Chapter 17
A Study on Spatial Statistical Method of Poverty and Sustainable Development of North-Eastern States of India

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Abstract The interrelationship between 'population and economic development' and 'poverty and human development' is direct but negative. Both are two faces of a coin and they are mutually exclusive. Rising population affects the economic growth of a region and hence this exacerbates starvation and brings poverty in the population. Poverty magnifies the problem of hunger, poor health forms, malnutrition. Educating women, children and adults in the population would help to control the growth rate of population, work for spouse, better health care and livelihood. Several concepts are available in the literature to measure poverty. The goal of this chapter is to analyse the spatial distribution of poverty levels from the viewpoint of several poverty indicators and looks into mitigation of poverty and sustainable development in North-Eastern states of India through three important pillars of development, namely economic, social and education.

Keywords Anti-poverty programmes and policies · Environmental sustainability Human development · Population growth · Spatial distribution

17.1 Introduction

The concept of poverty is related to socially perceived deficiency with respect to vital human needs. Income dimension is the central part of most poverty-related problems to understand the poverty. Increasing per capita income affects the act of the economy and marginalizes even more the lower percentile of population without redistributing part of the wealth giving a negative impact in reducing the poverty (Molini 2005). The relation between poverty and human development (HD) is direct but negative. Both are two faces of a coin and they are mutually

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exclusive. Speedy growth of population, inequality in income, degradation of environment and corruption are the biggest challenge in NE India. This chapter considers for the mitigation of poverty by controlling the rapid growth of population through three essential pillars of development like economic, social and education. Economic growth is a pre-requisite in reducing the poverty due to increasing mean income and narrowing the income distribution (Ajakaiye and Adeyeye 2001). Another work of this chapter will be based on the selected poverty indicators are spatially autocorrelated with each other or not. Generally, poverty level based on different indicators. We will consider here four poverty indicators, namely per capita income, level of education, long-term unemployment and person living in without earned income. Mainly look out all the states of North-East which will specifically show the weight matrix, i.e. $W_{ij} = 1$. Spatial statistical methods are very helpful tools for study of poverty dimension through poverty indicators. Basically, measures of spatial autocorrelation quantify the existence of clusters in the spatial arrangement of a specified variable, while global and local versions of almost all measures can be estimated.

Goodchild (1987) discussed spatial autocorrelation in general that objects or activities at different places located nearby on the surface of earth are associated with some degrees and it reflects the first law of Tobler in human geography.

Most published measures of spatial autocorrelation can recast as a (normalized) cross-product statistic that indexes the degree of relation between corresponding entries from two matrices—one specifying the spatial connections among a set of n locations and the other reflecting a very explicit definition of similarity between the set of values on some variable x realized over n locations (Hubert and Arabie 1991).

17.2 Data and Methods

Data under the study are collected from NSSO of India, Directorate of economics and statistics, Report on employment and unemployment survey, 2011 Census and web pages available in the Internet through google. We will consider two data sets, viz., NSS 66th round during 2009–2010 and 68th round during 2011–12 reports in India for eight states of North-East of India to carry out the analysis.

Moran in 1950 proposed a measure of spatial autocorrelation and this is called Moran Index (I), which is related to the conventional correlation coefficient. The value of this index takes as 1 (having strong positive spatial autocorrelation) and −1 (having strong negative spatial autocorrelation). This index has been applied to compute the spatial autocorrelation and defined as

$$I = \frac{1}{P} \frac{\sum_i \sum_j W_{ij}(Z_i - \overline{Z})(Z_j - \overline{Z})}{\sum_i (Z_i - \overline{Z})^2}, \tag{17.1}$$

where $P = \frac{1}{n} \sum_{ij} W_{ij}$, Z_i denotes the observed value of population at location 'i', $\overline{Z}$ is the average of the Z_i over the n locations and W_{ij} is the spatial weight measure of contiguity and it takes value as 1 for location nearer to each other and 0 otherwise.

Choices of W_{ij} are the most important measure in the analysis. Prior information on range and intensity of spatial covariance between regions are needed to specify weights in the neibourhood. Ordinary techniques are required for row standardization, length of common boundary and distance functions. The matrix W_{ij} is used for weighing procedure as resist to a binary connection matrix allowing weights to be chosen, which are considered appropriate from previous deliberation. W_{ij} presents immense elasticity in defining the structure of the county system and it allows objects to be taken into account. Usually, W_{ij} depends on the geographical arrangement of the observations or contiguity. W_{ij} takes non-zero values when two locations share a common boundary or within a given distance of each other (Anselin 1992).

17.3   Various Poverty Indicators

Various poverty indicators used in analyses are listed below:

(a) **Per capita income**: Communicating average income by using per capita income is also used as a measure of wealth for a nation. To measure of standard of living for a country is judged by per capita income in earlier years expressing in terms of a common used international currency into PPP (purchasing power parity). Above points help in knowing the per capita income is often used to measure a country's standard of living. It is usually expressed in terms of a commonly used international currency under PPP such as US dollar or now the euro.

(b) **Level of Education**: Formal learning is typically divided into a number of educational stages covering early childhood education, primary education, secondary education, tertiary and higher education. Seven levels of education recognized by UNESCO following International Standard Classification of Education system from Level 0 (pre-primary education) to Level 6 (second stage of tertiary education). The database of country-specific education systems and their stages are sustained by UNESCO's International Bureau of Education.

(c) **Long-Term Unemployment**: If people are not working but actively seeking work then unemployment is occurred and its rate measures the prevalence of unemployment. This rate is obtained by dividing a number of unemployed persons to all persons currently put into labour force. During abnormal time period like depression, the country usually experiences relatively a higher unemployment rate.

(d) **Population living in a Household with no Earned Income or Low Work Intensity**: The activity related to capacity to do work is called work intensity and it affects differently to both, developed and developing country with different intensity. Multitask; time poverty, health implications and policy considerations are different characteristics for work intensity in which multitasking overlaps many activities that negatively impact the livelihood of people, especially women in the developing world. While time poverty relates to the lack of time for leisure and rest activities after time spent on working. A negative correlation is expected between multitasking and time poverty. An attempt will be made to include more women in workforce for the development and also for women empowerment.

17.4   Methodology

A null hypothesis and an alternative hypothesis are to be set up before computation of various Moran's I values. To make easier the calculation and understanding, re-evaluation of the method will be done part by part at first. Therefore, it is considered that values $\{Z_i\}$ and weights $\{W_{ij}\}$, which is merged by techniques with a function, which fulfil the following standard:

  (i)   If (Z_i, Z_j) are both positive or both negative, $f(Z_i, Z_j) > 0$.
 (ii)   If (Z_i, Z_j) are a mix of positive and negative, $f(Z_i, Z_j) < 0$.
(iii)   If (Z_i, Z_j) are both have large values, $f(Z_i, Z_j)$ is also large.
(iv)   Reflection of pattern adjacency in W must be explained to compute.

Multiplying the state values together with optionally adjusted overall mean value for all states including the adjacency information provides $\sum_i Z_i$ and $\sum_j Z_j$ or with mean adjustment and weights included in $\sum \sum W_{ij}(Z_i - \overline{Z})(Z_j - \overline{Z})$ produces a covariance values. This value is divided by the sum of the weights, which gives, $\frac{\sum_i \sum_j W_{ij}(Z_i - \overline{Z})(Z_j - \overline{Z})}{\sum_i \sum_j W_{ij}}$. Moran's I is defined as

$$I = \frac{1}{P} \frac{\sum_i \sum_j W_{ij}(Z_i - \overline{Z})(Z_i - \overline{Z})}{\sum_i (Z_i - \overline{Z})^2} \tag{17.2}$$

where $P = \frac{1}{n} \sum_{ij} W_{ij}$.

The technique to compute Moran's I could be referred to de Smith, Goodchild and Longley (2015).

17.4.1 Statistical Significance of Moran's I

Under the normality assumption the variance of Moran's I is computed as:

$$Var_N(I) = \left(\frac{1}{S_0^2(n^2 - 1)} (n^2 S_1 - n S_2 + 3 S_0^2) - E_N(I)^2 \right), \quad (17.3)$$

where n = number of observations $E_N(I) = -\frac{1}{n-1}$ $S_0 = \sum_{ij} W_{ij}$.

If W_{ij} is symmetric, then $S_1 = \frac{1}{2} \sum_i^n (W_{ij} + W_{ji})^2 = 2 \sum_{ij} W_{ij}$.

Again if W_{ij} is symmetric, then $S_2 = \sum_j^n (W_i + W_j)^2 = 4 \sum_i W_i^2$.

The standard deviation Moran's I are given by $SD_N(I) = \sqrt{Var_N(I)}$, while standard Z-scores of Moran I is obtained from $Z = \frac{(I - E_N(I))}{\sqrt{Var_N(I)}}$.

Figure 17.1 given below indicates the placement of North-East states through the map and this figure indicates that Sikkim has no neighbourhood state comparing to the remaining states. Generally, the weight matrix takes value from 0 to 1 and defined as

$$W_{ij} = \begin{cases} 1 & 'i' \text{ neighbour } 'j' \\ 0 & \text{otherwise} \end{cases}.$$

Spatial autocorrelation for a single variable cross-sectional data set is tested using the magnitude of an indicator and combining the value observed at each
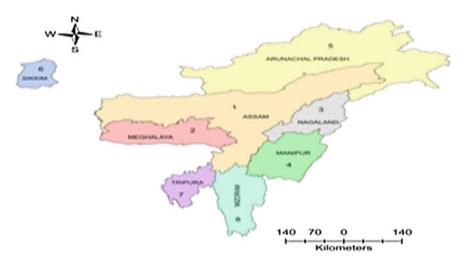

Fig. 17.1 Placements of Northeast states

Table 17.1 Weight matrix

States	Codes	States and codes							
		Assam (1)	Meghalaya (2)	Nagaland (3)	Manipur (4)	Arunachal Pradesh(5)	Sikkim (6)	Tripura (7)	Mizoram (8)
Assam	1	0	1	1	1	1	0	1	1
Meghalaya	2	1	0	0	0	0	0	0	0
Nagaland	3	1	0	0	1	1	0	0	0
Manipur	4	1	0	1	0	0	0	0	1
AP	5	1	0	1	0	0	0	0	1
Sikkim	6	0	0	0	0	0	0	0	0
Tripura	7	1	0	0	0	0	0	0	1
Mizoram	8	1	0	0	1	0	0	1	0

Source Author's calculation

location with the average value at neighbouring locations. Spatial autocorrelation statistic takes an extreme value as compared to no spatial autocorrelation under the null hypothesis (Anselin 1992).

Table 17.1 given above illustrates distribution of weights along with their codes. Unadjusted variance and covariance matrix are computed excluding Sikkim and only seven states comprising seven cells are considered for computation. Deviations from the overall mean value in the column and row bounding by 7×7 matrix with value C has been placed in each cell. The variance is obtained from the diagonal elements of matrix and the off diagonal elements give the covariance. Off diagonal elements of the matrix are required the adjustment in their weights. The total of these adjusted values is the row sum. The sum of diagonal values of the matrix is SSD. Moran's I is computed by (17.1).

17.5   Result and Discussion

Tables 17.2 and 17.3 demonstrate values in Moran's I with their p-values in four poverty indicators for the first data set and the second data set, respectively. Null and alternative hypotheses for both data sets are as: H_0: There is no spatial autocorrelation among four poverty indicators. H_1: There is spatial autocorrelation among four poverty indicators.

According to the Moran's I, the spatial autocorrelation coefficient with p-values are less than the Moran's I value in the both data sets, first and second. The null hypothesis is rejected. Thus, the variables are behaving significantly positively spatially autocorreleted and similarly values are clustered together. Hence, all the

Table 17.2 Moran's I value for first data set

Poverty indicators	Moran's index	p-value
Per capita income	0.4080	0.0536
Average level of education	0.3724	0.2020
Long term unemployment	0.4306	0.1916
Population living without earned income	0.5521	0.1710

Source Directorate of economics and statistics, Government of India

Table 17.3 Moran's I value for second data set

Poverty indicators	Moran's index	p-value
Per capita income	0.6273	0.0160
Average level of education	0.3526	0.2057
Long term unemployment	0.2466	0.2260
Population living without earned income	0.9186	0.6126

Source Directorate of economics and statistics, Government of India

selected poverty indicators have a high degree of positive autocorrelation among the states of North-East except Sikkim.

As we know, poverty is the creation of social, political and others factors and its occurrence depends upon place, time and society. A person, who fails to obtain the minimum level of calories, falls below the poverty line. Chakravarty and Majumder (2007) discussed that poverty is a multidimensional phenomenon and its analysis needs more dimensions than income. Rowntree (1901) defined families in poverty if their total earning is insufficient to meet the 'minimum necessities of merely physical efficiency' under income approach. The concept of poverty reflects failure in human life with many dimensions—unemployment, hunger, illness and health care, homelessness, powerlessness and victimization and social injustice. All of them are adding up to an assault of human dignity. Rapid growth of population in NE India is worrisome and great challenge. It is one such region that exhibits accelerated population growth—both natural (in terms of exponential growth) and artificial (illegal migrants from neighbouring countries) increases—after independence. An urge is required to have at most one girl child (with low fecundity) in each family and use of contraception for controlling the rapid growth of population. Practice of contraceptives should be encouraged through awareness. There is a need to enhance the amount of incentive for the family planning sterilization of male and female to control the rapid growth of population. Good impact of this is visible in rural areas. The sex ratio in 2011 is very good (above 900) in all NE states except Sikkim and in each state, an increasing trend is expected in future years, which is good sign of improvement in sex ratio within NE. Population projection based on migration, fertility, mortality and sex-age composition gives better approximation.

State-wise poverty from 2000 to 2014 is demonstrated in Table 17.4, in which poverty rates associated with five states like Arunachal Pradesh, Assam, Manipur, Meghalaya and Mizoram exhibit peculiar behaviour from 2011 onward but poverty rates in Nagaland, Sikkim and Tripura are reducing year by year. This indicates that programmes and policies for poverty reduction were implemented nicely in these three states. More attention is required to implement those policies in remaining five states. Poverty is multidimensional and a much broader concept than, what is generally thought of. The term human deprivation can only be identified through elasticities of various poverty indices. Alleviation of poverty is a great challenge before the governments and societies on the globe including NE India.

As we know jhum (or shifting) cultivation is popular for agricultural practice in North-East India. People cut valuable and pre-matured trees and burn them with other smaller plants in the forest under shifting cultivation, which affects the environment. There is a need to stop this practice for the environmental sustainability. Time came to protect the trees and other plants in forests and all other places for better livelihood because trees are the best friends of us and they (trees) keep the environment healthier and balanced by observing harmful substances present in the air. They (trees) also keep away from natural calamity such as flood, draught, cloudbursts, etc. Continued deforestation in North-East brings people in deprivation from valuable forest resources like wood products, food and medicines. That is why it is needed to plant more trees in North-East India using the principle 'my earth my

Table 17.4 State-wise changes in poverty rate since 2000 in North-Eastern region of India

Year	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
2000	39.4	40.9	33.8	37.9	25.7	37.9	41.4	39.0
2001	37.35	39.16	30.77	35.32	25.06	36.32	38.21	39.01
2002	33.47	36.06	28.54	33.87	19.47	32.67	36.55	34.44
2003	32.67	35.09	27.54	30.87	18.25	30.98	33.68	23.44
2004	29.47	32.29	26.64	30.67	16.82	32.67	36.55	34.44
2005	33.47	36.09	28.54	33.87	19.47	29.30	31.69	28.35
2006	31.5	36.1	25.8	32.9	21.3	30.8	34.6	31.4
2007	17.6	19.7	17.3	18.5	12.6	19.0	20.1	18.9
2008	15.6	18.4	15.1	16.41	10.6	15.07	20.5	18.4
2009	15.3	17.2	16.4	11.2	16.9	46.4	22.5	32.8
2010	16.8	17.1	16.1	18.5	12.1	15.2	20.1	22.5
2011	28.20	31.10	34.40	38.00	16.10	15.30	9.00	31.10
2012	22.8	25.9	37.9	47.1	17.7	21.1	20.9	13.0
2013	34.67	31.98	36.89	11.87	20.40	18.88	5.19	14.05
2014	24.67	27.98	30.98	10.29	18.32	16.56	8.19	12.02

Source Directorate of economics and statistics, Government of India

duty'. Land reforms are requiring to achieve redistributive justice and to attain higher levels of agricultural production and income in rural areas. The successful implementation of land reforms is responsibility rests with concerned state government. Flood and erosion are related to some other major problems faced in North-East India and during the last 50 years, erosion taken by the mighty river Brahmaputra has eaten away half of the river island Majuli, which is believed to be the home of Assamese culture. Improvement of access to clean and safe water and sanitation is the most significant environment priority for the poor in the region. Inadequate protection and conservation of environment bring substantial direct and indirect impacts on health and livelihoods by increasing the vulnerability of poor people throughout the region. The most sufferers from environment health problems among poor are especially the women and children. Urban population suffers from faecal contamination of water and food due to poor or non-existence of excreta disposal systems. Most of the major rivers' water near cities and industrial areas became faecal contaminated and this brings various types of diseases in NE. Increasing demand of fresh water will be short due to high growth in population in this region.

Singh (2012) discussed that scholars, policy makers, academicians, educationists and religious leaders have been discussing the relationship between population and development. This is true that the relationship between population and development is negative. If population will increase rapidly, the economic growth is affected and hence the development is also affected.

Human rights perspective may be applied as strategy for poverty reduction. A view has been emerged that the denial or non-fulfilment of human rights (HR) also constitutes the poverty. There may be few certain kinds of human right matters, which exacerbate severity of the poverty. The HR can be relevant to poverty in three different ways—constitutive relevance, instrumental relevance and constraint-based relevance. Instrumental relevance characterizes in two different types such as evaluative and causative. Amartya Sen in his pioneering work on families demonstrated the causative relevance of some human rights. The causative relevance also exacerbates less extreme but persistent poverty. A wide range of civil and political rights should be protected. HR and poverty are complementary to each other. HR approach reduces the poverty by empowering the poor as the power-lessness weakens them but empowerment enhances the capabilities of poor persons and their freedom of choice is expanded. HR equalizes the distribution and exercise of power between and within societies. The poor get frequent experience of social exclusion, alienation, discrimination, isolation and inequality in gender, income and socio-cultural factors like the religion, colour, ethnicity, social hierarchy, etc. That is why it is needed to promote and protect non-discrimination, equality and empowerment.

Development thus can be achieved by shifting ill being to well being with good quality of life under equality. Poverty line should not be determined using the selection of low level of income only but also selection of lack of or little wealth and lack of low quality of other assets like education, health, shelter, clothing, furniture, personal means of transport, etc. Only scientific criterion can justify drawing the poverty line. Self-employment programme and allied programmes under rural development programme place prominence on focused approach to poverty alleviation, capitalizing advantages of group lending and overcoming the problems associated with multiplicity of programmes. Acceleration of economic growth together with focusing on sectors, which are employment intensive, facilitates the removal of poverty in the long run. Strategies like economic growth and redistribution are not only required to eradicate the poverty but also direct intervention in many areas—reducing population growth, empowerment, expanding education, eliminating discrimination and corruption, securing human rights and social justice; different types of deprivations related to human lives are interrelated and reinforce one another. Empowering poor persons will remove formal and informal institutional barriers that prevent them from taking action to improve their well being. Main industries are available on tea based, crude oil and natural gas, silk, bamboo and handicrafts in this region. The states are heavily forested and have plentiful rainfall.

The measure of social development is based on the UNDP Human Development Index (HDI). Whereas per capita GDP is correlated with (though does not directly measure) longevity and education, the HDI measures per capita income, longevity and education directly. GDP measures productivity in the aggregate. Contrasting per capita GDP, the HDI is able to distinguish between standard of living and income. In addition to it, indicators like Gini coefficient of income distribution and percentage of population below poverty line are used. The important dimensions of

social development like literacy, infant mortality rate, expectation of life and composite indices such as physical quality of life (PQLI), Human development index (HDI) and gender-related development index (GDI) are used. NFHS 1992–93 report shows that total fertility rate is reduced as the level of education increased in different religions and also for total population.

To educate women has many advantages in the societies. The educated mothers are able to take better care of themselves and their families and children. Education or formal schooling plays a greater role in affecting reproductive behaviour and increased knowledge of health, hygiene, cleanliness, sanitation and demand for fewer children in the families. Education also promotes better antenatal lifestyles and educated parents place greater emphasis on child quality than the child quantity. They prefer, in general, fewer but better educated, healthier and well-nourished children. The education reduces the number of children a couple has by encouraging contraception. It also minimizes the fear of adopting such new technologies and also makes individuals think and realize. Planning is a systematic attempt by the government to analyze the existing situation, sort out the requirements and choose the measures needed to accomplish the selected goals to transform the society deliberately. Education is the key to development and the most powerful weapon available in the fight against inequality to reduce poverty.

The aim of anti-poverty policies and programmes for North-East India should be based on reduction of population growth, expanding education, eliminating discrimination and corruption, securing human rights and social justice. Anti-poverty programmes are designed specifically in such a way that they generate both the self and wage employments in rural areas in order to improve their effectiveness and impact on the decant and get better their sustainability. Emphasis will be given to cover entire area and all poor. Funds of all programmes and policies are directly released to village councils through village punchayats. Singh (2011) provided an example that Bihar government has been implementing the programmes and policies available in nice way assuming prime duty and as a result Bihar achieved annual growth rate of development above 11% in financial year 2008–09. One may say that 'Where there is will, there is a way'. Most of the anti-poverty policies and programmes in North-East India suffer from human diseases like discriminations, corruptions and selfishness. Good governance guarantees the transparent use of public funds, encourages growth of public and private sectors, promotes effective of public services and helps to establish the rule of law. Regular monitoring of anti-poverty and anti-corruption programmes and policies in North-East India are required with full will-power and honesty.

17.6 Concluding Remark

Moran's I spatial autocorrelation coefficient with p-values on four poverty indicators such as per capita income, average level of education, long term unemployment and population living without earned income is computed for the first data set and

the second data set, respectively, and found behaving significantly positively spatially autocorreleted. Hence, all the selected poverty indicators have a high degree of positive autocorrelation among the states of North-East except Sikkim.

To improve quality of lives of all the people in the region is possible only by lowering the rate of population growth and the infant mortality rate; increasing the per capita income, level of education, expectancy of life and healthcare and eliminating discriminations, all sorts of corruptions and environmental pollutions from North-East India. Government should make programmes and policies and then implement those policies seriously and nicely with full willpower to combat the poverty from North-East India. The anti-poverty programmes and policies should continue. There is a need to develop a good technology so that maximum share of fund of the programmes and policies should reach to the beneficiaries who need badly as the relief to come out from poverty in the region.

Attempts should be made for compulsory education to all children, women and adults for lowering the rate of population growth and the rate of pollution, better health facilities to all, implementation of birth control and healthcare programmes and free from all sorts of corruptions in the societies.

The Brahmaputra and all other rivers in North-East India should be interconnected with pucca banks on both the sides of the rivers, if possible but gradually. Special emphasis on tapping the tourism potential in North-East India is required and to be given under Tourism Policy to promote better livelihood.

Better lives are possible in North-East India by increasing per capita income, level of education, expectancy of life, women empowerment, ensuring equality in each section of population, providing better health care and lowering the infant mortality rate. Encouragement to work for both the spouse in each household is required for the betterment of income and their lives in North-East India.

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