International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 3; Issue 6; June 2016; Page No. 15-20

Water paradox in India: A case study of north-eastern states

[1] MS Bhatt, [2] Jasleen Kaur

[1] Former Professor, Department of Economics, Jamia Millia Islamia, New Delhi, India.
[2] Assistant Professor, University of Delhi and Research Scholar, Jamia Millia Islamia, New Delhi, India.

Abstract
Water scarcity is one of the most critical issues of recent times. Nations across the globe are in the grip of water crisis. However, scarcity is not only being witnessed in the naturally water-scarce regions of the globe, but also in regions where this resource is available in plenty. This paper provides a descriptive analysis of water situation in the water-rich North-Eastern states of India. The analysis focuses on the concept of water poverty, rather than water scarcity, indicating that the former is a more comprehensive term. Water poverty assesses water situation in terms of factors like access to water, income of people, use of water and water quality. The analysis reveals that there exists a paradox in this region. This part of India may not be water scarce, but shows characteristics of water poverty.

Keywords India, North-East, Poverty, Scarcity, Water

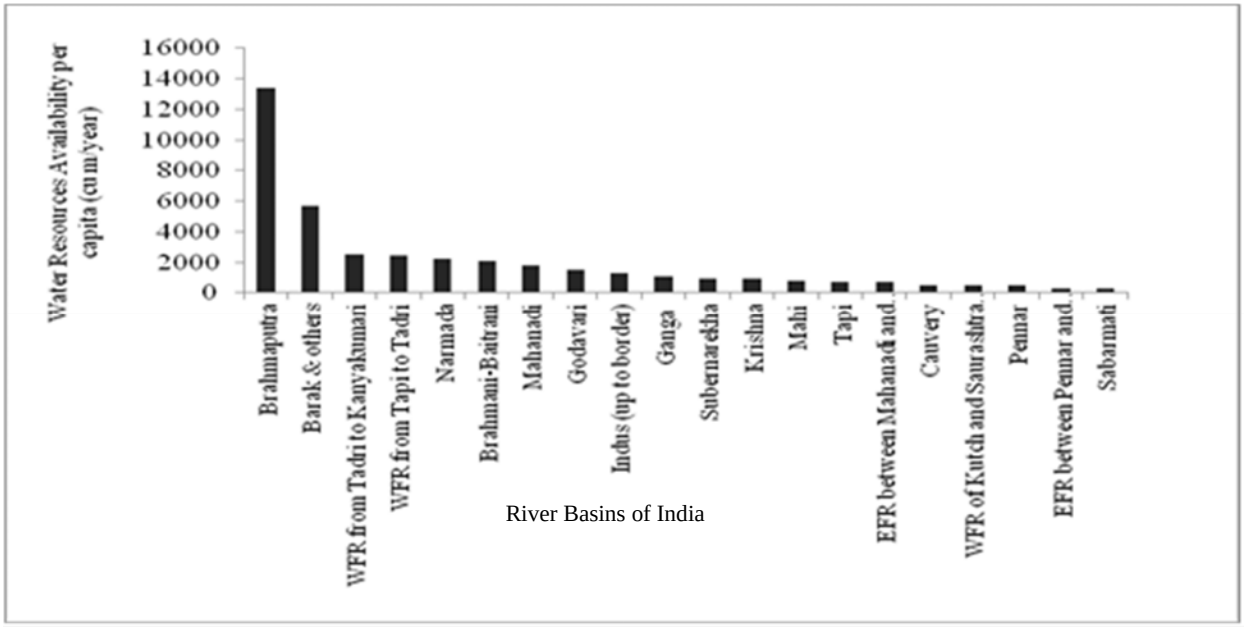
1. Introduction
Water is one of the most sacred gifts of nature. Besides being a basic need for all life on earth, it is an important input in economic activity: in agriculture, industry and commerce. It is a fundamental part of the ecological system, sustaining and being sustained by it. It is a means of transportation, a public good and an important part of our social and cultural life [1]. However, the past few decades have witnessed increased population, urbanization, industrialization and a growing consumerist culture. This has not only increased the demand for water but also altered the hydrological cycle, putting nations and regions within nations, in the throes of a water crisis. Mismanagement, profligacy and wastefulness are making this crisis loom large. Apart from regions which are naturally less endowed with water resources, there is scarcity also found amidst plenty. It is for this reason economists have been looking at water scarcity beyond the mere paucity of resources. The resource-centric term 'water scarcity' has been replaced with the more comprehensive people-centric term 'water-poverty'. Water poverty denotes the population's inability to access the available water either due to lack of proper distribution network or lack of income to buy it. It also represents the inability of the people to get water of good quality despite its abundance [2, 3]. The objective of this paper is to present a descriptive analysis of water poverty in the most water abundant region of India - the North East region. Data for the year 2011-12 on many variables have been studied[1]. The purpose is to examine the existence of a paradox, to find out whether the region exhibits characteristics of water poverty, despite resource abundance. This paper has been divided into three sections: Section 1 throws light on the volume of water resources and per capita availability in North-East India. Section 2 discusses in detail the factors that make the region water poor. Issues in the North-East like accessibility to water, adaptive capacity to sustain access, use of water and environmental integrity have been raised in this part. Lastly, Section 3 provides conclusion.

1.1 Water Resources of North East India
India is a land of many rivers. The Indian topography is characterized with twenty river basins/group of river basins, comprising of twelve major and eight medium and small river basins. The total average annual water resource potential of all basins is 1869 billion cubic metres (bcm). However, the distribution of water resources among the individual river basins is highly uneven. Out of the average annual water resource potential of 1869 bcm, the Brahmaputra and Barak rivers, covering the entire North-East (NE) region of the country, account for 586 bcm (which is roughly 32% of the total potential [4, 5]). The NE region of India comprises of seven sister states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and the Himalayan state of Sikkim. Thus, one-third of the water wealth of the country is concentrated in the region, popularly called the 'Water Tower of India'.
One of the earliest measures of water scarcity/abundance was given by Falkenmark in the year 1989 when he introduced the Hydrological Water Stress Index (HWSI) [6]. According to HWSI, also known as the Falkenmark Index, the total renewable water resource in a region is divided by the population of that region to arrive at per capita water availability. Water availability of more than 1,700m³/capita/year is defined as the threshold above which water shortage occurs only irregularly or locally. Below this level, water scarcity arises in different levels of severity [6, 7]. Water resource available per capita in different river basins of India is shown in Figure 1. There is a stark contrast in the water available per capita in the Brahmaputra river basin and the rest. With only 2.6% of the total population in the country, the per capita availability of water is highest in the Brahmaputra basin which covers the entire NE region of India. The region has per capita water availability of more than 13000 cubic metres (cu.m.)./year, which is well above the 1700 cu.m.per capita threshold defined by Falkenmark. It is also well above the national average of 1544 cu.m.per capita per year[2] [4]. However, there has been scarcity emerging at the local level,

[1] The choice of the year rests on the rationale that 2011-12 was a stable year. Besides, since it is closer to the Census year, it enabled us to use Census data in case of variables for which data was not available otherwise.

[2] This is based on the Central Water Commission's (CWC) estimation. 1869/1210 = 1544, where 1210 billion is the population of India as per Census 2011

especially during the non-monsoon season. Despite the heavy rainfall this region receives, a number of water related challenges have emerged during the last decade [8].



Note: WFR and EFR are West Flowing Rivers and East Flowing Rivers respectively

Fig 1: Water Resources Available Per Capita (in cubic metres per year)

2. Water Poverty in North-East India

The term 'water poverty' was introduced by Sullivan [2] in the year 2002 and further developed by Lawrence *et al.* [3] in the same year. The authors define variables that should be taken into account while understanding the water situation of a region. Much of literary work on water poverty, however, can be seen even before this term was introduced [9, 10, 11, 12]. Water poverty refers to the lack of water resources due to the lack of any/all of the following factors;

- Physical volume of water resources per capita;
- Access to water resources that are reliable, adequate and in regular supply;
- Social adaptive capacity in the form of incomes that indicate the ability to buy water and sustain access;
- Use of water for domestic, agricultural and industrial purposes;
- Appropriate water quality; and
- Adequate water for the ecosystem

For the water-abundant NE states of India, all factors (except the first one, which has been dealt with in Section 1) have been analyzed in detail below.

2.1 Access to Safe Drinking Water and Improved Sanitation

Availability of water resources does not guarantee equitable access or 100 per cent coverage of the entire population. Access to water relates to people's ability to obtain that water to satisfy their needs, taking into account factors such as time and distance to collect water, rights of access and costs [13]. Access to safe water and sanitation are directly linked to poverty alleviation and nobody can be lifted out of poverty without the adequate accessibility. Due to its indispensable role in eradication of poverty, reducing proportion of people without access to safe drinking water has also been one of the targets to achieve the Millennium Development Goals[3] [14].

According to Census 2011 [15], drinking water can be derived from tap water (from treated and untreated sources, both), wells (covered and uncovered, both), hand-pumps, tubewells, springs, rivers, canals, tanks, ponds, lakes and other sources. Out of all the sources of access to water, tap water, hand-pumps and tube-wells are considered 'safe' sources of water supply[4] [16, 17]. A look at figure 2 reveals that except for Arunachal Pradesh and Sikkim, more than one-third of the households in the NE states do not have access to safe water. In case of Manipur and Meghalaya, this figure exceeds more than 50 per cent. In addition, percentage of households with access to unsafe water exceeds the national figure of 14 per cent. Besides, in all the NE states (except Sikkim), more than 50 per cent of the households have access to water sources, which are not within the premises. Most of the sources are either near the premises or away from the premises.

[3] Target 10: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation; which achieves Goal 1: Eradicate extreme poverty and hunger; and Goal Number 7: Ensure Environmental Sustainability

[4] These sources are considered 'improved' sources of drinking water by the WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. Retrieved from http://data.worldbank.org/indicator/SH.H2O.SAFE.ZS on 17/01/2016 at 21:10 hrs

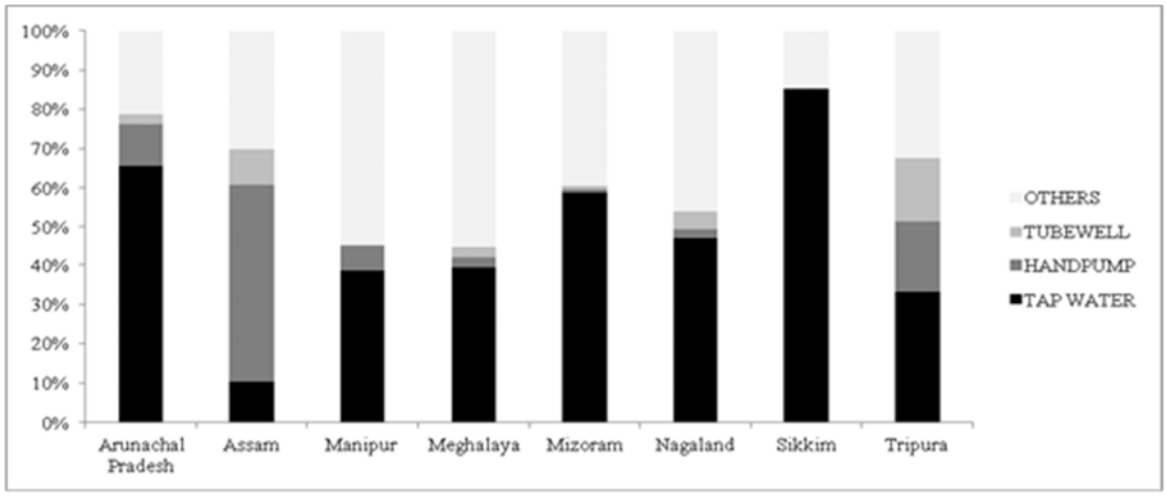


Fig 2: Percentage of Households with Access to Safe Drinking Water in North Eastern States of India in 2011

Like safe drinking water, access to proper sanitation facilities is a measure of the socio-economic status of the household and is a prerequisite for poverty alleviation [18]. According to Census 2011 [15], Indian households across states are divided in terms of the type of sanitation facility they use. 'Improved' sanitation facilities include (a) Flush/Pour Flush Latrine connected to Piped sewer system and Septic Tank; and (b) Pit Latrine with Slab/Ventilated improved pit [17]. According to the WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation, these facilities are considered 'improved' because they are likely to ensure hygienic separation of human excreta from human contact. The 2011 Census figures indicate that more than 50 percent of the households in Arunachal Pradesh, Assam, Manipur, Meghalaya and Nagaland do not have access to improved sanitation facilities. They are relying on other forms of sanitation like the flush/pour flush latrine not connected to piped sewer system and septic tank, pit latrine without slab or open pit, night soil disposed in open drain, or removed by human or serviced by animal. In addition, more than half the number of households in all these states do not have access within the premises. In the states of Manipur, Mizoram, Sikkim and Tripura, less than 15 per cent of the households have access to latrine available within the premises. Out of the rest, a mere 4 per cent use public latrine and a majority defecate in open.

2.2 Social Adaptive Capacity

It is also known as 'second order scarcity' and refers to the lack of social resources required to successfully adjust to the first-order water scarcity (which occurs because of natural resource shortage) [10]. Social adaptive capacity refers to the ability of the people to access water, sustain access, manage it, use it effectively and lobby for its improvement. According to Lawrence *et al.* [3], 'people can be water poor because they are income poor'. Social adaptive capacity is measured through factors like distributional equity, political participation, access to education and the like, which determine the capability of a society to respond to issues related to water. In general, the human development indicators capture such capacity.

A closer look at the indicators in Table 1 reveal that except Arunachal Pradesh and Sikkim, all the other NE states have per capita income below the national average of 54021 rupees. Literacy rates for all the states, except Arunachal Pradesh and Assam are above the national average but still below the literacy rate of Kerala which boasts of 94 per cent literacy rate. To have a closer look at the education level in this region, the Intensity of Formal Education (IFE) was computed using the NHDR 2001 methodology [18]. The intensity of formal education is based on class-wise enrollment rates and hence assesses the spread of formal education. It weighs progressively the capacity of the education system to retain enrolled students over successive classes from class I to XII [18]. In case of IFE, Assam is the lowest not only among the NE region but also among all the states. The states of Manipur, Meghalaya and Nagaland also have low IFE as compared to the national average. The region, however, is blessed in terms of better life expectancy as compared to the other regions of the country.

Table 1: Human Development Indicators of the North Eastern States in Census 2011

India/ State	Per capita Income# (in rupees)	Literacy Rate (in percent)	IMR (per 1000 live births)	IFE# (in years)	Life Expectancy at Birth
INDIA	54021+	74.04	44	5.4	66.9
Arunachal Pradesh	60935	66.95	32	5.6	69.9
Assam	33087	73.18	55	3.8	63.3
Manipur	28931	79.85	11	4.9	69.9
Meghalaya	49261	75.48	52	4.9	70
Mizoram	50956	91.58	34	6.1	70
Nagaland	55582	80.11	21	4	69.9
Sikkim	108972	82.2	26	6	69.8
Tripura	46050	87.75	29	6.2	69.9

Source: Compiled from the Economic Survey 2014-15 and Statistics of School education 2011-12
in 2011-12

2.3 Use of Water

Water use reflects the demand side of water**.** Broadly, water is used by three sectors – (a) domestic sector**;** (b) agriculture sector; (c) industrial sector. The amount of water used in a particular region depends on how easily it is accessible, the nature of demand and living standard of people. Usage of water increases further with increase in agricultural and industrial activities [19]. Studies have shown that the general interval for water demand in the semi-arid developing countries is low (in the range of 20-100H) in comparison with their developed counterparts (in the range of 75-200H), indicating that demand for water increases with economic development [19 as cited in 20]. Thus, higher use is associated with better water situation, because it is indicative of better accessibility and low poverty levels [21]. Water use below certain threshold means that water is not used to the most efficient degree possible. In contrast, water use, especially, for domestic purposes, beyond threshold level denotes profligacy and mismanagement of water [3].

While designing Indian cities and towns, the Central Public Health and Environmental Engineering Organisation (CPHEEO) has defined the maximum water supply levels. For towns (with population less than 20,000) provided with piped water supply but without sewerage system, the recommended norm of water supply is 70 litres per capita per day (lpcd). For cities (with population 100,000 to Less than 1,000,000) provided with piped water supply, the norm is 100 (with no sewerage system) and 135 (with sewerage system). In case of metropolitan and mega cities (with population 1,000,000 and above) provided with piped water supply where sewerage system is existing or contemplated, the norm is 150 (+15% for leakages and Unaccounted for Water). The CPHEEO norms are also in conformity with the norms laid down by the National Commission for Integrated Water Management (NCIWRD) [22]. One fifty litres per capita per day is considered the threshold beyond which profligacy is said to be exist [23, 24].

The Central Pollution Control Board (CPCB) produces decadal publications on the water supplied in Class I and Class II towns of India, the latest of which is available for the year 2008-09 [25]. For our analysis, water supplied was divided by the population in Class I and Class II towns in the same period to arrive at the per capita domestic water supply. Considering the minimum norm of 70 lpcd and maximum norm of 150, it was seen that in the NE region, the state of Assam, showed a usage of 253 lpcd, which is much higher than the maximum limit. The state of Manipur also crosses this limit with a 170 lpcd usage of water for domestic purposes. The other states of Meghalaya, Mizoram, Nagaland and Tripura show domestic water usage within limits.

Usage of water in the agricultural sector can be analysed through the proportion of irrigated land to gross cropped area. A well-developed irrigated agriculture is the major driver of economic growth and poverty alleviation in a region. This is because it reduces the dependence of agriculture on natural conditions and stabilized farmer's income, thereby improving their livelihood [26]. Irrigation is the lifeline of Indian agriculture, a sector which is the largest consumer of water. Demand of water for irrigation is roughly 80% of the total demand for water in India. However, less than one-fourth gross cropped area in all the north-eastern states is irrigated. It is less than the national figure which is roughly 50 percent. In Assam, a mere 4 per cent gross cropped area is irrigated.

2.4 Water Quality

The quality of surface water and groundwater is assessed on the basis of many parameters. Some of them are Dissolved Oxygen, pH (test of acid/basic), Conductivity, Biological Oxygen Demand (BOD), Feacal Coliform and Total Coliform. Besides, there are nutrients like nitrates and phosphates and metals like copper, zinc and lead that also influence water quality. In all, there are 75 parameters outlined by the Central Pollution Control Board [27] to assess the quality of water. The Water Quality Status Report 2012 produces a list of all the states, where samples are collected and tested for water quality on certain parameters. The list includes the number of observations violated by each state with respect to five parameters (DO, pH, BOD, Faecal Coliforms and Total Coliforms). Biological Oxygen demand is the most widely used parameter to assess the quality of water. BOD is the amount of dissolved oxygen required by an aquatic body to fight biological organisms present in it. The desired level of BOD required in 3mg/l for 5 days at 20^{o} C (CWC 2013). When BOD level exceeds this level, the quality of water deteriorates. The report identifies that one-third of the samples collected in different surface water bodies in Assam, Meghalaya and Manipur violated the maximum level of BOD required. The BOD violations were over 70 per cent in the states of Nagaland and Tripura. Looking at the output variable of assessing water quality, i.e. the diarrhoeal morbidity rate[5] [28] all the states, except Assam in the NE region had rates exceeding the national rate, which is 10 per thousand population. In the state of Meghalaya and Sikkim, the rate is as high as 50 and 70 per thousand population respectively [15].

2.5 Water for the Ecosystem

A degraded ecosystem lacks the capacity to provide goods and services in adequate quantity. Practices such as illegal logging and unscientific cultivation cause land degradation and loss of forest cover. This in turn intervenes with the functioning of the hydrological cycle, leading to a vicious circle of environmental degradation, making it vulnerable. In India, data on land degradation of all 19 types[6] are included in the report on 'Degraded and Wastelands of India' [29]. Figure 3 below shows degraded area as a percentage of total geographical area in each of the NE state.

[5] Diarrhoeal Morbidity Rate is defined as the number of cases reporting diarrhea in a particular year per 1000 population

[6] These include (1) Water erosion under open forest; (2) Forest; (3) Exclusively acid soils (pH <5.5); (4) Acid soils under water erosion; (5) Acid soils under open forest; (6) Exclusively wind erosion; (7) Exclusively saline soils; (8) Eroded saline soils; (9) Acid saline soils; (10) Saline soils under wind erosion; (11) Saline soils under open forest; (12) Water logged saline soils; (13) Exclusively sodic soils; (14) Eroded sodic soils; (15) Sodic soils under wind erosion; (16) Sodic soils under open forest; (17) Eroded sodic soils under open forest; (18) Mining / Industrial waste; and (19) Waterlogged area (Permanent) (See ICAR Report on Degraded and Wastelands of India: Status and Spatial Distribution)

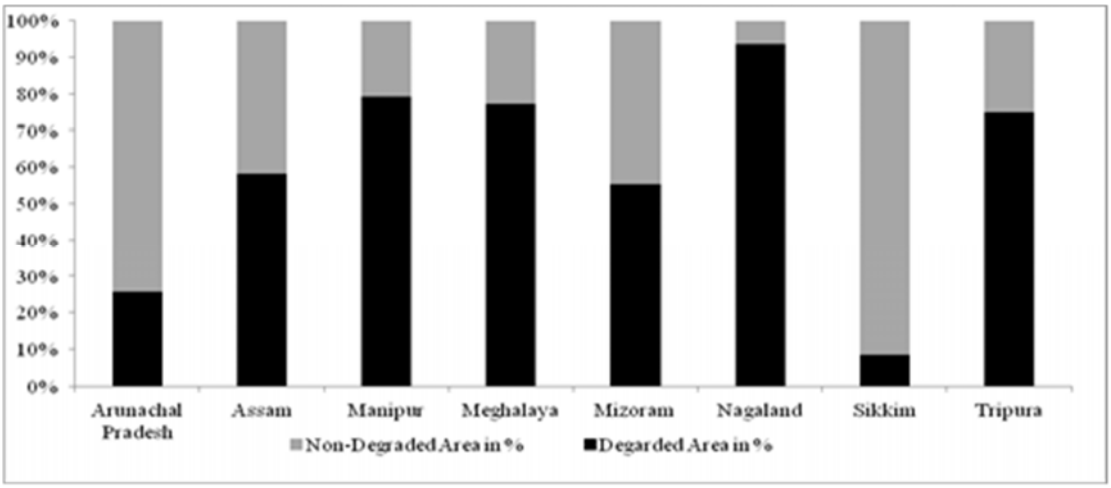


Fig 3: Degraded Land as a percentage of Total Geographical Area in the NE states

According to the Report, a major portion of the NE geographical area is under the category of 'degraded land'. The state of Nagaland has more than 90 per cent degraded area, which is the highest for any state in India. At the national level, 36% of the total geographical area of India reports 'degraded land', and all the states in the NE region have this figure more than the national figure. This is because this region is predominantly affected by acidic soils and water erosion. Soils become acidic in humid areas where rainfall causes excessive leaching of cations[7]. This in turn brings down the pH level and the fertility of soil. Water erosion, on the other hand, is a rather more widespread form of degradation especially in the agrolimatic zone of the NE region i.e the Eastern Himalayan region. Water erosion (or soil erosion by water) means loss of the top layer of the soil. When rain falls on the sloping land, the soil material gets detached and flows with the run off. Water erosion can take many forms- splash, sheet, rill or gully erosion. Since the north eastern region is characterized with excessive rainfall and steeper land slopes, water erosion is the common form of degradation.

3. Conclusion

This paper gives a comprehensive perspective of water situation in the North-East India. It highlights that water shortage or water issues need to be understood beyond per capita availability. Despite being the wealthiest region of India in terms of water endowment, North-East India is actually water poor. That is, households and individuals in the region lack access to water supply. The average income of an individual is relatively low indicating the lack of capacity to ensure access to safe water and sanitation within the premises. The education levels are also poor, which interact with low incomes to ensure poor management of water resources. A few states in the region also depict profligacy and almost all of them show water-related environment degradation. In light of this, there is a need at the planning level to realize the factors which need to be improved in this region so that people are not deprived of water despite its abundance.

4. References

1. Iyer R. Towards Water Wisdom, Limits, Justice, Harmony. SAGE Publications. Los Angeles, California, 2007.
2. Sullivan C. Calculating a Water Poverty Index. World Development, 2002; 30(7):1195-1211.
3. Lawrence P, Meigh J, Sullivan C. The Water Poverty Index: An International Comparison. Keele Economics Research Papers. Keele University, Keele, UK. 2002.
4. Central Water Commission (CWC). Water and Related Statistics. Water Resources Information System Directorate, Information System Organisation, Water Planning and Project Wing. New Delhi, 2013.
5. Jain SK, Agarwal PK, Singh VP. Hydrology and Water Resources of India. Dordrecht: Springer. 2007.
6. Falkenmark M. The Massive Water Scarcity Now Threatening Africa - Why isn't it Being Addressed? Ambio, 1989; 18(2):112-118.
7. Falkenmark M, Lundquist J, Widstrand C. Macro-scale Water Scarcity Requires Micro-Scale Approaches: Aspects of Vulnerability in Semi-arid Development. Natural Resources Forum, 1989; 13(4):258-267.
8. GIZ. Scarcity amidst Plenty: Water in North East India. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, New Delhi, 2014.
9. Ohlsson L. Water and Social Resource Scarcity. An issue paper commissioned by the FAO AGLW (Rome). 1998.
10. Ohlsson L, Turton AR. The Turning of Screw: Social Resource Scarcity as a Bottleneck in Adaptation to Water Scarcity. School of Oriental African Studies, University of London. 1999.
11. Turton AR, Warner JF. Exploring the Population/Water Resources Nexus in the Developing World. The Woodrow Wilson Institute "Environmental Change and Security Project", USA: Washington DC, 2002.
12. Feitelson E, Chenoweth J. Water Poverty: Towards a Meaningful Indicator. Water Policy, 2002; 4(3):263-281.
13. Sullivan CA. The Water Poverty Index: Development and Application at the community Scale. Natural Resources Forum, 2003; 27:189-199.
14. UNDP. Human Development Report. UNDP, New York, 2006.
15. National Health Profile 2011. Central Bureau of Health Intelligence. Directorate General of Health Services.

[7] Cation is the loss of one or more electrons from a neutral atom.

Ministry of Health and Family Welfare, 2012.
16. Economic Survey 2012-13, Government of India, 2013.
17. Kumar A, Das KC. Drinking Water and Sanitation Facility in India and Its Linkages with Diarrhoea among Children under Five: Evidences from Recent Data. International. Journal of Humanities and Social Science Invention. 2014; 3(4):50-60.
18. National Human Development Report 2001. Planning Commission, 2002.
19. Falkenmark M, Widstrand C. Population and Water Resources: A Delicate Balance. Population Bulletin, Washington: Population Reference Bureau, 1992.
20. Forkasiewicz J. Margat J. Tableau Mondial de Donntes Nationales D'Economie de L'Eau, Resources Utilisations, Department Hydrogeologie, 79 SGN 784 HYD, Orleans, 1980.
21. Heidecke C. Development and Evaluation of a Regional Water Poverty Index for Benin. EPT Discussion Paper 145, Environment and Production Technology Division, International Food Policy Research Institute, Washington, DC, USA, 2006.
22. National Institute of Hydrology. Retrieved from http://www. nih.ernet.in/ on 19/03/2016 at 16:00hrs.
23. Sullivan CA, Jemmali H. Towards Understanding Water Conflicts in MENA Region: A Comparative Analysis Using Water Poverty Index. Economic Research Forum, 2014. Working Paper 859.
24. Jemmali H, Matoussi MS. A Multidimensional Analysis of Water Poverty at Local Scale: Application of Improved Water Poverty Index for Tunisia. Water Policy, 2013; 15(1):98-115.
25. Central Pollution Control Board (CPCB). Status of Water Supply, Waste Water Generation and Treatment in Class I Cities and Class II Towns of India. Ministry of Environment and Forests, Government of India, 2009.
26. Manandhar S. Pandey VP. Application of Water Poverty Index (WPI) in Nepalese Context: A Case Study of Kali Gandaki River Basin (KGRB). Water Resource Management, 2012; 26:89-107.
27. Central Pollution Control Board (CPCB). Status of Water Quality in India 2010. Ministry of Environment and Forests. Government of India, 2012.
28. Mingzxuan F, Rao B. India Infrastructure Report: Water: Policy and Performance for Sustainable Development. Infrastructure Development Finance Company. Oxford University Press, New Delhi, 2011.
29. Indian Council of Agricultural Research (ICAR). Degraded and Wastelands of India: Status and Spatial Distribution. New Delhi, 2010.