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STATUS OF DRINKING WATER IN THE EASTERN AND NORTH EASTERN STATES OF INDIA: AN ANALYSIS THROUGH CENSUS

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ABSTRACT

The finding of the study reveals many facts about the drinking water scenario across the Eastern and North-Eastern states of India. Data taken from the Census for both 2001 and 2011, shows a much distinct variation where almost all the districts of all the state has made a good progress in safe drinking water than the previous year. Geographically, two regions vary with one another, so the sources of drinking water used in this region also vary. The two contrasting regions of India, namely Eastern and North Eastern region have been covered by the mighty Brahmaputra and Ganga River which feeds the whole region and having the geological rock formation from pre- Cambrian to recent Pleistocene. Interestingly enough one region is situated on the Himalayas and the other on the floodplains, one region receives high rainfall almost throughout the year except some dry months and another receives high rainfall only during monsoon season. One region have a good coverage of safe drinking water and the other does not have, one region has a greater use of the spring water, which is meant to be a boon and for the other this proves to be a bane if taken up for the consumption.

Keywords: Census 2001 and 2011, Drinking water, Eastern and north -eastern states, Hydrogeology, Socio-economic factors

1. INTRODUCTION

Situated on the Himalaya and the floodplain the two contrasting regions of India namely East and North- East India have a unique geography. These regions together comprise 12 states and districts and the region has different geologic and hydrogeology features which have been discussed in the paper. Besides, the possible socio-economic factors are also been taken into account to explain the variation of the use of the different sources of drinking water thus, the main objective of the paper is to identify the various sources of drinking water at district level in Eastern and North-Eastern states of India and to trace out the socio- economic factors that explain the variation of drinking water facilities in the respective states.

2. DATABASE AND METHODOLOGY:

The present study in totality is based on the secondary data available from the census of India (2001 and 2011). Census 2011 has been taken as a reference to explain how socio-economic

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factors can explain the variation of the use of the different sources of drinking water. For the analysis of the work the NSSO data has also been consulted. 10 main sources of drinking water have been taken from 2011 census data (8 main sources for calculating 2001). Government data from the Central Ground Water Board (CGWB) has also been used in order to understand the role of the hydrogeology in the region.

Following types of Drinking water sources are available through census-

1) Tap water- treated
2) Tap water- untreated
3) Covered well
4) tube well/borehole
5) hand pump
6) Uncovered well
7) Spring
8) River/Canal
9) Tank/ Pond/Lake
10) Other sources

Amongst all the sources of water, tap water is generally meant to be the safest drinking water; now 2011 census of India has again given a clear cut division of tap water into two categories

1) Tap water from treated source 2) Tap water from untreated source which will be helpful to understand the quality of water which people are using for the drinking purpose.

In order to know the socio economic factors affecting proportion of use of tap water, multiple linear regressions has been used to see different model. For this the following formula has been used.

$$y= a_0+a_1x_1+a_2x_2+a_3x_3+a_4x_4+a_5x_5+a_6x_6+a_7x_7$$

Where, a0= constant

a1,a2,…….. a7 are the coefficient of X1, X2……..X7 respectively

and X1, X2……X7 are the socio economic variables

However, for the convenience of the calculation SPSS version 20 has been used to get the summary table. The source and quality of water has been plotted on various graphs and maps.

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3. AREA OF STUDY

There are at least seven (now eight) states under North-Eastern region of India, which are Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim which is well-known as seven sisters (now eight). These regions are surrounded by the critical geopolitical issues in India with its neighboring countries. Some of the exceptional characteristics of these regions are landlessness; poor expansion of economic opportunities, immigration, ethnic agitation, insurgency etc. The total geographical area of the region is 8.05 percent. North-East region is basically hilly in nature characterized by curves and terrains. Here the economic and infrastructure expenditure are poor. They receive financial assistance under the provision of Special Category States from the central government as the states alone cannot meet the budgets.

Eastern region of India consists of West Bengal, Bihar, Jharkhand and Orissa where the population is 226 million covering 418, 323 km square of the total geographical area of the country. The largest city of the region is Kolkata, capital of West Bengal. The major portion of the eastern region lies on the Indo Gangetic plain and on the east coast by the Bay of Bengal. The region is surrounded by the Nepal and Sikkim Himalayas in the north, states of Uttar Pradesh and Chhattisgarh on the west, state of Andhra Pradesh in the south and the Bay of Bengal on the east.

4. THE HYDROGEOLOGY OF THE STATES AND ITS DISTRICTS OF EASTERN AND NORTH EASTERN REGION OF INDIA

The region has many water problems regarding its quality which has been shown by the table no 1 given by the Central Ground Water Board or CGWB.

Table 1: Major Contaminants of Drinking Water in the States and its Districts of Eastern and North Eastern India

STATE	FLUORIDE (>1.5 mg/l)	IRON (>1.0 mg/l)	ARSENIC (>0.05 mg/l)	NITRATE (>45 mg/l)	SALINITY (EC>3000 µS/cm at 25° C)
ASSAM	Goalpapra, Kamrup, Karbi Anglong, Nagaon	Cachar, Darrang, Dhemaji, Dhubri, Goalpapra, Golaghat, Hailakandi, Jorhat, Kamrup, Karbi Anglong, Karimganj, Kokrajhar, Lakhimpur, Morigaon, Nagaon, Nalbari, Sibsagar, Sonitpur	Dhemaji		
	Aurangabad,	Aurangabad,	Begusarai,	Aurangabad,	

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BIHAR	Banka, Bhagalpur, Buxar, Gaya, Jamui, Kaimur(Bhabua), Munger, Nawada, Rohtas, Supaul	Begusarai, Bhojpur, Buxar, East Champaran, Gopalganj, Katihar, Khagaria, Kishanganj, Lakhiserai, Madhepura, Muzaffarpur, Nawada, Rohtas, Saharsa, Samastipur, Siwan, Supaul, West Champaran	Bhagalpur, Bhojpur, Buxar, Darbhanga, Katihar, Khagaria, Kishanganj, Lakhisarai, Munger, Patna, Purnea, Samastipur, Saran, Vaishali	Banka, Bhagalpur, Bhojpur, Darbhanga, Kaimur(Bhabua), Patna, Rohtas, Saran, Siwan	
JHARKHAND	Bokaro, Giridih, Godda, Gumla, Palamu, Ramgarh, Ranchi	Chatra, Deoghar, East Singhbhum, Giridih, Ranchi, West Singhbhum		Chatra, Garhwa, Godda, Gumla, Lohardaga, Pakur, Palamu, Paschimi Singhbhum, Purbi Singhbhum, Ranchi, Sahibganj	
MANIPUR		Bishnupur, Thoubal	Bishnupur, Thoubal		
MEGHALAYA		East Garo Hills, East Khasi Hills, Jaintia Hills			
WEST BENGAL	Bankura, Bardhaman, Birbhum, Dakshindinajpur, Malda, Nadia, Purulia, Uttardinajpur, South 24 Praganas	Bankura, Bardhaman, Birbhum, Dakhindinajpur, E. Midnapur, Howrah, Hugli, Jalpaiguri, Kolkatta, Murshidabad, N-24 praganna, Nadia, S-24pragannas, Uttardinajpur, West Midnapur	Bardhaman, Hooghly, Howrah, Malda, Murshidabad, Nadia, North 24 Praganas, South 24 Pragannas	Bankura, Bardhaman	Howrah, N 24 Parganas, Purba Medinipore, S 24 Parganas
ORISSA	Angul, Balasore, Bargarh, Bhadrak, Baudh, Cuttack, Deogarh, Dhenkanal, Jajpur, Keonjhar, Khurda, Mayurbhanj, Nayagarh, Nawapara, Sonpur	Balasore, Bargarh, Bhadrak, Cuttack, Deogarh, J.Singhpur, Jajpur, Jharsuguda, Kalahandi, Kandmahal, Keonjhar, Kendrapara,Khurda, Koraput, Mayurbhanj, Nayagarh, Puri, Rayagada, Sambalpur,	Angul, Balasore, Bargarh, Bhadrak, Bolangir, Baudh, Cuttack, Deogarh, Dhenkanal, Gajapati, Ganjam,	Angul, Balasore, Bargarh, Bhadrak, Bolangir, Baudh, Cuttack, Deogarh, Dhenkanal, Gajapati, Ganjam, J.Singhpur,	Balasore, Bhadrak, Ganjam, Jagatsingpur, Jajpur, Kendrapara, Puri

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		Sundergarh, Sonpur	J.Singhpur	Jajpur, Jharsuguda, Kalahandi, Kendrapara, Keonjhar, Khurda, Koraput, Malkangiri, Mayurbhanj, Nawapada, Nayagarh, Phulbani, Puri, Sambalpur, Sundergarh, Sonpur	
TRIPURA		Dhalai, North Tripura, South Tripura, West Tripura.			

SOURCE: CENTRAL GROUND WATER BOARD, INDIA

There used to be the issue of accessibility of drinking water to the people worldwide nowadays the burning issue of water quality is coming out worldwide. People are coming out with the solution of accessibility by digging up their own private wells, though this has reduced some problem of accessibility and availability, but has increased the number of contamination cases as their own private wells are being built without the proper knowledge of the Hydro-geologic condition of their area. Central Ground Water Board, India has given a data on the groundwater quality of the states and its districts of India of which eastern and north eastern states has been taken out here. The major contaminants found are the Fluoride, Iron, Arsenic, Nitrate and Salinity of which almost all the states and districts are coming up with one or the other problem. The states which are free from all these contaminants are Arunachal Pradesh, Mizoram, Sikkim and Nagaland. Almost all the eastern states and its districts have one of the above problem of contaminants and also some of north eastern states and district are revealed to have these problems and the people of these area are supposed to have been taking contaminated water. Thus, it draws some major attention of the government and stake holders to have immediate enquiry upon this matter as many people are exposed to the contaminant water in these areas.

The main source of freshwater in the earth is the groundwater which is the most important source of drinking water for the people residing in both urban and rural areas. But no surface and ground water is free from any kinds of contamination, surface water is contaminated by the many bacteriological agents and the ground water is contaminated with the many physio-chemical agents. India's groundwater is crippled with the occurrence of excess arsenic, nitrate and fluoride and her surface water is crippled with the loads of pollution. Though groundwater is meant to be pollution free for drinking but this resource is exploited excessively and erratically without having any knowledge of Hydro-geological features of the

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aquifer system and its upcoming cost on the quality of drinking water. The two contrasting region of India Eastern and North eastern is situated on the Ganga Brahmaputra plain (GBP) where a number of cases of contamination especially arsenic is found to be exceeded above the WHO permissible value of 10 µg/ L in drinking water. This region lies in the aquifer of the Holocene period of the GB alluvial plains which are the source of unsafe contaminants of geogenic origin (CGWB 2010).

4.1 State wise Distribution of Principle Aquifer Systems:

The CGWB has given a broad description on the principle aquifer system of the country and its state out of which the state of Eastern and North Eastern region are shown on the table below-

Table 2: State wise Distribution of Aquifer System in Eastern and North Eastern States, India (in percentage)

State	Alluvium	Laterite	Basalt	Sandstone	Shale	limestone	Granite	Schist
Arunachal Pradesh	5.6	0	1.7	0.09	44.8	0.3	10.9	3.6
Assam	75.5	0	0	7.4	6.0	0	0	0
Manipur	18.4	0	0	24.4	55.7	0	0	0
Meghalaya	4.6	0	0	0	57.2	0	4.7	0
Mizoram	0	0	0	15.4	84.5	0	0	0
Nagaland	3.3	0	0	24.4	67.1	0	0	0
Sikkim	0.2	0	0	1.4	1.8	0	0.5	24.1
Tripura	6	0	0	55.1	38.8	0	0	0
Bihar	90.3	0.02	0.04	2.7	0	0.9	0.5	0.2
Jharkhand	7.4	0.9	4.0	5.5	0	0.6	2.3	13.0
Orissa	25.3	3.5	0	3.3	1.9	0	0.8	3.2
West Bengal	70.6	17.3	0.3	0.9	0.3	0.1	0.4	3.3

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Quartzite	0	0.9	0	0	0	0	1.1	0	0.2	1.9	2.7	0
Charnockite	0	0	0	0	0	0	0	0	0	0.2	9.2	0
Khondalite	0	0	0	0	0	0	0	0	0	0	9.4	0
BGC	0	10.1	0	33.3	0	0	0	0	4.6	60.2	36.9	5.9
Gneiss	2.3	0	0	0	0	1.1	49.6	0	0.9	2.7	0	0.1
Intrusives	0	0	1.4	0	0	3.9	0	0	0.02	0.8	3.2	0.3
Unclassified	30.3	0	0	0	0	0	20.9	0	0	0	0	0
Total area	79334	75576	21448	21594	20289	15977	6885	10036	90549	76702	148798	82104

Source- Central Ground Water Board

The above table compiled by the Central Ground Water Board gives a clear picture of percentage of hydro geological contents of the state which helps us to understand how important it is to understand the whole scenario of the distribution of the geological structure which varies across the state and which determine the potentiality of the production of the water. Rather, it is important to take note of all the regional and local level aspects of the water management approach which gives a broad knowledge about why this variation in drinking water is taking place. India has developed its water resources in a shrewd manner so it is important to take a bottom-up water management approach i.e. through the community level. Also it is important to adopt such strategies which could fill the demand-supply gap like water conservation, guidelines of groundwater, increase in water use effectiveness, improving the aquifer, intensification of recharge of the aquifers etc are the several ways through which the variation of the drinking water can be minimized across the geographical location of the area and to carry out such strategies first it is important to understand the

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whole geographical setting of the area. The World Bank reports suggests that there are number of aquifers in India which are increasingly going to be in critical level of utilization so much so that if this scenario still continues for 20 years than the percentage of the critical aquifers will rise up to 60 percent (The World Bank, 2010).

5. THE GEOLOGY OF THE REGION AND THE STATUS OF DRINKING WATER

According to the latest census of 2011 there are altogether ten sources of drinking water (8 in 2001), where the safest is meant to be the tap water which is found higher in hilly areas in the North-Eastern region than the Eastern region. Also a vast proportion is found to be using spring water in the North East region which is not seen in the eastern region in that proportion shown in the table below.

The two contrasting regions of India, namely Eastern and North Eastern lie along the Country's major river system called "Ganga- Brahmaputra" which is a lifeline for almost all the states of the regions. Talking about the drinking water availability the census of India has given a good data on the sources used by the state and its districts of the two regions and for this matter data for the latest census has been used to see the level and the types of sources used by the different states of the region.

5.1 The North- Eastern Region of India:

The North East region of India is situated on the Eastern Himalaya and occupies a large chunk of about 2,6, 179 square km area. It is mainly comprised of 8 states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The region is endowed with a faulted steep slope with well laminated schist which rests upon the gneissic rock and a series of artesian spring dominates the region (Nag 1992/2002).

This region stands out amongst rest in terms of its geography, environment and socio-cultural practices. Moreover, the region is wet throughout the year with high monsoon rainfall, its geophysical structure is quite tender, the earthquake is most prominent in this region in spite of this the region is well known for its rich biodiversity. The region is rich in terms of its water resource; and the Brahmaputra-Barak river system feeds the whole region. The sub Himalaya range is made up of Tertiary sandstones bordering the Brahmaputra valley. The range called Patkai- Naga is made up of tertiary rock having several dynamic faults and the Mikir hills and Meghalaya plateau consists of rock from the Precambrian age namely Gneisses and Schist's. Besides in Assam the Tectono-Sedimentary Basin is found along the whole of Brahmaputra Valley supported by the recent thick alluvium soil deposits (Goswami 2005). The region has been extensively divided into three categories i.e. the Meghalaya plateau, the North-Eastern Hills and Basin and the Brahmaputra valley and the region encompasses geographical extent of overall 2.555 lakh km^2 i.e. about 8% of the total area (Dabral 2002). The region is a home for many endangered species of flora and fauna and has been appreciated for its value of medicinal plants.

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5.2 The Eastern Region of India:

The Eastern region of India consists of West Bengal, Bihar, Jharkhand and Orissa. It comprises of the population of 226 million and it covers about 418, 323 km square of the total geographical area of the country. A huge chunk of the region lies on the plains of Indo Ganga and on the east coast by the Bay of Bengal. Geologically, the region is situated on the flood prone area by the Ganga River, the state of Bihar extends over the Ganga basin i.e. about two third parts, where the basin is created by the alluvium and some rocks in the bottom. The state receives highest rainfall, but is limited to three months of monsoon and a severe problem of frequent floods is most common in the region (Mishra 2009).The State of West Bengal is surrounded extensively by two regions, namely: the Gangetic plain in the south and the Sub- Himalayan and Himalayan area in the north. The main river of the state is Ganga, and most of the area is subject to flood during the monsoon season. Groundwater of some nine districts is prone to arsenic contamination which attracts a major concern to ponder upon.

6. UNDERSTANDING THE VARIATION OF THE SOURCES OF DRINKING WATER IN THE EAST AND NORTH EAST REGION OF INDIA:

It is important to understand how sources of drinking water are varying across the region because of the diversity of the region the sources may also vary. It is a fact that people of one particular region may not be using the same exact sources of drinking water as the people from another region. For this reason data for two consecutive years are being used to understand the variation of the use of sources from the census which can be seen below-

Table 3: Percentage of Sources of Drinking Water along the Eastern and North Eastern States India 2001

Area Name	Total number of households	Main Source of drinking water							
		Tap	Handpump	Tubewell	Well	Tank, Pond, lake	River, Canal	Spring	Any other
Arunachal Pradesh	212,615	67.8	7.4	2.4	4.7	1.2	8.0	6.2	2.4
Assam	4,935,358	9.2	44.6	5.0	26.7	7.0	5.2	1.4	1.0
Manipur	397,656	29.3	6.4	1.3	6.4	26.8	17.8	10.3	1.7
Meghalaya	420,246	34.5	2.0	2.5	27.4	5.5	4.2	21.9	2.0
Mizoram	160,966	31.9	1.9	2.1	2.0	4.0	11.4	40.6	6.0
Nagaland	332,050	42.0	2.5	2.0	34.9	9.6	2.2	5.5	1.3
Sikkim	104,738	70.3	0.2	0.2	0.1	0.9	1.2	25.3	1.7
Tripura	662,023	24.6	14.9	13.1	38.3	1.7	3.0	2.5	1.9
Bihar	13,982,590	3.7	77.9	5.0	12.6	0.0	0.2	0.1	0.5
Orissa	7,870,127	8.7	28.5	27.0	28.6	1.9	2.6	2.2	0.6
West Bengal	15,715,915	21.4	55.8	11.3	10.0	0.2	0.3	0.7	0.4

Calculated by author based on census 2001 data

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Table 4: Percentage of Sources of Drinking Water along the Eastern and North Eastern States India 2011

Area Name	Total No- of House holds	Main Source of Drinking Water									
		Tap water treated	Tap water un-treated	Covered well	Un-covered well	Hand pump	Tubewell/ Borehole	Spring	River/ Canal	Tank/ Pond/ Lake	Other sources
Arunachal Pradesh	261,614	26.4	39.1	1.4	4.3	10.7	2.4	5.7	5.9	0.9	3.2
Assam	6,367,295	9.2	1.3	1.7	17.2	50.2	9.2	1.3	3.4	4.6	2.0
Manipur	507,152	25.6	13.0	2.8	4.7	6.5	0.4	5.6	15.0	23.2	3.4
Meghalaya	538,299	27.8	11.5	6.9	18.4	2.8	2.6	19.0	2.6	5.7	2.6
Mizoram	221,077	39.4	19.3	2.0	2.7	0.8	0.9	18.4	7.7	1.8	6.9
Nagaland	399,965	6.1	41.1	6.6	19.1	2.2	4.5	5.6	2.0	10.3	2.7
Sikkim	128,131	29.2	56.1	0.4	0.2	0.0	0.0	11.1	0.4	0.6	2.0
Tripura	842,781	20.3	12.9	2.9	18.1	16.3	24.5	1.9	1.8	0.5	0.9
Bihar	18,940,629	3.1	1.3	0.7	3.7	86.6	3.0	0.0	0.2	0.1	1.4
Jharkhand	6,181,607	10.0	2.9	1.9	34.6	43.8	3.5	0.8	1.6	0.2	0.7
Odisha	9,661,085	10.0	3.9	2.2	17.3	41.4	20.0	1.8	1.7	0.9	0.8
West Bengal	20,067,299	21.0	4.4	0.7	5.4	50.1	16.7	0.5	0.3	0.2	0.8

Calculated by author based on census 2011 data

Thus, the above table represents an interesting facts which shows that the state which was using tap water in 2001 has been and those states are found to be using the other than tap water sources in 2011. It can be said that in some improvements have been done in 2011 compared to 2001 but the situation is equally grim in some of the eastern states like Bihar and Orissa with regards to the tap water which is meant to be the safest of all. The north eastern states are found to be using tap water from both treated and untreated sources and also the other sources like spring. Whereas the eastern states are found to be using hand pump, tube well/borehole rather than tap water which is used in very low proportion. In both the region certain alarming issues of drinking water crop up which demands instantaneous attention which is revealed by the data that the availability of safe drinking water should be sorted out. There is a total change in the sources of drinking water shown in the above table, the sources have been broadened so is the percentage of the user of the sources.

Also data from the NSSO 65th round (2008-2009) has been used for more clarity of the situation of drinking water in India. NSSO has used a vigorous classification of source of

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drinking water in its 65th round which has included some sources like bottled water, harvested rainwater which is not being used in the census.

Table 5: Percentage of Major Sources of Drinking Water along the Eastern and North Eastern States, India According to NSSO 65th Round

State/ UT/ All India	Major Sources of Drinking Water										
	Bottled Water	Tap	Tubewell/ Hand pump	Protected Well	Unprotected Well	Tank/Pond (reserved for drinking)	Other Tank /Pond	River/ Canal/ Lake	Spring	Harvested Rainwater	Others
Arunachal Pradesh	13	798	112	7	23	0	11	24	11	0	0
Assam	1	63	654	104	78	6	30	28	32	0	3
Manipur	10	247	104	37	0	145	62	212	167	1	14
Meghalaya	4	506	94	60	53	38	6	17	221	0	0
Mizoram	0	146	48	4	0	27	12	56	685	6	16
Nagaland	1	286	52	299	108	150	34	12	53	4	0
Sikkim	0	674	0	0	0	13	0	0	313	0	0
Tripura	2	274	437	53	183	9	4	21	3	0	13
Bihar	9	11	938	24	18	0	0	0	0	0	0
Jharkhand	1	35	509	90	347	0	0	17	0	0	0
Contd…											
Orissa	1	58	733	42	135	3	1	18	9	0	1
West Bengal	2	78	848	23	31	3	0	1	11	0	1
All India	5	301	547	55	63	8	3	7	7	1	3

SOURCE- NSS Report No. 535: Housing Condition and Amenities in India: July, 2008- June, 2009

As mentioned earlier the source by the NSSO has been broadened and has thrown some light upon the use of bottled water and harvested rainwater as a source of drinking water. Though in a small amount these sources are used in some states and it must have been increased in the next new round of the NSSO. From the above figure it can be seen that the people are seen using tap water, tube well/hand pumps in maximum number, whereas sources like other tank/pond and river/canal/lake is also used in higher number but not as high as the previous mentioned sources. Source like spring are seen used highly in North Eastern states which is in fact higher than the tap water in states like Mizoram.

In the North Eastern region of India there is an increasing trend in the availability of safe drinking water whereas in the Eastern parts of India this trend is decreasing day by day making the moderately safe drinking water to increase at a faster pace. It can be seen that there is a great variation in the availability of drinking water among the states in eastern and north eastern part of the country.

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7. IMPORTANCE OF SOCIO- ECONOMIC FACTORS IN EXPLAINING THE VARIATION OF THE DRINKING WATER IN THE EASTERN AND NORTH EASTERN STATES OF INDIA:

Socio-Economic factors are very important to determine the use of source of drinking water, these factors plays a key role to understand the situation of the people and their livelihood. Countries especially developing and under developing ones are facing the gap within their socio economic status when it comes to access of water and its management. India is land with diverse socio- economic factors; the country has second largest population in the world with diverse geographical areas with diverse people in it. There are many socio economic factors to talk about but for the convenience and the information provided by the *Census data 2011 factors like Banking facilities, Literacy, Main worker, Latrine facilities within the premises, use of LPG and Total SC/ST population and Household having No assets* is taken into consideration of all the districts of Eastern and North Eastern states in India and multiple linear regression has been performed.

For district level analysis, tap water as dependent factor and the other socio-economic factors as independent factors are taken. Dependent variable is measured as percentage of household having tap water as main source of drinking water (treated and untreated both). The independent variables are measured as: percentage of population availing banking facilities in the district; percentage of literate people above age six; percentage of main workers out of total population in the district; percentage of households having toilet; percentage of households using LPG as main source of cooking fuel and percentage of SC/ST population in the district. Multiple Linear Regression has been performed for the socio-economic factors that have taken out from the census 2011 data.

7.1. Regression Analysis of the selected socio- economic variables of the Eastern and North Eastern States and its districts:

Tap water, which is one of the important source for drinking purpose as well as for other daily life activities is primarily dependent on how community, society and the government has managed to provide to all households. In earlier days people in different parts of India had their own practice to get water. For example people used hand pump, well, flowing river, ponds etc. as a major source not only for their daily activities but also for drinking purpose, with or without purification. Therefore, Tap water which is also a recent and safest means of getting water in a household is dependent on various socio-economic factors of that place (district or state, country etc).This study assumes availability of Tap water is affected by a number of socio-economic factors such as banking facilities used by the people, literacy rate, latrine facilities available in a house, percentage of SC/ST in the state and its district, percentage of household assets in the household of the districts, electricity available in district level. The whole study states are divided into two regions as North-eastern and Eastern region. Districts of all the states are separately taken. Multiple regression analysis is used to

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see how the socio-economic factors taken under study for these broad regions play a role in showing expected proportion of use of tap water. Since this study does not aim to best fit the model along the individual state, even, these socio-economic variables are checked with multicolinearity before running model. If two or more than two variables are highly correlated (r >0.7) to each other, then only represented variable/s are taken instead of taking all.

7.2 Correlation and Multiple Linear Regression of North East states and its districts:

Table 6: Correlation Matrix among selected Socio- Economic Variables for North Eastern States and its districts

Correlations									
	Tap water	Banking	Elect	Lit	Main worker	Latrine	LPG	SC/ST	No Assets
Tap water	1								
Banking	.272*	1							
Electricity	.680**	.393**	1						
Literacy	.121	.411**	.558**	1					
Main worker	.417**	-.156	.459**	.116	1				
Latrine	.200	.316**	.610**	.710**	.165	1			
LPG	.402**	.503**	.595**	.482**	.007	.462**	1		
SC/ST	.506**	-.186	.362**	.009	.433**	-.010	-.050	1	
No Assets	.164	-.405**	-.253*	-.534**	.145	-.361**	-.511**	.495**	1
*. Correlation is significant at the 0.05 level (2-tailed).									
**. Correlation is significant at the 0.01 level (2-tailed).									

Since latrine and literacy are highly correlated, two regression models are used. The first one is done by excluding Latrine in the list of variables under study and the second model is run by excluding Literacy.

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Table 7: Regression Model 1(Excluding Latrine)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.822[a]	.675	.646	17.169
a. Predictors: (Constant), No Assets, Main worker, Banking, Literacy, LPG, SC/ST, Electricity				

Table 8: Result of multiple regression analysis

Coefficients [a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-17.956	22.924		-.783	.436	-63.595	27.682
	Banking	.297	.127	.194	2.347	.021	.045	.549
	Electricity	.675	.142	.563	4.762	.000	.393	.957
	Literacy	-.757	.265	-.259	-2.863	.005	-1.284	-.231
	Main worker	.456	.370	.103	1.232	.222	-.281	1.193
	LPG	.369	.148	.239	2.498	.015	.075	.662
	SC/ST	.150	.081	.175	1.850	.068	-.011	.311
	No Assets	.551	.212	.267	2.597	.011	.129	.973
a. Dependent Variable: Tap water								

Table 9: Regression Model 2 (excluding literacy)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.818[a]	.670	.640	17.312
a. Predictors: (Constant), No Assets, Main worker, Banking, Latrine, SC/ST, LPG, Electricity				

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Table 10: Result of multiple regression analysis

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-43.518	18.204		-2.391	.019
	Banking	.237	.127	.155	1.869	.065
	Electricity	.747	.155	.623	4.817	.000
	Main worker	.430	.374	.097	1.151	.253
	Latrine	-.359	.138	-.227	-2.602	.011
	LPG	.388	.149	.252	2.609	.011
	SC/ST	.080	.082	.094	.972	.334
	No Assets	.765	.195	.370	3.930	.000
a. Dependent Variable: Tap water						

Source: *Computed by author based on census 2011 data*

7.3 North-Eastern States

The correlation table shows that the proportion of households having Latrine facilities and the proportion of literate people (6 above) are highly correlated (r=0.710) to each other. The presence of both the variables would not give better result due to multicolinearity. Here, two models are shown. The first model is drawn by excluding latrine variable from the list of variables under study. It shows that the value of adjusted R-square is 0.646.This says that about 65 percent of the variation in proportion of use of tap water is explained by the variables under study. While looking at its unstandardized coefficients, SC/ST and Main worker are out of significant level (more than 95%). While running another model 2 by excluding Literacy, no change in adjusted R-square has been observed. But, at this second model, three variables Banking, Main worker and SC/ST are insignificant.

7.4 Correlation and Multiple Linear Regressions of Eastern States and its districts:

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Table 11: Correlation matrix among selected Socio- Economic variables for Eastern States

Correlations									
	Tap w	Banking	Electricity	Literacy	Main worker	Latrine	LPG	SC/ST	No Assets
Tap water	1								
Banking	.490**	1							
Electricity	.806**	.520**	1						
Literacy	.593**	.502**	.760**	1					
Main worker	.054	-.267**	-.003	-.121	1				
Latrine	.729**	.379**	.623**	.619**	-.284**	1			
LPG	.868**	.565**	.714**	.529**	-.156	.762**	1		
SC/ST	-.010	-.122	.013	-.095	.796**	-.271**	-.166	1	
No Assets	-.376**	-.623**	-.505**	-.586**	.309**	-.360**	-.468**	.256**	1
**. Correlation is significant at the 0.01 level (2-tailed).									

Table 12: Model 1(Using All Variables)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.931[a]	.866	.856	4.560
a. Predictors: (Constant), No Assets, SC/ST, Latrine, Banking, Electricity, Literacy, Main worker, LPG				

Table 13: Result of multiple regression analysis

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-26.349	6.497		-4.056	.000
	Banking	.066	.054	.066	1.229	.222
	Electricity	.194	.039	.352	5.022	.000
	Literacy	-.027	.076	-.024	-.359	.721
	Main worker	.486	.125	.253	3.883	.000
	Latrine	.120	.044	.182	2.690	.008
	LPG	.680	.097	.515	7.020	.000
	SC/ST	-.063	.041	-.096	-1.537	.127

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	No Assets	.107	.069	.083	1.553	.123
a. Dependent Variable: Tap water						

Table 14: Model2 (Excluding LPG, Literacy and SC/ST)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.883[a]	.780	.770	5.765
a. Predictors: (Constant), No Assets, Main worker, Latrine, Banking, Electricity				

Table 15: Result of multiple regression analysis

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-31.613	5.715		-5.531	.000
	Banking	.172	.062	.172	2.767	.007
	Electricity	.257	.039	.465	6.601	.000
	Main worker	.407	.102	.211	3.969	.000
	Latrine	.300	.041	.458	7.288	.000
	No Assets	.086	.081	.067	1.061	.291
a. Dependent Variable: Tap water						

Source: *Computed by author based on census 2011 data*

7.5 Eastern States

Eastern state includes Bihar, Jharkhand, Orissa and West Bengal the same set of variables are taken to study the expected use of tap water in this region. The correlation matrix shows that literacy and electricity are highly correlated (0.76). Similarly, LPG with electricity and Latrine are also highly correlated. Besides these two, SC/ST is highly correlated with Main worker. In order to remove the multicolenearity effect in the model, two models are drawn here. The first model has been shown to see even if there is multicolinearity effect then what would be the model and the second one is drawn based on excluding LPG, Literacy and SC/ST. The adjusted R-square of the first model on this state is 0.85 while second model gives only 0.77. However, in the first model, 4 variables: Banking, literacy, SC/ST and No Assets show the insignificant coefficients while No Assets only remained insignificant in second model.

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7.6 Correlation and Multiple Linear Regressions of both Eastern and North Eastern States and its Districts:

Table 16: Correlation matrix among selected Socio- Economic variables for the Eastern and North Eastern States

Correlations									
	Tap water	Banking	Electricity	Literacy	Main worker	Latrine	LPG	SC/ST	No Assets
Tap water	1								
Banking	.232**	1							
Electricity	.762**	.361**	1						
Literacy	.381**	.410**	**.705****	1					
Main worker	.406**	-.208**	.343**	.087	1				
Latrine	.622**	.182*	**.719****	.638**	.213**	1			
LPG	.605**	.444**	.684**	.527**	.096	.627**	1		
SC/ST	.541**	-.170*	.391**	.110	.621**	.283**	.118	1	
No Assets	.099	-.478**	-.240**	-.466**	.250**	-.112	-.388**	.434**	1
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Table 17: Model 1(Electricity excluded)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.818[a]	.670	.657	14.928
a. Predictors: (Constant), No Assets, Latrine, Main worker, Banking, SC/ST, LPG, Literacy				

Table 18: Result of multiple regression analysis

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-50.416	12.730		-3.960	.000
	Banking	.311	.086	.189	3.615	.000
	Literacy	-.054	.157	-.023	-.343	.732
	Main worker	.460	.205	.121	2.244	.026
	Latrine	.239	.060	.268	3.979	.000

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	LPG	.665	.104	.401	6.399	.000
	SC/ST	.250	.054	.286	4.671	.000
	No Assets	.462	.138	.210	3.359	.001
a. Dependent Variable: Tap water						

Table 19: Model 2 (Literacy and Latrine excluded)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.857[a]	.734	.725	13.362
a. Predictors: (Constant), No Assets, Electricity, Main worker, Banking, LPG, SC/ST				

Table 20: Result of multiple regression analysis

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-44.687	8.673		-5.153	.000
	Banking	.153	.077	.093	1.992	.048
	Electricity	.504	.059	.514	8.502	.000
	Main worker	.166	.187	.044	.889	.375
	LPG	.511	.091	.308	5.608	.000
	SC/ST	.140	.050	.160	2.820	.005
	No Assets	.672	.111	.306	6.041	.000
a. Dependent Variable: Tap water						

Source: *Computed by author based on census 2011 data*

7.7 All Districts of Eastern and North Eastern States-

The correlation table drawn by taking all the districts of north-east and the eastern states shows that there is high correlation between literacy and electricity and also with electricity and latrine. Therefore, here too, two models are drawn. The first model is drawn by excluding electricity variables from the list of study variables and both literacy and latrine are excluded from the list to draw second model. The adjusted R- square of the first model is 0.657 whereas the second model of all districts shows 0.725. Coefficient of literacy shows the insignificant result whereas in the second model Main worker is insignificant.

8. DISCUSSION OF THE RESULTS

Based on the result obtained from the regression equation it can be said that the expected proportion of use of tap water is not uniformly affected by same types of socio-economic variables. It is seen from the regression Model 2 of North-east that all the study variables

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except banking, main worker and SC/ST are insignificant. It can be implied that despite there is presence of banking facilities or large proportion of people are main worker in the family or even large proportion of SC/ST people are in the region may not affect in expected proportion of use of tap water. Similarly, eastern region has a little bit different result than that of the north-east region. Whether the household assets are available or not people like to use tap water in the region. It means that variables under study might have affected the expected proportion of use of tap water. And, when all the districts of both the regions are considered as one region, the presence of main worker in the household may not affect the expected proportion of use of tap water. Finally, it can be argued that the proportion of tap water is affected by socio-economic factors of the regions. Though this study draws conclusion based on broad region of India, the further study based on the state might be varied. However, it cannot be denied that the factors would be quite different than the variables taken for this study.Here, the variables like Banking Facilities and Main workers and No assets are taken as economic factors, variables like Electricity, Latrine Facilities, LPG users represents the Basic amenities and the variables like Literacy and No assets are Social Factors.

Reports of United Nation (UN) also suggest that deficiency of availability of water has created the differences amongst people belonging to several category and communities in India. Also the number of arguments regarding water between the two gigantic sectors like agriculture and industry has put lots of pressure on the domestic sectors as well so much so that even the domestic sector are coming up the increasing demands of water. Gender disparity and water in India is also severe within the social hierarchies of population and also there is lack of basic data regarding this (Dhar 2013). The World Bank report for India states that though there is increase in the access to water supply and sanitation but still there is a gap in the accessibility of this infrastructure in unfailing, sustainable and economical way. The report also suggests that the India will remain in this position until and unless if it improves the provision of basic services with the inclusion of better policies, organization of institution and monetary inducements (The World Bank 2005). The most common contaminant of the groundwater is arsenic, fluoride, iron etc according to CGWB the most common contaminant found in the eastern and north eastern states is the problem of arsenic. Arsenic problem can only be tackled if the relationship between various socio economic factors is being identified like economic condition, demographic status which can be a key solution to the arsenic problem (Sil 2003).

9. CONCLUSION

As regards to the distribution of the sources of drinking water, the availability of the various sources have quite improved, the reason may be the decentralization of the government control over the water in almost all the districts of the state as reflected. The district, which was there, has also experienced a shoot up in the improvement of the availability of the sources of drinking water. The situation may be accredited to the passing of the 73rd and 74th

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constitutional amendment act in 1992 and which has decentralized the government's control of water and adoption of policies like National water Policy and National Water Reform. The available data suggest that there is inequality in the distribution of the tap water source in eastern state which raises necessary concern to find out the ways that can handle this situation. Some of the appropriate solutions to tackle this situation is the acknowledgment of the lucrative, sustainable, and a policy benchmark with the greater level of public participation.

India has a great potentiality of water both surface and groundwater yet it has not been harnessed as such. The latest census of 2011 has broadened the sources of drinking water into ten extensive sources from which people are taking the water. The studies suggest that the two contrasting regions of India, namely Eastern and North Eastern region have been covered by the mighty Brahmaputra and Ganga River which feeds the whole region and having the geological rock formation from pre- Cambrian to recent Pleistocene. Interestingly enough one region is situated on the Himalayas and the other on the floodplains, one region receives high rainfall almost throughout the year except some dry months and one region receives high rainfall only during monsoon season. One region have a good coverage of tap water and the other region has a good coverage of other than tap water sources, one region has a greater use of the spring water, which is meant to be a boon and for the other region this proves to be a bane if taken up for the consumption. Geographically, two regions vary with one another, so the sources of drinking water used in this region may also vary. By comparing the data from the census of two consecutive years, it can be seen that the use of tap water has gone up in the North Eastern states and the use of other than tap water has shot up in the Eastern states. Likewise for the clarity of the situation of the drinking water NSSO 65^{th} round data have also been used which have included the sources like bottled water and harvested rainwater which has not been used in the census. The socio-economic factors taken like literacy, SC/ST population, toilet facilities, cooking gas, banking facilities, lighting, work force participation and percentage of population having No Assets have been taken from the census which shows that these factors do affect the variation in the availability of drinking water and is found to be significant. The depressing situation of inequality in terms of the availability of safe drinking water in the eastern states of India raises necessary involvement of how the situation can be managed. Nevertheless, it's an important moment to make the general public aware of their right to safe drinking water and make them aware of the precious resources like water instead of putting negative viewpoint and blaming each other. If the general public becomes sensible, then to a great level the service providers will also find themselves responsible. Government actions can only be lucid if the receiver is aware and knowledgeable of their rights and if they start to respect the water as a precious resource.

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