up.

With the growing concerns over a potential increase in the frequency and severity of drought it is imperative that a greater emphasis is laid on pro-active drought policies and preparedness. For this to happen there is a need to:

1. Put in place an effective institutional mechanism, backed by a legal framework for the creation of an enabling regulatory environment for water.
2. Promote a culture of prevention of drought through efficient water management and conservation.
3. Understand that the people are the most important stakeholder and their understanding and involvement is key.
4. Encourage mitigation-measures based on state-of-the-art technology and environmental sustainability.
5. Develop contemporary forecasting and early warning systems backed by responsive and fail-safe communications and information technology support.
6. Promote effective partnerships with the media for awareness generation and capacity building.
7. Undertake recovery to bring back the community to a better and safer level than the pre-disaster stage.
8. Strengthen implementation of the commitment to move towards disaster preparedness from response.
9. Removal of delays in drought declaration: The time lag between the declaration of drought and the relief package needs to be curtailed.
10. Improvement in weather forecasting and its communication to communities who will be affected.
11. Prioritising water allocation during drought to drinking water, followed by water for subsistence agriculture. The other demands over water—commercial agriculture, industry, etc. can follow, depending on water availability.
12. Promoting economic growth in drought prone areas in consonance with the water availability.
13. As committed in the high-level meet on national drought policy in March 2013 (see Box below), India should develop a policy backed by an implementation plan and financial and human resources.

(*Source*: *Ranjit Barthakur and Indira Khurana (eds), 2015. Reflections on managing water: Earth's greatest natural asset, Balipara Foundation*).

Box: The high-level meet on national drought management policy

The High-level Meeting on National Drought Policy (HMNDP) was held on March 11–15, 2013, in Geneva, Switzerland, with more than 300 participants drawn from government decision-makers, development agencies, and leading scientists and researchers.

The meeting laid the foundation for practical and proactive national drought policies to increase resilience to the world's most destructive natural hazard, which is being aggravated by climate change. It issued a consensus declaration stressing the need for national drought management policies. It encouraged governments to:

- Develop proactive drought impact mitigation, preventive and planning measures, risk management, fostering of science, appropriate technology and innovation, public outreach and resource management as key elements of effective national drought policy.
- Promote greater collaboration to enhance quality of local/national/regional/global observation networks and delivery systems.
- Improve public awareness of drought risk and preparedness.
- Consider, where possible within the legal framework of each country, economic instruments, and financial strategies, including risk reduction, risk sharing and risk transfer tools in drought management plans.
- Establish emergency relief plans based on sound management of natural resources and self-help at appropriate governance levels.
- Link drought management plans to local/national development policies.
- Better drought management is one of the priorities of the Global Framework for Climate Services (GFCS). Climate services aim to increase drought resilience by improving climate information and services, especially for the most vulnerable. They will build on fast improving climate prediction capabilities.

The GFCS aims to give global access to improved services for four initial priority sectors—food security and agriculture, water, health and disaster risk reduction—by the end of 2017. (The HMNDP declaration is available for download at http://www.hmndp.org/node/335).

Source: *Ranjit Barthakur and Indira Khurana (eds), 2015. Reflections on managing water: Earth's greatest natural asset, Balipara Foundation).*

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Dr. Indira Khurana is a development management professional with over 22 years' experience in the social sector. She has interest in several areas including drinking water and sanitation, drought and rural development.

Chapter 2
Mechanics of Floods in Ganga and Brahmaputra Basins and Long Term Solutions

N. N. Rai, J. Chandrashekhar Iyer and T. S. Mehra

Abstract The Ganga River basin is one of the largest and complex river network traversing eleven States of India, revered and regarded as lifeline of the region. Brahmaputra water is the prime resource endowed to the NE region and it has the potential to bring all the desired growth and prosperity to the region. Flood is a major concern in Ganga and Brahmaputra basins and it becomes the biggest bottleneck against development due to recurring floods. River Governance is a multi-dimensional and multi-disciplinary task and poses a formidable challenge for administrators, decision makers and water sector professionals, both in Central and State Government. This paper focuses itself on one such river governance dimension i.e. integrated approach in tackling the recurrent floods. The primary responsibility for flood control lies with the States. The Union Government renders assistance to States which is technical, advisory, catalytic and promotional in nature. We need to remind ourselves that floods per se do not understand State boundaries. Further, for large basins like Ganga and Brahmaputra, the cooperation and synergy among the riparian States on the issue of tackling flood is very vital. In this context, the significance of integrated development and operation of storages in the major sub-basins of Ganga and Brahmaputra river systems to mitigate the flood damages is emphasized in this paper presenting outcome of a study.

N. N. Rai
Central Water Commission, New Delhi, India
e-mail: nnraicwc@gmail.com

J. Chandrashekhar Iyer · T. S. Mehra (✉)
Ministry of Water Resources, Government of India, New Delhi, India
e-mail: tsmehra@hotmail.com

J. Chandrashekhar Iyer
e-mail: jchandra69@gmail.com

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2.1 Brief Description of Ganga River Basin

The Ganga River basin is one of the largest and complex river network traversing eleven States of India viz. Uttarakhand, Himachal Pradesh, Haryana, Rajasthan, Delhi, Madhya Pradesh, Uttar Pradesh, Bihar, Jharkhand, Chattisgarh and West Bengal. River Bhagirathi rises from the Gangotri glacier in the Himalayas at an elevation of about 4000 m above mean sea level (MSL) in Uttarkashi district of Uttarakhand. River Alaknanda rises from the confluence of Satopath and Bhagirathi Kharak glaciers at an elevation of about 5000 m, in Chamoli district of Uttarakhand. The Alaknanda and the Bhagirathi rivers unite near Devprayag and form river Ganga which traverses its course of 2525 km (1450 km in Uttarakhand and Uttar Pradesh, 110 km along Uttar Pradesh-Bihar border, 445 km in Bihar and Jharkhand and 520 km in West Bengal) before its outfall into the Bay of Bengal. Ganga River is joined by a number of tributaries in its course, such as Ramganga, Yamuna, Tauns, Gomti, Ghaghara, Sone, Gandak, Kosi, Damodar and other small streams.

The total drainage area of Ganga river at Farakka barrage, including the drainage area in Nepal and China as estimated works out to be about 9,31,000 km^2. The drainage area map of Ganga basin up to Farakka barrage is presented in Fig. 2.1. The drainage area of some of the rivers of Ganga river system is presented in Table 2.1.

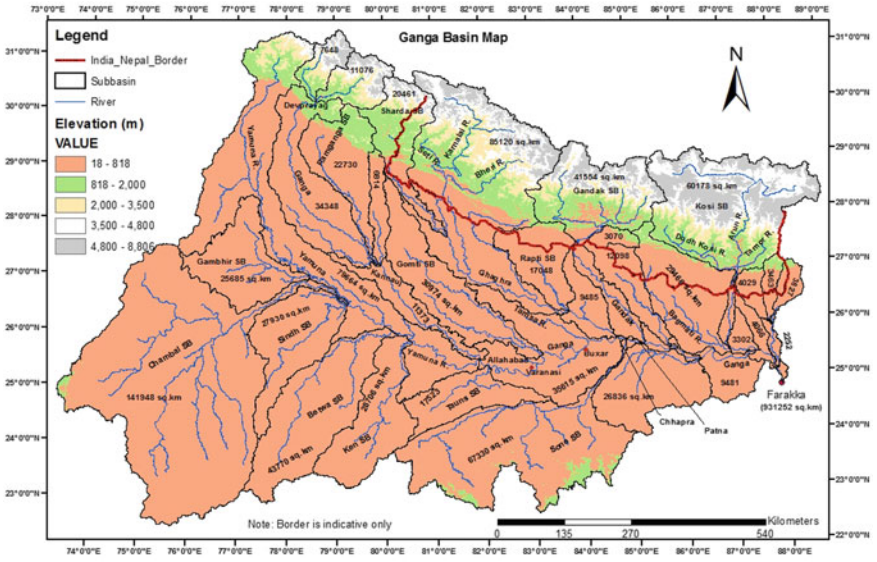

Fig. 2.1 Drainage area map of river Ganga at Farakka barrage

Table 2.1 Drainage area of some of the rivers of Ganga basin

River	Drainage area (km^2)
Ganga at Allahabad	93,989
Yamuna at Allahabad	347,703
Tauns	17,523
Ghaghra	132,114
Gandak	41,554
Sone	67,330
Kosi	60,178
Bagmati	29,466
Tributaries of Yamuna	
Gambhir	25,685
Chambal	141,948
Sind	27,930
Betwa	43,770
Ken	28,706

2.2 Meteorological Scenario of Ganga Basin

The southwest monsoon makes landfall at the mouth of the Ganga around the first week of June and advances upstream. By the end of July, the monsoon reaches the western end of the basin. The mean annual rainfall in the basin is about 1,170 mm. About 88% of the annual rainfall is received during the period of June to October. The bulk of the remaining 12% occurs mostly in the periods of March to May and November to December. During monsoon, cyclonic disturbances cause heavy spells of rainfall in the Ganga River Basin. On an average seven cyclonic disturbances (mainly depressions) form in the Bay of Bengal during the 4 months from June to September. These disturbances generally move in a west-northwest direction after their formation at the head of the Bay of Bengal up to the central parts of the country before weakening. It is well known that heavy rainfall occurs in the south western sector of the monsoon depressions due to strong convergence in that sector. The part of basin comes in the southwest of monsoon depressions tracks and as such heavy to very heavy rainfall occurs over different parts of the Basin.

The topography of the basin including Himalayas also plays an important role in causing heavy rainfall in the parts of the basin during the southwest monsoon season. The main synoptic situations of the southwest monsoon system that produce heavy rainfall over the Ganga River Basin are formation and subsequent movement of monsoon depressions, low-pressure systems from the head Bay of Bengal and well marked seasonal trough. Some of the severe rainstorm producing tracks of cyclonic disturbances are presented in Fig. 2.2.

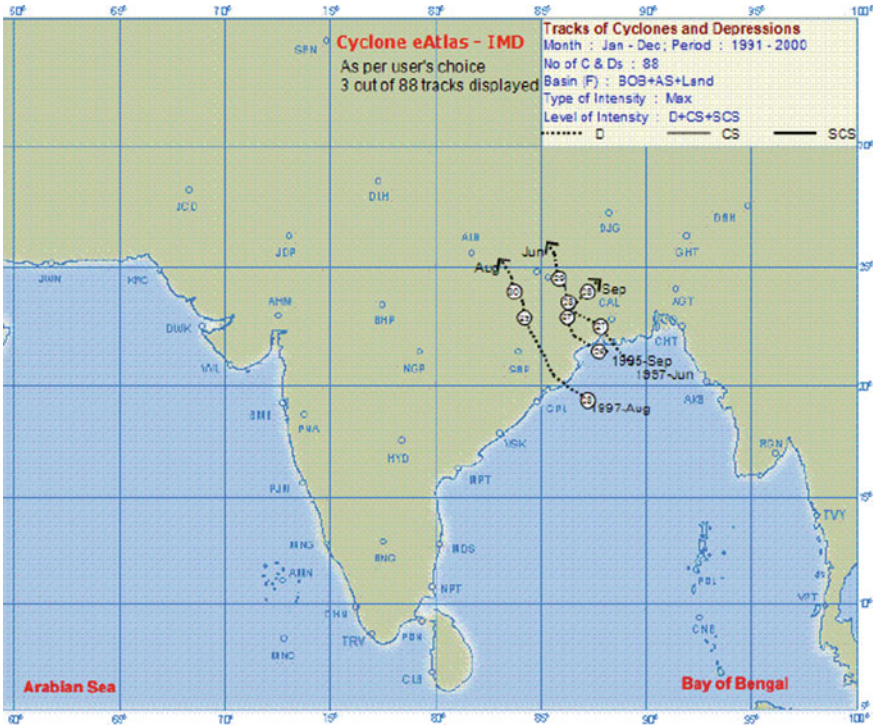

Fig. 2.2 Ganga river basin severe rainstorm producing tracks of cyclonic disturbances (1991–00) (*Source* Cyclone eAtlas—IMD)

The August 2016 floods in the Gangetic plains was also due to low pressure depression formations. As per IMD two low pressure systems were active during the period 1st to 10th August which affected the areas of Gangetic West Bengal, Jharkhand, Madhya Pradesh and East Rajasthan. Consequent to these two low pressure systems heavy to very heavy rainfall occurred in the sub-catchments of Koel, Rihand, Sone, Tauns, Ken, Betwa, Urmil, Lower Chambal, Kalisindh, Gambhir, Yamuna and Ganga downstream of Dalmau sub-catchments.

Meanwhile a slow moving deep depression also formed in Gangetic West Bengal and adjoining Bangladesh on 16th August 2016 and moved very slowly west wards after intensifying from 16th to 21st August 2016. It finally weakened in East Rajasthan. Rainfall of heavy to very heavy intensity at a few places with extremely heavy rainfall at isolated places were witnessed in the basins of Koel, Rihand, Sone, Tons, Ken, Betwa, Urmil, Lower Chambal, Kalisindh, Gambhir, Yamuna and Ganga downstream of Dalmau sub-catchments.

2.3 Floods in Ganga Basin

The management of the recurrent floods in Ganga River is a formidable challenge for the Central and State Governments. The flood control and management schemes are planned, investigated, formulated and implemented by the State Government. The Union Government renders assistance to States which is technical, advisory, catalytic and promotional in nature. The flood prone area in this basin as reported by States to the 12th Plan Working group is around 242 lakh hectare.

The country is witness to several flood events in the recent past when the wrath of the river in spate has left behind a trail of destruction spread across many States. *There are several structural and non-structural measures in flood management.* Nevertheless, reservoirs along the river basin are central to the issue of flood management as they can moderate the intensity and timing of the incoming flood. They are more effective for flood management if, apart from the incidental moderation available, specific flood volume is earmarked as in the case of DVC dams. At present, of the 80 odd large dams having height more than 100 m and capacity above 1 km^3, dedicated flood cushion has been provided only in 10 dams.

The August 2016 floods in the Gangetic plains is fresh in our minds that brings to the fore several intricate issues pertaining to management of a river basin reeling under floods. A study initiated recently post August—2016 floods in Bihar at the instance of Ministry of Water Resources, River Development and Ganga Rejuvenation by Central Water Commission to holistically understand the flood peak formation phenomenon in river Ganga and to estimate the flood storage requirements in the Ganga basin has interesting revelations that is briefly discussed here. The other structural and non-structural possibilities in flood management, sediment issues etc. are not dealt in this paper to ensure focus on the significance of flood storages in the basin and surrounding issues.

2.4 Flood Peak Pattern Analysis of Ganga River System

The vast historical data available on Ganga river system has been examined and an attempt has been made to understand the flood peak formation phenomenon in the main stem of river Ganga between Allahabad and Patna for which the annual flood peak patterns of different contributing rivers have been plotted in Fig. 2.3. The flood peak data of river Ganga and its tributaries for more than 50 years has been used. From the flood peak pattern plot and date of occurrence of flood peak at respective locations, the study concludes that the flood peaks in main stem of river Ganga i.e. at Varanasi and Gandhighat, Patna is being governed by the flood peaks in river Yamuna at Partappur. Further, the second most important contributor in flood peak of river Ganga at Patna is Sone river system.

It is seen that in Ghaghra river system, most of the flows gets spread out in vast territory of UP and Bihar creating huge floods. Thus Ghagra's contribution in flood

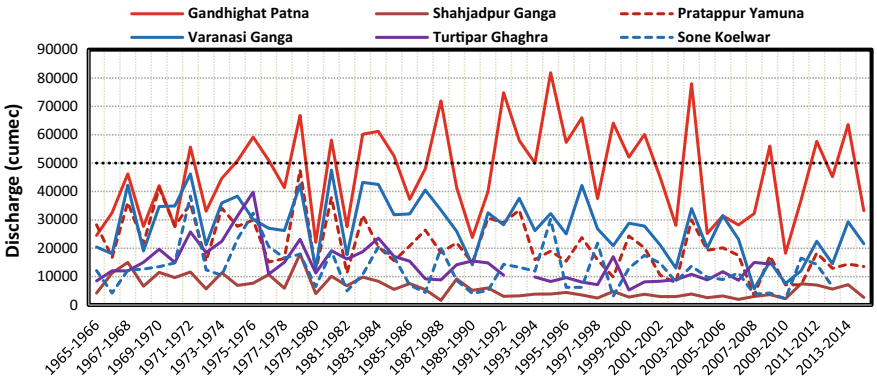

Fig. 2.3 Annual flood peak pattern in river Ganga and its tributaries

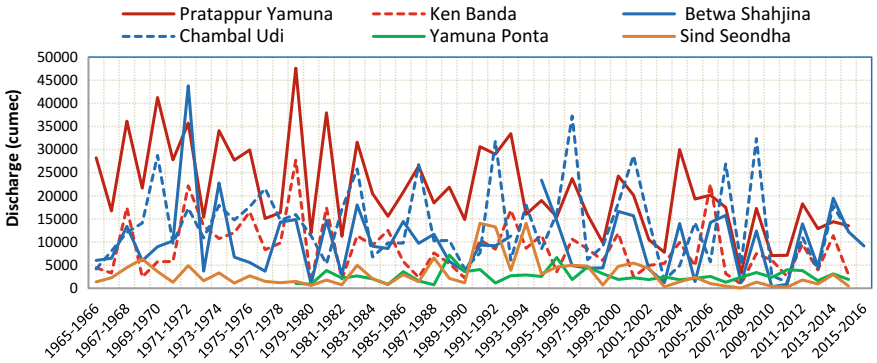

Fig. 2.4 Annual flood peak pattern in river Yamuna and its tributaries

peaks in the main stem of river Ganga is of the order of about 8000 to 10,000 cumec. One of the important revelations is that the concurrent occurrence of Kosi flood peak with Ganga flood peaks is very rare. However, the huge discharge in Kosi river results in flooding within its drainage area in Bihar.

The flood peak pattern analysis carried out for the Yamuna river system as presented in Fig. 2.4 reveals that majority of the flood peaks occurrences in Yamuna are due to significant contributions from its tributaries viz. Chambal, Betwa and Ken.

In Chambal river, the major storage projects viz Gandhi Sagar and Ranapratap Sagar were commissioned way back in the year 1970. As can be seen from the annual flood peak pattern, number of flood peaks with a significant discharge of more than 20,000 cumec have continued even after the year 1970. As per the study, some significant additional flood storage is essential on river Chambal and some dedicated flood cushion in existing projects coupled with inflow forecast may help further mitigation of flood peaks.

As on date, there is no storage project on the river Ken, and contribution of river Ken during the major flood events is more than 10,000 cumec, the study concludes that significant flood storage is essential on river Ken. Similarly, provision of dedicated flood cushion coupled with inflow forecast in the existing projects on river Betwa and additional storage will help in mitigating the flood peaks of river Betwa.

2.5 Flood Storage Estimate for Ganga Basin

As a sequel to the flood peak pattern analysis, flood storage estimate study for the entire Ganga basin too has valuable findings. It is worth mentioning here that the drainage area of river Ganga at Gandhighat Patna is about 7,25,000 km^2. Considering the possibilities of storage on Yamuna river system viz Ken, Betwa, Sind, Chambal etc. and Himalayan part of Yamuna, Tauns, Sone, Ghaghra, the total drainage area which can be tapped is about 2,70,000 km^2 only. About 4,55,000 km^2 (i.e. about 63% of the drainage area) shall remain untapped due to topographical constraints. This contribution from untapped catchment may vary from 30,000 cumec to 40,000 cumec in a flood scenario of above 65,000 cumec.

From the data of flood peaks at Gandhighat, Patna, Hathidah and Farakka on main stem of river Ganga, it has been found that the magnitude of flood peak at Gandhighat Patna is maximum in almost all the flood events that have occurred so far. The lesser flood peak at Hathidah and Farakka in comparison to Patna due to attenuation of flood peak by Mokama Taal and spillage of water in flood plains. To illustrate, daily discharge pattern of four worst flood events of years 1987, 1991, 1994, 2003 and 2016 each of them having peak discharge of more than 70,000 cumec has been picked up and analysed to estimate flood storage requirement. In the analysis the flood volume has been estimated considering a target to curtail the flood peak at Patna by about 20,000–25,000 cumec. Accordingly, for the flood events with peak flow below 75,000 cumec, volume has been estimated above 50,000 cumec discharge. For the flood events with peak flow above 75,000 cumec, volume has been estimated above 55,000 cumec discharge. The study reveals that:

- For September 1987 flood, maximum recorded peak was 71,900 cumec and flood volume above 50,000 cumec was about 4.8 BCM.
- For September 1991 flood, maximum recorded peak was 72,608 cumec and flood volume above 50,000 cumec was about 11.9 BCM.
- For August 1994 flood, maximum recorded peak was 81,839 cumec and flood volume above 55,000 cumec was about 10.9 BCM.
- For September 2003 flood, maximum recorded peak was 78,000 cumec and flood volume above 55,000 cumec was about 16.8 BCM.
- For August-September, 2016 flood the flood volume at Patna above 55,000 cumec was about 12 BCM.

As stated above, the maximum influence on Ganga flood is mainly from Yamuna and Sone river systems. Considering that, a total flood storage of about 12 BCM in

Yamuna, Sone and Ghaghra sub basins may be beneficial in moderating the floods in the main stem of river Ganga between Allahabad, Patna and downstream of Patna. In order to mitigate the flood peaks at Patna by 20,000 cumec to 25,000 cumec, flood storage estimates for Chambal, Betwa and Ken river systems as per the study works out to 3.0 BCM, 2.5 BCM and 2.0 BCM respectively. The estimate for Sone river system is projected as 2.5 BCM. In the drainage area of Ghaghra, Gandak and Kosi river systems, flood storage of 3.0 BCM, 2.3 BCM and 3.25 BCM respectively has been estimated.

As per the study, efforts should be made to ensure some dynamic flood cushion supported with inflow forecast in existing projects viz Gandhisagar in Chambal sub basin, Bansagar, Rihand in Sone sub basin, Rajghat, Matatila in Betwa basin. The major projects being considered on Ghaghra river system are Pancheshwar multipurpose project on Sharda, Karnali (Chisapani) multipurpose project on Karnali (Ghaghra), Namure multipurpose project on River West Rapti which are at different stages of preparation in association with Government of Nepal. Similarly, on the Kosi river system, Saptakosi & Sunkosi multipurpose projects, Bagmati multipurpose project and Kamla Dam project are being investigated jointly with Government of Nepal. Substantial moderation of floods in Uttar Pradesh and Bihar can be expected from these projects.

2.6 Brief Description of Brahmaputra River Basin

Brahmaputra River originates as Yarlung Tsangpo river from Mansarovar near Mt. Kailash in the Himalayas, flows via Tibet, China, India and Bangladesh into Bay of Bengal. The total length of the river is about 2900 km. The drainage basin of the Brahmaputra extends to an area of about 580,000 km^2, from 82°E to 97° 50′ E longitudes and 25° 10′ to 31° 30′ N latitudes. The basin spans over an area of 293,000 km^2 (50.51%) in Tibet (China), 45,000 km^2 (7.75%) in Bhutan, 194,413 km^2 (33.52%) in India and 47,000 km^2 (8.1%) in Bangladesh. Its basin in India is shared by six states namely, Arunachal Pradesh (41.88%), Assam (36.33%), Nagaland (5.57%), Meghalaya (6.10%), Sikkim (3.75%) and West Bengal (6.47%). The mighty Brahmaputra and its tributaries flows above the danger level across Assam almost every year and affects more than one lakh people inundating human habitations and farm land in several districts of Assam and Arunachal Pradesh of North Eastern region of India.

Brahmaputra water is the prime resource endowed to this region, which has the potential to bring all the desired growth and prosperity to the region. If left unmanaged, it will become the biggest bottleneck against development due to recurring floods as this also gives sense of insecurity for sustainability of infrastructure. Accordingly, flood is a major concern for the overall development of North Eastern Region. Besides, Assam suffers an average loss of more than Rs. 200 crore every year due to floods, it loses large swathes of land to river bank erosion and recovering such lost land has become a challenging task for the state. The above problem can be solved effectively to a great extent through a flood management approach, where

flood peaks of Brahmaputra are curtailed through storage of flood water in different sub basins of Brahmaputra. About 6 to 7 judiciously located storage projects leading to about 14 BCM of storage can turn around the biggest bottleneck of recurrent floods into a great opportunity of cheap and reliable non-polluting power with an efficient navigation round the year approaching all the way across the region.

2.7 Formation of Flood Waves in Brahmaputra Basin

In order to understand the flooding scenario in Brahmaputra river, it is essential to visualize the rainfall scenario in Brahmaputra basin. The same is shown in Fig. 2.5, where it can be seen that the average annual rainfall in Siang river upstream of great bend is less than 500 mm. The same scenario is also in Lohit basin where the rainfall in Chinese catchment of Lohit river is less than 500 mm. The average annual rainfall in Siang valley downstream of great bend and up to Passighat is of the order of 3500 mm. The rainfall in lower region of Dibang and Lohit basins is more than 4000 mm. There are certain pockets in Siang, Dibang and Lohit basins where annual rainfall is even of the order of 5500 mm. Similarly in some pockets of Subansiri basin the annual rainfall is more than 3000 mm. In the catchment of Brahmaputra plain the average annual rainfall is of the order of 2400 mm.

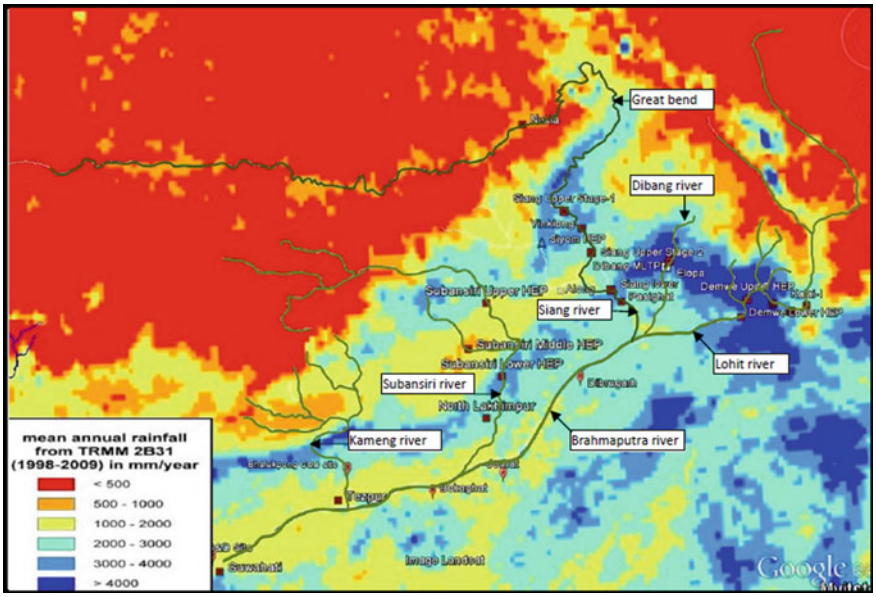

Fig. 2.5 Rainfall scenario in Brahmaputra basin

Apart from the rainfall scenario a comparison of flood peaks observed in Siang river at Tuting and Brahmaputra river at Guwahati is given below:

Siang at Tuting (About 25 km d/s of India-China Border)		Brahmaputra at Guwahati	
Date	Observed flood Peak (cumec)	Date	Observed flood Peak (cumec)
08/09/2007	12,180	12/9/2007	44,508
01/09/2008	13,485	4/9/2008	49,659
01/07/2009	9230	24/08/2009	36,138
05/09/2010	11,300	19/09/2010	39,469

From the above rainfall scenario and flood peak data of Tuting and Guwahati, it can be said that the flood or high discharge in Brahmaputra basin is basically due to very high rainfall in the Indian catchment of the basin. This may further get worsen due to climate change leading to more erratic and intense rainfall pattern, resulting in increase in the intensity of floods.

2.8 Flood Storage Requirement in Brahmaputra Basin

In addition to all non structural measures, it is essential to adopt all possible and effective structural measures for flood management so as to tackle the problem of floods in Brahmaputra basin. The catchment area of Brahmaputra at Guwahati is about 417,000 km^2 in which the catchment area of Siang alone is about 251,521 km^2. The Catchment area of Lohit near Parsuramkund is about 21,000 km^2, while Subansiri at Gerukamukh is about 26,000 km^2. Due to natural topography and availability of limited storage sites, it is possible to construct storage projects on Siang, Dibang, Lohit and Subansiri rivers at those sites only. Further, a large catchment area of about 108,669 km^2 up to Guwahati lies in plain, where no storage project is possible. It has been estimated that from the unregulated catchment of Brahmaputra plain a flood discharge of about 22,000 to 25,000 cumec is expected during the flood events of 100 year return period. However with judicious storage of flood waters in Siang, Dibang, Lohit and Subansiri rivers at identified locations, the flood peak of Brahmaputra can be mitigated to safer levels. The adequate flood storages can be provided in Upper Siang storage project in Siang sub basin, Dibang multipurpose project in Dibang sub basin, Subansiri lower, Kamla and Subansiri upper projects in Subansiri sub basin. In Lohit sub basin the storage available between operating level during monsoon and Full Reservoir Level (FRL) of Demwe lower, Demwe upper, Hutong-II, Kalai-II and Kalai-I can be used to meet the flood storage requirements. The location of above projects is shown in Fig. 2.6.

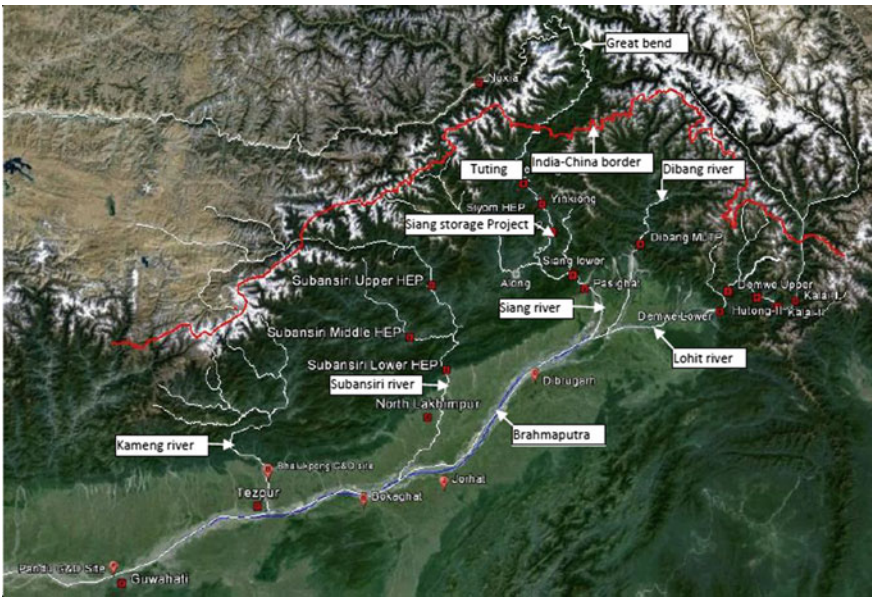

Fig. 2.6 Major River Valley Projects in Brahmaputra basin

In order to estimate the flood storage requirement in Brahmaputra basin, a Committee under Chairmanship of Member (D&R), CWC with experts from NHPC, CEA, Brahmaputra Board, Govt of Arunachal Pradesh and Govt of Assam was constituted by MoWR in July, 2013. The Committee after detailed analysis and several deliberations identified that the major contributor of flood in Brahmaputra is Siang. The other rivers which contribute significantly in Brahmaputra flood peak formation are Dibang, Lohit and Subansiri. In order to mitigate the Brahmaputra flood fury, the Committee estimated a flood storage requirement of 9.2 BCM in Siang, 0.6 BCM in Dibang, 1.61 BCM in Lohit and 1.91 BCM in Subansiri sub basins.

2.9 Benefits of Storage Projects

Flood management in Brahmaputra basin may be achieved by ensuring the availability of the required quantity of water at the required point of time. This may be made possible through storing flood water during flood season by moderating the flood peaks and releasing it at an appropriate time of requirement. With aforesaid proposed flood storage projects, it will be possible to reduce the 100 year flood peak at Guwahati from 62,000 cumec to about 42,000 cumec. The 25 year return period flood of about 55,000 cumec will be possible to reduce below 40,000 cumec. Depending upon the contribution from the unregulated catchment, the proposed flood storage

scenario will result into reduction in water level at Guwahati by about 1.1–1.5 m. This will bring a major relief from floods and recurrent flood damages. Apart from the floods on account of rainfall occurrences, floods from Glacial Lake Outburst, breaching of land slide dams will also be effectively attenuated by proposed reservoirs, thus effectively mitigating their downstream impact. The benefits of flood moderation besides water security and better navigability during lean period would also be available up to Bangladesh which is a lower riparian country.

Through these storage projects in upper reaches of the Brahmaputra basin the flood levels in the main stem of Brahmaputra river will be reduced considerably. This will also facilitate removal of flood congestion and consequent reduction in flooding in the drainage area of the tributaries joining Brahmaputra river in downstream areas. One of such prominent area besides other areas where relief due removal of flood congestion would be available is Bodoland Territorial Council area in Assam.

The maximum flood storage is essential in Siang sub basin where the proposed Upper Siang Storage Project with installed capacity of 10,000 MW shall generate about 48,000 million unit of electricity annually even during the dry years.

Apart from the flood mitigation, the storage projects will help in overall development of NE region's economy through hydropower generation, major employment generation, industrialization, education, better medical facilities etc. Large reservoirs will also provide the huge employment generation through Tourism and fisheries for the local people. Other benefits are better navigability of Brahmaputra, water sports and enhanced river flows during lean period resulting in better river ecosystem besides adding the effectiveness to anti erosion/flood management and infrastructural works in Brahmaputra basin.

2.10 Water Security Aspects of Brahmaputra

Being a snow fed, Siang river is the major contributor of non-monsoon(November to April) flow of river Brahmaputra. The contribution of non-monsoon flow in Brahmaputra by Siang during November to April is about 22 BCM, out of which about 18 BCM is contributed from the drainage area in China. The possibility of diversion of Siang water by China has been raised by media from time to time. Also, as apprehended, the climatic change is reducing the size of glaciers which may also result in reduction of availability of water during non-monsoon period. Considering the possibility of reduction of Siang water in future, the upper Siang storage project will also ensure the non-monsoon water security in Brahmaputra basin besides becoming a safeguard to power projects and providing protection to ecology and environment.

2.11 Regulatory Framework for Brahmaputra Basin

Integrated water resources management (IWRM) of any basin for its overall development including integrated flood management may be achieved if there exists a well-structured and appropriately empowered regulatory authority at basin level. In Brahmaputra basin there exists a statutory body namely Brahmaputra Board at Guwahati, Assam since 1982, with certain limitations on its mandate. Presently Board is certainly not a regulatory authority. However, Brahmaputra Board may be revamped appropriately as a basin authority and may be made responsible for Brahmaputra basin's water resources management with the mandate of all activities of water resources including management of floods and regulation of reservoirs etc. As the effectiveness of flood storage can only be ensured by integrated operation of the proposed reservoirs in Brahmaputra basin hence, whenever projects come into existence, a Reservoir Regulation Committee comprising of all stakeholders for coordinated operation of reservoirs during monsoon shall be essential to ensure optimum flood moderation benefits through integrated flood management. The advice given by the Committee should be binding to all the project owners of the basin.

Further, policy for operation of multipurpose reservoirs is needed for reducing the impact of flood cushion requirement vis-à-vis power generation from the project. For coordinating large reservoirs in real time, comprehensive data collection and Decision Support System will be required to be set up. Land use planning, flood plain zoning in unregulated catchment of Brahmaputra will further enhance the effectiveness of integrated flood management approach.

2.12 Flood Management—A State Subject

The subject of flood control, unlike irrigation, does not figure as such in any of the three legislative lists included in the Constitution of India. However, Drainage and Embankments, are two of the measures specifically mentioned in Entry 17 of List II (State List), reproduced below:

> Water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provision of entry 56 of List I (Union List).

Entry 56 of List I (Union List) reads as follows:

> Regulation and development of inter-State rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest.

It may be seen that the primary responsibility for flood control lies with the States. A number of States have already enacted laws with provisions to deal with the matters connected with flood control works. However, there exists a significant provision that the powers to be exercised are subject to Entry 56 of Union List.

2.13 Conclusion

The paper focuses on appreciation of two key aspects relating to flood moderation in Ganga and Brahmaputra river basins. One is the flood peak pattern analysis and the other is the estimate of flood storage requirement in different sub basins of Ganga river system. All over the world including India, the storage projects are playing key role to moderate the flood peaks and are bringing relief from devastation and fury of floods. In India, Bhakra Nangal dam in Sutlej basin, Bargi dam in Narmada basin, number of storage projects in Damodar valley, Tehri Dam in Ganga basin are some live examples, which are efficiently controlling the floods in their region. Similarly, in Murray Darling basin (Australia), Yellow river basin (China), Brantas river basin (Indonesia) and many other basins in all over the world, basin authorities are relying on flood management mainly with the help of large storage projects. Most of the basin authorities all over the world are relying on integrated flood management mainly with the help of large storage projects.

There is no doubt that the flood flows have to be managed effectively by the State and Central Government to mitigate the adverse flood impacts. We need to remind ourselves that floods per se do not understand man-made State boundaries. Floods have been inflicting damages to almost all the States in Ganga basin and Arunachal and Assam in Brahmaputra basin. While tackling floods in a large basins like Ganga and Brahmaputra, the cooperation and synergy among the riparian States on the issue of tackling flood is very vital in the interest of all. Integrated development and operation of the reservoirs in a river basin world over has significantly helped in efficient flood moderation.

Ganga and Brahmaputra basins are also not exception to that and strategic storage projects in the basin are essentially required for Integrated flood management. From the analysis of flood scenarios in Ganga basin it can be concluded that efforts should be made to ensure some dynamic flood cushion supported with inflow forecast in existing projects viz Gandhisagar in Chambal sub basin, Bansagar, Rihand in Sone sub basin, Rajghat, Matatila in Betwa basin. Further, on the rivers Ghaghra, Sharda, West Rapti, Kosi and Bagmati etc. in Ganga basin, construction of storage projects in association with Government of Nepal with adequate flood cushion may provide substantial moderation of floods in Uttar Pradesh and Bihar, apart from providing clean energy as hydropower for India and Nepal.

Similarly, flood storage projects can be provided only in North Brahmaputra where storage sites are available in Subansiri, Siang, Dibang and Lohit sub basins. The major contribution of flood in Brahmaputra is from the Siang river. With the proposed flood storage provisions it will be possible to mitigate the Brahmaputra floods substantially. The proposed storage will provide a major relief to frequently affected flood areas in the basin with average annual saving of more than Rs. 200 crore from flood damages in Assam apart from hydropower in the region and India. These projects will also provide effective relief from flooding in Arunachal Pradesh. Apart from the flood mitigation benefits, Government of Arunachal Pradesh will get huge free power and other benefits from all these projects. Hence, management of

Brahmaputra waters through construction of strategic storage projects with stakeholder's active participation and integrated management of floods could be a key to overall development of NE region.

As already stated above, water is mentioned in the State List of the Constitution and the primary responsibility for flood control lies with the States. The flood control and management schemes are planned, investigated, formulated and implemented by the State Government. The Union Government renders assistance to States which is technical, advisory, catalytic and promotional in nature. From State to State, the priority of projects normally differ and therefore all States may not necessarily agree to the integrated planning approach.

From the study outcome above, it is seen that large storage volumes are needed supported with reliable inflow forecast network for moderating floods in a large basin like Ganga and Brahmaputra implying huge financial implications. Some of these reservoirs in all likelihood would be inter-state projects requiring consensus among the party States and hence agreement on cost-benefit sharing would be vital. Difference of opinion between two States is enough to jeopardize the entire project. Above all, the proposed projects have to be environmentally sound and socially acceptable. River Ganga and Brahmaputra are holy rivers, worshipped, revered and regarded as lifeline of the region. Any interference in the river environment and its regime will not be taken lightly by the people and therefore building storages would require serious consideration and consultation of all stakeholders on all issues at the planning and developmental stage itself.

On the operational front, the best practices calls for all the major reservoirs (from storage volume consideration) to ideally come under integrated operation to ensure that the flood waters are efficiently routed and regulated. Further, for real time integrated operation, a robust state-of-art data acquisition, storage, retrieval and transmission system to and from the centralised control and command centre is paramount. However, with water being in State domain, the control over releases from reservoirs remain with the State Governments. Further, with increasing water conflicts among stakeholders in the basin, integrated operation would have to negotiate many hurdles. The issues on trans-boundary rivers too pose multiplicity of challenges. Confidence and Consensus building through participatory approach is therefore important and sincere efforts should continue diligently.

Disclaimer The views expressed in the paper are purely personal and not necessarily the views of the organisation.

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N. N. Rai is Director at Central Water Commission, New Delhi.

J. Chandrashekhar Iyer is Commissioner (FM), Ministry of Water Resources, Govt of India.

T. S. Mehra is Commissioner (BB), Ministry of Water Resources, Govt of India.

Chapter 3
Comprehensive Approach for Hydropower Development for Energy-Water Security

Ashwin B. Pandya

Abstract India, blessed with suitable topography in Himalayan and Western and Eastern Ghats region, has substantial potential for hydropower. As a means of clean energy, hydropower also supports much needed conservation suitable for monsoon-based intermittent and disparate water availability regime of the country. Development of hydropower addresses water security as well, thereby strengthening the water and energy vertices of the water-food-energy nexus triangle. India has 148,701 MW of hydropower potential, of which exploitation has been a meagre 38,000 MW representing just 26% of available potential. Hydropower development has been the least in the region with the highest potential namely, Himalayan region and especially the North-Eastern areas. Immediately post-Independence, hydropower development was coupled with creation of water conservation infrastructure in form of large reservoirs needed for ensuring water and food security. However, the same pace has not been maintained since then and development in the sector is lagging. The chapter makes a case for taking up hydropower development as a strategy for water and energy security as also to provide impetus to generation of green power, now mandatorily required to meet climate change resilience goals of the country. At present, the policy climate for hydropower is beset with many misconceptions and provides hurdles in terms of excessive tax burden, load of welfare measures which are not necessarily associated with hydropower schemes and other interventions working against the techno-economic viability of the schemes. The chapter argues for multi-sectoral approach for resolving the problems associated with a comprehensive development for overall development of the power and water sector in the country.

Keywords Hydropower · Reservoirs · Water security · Environmental sustainability · Techno-economic viability · Climate change · Environmental impact · Grid stability · Gap reduction measures · Environmental flow · Renewable energy policy · Power purchase policy

A. B. Pandya (✉)
International Commission on Irrigation and Drainage (ICID), New Delhi, India
e-mail: abpandya@yahoo.co.uk

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3.1 Potential of Hydropower Development in India

India has been blessed with large hydroelectric power potential of about 1, 48,701 MW projects (1,45,320 MW from HE schemes above 25 MW capacity). However, the growth of hydro power development in the country has been slow and only about 26% (37,998 MW excluding Pumped Storage Schemes) of the identified potential has been exploited so far while hydro projects with identified potential of about 9% (12,502 MW) are presently under construction.

3.1.1 State-Wise Status of Development

The Region-wise status of hydro power and its development is given below:

Region	Potential capacity (MW)		Developed (MW)		Under construction (MW)	
	Total	>25 MW	MW	%	MW	%
Northern	53395	52263	18302	35.02	5032	9.63
Western	8928	8131	5552	68.28	400	4.92
Southern	16458	15890	9587	60.33	1310	8.24
Eastern	10949	10680	3315	31.04	2726	25.52
North Eastern	58971	58356	1242	2.13	2954	5.06
Total	148701	145320	37998	26.15	12422	8.55

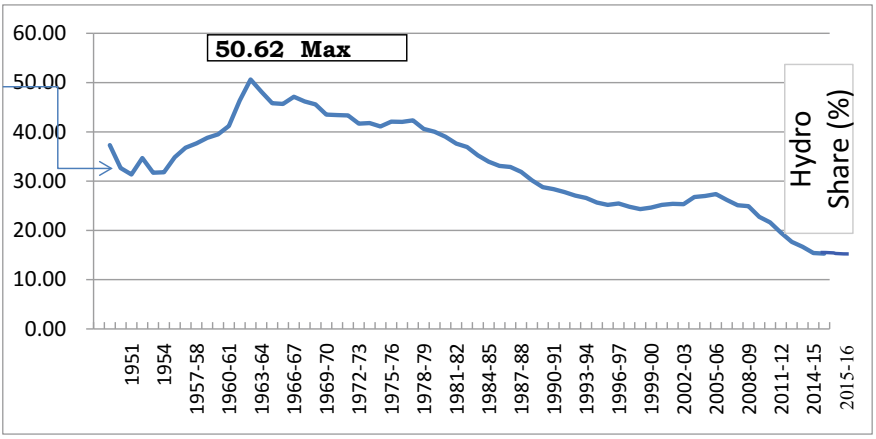
3.1.2 Basin-Wise Status

The Detailed status of Basin-wise hydro power potential and its development is given below:

Basin/river	Potential (MW)		Developed		Under construction	
	Total	>25 MW	MW	%	MW	%
Indus	33832	33028	13573	41.10	3491	10.57
Ganga	20711	20252	5317	26.26	1541	7.61
Central Indian rivers	4152	3868	3148	81.37	400	10.34
West-flowing rivers	9430	8997	5661	62.92	100	1.11
East-flowing rivers	14511	13775	8003	58.10	1210	8.78
Brahmaputra	66065	65400	2296	3.51	5680	8.69
Total	148701	145320	37998	26.15	12422	8.55

3.1.3 Declining Share of Hydropower

After Independence, hydro power contributed to about 37% of total power which gradually reached 46% by the end of 3rd Plan. The share of hydro power showed gradual decline reaching 40% by Eighties. Then, contribution from hydro power started reducing drastically reaching 34% by the end of 6th Plan and 25–29% during 7–10th Plan. Afterwards, it has been declining and has reached to 14.2% in 12th Plan. In the year 1962–63, the hydro thermal mix was at the highest at 50.62% which has dropped down to about 14.2% in 2015–16 as shown in the graph below.



As against the declining hydro share in the country, hydro power has experienced an upsurge at the global level over the past decade, reaching 1000 GW of total installed capacity with 40 GW in the year 2013 alone. Climate change and other negative effects of fossil fuels and increasing concern of energy security are driving hydro power expansion world-wide. However, there has been a continuously falling trend in the hydro share in India.

A number of factors, apart from lack of adequate infrastructure, have contributed to the slow growth of hydro and declining share of hydropower. Some of the reasons are given below:

(a) Up to 1960s, the major emphasis of the Government was on development of multi-purpose reservoir based hydro projects like Hirakud, Bhakhra, Damodar Valley projects etc. mainly to have irrigation for better food security which also led to development/augmentation of hydro generation capacity in the country.
(b) One of the major factors is drying-up of funding by bi-lateral/multi-lateral agencies as their focus shifted from infrastructure based projects to social and health sector projects etc.
(c) Further, the environment clearance regime for hydro projects after 1970s has also become increasingly stringent due to world-wide focus on environmental & ecological and R&R issues and consequent activism against the development of hydro projects by NGOs/Environmental activists (e.g. Narmada Bachao Abhiyaan by Ms Medha Patkar, Chipko Movement of Sh. Sunder Lal Bahuguna and Silent Valley protests etc.). Such activism led to wide spread delays in development of hydro projects like Indira Sagar, Sardar Sarovar, Tehri etc. This also led to cancellation of multi-lateral funding in projects like Sardar Sarovar (1450 MW), Upper Indravati (600 MW), Sharavathy TR (240 MW) and Kalinadi-2 (120 MW) etc. and non-tie-up of World Bank loan in others like Indira Sagar Project (1000 MW) etc.
(d) In addition, a number of Acts have been introduced since the 1970s by the Govt. including the Water (Prevention and Control of Pollution) Act of 1974, the Forest (Conservation) Act of 1980, the Air (Prevention and Control of Pollution) Act of 1981, the Environment (Protection) Act of 1986, the Recognition of Forest Rights Act of 2006 etc.

3.2 Advantages of Hydropower

3.2.1 Comparison of Techno-economic Parameters

Hydropower is conventionally regarded to be the cheapest way to generate electricity. That's because once a dam has been built and the equipment installed, the energy source—flowing water—is free. It is a clean fuel source that is renewable yearly by snow and rainfall. Furthermore, hydro plants do not emit pollutants into the air because they burn no fuel, thereby not causing any progressive degradation of

additional land during their operative period. Hydropower is also readily available; engineers can control the flow of water through the turbines to produce electricity on demand. In addition, ponds created may offer recreational opportunities, such as swimming and boating as well as commercial fishing. A comparison of techno-economic parameters of various sources of power has been attempted in the following table to establish the inherent advantages of hydropower:

Attribute	Coal based	Gas based	Nuclear	Solar (PV)	Solar (thermal)	Wind	Hydro
Project life (years)[a]	25	25	60	25	25	25	35**
Capital cost[b] (Rs. crore/MW)	5.08		15	6.05	12	6.19	6
O&M cost (Rs. lakh/MW)[a]	16	16	1% of project cost	7	15	10.63	2% of project cost
Normative plant[a] availability factor	85%	85%	85%	19%	23%	20–32%*	90%
Auxiliary consumption	7.5–8%	3%	<10%	Nil	10%	Nil	1%
Fuel cost (Rs./kWH)	0.90	6–7	<1	Nil	Nil	Nil	Nil
Cost of generation (Rs./kWH)	3–4	7–8	3.5–4	4–5		4–5	2–3
Land area requirement[c]	1.42		1.5	4	6	30	2.5
Consumptive use of[d] water (cumec/h per MW)	3.5–4	3.5–4	3.5–4	Nil	3.78–4	Nil	Nil

*Depending on wind zone

**The life mentioned here is for the investment return point of view only. The actual operational life of a hydro project often exceeds 100 years with many such projects operational in the country and in the world

[a]Data collected from CERC Tariff Regulations 2014–19

[b]Data collected from Benchmark Capital Cost for TPS CEA, CERC Tariff Regulations for RE

[c]Data from CEA report on Land Requirement for TPS

[d]Data from CEA report for water requirement for TPS

It is necessary to point out that comparison between other non-conventional sources and hydropower often ignores the fact that the availability of power on demand is never assured in case of solar or wind power sources. Whereas the thermal including nuclear and hydropower are the only sources which can be deployed at will. Power is a dynamic resource and has to be generated instantaneously on demand. Storage options on a grid scale are feasible through pumped storage schemes which are again a form of hydropower based management. Hence, globally, hydropower generating capacity forms the backbone of grid management measures.

3.2.2 Comparison of Socio-environmental Parameters

The following advantages over thermal energy, which is seen and being pursued as an option for Hydropower need to be seriously considered in the environmental context.

3.2.2.1 Significantly Lower Pollution Levels

A study conducted by U.S. Department of Energy, Washington D.C., USA, concludes that a mix of fossil fired power generation produced an average of 874 metric tons of CO_2/GWh while renewable energy technology produced an average of 18 metric tons of CO_2/GWh. In case of large hydropower projects this was only 3.1 t CO_2/GWh. *(Source: Environmental Emissions from Energy Technology Systems: The Total Fuel Cycle; Dr. Robert L. San Martin, Deputy Assistant Secretary for Renewable Energy, U.S. Department of Energy)*

A similar study by Hydro Quebec published the following results for GHG emissions by different sources of power:

Source of power	GHG emissions per kWh in gram equivalent CO_2
Thermal–Coal	957
Thermal–Gas	422
RES–Solar	38
Hydro–Storage	10
RES–Wind	9
Nuclear	6

Source Hydro Quebec, Canada

3.2.2.2 Significantly Lower and One-Time Land Usage

In case of hydropower stations, the area on which project is built is only a one time investment, which will result yield for considerable periods, (not less than 100 years). But in case of thermal power, the land area is progressively exhausted and degraded. In contrast, area of reservoir made for hydropower projects could be developed to generate tourism and combining additional utilities.

As per a compilation titled "Public Watch" by Centre for Science and Environment (CSE), a prominent NGO, during 2012 there were 581 coal mines in India with about 2.1 lakh ha. mine lease area yielding coal production of the order of 554 million tonnes. This roughly provides a relationship between coal production and land area needed for that. Since 1 MW of thermal power requires about 5050 t of coal annually, each megawatt of hydel power to be replaced with thermal power will need an area of 1.9 ha. to be sacrificed which will be permanently degraded and may be lost forever or will need very costly restoration. Apart from this, the land will also be needed for flyash disposal in form of ash ponds and also storage facilities of fly ash.

(a) Beneficiation plants produce large volumes of tailings and solid wastes. Storage and handling of coal generates dust at rates of as much as 3 kilograms per metric ton (kg/t) of coal mined, with the ambient dust concentration ranging from 10 to 300 micrograms per cubic meter (μg/m3) above the background level at the mine site. This will yield 49,200 kg of dust per MW and will need additional land area and resources for its disposal.

(b) Considering 2608 MW of hydropower contained in 24 Hydropower Projects in the State of Uttarakhand, if sacrificed, will involve an alternative consumption of coal of the order of $2608 \times 5050 = 13.17$ million tonnes of coal per year perpetually. Hence, over a 100 year period of operation of hydropower project, an aggregate of 1317 million tonnes of coal would have been consumed and would result in 0.5 million hectares of land degradation. This is much higher than the land being submerged by the hydro project reservoirs.

(c) In the above study, the thermal cycle will require water of at least 4.5 M^3/h/MW of installed capacity under maximum efficiency regime as determined by CEA and TERI. Thus, 2608 MW power generation will require 2608 * 24 * 365 * 4.5 = 102.8 MCM of water consumption annually which will translate to domestic water supply to a population of about 2 Millions at the rate of 135 L/Capita/day ignoring the losses in treatment which are offset by not counting the losses in evaporation of the stored water in cooling ponds for the thermal plants. Due to environmental concerns, "once-through" system of cooling is no longer preferred and thermal and nuclear plants operating in the country are becoming almost zero discharge plants thereby net consumers of fresh water in relatively dry regions.

(d) In the country, the availability of coal and water are negatively correlated. The coal rich regions are relatively arid and water rich regions do not have adequate local coal resources. Hence, the costs of transportation as well as social costs of adequate water availability cannot be met with simultaneously.

3.2.3 Significantly Lower Environmental Impact

The major benefits of hydropower are no emission of sulphur and nitrogen oxides, few solid wastes, minimal effects from resource extraction, preparation, and transportation, flood control, water supply for drinking, irrigation, and industry, reservoir-based recreation, reservoir-based fisheries, enhanced tail water fisheries, improved navigation on inland waterways below the dam, only one time inundation of wetlands and terrestrial vegetation.

The table below attempts to bring out few shortcomings of run-of-river (RoR) Hydro Power Projects and effective countermeasures to deal with the adverse effects.

Adverse effects	Counter measures for RoR projects
• Conversion of a free-flowing river to a reservoir • Replacement of riverine aquatic communities with reservoir communities • Displacement of people and terrestrial wildlife • Alteration of river flow patterns below dams • Loss of river-based recreation and fisheries • Retention of sediments/nutrients in reservoirs • Development of aquatic weeds and eutrophication • Alteration of water quality and temperature • Interference with upstream and downstream passage of aquatic organisms • Emissions of greenhouse gases (CH4, CO2) from flooded vegetation at some sites	• Is prevented by releasing min. environmental flow • No large scale impounding reservoir in RoR schemes • Minimal or nil due to low pondage • None because of min. Flow downstream released • Re-creation facilitated due to easy approach • Flushing reservoirs regularly will mitigate this • No stagnant water, RoR involves daily filling and depletion • No effect in tropical climates like India • Continuity of passage ensured through environmental release/other means like passes • Typical RoR schemes involve minuscule pondage. No GH effects

3.2.4 Role of Hydropower in Overall Water Management and Water Security

India has a monsoon rain-fed climate and the rainfall occurs only over a small period of less than 100 days resulting in flood flows in rivers for a period of about 150 days. For a sustainable irrigated agriculture and also the industrial and urban demand, only about 225 BCM of storage has been created as against the optimal requirement of 450 BCM or more to manage the surface water resources of 690 BCM occurring over an average year. Storage based utilisation of our surface water resources can only reduce the stress on groundwater exploitation for agriculture and ensure quality water for human consumption.

Apart from the water conservation, the storage projects form a bulwark for protecting the downstream areas from floods. As per the study conducted in Central water

Commission, a total storage of about 13.2 BCM in Brahmaputra basin in Arunachal can provide a flood relief of 18000 Cumecs at Guwahati for a 100 year return flood, which when evaluated in quantitative terms, results in significant flood relief in the entire Brahmaputra flood plains comprising of a majority of Assam districts and also will enable to provide about 34 BCM to Interlinking of rivers of programme for alleviating the water stress in Krishna and Cauvery basins.

Our large water management projects are also the large hydropower projects, like Bhakra, Hirakud, Ukai, Nagarjunasagar-Srisailam projects, Sardar Sarovar project etc. In future, our ambitious interlinking of rivers programme is also involving large reservoir based hydro projects like Sankosh HEP (Bhutan), Pancheshwar (India and Nepal), Karnali project (Nepal), Sun Kosi-SaptKosi project (India and Nepal), and Storage projects in Brahmaputra basin which are under planning and implementation stage.

3.2.5 Role of Hydropower in Grid Stability in the Context of Renewable Energy Integration

As per INDC, India is committed to generate 3,50,000 MW of solar and wind power by 2030 which is infirm in nature, being not available during nights and also in rainy seasons. For grid stability, it is essential to have some firm power that can quickly ramp up and down, depending on the grid stability/balancing requirements. Considering the advantages, hydropower projects, especially pumped storage projects, are essential for enabling the use of other renewable in the system. Hydropower is increasingly being used to maintain the stability of the grid through array of services like black-start capability, frequency regulation, inertial response, spinning and non spinning reserve and voltage support, among others. Even without storage, hydro can balance variation in solar generation during rainfall months. Ideal mix would be 5:1 of solar and hydro. This adjusts the low PLF of solar appropriately. 150 GW of solar power by 2030 would require 30 GW of hydropower in addition to the existing capacity.

3.3 India's Intended Nationally Determined Contribution (INDC) for Climate Change

The INDC centres around India's policies and programmes on promotion of clean energy, especially renewable energy, enhancement of energy efficiency, development of less carbon intensive and resilient urban centres, promotion of waste to wealth, safe, smart and sustainable green transportation network, abatement of pollution and India's efforts to enhance carbon sink through creation of forest and tree cover. It also captures citizens and private sector contribution to combating climate change.

INDC includes mainly the following commitments:

- To reduce the emission intensity of its GDP by 33–35% by 2030 from 2005 level
- To achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030
- To create additional Carbon Sink of 2.5–3 billion tones of CO2 equivalent

In line with the above commitment, the targeted hydro capacity by the year 2030 is likely to be 65,000 MW as against about 42,703 MW at present. Presently, projects with an aggregate capacity of 13,582 MW are under construction while projects with the capacity of about 26,000 MW have been concurred by CEA.

Source	Capacity (GW)
Solar	243
Wind	119
Thermal–Coal	286
Thermal–Gas	60
Hydro	65
Small hydro	18
Nuclear	16
Biomass	13
Total	820

3.4 Projected Gap in Hydropower by 2030

As per INDC, Hydro capacity is targeted to be 65,000 MW by the year 2030. Further as mentioned at para 2.6 above, there is requirement of 35,000 MW for ensuring Grid stability in the light of projected 1,50,000 MW of Solar Power targeted by 2030. Even if the INDC commitment of 65,000 MW is targeted from about 42,783 MW at present, there is a Gap of 22,217 MW to be developed in a period of 14 years.

The targets have been set up in terms of a projection of growth of energy generation which may vary depending on the actual demand that may come up in the period. Looking at the targets decided, it will be prudent to consider the targets in terms of percentage of the aggregate capacity envisaged in 2030 and set the intermediate quantitative targets in terms of percentage of the capacities actually added in the period up to 2030.

3.4.1 Existing Plans to Meet the Gap

As stated in 4.4 above, the projected Gap to be filled up by the year 2030 to honour the INDC is about 23,000 MW. Recently all the Hydropower projects under construction and under clearance stage were reviewed and categorized as given below.

Category-I Hydro projects under construction with no major constraints
Category-II Hydro projects under construction having major constraints
Category-III Concurred Hydro Projects to be cleared from environment and forest angle and works to be taken up—Commissioning likely beyond 13th Plan

Summary of these projects is given below:

	Nos.	MW
Category-I	32	7510
Category-II	15	5992
Category-III	34	23065

As can be seen above, only 32 projects of capacity of 7510 MW are without major constraints and are likely to be completed by 2019–20. As many as 15 projects of 5992 MW capacity have got stalled/stranded due to several reasons including financial constraints, interstate disputes, and commercial issues. These projects have suffered huge cost and time overrun and are becoming financially unviable. As tariff has increased significantly, it is becoming increasingly difficult to the developers to sign PPAs with state governments.

Considering the advantages of hydropower, it is essential to consider policy in initiatives to encourage hydropower development without which honouring INDC requirement and ensuring Grid stability cannot be achieved.

3.5 Existing Policy Provisions in Relation to Hydropower Development

3.5.1 National Electricity Policy, 2005

National Electricity Policy, 2005 was notified by Govt. of India on 12.2.2015. The salient features of the policy are given below:

- The policy lays maximum emphasis on full development of the feasible hydro potential in the country which will facilitate economical development of States, particularly North Eastern States, Uttarakhand, Himachal Pradesh and Jammu & Kashmir.

- Since the hydel projects call for comparatively larger capital investment, debt financing of longer tenure has been recommended.
- The State Governments have been advised to review procedure for land acquisition and other approvals/clearances for speedy implementation of hydro projects.
- Full support of Central Government has been extended for hydel development by offering the services of CPSUs like NHPC, NEEPCO, SJVNL, THDC etc.

3.5.2 Hydro Power Policy-2008: Salient Features (Including Subsequent Changes)

Hydro Power Policy, 2008 was notified by Govt. of India on 31.3.2008. The salient features of the policy are given below:

- The cost plus Tariff regime (in which tariff is to be determined by the regulator under section 62 of Electricity Act, 2003) has been extended for public as well as private sector hydro power projects up to December 2015.
- Transparent selection criteria for awarding sites to private developers.
- Enables developer to recover his additional costs through merchant sale of up to a maximum of 40% of the saleable energy. 5% reduction for a delay of every six months.—Balance long term PPAs.
- For 10 years from the COD, developer to provide 100 units of electricity per month to each PAF—in cash or kind or a combination of both.
- Project developer assists in implementing rural electrification in the vicinity of the project area and contributes the 10% share of the State Govt. under the RGGVY scheme.
- Additional 1% free power from the project (over and above 12% free power earmarked for the host State) for a Local Area Development Fund,—regular revenue stream for welfare schemes, creation of additional infrastructure and common facilities.
- The State Governments would also contribute a matching 1% from their share of 12% free power.

3.5.3 Tariff Policy, 2016 (Portions Relevant to Hydropower)

- Intent of Government for promotion of HEP emphasised in the objective of the Policy—"*To promote HEP generation including PSP to provide adequate peaking reserves, reliable grid operation and integration of variable RE sources*"
- Renewable Purchase Obligation—Hydropower excluded from RPO (8% of the total consumption excluding Hydro power)

- Certainty of long term PPA for min. 60% of capacity, balance through merchant sale—Provision for extension of PPA beyond 35 years for a further period of 15 years
- Enabling provision for suitable regulatory framework incentivizing Hydropower Projects for using long term financial instruments—in order to reduce tariff burden in the initial years
- Depreciation—Developer shall have the option of charging lower rate of depreciation vis-à-vis the ceiling determined by CERC
- Exemption from competitive bidding extended up to 2022

3.6 Developmental Challenges Faced by Hydropower Developments

Development of hydropower involves works in multiple fields and most of them having their own constraint sets and priorities. The challenges have been categorized in terms of geography, discipline and policy frameworks at central and state level. Each of these challenges will require intervention for smooth progress of project planning and implementation process. However, the interventions have a one-to-many relationship with the challenges and the well-directed limited set of interventions can meet most of the challenges.

3.6.1 Regional Issues

Hydropower is primarily concentrated in Himalayan region of North and North-Eastern parts of the country and its neighbourhood. The problems faced can be classified as state/basin wise regarding their nature. The peninsular India, especially Western Ghats and other hilly areas, have different types of problems not reflected in the Himalayan region. The region-wise issues and suggestions are given below:

3.6.1.1 Peninsular Indian Region

- Rivers are all monsoon-fed and non perennial. Run-of-the-river developments not viable. Only storage based solutions can succeed.
  - Due to ever growing consumptive demand of irrigated agriculture, drinking water and industrial water, the hydro development has to tailor its generation policy as a second priority of operation.
  - Due to increase in demand, some of the dedicated hydro projects like Rihand HEP are under threat of converting to water conservation projects and lose flexibility of generation.

– A number of small falls are existing which can be exploited in an opportunistic way for augmenting generation on the same lines as that of wind power. However, they can supplement the irrigation pumping demand as the operation will be concurrent with the supply requirements. Canal head power houses are a solution to be explored.
– Most of the large plants in the region are about 30 years or more in age.

Re-assessment of the efficiencies and improvements to the old hydropower plants may be considered.

3.6.1.2 North-West (Indus Basin)

- Primary problem of clearance from international angle under Indus treaty. Long drawn processes and determination of disputes at international level requires long diligence and sustained interest.
- Accessibility problems to the site arising out of personnel security in the field and also remoteness of the sites (Ladakh).
- Only run-of-river development feasible on Western rivers of the Indus basin (Indus, Jhelum, Chenab). Backing by storage not feasible.
- Management of silt and conservation of reservoir capacity by draw down flushing constrained after Kishanganga judgement.

Strategic assistance to the developers to negotiate the Indus treaty obligations and litigations need be provided.

3.6.1.3 Ganga Basin-India (Himachal, Uttarakhand)

- Environmental concerns and lopsided presentation of priorities from environmental angle.
- Active judicial interventions leading to delays.
- Lack of debates and clarity on religious and political grounds.
- Strong linkage of the storage based hydro projects with water security and availability problems in Ganga and Yamuna plains covering Uttarakhand, Uttar Pradesh and Bihar.
- Inter-state issues particularly in Yamuna basin.

Active support required from the governmental and scientific institutions required in a co-ordinated manner to resolve issues in Uttarakhand as well as interstate issues

3.6.1.4 Ganga Basin-Nepal

- Strong needs of active international cooperation based on mutual trust.
- Entering into a competitive environment with China and other international agencies having separate developmental agenda.
- Environmental and sociological perceptions war.

Indian interests demand storage based developments in at least 5 locations namely, Pancheshwar, Karnali, Gandak and Kosi (SaptKosi-Sunkosi). These are vital for us to provide water security (quantitative and qualitative) to entire Ganga basin (53% of country), success of Inter Linking of Rivers programme and stabilising our issues with Bangladesh over Ganga waters

A focused thrust from foreign policy and strategy angle is needed for ensuring the lifeline resources for the country. At present, the coordination effort at the inter-ministerial level is project specific. For this purpose, Ministries of External affairs, Power and Water Resources need to work in a single standing group covering the entire developmental spectrum of international hydropower projects.

3.6.1.5 Brahmaputra Basin-Sikkim, Bhutan Region

- Relatively easy region from ease of development angle.
- Sikkim has only Teesta basin for development. Lower projects on Teesta in Sikkim are languishing due to various financial and technical reasons.

Needs govt. support after the massive earthquake induced damages and cost escalations

- Bhutan success story needs nurturing for at least 20,000 MW development in continuation with the present projects.
- Joint venture route in Bhutan needs ironing out so that the implementation can get off the ground faster.
- Technological soundness in designs and implementation to be ensured especially in joint venture projects to avoid complications at international level. Involvement of CEA and CWC highly desirable.

JV formation and technological soundness for Bhutan projects must be given priority

3.6.1.6 Brahmaputra Basin-Arunachal

- One of the most potent basin from hydro potential point of view and beset with maximum problems.
- Allotment based on PFRs prepared earlier need review for rationalising the project parameters in a cascade.
- Complete lack of technological capability for monitoring and mentoring at local level. Lack of data requires longer periods for investigations and planning and financial, technical and logistical support needed at this stage, which is not available presently from the state government or the central government.
- Accessibility from the road network angle requires additional time for investigation and mobilisation.
- Differing perceptions in neighbouring Assam leading to discouraging atmosphere for developers for mobilisation and cost of operation in a hostile environment for logistics. Need to set the dialogue on Arunachal development right in Assam by bringing various groups as well as the state government on board. Lower Subansiri is a test case to get off the ground. A joint mechanism of Arunachal, Assam and central government needed. Brahmaputra board unable to provide the same.
- Environmental concerns and lopsided presentations of the impacts of projects. Lack of a dialogue for solving the problems in a rational manner. Mentality of rejection has to give way to approach of accommodation coupled with strong monitoring mechanisms on the ground.
- Many of the developers have not yet started work on the projects and are attempting trading means to exit. Such squatters have to be identified and removed.
- Flood mitigation benefits to Assam through Arunachal Pradesh based projects has not yet been recognised as a part of development dialogue.
- Pro-active strategy for preserving water security for India against future diversions by China needs recognition from strategic angle and faster pace of development has to be ensured to cover the eventualities in near future of say 25–30 years.

- Water storage and management in Arunachal and Bhutan necessary for success of ILR programme in Southern India. Solution to the water disputes of Southern India lie in Brahmaputra water harnessed in Arunachal and Bhutan and the hydro development is the key to the solution.
- Joint mechanism involving Arunachal Pradesh, Assam and Govt. of India is required for resolving inter-state disputes. Need to bring the policy advocacy groups to table to re-orient the local opinions.
- Active involvement of expert agencies like CEA/CWC needed for consistent resolution of complex problems of technical soundness and national level policies.

3.6.1.7 Other North-East Region States

- Law and order problems hampering the investigations and planning.
- Though rainfall is copious, the monsoon fed rivers need storage based developments to succeed for year round generation.
- Long routes through Indian Territory for logistic support. Shorter connectivity can improve the development.
- Bringing Bangladesh on board with power trading for improving the *economic viability of the projects. Example being Tipaimukh project on* Barak basin.
- Complex geotechnical conditions require expert designs and implementation. Quality of solutions need be assured at CEA/CWC level.

3.6.2 Techno-economic Issues

3.6.2.1 Increasing Tariff Especially in Initial Years

As per prevailing CERC Regulations 2014, the tariff of the Hydro Project is determined based on Return on Equity, Depreciation, Interest on Loan, Interest on working capital and O&M expenses. Increasing tariff in the initial years is mainly due to (i) higher rate of interest on loan and (ii) short tenure (12 years) of normative repayment of loan, which results into higher rate of depreciation.

Hydro projects are typically capable of lasting for almost 100 years except for electromechanical components. However, a large part of the capital invested is for the civil structures like dam, water conductor system and power house civil structures. The civil components almost amount to 70% of the overall cost of the project. Most of the banks are unwilling to finance for a period more than 12 years. Though life of Hydropower Projects is much more than 50–60 years, the developer has to return the loan component in the initial 12 years of the project, leading to cash flow problems as the revenue realized is more than the cash generation. Recently, for the Ahmedabad-Mumbai metro project, finance has been arranged for a period of 50 years with initial deferment of loan for 15 years and with repayment period of 30 years besides the repayment period has been fixed for 30 years.

Though beneficiaries benefit in the long term due to very low tariff in the later stage, Discoms are reluctant to buy electricity from Hydrodue to high initial tariff in comparison to other sources of power.

3.6.2.2 Implementation Issues

The present method of project formulation is oriented towards the government department based implementation process. The process is capable of absorbing time and cost overruns due to the capacity of the government to manage them through internal means. However, such a capacity cannot exist in a commercial entity in private or public sector. The project formulation has to take this into account and come up with firm proposals.

- In case of underground works, the surprises in Himalayan terrain cannot be avoided. The EPC based model inherited from other thermal power projects needs change to manage these eventualities.
- The assurance of implementation of the soundness and safety measures built into the designs presented at the appraisal stage are completely lacking in the present mode of implementation monitoring. Since these projects have to be eventually be taken over by the state/central government, the soundness of implementation need to be monitored closely. Necessary mechanisms in governmental institutions like CEA, CWC and other bodies are required. At present, serious problems exist in the privately implemented projects which are not known at the governmental level.

3.6.2.3 Impact of Water Cess on Tariff (Pres)

Any water cess or electricity cess imposed by state Govt. or any other agency, increases the cost of electricity by that much amount. In addition to Water Cess charged by Jammu & Kashmir, Uttrakhand Govt. has recently notified Green Energy Cess @ 10 paisa/unit for electricity generated within state but transmitted to outside the state. Similarly, a water cess of @ 2 paisa to 10 paisa per cubic metre of water consumed in generation for projects having more than 5 MW installed capacity have been imposed with effect from 07.11.2015. These cess are over and above 1% additional free power being provided to home state recently in addition to original provision of 12% free power as royalty.

3.6.2.4 Impact of Cost of Enabling Infrastructure

Enabling infrastructure is required invariably in all the hydro projects on these are located in remote areas where adequate enabling infrastructure facilities such as roads, bridges etc. of the required capacity/size/dimensions are not available. As the

balance untapped hydro potential of the country is located in further difficult/inaccessible terrain, the expenditure on this account will be quite substantial for future hydro projects. Though there are huge economic gains due to hydropower projects, the same are not factored in the tariff.

3.6.2.5 Contractual Issues Especially in Cases of Geological Surprise

Howsoever elaborate the subsurface exploration is, the geological surprises cannot be avoided is a myth. With perfect planning of construction methodology as per investigation data, which perhaps requires substantial time and money, the geological surprises can be avoided. By giving more time and money for subsurface investigation works, deploying latest technology for comprehensive study of rocks and by using the latest geotechnical instruments and development during preconstruction and construction stage, the probability of geological surprises can be reduced. A contract document cannot foresee everything in advance and hence all provisions cannot be built in.

Further PSUs shy away from taking bold initiatives to resolve the issue from being blamed later for 'favour to contractor'. PSUs should be encouraged by Authorities—Administrative Ministry, CAG, Vigilance to take bold decisions transparently in the interest of project. This change in attitude/mind set can do wonders for expediting completion of hydro projects.

3.6.3 Environmental Issues

The national impact of offsetting hydropower by other means like thermal or gas has not been realised at the environmental policy level and impacts confined to the local area only are being considered giving a raw deal to hydropower vis-a-vis other means of bulk power generation. This is especially relevant in terms of climate change scenario and obligations of the country towards reduction in emissions. Environmental concerns and lopsided presentations of the impacts of projects and lack of a dialogue for solving the problems in a rational manner, are major impediments.

The MOEF clearances lack finality. The challenges to the clearances primarily raise the issues already covered in the clearance process. Reopening of such issues poses enormous challenges to the project after lot of investment has been made. New issues of environmental flows, longitudinal connectivity and lateral connectivity are brought into picture impacting the design and economics of the projects. At present, inter-ministerial consultations and also involvement of the expert agencies in formulation of these guidelines are lacking. The present clearance process has a disproportionate weight of non-governmental agencies and individuals which results in inconsistent decisions and victimisation individual projects. Unfortunately, the academic institutions are provided with disproportionate role in policy formulation

with little obligations towards facing the consequences of an idealistic decisions lacking in a holistic view. Some of the specific issues are highlighted below:

3.6.3.1 Cumulative Basin Studies

Cumulative Impact Assessment studies are being conducted by MoEF&CC as a policy decision. The basin studies are not getting completed within stipulated time thereby delaying clearances of individual projects.

Assessment of Environmental Flow: As per the standard ToR of MoEF&CC for hydropower projects, a minimum of 20% is to be released in lean season and 30% during monsoon. For remaining months it should be in between 20% and 30% based on site specific requirements. The quantum of e-flow specified (20–30%) would make many projects unviable. Further, in case of storage projects, releasing 30% inflow (during monsoon) into the river may lead to reservoir not attaining the full capacity at the end of monsoon. Some of the provisions especially, the free stretch of river of 1 km length, have been arrived at without wide consultations and also without a sound scientific basis. The recommendations are not fully relevant as a blanket provision and have also to be made site specific. Steep river stretches will not be able to be utilised optimally in view of these omnibus provisions.

The retrospective effect to the issues of environmental flows, longitudinal connectivity and lateral connectivity are impacting the design and economics of the projects. At present, inter-ministerial consultations and also involvement of the expert agencies in formulation of these guidelines are lacking.

3.6.3.2 Environmental Clearances—Timeframe and Processes

As per the EIA notification 2006, hydro projects up to 25 MW are exempted from the preview of Environmental Clearance (EC). Appraisal for Category A (>50 MW) is done by MOEF and of Category B1, B2 (<50 MW) are at State Level by State Level Environment Impact Assessment Authority (SEIAA) (with specified exceptions). However, the timelines are not being adhered to in case of most projects.

3.6.3.3 Forest Clearance—Timeframe and Processes

Forest clearance involves a two stage process having many steps. Further, The Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 is required to be complied by State Govt. for submitting the forest proposal to MoEF&CC for FC (Stage-I).

Site inspection is carried out at three stages by three different offices viz, DFO, CF and RO. Besides this, the proposal moves through many more offices. Even if the timeline is adhered to, it will take minimum one year to get Stage-I FC. On an average, 5 years are required to get FC Stage-I and Stage II. Many re-thinks on

the approvals accorded happen in the meanwhile, which render the process very unpredictable and time consuming.

Compliance by the State Govt. is required under the FRA, 2006 as prescribed by MoEF&CC for forest clearance. As per procedure, no objection certificate is required from various Gram Sabha/Panchayats after conducting public meetings in each Gram Sabha/Panchayat within the project area. The process of compliance under FRA 2006 is causing considerable delay in forest clearance.

3.6.3.4 Wildlife Clearance—Timeframe and Processes

Wildlife clearance is required for projects involving diversion of forest land for non-forest purposes involving part of National Parks and Wildlife Sanctuaries falling in and within 10 km of their boundary.

3.7 Allocation Issues

Different states in the country have different parameters as well as different terms and conditions of allocation of hydropower projects. There is no uniformity in either allocating or sharing the benefits. While some states like Arunachal Pradesh adopt a negotiated MOA route, the States of Jammu and Kashmir and Uttarakhand adopt competitive bidding route. The return back period is 35 years for J&K and Sikkim while it is 40 years for Arunachal Pradesh and Himachal Pradesh and 45 years for Uttarakhand. The free power to the state also varies from 12% to 30%. Equity participation varies from 0% to 26%. Non-refundable upfront premium varies from Rs. 1 lakh per MW to Rs. 20 lakh per MW to Rs. 5 crore per Project. In the state of Arunachal Pradesh, were the major chunk of hydropower potential lies, only 405 MW has been commissioned against projects allotted for over 45,000 MW. Projects allotted in Sikkim to private developers are getting stranded or becoming financially unviable.

3.7.1 Benefits for Hydropower (>25 MW), not at Par with Solar and Wind

Hydropower is a clean, green and sustainable source of power. Many countries such as **Norway, China, Sweden, Russia, Canada, Japan, South Africa, Turkey, Iran, Italy, some states of USA** consider hydropower as renewable energy, irrespective of the size of the project.

It is observed that in most of the countries there is no cap on generating capacity for classification as renewable. However, in our country, hydropower only below

25 MW capacity is considered as Renewable energy while Solar Power and Wind Power (of all capacities), which have higher GHG emissions and involve consumptive use of water are declared as Renewable Energy and given benefits like RPO, VGF and Exemption from royalty, taxes and duties, wheeling charges etc.

Small hydro plants of less than 25 MW are inherently costlier and may not contribute significantly in the capacity addition. By limiting the renewable category to 25 MW hydro plants, the benefits are getting passed on to the insignificant and costly source of power while large hydropower projects, which can contribute significantly and efficiently, are being denied these benefits. Therefore, generation from a large hydropower plant is least resource—intensive and involves least environment cost. However, there are concerns regarding large submergence involved in storage projects.

3.7.2 Hydropower Remaining Unpurchased During Load Shedding Even When More Expensive (3–4 Times) Diesel Generators Are Widely Used

It is observed that there are many occasions of load shedding in different parts of the country which is not clearly captured in the power demand supply statistics due to suppressed demand projection by the Discoms. During the period of load shedding, many users, mainly high rise buildings, telecom towers, commercial consumers, small industries etc. use diesel generators for continuing their activities unhindered. The average price per unit for DG sets generation is around INR 15/kWh which is way higher than the average tariff of INR 5–6/kWh for commercial and residential consumers in India. The arbitrage in this has allowed the polluting DG set industry to flourish at the same time not enabling hydropower, which is available @ Rs. 5–6 per unit. This is due to lack of mechanism of accounting or regulations which enable discoms to provide 24 $\times$ 7 power to these consumers at higher tariff for the period when they are otherwise unable to provide the power at the nominal tariff due to their economical and financial constraints. The regulator doesn't approve higher cost of power (based on the merit order) since the discoms don't account for providing power 24 $\times$ 7 to these consumers.

Hydropower, with its instantaneous start and stop capability, is best suited to meet peaking power requirement during these hours of load shedding. Moreover, a correlation exists between the higher demands in majority parts of urbanised and industrialised of India and the hydropower generation opportunities in the Himalayan region. Since the monsoon arrives by mid-May in these areas bringing in increased inflows and substantial generation opportunities, the rest of the country witnesses all day round higher demands due to air conditioning requirements, lack of consumptive water for thermal generation, pumping requirements for transporting drinking water supplies over long distances and pumping loads of agriculture operations for sowing and raising nurseries. The situation aggravates further during periods of late arrival of

monsoon and drought years. It is undeniable that the consumers, who use diesel generators at 2–4 times the cost of hydropower, would be keen to purchase hydropower than opting for more expensive power from diesel generator provided the delivery is assured. Since there are no provisions in the present regulations to provide power at a premium to willing buyers, the discoms resort to load shedding to cut their losses rather than make available hydropower at higher rates(but significantly lower than power from DG sets) than normal tariff.

Rampant usage of more expensive and environmentally harmful diesel generators (while much cheaper hydropower goes unpurchased) is happening due to lack of regulations/facilities that facilitate the discoms to sell power at higher tariff even when there are willing customers. There are large urban clusters especially the traditional markets in urban centres where such unregulated diesel generation creates serious issues of air pollution virtually making the environment un-breathable for the persons in the area. This hidden cost on environment is not being accounted for anywhere.

3.8 Planning and Investigation Issues

This is a most crucial phase for a water resources and especially hydroelectric project. Problems left out at the planning stage have a cascading effect on the future implementability and economic value of the project.

- Hydro projects almost always have a unique setup in the sense that it is not possible to change the project layout beyond a small margin from what is already indicated at the Pre-Feasibility stage.
- Many crucial investigations and field works are time consuming and difficult to complete in time. One that comes to the mind are the excavation of drifts (small exploratory tunnels) for dam and underground works. However, the development in absence of such data also leads to difficulties later on.
- Geological surprises are a reality in Himalayan terrain. However, the same cannot be a ruse for hiding the inadequate investigations and corner cutting measures.
- New guidelines provide for discussion of general planning schemes and also the investigations that will be required to be undertaken. The guidelines should also give the flexibility to the appraiser to extend the investigation times for completing some essential works before the Detailed Project Report is considered complete.
- Present system of investigations and planning is not oriented towards a Detailed Project Report on which the bankability of the proposal and risk costs involved can be based.
- The expertise available at the non-governmental level in the planning and development of the projects is lacking outside the government sphere.

3.8.1 Appraisal and Investment Decisions

The present appraisal system is generally carrying out its functions well but the issues of time delays need addressing. The collaborative approach, detailed in the foregoing para, should be implemented. At present, due to recent changes in guidelines, there are projects under appraisal which have been submitted outside the process in vogue now. Such projects are facing delays due to lack of field data and also recommended changes in design layouts but the same are being shown as pending against the appraising agencies. The construction technology and equipments have undergone a large change and the guidelines in these respects are quite old and require revamping. In case of hydropower, the structures, especially the dams and water conductance structures, have a strong linkage towards public safety and hazard mitigation. Such concerns cannot be linked to the finances or capacity of the project. The clearance waivers, in terms of capacity, have the potential of neglecting these concerns.

3.8.2 Long Term Commitments of Operation

By its very nature, a hydropower project, once implemented, can rarely be replaced or abandoned and hence an artificial time line for operation of the project should be avoided. At present, the individual developer considers its obligations are limited to 35 years which need be extended to at least 50–75 years or even 100 years as evidenced in case of existing projects in India and world over.

3.9 Interventions Required for Faster Pace of Hydropower Development

3.9.1 Policy Related Interventions

3.9.1.1 Declaring Hydropower as Renewable Energy

Keeping in view the advantages as well as concerns regarding hydropower projects detailed in this chapter and Sect. 3.7.1 above, the following hydropower projects, irrespective of size, be declared as renewable source of energy:

(I) All Run-of-the River Schemes with diurnal storage.
(II) All multipurpose projects catering to irrigation/drinking water supply/flood protection combined with hydropower generation.
(III) Storage projects where Energy Density is more than 2 MU per hectare of land under submergence.

3.9.1.2 Fair and Transparent Policy for Allocation of Hydropower Projects

Considering significant differences between policies in different states for allocation of hydro projects as detailed at Sect. 3.7 above, Govt. of India may provide a template for allocation of the projects for adoption by the state governments. The key parameters/issues to be addressed in the Policy template may include the following:

i. Amount of upfront premium per 100 MU of energy (instead of per MW)
ii. Amount of royalty (free power) on generation
iii. Percentage of free equity

The above parameters may be fixed as per the size, estimated cost of the project, load factor, tariff and overall viability the project. Further, the following also need to be considered:

(a) The central or the state government can take up investigation and planning through well directed funding preferably through a non interest bearing loan from National Clean Energy Fund to prepare bankable project proposals in the form of Detailed Project Reports and then take up a transparent bidding process for allocation to a competent bidder. The cost of investigations can be recovered from the successful bidder and restored in the clean energy fund. Spare capacities of specialised Central and State PSUs and expert organisations like CEA and CWC can be utilised for the purpose. This is considered all the more necessary as there are limited capabilities for sound planning and designs in the private sector, which can also be built up through a capacity building programme.
(b) The activities before the actual start of the construction work should be treated as pre-investment activities. Therefore, financial approval at this stage should be approved as pre-investment activities and not as original cost estimation.
(c) Obligation of the State Govt. to facilitate environmental and forest clearance/land acquisition be specified along with timelines for various steps for completing these procedures. Payment of upfront premium should be linked to these steps required for clearance. Graded penalty for delay at each step be specified.
(d) A review needs to be taken for the allotted projects which have not yet been taken up for construction and/or planning after the necessary clearances have been put in place. The agencies found operating in a squatter mode should be penalised. Further, the agency selection requires pre-qualification in terms of technical and managerial capability for executing a project of a specified size and nature. Categories in terms of size of structures rather than the installed capacity need be specified.
(e) Mechanism for taking back the project from the developer by the State Govt. with cost compensation to either parties, in case of unreasonable delays. To avoid such squatting, the projects can be reallocated through a transparent bidding process with adequate financial arrangements for accounting and compensating for the works already carried out.

(f) Projects of strategic importance may be reserved for Central and State PSUs, depending on their capacities.
(g) Agency should be given mobilisation time for investigation and planning looking at the complexities involved in setting up necessary logistical infrastructure at the site for investigations.
(h) An in-principle clearance is required to be made available to the agency pending detailed clearances in respect of the relevant aspects so that the risk of complete rejection of the proposal at the investigation stage gets covered.
(i) For projects in virgin areas, where site specific data is rarely available, the risk of failure, in the event of the project being found unviable, should be jointly shared between the government and the developer.
(j) Enactment of dam safety bill and similar other legislations in this area need be covered in the concession agreement.

3.9.1.3 Preferential Treatment for Environmental and Forest Clearances for Hydropower Projects Considering Emission Reduction

Considering the advantages of hydropower as detailed above and the concerns raised, it is essential that hydropower be given preferential treatment. While examining a hydropower project, due cognisance of its national and global beneficial impacts to the environment and ecology may be taken into account. Appropriately, the local adverse effects can be offset against the quantifiable national and global level benefits. Mentality of rejection has to give way to approach of accommodation coupled with strong monitoring mechanisms on the ground.

(i) Objective criteria should be fixed for acceptance/rejection of any forest/environment clearances. For example, 2 MU hydro energy would avoid about 1800 tonnes per annum Co2 from a thermal plant. This is equivalent to Co2 absorbed annually by 72,000 fully grown trees in 48 ha area of good forest. We may give preferential treatment for FC–I for hydroprojects generating more than, say 2 MU per hectare forest area. In such projects, construction should start at the earliest after depositing NPV, CA, CAT etc. on a lumpsum basis, say Rs. 25 lakhs per hectare, which can be adjusted later as per the actual calculation. Similarly, hydro projects (without irrigation benefits) generating less than 0.4 MU per hectare of forest land, should not be considered at all.
(ii) Considering the problems detailed above, there is a need to define the e-flow as per the site conditions. Alternatively, minimum be fixed as only 10%. The guidelines and controlling parameters should be fixed by involving the governmental expert institutions and should be based on the institutional wisdom rather than the individual opinion based approach followed by the MoEF&CC. Similarly, the present clearance process has a disproportionate weight of non-governmental agencies and individuals which results in inconsistent decisions and victimisation of individual projects.

(iii) The number of offices/processes involved in Environment & Forest Clearance should be reduced to time taken for clearances. There should be clear-cut demarcation between Environment and Forest Clearance—related issues.

(iv) In many states where the rights of forest dwellers are well established, FRA compliance should not be linked with Forest Clearance Stage-I. Further, a percentage of royalty (free power) may be earmarked for forest-dwellers.

(v) In States where most of the area is under forest cover and identification of degraded land for CA is difficult and time-consuming, dispensation of compensatory afforestation or other alternatives viz., identification of land for compensatory afforestation in other states/degraded forest land bank, may be considered.

(vi) The process of declaration of Eco Sensitive Zones around all protected areas (National Parks, Wild Life Sanctuaries etc.) may be expedited to clear the ambiguity regarding requirement of this clearance.

(vii) The qualification and experience of the members of EAC and FAC should be defined to get overall perspective and ensure equitable representation of all stakeholders. Roles of academic institutions as advisers has to be matched with the knowledge base and national view of the sector from the governmental institutions involved with ensuring water and energy security. Unfortunately, the academic institutions are provided with disproportionate role in policy formulation with little obligations towards facing the consequences of an idealistic decision, lacking a holistic view.

(viii) A special purpose vehicle (SPV) to implement the environmental safeguards and monitor the implementation of the embedded components in the construction of the project is desirable for the projects of 500 MW capacity and more. The SPV can draw funds from the project owner and be responsible for quality and time lines of implementation. Some cost can also be apportioned to the state out of free power component from the project. Such SPV can be created with necessary expertise and logistics for a cluster of projects in the near vicinity. The SPV will be especially useful in its monitoring role in issues like release of environmental flows and ensuring the fish migration aspects.

(ix) To avoid escalation of the Management of safeguards and provisions provided in the R&R policy and against environmental degradation and consequent long litigation processes, a grievance redressal mechanism for each project exceeding 500 MW installed capacity may be setup at the project site. The mechanism can be provided with adequate legal and financial powers so that small and medium level conflicts can be resolved at the site. In case of small projects, the mechanism can be on a shared basis by a cluster of near vicinity projects not crossing the state boundaries and the cluster not exceeding an aggregate installed capacity of 500 MW.

(x) The Govt. should take up the matter of land acquisition issue affecting the BRO road projects with the respective state governments. At appropriate level with a view to finding amicable and lasting solutions. They should also persuade the states which are endowed with hydropower to grant forest and wildlife clearance to BRO road projects more expeditiously and liberally as the time

bound development of many hydropower projects are dependent on the timely completion of these connecting roads

(xi) The BRO must make utmost efforts to expedite the execution pace of the allocated road projects. The Committee also recommend to the Govt. to consider the issue of augmenting the capacity of BRO or make provisions to allow them to engage private contractors for the time-bound development of these crucial projects, subject to stringent quality control.

3.9.2 Planning Related Interventions

3.9.2.1 Guidelines for Handling Geological Surprises and Natural Calamities and Risk Sharing Mechanism

In order to check the increase in time and cost due to geological uncertainties, a Geotechnical Baseline Report (GBR) may be incorporated in the contract for under construction projects. GBR provides the geotechnical details of the site in advance and proper planning done to mitigate the risks of geological surprises. Allocation of risk may be done between the owner and the contractor. Thus, the increase in time due to geological uncertainties may be minimized. Variation (time and cost) in geology from that given in the GBR may be payable to the contractor.

The following modifications and improvements are suggested:

(i) Deployment of appropriate technologies and simulation tools is required to minimize the effects of geological surprises.

(ii) The detailing at the DPR level has to quantify the risks at the present investigation level and build the same in the cost components as an insurance against the requirement and deployment of additional funds so that a probability based decision at the developer and financier level is possible.

(iii) To cut down delay in appraisal process, the strength of the appraising setup in CWC and CEA need be augmented. The constraint on CWC and CEA for taking up designs and planning of private sector projects may be relaxed.

(iv) CWC and CEA may be provided with individual senior level expert help for speedy decisions and resolution of differences.

(v) Resolution of the technical issues and the cost of additional investigations and planning need be built into the project financing so that the same can progress further.

(vi) Due to long hiatus in the field, the expertise and capacity for planning and design is under erosion. Revamping the same will be needed in step with other measures. Institutions like CBIP, NPTI and NWA can be involved in a systematic programme.

(vii) A safety and rehabilitation fund in form of insurance should be introduced for covering large cost repairs of damages either natural or due to inappropriate operation or due to ageing of the key structures.

(viii) Govt. should give utmost priority to research and development activities of hydropower and also explore the options of collaboration with advanced technologies in this sphere across the world.

Recently, a Committee was formed by the Ministry of Power, GoI for developing provisions/guidelines required for better contract management to avoid time and cost over-run in the implementation of hydropower projects. The committee submitted its report in September 2015. The conclusion of the Committee may be adopted by the CPSUs. The EPC model of contracts especially the ones involving the underground works and slope stabilisation aspects, is forcing the implementing construction agencies towards safety and longevity compromises. Flexibility in tender engineering and operation may be developed through wide consultations and implemented.

3.9.2.2 Formulate Mechanism and Amend CERC Regulations to Facilitate Sale of Hydropower to Special Category of Customers Willing to Purchase Power at Higher Tariff

In this era when reduction of carbon emission has become not only a moral/ethical issue but also a national commitment from India to the world, it is essential that regulations/mechanism be put in place that discourages the use of diesel generators and encourages hydropower which is clean, green sustainable and much more economical. This will need creation of a new category of consumers who are willing to pay higher tariff to ensure uninterrupted power supply. Such creation of special categories exists even now as in the case of Indian Railways.

With adequate mechanism, the discoms can generate extra revenue even after signing PPAs with hydropower projects at cost higher than normal tariff due to advantage of reliable power. There could be implementation issues in segregating feeders of these preferred consumers from other consumers who may not be willing to purchase such premium power, separate accounting of preferred consumers and also in strong day to day monitoring of power demand and supply. Considering the overall advantages the committee recommends the mechanism be put in place and regulations amended accordingly after extensive stakeholder consultation to facilitates the above arrangement of discoms providing power from hydro sources to customers willing to pay higher tariff (with provision for discoms to earn some percentage as profit for the sale of hydropower).

3.9.2.3 Local Community to Be Made Stakeholder

(i) Out of the 13% free power as royalty, at least 4% free power should be earmarked for local area. To enforce this, revenue received from the sale proceeds of 4% free power should be deposited in a separate joint account of Deputy Commissioner/District Administration and local project head. State Govt. may frame Policy for utilisation of this amount including direct cash transfer (say

1% free power revenue) to PAFs and forest dwellers. This will also help in expediting compliance of FRA, 2006.

(ii) Local Area Development Funds be created during construction of the project. In case upfront premium is charged by the government, at least half of the amount should be deposited in LADF to facilitate clearance process. During construction of the project, 1–2% of the project cost should be earmarked for LADF. This should be charged as per the annual expenditure of the project. This amount can also be in the form of loan, which can be adjusted against some portion of the 4% royalty to be received during generation stage.

(iii) Instead of outright acquisition/purchase of land, long term (99 years) lease should be considered. The annual lease amount, fixed initially, may be increased annually to account for inflation.

(iv) Local communities are often unaware of the diligences that have been put in planning and designs and are consequently influenced by the fear of unknowns leading to stalling of the projects. For this purpose, it is necessary that a capacity building and appreciation programme about the principles involved may be taken up at different levels of exposure to local opinion makers and affected population in general.

3.9.2.4 Guidelines for Monitoring Mechanism of the Projects

Post TEC of DPR, safety and soundness of the structures depend on the construction being carried out by the agency. Main cost and safety implications are concentrated in civil work of dam, water conductor system and power house. To check that construction being carried out is as per the concurrence granted by CEA, a proactive and neutral mechanism is necessary to safeguard the interest of the state. Similarly, it is also essential that generator, turbine and other major equipments are procured as per the concurrence of the CEA. Any deviation must be brought to the notice of CEA/CWC/MoP. This necessitates the requirement of a monitoring mechanism of the Projects at CEA/MoP level, separately for CPSUs and Private developers. The roles shall be as given below.

Monitoring for CPSU Projects (for MOU Finalization)

(i) 20% weightage should be given to construction project implementation.

(ii) Annual budgeted expenditure should be calculated on the basis of value of balance left over works and balance time required for the completion of the project.

(iii) IDC of establishment expenditure be excluded from the annual budget expenditure to arrive at the money spent on the actual work done at site. This expenditure forms the basis of target fixation and evaluation. Ten per cent weightage should be given to such evaluation.

(iv) Milestones should be based on the critical part analysis. Ten per cent weightage should be given to these milestones. Monitoring teams should certify these achievements.

Monitoring for Private Projects

(i) Monitoring team constituted the Ministry should monitor all the private projects financed by PFC, REC and public sector banks.
(ii) A fair assessment of the value of physical works done be made by the monitoring team as per cost cleared by CEA/CWC. It could give an indication of the extent of the deviation of actual expenditure being claimed by the developer vis-a-vs cost estimates. It will assist the lenders in fund disbursements. Lenders should share target set for the projects to MoP for proper monitoring.
(iii) Important aspects of safety of the structures, especially the storage and diversion structures, may be monitored by the teams constituted by the ministry and rectifications have to be ensured before the project is able to sell the power generated. Since Electricity Act specifically mandates the same, it would be desirable to have a standing mechanism involving CWC and other organisations.
(iv) Active handholding should be mandatory to avoid faulty planning and subsequent difficulties in clearance/implementation.
(v) A concerted approach involving the construction industry is needed for revamping the guidelines for construction technology and equipments by CWC/CEA.
(vi) Operational audit from this aspect by the appropriate governmental agencies can be brought in.

3.9.3 Tariff–Related Interventions

3.9.3.1 Measures to Reduce the Cost of the Hydro Projects

Considering the issues raised in Sect. 3.7.2 above, the following measures are recommended to reduce the cost of hydropower projects.

(i) Present method of cost plus regime for tariffs may be modified to discourage padding of costs of development.
(ii) Priority should be given to implement 500 MW and above capacity projects considering cost-effectiveness due to size.
(iii) Rate of depreciation may be fixed as per the life of the project. Life of the RoR projects should be specified as 50 years and life of reservoir-based projects be specified as 100 years.
(iv) Cost of enabling infrastructure be borne out of Clean Energy Fund or by the Central/State Govt. and should not be included in the cost of the project.

Further, in case that is not feasible, then cost of infrastructure development in particular river basin, should be shared by all the projects and not by the first project alone.

(v) Return on Equity should be linked to timely completion of the project with maximum ROE of 16.5% being applicable for projects completed as per schedule and reduction of 0.5% per year for each year of delay. Further ROE can be revised upwards after every 10 years to account for inflation.

(vi) There should be more categories of O&M Cost in CERC Regulations based on the size and type of the scheme (RoR or storage). For 1000 MW and above plants, the O&M Cost may be limited to 1% during 1st year.

(vii) Time of the Day (ToD) tariff regime needs to be implemented effectively so that the hydro generators are encouraged to improve performance of the hydro and pumped storage plants. With increasing generation from non-conventional sources, the measure will prove a boon for the coexistence of the thermal/nuclear and hydro plants and stabilising the grid.

3.9.3.2 Long Term Financing

Considering the issues at Sect. 3.7.2 above and also the fact that the hydropower structures last very long, a longer loan tenure will help in smoothening/flattening of tariff profile and help in reducing 1st year tariff for better acceptability by DISCOMs. Owing to longer time taken to repay the loan, the levelised tariff will tend to increase for any given rate for interest post commissioning. On the other hand, there is hardly any replacement requirements in respect of the civil structures which may lead to heavy capital infusion at a later date on this account. The CERC norms allow for increase in tariff due to O&M increase post refurbishment of E&M components. Some of the increase can be offset against the tariff increase on account of longer repayment period.

Further, as outlined at Sect. 3.7.2 above, it is desirable that on the same lines as for the Bullet train project in Gujarat, Ministry of Finance may come out with the long term financing instrument to finance the Hydropower Projects at cheaper interest rate.

3.9.3.3 Financing of HEP at Affordable Interest Rate

Considering the issues at Sect. 3.7.2 above, it is necessary that banks/FIs/LIC/Pension Funds/multi-lateral agencies like *World Bank, ADB* finance the Hydropower Projects at affordable rate, at least 3–4% less than the rate presently charged by them. In order to achieve the same, special status is required to be conferred to Hydropower Projects. It is also proposed that hydro CPSUs may be allowed to raise tax free bonds, long term capital bonds under section 54 EC of Income Tax Act etc. Development Financing Institutions like IFCL may be requested to have a special window for financing

Hydropower Projects in consultation with Ministry of Finance. **Reducing the rate of interest from 12 to 9.5% would reduce the 1st year tariff by about Rs. 0.45.**

3.9.3.4 Tax Holiday and Exemptions

Keeping a view the importance of Hydropower Projects, it is recommended that Tax Holiday under section 80I (A) of the Income Tax Act, 1956, be made applicable for 10 years for all Hydropower Projects including under implementation projects. This measure is being offset with the levy of minimum alternative tax. It is recommended that the MAT may also be removed for making the beneficial impact of the above recommendation. It is estimated that for a project costing between Rs. 8 and 12 cr. Per MW, exempting MAT would result in reducing the tariff by Rs. 0.20–0.30 per unit.

Some other measures being recommended are as follows.

- Re-introduction of Mega Power Benefits for Hydro Projects: Withdrawn in 2012. These included VAT and custom duty exemption on import of capital equipment; deemed export benefits accorded as per the EXIM Policy and exemption of sales tax and other local levies on supplies to Mega power Plants by the State Governments.
- Waiver/reduction in Advalorem Charges/Tax (LADF, Entry Tax, Labour Cess, Excise Duty, Work Charge Tax, CST, etc.) in respect of project equipment (construction, E&M, HM), steel, cement, etc. required for development of Hydropower projects.
- Service tax exemption to services used in relation to Hydro Power Projects
- Earlier section 10(23) g of IT Act, 1961 allowed for the exemption of tax on the interest income earned by the Financial Institutions (FIs) from Infrastructure projects. However benefit was withdrawn. The benefits may be extended for hydropower projects.

Further, last mile equity can be generated by securitizing the free power of states and the states can sell their share in power on cost plus tariff basis or as merchant power and loans can be raised against such future revenue streams which can be infused in the project. This will especially be useful for providing last tranches of funding to projects nearing completion and stalled due to financial reasons.

3.9.3.5 Exemption from Inter-state Wheeling Charges

Hydropower projects are generally located in North and North-eastern states which don't require much power. Therefore, it is essential to evacuate hydropower to other states. The current inter-state transmission charges are based on capacity (MW), disadvantaging renewable energy sources which have lower PLF. Solar and wind have lower PLF than hydropower and both these power sources have been exempted from transmission charges. Hydropower, which is also a clean and green source of power, should be at treated at par with solar and wind and therefore exempted from

the interstate Transmission charges. On the basis of annual projection based on total transmission charges paid in Q2 & Q3 of FY 2015–16 and the energy generation for the same period, the interstate transmission charges per unit works out to Rs. 0.59.

3.9.3.6 Deferment of Part of Free Power to State Governments

State government is to be provided 12% of free power as royalty from the hydropower project to be developed in the state. The state governments may, however, consider deferment of part of free power share for at least initial years of repayment of loan period since project developers face maximum repayment strains in the initial years of loan sanction. Such share can be retained at a later date by enhanced rates to compensate the deferred share in future. The policy on similar lines is being followed by Himachal Pradesh. This, being a state subject, can be finalised in consultation with the states.

3.9.3.7 Reconsider Policy of State Governments for Water Cess, Green Cess and Environment Cess

Free power at the rate of 12–30% is being provided to the state governments as per their respective policies. Additional cess increases the tariff of the hydropower. Environment cess charged by the Sikkim govt. impacts the tariff by Rs. 0.03–0.05. Water cess charged by Jammu & Kashmir impact the tariff by Rs. 0.44–1.10. In Uttarakhand, water cess impacts the tariff by Rs. 0.13–0.39 and green cess further increases the tariff by Rs. 0.10. One of the measures to reduce the tariff of the hydropower projects would be reconsidering the policy provisions of the state governments regarding their application of additional cess like water cess, green cess etc.

3.9.3.8 Extending Amortisation Period in 5–25 Scheme of RBI

During the last decade, commercial banks have become the primary source of long term debt financing to projects in infrastructure and core industries. Infrastructure and core industries projects are characterised by long gestation periods and large capital investments. The long maturities of such project loans consist of the initial construction period and the economic life of the asset/underlying concession period (usually 25–30 years). In order to ensure stress free repayment of such long gestation loans, their repayment tenor should bear some correspondence to the period when cash flows are generated by the asset. After factoring in the initial construction period and repayment moratorium, the repayment of the bank loan is compressed to a shorter period of 10–12 years (with resultant higher loan instalments), which not only strains the viability of the project, but also constrains the ability of promoters to generate fresh equity out of internal generation for further investments. As a result of these

factors, some of the long term projects have been experiencing stress in servicing the project loan. With a view to overcoming these problems, banks have requested that they may be allowed to fix longer amortisation period for loans to projects in infrastructure and core industries sectors, say 25 years, based on the economic life or concession period of the project, with periodic refinancing, say every 5 years. **As far as hydropower projects are concerned, the amortisation period may be considered as 50 years as almost all hydro-projects exhibit an economic life of almost 100 years**.

Adoption of hybrid PPP model for hydropower sector as done for highways, railways and Namami Gange projects: The hydrid PPP model wherein Government is to invest 40% (balance to be invested by the developer), may be considered for hydropower projects also as they fall in the similar category of long gestation period like other infrastructure projects included above. Further, land acquisition has to be completed by the Government before commencement of the project.

3.9.3.9 Hydropower Purchase Obligations (HPOs)

Hydropower Purchase Obligations (HPOs) on the lines of Renewable Purchase Obligation is being considered as a solution to promote hydropower. However, if the entire hydropower as outlined in para 8.1 above, the provision of HPO may not be required separately. However, considering the advantages of hydropower to meet peaking power requirement and spinning power requirement as explained at clause 4.1 and 4.2 above, it is recommended that hydro should be obligated as a fixed percentage of Wind and Solar to balance the grid and also a percentage of hydro should be made mandatory for spinning reserve and peaking power.

3.10 Summing up

The chapter has tried to examine various issues related to hydropower development in India and has highlighted issues that are plaguing the sector at various levels. It is felt that an eminently desirable source of power in respect of sustainability is being denied to the country due to various misconceptions based policy and planning interventions. It will not be possible to tinker with any one aspect and expect the sector to revive and take its pride of place in the development agenda of the country. Especially a consistent and global approach in terms of environmental and social assessments and finality of the decisions made is considered necessary for setting up a favourable investment and implementation scenario.

The oncoming threat of climate change induced adversities can be ameliorated by the active promotion of hydropower. If we miss the same now, it may be too late for the future.

References

The chapter contains results of an internal study carried out on behalf of Ministry of Power in 2016 for the purpose of promoting development of hydropower in the country. The information contained in the chapter was collected as part of this exercise from trade bodies viz hydropower producers association, Himachal Pradesh, ASSOCHAM, New Delhi and experiences gained as Member D&R and Chairman, CWC while dealing with various cases in Central Water Commission and Central Electricity Authority. The contributions made by various bodies is gratefully acknowledged. The assessments made and opinions expressed are author's alone and no endorsements of the same are claimed from the organisations involved.

Ashwin B. Pandya is Secretary General of International Commission on Irrigation and Drainage (ICID) and a former Chairman of Central Water Commission, New Delhi.

Chapter 4
Transboundary Water Sharing Issues in International and National Perspectives

Arundhati Deka, Vishaka Gulati and Anamika Barua

Abstract This chapter describes the parallels and interdependencies between inter-state water conflicts within India, and the transboundary ones with its neighbours, emphasizing on the Brahmaputra river basin. Water disputes in India are often more conflicted than the disputes at transboundary level. Despite that, there has been no or very little assessment conducted regarding how the decentralised and fragmented approach to water governance within India creates ambiguity over water ownership and leads to inter-state disputes, and also affects transboundary water governance. Although work has been conducted on degenerated federalism and an extensive amount of literature is available on its effect on different sectors—such as land, law & order and education—of interest here is the effect of state-based water resource management on transboundary water governance. Also, several Indian states tend to have significant influence over transboundary water governance, which sometimes leads to an additional layer of complexity. Views and sensitivities of the involved states have to be taken into account even as this extra layer of complication may fasten discussions or even prolong them. The chapter also looks at some of the concerned water policies (state and Central) and how they can possibly assist in effective governance and management of the resource. Also, introduction of a basin level organisation will be fruitful, given the intense politicking both at the state and transboundary level.

Keywords Brahmaputra · Inter-state · Water conflicts · Transboundary · Water governance · Inter-state water disputes

A. Deka (✉) · V. Gulati · A. Barua
Department of Humanities and Social Sciences, IIT-Guwahati, Guwahati, Assam, India
e-mail: arundhatideka91@gmail.com

V. Gulati
e-mail: vishaka.gulati@gmail.com

A. Barua
e-mail: anamika.barua@gmail.com

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4.1 Introduction

India has two major river systems—the perennial rivers (Himalayan network) and seasonal rivers (Peninsular network) with a total number of 25 basins and 101 sub-basins (India-WRIS 2012). Rivers like the Brahmaputra traverse through various administrative and political boundaries both within and outside the country (Jamil et al. 2012). It not only creates hydrological interdependence among the states (and nations) sharing the river but also encompasses several stakeholders having different interests, concerns and priorities. Hence along with the presence of varied interests (which are often conflicting in nature), a large number of individual rules and policies also exist at local, national and regional levels which gives rise to conflicting situations (Finger et al. 2006). Formulating efficient and equitable mechanisms for allocating river water across state boundaries has always been a legal and constitutional challenge as India is a federal democratic system, and therefore states have the authority over their water resources (Jamil et al. 2012).

The inter-state water disputes in India in fact have been on the rise in recent times. "Interstate water disputes raise deeper and morbid concerns in the light of the prophecies about future wars over water resources" (Chokkakula 2012). The livelihoods of the local communities are impacted when the disputes become frequent and deliberations become longer, causing insecurity among the people (Chokkakula 2012). Most studies concerning inter-state conflicts focus on the constitutional provisions for jurisdictions over water issues, or the legal aspects associated with India's water conflict tribunals. There is hardly any analysis present regarding hydro-politics involving the Indian states, which also relates to water interactions with China, Bhutan and Bangladesh. This chapter attempts to dwell on the parallels and interdependencies between inter-state water conflicts within India and the transboundary ones with the country's neighbours, along with the constitutional provisions for conflict resolution, particularly for the Brahmaputra and its tributaries. Interestingly, India has been able to negotiate with the riparian countries through treaties and other form of agreements, regarding river water disputes, comparatively better than resolving internal disputes within the federal structure (Paula 2015).

4.1.1 The Brahmaputra River Basin

The Brahmaputra River originates in the Tibetan Autonomous region of China (where it is known as the YarlungTsangpo) and traverses a distance of nearly 2,880 km. In India it flows through the north eastern states of Arunachal Pradesh as the Siang and Assam as the Brahmaputra before finally entering Bangladesh as the Jamuna. It is also joined by the four major rivers of Bhutan: Torsa (Ammochu), Sankosh (Punatsangchu), Wangchu (Raidak) and the Manas (IDSA Task Force 2010). Out of the total drainage basin area of 543,400 km^2, 270,900 km^2 falls in China, 195,000 km^2 in India, 39,100 km^2 in Bangladesh and 38,400 km^2 in Bhutan (Rai and Sharma 2016).

Throughout its course, the river plays an important role in shaping the social, cultural, economic and political aspects of the region. Within India itself, the Brahmaputra holds approximately 44% of the total hydropower potential, most of which has still not been harnessed (Jiang et al. 2017). Apart from that, the mighty river is of great cultural significance for the people of the region. For example, the Tani group of tribes inhabiting the lower and upper Subansiri districts of Arunachal Pradesh, gets its name from the river. Many of the local tribes in Arunachal Pradesh associate the river with agriculture, natural calamities and even spirits. The dependence of the local communities on river (for fishing and agriculture) is easily reflected through their culture, with many tribes of Siang-Dihang region possessing agricultural association with their religious festivals. Similarly, the Brahmaputra has been shaping the cultural, socio-economic and institutional arrangements within Assam. The legends have already mentioned the fondness of the Mishings (community from Assam) for the river, as settlement sites, and the importance of fishing for them throughout the decades (Bandyopadhyay et al. 2016). Therefore, the mighty river has been playing a very crucial role in shaping the overall structure of the society in both Assam and Arunachal Pradesh.

The purpose of this chapter is to provide insights into understanding the intricacies of water resource governance within India, which in turn would be able to provide insights into the management of transboundary waters. Reasons being, water disputes within India itself are more conflicted than transboundary-dispute; the hydro-politics between India, Bhutan and Bangladesh (less with China) have been comparatively cooperative when compared to water interactions between some of the Indian states. Also, domestic disputes tend to catch the attention of more political entities within India than the international ones. Indian states also have considerable control over transboundary water governance as water is considered to be a state subject. Finally, the philosophy that define water conflict resolution and water governance within and between the states, are also reflected in the country's approach to international water issues and subsequent deliberations (Paula 2015).

4.2 Constitutional Provisions: For Dispute Resolution

India has witnessed several inter-state river water disputes since its independence probably, and not all disputes have ended cordially, for example the major dispute between Karnataka and Tamil Nadu over the water resources of the Cauvery River still rages on. Inter-state water disputes have continued to aggravate, and have become a persistent phenomenon within the country. Part of the difficulty in India is the plethora of actors (state and central departments), and the complexity of the number of institutions present within which the various parties have to work to reach an accord. "Actors usually include state governments (further divided into professional politicians, political parties, and interest groups), central ministries, and the courts, and ad hoc water tribunals, setup to negotiate river water disputes within a rich institutional setting" (Richards and Singh 2002). There is a growing agreement among

the masses that the existing institutions placed to arbitrate disputes have failed to generate outcomes which could contribute towards economic development and national welfare (Richards and Singh 2002). It was the Government of India (GOI) Act of 1935 that drew attention explicitly to river disputes between one province and another or between a province in British India and a federated Indian state. The provincial legislative list included *"water, that is to say water supplies, irrigation and canals, drainage and embankments, water storage and water power"* (Jamil et al. 2012).

The relevant provisions in the present Indian Constitution are—Entry 17 in the State List, Entry 56 in the Union List, and Article 262. Entry 17 makes water a state subject but qualified by Entry 56 in the Union List. "It empowers the Union regarding the regulation and development of inter-state rivers and river valleys to the extent to which such control of the Union is declared by parliament by law to be expedient in the public interest". Whereas Article 262 grants right to legislate, to parliament explicitly over the issues that have been raised through Entry 56, and also provides it with pre-eminence over the Supreme Court (Jamil et al. 2012).

Instead of establishing River Authorities as bodies vested with powers of management, River Boards with only advisory powers have been created to deal with inter-state water disputes, so far. Article 262 states that "the Parliament, may by law, provide for the adjudication of any dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-state river or river valley. Notwithstanding anything in this Constitution, Parliament may by law provide that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in the previous clause" (Jamil et al. 2012).

The Parliament of India has enacted two laws under the above provisions—The River Boards Act of 1956 has been enacted for setting up of boards by the central government, at the request of the interested parties. And the Inter-State Water Disputes Act of 1956 which states that in case of a dispute, the affected State has the power to request the Central government to refer disputes relating to the use, distribution, or control of inter-state river waters for arbitration by a tribunal, which has been constituted under this Act. Additionally, if the Central Government concludes that the ensuing or ongoing water dispute cannot be settled through negotiation among the states alone, then also it can refer the dispute for mediation by a tribunal constituted under the same Act (Richards and Singh 2002).

The role of the tribunal would be to investigate the complaint and then forward the findings to the Central government through a report, known as an order or award of the tribunal. Within three months of submission of the order, the Central Government or the concerned State Government can approach the tribunal for clarification. The tribunal's decision would be published in the official gazette by the centre, and then the decision would be ultimate and binding on all the parties to the dispute. Neither the Supreme Court, nor any other courts have any jurisdiction over the water disputes that have been referred to a tribunal (Jamil et al. 2012).

This listing of water in the State List has given predominant role to the States in managing water resources. "It is argued that lack of uniform policy and synergy between the States lead to emergence and recurrence of interstate water disputes"

(Chokkakula 2012). This led to the belief that shifting water to the Union List would provide greater role to the Centre. These arguments however appear to be misinformed. The Entry 17 of the State List is subjective to the Entry 56 of the Union List, which has explicitly stated otherwise (stated above). In an extensive critique of this view, Iyer (1994) has argued that the Centre has never actually exercised its powers under the Entry 56 and has always let the States take the responsibility. It gave an impression that states have exclusive authority over the water resources. For instance, the provisions of the Entry 20 in the Concurrent List has mentioned that economic and social planning in a state would require clearance from the Centre, and for any development in the water resource sector—including the projects for irrigation, hydropower, flood control etc. (Chokkakula 2012). "Listing of water under State List cannot be a reason for emergence of interstate water disputes. It is the application (or lack) of available Constitutional provisions that is contributing to disputes" (Chokkakula 2012).

4.3 Transboundary and Interstate Water Conflict: A Brief Parallel Discussion

Sustainable management of water resources is as it is a complex process which involves achieving a balance between various environmental and socio-economic aspects associated with it (Hussein and Grandi 2017). It becomes even more convoluted with the involvement of two or more sovereign nations. The prevailing interstate water discord between Assam and Arunachal Pradesh over the Brahmaputra within India also has an effect on the transboundary water interactions taking place at the international level (i.e. with Bangladesh, Bhutan and China) (Paula 2015). Furthermore, transboundary waters are considered to be neither public nor private goods, rather they are seen as common pool resources (or collective goods). But it is challenging for the riparian countries to exercise their sovereignty collectively (IDSA Task Force 2010). Within South Asia, it has been difficult to reach an agreement between the riparian nations owing to the presence of multiple factors like power asymmetry, historical rivalries, zero-sum game attitude, lack of trust etc. (Varis et al. 2008; Barua et al. 2017). Among the four riparian nations of the Brahmaputra River Basin (India, China, Bhutan and Bangladesh), only bilateral agreements related to the river exist between the countries, although certain multilateral agreements do exist for issues like trade and connectivity (Price and Mittra 2016). Most of the bilateral arrangements that exist for the river have narrow scope and are often contentious in nature. The Simla Convention is one of the first legal agreements to be signed between the riparian countries of the basin. In order to negotiate boundaries between India and Tibet, a meeting have been conducted in 1914, which involved Great Britain, China and Tibet, and resulted in the recognition of "McMahon Line" that has been based on the natural boundary of the Brahmaputra watershed. The line which stretches from Bhutan to the Great Bend significantly shifted the border

north, thereby making India one of the riparians of the Brahmaputra Basin (Uprety and Salman 2011). But the treaty itself has been a source of contention between India and China, with China questioning the legality of the line (Shelvankar 1962). But there have been other bilateral treaties, involving India, which has performed well so far barring few hitches. For close to 50 years, Pakistani and Indian competition for the Indus water has been moderated by a relatively stable Indus Water treaty. In 2005, a disagreement between the two countries over India's construction of a hydroelectric project (Baglihar dam) on the Chenab River, Indus tributary, have been referred to a neutral third party by both Pakistan and India; the neutral expert's decision in 2007 has been considered final (Salman 2008). Water competition within each nation could unsettle stable relationships, as foreshadowed by the third party involvement. Therefore, the elements of both conflict and cooperation coexist among the riparian nations of the region.

4.3.1 A Comparative Analysis

When a river's natural course gets intersected by political and administrative boundaries, it induces an asymmetrical power relationship among the involved states. The upstream state would always be at an advantage, and in the case of transboundary waters, the upstream nation is always at a beneficial power position with the ability to mould discussions around the basin. The power affiliation is particularly more complicated in countries with a history of colonization, as the political boundaries have often been restructured. The reorganization of states in India has happened more than once and likely to happen again in the future, if trends are any indication. The reorganization of the boundaries of states did not just stop after 1956. River courses or resource distribution has not been prioritized, while delineating borders for the states, and this would not only create complications for the existing water sharing agreements among the states but also has the capacity to breed politically inspired contestations or conflicts (Chokkakula 2012).

The basis for reorganization of states in India after its independence has been through linguistic homogeneity. There have been other factors also responsible for reorganization, like, construction of social and political boundaries of us vs. them, and disputing of water sharing arrangements as part of political power plays triggered by say, change in political configurations or a 'vote bank' political strategy (Chokkakula 2012). This reorganization also applies to the riparian neighbour of the basin, Bangladesh, which used to be a part of India for a long time. "Historical and socio-culturally constructed regionalism is a reality and needs to be considered as an important dimension in understanding political geography of States in India" (Chokkakula 2012). Redistribution of shares is one of the major challenges posed due to reorganization of boundaries, as historical contestation regarding of ownership of resources is also involved both at the sub-national and international level. The asymmetrical power relationships discussed above can be a source of continuing political contestations. This asymmetry in power have massive influence over negotiations

and subsequently on water sharing agreements, often favouring the more powerful (Paula 2015).

"In comparison to interstate water disputes, literature about international water conflicts is far more comprehensive and inclusive" (Chokkakula 2012). India's river water governance is decentralised, as the states have principal jurisdiction over the administration of water within the state boundaries, rather than the central government (Cullet 2007). It is fragmented also because there are various authorities, departments and institutions that have responsibility over water resource management, and several laws that create multifaceted regulations regarding water resources (Lahiri-Dutt 2008).

The decentralised authority over India's rivers become ever more challenging, as the increasing demand for water directly contributes to the politics of federalism. The movement towards economic liberalisation (beginning from the 1990s and pacing up during the 2000s) has increased the competition and almost each state has become more conscientious towards attracting investment and funding their own development programmes (Hill 2008). Competition is thus one of the reasons for inter-state water conflicts in India. The subject of ownership is another cause for disputes. As Lahiri-Dutt has pointed out, "the question of ownership is posed at different scales: Between the state and communities in general, between the central government and respective states, and between local and state governments" (Lahiri-Dutt 2008).

As mentioned in the previous section, though the Indian Constitution has provided for the establishment of tribunals to resolve inter-state river water disputes, but in practice this has not given the central government any advantage or manoeuvrability over the states, as the decisions made would still depend on the people of the state and certain interest groups (Wood 2007). These tribunals have been partially effective in resolving disputes among the contesting states (Mohan et al. 2010). Without the presence of an effective mechanism or authority for adjudication, the interstate water disputes within India would also be left in a similar situation as the transboundary water disputes. Due to the radical nature of international law and conventions, transboundary water issues cannot be arbitrated by a higher authority, especially not in the Brahmaputra basin where no basin level organisation even exists.

Also, the intense domestic politicking over interstate water disputes within India distracts political attention from transboundary matters, failing not only to generate adequate awards for inter-state disputes but also failing to even initiate a dialogue at the transboundary level. This has significant implications for policies aiming to improve water cooperation in the basin, as it is not easy to bring together four nations (in case of Brahmaputra basin) when the concerned political entities are occupied serving their self interest regarding domestic issues. Domestic issues always tend to take priority over regional cooperation. As Dash (2008) has said, "Regional cooperation is a two-level process in which domestic support, and regional bargains and negotiations must overlap if cooperation is to proceed". Although according to hegemonic stability theory, lack of regional cooperation is due to the aspiration of India to prevent multilateral regional cooperation, being an upstream nation, domestic factors including political instability and nationalist interests intensify the conflict and also prevent cooperation (Dinar 2002). It also demonstrates that the political context must

always be considered while addressing water conflicts. Also, the intense politicking among Indian states generates a negative impression on the transboundary front as well: "that if India cannot manage its own domestic water conflicts, it will not be able to manage the international ones either" (Paula 2015).

Yet India's transboundary water relationships seem to be superior to the water interactions within Indian states. While there is an amount of basin wide coordination between India and its neighbours, like sharing of hydrological data with China during monsoon and hydropower development in Bhutan by India, no such understanding exist within Indian states. In fact there has been no support from the state governments of Assam, Arunachal Pradesh, and West Bengal for the creation of a basin level organization (Iyer 2007). And this poses as a challenge for the stakeholders who are working along the riparian nations to accord a policy change on a basin level.

Also, the existing legal laws and arrangements do not permit the involvement of non-state actors in the arbitration of inter-state water disputes (Chokkakula 2012). This is challenging because, as Iyer (2007) has argued, "any consultative, interactive approach to conflict-resolution must also be inclusive". A broader and inclusive stakeholder perspective is necessary for effective transboundary water governance in the basin but due to lack of regional cooperation and the absence of local (community level) and sub-national perspectives has continued to prevent sustainable development and management of water resources for livelihood improvement, food security, poverty reduction, and effective adaptation to climate change (Prasai and Surie 2013). Further, the relationship between the state governments and the central government is very negative: the mind-set prevailing is that one side's gain is the other's loss. "Increasing roles for Central institutions does not necessarily mean a whittling down of the powers of the states" (Mohan and Routray 2012). This may become an essential paradigm shift if India decides to embark on the Inter-Linking Rivers Project, as it will require India's central government to better manage and organize the states on water issues because of the vast amounts of water that will be moved among the states (Paula 2015).

4.3.2 Interdependencies

States are the most significant stakeholders in transboundary water interactions and it is important for them to be a part of discussions regarding river waters that flow within their boundaries, and how should they be managed. Even though there are various basin level platforms, the state representatives from the government are hardly ever found participating in them. The governance of the Brahmaputra basin is dependent on how the Indian states manage their water because the river water would flow through India, so the amount of water taken out or polluted within India, will also have effects downstream, i.e., for Bangladesh, and the amount of water that Indian states claim they need will require water-sharing negotiations with upstream China and Bhutan (Paula 2015).

The influence of the states is significant when it comes to transboundary water governance as international water-sharing agreements cannot be reached with the input of the central government alone, and the support of the relevant states is also vital, both during the formulation and implementation of policies. Sikkim and West Bengal have been able to prevent water-sharing agreements that the central government have negotiated with Bangladesh regarding the Teesta River, tributary of Brahmaputra, on the grounds that it did not allocate satisfactory amounts of water for Sikkim and North Bengal (Paula 2015).

The northeastern region of India has been a house to various issues associated with river basin management, which might have an impact on transboundary water governance. For example, Arunachal Pradesh has enormous hydropower potential on the fast flowing Brahmaputra River in the mountainous terrains. Around 150 dams have been planned to harness the potential of the river and enhance economic growth in the state, but they are having issues with the downstream riparian state of Assam, due to annual flooding and siltation (Paula 2015). While Arunachal Pradesh considers the development of hydropower to be economically beneficial for the state, it is believed that Assam is against the development of the state (may be due to historical social and cultural oppression of the state by Assam, along with economic blockades imposed on the state by Assam from time to time) and therefore opposes the construction of such projects (Baruah 2017). Dispassionate scientific and sociological dialogue is needed between the two states before progress in a mutually beneficial manner can be carried out. Once the internal plans are in place, Bangladesh can be approached for dialogue to bring it on board with an integrated management regime, having benefits for Bangladesh as well. But again there has been a long term dispute between Assam in India and Bangladesh regarding illegal migration of Bangladeshi citizens into the state, and whether they should be provided with permanent citizenship (Sharma 2012; Upadhyaya 2017). So instigating a discussion with Bangladesh also wouldn't be that simple.

The diversion of the Ganges from Farrakka Barrage to the Bhagirathi Hoogli river system, has been a major source of discord between India and Bangladesh. However, with Ganga treaty, the operation has become relatively smooth. Also, the Teesta river sharing has been a long standing issue between India and Bangladesh, especially due to the influence of the state of West Bengal. Negotiations have been going on since the 1950s, and have been mostly inconclusive. The state's Chief Minister, Ms. Mamata Banerjee refused to entertain the proposed agreement on water sharing in September 2011 between the central government of India and Bangladesh, wherein 50% of the river water would have been allocated to Bangladesh, during the UPA (United Progressive Alliance) government's term. Political equations override the water management concerns and feasible alternatives. Unless the political entities arrive at a harmony on the issue, the progress remain difficult. So domestic politics is substantially important in transboundary hydro-politics and negotiations as well, and it must be taken into account during international dialogues and while formulating policies (Prasai and Surie 2013).

4.3.3 Parallels

Apart from the influence of Indian states on transboundary governance for water, there are also several parallels between water governance within Indian states and basin wide regional water governance. These parallels would explore for possible policy approaches for water governance (both at state and regional level) as the strategies that have successfully worked at one level may work on another as well. Power asymmetry between actors and the broader political context matters significantly for both inter-state and regional context (Zeitoun and Allan 2008). Basically, the same political, military, economic and upstream power dynamics play out between Indian states as it does between India and Bangladesh. For example, Arunachal Pradesh does not favour the reorganization of the Brahmaputra Board (consisting of India's north-eastern states) because the new constitution may weaken its hegemonic power position (Paula 2015). "Negotiations over water are about 'horse trading' and the actors with the most issued power would always have the upper hand" (Paula 2015).

The same power dynamics also leads to this another parallel between inter-state and transboundary negotiation, i.e., to always favour bilateral agreement over multilateral. Bilateral cooperation tends to be beneficial for the powerful party. For example, upstream Arunachal Pradesh favours strictly bilateral collaboration with downstream Assam instead of supporting the construction of the more beneficial basin level organisation, as the authority to hold dialogues and negotiations, which the latter is proposing (Paula 2015). Similarly at the international level, India as a more economically developed nation tends to deal with Bhutan and Bangladesh in an exclusively bilateral way as well. Bilateral agreements have a tendency to work in the favour of the powerful, be it the upstream nation or the economically more developed nation. But if bilateral agreements are worked out with pragmatic approach, they also have the potential to generate lasting goodwill between the parties, like the execution of Land Boundary agreement, 2015 between India and Bangladesh on the status of erstwhile enclaves' people. Both the countries have already provided identity cards for citizenship to the erstwhile enclaves' population who opted to stay within the territory of the concerned state. Similar arrangements for development of hydropower between Bhutan and India has resulted in increased prosperity for Bhutan and corresponding peaking power benefits to India. In this context, the "win-win" situation is achieved without concerns of hegemony. Apart from conflict in sharing water resources, hydrological data, especially the consumption data, are not readily shared between Indian states, or between the riparians in the Brahmaputra basin. As Mohan (2010) has stated, "inter-state water sharing and conflict resolution is constrained by inadequate availability of information, as well as hardened regional identities and loyalties which stand in the way of sharing available data". At the transboundary level, there is no basin-wide knowledge base present and data in any form is difficult to obtain in this region. South Asian governments are usually suspicious of each other due to the history of geopolitical conflicts and it is very unlikely that data will be shared freely anytime soon (Behera 2002). Even when river valley projects are planned on the transboundary waters, the information is not shared by one national

government to the other and it is only through mass media reporting that such information comes to the surface (Singh 2008). Even within India, the detailed project reports on interstate rivers need clearance of CWC (Central Water Commission) and the same is not accorded till the other state government concurs with the same. There is indeed, always a fear in the basin that China would secretly plan to build mega dams upstream, which would possibly have adverse affects downstream with reduced availability of water. When there is no transparency in sharing information, such kind of "propaganda" news always keeps doing the round. Also, hydrological data is withheld whenever there is a political conflict among the riparians. For example, China shares hydrological data with India during the monsoon season every year, but they refused to share the data in 2017 as India has been in support of Bhutan during the Dokalam standoff. There is a lack of integrative thinking or planning when it comes to sharing of water or data, both at inter-state and transboundary level (Paranjpye 2010).

Bhutan is one of the upper riparian countries in the Brahmaputra River Basin and the constructive collaboration between India and Bhutan is seen as one of the best examples in terms of sharing of data and resources, especially within the developing world (Varis et al. 2008). In 1955, India's Ministry of External Affairs in order to improve the flood warning measures, established 19 rain gauge stations and 8 wireless stations in Bhutan which have been eventually handed over to its government. This commenced the bilateral cooperation between the two countries in the water sector (Yasuda et al. 2017). A Joint Group of Expert (JGE) on flood management exists between the countries which look into the probable causes and impacts of flood and erosion (India-Bhutan Cooperation, 2018). A Joint Expert Team (JET), comprising of experts from both Bhutan and India, has been established in 1979 and works towards the prevention of floods on shared rivers. Under the 'Comprehensive Scheme for Establishment of Hydro-meteorological and Flood Forecasting Network on rivers Common to India and Bhutan', 32 Hydro-meteorological/meteorological stations located in Bhutan are being maintained by its government with the support from India (Yasuda et al. 2017). Furthermore, the hydropower potential of the country is around 20,000 MW which if utilized efficiently and sustainably can foster its economic development (Varis et al. 2008). The India-Bhutan energy collaboration on papers is strongly based on the principle of mutual benefits that extend to overall security. A large number of Indian development assistance is targeted in the energy sector of Bhutan, with them receiving over 88%, amounting to Rs. 57 billion of all Indian grants and loans dedicated to the energy sector. The joint effort also illustrates that neighbouring countries can successfully engage in cross-border trade of electricity, and this unique opportunity can further facilitate diplomatic relations, generate substantial revenues, and bridge the gap between energy supply and demand (Tortajada and Saklani 2018).

Also, both inter-state disputes and transboundary conflict are driven by unsustainable demand for resources from the river basin. Supply of resources creates more and more need, creating demand for the concerned resources and thus generates necessity for more supply (Iyer 2010). But water governance at all levels is controlled by the concern of the supply side, just as much as it is controlled by the various disciplines of

engineering (Routray 2010). The proposed river interlinking project, where the water from the Himalayan Rivers has been planned to be transferred to the drier regions of the south, is one such example in India (Iyer 2007). Even at the transboundary level, the discussion for basin management has always been technical, dominated by the perspectives from civil engineering, economics and international laws and conventions, leaving little or no space for discussion from a social perspective (Prasai and Surie 2013). This can highlighted by the fact that state and even non-state actors at times tend to promote hydropower development as green and sustainable source of energy, both within the nation and at the transboundary level, leaving little space for a holistic plan for development (Paula 2015).

Starting from the 1961 agreement for the construction of Jaldhaka hydropower project, a number of such agreements have been signed between India and Bhutan (Yasuda et al. 2017). According to an agreement signed in July 2006, India has agreed to assist Bhutan in the development of at least 5,000 MW of hydropower by 2020 and to import the extra electricity to India. The agreement has been later revised in 2009 and the capacity of hydropower development has been increased to at least 10,000 MW (Premkumar 2016). The cooperative relationship between India and Bhutan is based upon the 1949 'Treaty of Friendship' signed between the two countries (it was further updated and renewed in 2007). Although the treaty is not related to water resources directly; but formed a basis for joint hydro-power development on various tributaries of the Brahmaputra River. The hydropower sector has undoubtedly benefited Bhutan's economy through generation of national revenue but the sector is currently facing a multitude of problems, particularly of economic nature. The environmental assessments are done at a much later stage in the project cycle, which has "reduced regulatory processes, impact analysis, and consents and clearances from ministries to become inconsequential proceedings" and the National Environment Commission of Bhutan lacks the institutional capacity to discharge its responsibilities effectively, given the scale of proposed hydropower development in Bhutan. There is minimal access to basic information relating to the agreements and hydropower projects implemented with assistance from India (Premkumar 2016). Moreover, India has a substantial influence over the terms of trade and is always in the favour of bilateral negotiations and develops different approaches to deal with each of the riparian nations, leading to suspicon at times (Yasuda et al. 2017).

Both within the states and transnationally, it has been witnessed that the social and environmental impact reports are usually not made public, especially to the concerned communities (Barua et al. 2017). Apart from Bhutan, the hydropower that north-east India is expected to produce is meant almost entirely for use elsewhere, but the locals are hardly made aware of the plans (Baruah 2017; Premkumar 2016). Potential adverse impacts of large hydropower projects on the natural environment and people are usually not discussed during consultative meetings or public hearings (if they happen) with community, only the benefits and the potential construction of basic infrastructure such as roads, health facilities and schools, would be conveyed. The planning of these projects would require more transparency at all levels, in order to prevent future conflict (like between Assam and Arunachal Pradesh for the construction of dams) as addressing environmental and social issues associated with

large-scale hydropower development will be a major challenge in the coming years. The countries involved need to become more accountable and ensure dissemination of basic information, and call for discussion for better sharing of the benefits of the projects, within India and regionally (Premkumar 2016; Ahlers et al. 2015).

4.4 Conclusion

It is significant to understand the inter-state water conflict dynamics, politics and existing policies, and how they are negotiated to be able to initiate the same process in transboundary water governance (and vice versa at times), as there are no set of binding rules for the same and international law is quite anarchic. India's domestic water governance policy is decentralised in nature, and due to such kind of fragmentation there is an uncertainty over water ownership, which leads to inter-state disputes. Though tribunals are in place to adjudicate these disputes, at times they have failed to ensure appropriate implementation or delivery of the awards due to the absence of adequate institutions some times, and tribunals and their awards can also be undermined by jurisdictional conflicts with the Supreme Court.

Transboundary water issues just cannot be resolved by just introducing a higher authority such as a basin wide organisation with representatives from each riparian nation and respective states within the sub-national level, as both transboundary water disputes and India's interstate ones are subjected to intense politicking. However, domestic water issues tend to divert political attention away from transboundary governance issues in India. Also, the amount of control the states have over transboundary water governance is at times at odds with India's central government and necessitates that the riparian nations also communicate with the states while resolving any basin level issue. It increases the layer of political entities in turn. Also, though water is a state subject, the central government needs to take on a greater role, which has already been facilitated by the constitution. Unless the centre takes larger responsibilities, the river basin organisation would never see the light of the day, nor would it function very integrally even if the organisation is created.

Willingness to share data and resources need to take larger precedence both at the state and transboundary level. This could be the beginning to initiate a basin level organisation, binding both the states and the nations. Multilateral dialogues should be initiated by the hegemons as well, as it would play a significant role towards bringing a basin level coordination, and assist in working towards common issues, like flood and disaster management (India and Bangladesh being subjected to annual floods) more effectively. The hegemons of the basin, be at the sub-national or transboundary level, should act as a basin leader and level the playing field instead of working only towards their own profit. Rivers are not confirmed by boundaries and efficient resource management and sharing would require the cooperation of all the riparians. But most of the time, the demand for resources are only met by the supply-side solutions. Also, the global discourse needs to shift from hydropower and

engineering perspective to a more holistic deliberation, taking into account the lives and livelihood of the communities living along the river.

Therefore, the role of states in water governance across the borders cannot be ignored. While setting up dialogue with the riparian nations, views and sensitivities of the involved states has to be taken into account. This extra layer of complication may fasten the discussions or prolong them. Though India may not really support the idea of a basin level organisation, at least at the initial stage, since it would imply the commencement of a multilateral dialogue, but there are also policy makers who are interested in generating an institutional approach to transboundary water governance and making the management of water resources easier and smoother by cultivating positive attitudes toward water sharing.

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Arundhati Deka is a Research Associate at Department of Humanities & Social Sciences, IIT-Guwahati in Assam. She has a M.Sc. in Environmental Studies and Resource Management. Her research interests lie in water science, policy and governance; socio-hydrology and gender; and water, food and livelihood security.

Vishaka Gulati is pursuing her Ph.D. in Development Studies from Department of Humanities and Social Sciences, IIT-Guwahati. She holds a Master's degree in Climate Science and Policy. Her research interests include power and water governance, livelihood security and climate change vulnerability assessment.

Dr Anamika Barua is an Associate Professor at Department of Humanities and Social Sciences, IIT-Guwahati in Assam. She has a Master's in Economics and a PhD in Ecological Economics from School of Earth and Environment, University of Leeds, UK. Her research interests include socio economic vulnerability to climate change, water and livelihood security, ecological accounting and water governance.

Chapter 5
Multi-stakeholder Engagement for River Rejuvenation

Robert Alexander Speed, Suresh Babu, Nitin Kaushal, Romit Sen, Arjit Mishra and Mohammad Alam

Abstract Rivers have been a major source of water. River basin is considered as the basic hydrological unit for planning and development of water resources. The discourse on river basin management has developed over time in response to the changing demands placed on river systems by societies, and the changing conditions of rivers. WWF India has been working across important river systems in the country with the aim of making river systems healthy, rich in biodiversity and providing long term water security to communities, businesses and nature. The chapter outlines the efforts undertaken as part of the Rivers for Life, Life for Rivers programme of WWF India, to develop a basin management plan for the river using a hybrid top-down and bottom-up approach, engaging with various stakeholders in the Ramganga river basin. The process of developing the basin plan involved making decisions over the different uses and demands for water resources and associated systems within the Ramganga basin. The basin plans outline measures for developing, protecting and harnessing the resources of the Ramganga basin in order to achieve water demand of different uses while ensuring health and safety of the river itself.

R. Alexander Speed (✉)
Badu Advisory Pty Ltd, Brisbane, QLD, Australia
e-mail: robert.speed@baduadvisory.com

S. Babu · N. Kaushal · R. Sen · A. Mishra · M. Alam
Rivers, Wetlands and Water Policy Division, WWF India, New Delhi, India
e-mail: suresh@wwfindia.net

N. Kaushal
e-mail: nkaushal@wwfindia.net

R. Sen
e-mail: rsen@wwfindia.net

A. Mishra
e-mail: arjit@wwfindia.net

M. Alam
e-mail: malam@wwfindia.net

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Keywords Ramganga · River · Basin plan · Water uses · Multi-stakeholder platforms

5.1 Introduction

Water has defined the survival and growth of the Indian civilization. The civilization came up on the banks of rivers and our existence and progress has been impacted by the availability, use, misuse and governance of water. India has 4% of the world's renewable water resource supporting 17% of the global population. In terms of per capita water availability India ranks 50th in the world. Rivers have been a major source of water. Despite an increasing trend of groundwater usage, rivers continue to remain an important source of water. River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20,000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. There are 46 medium river basins with catchment area between 2,000 and 20,000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature which covers about 81% of the geographical area of the country.

With increasing spatial and temporal uncertainly in water availability, frequent hydrological extremes manifested in form of floods and droughts, deteriorating water quality and low water use efficiency, the stress on water resources is increasing. If we are to meet the development and economic growth needs managing water resources will be important. If challenges facing the water sector are not addressed, water will increasingly be limiting factor in economic growth in many sectors and in reduction of poverty and improving human well being.

The discourse on river basin management has developed over time in response to the changing demands placed on river systems by societies, and the changing conditions of rivers. The first attempt to manage the hydrological cycle in a coherent way was undertaken in China about two millennia ago. The concept of the river basin as a unit of management became more widely established in the middle of the nineteenth century. It was the massive water resources infrastructure development that took place across the world between 1920 and 1970 that ushered in a phase of 'water resources development planning'. At the core of these initiatives was the view that river basin planning is primarily a technical activity that can be undertaken by engineers, with the objective of optimizing the benefits derived from infrastructure development and operation. During the 1980s and 1990s it became evident that engineering solutions were no longer adequate to address the multifaceted problems of river management, particularly the trade-offs between competing interests and values that relates to the river holds for every user.

WWF India has been working across important river systems in the country with the aim of making our river systems healthy, rich in biodiversity and providing long term water security to communities, businesses and nature. As part of this programme, WWF India is focusing on the Ramganga, which is over a 650 km long

river, originating in Chamoli district of Uttarakhand and joining River Ganga in Hardoi district of Uttar Pradesh. Over 70% of the main river stretch flows through various district of Uttar Pradesh (Bijnor, Moradabad, Rampur, Bareilly, Shahjahanpur and Hardoi).

WWF-India jointly with various partners is engaged in several initiatives cutting across four pillars, with an aim to restore the ecological health of the river. These include:

- Environmental Flows (E-Flows) assessment for River Ramganga and a framework to demonstrate E-Flows in a stretch of Ramganga. Recommendations for rationalization of water allocation priorities in the state of Uttar Pradesh to integrate E-Flows.
- Habitat and biodiversity conservation for three species- Gharial, 3 species of freshwater turtles, Ganga River Dolphin and Golden Mahseer) in critical stretches of Ramganga.
- Reducing vulnerabilities of people through adoption of climate smart agriculture and water management practices in over 40 villages in the Ramganga basin and enhancing its base flows.
- Working with the urban local bodies and industrial units to reduce their water footprint and its impact onto the Ramganga river system by adopting water stewardship approach.
- Facilitating institutional platforms for multi-stakeholder engagement in basin governance through the formation of mitras-friends of the river. Development of community based tools like river health protocol for promoting constructive engagement of stakeholders.

The paper outlines the efforts undertaken as part of the Rivers for Life, Life for Rivers programme of WWF India, to develop a basin management plan for the river using a hybrid approach of top-down and bottom-up, engaging with various stakeholders in the basin.

5.2 Ramganga Basin

The Ramganga River (also referred to as the Western Ramganga) is a spring fed river and the first major tributary joining River Ganga. The source of the river is located at an elevation of 3,110 m above sea level and from its origins there, in the Central Lower Himalayas within the state of Uttarakhand, the river descends through the Corbett National Park and onto the Ganga floodplains (Fig. 5.1). A monsoon-fed system, the river flows approximately 665 km, predominately in a southerly direction until it joins the River Ganga at Tehra Ghat village in Hardoi district of Uttar Pradesh. The basin has an area of approximately area 24,459 km^2. This represents around 8% of the total area of the Ganga Basin.

The basin is home to a population of around 16.8 million people, many of whom are dependent upon groundwater-irrigated agriculture. The average annual surface

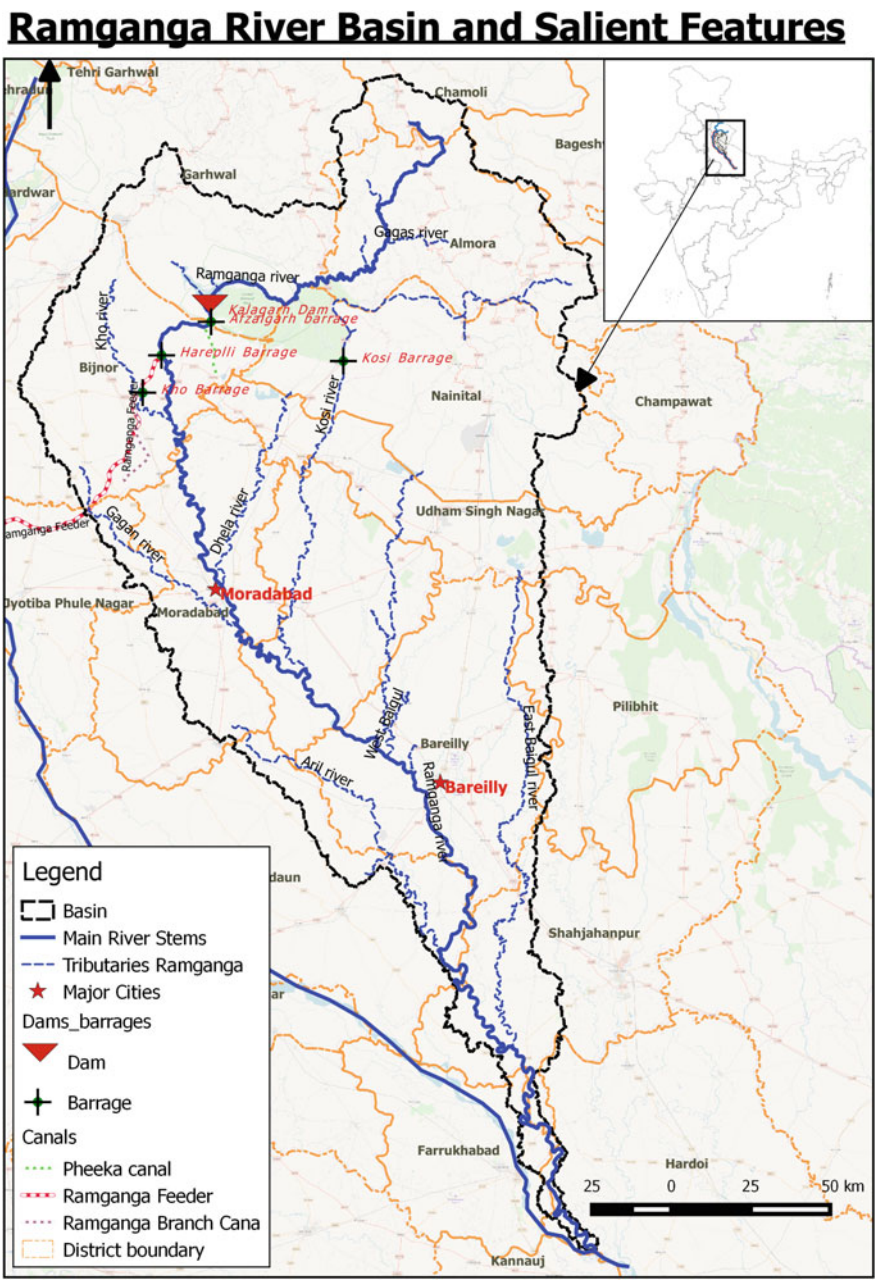

Fig. 5.1 Map of Ramganga Basin. *Source* WWF India

water potential of the Ramganga is about 11.2 billion m^3 (BCM), which is 3% of the total water resources of the Ganga. The mean annual regulated flow at the basin outlet is around 6.3 BCM. The total renewable groundwater resource in the basin is approximately 6.2 BCM, and around 73% of that resource is presently abstracted, with groundwater taken both for irrigation purposes but also to supplement or replace domestic water supply systems.

The average annual rainfall in the basin ranges from 2,200 mm in the higher, northern parts of the basin to 800 mm in the south. The western parts of the basin receive more rain on average than the eastern parts. While some of the river flow is a result of snow melt during the hotter months (April–June), most rain falls during the monsoon period from July to October. Flows in the river are highly influenced by the monsoon, with around 80% of the total surface water flow recorded during the monsoon months (15 June–15 October). At the same time, more than 70% of the annual sediment load is transported during monsoon months.

The basin is dominated by an agrarian economy, with most the population engaged in agriculture or related activities. Wheat and rice (paddy) are the dominant crops, with sugar cane also significant in some districts. The basin includes 15.53 lakh hectares of cultivable land. Of that, 7.25 lakh hectares is within the canal command area, and approximately 3.52 lakh hectares is irrigated by surface water on average. The area under irrigated agriculture is approximately 14,660 km^2 while rain-fed agriculture is practiced under 431 km^2. Of the area under irrigated agriculture, around 21% uses only surface water, while the balance involves a mix of surface and groundwater.

There are approximately 35,000 industries located along the Ramganga River, and more than 30,000 of these are metalware industries in Moradabad. Other industries include those involved in the production of chemicals, fertilizers, paper, pulp, textiles, and leather (INRM 2014). These industries rely on groundwater for their water needs. As at 2001, industrial users accounted for only 1% of water demand, although they are expected to account for up to 9% by 2050.

5.2.1 Water Use in the Basin

The main-stem of the Ramganga and its tributaries are highly regulated with dams, barrages, and weirs, much of which is designed to support a large irrigation canal system (see Fig. 5.2). The infrastructure includes works to support inter-basin water transfers (i) from the Ramganga to the Ganga basin and (ii) from Sarda basin to Ramganga basin. The largest of the water supply infrastructure is Kalagarh Dam. In addition to the Kalagarh Dam, there are a further 10 dams, 9 barrages, and 1 weir within the basin, which supply approximate 0.44 BCM per year and are primarily used for irrigation.

In addition to the existing infrastructure, a new barrage is currently under construction at Bareilly and a further 20 projects are proposed, all in the upper reaches of the basin, located within Uttarakhand (National Institute of Hydrology, 1998–99).

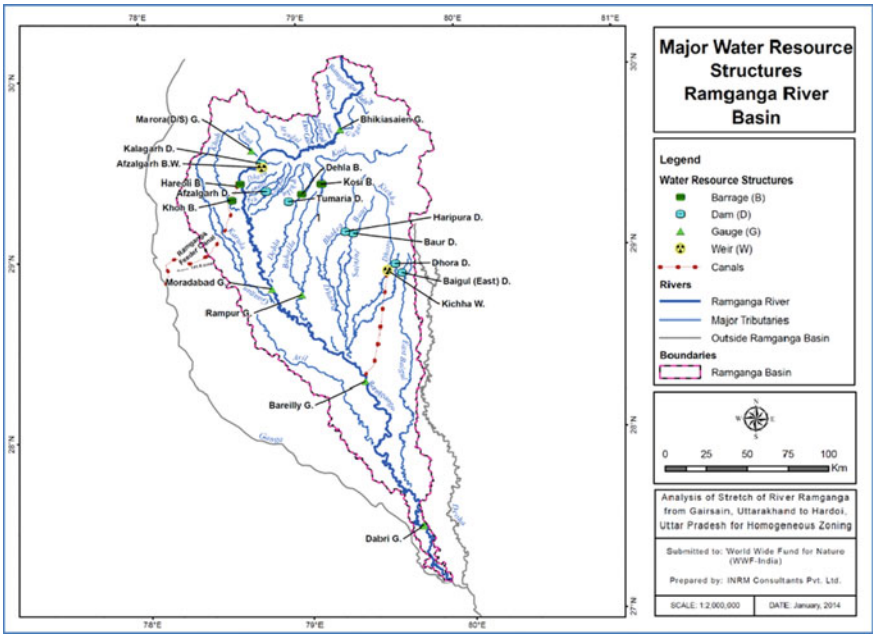

Fig. 5.2 Major water resources structures in Ramganga Basin

The status of many of these projects is currently unclear, and it is uncertain how many of them are likely to proceed. While relatively small, these projects pose a significant risk to connectivity along the river.

Total groundwater available in the basin is approximately 5.64 BCM, of which around 73% is used annually. More than 90% of the groundwater abstracted is used for irrigation, although demand for groundwater for urban and industrial purposes is expected to increase by around 50% by 2025.

5.2.2 River Health

River health in the basin deteriorates significantly from upstream to downstream. While some of the upper reaches of the river are in near pristine condition, much of the lower reaches are in poor health, and several sites have been classified as "degraded" by an expert scientific panel (see Table 5.1).

Table 5.1 River health along River Ramganga

Site	Remarks	Category
Bhikiasain	• Natural water quality • Insignificant contamination	Near pristine
Marchula	• Natural water quality • Insignificant contamination	Near pristine
Afzalgarh	• No industrial pollution • Very low input from agricultural and domestic influence indicated by nutrient, coliform, TDS/chloride levels	Slightly modified
D/S Hareoli	• No industrial pollution • Very low input from agricultural and domestic influence indicated by nutrient, coliform, TDS/chloride levels	Slightly modified
Agwaanpur	• Industrial, agricultural and domestic pollution • Indicated by nutrient, coliform, TDS, and pesticide levels	Moderately modified
Katghar–Moradabad	• Industrial, agricultural and domestic pollution • Indicated by nutrient, coliform, TDS, and pesticide levels	Degraded
Chaubari–Bareilly	• Industrial, agricultural and domestic pollution • Indicated by nutrient, coliform, TDS, and pesticide levels	Degraded
Dabri	• Industrial, agricultural and domestic pollution • Indicated by nutrient, coliform, TDS, and pesticide levels	Degraded

5.2.3 Water Abstraction and Use

Of the factors that contribute to the poor health of the lower reaches of the basin, one of the most notable is the over-abstraction of surface and groundwater. Water infrastructure development in the river has reduced flood risks and moderated flood damage, but it has also significantly reduced flows downstream, which in turn has impacted on the river's assimilative capacity and overall ecological health.

Diversions from the Afzalgarh dam and other barrages have left the river dry for more than half its length. This has contributed to ecological degradation and high levels of pollution. More than 80% of the mean annual runoff is abstracted. During the dry season as much as 90% is abstracted. Most of this water (more than 90%) is used for irrigation, although water use efficiency is relatively low, estimated at 20–30%.

Over abstraction of groundwater is also a significant issue. Most of the surface water that is diverted for irrigation is used outside of the basin. However, local irriga-

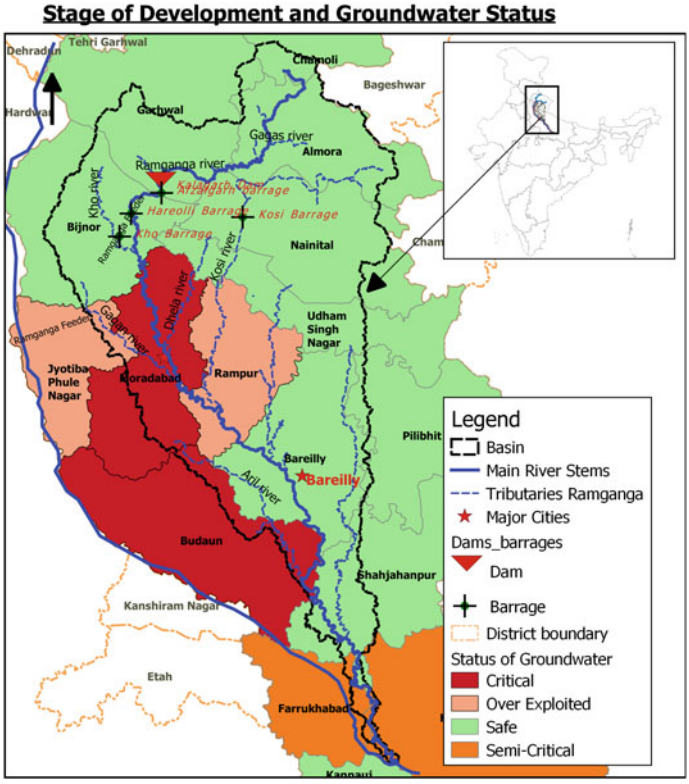

Fig. 5.3 Level of groundwater development in the basin

tion also has a significant influence on river health due to its reliance on groundwater, with excessive groundwater abstractions affecting river flows because of the reduced recharge into the river system. Approximately 12.5% of the basin is categorized as groundwater stressed (see Fig. 5.3), with most groundwater taken for irrigation. Increased intensity of agriculture is resulting in increased groundwater abstractions.

While most groundwater is used for agriculture, urban growth is putting localized pressure on groundwater resources. Cities in the basin are dependent on groundwater and the population growth, coupled with limited urban water supply systems and poor regulation has resulted in over abstraction in a number of cities.

5.2.4 Water Pollution

Both point and non-point source pollution have contributed to poor river health in the Ramganga. This includes:

Table 5.2 Wastewater generation from Class I Cities in the Ramganga river basin

Class I City	Wastewater generation (million litres per day, MLD)
Haldwani	21.6
Bareilly	171.2[a]
Moradabad	133[b]
Shahjahanpur	49.11
Rampur	46.4
Sambhal	30.15
Amorha	7.2
Badaun	24.2
Chandausi	17.1
Hardoi	18.54

[a]City Sanitation Plan. Moradabad and Bareilly are the only two cities which have City Sanitation Plan. Hence those two have been referenced separately
[b]City Sanitation Plan for Moradabad

Table 5.3 Status of industrial wastewater generation in Ramganga basin

Category	Number of industries[a]	Wastewater generation (MLD)
Chemical	2	4.8
Distillery	9	13.2
Food, Dairy and Beverage	1	0.5
Others	2	12.4
Pulp and Paper	35	135.6
Sugar	30	60.4
Textile, Bleaching and Dyeing	1	1.5
Total	80	228.4

[a]These statistics are for grossly polluting industries directly discharging into the Rāmgangā River, which are defined as those discharging wastewater more than 100 KLD. The total number of industries in the basin is far higher, in the order of 30–35,000

- Untreated urban (domestic) wastewater—there is limited treatment of wastewater, with most sewage released untreated into the river (see Table 5.2).
- Industrial wastewater, with the pulp and paper industries the major polluting industries in the basin (see Table 5.3).
- Diffuse pollution, especially from palaze farming, because of the use of fertilizers and pesticides.

Approximately 228 MLD industrial waste is discharged into the river from Uttarakhand (122 MLD) and Uttar Pradesh (106 MLD). Around 96% of industrial wastewater generated in Uttarakhand is discharged into Ramganga, which ultimately leads to the main stem of River Ganga at Kannauj Upstream (Uttar Pradesh). In Uttarakhand, the pulp and paper sector contributes 90% of total wastewater discharge

into Ramganga, whereas in Uttar Pradesh the sugar and distillery sector contributes 50% of the effluent discharge.

Because of these and other inputs, water quality is declining. Water quality in the Ramganga at Moradabad, Bareilly and Dabri is not safe for drinking, bathing or other purposes. Beyond the basin itself, the Ramganga is a major source of pollution for the Ganga, and the largest amount of industrial wastewater in the Ganga system is carried by the Ramganga, more than by the main stem of the Ganga.

5.2.5 Climate Change

While responding to climate change poses a challenge across much of India, there are particular issues to consider within the Ramganga Basin. Analysis of historical weather data (rainfall and temperature) from sites within the basin for the period 1982–2010 (Indian Meteorological Department) shows concerning trends, including:

- Decreasing diurnal temperature range. This is the difference between maximum and minimum temperatures. Studies suggest that a decreasing diurnal temperature range impacts negatively to yield of grain based crops like paddy and wheat.
- Decreasing winter rainfall. In Thakurdwara block (Moradabad district) winter rainfall decreased by 9.02, 16.28 and 4.24 mm in each of the decades. This is likely to further stress the groundwater as abstractions increase to irrigate winter crops like wheat.

The climate sensitivity of agriculture in UP (and, by implication, for much of the Ramganga basin) is very high in the state and high level poverty, rapid urbanization coupled with flood, heat waves and cold waves makes it one of the most vulnerable areas in India (UP Department of Environment, State Action Plan on Climate Change). Further, the State is the highest emitter of greenhouse gases (GHS) in India, with agriculture a major contributor. In addition, some of the other challenges facing the basin include increasing population, sand mining, flooding and geo-morphological changes in the river accelerated by anthropogenic interventions.

5.3 Developing the Basin Plan

While there are a range of initiatives proposed, in place, or under developed, there is presently no overarching plan or vision for the basin to respond to the multiple threats faced by the based, nor a document to help coordinate the many responses underway. The aim of developing a basin plan is to respond to this gap, by providing a strategic, high-level view of priorities for the basin.

5.3.1 Vision

To begin with it is essential that a vision for the basin is developed. The development of the vision is serves as an important tool to guide the overall process and enable stakeholders identify the aim of the exercise. The vision developed for the Ramganga basin was that the basin remains healthy and full of life, providing long term water security to all parts of society, including the ecology. In drawing on the approach adopted in the Ganga River Basin Management Plan, the vision is built upon two traditional Indian concepts (aviral dhara and nirmal dhara), as well as a contemporary understanding of how the elements of a river system contribute to its health and function. The vision incorporates four dimensions of the river level system, which are taken from the GRBMP. Those dimensions are:

- Aviral dhara (i.e. continuous flow): The flow of water, sediments and other natural constituents of Ramganga River are continuous and adequate over the entire length of the river throughout the year.
- Nirmal dhara (i.e. unpolluted flow): The flow in the river is bereft of manmade pollution; hence the river water quality should not be sullied by human activities.
- Geologic Entity: The Ganga River System is the earth's creations of ancient times, which may not be reparable if damaged.
- Ecological Entity: The Ganga River System is a delicately structured balance between various living species and the physical environment, achieved by nature over thousands of years and vulnerable to irreversible changes.

These four dimensions relate to the key elements that make up a river ecosystem. They provide guidance with respect to preserving:

- The flow regime, including environmental flows (through the concept of 'continuous flow')
- Water quality and sediment chemistry (through the concept of 'unpolluted flow')
- Habitat, in the form of the physical structure of the river ecosystem ('geologic entity'), and
- Aquatic and riparian biodiversity (ecological entity).

The linkages between these components are shown in Fig. 5.4.

5.3.2 Goals and Objectives

At the next level one need to clearly articulate the goals and objectives which serve as stepping-stones on the way to achieving the vision. For the Ramganga basin, the goals and objectives were divided into the following four categories:

I. *River and basin ecosystem health*: these goals and objectives relate to the physical condition of the river ecosystem itself. This includes the state of the river, its tributaries, wetlands and floodplains, and relevant parts of the catchment

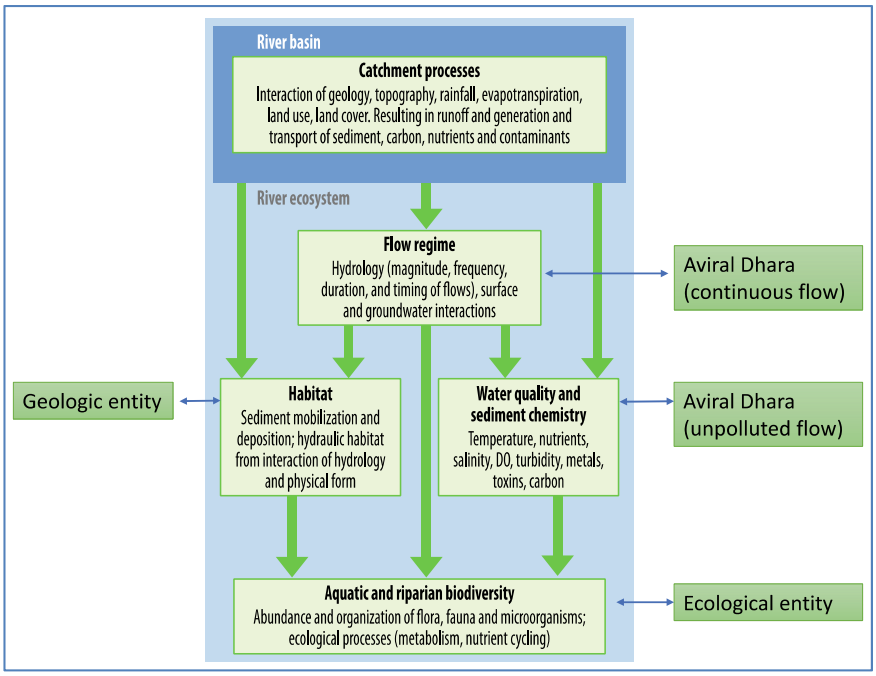

Fig. 5.4 Key elements that contribute to the structure and function of a river ecosystem and how they relate to the dimensions of the vision for the Ramganga Basin

(including groundwater systems). It also includes the river flows and the quality of the water, as well as the state of the plants and animals in the basin that are dependent on freshwater systems.

II. *Social, economic, and cultural benefits*: these goals and objectives relate to the extent to which the basin provides benefits to society. These are the benefits that are derived from the basin's freshwater ecosystem services that the basin should be providing, and include targets around the contribution of the basin towards socio-economic development and meeting spiritual and cultural needs.

III. *Basin governance and stakeholder practices*: these goals and objectives relate to the way the basin is being managed and the activities of stakeholders with the basins. This includes goals and objectives include (i) the management arrangements (e.g. plans, regulations, and policies) that will be in place for the protection and development of the basin and (ii) the way key stakeholders are undertaking activities that may have the potential to impact on river health and the provision of ecosystem services (e.g. the level of water use efficiency, the amount of wastewater produced). This category also includes targets related to the way in which major risks are mitigated and the impact of disasters is minimized. The goals and objectives in this category are not end of themselves, but rather are a means of identifying and measuring the certain changes in the basin that are

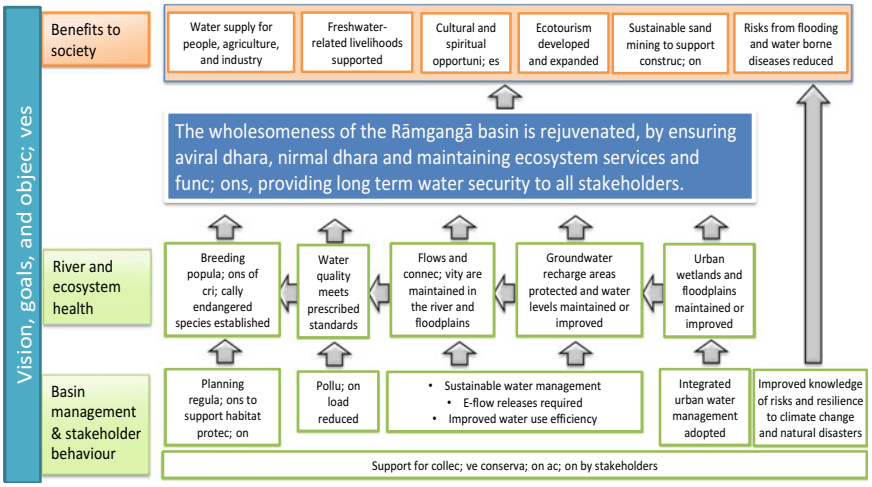

Fig. 5.5 Relationship between vision and goals

required to contribute to achieving the river health and social, economic, and cultural goals and objectives.

IV. *Disaster and risk management*: these goals and objectives relate to reducing the risk, frequency, and severity of disasters (notably floods and droughts).

The objectives set short-term targets for the basin and the aim of the plan is to achieve these targets within five years. Again, objectives are designed as stepping-stones on the path to achieving the goals and, ultimately, the vision, for the basin. The linkages between different goals (and objectives) and the vision are shown in Fig. 5.5. Notably, the goals are presented in a way to highlight that understanding that improving basin management and changing stakeholder behaviour will reduce threats to the river system and thus improve river health. This will support the overall vision of restoring the wholesomeness of the river basin. This in turn will allow for the river to provide a range of benefits to society.

5.3.3 Strategy and Action

The development of the goals and objectives is to be followed by a set of strategies and action. The strategy of a basin plan should focus on coordinating a range of activities towards a common set of goals. While doing so it is important that we understand the existing policies and programmes of the government and build synergies with the proposals outlined. It is important to note that a basin plan should not been seen/developed as a list of new actions that are required to better manage the basin, but rather be seen a means of bringing together many activities that are already being

undertaken or contemplated and coordinating them, along with a range of additional interventions.

The strategy of a basin plan should consist of three categories of action:

- Policy and regulation: these are actions aimed at developing and improving plans, policies and regulations related to the management of the natural resources of the basin. These include policies related to water allocation, climate change, fisheries management, and biodiversity and habitat protection. It also includes establishing mechanisms for promoting clean technology. These measures are designed to establish a better management framework and to mandate changes in behaviour of important stakeholders in the basin, including the practices of farmers, industry, and the hydropower sector.
- Research, assessment and monitoring: these actions are aimed at improving our knowledge of the basin, including gathering information to better understand threats to the river system, and the consequences of ongoing activities. These actions are designed to provide a basis for better decision making by both government and other stakeholders in the basin. This category also includes river health assessment, which is designed to assess the extent to which actions are being effective in improving river condition, as well as to contribute to overall understanding of the river system.
- Capacity building and stakeholder engagement: this category includes actions that are designed to (i) improve the understanding of different stakeholders (including farmers, industries, and government) of the impacts of different actions on the river system, as well as provide them with the capacity to reduce some of those impacts. It also includes actions that are aimed at establishing a multi-stakeholder platform, as the basis for sharing knowledge and building momentum towards change.

Each action should be linked with the higher-level goals. The actions should primarily be targeted at the goals related to improving basin management and changing stakeholder behaviour, on the basis that changes in those factors will reduce threats to the river system (such as pollution, development in the riparian zone and floodplains), and thus improve river and ecosystem health. Improving river ecosystem health is, in turn, expected to enhance the capacity of the basin to provide benefits to society. Figure 5.6 summarizes the various actions and lists them underneath the relevant goal. There can be a number of actions that are proposed to achieve a single goal. Likewise, a single action can contribute towards multiples goals and objectives.

5.3.4 Process

The process of developing a basin plan involves making decisions over the different uses and demands for water resources and associated systems within a basin. A basin plans set objectives and the measures for developing, protecting and harnessing the resources of the basin in order to achieve these objectives and health and safety of the river itself.

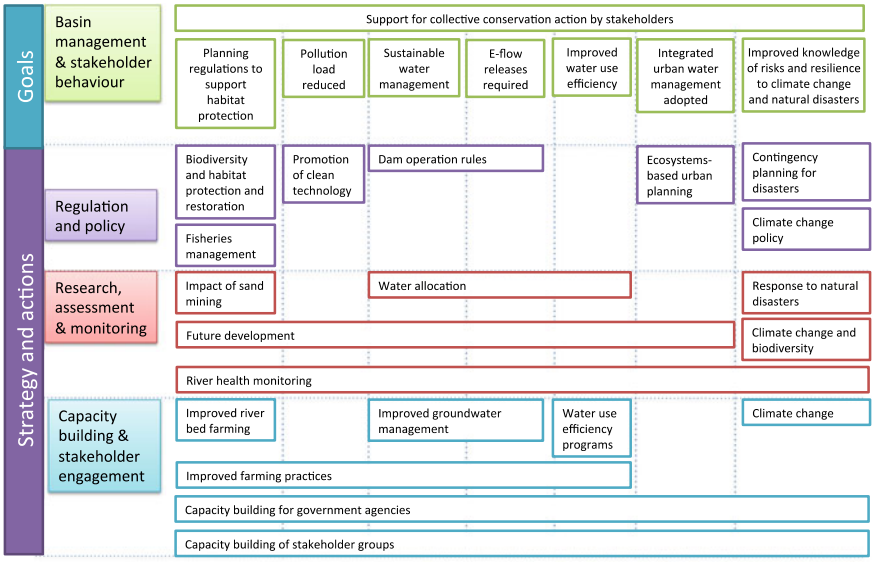

Fig. 5.6 Links between actions and goals

Basin planning has been undertaken for many different purposes and in different types of basins across several countries. Depending on the scenario and objective, planning has been formal and organized in some occasions while in other occasions it is less organized and is developed organically over time. While there are some common themes and principles that have emerged, there is no universally applicable template or roadmap for river basin planning. By nature, basin planning must reflect, consider and respond to the historical, physical, political, social, economic and institutional characteristics of the basin. It is this feature that complicates the development of generic guidelines for basin planning.

The process followed in the development of the Ramganga basin plan involved the following stages:

- *Baseline situational assessment*—This involved data collection on the various sectors and parameters relating to water use, allocation, pollution, flows, transfer, population, weather and climate, threats concerning river and institutional mapping. Both primary and secondary information were collected as part of the baseline data for developing the basin plan. It was not possible to collect uniform time series data for all the parameters but wherever possible, attempt was made to collect time series data for better development of trends and patterns for analysis and documentation.
- *Engagement with stakeholders and consultations*—This was one of the most exhaustive stages in the entire basin planning exercise. Engaging with the various line departments at state and district level, academic and research institutions, civil society organizations and citizens helped in not only getting information but also

enabled in framing the vision, goals, objectives and approaches to the basin plan. The Ramganga *mitras (see Box),* a multi-stakeholder platform set up in the basin has been instrumental in generating information, building awareness and creating dialogues for the development of the basin plan.

Ramganga Mitras—A multi stakeholder platform for river governance

Water is a shared resource as well as a shared risk. Any sustainable long term river conservation initiative will therefore require collaboration between competing water users (agriculture, industry and domestic). The development of sustainable river conservation strategies also necessitates engagement with policy makers, academicians, teachers and school children. There are currently limited spaces for stakeholders to engage in basin governance with no platforms for competing water users to meet, discuss, debate on issues and solutions. Most importantly, these stakeholders operate in silos and there lacks a shared vision for the river collectively arrived upon by all stakeholders.

WWF-India's Ramganga *Mitra* initiative aims to address these institutional challenges by creating democratic spaces for stakeholder engagement. The *Mitra* platform has been established to facilitate discussions and debates among competing water users which would result in the designing of multi stakeholder initiatives to mitigate water risks to the river. People who possess the inspiration and passion to initiate change coupled with the willingness to involve other key stakeholders in the journey of a river's rejuvenation have come forward to become mitras across the programme districts in the Ramganga basin.

These groups (riparian communities, industries, farmers and policy makers) are envisioned to emerge as voices for sustainable management of the Ganga system through constructive engagement in river conservation. WWF-India has facilitated the signing up of 4,000 people to become Ramganga Mitras in the basin. Children and youth groups known as Bal Ramganga *mitras* have also been formed to inspire young minds towards river rejuvenation.

- *Mapping of regulatory measures*—There are various regulatory and planning measures in place that relate to the various challenges facing the river. These are summarized in Table 5.4. An understanding of these measures becomes important to link the actions identified in the basin plan with the ongoing initiatives being undertaken through the implementation of policies, programmes by various institutions.
- *Developing the draft basin plan*—Based on the information obtained in the above 2 stages, a draft 'Ramganga Basin Plan' was developed which outlined the vision, goals, objectives and detailed out the strategies and actions.
- *Stakeholder consultations*—Stakeholders consultations are critical to not only assessing the effectiveness of the plan but also to get the buy-in and support for future implementation. Consultations were held at district level (covering all districts in the basin) with various stakeholders and feedback was incorporated in the

Table 5.4 Planning and regulatory measures and institutional responsibilities

Issue	Planning instruments, regulatory controls and other responses	Institutional responsibilities
Basin planning	National Ganga River Basin Authority (NGRBA) constitution on 20th February 2009, with responsibility for comprehensive management of the river. Intended to adopt a river-basin approach and given a multi-sector mandate to address both water quantity and quality aspects. State-level basin plans under preparation	• NGRBA • State Irrigation Departments
Water allocation and management and environmental flows (surface water)	Water abstraction permits granted for irrigation. Permits granted based on the dependable flows at 75% probability for any given site. Of that flow, 85% of available volume is allocated for irrigation purpose, with the balance 15% is left for 'other-uses', including domestic, nature and industrial. Based on a ruling of the UP High Court at Allahabad in 2012–13, water withdrawals from the rivers should not be more than 50% of the total volume and flows, although this is not always the case given existing allocations	• Water abstraction and infrastructure operations primarily the responsibility of irrigation departments of the states. Kalagarh dam is managed by UPID for flood protection and irrigation and hydropower generation is managed by UJVNL Uttarakhand Jal Vidyut Nigam Limited • At central level, the Ministry of Water Resources, Ganga Rejuvenation and River Development and associated departments are responsible for implementation of national water policy • UP Irrigation Department is responsible for the implementation of State Water Policy • SWARA responsible for policy formulation • National and State policies mention e-flows but no standard in place

(continued)

Table 5.4 (continued)

Issue	Planning instruments, regulatory controls and other responses	Institutional responsibilities
Water allocation and management (groundwater)	Permits required for abstraction for groundwater for industrial purposes. Generally no regulation of groundwater for irrigation purposes. Restrictions on groundwater use in areas classified as Critical (100% or more of sustainable volume being abstracted) or Over-Exploited (90–100%). Draft groundwater policy prepared (Government of UP) has giving responsibility to control groundwater abstraction in rural areas to WUAs. Proposes restrictions on pumps above 7.5 HP and to housing societies in urban area not to use >1 hp pump for their municipal use. Proposal is that Government will not provide drilling, finance, subsidy and will not support tubewells within over-exploited or critical block areas Model national groundwater bill proposed, but not yet adopted at State level	• State Ground Water Department • Minor Irrigation Department of UP Irrigation Department
Water use efficiency measures	This has been advocated by the National Commission on Integrated Water Resources Development Plan (NCIWRDP). The commission recommends at least 20% improvement in the current efficiency levels in irrigation water use. The National Water Mission also has set a target of 20% improvement in water use efficiency	• NCIWRDP • National Water Mission

(continued)

Table 5.4 (continued)

Issue	Planning instruments, regulatory controls and other responses	Institutional responsibilities
Water quality	The NGRBA has resolved that by year 2020, no untreated municipal sewage or industrial effluents will be discharged into River Ganga, including tributaries like the Ramganga Of the 80+ polluting industries in the basin that discharge into the river's tributaries, the CPCB has identified 21 grossly polluting industries. Seventeen of these have installed effluent treatment plans, and the remaining four are closed	• State Environment Department • Central and State Pollution Control Boards • National Green Tribunal
Sand mining	EIA required for all sand mining activity (in response to ruling of National Green Tribunal), but enforcement limited	• District Administration
Climate change	National Action Plan on Climate Change and State Action Plans for UP and UK. These plans include various actions aimed at improving adaptive capacity of people and industries in the basin, including modernisation of irrigation schemes, improved water use efficiency (both delivery and on-farm), implementation of integrated water resources management in over exploited areas. National Water Mission sets a goal of 20% improvement in water use efficiency, through pricing and other measures	• Department of Environment • District Administrations • NABARD
New water infrastructure	Environmental and financial clearance and inter-state or international aspects are to be checked by Central Government	• Ministry of Water Resource, Finance department, Ministry of Environment and Forest

(continued)

Table 5.4 (continued)

Issue	Planning instruments, regulatory controls and other responses	Institutional responsibilities
District Plans	District Planning Committees which approve the district plans in line with Government schemes. All issues linked to Ramganga are also reflected here: irrigation, agriculture, drinking water, sanitation, urban waste management, etc All districts are now developing District Irrigation Plans, Soil Health Cards, proposals on Jal Gram (to be funded by Government of India)	• State Planning Board • District Administration • All departments
Urban land use, infrastructure and water management	Moradabad/Bareilly Development Authorities-A para-statal body, mandated to build infrastructural facilities. It acquires land and develops new colonies, suburbs and builds all infrastructural facilities for it District Urban Development Agency (DUDA) Agency specifically established to undertake and implement infrastructure programs under central schemes, mainly for urban BPL families and slums (Under Ministry of Urban Employment and Poverty Alleviation) U.P Jal Nigam (UPJN), Mainly responsible for construction, operation and management of water supply and sanitation related infrastructure across the state, on behalf of the state government	• State Urban Development Department • District Development Authorities • District Urban Development Agencies • Municipal Corporations
Industrial Development	Cluster Development Plans/Infrastructure planning/funding	• Department of Industrial Policy and Promotion, Government of India • Department of Industries (State) • District Industries Centre

Source Compiled from information from various Central and State Government department website

plan document. The consultations also played an important role in developing an agenda for action for the district administrations and the various line departments. It also outlined the role for communities to be part of the process of monitoring and feedback. Going, forward there are plans to have consultations at the state level.

- *Finalizing the basin plan*: Based on the inputs, a final basin plan will be developed and presented to the stakeholders.

5.4 Conclusions

The development of the Ramganga River Basin Management Plan (RRBMP) has been an exercise to understand the aspirations, arguments of various users and institutions engaged in managing the water resources in the basin. Different groups have different views on how water resources should be allocated, used and managed. Getting them to discuss and agree on a common vision for River Ramganga was tedious job. It involved a long drawn process of generating and sharing information, consultations and making users realize the benefits of such an exercise.

There are chances that unexpected issues or perspectives will arise during the planning process, regardless of the technical know-how and information based on data. The key in developing a plan in such a scenario is the need to evolve an agreement and understanding that a workable plan needs to engage and possibly reflect the diversity of relevant issues and perspectives. This also involves an agreement from people and institutions who will be engaged in the implementation.

Mutual trust amongst diverse users and the trust of the planners that such a plan is an evolving document and is workable are important to ensure success. A clearly scoped and designed process with a specified timeframe and outcome should facilitate, contain and make sense of the complexity and iteration required to converge on an implementable plan.

Basin planning is inherently a social, multi disciplinary and a multi stakeholder process involving various actors. India will need to embrace such an approach given the fact the competing users and water uses exist and shared vision will be the key for a stakeholder owned basin to be successful and sustainable.

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Robert Alexander Speed is water resources and basin plan specialist, currently with Badu Advisory Pty Ltd.

Suresh Babu is Director with Rivers, Wetlands and Water Policy Division of WWF India.

Nitin Kaushal is Associate Director with Rivers, Wetlands and Water Policy Division of WWF India.

Romit Sen is Associate Director with Rivers, Wetlands and Water Policy Division of WWF India.

Arjit Mishra is Senior Hydrologist with Rivers, Wetlands and Water Policy Division of WWF India.

Mohammad Alam is Senior Project Officer with Rivers, Wetlands and Water Policy Division of WWF India.

Chapter 6
Local Governance and Participative Water Management in Urban Contexts

Nitya Jacob

Abstract Water governance has traditionally been in the hands of local communities. During the British Colonial period, and later in Independent India, the State arrogated control. While intentions were good, the outcomes were not. On the other hand, local water governance deteriorated with the decline of local institutions. While macro management should have taken a wider view of the resource, micro management had to ensure equitable distribution. Neither achieved their outcomes owing to limited abilities and vision. Further, the ability of local government institutions varies from state to state and, more often than not, declines with its size, i.e., smaller urban local bodies or panchayats are less capable than larger ones in water management. To address this, both the national and state institutions need to build capacities of local institutions while transferring power and finances to enable them to do their job. On their part, local institutions need to see their role as managers and not merely implementers of national or state policies and programmes.

Keywords Local water management · Community ownership · Water governance · Mansagar Lake · Jaipur · Bhopal · Odisha · Arvari Sansad

A poster on water shows a tree, roots and all. The caption says water from the top has no effect till it reaches the ground. That sums up how water ought to be managed, from the ground up. It also shows how it is managed in a top-down manner, by looking mostly only the higher levels of management and ignoring the local levels. There is a clear demarcation between macro and micro management in policy and practice. While macro management must take a wider view of the resource, micro management has to ensure equitable distribution. There are several problems with both levels of management originating from the ways macro managers view water (as an input) and micro managers lack the capacity to discharge their responsibilities. As per the national water policy which has been largely adopted by the states, the drinking water for human and other consumption has been given highest priority followed by agriculture and industrial uses in that order.

N. Jacob (✉)
New Delhi, India
e-mail: nityajacob@gmail.com

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Integrated water resources management (IWRM) requires the multiple sources and uses to be factored in. It considers water as a resource to be managed, rather than just an input for other uses. The sources are surface water and ground water. The major uses are domestic, livelihoods, agriculture and ecological. The quality and quantity of water from the different sources and uses vary sharply. The least quantity is for water for domestic use, but this demands the highest quality. Agriculture on the other hand needs the most water but of lower quality.

This chapter looks at the role of local government in water management in urban and rural areas. Each has its own section and examines it from the local to the state and Central levels with case studies. Local governments in an urban setting include municipalities while the higher levels include state and Central governments. Rural local governments include block and gram panchayats while higher levels start from the district through the Central government.

Municipalities are stand-alone entities reporting to state urban departments that in turn have a dotted-line reporting to the Central Ministry of Housing and Urban Affairs (MoHUA). Panchayats are 'managed' by block officials or engineers who report upwards to districts, state rural development departments and the Central government. At the Central government level there are multiple ministries concerned with water, the Ministry of Drinking Water and Sanitation (MDWS) being the most important from the point of view of local governance in rural context, followed by the ministries of rural development, panchayati raj, water resources and environment and forests. The districts are the unit of administration where macro plans merge with local ones and planning and implementation start.

Water does not follow administrative boundaries as watersheds and aquifers usually spread over several panchayats, or conversely a panchayat has more than one of them. This applies to larger areas as well. It makes planning and management of water resources difficult. Another confounding factor is the multiplicity of agencies at all levels. Irrigation, forest, rural development, fisheries, agriculture and revenue are some of the departments that control local water resources. Each has competing priorities that dictate how they manage water. On the other hand, the local level users have to share the same source for multiple uses.

Conventional water management does not differentiate between sources. The same source, usually groundwater, feeds multiple uses. A tube-well can be used for drinking, animal husbandry and agriculture. The overflow goes to recharge ground water or results in surface runoff water. It's the same case with ponds and rivers. This approach does not consider quality and focuses on adequate allocation in quantitative terms with the assumption that the quality will be taken care of by the consumer/indenting agency.

Government water provision for rural drinking water demands relies excessively on ground water. MDWS' statistics indicate over 90% of water for domestic use comes from this source.[1] Nearly 50% of water for irrigation also comes from the

[1] Census of India 2011.

same source, according to the Ministry of Water Resources. Rain irrigates over half of the farmed area. Surface water channelled through canals accounts for just 26%.[2]

In this muddle, local governments find themselves as passive recipients. This is despite the fact the National Rural Drinking Water Programme (NRDWP) mandates a role for panchayats to plan and monitor drinking water. Farmers get loans to install tubewells and subsidised (or free) power and diesel to run them. Village ponds are made and maintained by local people, their labour paid for under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS).

Irrigation infrastructure is built and operated by Central and state irrigation departments. They have little to do with local governments as works are planned and operated by state departments, subject to the availability of water. Irrigation is the single largest user of water, consuming more than 80%.[3] Most of the time, raw water is shared between the irrigation and the domestic sectors where the dependence has been increasing on large reservoirs as the source (Water grid of Gujarat). Real time allocation and reservation of the water for various uses is strongly affected by the political economy and the pressures of livelihood assurance. Due to limited capacity of the rural and urban local bodies to provide adequate financial and political resources, the domestic use has the potential of getting short changed in an intensely competitive environment even though drinking water has been given the first priority by the Water Policy.

Local governments in rural and urban areas, therefore, have limited say in how water is supplied or allocated. One of the key problems affecting equitable water distribution in urban and rural areas is the limited capacity of the local bodies to maintain and operate the last mile distribution systems, which require large fund inputs that cannot be recovered from the end beneficiaries because of populist consideration. This leads to situations where even after providing adequate quantities at source, the pockets experience intense scarcity. Often, in such circumstances, people in both cities and villages have their coping strategies to make up for systemic deficiencies. Nearly 30 million tube wells—quite some numbers in the areas served by the piped networks in India—are a testimony to this. Most are privately owned. Digging of wells and of late, tubewells has been a traditional way of water supply at the household or community level since historic times. However, the increase in population has put this approach at increasing stress. That is not to say they have no expectations from the government: people raise demands through local elected representatives who in turn take up the matter with service providers. Public pressure has forced the latter to act. For example, Latur in Maharashtra faced a severe drought in 2016 and the state government started a water train to bring water from 160 km away.[4]

[2] Agriculture Census 2010–11.

[3] Prakash et al. (2012).

[4] Rashid and More (2016).

6.1 Urban Water Supply

MoHUA launched the Accelerated Urban Water Supply Programme (AUWSP) in September 1994 to provide water supply facilities in towns with populations less than 20,000. The main aim was to improve the quality of life and environment of the poor, specially the most vulnerable sections of the population such as women, children; and other deprived sections who do not have access to safe water.

In its implementation, community participation emphasis on rationalization of tariffs, separate of budget for water supply and sanitation from the municipal budget; subsidies for identified target groups and water conservation were envisaged. Operation, maintenance, distribution leak detection and preventive maintenance along with rehabilitation of existing system were given priority over new capital works. The water supply sector had to be treated as a public utility rather than a service. Water supply schemes in 575 towns were approved on March 31, 2001. These water supply schemes are to be operated and maintained by the Urban Local Bodies (ULBs) as they were mandated to do so under the 74th Constitutional Amendment.

This programme was folded into the urban reforms initiated in the mid-2000s under the Urban Infrastructure Development Scheme for Small & Medium Towns (UIDSSMT). ULBs were to prepare the Detailed Project Reports (DPRs) reflecting their priorities and submit them to State Level Nodal Agency (SLNA). SLNAs appraised the DPRs and submitted them to the State Level Sanctioning Committee (SLSC). From here, the reports were sent to MoUD and the Town and Country Planning Office (TCPO) for comments. Once finally approved, SLSC would submit the DPRs for funding to MoUD, sign a Memorandum of Agreement (MOA) for urban reforms with the state government, and send the release proposal to Ministry of Finance.

This Centrally-sponsored scheme was jointly funded by the Central and state governments in ratio of 80:10. The balance 10% could be raised by the implementing agencies including ULBs from the internal resources or from financial institutions.

MoUD monitored the scheme through a committee under the chairmanship of Joint Secretary (UD). The SLNAs were required to send quarterly progress report to MoUD through the TCPO. This indicated ULBs were to prepare DPRs that were collated and assessed the state government. Those that passed muster were included in the state plan and submitted for funding.

Currently, state action plans have replaced individual DPRs though the rest of the process more of less the same. Continuing JNNURM's mission, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) ensures every household has access to a tap with assured supply of water and a sewerage connection. "All these outcomes are valued by citizens, particularly women, and indicators and standards have been prescribed by MoUD in the form of Service Level Benchmarks (SLBs)".[5] To provide piped water to all the estimated costs are ₹800,000 crores.[6] This is clearly an impossible amount.

[5] AMRUT (2017).

[6] Excreta Matters.

The gradation of responsibilities means the onus of planning and execution falls solely on the ULBs. In addition, they are supposed to run urban water supply networks. However, the Asian Development Bank[7] has found these are severely constrained by the following factors:

1. Involvement of multiple institutions in water governance at the ULB level, such as water supply, drainage, health, roads, sewage and finance. They often work at cross-purposes
2. Capital intensity of urban water supply. An estimate places the cost of a new connection at Rs. 20,000 and recurring costs anywhere between Rs. 15 and Rs. 30 per kilo-litre. Tariffs do not come anywhere near that
3. Large-scale procurement of hardware that is beyond the ability or finances of most ULBs, necessitating continuous grant funding from state or Central governments
4. Interface between public and private sectors is lacking
5. Political pressure on tariffs enforces insolvency on the ULB
6. High demand for water services that is growing rapidly with urbanization and changing lifestyles (people are using washing machines, flush toilets and running water)
7. Water scarcity (and becoming more so due to population growth, resource depletion and climate change)
8. Dispersed service provision since some towns have very scattered settlements. Towns themselves can be very far from a viable source pushing up costs and losses
9. Weak institutional capacity. Vulnerabilities exist in policy making, regulation, organizational management, and operations. Often one engineer manages several departments and pays attention only to the lucrative or politically important ones

Local urban water supply systems in small towns are rudimentary, designed by the department concerned of the municipality. In larger towns have well-designed systems by a dedicated water supply agency in formal settlements. But for informal settlements (such as slums or peri-urban areas), some cities provide bulk connections or high capacity ground water extraction systems connected to stand-posts or pipelines laid by an informal service provider.

On a regular basis, ULBs are unresponsive to people's needs and are supply-driven. Development of urban conglomerations especially un-planned colonies put stress on the planned infrastructure and make the same fail. Thus, people cannot decide when water will be supplied, the quantity or the quality. People must build their lives around water rather than the other way around. The logic service providers have is they have only so much water to around so must stagger supply timings.

In several slums of New Delhi, the Delhi Jal Board (DJB) has installed tube-wells. The local municipal councillor, who is usually the strongman of the area, provides that pipeline network and charges Rs. 1500–2000 per connection. Monthly charges average Rs. 30 to cover power and maintenance costs.[8] Quality is seldom monitored.

[7] Learning Lessons, Urban Water Supply Sector (2011).

[8] Personal observations from visits to slum areas in Rangpuri Pahari, Govindpuri and Sanjay Colony.

While this system is responsive to local needs, it does not, crucially, involve people in decision-making or monitoring.

As these functions are discharged by the strongman who is the operator, it distorts local governance; the supplier favours supporters over others. This causes a permanent imbalance in water supply in a closed community. It forces the have-nots to create alternatives, pushing up their coping costs. Water becomes a tool in the hands of local politicians to reward or punish. It is not a chargeable service to be provided to everybody for which the representatives are accountable. The formal water service provider has not reached into slums with formal water supply networks owing to political pressure by these same people.

DJB officials have admitted as much in meetings. Political interference is rife as the agency reports to the state government. Localities supporting the ruling political dispensation get preferential treatment. In an experiment to circumvent this, DJB piloted private supply and tariff collection in three zones, Nangloi, Malviya Nagar and Vasant Vihar to improve service levels and tariff collection. DJB retains 'ownership' of the resource while private operators run the network.

Many other cities have experimented with public-private partnerships in small areas. The results are mixed.[9] Most people, according to research, consider water to be a free service. This works if the service provider is the government or its agency who can be bullied. A private supplier, concerned with profits, will ensure bill collection or disconnection. In PPP models, it is the people's representatives, and not the people directly, who set tariffs. People do not directly get to decide hours of supply and other issues. Again, the political economy ensures that local government interferes with the influence people have over their water service providers. This is appropriated by their elected representatives who, as we have seen, may have a different agenda.

Tariffs are another area where people have little say. Water tariffs, either volumetric or fixed, cover between a quarter and a third of the cost of supply. Some ULBs meet this gap by charging high tariffs from industrial connections or selling sewage, but the balance sheets of most are red. Water and power supply are the main causes. Raising tariffs is nearly politicallyimpossible. In turn, this means ULBs are permanently dependent on their state governments for grants. This further erodes any influence local people may have in planning or monitoring water supply systems. In fact, the Indian state water apparatus still shows little interest in the key issues of the management stage—participation, incentives, water entitlements, transparency, entry of the private sector, competition, accountability, financing, and environmental quality.[10]

[9] Excreta Matters (2012).

[10] Briscoe and Malik (2006).

This cycle of poor public participation, high capital costs, inadequate tariffs and overall poor governance, has created a situation in most cities where only a fraction of the population has municipal drinking water. The urban middle class have learned to make do with this. Their coping strategies include creating household storage, bottled water for drinking and household water purification systems. They have shown great ingenuity in 'working around' a poorly governed water system, purchase of water from vendors, and private wells to tap groundwater.

This works for the middle class even though they pay many times what they pay the water utility. But the urban poor fare far worse. They live in slums or resettlement colonies at the end of the water network, or off grid. They cannot afford to make the same coping investments as the middle class. They depend heavily on water vendors, most of which are, again, supplied by groundwater, and provide water of very high cost and dubious quality.

> Slums and informal settlements make up 25-40 per cent of most cities' populations. On average they consume just 5 per cent of the total water supply. This is a very iniquitous situation, aggravated by their exclusion from formal water networks. The political economy is at work: these are vote banks that are kept on the edge of basic services provision by their political masters by making provisions out of an already stressed system. Members of municipalities and councils who are supposed to voice their interests have instead appropriated the space occupied by suppliers. People have no say in water supply in these areas. As citizens of the country, they have a right to water and sewage services, and the willingness to pay. Ample studies bear this out. Some studies have put the amount slums 'tap' at just 5% of the total water supply to a city/town, less than the 50% distribution losses.

ULBs report to a state department of urban development that adapts national policies and allocates funds. While the Central government stipulates guidelines for urban water supply such as the quantity in litres per capita per day (lpcd), quality, distance to water point, etc., state governments modify these to suit their peculiar urban situations. State governments pass these guidelines onto ULBs for implementation as the situation in each town is unique.

Let us take the example of service level benchmarks for urban water supply. These have been developed by the Central Public Health Environmental Engineering Organization (CHPEEO), the technical wing of MoHUA. State urban development departments were advised to adopt it to guide ULBs on water supply, sanitation, sewage and storm water management. In principle, one department in a ULB was to handle all these activities; in practice there are several departments, officials or engineers.

The Service Level Benchmarks (SLBs) set the standards and define roles for each level of government described in table[11] below:

[11] Central Public Health Environmental Engineering Organization (2009).

Central government	State government	Urban local bodies
MoHUA will take the lead disseminating these service level performance parameters and building wider acceptance. They will be institutionalized through the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and other programmes. They will be an integral part of City Development Planning processes, both for assessment of current situation, and for setting targets under their plans. Wherever appropriate, SLBs will be dovetailed with the commitment on reforms, and subsequent process of appraisal of reforms. The SLBs should be part of Detailed Project Reports for concerned sectors, indicating both the current situation and what change the project will bring about. Subsequent processes of monitoring implementation of the project will also examine these SLBs. Under AMRUT, support may be extended to enable ULBs and other civic agencies to establish systems in their respective institutions for periodic measurement, reporting and analysis of SLBs	State Governments and their agencies in the urban sector have a critical role in driving performance of ULBs and city level civic agencies. State governments will need to periodically examine the SLBs as an input for its decisions related to policy, resource allocations, providing incentives and penalties, channelizing technical and manpower support, and regulatory considerations amongst others. The Directorate of Local Bodies/Department of Municipal Administration will need to play a key role in this process through constant inter-city comparisons. These departments should leverage the power of information technology to build and operate systems that periodically capture and report on SLBs. Web-based technologies should be leveraged for managing information flow. For other nodal state level agencies, the SLBs will provide specific inputs for their programs and interface with the ULBs and other civic agencies. SLBs will also be an important input to state finance commissions	ULBs are the most important stakeholders for institutionalization of SLBs. As service delivery institutions, ULBs will find it useful to institutionalize systems for performance management using SLBs. Performance data at the sub-ULB level (zone or ward level) is particularly useful for the ULB for taking appropriate decisions and monitoring performance of the various field units. Benchmarking with other cities within a state, or with similar cities facilitate a healthy competitive environment for continuous improvement. As the principal elected institution for self-governance in the city, ULBs will need to examine performance of other para-statal civic agencies, even if the ULBs are not directly responsible for service delivery in those areas. Performance management data using SLBs should be included in the set of information disseminated under mandatory public disclosure, as required by the reforms under AMRUT

This table show a gradation of roles from MoUD to ULBs. The Central Government makes and disseminates the policy to the state departments concerned. In turn, state governments tweak them and allot money, incentives and penalties, ensure human resources and monitor the performance of ULBs. ULBs implement the policies.

The ability of ULBs to manage or build water supply networks reduces progressively with the population served. While large cities have dedicated agencies, small towns typically have one engineer in charge of several departments, including water supply.

Several studies have pointed to the inability of the government water machinery to address the problems of the provision of urban water supply services. User charges are negligible, resulting in lack of accountability and insufficient generation of revenue even for O&M. The gap between tariff and value of water supply services has fuelled endemic corruption. Staffing levels are 10 times international norms, and most public funds are spent on salaries and pensions instead of maintaining infrastructure of creating new networks. This has been aptly described as 'Build-Neglect-Rebuild'.[12]

In principle, therefore, while urban water management ought to be completely within the ULBs' control, it is anything but. ULBs should decide and execute projects to ensure their citizens get adequate water of the stipulated quality. In practice, ULBs are permanently dependent on state governments for funds, bulk water supply and even treatment and distribution. In many states, a state agency sources and supplies bulk water to ULBs who treat and distribute it within their territories.

In Uttar Pradesh, the UP Jal Nigam performs these functions. In Karnataka, is the Karnataka Urban Water Supply and Drainage Board is the agency concerned, in Tamil Nadu, the TN Water and Drainage Board. There are similar agencies in most states. The good thing is they are staffed by experienced engineers familiar with building and running water supply networks.

The bad thing is they are not transparent, responsive or accessible to the people they serve. This top-down, hierarchical and rigid model takes a one-size-fits-all approach to water supply. Only planned or 'recognised' settlements in towns and cities are covered. The rest are left to their devices. There is no emphasis on water management, just on supply.

While intra-city water sharing is iniquitous, as we have seen, sourcing water is equally problematic. Few cities have adequate resources within their geographic boundaries. This propensity to source water from external and distant sources has been a cause for conflict between rural and urban India, and between states. Again, ULBs have no say in sourcing or conflict resolution.

Water sources pose perhaps the single biggest challenge to urban supply systems. In nearly all towns, ground water is over-extracted and polluted. The Central Ground Water Board's 2015 assessment report says, "A serious ground water crisis prevails currently in India due to excessive over-extraction and groundwater contamination covering nearly 60% of all districts in India and posing a risk to drinking water security of the population.[13]"

The report states that out of 6607 assessed administrative units (Blocks/Taluks/Mandals/Districts), 1071 units were over-exploited, 217 units were critical, 697 units were semi-critical, and 4530 units were safe. The moot point is, the endangered units happen to be in and around urban areas.

Conventional approaches to urban water supply of drilling tube-wells and connecting pipes to overhead tanks will, therefore, not be viable much longer. Surface water is not always available or may be too polluted to use without expensive treatment. Agra, a few hundred KM downstream of Delhi, received Yamuna River water

[12] India's Water Future.

[13] Report of the Groundwater Estimation Committee (2015).

that is too polluted to treat by conventional means. It has had to construct tertiary water treatment plants that are grant-funded and expensive to operate.

Some conflicts in recent years are those between Delhi and Uttar Pradesh over sharing water from the Tehri Dam and between Delhi and Punjab and Haryana over the Sutlej canal. Bangalore draws on the Cauvery River that is disputed by the states of Tamil Nadu and Karnataka. Chennai sources water from rural areas raising the hackles of local farmers. Mumbai's water comes from artificial lakes in the Western Ghats, contested by local people living near them. Jaipur gets its water now from the Bisalpur dam that was originally built to provide irrigation to farmers in Tonk district; several died in policy firing to protest the construction of the pipeline to supply to water Jaipur.[14]

The state governments concerned have been ham-handed in their response. Police have been deployed to forcible silence protests. Delhi, Haryana, UP and Punjab have attempted to dialogue with mixed success. The Central government, which is Constitutionally mandated to intervene in inter-state water disputes, has opened endless dialogues with these governments. Rather than reach an agreement, these have simply exhausted the parties and options.

Current domestic water supply approaches in cities do not provide an opportunity for users to choose their service. People should use the available water supply in the area or city. While water pricing depends on the utility, the water sources are often limited. Both pricing and supply are, however, of primary concern for water users. In the past there were movements to privatize water utilities to enhance profits. However, such movements have been revised to balance the public aspect of water utilities in meeting the social needs together with the business aspect of operation effectiveness and cost reduction.

Another characteristic of India's water bureaucracies is the near total lack of women at mid- or senior-management level.[15] What this means on the ground is these bureaucracies are gender-blind when it comes to design and operation of water networks. Systems that pipe water into homes are not such a problem but those that provide water through stand-posts can be an issue. Factors such as distance to home and the location of these stand-posts are important considerations for women, but not for the service providers. Here again, people are disconnected from ULBs.

State level water bureaucracies are supposed to develop policies, guidelines and allot funds. They adapt national guidelines and channel Central government funds to ULBs. Most state bureaucracies are top-heavy with an excess of engineers and bureaucrats in the state capital. The districts and ULBs are deprived of human resources.

In the middle, the district governments have little say in urban water supply. This peculiar situation arises from the way reporting systems and financial flows are set up. This despite the fact most district headquarters are in towns over which they have little jurisdiction. The district collector/magistrate, the head of the district, has nominal say in how the municipalities work.

[14] Media reports from 2005 onwards.

[15] Water in India, Situation and Prospects.

Often, municipalities in smaller towns are headed by a junior officer who handles multiple portfolios. Additionally, the elected ward representatives and mayor have limited understanding of their duties and government schemes. They cannot turn to the better staffed and trained district administration for support. Instead, they must rely on a distant state government. This creates a long line of command that is inimical to decision making and, more so, to public participation in governance.

Thus, in small-town India that has grown rapidly in recent decades, water supply is at the mercy of inadequately staffed and funded ULBs. The problem is set of intensify. Big cities are huge water sinks, sucking in water from distant source and polluting water bodies for many hundreds of kilometres around.

6.2 IWRM and Urban Water Supply

IWRM principles of conjunctive use, waste treatment, conservation, equity, pricing and consultative management between providers and users are not followed by ULBs or state governments. Domestic water supply is supposed to provide clean water to people in a stable manner and is highly public in its nature. It is essential for improvements in the social environment, such as less time for fetching water, etc.

When demands for water supply increase the utility must locate new sources, and be faced with the need to implement IWRM. When introducing IWRM, conformity with plans by other municipalities or other water users must be ensured by: accounting for upstream and downstream; right and left banks; and coordination among municipalities or water utilities.

Furthermore, infrastructure such as dams, intake weirs and treatment plants can be jointly developed and a joint management framework can be established. These can present substantial advantages to the domestic water supply sector. If there is shortage of water due to population growth or rapid urbanization, water transfers from other uses, particularly the agriculture sector, can become an option.[16] However, as has been witnessed at most parts of the country, the linkage of irrigated agriculture with livelihoods and economic security, leads to intractable conflicts which, as per the Water Policy, are to be managed only through interventions at higher levels of governance.

Maximising local water supply by rain water harvesting, conservation and recycling and reusing waste water and sewage are equally critical. Studies show cities can meet up to a third of their annual water needs through these methods at little extra cost.[17] Nearly all urban centres have public buildings, parks and roads that cover a substantial surface area. Rain water from these areas can be used for ground water recharge after suitable filtration. Similarly, they have ponds and other water bodies

[16]IWRM Guidelines at the Basin Level, 2009. UNESCO, World Water Assessment Programme, Network of Asian River Basin Organizations.

[17]Excreta Matters.

that can be provided legal protection and used for both storing excess rain and ground water recharge.

However, these will require change in municipal bye-laws and an intensive citizen education campaign. ULBs have not shown much inclination to do either. However, there have been some alternatives in maximising local water availability through people's movements.

6.3 The People Step In—Mansagar Lake, Jaipur

When a deadly famine struck Rajasthan in 1596, the ruler of Amer, a town near Jaipur, built an earth and quartzite dam across the Darbhawati river to meet the concomitant water shortage. The dam directed water into a natural basin in Aravalli hills, creating the 300-acre Mansagar lake. At its centre was built the majestic Jal Mahal or 'water palace'—a summer resort where the royal family would host duck-hunting parties. Maharaja Jai Singh II restored the lake and the palace in the 18th century, the last time a comprehensive project was undertaken.

The Jaipur city administration's plans in the 1960s entailed channelling sewage from the city into the two large storm water drains that fed the lake from its catchments in the Aravalli Hills. This rapidly converted it into a cesspool and ruined the palace. The lake silted up, birds and local flora suffered. Some attempts were made to restore the lake but these piece meal, ill-funded projects were unsuccessful.

The turnaround for the lake began in 1999 when the state government developed a plan to clean up and revive Mansagar lake. The fact that it was the state government and not the ULB, the Jaipur Municipal Corporation, that took the plunge indicates a lack of foresight and ability on its the Corporation's part to undertake such a mission. This finds echo in other cities as well where municipalities have not planned and executed revival plans for lakes in their jurisdiction, as we will see. A public-private model was developed involving the Jaipur Development Authority, local citizens and a private company called the Kothari Group. Jal Mahal Resorts Private Limited won the tender for the project in 2004.[18]

The company was to clean and repair the lake and the palace and the government leased it 100 acres of land near the lake for developing tourism and recreation activities to recover its investments. Citizens were part of the monitoring committee that included officials from JDA and the Ministry of Environment and Forests. The project was executed under the National Lake Conservation Plan of the Ministry. A 99-year lease was signed between JDA and the private company at an annual lease of Rs. 2.52 crores with an increase by 10% every three years.

[18]Mansagar restoration model—success through innovation, 2013. Jal Mahal Resorts Pvt Ltd.

The first task was to stop inflow of sewage and solid waste through the drains, Brahampuri and Nagatalai, that flowed from the catchments through Jaipur, collecting the waste. In the map, the drains are marked in blue. They are fed by small streams from the east and west hills that carry untreated sewage from the city. A 1.5 km channel was constructed to divert this water to the south of the lake into a sedimentation basin on the east side of the lake. This screened out solid waste. The lake was dredged to remove accumulated silt deepening it by nearly 2 m and increasing its storage.

This had a salutary effect on water quality. Tests on water samples showed a sharp reduction in the biochemical oxygen demand (BOD) after passing through the sedimentation basin from 450 mg/L to 25. The coliform count fell from 2.4 million in 2000 to just 7000 in 2009–11.[19]

Apart from these two major steps, two sewage treatment plants also constructed to treat 7 million litres of sewage daily. This sewage was discharged into the lake. This helped maintain water levels in the lake. Mansagar Lake, that used to dry up in summers, now had water through the year. Five artificial nesting islands were made to attract migratory birds, fishes were introduced and giant bubblers were installed for aeration.

In 2010, the citizens and JDA organised a birding fair near the lake to popularise it as a tourism destination. This was a huge success and drew attention to its ecological importance.

In an unexpected development, the Rajasthan High Court in 2012 abruptly ruled that status quo must be restored in the lake. This meant dismantling all the infrastructure and letting sewage flow back in. The petitioners, K P Sharma of Rajasthan University, Dharohar Bachao Samiti and Heritage Preservation Society, said the project gave the private company undue benefits that violated various national acts and local municipal rules. However, shortly thereafter the Supreme Court stayed the

[19]Revival of Mansagar Lake, Jaipur: A case study, 2016. National Institute of Urban Affairs.

order and instructed the private company to only continue with maintenance work on the lake.

The Mansagar lake example shows how a well-conceived restoration activity can quickly run afoul of people who see conspiracies in private sector engagement in water-related projects. It also shows local authorities often do not have expertise in lake restoration and must engage experts.

6.4 Delhi, Neela Hauz

Like Mansagar, Neela Hauz in south Delhi is an artificial lake in a depression. It was created by building a low wall across a seasonal drain. The lake is at the head of a long water system that through a series of ponds and channels ends at the Hauz Khas lake. It is ecologically important as it helps maintain aquifer levels in south Delhi and is a source of water for local animals. It covers an area of about 2 ha and is bordered by Sanjay Van, a reserved forest, on three sides and institutions on the fourth.

Before Vasant Kunj and surrounding areas were developed, local people say the Hauz had plenty of rain water and was clean enough to swim in. After the developments, untreated sewage was discharged into the Hauz by the Municipality from Kishangarh, a nearby urbanised village and Vasant Kunj. This quickly reduced the Hauz to a cesspool. Local contractors dumbed construction debris and people threw garbage and dead animals into the pond. It was on a fast lane to becoming a memory like so many other water bodies of Delhi.

In 2008 the Delhi government started preparing for the 2010 Commonwealth Games. One of the projects was building a bridge over the Hauz to connect newly-made quarters for athletes in Vasant Kunj to the stadia. While residents welcomed this, they opposed destruction of the Hauz. They banded together under the Neela Hauz Citizens Group banner and launched a campaign to restore it. Public meetings and protests drew attention to the problem with the lake.

Meetings with the government revealed agencies working at cross-purposes. The Delhi Development Authority owned the land. The Public Works Department built the bridge through a contractor. The state environment and forests department gave the necessary clearances. The Municipal Corporation of Delhi washed its hands off the matter. None was willing to take responsibility for restoring the lake once construction was[20] over.

The Neela Hauz Citizens Group went to court to hold the authorities to account. This established ownership of the land, which all were denying. Some pointed to the MCD as the land owner. In court, however, DDA claimed ownership. A sequence was established for its restoration.

[20]Writ Petition No. 6914 of 2011, Delhi High Court. Malvika Kaul Versus Government of NCT of Delhi and Others.

PWD was to clear the area of all construction debris and material at the earliest and hand over the land to DDA for restoration. The Delhi Jal Board, that managed water supply and sewage treatment, was to prevent the ingress of untreated sewage from the adjacent village into the lake. Instead, it would provide treated water from a sewage treatment plant nearby. Neither happened even after the DDA completed its restoration.

As a workaround, the Neela Hauz Citizens Group worked with DDA to develop a water treatment system through an artificial wetland on the side from where sewage entered the lake. The lake was dredged, a wall constructed to raise its water level and trees and shrubs were planted to improve the local ecology. The steady inflow of water, treated and filtered through the wetland, has now ensured a stable water level in the lake. The overflow goes through a forest and into the Hauz Khas lake a few KM away.

Neela Hauz's example demonstrates the value of litigation coupled with local action in a positive manner. The group kept up pressure on the authorities through meetings, media and the courts. It drew in experts to advise on water treatment and brought DJB, DDA and PWD to the negotiating table. Called to account the agencies had to agree to a time-bound restoration plan.

The plans prepared by DDA, the agency responsible for restoration, were strange. They had construction of a boundary wall and walking track, parking area, tree plantation and beautification of the area adjoining the Hauz. There was no mention of how DDA would improve water quality. Through subsequent negotiations, the Group impressed upon the DDA officials to build an artificial wetland to treat sewage before it entered the Hauz.

The PIL impleaded DJB to only release treated sewage into the Hauz, intercept and treat all sewage flowing into the Hauz. While DJB's officials agreed to this in a meeting with the Group, it was only partly implemented. DJB intercepted one drain and diverted it to its treatment plant. Another, larger drain, was 'discovered' later and left untouched. Sewage from this one flows through the wetland, into the Hauz and beyond.

Even so, the restoration carried on till 2015. The court had ordered it completed by 2011. In its current form, an artificial wetland where the sewage enters the Hauz partially treats the water. The rest of the treatment happens in the pond. Water from the pond flows through a pipe into the neighbouring forests. Its quality is much better than a decade ago.

There are conflicting opinions on using these water bodies as treatment zones or even allowing treated sewage into them to maintain aquifers. One opinion states since DJB is incapable of treating all the sewage in the city, these bodies will continue getting untreated sewage. Therefore, all inflow of this water must be blocked to keep them from becoming cesspools. The counter-opinion states that these bodies need water and since their catchments have been built over, treated sewage is their only source of water.

The solution is viable citizens' bodies comprising residents to ensure no raw sewage enters these ponds and lakes. These bodies are already empowered under various legal cases to act and can take up the issue with DDA and DJB. It is critical

to keep these water bodies full of water and protect them from those would dump debris in them.

In this case, the city's development agencies worked at cross-purposes. The overall effect was to degrade the environment in a part of South Delhi affecting local water resources and forests. The custodian of these resources is a non-representative body, DDA. Its functioning is opaque and consequently, riddled with corruption.[21,22,23,24] When they refused to respond to letters and requests for meetings, the Group filed the PIL that forced them to the negotiating table. The first order of the court was for a time-bound restoration plan. When the agencies failed to comply, the Group filed another petition that finally forced the DDA and PWD to act.

6.5 Hussain Sagar, Hyderabad

This old artificial lake was built by Sultan Ibrahim Qutb Shah in 1575 at a cost of Rs. 2.5 lakh. It supplied drinking water to Hyderabad, but since 1930, the city has switched to other sources. It has also protected people living in low-lying areas from floods. The main threat to the lake was encroachment by private and public agencies. Over 30 years, its area shrank 40 per cent from 550 to 350 ha. Additionally, untreated domestic sewage and industrial effluents turned it into a cesspool.

Knee jerk, piece meal efforts have been going on for 15 years to revive and protect the lake. In 1995, a Public Interest Litigation was filed by K L Vyas, convenor of the Save the Lake Campaign in the state high court. The judgement covered the protection of all water bodies in Andhra Pradesh. In 2000, the Hyderabad Urban Development Authority (HUDA) issued a notification to protect lakes in and around the city but it has continued to sanction projects on water bodies. In 2001, the court finally ruled that no further permanent structures including involving activities will be allowed on or near the water of the catchment area.

In 2007, WWF and the Buddha Purnima Project Authority of the Hyderabad Urban Development Authority (HUDA) studied its biodiversity. It suggested mitigation strategies to restore the lake and improve its biodiversity. Four drains carry polluted water into the lake: the Kukatpally drain, Balkapur drain, Banjara drain and Picket drain. These carry 78 MLD of sewage into the lake, according to the state pollution control board.[25]

A sewage treatment plant has been set up on the Balkapur drain to treat 30 MLD, and another 20 MLD one has been made to handle waste water from the Kukatpally and Picket drains. However, Save Our Urban Lakes (SOUL) activists say these are inadequate. A proposal for improving water quality entailed diverting untreated

[21] 17 DDA Officers Booked for Corruption in Last Three Years (2016).

[22] Over 300 DDA Employees Face Corruption Charges (2009).

[23] MCD Tops in Corruption Cases (2009).

[24] Lokayukta be Allowed to Probe Corruption in DDA (2015).

[25] Sengupta (2015).

sewage and industrial effluents into the Kukatpally drain that bypasses the lake and empties in the Musi River. However, this has its own problems as the water is very severely polluted. In 2010, HUDA tried out bio-remediation to improve water quality with little success.

To mitigate the high concentration of heavy metals in the water and sediments, and pollution in general, it proposed bioremediation strategies using microbial inoculation, phytoremediation and bioaugmentation. In 2012, C. Venkateshwar of Osmania University claimed he had technology to clean up the lake in 15 days. Called Venkateshwara Technology, he said it would do the needful at a fraction of the cost of other methods.[26]

The different citizens groups like SOUL and Forum for a Better Hyderabad have been pressuring the government agencies for restoring the lake. In 2005 the Supreme Court appointed a three-member committee to examine all aspects of the lake. The committee assessed the encroachments and recommended their removal.[27] This is only now beginning to bear fruit.

In addition to the lake, its feeder channels have been encroached upon. GHMC was assigned the job to remove these but in 2014–15, managed to remove only 775 of 2452 encroachments. Political interference is the main reason for this. In 2015, the new government of Telangana proposed drastic measures—to drain the lake, desilt it and refill it. Thankfully, this was never carried out given its gargantuan size.

Here again, while the Greater Hyderabad Municipal Corporation (GHMC) was largely responsible for the lake's deterioration, it had no role in its restoration. The citizens and courts have kept up the pressure on the authorities. This at least has halted encroachment even though it has not had any tangible impact on the water quality. Hopefully the government and citizens will come together with a viable plan for the lake.

6.6 The Bhoj Wetlands Projects, Bhopal

There are 18 lakes in and around Bhopal, the largest of which is the Upper Lake. Created by constructing an earthen dam across the Kolans driver in the 11th century, its original spread was about 300 km^2. In 2002, MoEF declared them as the Bhoj wetland and it was declared a Ramsar site. An integrated plan for its conservation was developed and executed from 1995–2004.

On its part the state government constituted the Lake Conservation Authority in 2004 and registered it as an autonomous society to manage all the lakes in the state.

The rapid growth of Bhopal created the usual mix of pollution and encroachment. Water inflows were reduced because of construction in the catchments. Idol immersions raised the amount of clay and non-biodegradable material in the lakes. Obstruction of the spillway for the Upper Lake increased siltation. Untreated sewage,

[26] Sreedhar (2012).

[27] Nitin (2016).

dumping of solid waste by the Bhopal Municipal Corporation and encroachments along the edges polluted the water.

The conservation plan took care of these issues in an integrated manner. Executed by the Bhoj Wetland Project Directorate and supported by the Japan Bank for International Cooperation, it was started in 1993. It gathered speed only five years later when procedural and administrative issues were sorted out.

In the project, no construction was allowed within 50 m of the full tank level. Encroachments were removed and roads were built to demarcate the lake's boundaries to the north-east and south-east. Plantations were created in buffer zones to check soil erosion. The catchment areas were treated. Sewage lines, pumps and treatments plants were made—87 km of sewers were laid in areas from where sewage flowed into the lake and STPs with a combined capacity of 56 MLD were made. The lake was dredged in five zones. Idol immersion during festivals was stopped and restricted to a certain area of the lake.[28]

A NGO called Prayatna filed a PIL with the State Human Rights Commission on the mismanagement of biomedical waste by the Hammadi Hospital.

The case of the Bhoj Wetlands is interesting as it was a multi-stakeholder high-stakes project. The work done under the project was designed to handle future growth. Even though political compulsions in the form of pressure from builders continues to gnaw at the lakes, they have held their own more than a decade after the project was completed. NGOs have ensured the government remains on its toes. Here again, the Bhopal Municipal Corporate has little role to play, underlining the lack of interest and ability from the ULB.

In all the cases above, the municipality has been a bit-player or the agency responsible for destruction of the water bodies. ULBs also have little or no role in providing water, as we saw in the first part of this section. This lowest rung of governance, where citizens have a voice through their municipal councillors, is ineffective in providing drinking water or protecting what is left of local resources. The causes and solutions have been discussed above. It is for bureaucrats and politicians to provide space for ULBs to grow by handing over responsibilities to specialised cells within them. Only then can they claim to represent the needs of the people.

6.7 Rural Water Issues

Compared to the mess and opacity of urban water supply, rural water supply is relatively straightforward. In most states, a single agency such as the public health engineering department, provides drinking water while the irrigation department provides with water for agriculture. A single source usually covers multiple uses, called multiple use water supply (MUWS). For instance, the same tube well could be used for drinking, irrigation and watering animals.

[28] Kodarkar and Mukherjee (2006).

Tube wells are the main source of drinking water, covering about 80% of the rural population.[29] The trend of providing hand pumps and tube wells started in the 1960s, accelerated through the 1980s and 1990s and is now the accepted norm. Various estimates put the number of tube wells in India at about 30 million; these include irrigation pump sets, hand pumps, private tube wells, wells by industries and water utilities. This, along with urbanization, has put a severe strain on ground water as we saw in the previous section. It is now the main cause of rural water shortages.

Under the 73rd Constitutional Amendment, panchayats are mandated to build and manage their water supply systems. In practice, it is very different. The government department concerned installs tube wells or hand pumps on the demand of panchayats. In most states, they also repair faults. Some states have local networks of hand pump mechanics who, for a fee, perform this job. Some have upgraded their skills to fix piped water networks as well.

Each sarpanch and village secretary, along with the ward members of the panchayat, is responsible for preparing a water security plan. The National Rural Drinking Water Programme (NRDWP) guidelines place the onus of this on the panchayat. They also state panchayats need to have a village water and sanitation committee (later, this was change to the village health, sanitation and nutrition committee) for the purpose. The committee is to ensure all households have adequate and safe water. The current service level under NRDWP is 40 L per capita per day (lpcd) and drinking water must meet standards of the Bureau of Indian Standards (BIS).

Water governance at the panchayat level has slowly moved from a supply-led to a demand-led approach. The high gross coverage levels of 98% is one reason, as people do not merely need a top-down approach to coverage. Instead, they need a system that responds to faults and quality issues.

In this, people express their needs at gram sabha meetings that are recorded and collated into a water demand from the panchayat. The overall availability, quality or access are not considered, just the presence of a working water source. For instance, they could demand a hand pump in place of another that has gone dry. Even knowing the cause (depleting aquifer) will not deter them from placing this demand if it provides water for the present.

Sarpanchs collate and present the demands from the village to the block office where a junior engineer vets them and gives approval if it meets certain criteria. The criteria he uses is the presence of another working source within the prescribed distance (of 150 m) or recorded water quality issues. Each panchayat is provided a field test kit to do a quick and dirty quality assessment. If a problem is found, the panchayat can opt for testing in a district water quality lab. This and water plans are passed up to the district water mission for approval and action.

Each district has a water (and sanitation till Swachh Bharat Mission started) mission. The executive engineer heads the mission that is chaired by the collector or magistrate and co-chaired by the district chief executive officer. This multi-stakeholder body is supposed to plan water supply for rural areas in the district, allot funds and monitor. It is also supposed to run water quality testing laboratories where pan-

[29] Ministry of Drinking Water and Sanitation MIS.

chayats can send suspect water samples. Most districts have laboratories but not all are adequately staffed or funded. The Central government recently allowed district water missions to use the services of local colleges that are equipped to test water on payment.

In practice, it collates plans and requests received from blocks into a district plan according to a format specified in NRDWP. This is sent further up to the state public health engineering department. In some states, this sits under the rural development department that is headed by a principal or additional chief secretary. A chief engineer runs the PHED in the state, supported by additional chief engineers for different functions such as engineering and finance. Zonal engineers take care of water supply in different zones of a state. This is the typical PHED structure though some states have variants of PHED that follow the same structure.

In most states, PHEDs do not have engineers below the block level. That means one engineer is responsible for managing water supply for approximately 100,000–120,000 people spread over 12–18 panchayats and a large area. This creates problems of adequate monitoring and timely fault repair. Conventional response times stretch over days or even weeks, forcing people to fall back on poorer quality water sources.

The village water security plan should have details of the water demand, sources, distribution, source protection and quality monitoring. It can be defined as the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks.[30] The plan balances supply with demand. It takes care to identify and protect sources for drinking water. The supply must be equitable and affordable.

A complex plan like this is often beyond the expertise of the sarpanch, his secretary or others in the panchayat. Here again, the government guidelines allow them to hire experts or an NGO to make the plan. Many NGOs do this as part of their regular, grant funded projects as well. A comprehensive village water security plan can have a multi-crore rupee budget and be implemented over several years.

Even if an NGO or expert prepares the water security plan, it is best done in consultation with the sarpanch and other village leaders. There are several variables to be considered: population composition, scattered hamlets, local water sources such as ponds or rivers, ground water, rainfall, terrain, land use, forest land on the one hand. Multiple uses of water in a typical village are irrigation, watering animals and human use (drinking, cooking, bathing, washing and hygiene). Each needs water of progressively higher quality.

The main consideration in water supply so far has been of quantity of 40 lpcd. This is somewhat erroneous. A person needs about 10 lpcd of water of the highest quality for cooking and drinking at or near home. Water for bathing and washing can be of lower quality i.e., have excess fluoride, arsenic or dissolved matter; people sometimes walk to the nearest well or hand pump not used for drinking. Animals are usually bathed in the nearest pond or stream, though this also has potential to pollute a source for the neighbourhood, if carried out indiscriminately.

[30] Water Security Plan of Tumbabel Panchayat, Jharkhand (2014).

Water security plans must cover these various aspects with adequate water of the right quality. In doing so, they must ensure drinking water sources are protected. There are two types of safeguards, one to ensure there is water year-round, and the other to ensure quality. Watershed treatment upstream of the source addresses both. State and district governments, NGOs and companies have extensive watershed treatment programmes. While not explicitly directed towards water security these are designed augment overall water availability in downstream areas.

Unfortunately, in these plans panchayats are passive recipients, even though they participate in planning. Their lack of expertise and funds to implement the plans are constraining factors. Very often, plans run afoul of forest departments since a large part of the watershed activities need to be executed on forest land. In some cases, the departments build the structures needed but this is the exception. Thus, water security plans need to factor the risk that forest departments will be unsupportive. Even petitioning the district collector/magistrate can fail to convince the department to let the panchayat build watershed structures on their land.

NGOs state their plans are made and executed with the panchayat. This is partly true. The panchayat does provide inputs for planning but seldom for execution. There are exceptions that prove the rule such as in the Sobara panchayat of Gajapati district, Odisha and Hiware Bazaar in Ahmadnagar district, Maharashtra. A somewhat different approach is to be seen in the Arvari river basin in Alwar district, Rajasthan.

6.8 Sobara Panchayat's Water Use Master Plan (WUMP)

A WUMP is a participatory planning tool developed to help experts and panchayat members prepare water master plans. One definition is that is a holistic, participatory and inclusive planning process that takes an integrated approach to the management of water resources and uses at the village level. It specifies the total water budget for its planning unit, the village development committee (VDC), and explores potential uses for it. It empowers marginalized groups to claim their rights to an equitable share of water with in and between communities. WUMP also helps local bodies with annual and periodic planning and project prioritization.[31]

WUMP was tried out in the Sobara panchayat of 11 villages on the Odisha-Andhra Pradesh border, in the Gajapati district. The hills are forested on their upper slopes with tropical deciduous forests, while the lower slopes are part covered with plantations and part denuded where the indigenous Soura people practice shifting cultivation. The flatlands are sown with paddy, sugarcane, ragi, vegetables, pulses and groundnut. Parts of the panchayat are well-watered by the Mahendratanaya River.

The lower slopes of the hills in the Panchayat have been planted with a monoculture of cashew. From just 20 acres 40 years ago, the area under cashew has increased to 240 now. They do not inter-crop cashew with other plants; inter-cropping helps improve soil moisture and reduce soil runoff.

[31] Bhatta (2013).

All villages have various water sources, the most common being a dug well, followed by handpumps and streams. Ponds have also been part of the water landscape for watering animals and irrigation but most villages have relegated them to the background; these are now making a comeback as part of village WUMPs. Along with ponds, people have started making small dykes across the many drains, along with percolation tanks, for rainwater harvesting (RWH).

A few of villages (Padmapur, Hatibadi and Gowda Talasing) have piped water systems, though only the one in Padmapur works. Each village occupies its own micro-watershed making water use planning localized and simpler as there are few upstream-downstream issues. Hatibadi is the only exception to this.

A local NGO, IWD, started the two-year WUMP project in 2010 to evaluate the impact on water resources and women's empowerment. WUMP was an exercise to assess the total availability of water and future trends. By getting people to understand, map and plan to improve their water resources WUMP has effectively empowered especially women with an understanding about their rights, responsibilities, government schemes and how to approach government officials. The planning included projecting current and future water use (up to 10 years in the future), preparing water balances, source sustainability, assessing natural resources, conducting a needs assessment and training for needs assessment and planning. It culminated in developing and executing a WUMP that included a capping mechanism to control the use of water, for example through changes in cropping patterns or alternative livelihoods. Sanitation was included to demonstrate the link with hygiene, health and the use of toilets.[32]

The main planning tool was a map of each village showing houses, natural resources (forests, water bodies and streams, grazing grounds and fields), defecation areas, garbage sites, roads, hills, places of worship, government buildings and big trees. The maps also showed the cattle paths, routes people took to bathing wells or springs, irrigation channels, check dams, light points and telephone towers. They helped people understand their surroundings geographically. The NGO staff supervised preparation of the maps while the educated youth of the village made them, along with palli sabha members and women from self-help groups. It was a guided, participatory process involving the panchayat as well.

Another tool listed the power hierarchies such as the powerful people and the relationship between them, and the community. This included government officials from the panchayat to the district, their functions and schemes they administer. These helped people understand how power flowed and by extension, who to approach for specific problems. For instance, they had to approach the district education officer for opening a school, or if a school teacher was not coming on duty regularly.

The water use charts indicated how much water the average household used, for what purposes, where they got it from and who fetched it. Women fetched 4 buckets of water a day per house but households using toilets needed another two a day. Therefore, toilets had increased the load on women that was the flip side of convenience, safety and any health benefits that may accrue.

[32] Jacob (2011).

IWD's work created considerable social capital though activities in women's empowerment, strengthening panchayats, livelihoods and governance over the past decade. There were self-help groups in the 11 villages covering 90% of adult women. These SHGs had given them employment and empowerment. SHG women were more vocal, politically aware and readier to get their due from their elected representatives and government officials.

For men, the NGO facilitated the creation of Village Development Committees (VDCs). These comprised half of men and half of women in each village and were responsible for all the development work. They were instrumental in securing government schemes and money and solving local problems. Ward members were also part of VDCs.

Both SHGs and VDCs helped in village cohesion, an important factor in more effective village planning under WUMP. This pre-existing social capital catalysed the project by accelerating the evolution of consensus around any issue. To the social capital was added expertise on watershed development and rural development by empowering panchayats. The WUMP process had the following steps –

1. A transect walk to understand the physical and social geography of each village along with all village members
2. Dividing the villagers into groups for each activity
3. Identifying literate youth to make maps and charts
4. Preparing the map with the physical, social and natural features, including garbage disposal and defecation sites
5. Preparing charts on power equations in the village, disease mapping by type, season and prevalence, water consumption per house by use and the government machinery responsible for different schemes
6. Identifying watershed activities required for improving water quality and quantity. For example, in S Talasing, people decided to dig two recharge ponds and two bunds upstream of the village to ensure that at least one well downstream has more water in summer; located next to the village church, the well is the only perennial well but even that has little water in summer
7. Watershed protection such as tree plantation even inside cashew plantations where, in the places around recharge ponds, local shrubs and trees were planted. However, the scope for additional tree plantation was limited owing to the natural forests and cashew plantations
8. Identifying improvements to existing wells, toilets and handpumps to improve sanitary conditions and reduce bacterial contamination
9. Other measures to improve better village hygiene. In Hatibadi for example, they decided to keep cows off the main village street as the huge quantity of cow dung made the street hard to walk on, attracted flies and smelt bad.

WUMP has achieved early success in the panchayat to improve water use planning, community empowerment, greater ability of panchayat members to deliver services and government schemes, and leveraging government funds. More than water, what was most striking was the confidence that some of the ward members and sarpanch showed in dealing with officialdom. Whereas earlier they were content to sit out their

terms, after the programme they became proactive agents of change who wanted to derive the maximum benefits from government schemes.

This project drew on the IWRM techniques of data collection, participatory planning, watershed treatment and conjunctive use of water to work out current and future water needs, and therefore, what must be done to meet them. It brought in sanitation and influenced behaviour. It enabled the panchayat to tap into MGNREGS and other government programmes to create village-level assets such as water harvesting structures and wells.

The work continued through source protection, watershed treatment, replacing plantation crops with natural forests, reducing soil erosion and discouraging jhum cultivation. Sanitation had improved, but toilets were sometimes located upstream of water sources. This needed to change.

Much more attention was needed on water quality, a glaring omission in the early part of the project. True, most water sources were checked and found to be clear of arsenic and fluoride, but bacterial contamination was common. This could be handled simply by boiling water.

Sobara's example showed how involving a wide range of local and higher-level officials and politicians accelerates a programme. Water became the rallying point for all other activities as people recognised it as a central resource. Being agrarian, the panchayat's people use water for everything. Most own farmland or plantations. This made it easy to evolve consensuses on WUMP.

The project took in the bigger picture of water security, not just drinking water. That was an essential ingredient for its success. Had it focussed only on drinking water, it would not have got the support of most men who manage cashew plantations and rice. Even though women were empowered by being in SHGs, their power to take larger decisions—a piped water scheme for a village, for example—was still inadequate to influence higher authorities.

WUMP also had the advantage of several micro-watersheds. Nearly all villages had their own and only two shared a watershed. In their case tensions had arisen over sharing water; the downstream village had a piped water scheme and the main supply pipe ran past the upstream village. The source was common to both. The villagers upstream frequently interrupted water supply. IWD resolved the matter only after protracted negotiations and the BDO's intervention. It was a fragile peace.

A well-established NGO can stretch government resources much beyond what they are designed for. In Sobara's case this meant using available MGNREGS funds for all the watershed treatment works, including digging pits, canals and check-dams. The forest department cooperated with the NGO unlike in many other places where water security plans have come to nought because of their intransigence. The NGO had built up the social capital required to fast-track the project; it could achieve in two years what might have otherwise taken four.

6.9 Hiware Bazaar, Maharashtra

Ahmadnagar district makes news for drought rather than sensible water management. This arid part of the state is susceptible to failures in rainfall. Tube wells have lowered the water table and made finding a water vein a hit or miss affair. The hard-rocky geology makes is even harder to get ground water. In this extreme environment, the example of Hiware Bazaar stands in stark contrast to moribund government schemes.

Hiware Bazaar in Nagar taluka has a population of about 1300 comprising mostly Marathas engaged in farming. Some had taken up jobs. However, nearly all families owned some land (about 10 out of 220 families did not). Those who did not had very limited say in the programme. Till the early 1990s, the panchayat had scarce water and most farmers could just manage one kharif crop and jowar in the rabi season. Alcoholism and gambling were common.

In 1989, some young villagers persuaded Popatrao Pawar to return to the village and work. He contested the gram panchayat elections and was elected as the sarpanch. Importantly, both the impetus for change and leadership came from within the village itself. The inspiration came from Ralegaon Siddhi and Tarun Bharat Sangh.

Pawar started with 'safe' works such as fixing the school walls and expansion, and repairing the village temple. Having established his credentials, he took on more pressing issues: eliminating alcoholism and augmenting water availability. The village took up watershed development and applied to the Adarsh Gram Yojna.

Gram sabha resolutions were adopted to work on the 'panchasutri' or five principles: restrictions on free grazing, ban on tree felling, ban on alcohol, adoption of family planning and voluntary labour. Pawar set up an NGO called Yashwant Agricultural, Rural and Watershed Development Agency in 1993 and started work in 1994. Here again, the NGO was home-grown and worked with the gram panchayat.

The geographic area of the village was divided into three micro-watersheds. Activities included contour trenching and tree plantation (on forest, private and panchayat land), contour bunding, nala bunding, making percolation tanks and storage structure (bandharas). These were completed in four years under AGY. This had the immediate visible impact of raising ground water levels and biomass.

The technical quality of the watershed works and the socio-economic changes have been widely documented and acknowledged. From a single cereal crop, farmers started growing high-value horticultural crops such as onions, garlic and mustard. Additionally, more area was brought under agriculture. The animal population increased as did dairying. Milk production increased tenfold and the village set up a dairy cooperative.

Socio-economically, migration to cities stopped. People built themselves brick and mortar houses in place of mud huts. All of them had toilets and water. Women did not have to walk long distances to fetch water. But they remained domestic water providers and responsible for watering and bathing animals.

Initially, the panchayat banned cutting of trees and demarcated areas for grazing, preventing cows from entering the areas where watershed works were in progress. The gram sabha resolution on tree felling prevented people from cutting any branches

of trees on the village commons; they could do so from trees on their land. This reduced soil erosion and enabled regeneration of local flora. But it deprived landless households of firewood and nothing was done to help them. Other water works followed such as contour bunding, building recharge structures and percolation tanks.

The panchayat imposed rules for water use and distribution. These determined who would get water and how it was allotted. All landed households were in principle allowed open access to ground water without separating land ownership from water rights. Those whose benefits from watershed development were limited were compensated.

The ban on tube wells for agriculture and water-intensive crops ensured groundwater use was both sustainable and equitable (larger farmers did overdraw ground water at the expense of smaller farmers).

Perhaps what is of most concern to women is water for domestic use. This is mentioned in the objectives of watershed development but technical works take precedence. In Hiware Bazaar, only a few common sources for drinking were built for drinking water. The panchayat installed 12 handpumps that ensured the benefits of improved water availability was not limited only to those with their own sources of water. Additionally, the distance to source was reduced and dependence on tankers in summer, eliminated.

Social aspects were harder and started later. These addressed alcoholism, family planning and getting villagers to contribute voluntary labour, 'shramdaan'. The village people adopted restrictions on cultivation of water-intensive crops and on the digging and use of borewells. Sugarcane and rice were a strict no-no.

The grazing restrictions were removed once the watershed structures were completed. People could take a head-load of grass a day on payment of a fee of Rs. 100 a year (waived for poor households).

Most households contributed voluntary labour, shramdaan, for the watershed project. Households contributed because it was a requirement under AGY. They also contributed because of the perceived agency it brought them in the programme. The contributions allowed them access, within rules, to the commons created or enriched by the programme. This applied to the landless and landed households alike.

Even though water availability increased, the benefits were unevenly distributed, at least in the beginning. Bigger land owners benefited earlier and more than others because land ownership was correlated to ground water ownership. While household incomes increased, so did intra-household disparities as women seldom owned land. Some claimed their work load had increased because of the rise in cattle population.

Employment and wages went up in the village. However, even here there were disparities with women getting half as much as men. Thus, while there was more work—the cropped areas increased as did the number of animals—men and women continued to be paid different rates.

Hiware Bazaar has several SHGs that have had a positive impact on women, especially from the landless, marginal, and small households who make up the bulk of members.

A limitation of these projects and programmes is their size. Both have been very successful in small, homogenous rural communities. An NGO has worked with the

panchayat to bring about change. The amount and quality of water has increased significantly. So, has the ability of people to plan and manage it. But when it comes to taking these examples farther afield, the models falter. They run into all sorts of resistance, from different socio-cultural contexts and climatic conditions to a recalcitrant bureaucracy and sarpanchs unwilling to change. An exception to this has been the Arvari Sansad that is one of the river basin level organizations in India.

6.10 Arvari Sansad, Rajasthan

The Arvari river flows through the Alwar district of Rajasthan. It has four tributaries and tens of villages in its catchment. The area is dry, on the edge of the Thar desert. Ground water was scarce and CGWB had declared it a 'dark zone' from where no further groundwater was possible. This was despite the Sariska Forest Reserve nearby and several other ranges of the Aravallis. Since the 1940s, when forests covered a lot of the area, it had been systematically denuded and farmed. This accelerated in the 1970s and 1980s creating an ecological wasteland. Extensive and mostly illegal mining, abetted by politicians and bureaucrats, added to the toxic mix.

From the mid-1980s Tarun Bharat Sangh, a local NGO, started working on restoring the water balance in the area. Nearly all villages have ponds (johads) that had gone dry in a prolonged dry spell in 1985–86. One of TBSs' early pioneers Rajendra Singh wanted to teach children in the local villages but a tribal elder suggested to solve the water problems instead. He explained the tradition of building johads, which were created by making an earthen check dam across a ditch to stop the flow of rain water allowing it to percolate into the ground.

Over the next 30 years, TBS built over 10,000 of these simple little water-harvesting structures and restored 2500 ponds in 1058 villages. Hydrological studies have indicated recharge of ground water from johads but in the absence of a baseline, it is impossible to quantify improvements since 1985. Anecdotal evidence from talks with village people points to substantial increases in water in wells; many that were dry have water round the year.

With the revival of the river, aquatic life prospered and there was natural growth of the fish population. As a result, the government gave the contract for catching fish to a private party. The people of the region, whose hard work had revived the river, resisted this move, suspecting that the government may try and take control of the whole river. Individual villages found it hard to resist this. TBS decided to unite them and present a single face that could take on larger, river basin issues.

There were also disputes between villages, such as between Bhaonta-Koylala and Aghar, over access to the Bhairon dev Lok Van Jeev Abhyaran, or people's wildlife sanctuary. This sanctuary is spread over 14 km^2 and has been formed by the people of 5 villages who decided to protect their common lands, as also wasteland, that lay between their villages. In just seven years, the hills are green and covered with shrubs that will grow into trees. The sanctuary is proof that people willing, old cultural links between man, water and forests can be revived, with dramatic effects.

The major challenge was carrying forward the Bhaonta experiment to neighbouring villages. Aghar is a larger village of about 5000 people, few of whom depend on farming. They feel there are ample natural resources now and don't feel the need to create more. Many brew liquor illegally for which they need wood. Rather than pay, they go into the sanctuary and cut what they need. Others from the village follow their example.

"In a large village like ours with 5000 people, only those with a stake in agriculture are concerned about the environment. Traders, those making hooch and other such people have little interest in protecting it," says Gauri Shankar, shopkeeper and farmer. "The TBS's work has been extremely successful in Bhaonta because it is small and more people have a stake in farming."

To deal with inter-village disputes and external threats, the Arvari River Parliament was set up in 1999. The Parliament, with two representatives each from 72 villages, has framed 11 rules regarding the use of the river waters, relating to all aspects of water management, from the extraction or selling of water from the river, to the revival of traditional methods of water conservation. A coordination committee comprising members selected by the Parliament handles the operations and ensures compliance with the rules.

The Arvari Parliament meets twice a year and has been successful in resolving conflicts and safeguarding the water resources. Though it has no legal status and its decisions are not legally binding, the moral force of the people made its survival possible. The staff of TBS facilitated the Parliament initially and its success has consolidated its position.

The village representatives are nominated by the gram sabha, not the sarpanch. Conventionally, they are people who have worked to restore local water resources such as johads, or plantations. This loose criterion has helped ensure those in Parliament know what they are talking about and discussions are focussed on water and soil conservation.

The Arvari basin presents a stark contrast to others in the area. For most of the year, farms are green. The vegetation is diverse though still dominated by vilayati babul, the Mexican mesquite the British imported at the turn of the 20th century to 'green' the Aravallis and provide their new imperial capital of Delhi with wood. Diversifying vegetation has not so far been a priority of TBS because it involves working with the forest department. However, villagers have planted peepul, neem, bargad, bel, ashok and amla local trees that are suited to the climate and soil.

Another blind spot has been transforming the condition of women. Like elsewhere in India, women provide for water at home and for livestock. The usual source is the hand pump, installed abundantly in the villages. True, most used to run dry before TBS started work and now have water round the year. This had made it easier for women to fetch water.

However, village rules such as those forbidding the entry of cattle into ponds to preserve water quality make it necessary for them to fetch water home to bathe livestock. While good for the johads, it is not so good for the women. TBS feels a blanket approach that improves overall water availability is good for all and therefore does not need to do something specifically for women.

This watershed improvement work has been gender-blind. It has not specifically reached out to people of lower castes, other religions and the disabled. Equity, in other words, has not been explicitly addressed and remains a glaring gap in an otherwise successful venture.

True, the overall availability of surface and ground water have improved. Despite increasing population and mining for dolomite, the water situation remains stable.

6.11 IWRM?

Perhaps unwittingly these three rural water augmentation cases have followed IWRM principles (or vice versa!). They have taken the overall water availability to use and balance the water budget. Cropping patterns have been altered with consent of farmers, overuse of ground water has been curbed and local institutions have been brought into decision-making and management. The missing component, of no great significance here, has been assigning water rights.

What has worked in their favour is the absence of any industry or major town in the vicinity. Both are large water sinks drawing in resources from far afield and large quantities of water to dilute their pollution. Small and relatively homogenous communities have helped develop the social capital quickly.

The NGO model where an organization works intensively in one area for an extended period has its strengths and weaknesses. The strengths are durability and longevity of the outcomes. The weakness is the model cannot be transplanted elsewhere given its peculiarities. However, some general principles can be extracted for use in any context.

6.12 Conclusion

Communities need to step up to the line. NGOs and leaders can show the way but until the local people want change and are willing to work towards it, watershed projects will not work. The projects have a long gestation period. NGOs and leaders change but local people do not. Their meaningful engagement mitigates the risk the project will end once the NGO moves on or runs out of funds, or the leaders will change.

Building local institutions that include people, not just their leaders, is critical. Instead of focusing only on panchayats, project proponents need to reach into the communities and identify those who can play a role in the activity.

These institutions need training to understand what water management entails. Mere watershed restoration or changing crops will not be enough. They also need to view the programme from an equity angle to ensure women, minorities, lower castes and the disabled are not left behind. From providing water, these programmes

have the potential to be socially transformative; this is a missed opportunity for all of them.

Local leaders are more important to the success of programmes than the local bureaucracy. They are unlikely to move out of the area and are usually heavily invested in their communities. Giving them due importance and real work ensures the programme's success. This group includes elected representatives and prominent citizens.

The government must support at least tacitly if not explicitly. Tacit support is basically staying out of the way, not creating hurdles. Explicit support can include getting difficult agencies such as the forest department to cooperate with the local government and NGO. It can also include financial support from various programmes.

Augmenting local water availability is the cornerstone of success. Regular rainfall can demonstrate success faster but even in deficient years, well-executed watershed works can have an immediate effect. Tapping all possible resources to augment local water resources is critical. This sometimes runs counter to grandiose government water supply schemes. Local communities are the best champions of this approach.

Wastewater, especially sewage, must be accounted for in the water use master plans. Too often water projects overlook what happens to sewage. This distorts the benefits because with more water comes more waste water. Its proper segregation and treatment, with reuse, has to be part of the programme's planning and execution.

It is also necessary to understand that the sewage may become the source of raw water for downstream communities and therefore, the costs of re-establishing the quality before the same is released back into the common stream is necessarily factored in. Unless use and discard approaches are curbed, the supply assurance will come under increasing stress.

Adequate resourcing is critical. Having the money to make watershed structures or rainwater harvesting systems can make the difference between success and failure. Human resources are also needed, suitably trained and motivated. Voluntarism may be good for building a spirit of cooperation but an underlying economic sustainability model can ensure the programme's outcomes last.

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Nitya Jacob is a New Delhi-based independent water policy analyst & consultant. He is the author of 'Jalyatra: Exploring India's traditional water management systems' published by Penguin in 2008.

Chapter 7
Empowerment Through Participation: Women in the Water Discourse

Tanusree Paul

Abstract The contemporary discourses on water management in India, as in other developing countries, increasingly emphasise on community participation in general and women's participation in particular. Although, most often such participation is sought for in the name of empowerment, the taken-for-grantedness behind such assumption has been extensively critiqued. That said, this chapter engages itself with the question as to how the discourse of 'participation' work towards (re)producing specific meanings of 'water' and 'women' and to what extent such meanings translate into women's empowerment. In doing so, this chapter calls for a feminist political ecological framework to expand scholarly conceptualisations of both 'participation' and 'empowerment'. It argues that empowerment is not only an end which is materially manifested through such indicators like membership in water users associations (WUAs), attending community meetings, participating in gender-ascribed roles such as generating awareness and arbitrating community practices regarding water and sanitation, ownership of assets and so forth. It also entails expansion of choices for functioning and it is in this context that the women's embodied experiences and the manner in which they make sense of such experiences must be given due recognition in any analysis of empowerment.

Keywords Women and water · Empowerment · Participation

7.1 Introduction

Since the 1970s, there has been a relentless emphasis on incorporating gender concerns in both theoretical and practical approaches to environmental and ecological

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T. Paul (✉)
Centre for Women's Studies, Visva-Bharati University, Santiniketan, West Bengal, India
e-mail: tanusree.paul@visva-bharat.ac.in; paul.tanusree@gmail.com
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concerns in general and those related to water resources in particular. The former, i.e. the theoretical approaches, at the behest of poststructuralist[1] and performative approaches in feminist theory try to "challenge role-based and relational approaches to gender that rest predominantly on fixed notions of autonomous subject, and that focus on men's and women's differentiated access to and control of environmental resources and socio-political processes" (Elmhirst 2011: 129). At the implementation level, several international policy initiatives have clearly highlighted the central role of women in the provisioning, management, and safeguarding of water resources way back in 1977 at the United Nations (UN) Water Conference at Mar del Plata. Since then, several initiatives have been taken up—such as the International Drinking Water and Sanitation Decade (1981–90) and the International resources programmes, including decision-making and implementation, in ways defined by them (ICWE 1992: 4). Other initiatives with a similar focus include Agenda 21 (paragraph 18.70.f) and the Johannesburg Plan of Implementation 2 (paragraph 25). The World Bank's policy on water resources management of 1993 mentioned women explicitly for the first time. The World Water II Forum held at the Hague in 2000 pledged to enhance the visibility of gender in thinking about water by funding the Gender and Water Alliance (Lahiri-Dutt 2015). Following this, several other initiatives were also taken up to address this cause, for instance, the constitution of the Interagency Gender and Water Task Force (GWTF) in 2003, the inclusion of a gender component in the "Water-for-Life" Decade, 2005–15, led by UN–Water Conference on Water and the Environment (ICWE) in Dublin (January 1992)—advocated the involvement of women's concerns in water-related issues and policies. The Dublin Statement on Water and the Environment adopted, and stated in Principle No 3: Women play a central part in the provision, management and safeguarding of water … Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water.

Some national water policies do articulate special gender-sensitive objectives. For example, the Bangladesh Water Development Board (BWDB) formulated a separate Gender Equity Strategy and Related Action Plan 2006–11 (BWDB 2006). Further, women's representation in executive committees of water users' associations has been mandated by statutory law in the Irrigation Regulation of Nepal of 2000. Accordingly, among the nine members of these committees, at least two must be women. The South African water policy is by far the most exemplary of gender sensitivity in its insistence on equal representation of women and men in water

[1]Poststructuralist approaches to power, subjectivity and women's agency have assumed great significance and have lead to destabilising of 'gender' as a central analytical category. Instead, intersectionalities in the construction of gender identities in terms of other axes of social differences such as race, sexuality, class and place etc. have been emphasised (Butler 2004; Radcliffe 2006; Elmhirst and Resurreccion 2008). This has also lead to a critique of the practice of development itself. However according to Elmhirst (2011), in gender and environment research, these theoretical developments have meant that the representational strategies articulated in the context of international agreements on sustainable development, focus on a globally unified category of 'women', and placing Third World woman subject at the Centre for inclusive development agenda. These strategies unfortunately translated into a homogenous and undifferentiated category of women bearing the responsibility of taking care of a degraded environment.

related institutions as well as on ensuring gender equity in water allocation (GWA 2003: 11).

Nevertheless, the gendered political struggle over water resources has been further accentuated with the recent seismic changes in the politico-economic scenario. On the one hand, with the introduction of market reforms, there has been an over-all change in the role of the State from that of the provider to that of the facilitator which has tremendous implications for social justice. On the other hand, and keeping in pace with the market logic in the context of water resources, there has been a marked paradigm shift from a 'supply-side' focus on appropriate water infrastructure and services at community and project levels promoting financial and social sustainability to a thrust on Integrated Water Resource Management with its accompanying emphasis on treating water as an economic good through pricing as well as community participation in water resource management. Elmhirst (2011) observes that the new forms of environmental governance and interventions heralded in by the afore-mentioned politico-economic changes are "inflected with gender discourses that set in motion differentiated and unjust life opportunities" (pp. 129–130). These gender discourses get manifested through concerns about water availability (appropriate quantity, multisectoral approach vis-a-vis multiple uses of water), accessibility (proximity to water sources, distance travelled, time needed to fetch water and physical burdens, household as a unit of allocation of water resources, water rights vis-a-vis right to water, also socio-cultural factors such as class, caste, power relations, gendered spaces, emotional labour invested in negotiating water rights), equity (social justice, equitable and sustainable development for women and men), affordability (women's ability to pay for water resources), participation (whether women participate as decision makers or merely as contributors of labour on account of their knowledge and customary role in provisioning and management of water mainly for reproductive and rarely, if at all, for productive uses), and sensitisation (gender-appropriate training of the project staff, engineers and technical persons to sensitise them to view women, not only men, as farmers also with specific needs of water, which might be different from that of the men's). Each of these issues intersect with each other in a complex maze and result in the production of gendered landscape related to water.

Unfortunately, despite considerable advocacy at the international policy-making level, these considerations continue to be undermined by the national water policies of most of the countries, especially India. A gendered critique of the National Water Policies of India has been presented in details elsewhere (Paul 2017). That said, the main objective of this paper is to explore how the discourse of 'participation' work towards (re)producing specific meanings of 'water' and 'women' and to what extent such meanings translate into women's empowerment, the latter being one of the oft quoted objective of development literature in advocating women's participation in water resource management. In doing so, this paper will draw on the case-studies and best practices with respect to women's participation in water management from the Indian context. This paper is organised in five sections. The introductory section is followed by a discussion on how women's participation is envisaged by the National Water Policies of India. The third section tries to grapple with the question as to how women's participation in water management can empower them. In doing so,

this section not only presents the existing lacunae in the ways in which both 'participation' and 'empowerment' have been constructed by the programmes and policies related to water but also tries to show, based on Indian case studies and best practices, how such lacunae can be overcome by holistically approaching the gender questions in waterscape. It must be pointed out that the intention here is not to provide an exhaustive repository of best practices in India, but to substantiate the theoretical arguments of the paper with empirical evidences. The fourth section concerns itself with how the discourse on modernity invests specific meanings in both 'women' and 'water'; how women negotiate and contest such meanings and the role of emotional affect therein. The final section concludes with a discussion as to how the envisioning of the two concepts of 'participation' and 'empowerment' can be widened considering the material, psychological and emotional aspects so as to produce empowered subjects through participation.

7.2 Indian Water Policies and Women's 'Participation'

In India, the Ministry of Water Resources (2002) called for management of water resources to accommodate diverse and competing uses through a participatory approach by involving various stakeholders from governmental agencies, industries, and communities (Ministry of Water Resources 2006). To this end, the National Water Policy (NWP) (2012) posited the Water Users' Associations (WUAs) as an effective mechanism of involving farmers in the decision-making process, assigning statutory powers to WUAs "to collect and retain a portion of water charges, manage the volumetric quantum of water allotted to them, and maintain the distribution system in their jurisdiction" (p. 7). With the shifting thrust of the National Water Policies (NWPs) to Integrated Water Resource Management (IWRM), such participatory practices have received much importance. Participation takes many forms: donating labour or perhaps attending meetings without speaking up at low levels of power, or active involvement in decisions about water-related technologies and priorities as well as the ability to ensure action on these priorities at higher levels of power (Ray 2007). For democratic and transparent water management, both men and women must have equal participation at all levels. The manner in which participation by stakeholders has been invoked in the NWPs has changed remarkably since 1987. The first NWP talked about "involving the farmers" and educating them in efficient water use and water management. In the Indian context, the 'farmer' is necessarily viewed as male. The NWP, 2002 appears to be a landmark in this context in the sense that for various aspects of planning, design, development and management of water resources, it emphasises that "necessary legal and institutional changes should be made at various levels … duly ensuring [an] appropriate role for women" (p. 5). The participation of the "community" has been invoked in the NWP, 2012 in matters of water conservation, floods, droughts, and groundwater management, with special focus on IWRM as the main principle for the planning, development, and management of water resources. However, the NWP, 2012 does

not explicitly call for women's participation. This may have serious implications as empirical evidence suggests that men and women experience participation differently and that women's participation remains confined within a "thus-far-and-no-farther" framework. This is, perhaps, the reason why women could successfully participate in the case of cooperatives and microcredit programmes, for example Self Employed Women's Association (SEWA), which deal with the creation of new assets, while in the context of natural resources, women's participation remain palpably proscribed since it entails sharing of property rights over existing resources (Meinzen-Dick and Zwarteveen 1998). Also constraining are the socio-cultural constructs that not only govern women's "ideal" behaviour even as they participate in the community but also shape intra-community power differences.

Much empirical evidence points to the fact that to facilitate the success of participatory irrigation management (PIM), the chief engineers and other officials of the Department of Irrigation must encourage free communication and interaction with the farmer–client. That a farmer is not necessarily a man is often missed out. Also, female farmers may have difficulty in communicating with bureaucratic officials, who tend to be mostly male, given their socio-cultural encodings within a certain frame of femininity and also asymmetrical gendered power relations. In this context, the question of capacity-building, training and awareness generation of government functionaries, WUA members, etc., need to be underscored. All three NWPs recognise the importance of providing adequate training for information systems, sector planning, project planning and formulation, project management, operation of projects, systems and the management, etc. The recipients of such training have been envisaged to be "all the categories of personnel involved in these activities as also the farmers" (Ministry of Water Resources 1987: 11, 2002: 9). The NWP, 2012 mentions that "a retraining and quality improvement programme for water planners and managers at all levels in India, both in private and public sectors, needs to be undertaken" (p. 12). It further mentions that "To meet the need of the skilled manpower in the water sector, regular training and academic courses in water management should be promoted … A national campaign for water literacy needs to be started for capacity building of different stakeholders in the water sector" (p. 13). Thus, none of the NWPs talk about training and sensitising the bureaucrats so as to enable them to address the challenges that women face in participating in the community.

The bureaucrats are trained to deliver water, not empowerment. They have little understanding of the functioning and use of local resources, pay no attention to socio-economic conditions, and work within a system that has begun to favour privatisation and markets. Targeting women for training and capacity-building is critical to the sustainability of water and sanitation initiatives, particularly in technical and managerial roles to ensure their presence in the decision-making process (Inter-agency Task Force on Gender and Water 2005–15). These NWPs also so not explicitly emphasise the need to strengthen the capacities of female stakeholders. Most of the mainstream literature on water resource management, especially irrigation, mentions gender differences only in the form of the occasional obligatory statements. Nor do they differentiate between male and female users. Mentions of women are, at best, made as users and seldom as managers and decision-makers (Meinzen-Dick

and Zwarteveen 1998). According to Bhattacharyya (2004: 20), programmes and the project-level experience of involving women in government and donor-assisted drinking water schemes in India indicate that women have been seen mostly as beneficiaries rather than as partners. Women's participation is often reduced to "labour utilisation" (particularly in drought relief work). "Consultation with communities" always means consultation with men as heads of households and community leaders.

7.3 Empowering Women Through Participation

Several key questions can be teased out from the preceding discussion on the ways in which women's participation has been envisaged by the NWPs in India. Firstly, to what extent does the gender division of labour in the water management structures hold true? That is, does women need water only for reproductive and men for productive uses, as mostly envisioned in the policies and programmes? Secondly, how can women's participation be appropriately co-opted in the water related policies and programmes? Is it only as to ensure 'efficient' use and arbitrate proper water and sanitation related practices of the household and the community or also as robust decision-makers in their own rights? Thirdly, to what extent is the claim that women lack the capabilities in terms of knowledge, negotiation and communication skills to function as technical partners of their male companions true? Do they really lack the capacity to discharge technical roles in the management of water? The succeeding section tries to grapple with these questions.

7.3.1 Reproductive Use for Women and Productive Use for Men?

Women's water needs for productive uses are completely ignored in most of these interventions in the waters sector thus reiterating the gender role stereotypes in the society. Not solely that. The presumption that the doing of reproductive and care work is the woman's responsibility also translates itself into the gendered allocation of tasks in water management practices. The water-related tasks can be classified either based on the domain in which those are undertaken or based on the very nature of the activity itself (Jha 2012). The domain-based classification encompasses those activities carried out within the household but also might have overlapping intercepts with the public domain, for instance collection of firewood for boiling water for consumption is a water-related task. Depending on the nature of activities, different tasks pertain to water acquisition; water treatment and storage; water use; water supply infrastructure operation and management (O & M); waste water disposal; and miscellaneous concerns. That said, Jha (2012) attempts to chart out the gender division of tasks related to water based on his evaluation study of the Jal Swara-

jya Scheme run by the Government of Maharashtra in twelve villages in Osmanabad, Sangli and Nashik districts. In doing so, he classifies tasks on the basis of whether men are preferred (Mp), those for which women are preferred (Wp), those for which both women and men are allowed (M&Wa) and those which require men and women (M&Wr). Mp and Wp refer to those tasks for which customary gender roles are stringently adhered to; M&Wa are those tasks which allow transgression of the rigidly defined male-female boundaries; M&Wr include those for which there are no gender specificities of roles. A classification of these tasks is presented in Table 7.1 from which two observations distinctly emerge. In the aforementioned table, customary tasks are those which have customarily existed in the society while contemporary tasks are those which have been introduced by state agencies or other external agencies. Firstly, most of the technocratic, decision-making and financial functions are allocated to men while those pertaining to reproductive and care work, spreading awareness, administering appropriate water and sanitation practices within the household are women's jobs. Secondly, the contemporary tasks involving water and sanitation projects are much more stringently aligned towards gender division of labour compared to the customary ones. That is, women play negligible role in the contemporary water schemes, their participation in the public domain being limited to interaction with health workers on issues concerning proper behavioural practices with respect to water and sanitation within their own households. Men are mostly preferred as decision-makers, even in the villages covered by Jal Swarajya scheme of the Government of Maharashtra. This sort of reinvigorates the point made earlier in this chapter that the neo-liberal water management structures tend to intensify the gender role stereotypes in the name of efficiency and equity in delivering water.

Volumes of literature talk about the primacy accorded to women's reproductive roles in the landscape of water policies and programmes placing them at the centre of all drinking water and sanitation related projects. Although seldom recognised, women also need water for productive uses. Empirical examples are replete with instances where women have assumed leadership roles in not only addressing existing water woos but also livelihood concerns triggered by acute water scarcities.

Panda and Sannabhadti (2012) in their case study of SEWA focusing on Ganeshpura village in Mehsana district, Navakheda cluster in Sabarkantha district, Thala-Malvan cluster of five villages in Surendranagar district of Gujarat discuss how women members of SEWA, realising that their lack of access to water directly influence their livelihoods in terms of income, time and health, organised across caste-class in water-related campaigns. Through several campaigns, negotiations and meetings, the women were able to wrest from the Gujarat Water Supply and Sewerage Board (GWSSB) the responsibility of reviving and maintaining the failing water systems in the villages. They also identified two immediate needs of the villagers: firstly to find non-water based economic activities; and secondly to revive traditional water sources and create alternative new water sources through rainwater harvesting structures. This partnership between SEWA and GWSSB laid down the foundation of the Millennium Water Campaign which was initiated in 1995. The experience of Navakheda cluster in the Bayad taluka of Sabarkantha district deserves special mention in this context. Excessive fluoride content in groundwater and high rates of

Table 7.1 Gender division of water supply related tasks

Gender divisions	Type of tasks	
Men are preferred (Mp)	Water supply related	*Customary system*: locating securing and maintaining water source; formulating rules about water *Contemporary system*: liaising with the government and external agency representatives; locating water source and using hydrological expertise from outside; operating and maintaining the source; constructing the scheme; pumping water from source to deliver to the settlements; formulating rules about scheme management; levying sanctions if rules are transgressed; collecting fees and fines; maintaining scheme finances; making repairs to the scheme; attending organisational meetings; electing/appointing candidates to water committees; crafting rules about latrine use and maintenance; periodic clearing out of latrine soak pits; building and maintaining drains for household sewage; latrine repair
	Sanitation related	*Customary system*: levying sanctions if such rules are transgressed *Contemporary system*: arranging finances for latrine construction; deciding on appropriate latrine type and technology
Women are preferred (Wp)	Water supply related	*Customary system*: fetching and storing water; harvesting rainwater; using water for domestic chores such as bathing children, cooking, washing, watering livestock kept at home, wastewater disposal etc. *Contemporary system*: treatment of water for domestic use; interaction with village health worker; spreading awareness about proper household water management in the community; daily maintenance of household latrines
	Sanitation related	*Customary system*: ensuring hygienic practices of children, elderly and the sick *Contemporary system*: spreading awareness about latrine use in the community
Both women and men are allowed (M&Wa)	Water supply related	*Customary system*: Using water for productive uses such as kitchen gardening, pottery making, masonry, making country liquor, hair cutting etc. *Contemporary system*:
	Sanitation related	*Customary system*: *Contemporary system*:
Men and women are required (M&Wr)	Water supply related	*Customary system*: monitoring rules about water *Contemporary system*:
	Sanitation related	*Customary system*: adhering to rules about gender-segregated defecation sites; monitoring adherence to sanitation rules; maintaining personal hygiene *Contemporary system*: daily maintenance of community latrines

Source summarised from Jha (2012)

soil erosion are the major challenges faced by this district. The interventions made in this district by SEWA include training a group of SEWA members to repair and maintain handpumps; reviving traditional sources of water such as well and ponds; conserve soil and water erosion; and also rooftop rainwater harvesting. Although initially SEWA tried to address problems of livelihood security for women in the district by organising micro-credit through self-help groups, eventually they realised that regular access to safe drinking water was a more pressing concern for the women rather than access to credit. Village women reported loss of livelihood opportunities due to lack of water and consequent poor health conditions. Having realised that the handpumps, the main source of water in the district, was not properly maintained by the Government agencies, SEWA trained women to repair handpumps. To start with there was much apprehension among the women members themselves as handpump repairing was considered a male job. Even the Government officials were reluctant to impart such trainings to illiterate poor women. There was lack of acceptance from the male members of the community as well. They refused to cooperate and even threatened women with grave consequences should the handpumps fail to function. Not only the men but also the service contractors, bureaucratic officials delivering such repairing services felt threatened by the emergence of the women mechanics as a better and sustainable alternative in the village. However, SEWA managed to negotiate with all the stakeholders and arrange for training women as handpump mechanics (Table 7.2).

The case of *Nehar Ka Nagla*, a suburb of the city of Agra is another interesting example. More than 50% of the urban population of Agra, the most populous city of Uttar Pradesh as per Census 2011, live in low-income settlements. *Nehar Ka Nagla*, a settlement in Ward no. 24, is a deemed urban slum where potable water is major problem, both in terms of quantity and quality. There is no supply of piped drinking water from the municipality and tankers are the only source. People have to wait in long queues for the tankers, and pay anywhere between Rs. 500 and Rs. 1500, and even up to 20% of the family income for buying water. Not only is the water supply erratic but is also characterised by high content of Total Dissolved Solids (TDS) and arsenic. In order to address the water woos, six women came up with an innovative idea to combat the drinking water. They formed a self-help group (SHG), called *Nai-Asha Swaya Sahayata Samuha*, with the aim to provide clean drinking water to their neighbourhood. They set up a plant, their water, called *Shudh Jal*, is priced at market rates and distributed in the market through a regular market distribution approach. However, the management and ownership of *Shudh Jal* is different from the popular market based approaches. The plant runs at a capacity of 4000 L a day and water is supplied in 20 L bottles priced at Rs. 5 if bought at source, and at Rs. 10 if delivered to the home. This initiative not only solved the water problem in the area but also generated employment opportunities. The women started exploring other business opportunities, developed entrepreneurial skills, engage with developing marketing strategies and operations as trained experts, carry out consultations with the households and other stakeholders. Thus, so far as the women themselves are concerned, it has given them a way of life, a sense

Table 7.2 Measures taken by the SEWA in promoting women's productive work through water-related interventions

	Ganeshpura (Mehsana district)	Navakheda (Sabarkantha district)	Thala-Malvan cluster of 5 villages (Surendranagar district)
Interventions	Wasteland development, small scale watershed interventions, agriculture, horticulture, agro-forestry	Agricultural improvement activities, handpump repairing, roof rainwater harvesting	Livelihood promotion activities with salt workers, agricultural improvements, revival f traditional sources of water, management of piped water supply scheme
Start of the intervention	Started with smokeless stoves	Started with promotion of vermin-composting	Started with livelihood activities of salt workers to reduce their vulnerability
Present status	Diversified into wasteland development and agro-forestry for provision of livelihood	Have taken up hand-pump repair-ing/maintenance in two talukas	Have taken up management of group water supply scheme for four villages
Time frame	19 years	6 years	5 years

Source Panda and Sannabhadti (2012)

of identity and achievement (http://www.indiawaterportal.org/articles/six-women-change-agras-water-story).

An important point that deserves mention at this juncture is that existing water management structures are gendered not only in seeing women as associated with reproductive roles but also in linking men's needs with productive roles only. Evidences indicate that men also bear the responsibility of water for domestic use. For example, Jha (2012) in his study of the Jal Swarajya programme of the Government of Maharashtra in twelve villages in Osmanabad, Sangli and Nasik districts observe that due to rigid caste ideologies, upper caste Maratha women were not permitted to fetch domestic water from common water sources in the community. This task was carried out by the male relatives or lower caste women employed by them. Men used to carry about four to six pots of water at a time on their bicycles. However Jha argues that the fact that the women are exempted from the drudgery of fetching water does not necessarily indicate that they occupy an emancipated status in the village. On the contrary, it is a mark of their subjugation. Since all the men in the village came from high caste and class background, the men "can afford to keep

the women secluded at home as befits people of their status. Within the household, women's duties remain the same" (Jha 2012: 215). In a village in Andhra Pradesh, contaminated groundwater compel people to travel long distances by bus to fetch water from a municipal tap in a peri-urban area. This task is done by the men rather than women due to concerns about lack of women's safety in the public spaces (Jha 2012).

7.3.2 Fitting Women in 'Appropriate' Role

As mentioned in an earlier section, in contemporary water policy discourses, participation and participatory management of water resources by the community emerged as a key policy thrust. According to Zwarteveen and Ahmed (2012), during the initial phases i.e. around the 1980s, what they term as the "first wave of participatory water development" (p. 71), community participation in water management was sought on the assumption that it would lead to socially equitable water distribution through technocratic water solutions and bureaucratic management. This so-called democratic move, which sought to allow all users to voice their opinions in ways to use and manage resources and negotiate with State agencies, also opened up space for women's participation, albeit mostly in the drinking water sector. "The idea was that by empowering women and making water projects more accountable to female water users, the goals of equity and efficiency would be simultaneously served" (Ibid).

In the 1990s, with increasing hegemony of the market and the thrust on privatisation, the meaning of 'participation' underwent radical change. Decentralisation emerged as a key mechanism through which management of water was transferred from the hands of the public to that of the private sector along with the formation of water users' association and their active role in delivering water sector reforms. According to Zwarteveen and Ahmed (2012), these neo-liberal discourses rendered visibility to women as "a hitherto unutilised resource" (p. 73). They go on to observe that "neo-liberal approaches emphasised that women were needed to keep water systems and local economies afloat. In addition to their directly productive potential, women were also valued because they were seen to constitute an important ingredient of the social capital that would be mobilised to render (water) operations more effective and efficient and was needed to make decentralisation efforts successful" (Ibid). Needless to mention that the neo-liberal discourse comfortably anchored itself in an essentialist female subjectivity that was predisposed towards serving and caring for the family and the community. Women's participation in the water management practices was increasingly sought in form of voluntary and unpaid work. According to Zwarteveen and Ahmed (2012), "[p]articipation, rather than a strategy to foster democracy and empowerment, thus increasingly seemed to become a tool to shift the costs and burdens of operating and managing water to users and the involvement of women seemed to be promoted more for reasons of economic efficiency than for reasons of empowerment, justice or equity (Ibid).

Kulkarni and Joy (2012) argue that the local site (i.e. the decentralised site of the community) must not be viewed as the most appropriate site of people's empowerment in general and women's empowerment in particular, as the neo-liberal discourses would have us believe. Given that the neo-liberal era is increasingly marked by the linking of the local with the global market, there are seismic reconfigurations in the nature-society relationships as well as the environmental conditions that "not only produce gender-differentiated effects and responses, but also reconfigure categories of social difference including gender and class" (Zwarteveen and Ahmed 2012: 79).

Although the National Water Policies give little recognition to the distinct needs and role of women in water, the programmes and schemes, especially those related to domestic water tend to acknowledge women only in the role of water managers (Joshi et al. 2003, c-2). There is a consistent dearth of a considered focus on the critical constraints imposed on women's access to water resources by social institutions and structures as well as by the asymmetrical distribution of social, political and economic privileges, the gender divisions of labour while co-opting them in water projects. Mostly the call for involving women in water projects is based on several assumptions: that women are the primary providers and managers of water for domestic use; that they bear the sole responsibility of fetching water and hence have sufficient knowledge about water resources; that they being the primary caregivers for the family would be more concerned about the proper maintenance of the water-related infrastructure, and so forth. Needless to mention that each of these assumption is firmly rooted in an instrumental logic which view women as a mechanism for efficiently delivering water to the community, rather than aiming at delivering water for women's needs. "Amidst efforts to mainstream gender into natural resource management interventions and into development policy more broadly, gender has lost its critical and politicised edge, having been institutionalised into a series of tools and techniques that are far removed from the transformatory potential of gender as a feminist concept" (Cornwall et al. 2007, cited in Elmhirst 2011: 130).

O'Reilly (2012: 277) rightly observes that "[p]articipatory approaches have sought to gather women's knowledge in their roles as water carriers and resource managers as a way of maximising the benefits of supply improvements or accessing women's 'natural' capacity for environmental protection." Reviewing the project literature of a drinking water project in Northern Rajasthan villages, she notes that women's active participation was sought in the water project to improve health and living conditions because women were the main users and organisers of household water as well as the main caregivers and providers of education for the family members. Thus, seen as having an invested relationship with water as mothers and wives, it was assumed that women would ensure sustainability of the water project to safeguard their own interests. "Basing women's participation on their water knowledge and customary roles results in an increase in women's exploitation" (Ibid: 281). Rather than providing enabling conditions for empowerment, women's participation thus served as a means to access their labour for community work.

7.4 Women as Decision-Makers and 'Partners' in Water Management

However, if given proper opportunities, women have shown considerable potential for leadership, technical and communication skills in water management. Given that decision-making occupies the highest rank in any ordering of tasks, it is worthwhile to delve into the two primary domains where decisions related to water are made, i.e. the household and the community/public assemblies. So far as the latter are concerned, mere attendance in meetings does not signify participation, nor empowerment. Sufficient evidences indicate that women tend to shy away form voicing their opinions in mixed gender forums, also social stratifications like class, caste, religion, even age act as additional hindrances even with women-only groups whereby upper caste, upper class, religious majority and elderly women tend to preside over the other women in the groups (Jha 2012).

However, there are several instances in the Indian context, which show that women have played major role in water management, and not just as consumers, managers and mediators of appropriate practices by the household and the community. The experience of the *Mahila Mangal Dal* in the Chopriali village of Uttarakhand is a case in point. Chopriali is a small village, plagued with erratic water supply from springs, copious outmigration in search of livelihood and a consequent decline in agricultural income, poor state of sanitation causing severe health hazards. In 2010, an organisation working in the area approached the local people to device ways of addressing their water and livelihood related problems. As a first step, they set up the *Mahila Mangal Dal* with the generic assumption that if properly trained, women are less likely to faulter with the management of public funds. However the women contributed much more. They cleaned the only existing tank which lay silted and almost redundant; excavated water sprouts; constructed new tanks, space for washing; planned and assisted in the construction of a canal to bring water to a convenient spot; also constructed sand filters and brought down the water to the village and ensured its sustainability by applying appropriate recharge and soil conservation measures in the recharge area of the spring. The women were intensely involved in the construction process of the tanks including deciding where to place them—they taught the men of the village that sitting a tank in the stream will place it in danger of being washed away, hence it should be placed beside the stream. Simultaneously, the villagers were also trained in vegetable cultivation, composting, and agricultural techniques during the slack seasons. Agricultural activities have been revived to the extent that the village now produces fine vegetables and some are supplied to Delhi market. The *Mahila Mangal Dal* now conduct regular monthly meetings, plan for maintenance of the sand filter and piped system, organise regular cleanups of the tanks, and have new plans of building loose boulder structures. Most importantly, given these opportunities to handle technical responsibilities independently, they have gained immense self-confidence. As observed by one the members of the *Dal*, "Bring us any project you have, we'll implement it" (http://www.indiawaterportal.org/articles/women-managers-chopriali).

The Water and Sanitation Management Organisation (WASMO) in Gujarat working towards empowering communities to manage their local water sources, drinking water supply and environmental sanitation offers another example in this context. As part of their different strategies for community mobilisation, they have also formed water groups called *Pani Samitis* with the consensus of the people obtained through Gram Sabha. Pani Samitis, each comprising 10–12 members, is a legal entity and is responsible for managing the improved village water supply services. One-third of the members and ideally about 50% of the members of these Samitis must be women. In 2014, the Government of Gujarat introduced the "*Mukhyamantri Mahila Pani Samiti Protshahan Yojna*" (Chief Minister Incentive Scheme for Women Water Committees) as a new item in its budget whereby each newly formed women Pani Samitis and existing Pani Samitis would be given a sum of INR 50,000 and INR 25,000 respectively. The experiences of Mahila Pani Samitis in Gujarat, working at the behest of WASMO show that women can play important role in deciding water sources, different stages of schemes, length of pipe lines, design and location of schemes at the planning stage. At the level of implementation, they can effectively participate in conflict resolutions, collection of funds from villagers, ensuring quality and availability of water etc. Given that, the State of Gujarat started considering women as partners and not mere beneficiaries in water management. The Water and Sanitation Management Organisation (WASMO) in Gujarat has several examples to show how women are capable of taking leadership role in every stage of water projects—from planning to post implementation stages. Studies conducted by WASMO also highlighted that *Paani Samitis* headed by women as chairpersons are more efficient, place more time at the disposal of women for the pursuit of economic activities through tap water connections.

Das (2015), based on her study of community-managed urban water supply projects in Gwalior, Indore, and Jabalpur in the state of Madhya Pradesh in India argues that women in participatory approach must be viewed as a collective (rather than as individual decision makers) so as to help organise themselves to resist and challenge the gendered power structures which constrain their participation. The projects she studied constituted the pro-poor component of the 'Water for Asian Cities Programme'—an initiative of UN-Habitat, Asian Development Bank (ADB) and the Government of India, launched in 2006. Her study was based on field research (undertaken in 2007–2008 and 2011), which included interviews with representatives of UN-Habitat, government officials, members of the user committees and intermediaries (community officers, NGO representatives, and social workers), focus group discussions (one with women committee members only), transect walks, and a survey of 323 households. It was observed during the survey that among the three cities, a critical mass of women committee members existed in Indore which allowed the user committee to act as a collective and began. This collective of women not only involved in issues related to water supply, but also those pertaining to other services such as sewerage, drainage, lighting, roads etc. from the local government. Some of them also participated in the externally-funded programmes that had provided training. According to these women members, despite repeated attempts to negotiate with the State agencies on issues related to land regularisation, ration cards, and

water supply, their demands remained unheeded till they collectively bargained as members of the water groups. The very act of visiting the project office for collection of bill payments and other administrative activities had an empowering effect since it allowed visibility in the public sphere and gave women access to information about the project, government resources and legal institutions. Managing the project increased spatial mobility and boosted their confidence. Thus even in the face of constraints, women's collective agency, facilitated by appropriate participatory spaces and institutional support resulted in substantive participation, which continued even beyond the project objectives and also ushered in material improvements in access to water supply. However in Gwalior and Jabalpur, there were fewer women in the water committees, less aware and motivated, lacked required training and also there was no permanent community officer to help the user committee liaise with the local government. Hence the project did not have any empowering effect on the women. Das thus teases out three important policy insights from this case studies: Firstly, in order that women's collectives continue to function efficiently beyond the life of the project, women must be capacitated on lines of building solidarity, enabled to liaise with higher decision making bodies and State agencies, trained into the craft of decision-making rather than mere programme objectives such as material benefits of water supply. Secondly, the places where meetings are held, official activities are carried out, i.e. the physical spaces of participation must be carefully decided upon by the programme officials because these spaces cast a telling impact on women's participation. Finally, appropriate policies must also address larger socioeconomic issues in addition to concerns about water, lest the narrow policy focus would fail to promote women's participation in water governance.

Another interesting example is offered by the informal water committees formed by the women in Bundelkhand, Uttar Pradesh. Women here had to walk about eight hours on an average to fetch water, suffered from severe health problems as well as time constraints. These daily struggles over water lead them to come together and form informal water committee or 'Paani Panchayat' to ensure water availability for all through the creation and conservation of water resources in their villages, so that water was available as a basic right. In doing so, they received support from a local organisation. Two women are nominated as 'Jal *Sahelis*' or 'water friends' by the '*Pani Panchayat Sanghatan*', their purpose is to meet, discuss and decide on how to tackle local water related problems. They also voice their opinions about the site of installation of new handpumps and also check dams for irrigation, process of reviving a dying '*talaab*' or village pond and also where check dams are needed for better irrigation. All this work is carried out at the block level through the village panchayat. At present there are nearly 500 *Jal Sahelis* across 7 districts of Madhya Pradesh and Uttar Pradesh. As observed by Sirkoo, a 39-year old woman who played an important role in the formation of these Pani Panchayats, "Earlier we did not know anything beyond the four walls of our homes, and now we travel, meet and talk to people on water" (http://www.indiawaterportal.org/articles/bundelkhand-women-forge-friendships-water).

These *Jal Sahelis* had to traverse a hostile path to taste such success. Initially, the men folk resisted women's moving out of the '*purdah*', however through years of

negotiation and convincing, they have now been able to curve out a respectable space for themselves whereby not only the community men but also the Panchayat Pradhan consider their opinions. They have prepared village Water Security Plan (WSP) or the 'Jal Suraksha Karya Yojana', built check dams with government allocations and '*shramdan*' or voluntary contributions by the community.

7.4.1 Capacitating Women Towards Efficient Participation

As observed by Green et al. (1998: 265), "most water supply projects have drawn on women's labour without enhancing their technical or managerial skills, and have based their findings on the assumption that involving women will in itself advance the objectives of the project and benefit women." Even as participation of women is being assiduously sought, there is no recognition of the fact that such participation of women in hitherto 'public' domain, albeit as users and managers, is fraught with the possibilities of changed gender power equations which might be threatening to the very concept of 'empowerment'. Although the role assigned to women in these water projects does not entail their participation in decision-making capacities, yet the very act of coming out of the domestic confines, attending meetings and voicing their concerns amidst other male members of the community could be both empowering as well as threatening.

Hence, initiatives for water management claiming to target women's empowerment must address the question as to how women's capacity to operate in the public domain can be enhanced? How can they be enabled to negotiate at par with different stakeholders? "There is a dominant assumption that participation in water resource management by women is empowering for them and leads to more gender-equitable outcomes" (Cleaver 2012: 32). It is important to recognise at this juncture that such success stories of women as decision-makers are unlikely to automatically follow at the instance of women's engagement with the water management structures. Adequate measures for training and capacity-building must accompany any call for women's participation. Lest, women's participation in water related projects and schemes would not really strengthen their empowerment and foster gender equality. To site from the case study by O'Reilly (2012), the project literature of a drinking water project in Northern Rajasthan observes that involving women in water groups would break their isolation, provide them with welcome opportunities to participate in the meetings and act as women's representatives in the water committees organised in the public domain, enable them to solve problems. This would have far-reaching implications for women's empowerment. As noted in the project handbook, "empowering the women of a village to help themselves and organise for the solution of other problems which are not necessarily related to water and sanitation issues" (Handbook: 2; cited in O'Reilly 2012: 285). However, 'participation' is no touchstone that would automatically break the socio-cultural barriers minding women's engagement with the public spaces, make their voices heard by the society at large and instil problem-solving skills in them.

In fact, empirical evidence shows that compelling women to participate in community management of natural resources including water, tends to jeopardise their lives. As observed by Jha (2012: 206), "[w]hen schemes are transferred to communities, local responsibilities increase exponentially as managerial, financial and technical duties are also delegated to community-based decision-making groups like village and water and sanitation committees (VWSCs)". Not only does community participation add to women's already existing dual burden of work, those of reproductive and productive (Moser 1989), but getting them involved in community management without ensuring them appropriate representation in the community-based decision-making groups translates into further increase in their disadvantages. They have to shoulder the responsibilities of community activity but significantly lack decision-making rights. Thus merely decentralising the water management scenario and invoking women's participation neither ensures equitable sharing of resources nor does it necessarily empower women. Women have to be capacitated to function as empowered individuals in water management practices.

Practical examples abound in experiences indicating how proper capacity building measures help in enabling women function as decision-makers and addressing problems in their own rights. Maharashtra is the first state in India to formulate a women policy in 1994, which was subsequently revised in 2001. This policy provides for participation, protection, economic development, capacity building and creation of a supportive environment for women. Keeping with the spirit of this policy, the *Jal Swarajya* was launched in 2004 by the Government of Maharashtra to scale up sector reform initiatives through innovative and participatory processes, covering 3025 Gram Panchayats (GPs) across the state. The project ensured minimum 50% representation for women in its village committees. Gender mainstreaming was one of the guiding principles for the project and a separate women empowerment component was developed to facilitate women's participation in decision making process and management of projects, not only in the context of water and sanitation but also for other economic and village development activities through skill training. Several skill based trainings were organised periodically and budgetary allocations were earmarked for the purpose. This helped in the development of small scale entrepreneurship activities for women such as candle making, production of vermi-compost, running of shops etc. Over-all, these initiatives cumulatively lead to strengthening of decision-making and leadership capacities among the women. Thus, the Jal Swarajya initiative helped to expand women's capacities beyond water and sanitation. Besides, women's active participation in decision-making in the general Gram Sabha was ensured by organising a separate Gram Sabha meeting exclusively for them prior to the general Gram Sabha to discuss and deliberate about issues pertaining to water and sanitation (http://www.indiaenvironmentportal.org.in/files/Empowering%20women.pdf). However, Jha (2012) in his study on the Jal Swarajya Scheme in Maharashtra, observe that in a particular village, an upper caste woman held the position of the *Panchayat Pradhan* as well as the president in the local water and sanitation committee. She was charged with mishandling public money allocated to the village under the Jal Swarajya Scheme, however she claimed that she could not handle the financial matters due to her and other female VWSC members'

lack of experience in managing large sums of money. Thus it is evident that there is an urgent need to build the awareness and financial skills of the female VWSC members.

In the Indian context, an example of women's successful participation in water resource management par excellence is that of the SEWA in Gujarat. Panda and Sannabhadti (2012) in their case study of SEWA in selected districts of Gujarat tried to understand the processes followed by the women of SEWA in local water resources management including their strategies employed in negotiating with the State agencies as well as programmes and sectors such as drinking water, irrigation water etc. The authors observe that in the initial years, SEWA was instrumental in providing wage support to the women members as their land was unproductive; forging links between the women's groups and various technical agencies and government departments like the Gujarat Agriculture University and the forestry department. SEWA also arranged for trainings for the groups in myriad subjects such as nursery, horticulture, agriculture, pest control, vermin-composting, efficient water storage, land-water-labour management for wasteland development etc. Not only technical, but training was also provided in non-technical aspects to capacitate women in institutional building—mobilisation, local organisation group formation, management, leadership, financial accounting, marketing etc. Besides, women's cooperatives were also linked up with the Gujarat State Mahila SEWA Cooperative Federation, which impart training in the area of accounts, audit and understanding the relevant by-laws for functioning. Such comprehensive initiatives in capacity building have enabled the women to manage their farm and cooperatives independently (Ibid). Besides, women's training in technical subjects also was instrumental in challenging the patriarchal stereotype which renders technical training as a prerogative of the men. According to Panda and Sannabhadti (2012), one of the most important factors that contribute to the success of the Women, Water and Work Campaign of the SEWA is the technical cadre of the women engineers and a cadre of "barefoot technicians" (Ibid: 543) operating at the grass roots level and working towards maintaining the piped water supply and handpumps in different districts.

Thus, empowerment in the sense of enhanced agency and ability to act is unlikely to be achieved without adequate measures of capacity building. Women socialised into believing that home is their rightful place are unlikely to perform successfully in the public domain in any capacity envisaged by the water related schemes. Unless appropriately trained, women ought to feel intimidated and disempowered in public forum.

7.5 Of Negotiations, Contestations and Embodied Experiences in 'Modern' Water Related Projects

Empowerment is not only an end which is materially manifested through such indicators like membership in WUAs, attending community meetings, participating in

gender-ascribed roles such as generating awareness and arbitrating community practices regarding water and sanitation, ownership of assets and so forth. It also entails expansion of choices for functioning. It is a "'process' as opposed to a condition or state of being" (Malhotra et al. 2002: 19). Kabeer (1997, 1998) observes that measuring empowerment as a process is also subjective not only in terms of the perceptions of the evaluators or the researchers, but also in terms of the women's own understanding. Thus "rather than relying on what is valued by the evaluators of programs, the process of empowerment should be judged as having occurred if it is self-assessed and validated by women themselves" (Malhotra et al. 2002: 19). It is in the context of such self-assessment of the process of empowerment that the questions pertaining to negotiations, contestations and embodied experiences undergone by the subject becomes extremely important in the analysis of empowerment. For these influence the psychological dimensions of empowerment which include women's psychological self-esteem and well-being, self-efficacy as well as collective awareness and potential of mobilisation, their sense of inclusion and entitlement and so forth (see Malhotra et al. 2002). That said, we need to widen our understanding regarding the interlinkages between women's participation in water management and empowerment. To start with, let us first explore the different nuances of the term 'modern' in the context of water.

7.5.1 Locating the 'Modern' in the Discourse of Gender and Water

In contemporary development discourses, empowerment is being increasingly portrayed as an embodied experience of the 'modern' women, which necessitates problematisation of both the categories, 'empowerment' and 'modern woman'. Almost all the development discourses underscore a dualism between progress/modernity and backwardness/tradition; a unidirectional strategy of emulating the socio-economic condition of the Western, industrial nations; pushing women to 'modernise' themselves through empowerment. "To be empowered is to become modern" (O'Reilly 2012: 285). In the context of water, this means that a 'traditional' (non-modern) woman is one who accesses the old water sources, located within the home and confined to mundane domestic chores only and conspicuously disempowered. On the other hand, a 'modern' woman who uses new sources of water, gains mobility beyond the confines of the household through their participation in village water groups, committee meetings in the public and thus derives a sense of empowerment from her ability to handle these new responsibilities.

O'Reilly studied a large drinking water supply project in northern Rajasthan between 1997 and 2002. The project comprised a technical side tied to the Public Health and Engineering Department of the Government of Rajasthan (GoR) and a project social side which aimed to mobilise community and women's participation. She observes that the project staff marketed water in a 'modern' package which

entailed *institutionalisation* i.e. managed by village water committees, *rationalisation* i.e. thrust on clean drinking water and *commoditisation* i.e. water must be paid for to prevent wastage, ensure people's accountability and proper maintenance. In this project, women as primary water consumers were mobilised to maintain the new drinking water project and also to pay for it. Critically reviewing the project literature, O'Reilly observed that the project co-opted women on account of their domestic and traditional roles whereby women's participation meant "building modern relationships between women and water in their homes (for example, covering water pots and teaching children water-based hygiene), and empowered relationships outside the home (for example, speaking in front of men in public meetings) (p. 278). Thus the 'modern' woman was the key to the sustainability of 'modern' water. To quote O'Reilly (2012: 280):

> ..the promotion of modern water by the project staff, ran parallel to a marketing of modern womanhood and consumerism in the form of 'women's participation'. Modern womanhood came packaged within the project component- that is, women's participation- which linked gender and modernity to 'new' responsibilities for women involving the clean water supply, including paying for it. These new responsibilities, in turn, supported water's packaging as 'modern'.

Thus through the implementation of different water supply schemes, water becomes commoditised in being "'new', 'improved' and worth paying for" and this process of commoditisation of water in turn depends on "reconfiguring gendered connections to it that add value to women and water" (Ibid: 274). Success and sustainability of such water schemes comes on the wheels of 'modern' women who are remade into modern consumers superseding their identities as traditional housewives, although their roles continue to be framed in terms of their reproductive responsibilities. Further, "new roles for women as public representatives, powerful household managers and public stand post of caretakers supported the making of 'modern' water" (Ibid: 295).

7.5.2 Contesting and Negotiating the 'Modern' in the Context of Gender and Water

It would be inappropriate to assume that women act as mere pawns in this entire discourse on empowerment, modernity and participation. O'Reilly in her study on Northern Rajasthan teases out instances of women's resistance based on their own perceptions about 'modernity' and empowerment. Their agency was reflected, according to the author, in the fact that the women in her study area tended to engage with those elements of the project which they considered useful while discarded other elements. The project staffs, fed with specific notions of 'traditional' ' backward' village women inculcated by the project plans, failed to recognise the women as powerful agents in their own rights. Notwithstanding the fact that women's domesticity and lack of public participation tends to be portrayed as a mark of their disempowerment by the water projects, O'Reilly shows how the village fieldworkers tried to convince the village women that they wield considerable power within

the household by bearing the responsibility of maintaining the health of the men folk through appropriate water handling practices. But the rural women across caste groups reported that they felt powerless when instructed to perform specific tasks by the project field staff. Thus, participation in the public domain does not necessarily make them feel empowered. They also resisted the notions thrust onto them by the field staff. O'Reilly cites the example of a powerful Rajput woman who told her that while she listened to what the field staff had to say about household cleaning, but since her hygiene practices did not fit with those propagated by the field workers (using ash instead of sand to clean utensils), she refused to comply. She also exhibited remarkable agency when she played an active role in settling a dispute, upon being invited by the field staff, in the village pertaining to the setting up of a public tap. Her decision, though did not coincide with that of the field staff, did prevail as it was accepted by the other village women. According to O'Reilly, these incidents show "how women exercised power in ways that did not necessarily coincide with project plans or plans of the staff" (p. 289). In fact, the case studies cited so far in the paper is replete with evidences that show women often have come together, devised their own strategies of water management, resisted the project plans thrust onto them and even negotiated with the State agencies to ensure sustainability of their initiatives, be it the case of the SEWA women in Gujarat, or that of the women organising in the *Nehar Ka Nangla* in the city of Agra, or the case of the *Mahila Mangal Dal o*f *Chopriali* village in Uttarakhand or the community managed urban water supply project in Indore, Madhya Pradesh, to name only a handful.

Cleaver (2012) observes that participation in the course of natural resource management unduly emphasises on "reflexive action, on deliberate purposive strategizing, and a relative neglect of the impact of the practical and unconscious on people's agency" (p. 56). As put by Myers (1996), "[b]oth conscious and unconscious emotions are critical in shaping people's sense of self-efficacy and social relationships" (cited in Cleaver 2012: 56). Individuals themselves must be able to realise the possibility of carrying out potential course of actions (Agarwal 2005; Kabeer 2005). Hence, according to Cleaver (2012), 'imagined autonomy' plays an important role in people's conceptualisation of their own agency. The discourse on subjective perceptions in the understanding of one's state of being, whether disempowered or empowered, can't be fully comprehended unless the emotional affect ingrained in the water management practices are explored- a point which is discussed in the following sub-section.

7.5.3 Importance of Emotional Affect in Understanding Empowerment Through Participation

Several scholars have highlighted that struggles over natural resources not only underscore embodied performances of gender and power relations, both are also mediated through social relations, ecological contexts as well as inter-sectionalities

based on class, race, ethnicity etc. (Gururani 2002; Harris 2006; Nightingale 2006; Resurreccion and Elmhirst 2008; Sultana 2009). Further, struggles over controlling resources not only entail material but also emotional challenges. Therefore, it is important to pay considered attention to the "the various emotions and meanings attached to processes of resource access, use and conflict in order to better understand the emotionality of the resources that exist in everyday struggles" (Sultana 2011: 163). Struggles and conflicts over resources are not abstract but are rooted in the "embodied emotional geographies of places, peoples, and resources, enabling us to enhance our comprehension of the complex ways resources and emotions come to matter in survival strategies and everyday resource management practices" (Ibid). Turner (2004) also maintains that emotional embodiments are as important as material struggles over natural resources.

It is important to introspect, at this juncture, whether the fact that women's participation in water management structures, in capacities, discussed so far, fail to question gender-based hierarchies lend itself to the complete writing-off of any claims to empowerment? There is no easy answer to this question. The fact that women are mostly targeted for drinking water projects and in the capacity of water consumers only lead some scholars to claim that the policy discourses merely exploit the existing gender-based hierarchies in the society and continue to frame women within the stereotypical gender roles of providing reproductive care. On the other hand, it cannot be ignored that participation in public decision-making also gives women self-esteem and self-confidence. The relevance of the opportunity for women to talk to other women in committees also should not be underestimated (GWA and UNDP 2006; UN OSAGI 2006). It strengthens their bargaining position and leads to overall development of personal capacities. Another direct benefit of improved access to water include "enhanced dignity, and less exposure to hazards associated with water fetching such as opportunistic gender-based violence, water-borne diseases, animal attacks, and physical problems due to heavy water loads" (Ivens 2008: 64). Indeed, women's involvement in drinking water projects does have several positive bearings on their lives not only in terms of reduction in the drudgery of the physical but also in terms of the emotional labour performed by them in fetching water. The latter point needs deeper exploration and in doing so, I draw on an example of a case-study conducted in Bangladesh which delves into the emotional geographies of women and water management structures and women's own perceptions about their labour. Although this paper draws on experiences in India, this case-study of Bangladesh has been used to substantiate the argument being posed here.

Sultana (2011) conducted her research in 18 villages in four districts in rural Bangladesh where acute potable water scarcity existed due to arsenic contamination. Her study was based on ethnographic research involving semi-structured and open-ended questionnaires with 232 households, case studies, and 15 focus group discussions involving men and women. In all the study areas, there was great disparity. The discovery of high levels of arsenic in the drinking water pumped through tubewells, the main source of potable water, rendered millions of tubewells unsafe and non-usable in the late 1990s. About 35 million people were exposed to the risk of severe health hazards. The concerned authorities tested the tubewells and painted

those with high levels of contamination as red and those supplying safe water as green. There existed considerable inequality in arsenic contamination of groundwater within short distances and due to this sharp spatial variation, some villages had large numbers of red tubewells with very few alternatives to access safe water. The tubewells accessing deep aquifers were safe while the shallow tubewells, which were cheaper to install and thus massively outnumbered the deep tubewells, were contaminated as these accessed the shallow aquifers. Consequently, according to Sultana (2011: 165), the spatial distribution of safe water also lead to a "spatialisation of power and hardship" whereby "those with control over a safe water source have additional powers over those who do not." Given these circumstances, possession of arsenic free safe water emerged as a status symbol and a bastion of power. Since fetching water for the household is primarily the women's responsibility, such a scenario complicated the everyday lives of the women with multiple emotions of conflict, cooperation, and control.

Based on her study, she observes that control over water may be routed through ownership of land and technology, but its access is a function of broader social relations. And it is in this context that emotionalities and embodiments come to occupy a critical position in understanding the every-day experiences of nature-society relationships in general and that of women and water in particular. According to Sultana (2011: 164),

> [c]lose attention to the emotional geographies of water are important in explaining how 'feeling subjects' (cf. Thien, 2009) relate to water and how water mediates social relations of resource management. Such an analysis can provide more nuanced explications of what constitutes resource conflicts and politics, by showing that conflicts over resources are thus as much about property rights and entitlements as they are about embodied emotions, feelings, and lived experiences relating to the resource.

She further argues that people come to relate to resources in general, and women to water in particular, through variegated emotions that manifest in situations of struggles over access and control of these resources. Writing in the context of rural Bangladesh, she argues that since women are encountered with first-hand experiences of pains and struggles inherent in their responsibility of providing for adequate water for their families, their material as well as emotional lives get affected in the process as well. Thus, their everyday woos do not merely concern the physical stress in fetching adequate resources/water, but also the emotional struggles inherent in accessing the same. These struggles are exacerbated by the fact that decisions to use water from particular sources are influenced by a range of social factors such as caste, class, religion, age and so forth. "The struggle over access to and control of resources are thus products of individual needs and decisions as well as a multitude of other factors such as institutions, relationships, and emotions" and point to emotional geographies of water (Ibid: 166).

Sultana (2011: 168) observes that "the negotiations on accessing safe water emotionally connect both the owners of wells and those dependent on obtaining water from it". For instance, in her study, she noticed that the households owning safe water wells appeared to be more likely to give water to those women who had children

over those who did not have children. Thus it seemed that a common understanding regarding the anguish of the children without access to potable water was also an important factor in sharing of water. Women from well owning and dependent households were tied together through their shared experiences of womanhood i.e. as mothers, daughters, daughters-in-law and such "inter-subjective relations…tied them together as well as validated their gender roles in their households and communities" (Ibid).

The emotional geographies of water also underscore a gendered connotation. Sultana further observes that although both men and women were deeply distressed in their everyday experiences of water management practices, there was a difference in terms of the reasons behind feeling such pain. While men reportedly were emotionally afflicted for not being able to protect their family members by purchasing a deep tubewell thus ensuring access to safe water, women's agonised emotions in this context related to the multiple sufferings associated with the responsibility of fetching safe water for domestic use and managing with meagre and erratic supplies. To quote Sultana (2011: 169),

> [The men] felt their masculinity threatened in their inability to resolve the situation, especially poorer men who did not have the financial or political clout to install deep tubewells…. [for the women] embodied pain of hauling water, the emotional pain from being told off while fetching water, sense of belittlement felt when having to fetch water from a source not their own or sanctioned by the owners, fear of fetching water at night from far distances, are common experiences that are entangled in the everyday journeys to fetch water.

The daily experiences of fetching water also subsume the emotions of pleasure, joy and relief at being able to provide arsenic-free water to the family members or being able to own an uncontaminated well or even being able to escape the mundane chores while going away to collect water, forging friendships with other women on their way and so forth. Thus, both the pains and the pleasures, the relationality to water as well as to other people/women in the community- all constitute the emotional landscapes of water (Ibid). The sense of self-efficacy in being able to adequately meet the water needs of the family and the feeling of accomplishment and self-esteem thus derived can't be underrated in any analysis of empowerment.

7.6 Towards a More Dynamic Understanding of Women's Empowerment in the Context of Water

The preceding discussion indicates that empowerment through women's participation in the water sector is a contentious question that does not lend itself to straightforward answers. For a better understanding of the interlinkages between empowerment and participation, we need to move beyond essentialist and efficiency based arguments in development discourse and adopt a feminist political ecological[2]

[2]Political Ecology has emerged as an important area of enquiry within Geography. It tries to address critical questions pertaining to poverty, social justice, the politics of environmental degradation and

framework which not only aids in fleshing out the multiple layers of identities and social relationships subsumed under 'naturalised' and 'undifferentiated' categories, but also provides a framework to problematise the relationship between women and natural resources, divulging the everyday experiences of women. According to Truelove (2011: 143–44), a feminist political ecological framework helps in directing focus on "the ways daily practices are produced by, and productive of, gender, class and other social power relations" and take into cognisance the "inequalities associated with processes of social and spatial differentiation and their consequences for daily life…". Rather than focussing on only the technical concerns about the supply, maintenance and management of water, it is more appropriate to consider the social relations of power associated with the gendered landscape and address questions like "who accesses water and sanitation, the practices by which access is achieved, and the physical, social and spatial meanings of the multiple water activities of everyday life" (Ibid: 144). The importance of a considered focus on micropolitics of everyday lives, on informal negotiations and contestations in understanding how lived experiences and practices are co-constituted by gendered ideologies, power relations have been highlighted recurrently in literature (see Cameron and Gibson-Graham 2003; Nagar et al. 2002; Mohanty 2003). Through such a focus, it is possible to link "everyday life and local gendered contexts and ideologies to the larger, transnational political and economic structures and ideologies of capitalism (Mohanty 2003: 225). Further, feminist political ecologies must also pay considered attention to emotional geographies as these influence the practices of access, use and control of resources. Interplay of emotions in the landscapes of resources is a political and ethical issue too (Sharp 2009, cited in Sultana 2011: 164). Unless studies on women's participation in water sector also take into consideration their everyday water practices, their emotional labour and embodied experiences; mere focus on their involvement in water groups and meetings, role in maintenance of water structures and appropriate usages is unlikely to yield a clear indication of empowerment.

Ivens (2008) observes that increased water access does not necessarily strengthen women's empowerment. Further, several practical examples indicate that women who gain access to water do not take up activities that strengthen their empowerment (WaterAid 2001; GWA and UNDP 2006; UN OSAGI 2006). Thus, Ivens argues that a mere focus on women's participation in public decision-making is unlikely to yield desired achievements so far as empowerment is concerned. Strategic gender needs and gendered power dynamics must also be addressed. Based on case-studies of best practices in three countries: a water supply programme in India, a domestic water

conservation, the neoliberalisation of nature and ongoing rounds of accumulation, enclosure and dispossession. In the 1990s, a further sub-field emerged within political ecology, termed as feminist political ecology (FPE) which sought to connect feminist scholarship with that of political ecology (see Rocheleau et al. 1996). Since Rocheleau et al. (1996), research in feminist political ecologies focus on such themes as gender dynamics in community-based institutions (Agarwal 2001; Colfer 2005; Tsing et al. 2005), gendered environmental knowledge (Jewitt 2002; Howard 2003; Momsen 2007; Walker and Robinson 2009); and the dynamics of gender in policy discourses and within environmental departments of development agencies (Leach 2007), field of environmental justice (Buckingham and Kulcur 2009; Gabrielson and Parady 2010).

supply programme in Pakistan and irrigation programme in Bangladesh, Ivens (2008) argues that in order to achieve best results, we need to adopt an empowering participatory approach. In all these countries, the programme components included formation of women's groups, meaningful involvement of women in decision making, initiatives to enhance access to income-generating activities and also, considered attempts to address the existing gender relations. Such an approach has lead to enhanced participation, improved social status, ownership of assets, increase in mobility, strengthening of bargaining power, larger role in household decision-making.

To be empowered is to gain control over one's personal life and enjoy the power to exercise choice. Thus it involves not only "power to" but also "power within", and "power with".[3] In other words, empowerment does not merely refer to explicit manifestation of progress one makes (in the context of women and water, participation in meetings, membership in water user groups, expressing their voices in matters related to domestic water use and so forth) but also the changes 'within' entailing better self-esteem and self-efficacy (for instance, deriving pleasure from being able to supply safe water to the family, being able to take part in the technical components of water management for productive use, receiving appropriate training, or simply being able to escape the drudgeries of household chores in going out and forging companionships in fetching water or participating in water related community activities). According to Kabeer (2005: 13), empowerment denotes the "processes by which those who have been denied the ability to make choices acquire such an ability" and underscores three important dimensions: *agency, resources and achievements*.

'Agency', i.e. the process by which choices are made and put into effect (Kabeer 2005: 14), must be experienced by women themselves through the exercise of their 'power within' and 'power with' rather than as passive recipients of the benefits targeted at them by the water related projects and schemes. The examples where women spontaneously engaged themselves in different initiatives to address their everyday struggles in finding sustainable water and livelihoods testify to the development of agency rather than those where they have been instructed and compelled by the water management projects to act in specific ways, such as spreading awareness about proper household water management in the community; daily maintenance of household latrines, interaction with village health workers and so forth. 'Resources'

[3]The concept of power has several connotations. "'P*ower over*' implies a mutually exclusive relationship of domination and subordination. It triggers either passive or active resistance; ' *power to*' implies a power which includes the ability to make decisions, have authority, and find solutions to problems, and which can be creative and enabling. The notion therefore refers to intellectual abilities (knowledge and know-how) as well as economic means, i.e. to the ability to access and control means of production and benefit (the notion of assets); '*power with*' refers to social or political power which highlights the notion of common purpose or understanding, as well as the ability to get together to negotiate and defend a common goal (individual and collective rights, political ideas such as lobbying, etc.). Collectively, people feel they have power when they can get together and unite in search of a common objective, or when they share the same vision; '*power within*' refers to self-awareness, self-esteem, identity and assertiveness (knowing how to be). It refers to how individuals, through self-analysis and internal power, can influence their lives and make changes." (Commission on Women and Development 2007: 10).

are the medium through which agency is exercised. As discussed at length in this chapter, it is the women who tend to be viewed as a 'resource' for efficient water management. However, it is 'water' which must be construed as a resource invested with much physical and emotional labour on the part of the women, a resource whose equitable distribution and management must be ensured so as to bring about progressive changes in the everyday lives of the women. This leads us to the third important aspect i.e. 'achievements' which denote the consequences of agency and also the extent to which individuals are able to lead the life of their choice. That is, women's participation in the water sector as a means of contributing forced labour can't be an expression of their empowerment. Neither can the pleasure and satisfaction derived by them from being able to provide safe water for their families be completely disavowed.

In other words, women's embodied experiences and the manner in which they make sense of such experiences must be given due recognition in any analysis of empowerment. Development research tends to ignore subjective positions by only concentrating on material conditions and it is through a consideration of the emotionalities linked to natural resources in general and water in particular that an awareness of women's agency can be appropriately conceptualised. As noted by Klouzal (2003: 256), "subjective responses tap into human agency and reflect the complexity and the depth of people, a process that involves confronting personalities, values, emotions and relationships as well as the ways psychological needs go unmet." Therefore, in considering how participation leads to empowerment, we must take cognisance of the various textures and nuances of participation, and must not adopt a reductionist view of empowerment that equates the latter to some unidirectional and measurable parameters. We must also delve into the reproduction of gendered inequalities in the context of water, the embodied experiences, emotional geographies and subtle negotiations and contestations undergone by the women for a more appropriate understanding of women's empowerment.

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Tanusree Paul is Assistant Professor at the Centre for Women's Studies at Visva-Bharati, Santiniketan in West Bengal.

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