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Safe Drinking Water and Socio-economic Development in West Bengal: An Attempt to Find Associations

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Water which is used for drinking and cooking purpose can be defined as drinking water. Water whether from treated or untreated sources if used for human consumption is considered as drinking water. Drinking water is a prerequisite for human hygiene, sanitation services, and food preparation. Accessibility of water affects time and health of people, especially of women because in our country where rural people are predominant, women have to take the responsibility of fetching water from the sources located outside of the houses and sometimes they have to travel a very long distance. It has been hypothetically assumed that availability of safe drinking water to the households of any region depends on the socio-economic development of that particular region. Therefore, in this paper an attempt has been made to find out the district-wise regional pattern of availability of safe drinking water and its association to the socio-economic development of the districts of the state of West Bengal. For the methodological purpose secondary data sources have been used and the data have been analyzed by z-score technique and correlation method.

Keywords: Safe drinking water, Treated Tap Water, Socio-economic Development, West Bengal

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Introduction

Water, which is used for drinking and cooking purposes can be defined as drinking water. Water whether from treated or untreated sources if used for human consumption is considered as drinking water (Standard, I., 1991). The need of water quite indispensable as it is essential for the survival of human being. Moreover, drinking water is also a prerequisite for human hygiene, sanitation services, and food preparation. Needs of water vary according to different factors like climate, lifestyle, diet and wealth (Gleick, P. H., 1996). The basic needs of human beings cannot be fulfilled without the availability of drinking water, considering this aspect the IUCN suggests the addition of water used in "drinking, bathing, cleaning, cooking, and sanitation" as the need of water in provision of human rights (Scanlon, J., Cassar, A., & Nemes, N., 2004). Although drinking water used for survival is given the first priority, still water used for sanitation and bathing have a noteworthy effect on human health (Gleick, P. H., 1996). Similarly, human hygiene is also directly dependent on the water used for cooking (U.N. International Human Rights Instruments, 1994). It is estimated that unsafe water and lack of basic sanitation and hygiene in terms of diarrhea, every year claim the lives of more than 1.2 million children under five years of age (Esrey, A., Potash, J. B., Roberts, L., & Shiff, C., 1991). Improvements in drinking-water, sanitation, hygiene and water resource management can reduce the burden of disease by around 10 per cent (Prüss-Üstün, A., Bos, R., Gore, F., & Bartram, J., 2008). Considering the benefits of safe drinking water and improved sanitation WHO targeted to halve the proportion of people without basic access to sanitation by 2015.

Accessibility of water affects time and health of people especially of women because in our country where rural people are predominant, women have to take the responsibility of fetching water from the sources located outside of the houses and sometimes they have to travel a very long distance. Not only the fetching work, but also the storage and adequate provision of water are also the responsibilities of women.

According to estimates the number of persons affected by waterborne diseases are 37.7 million and 15 million children die due to diarrhea. Not only that annually 73 million working days are lost because of waterborne diseases. If we talk about it in economic terms the burden is of $600 million per year. Moreover, millions of Indians are at risk due

to excessiveness of fluoride and arsenic and other chemical contamination (Handbook on drinking water treatment technologies, 2011),

Aims and Objectives

The present study has been undertaken with the following specific objectives:

i. To examine the spatial variations of availability of safe drinking water among the districts of state.
ii. To inspect the inter-district disparities in the levels of socio-economic development in the study area.
iii. To find out the relationship of availability of safe drinking water with their socio-economic development status in West Bengal.

Study Area

The state of West Bengal has been taken as the study area for this research work and district boundary has been considered as the smallest unit. The state of West Bengal extends from 21°25′ to 26°50′ north latitudes and 86°30′ to 89°58′ east longitudes. As per the 2011 Census of India, the state is comprised of nineteen districts. Total geographical area of the state is 88752 km2 which means it occupies 2.70 percent of total geographical area of India. It is surrounded by Sikkim and Bhutan in the north, the Bay of Bengal in the south, Assam and Bangladesh in the east and Orrisa, Jharkhand, Bihar and Nepal in the west. West Bengal is the second most densely populated (1028 persons per square kilometers) state in India after Bihar. According to census of India 2011, West Bengal has 9,12,76,115 population, which makes it fourth most populous state of the country. West Bengal ranks twentieth among the states and union territories in terms of literacy rate with 77.08 per cent of total literacy rate. Male literacy rate in the state is 82.67 per cent, which is 0.53 per cent point greater than the national average of 82.14 per cent, while the female literacy rate is 71.16 per cent, which is 5.7 per cent point higher than the country's average female literacy rate (65.46 per cent). Sex ratio in the state is 950 females for each 1000 male, which is above national average of 940 as per 2011 census.

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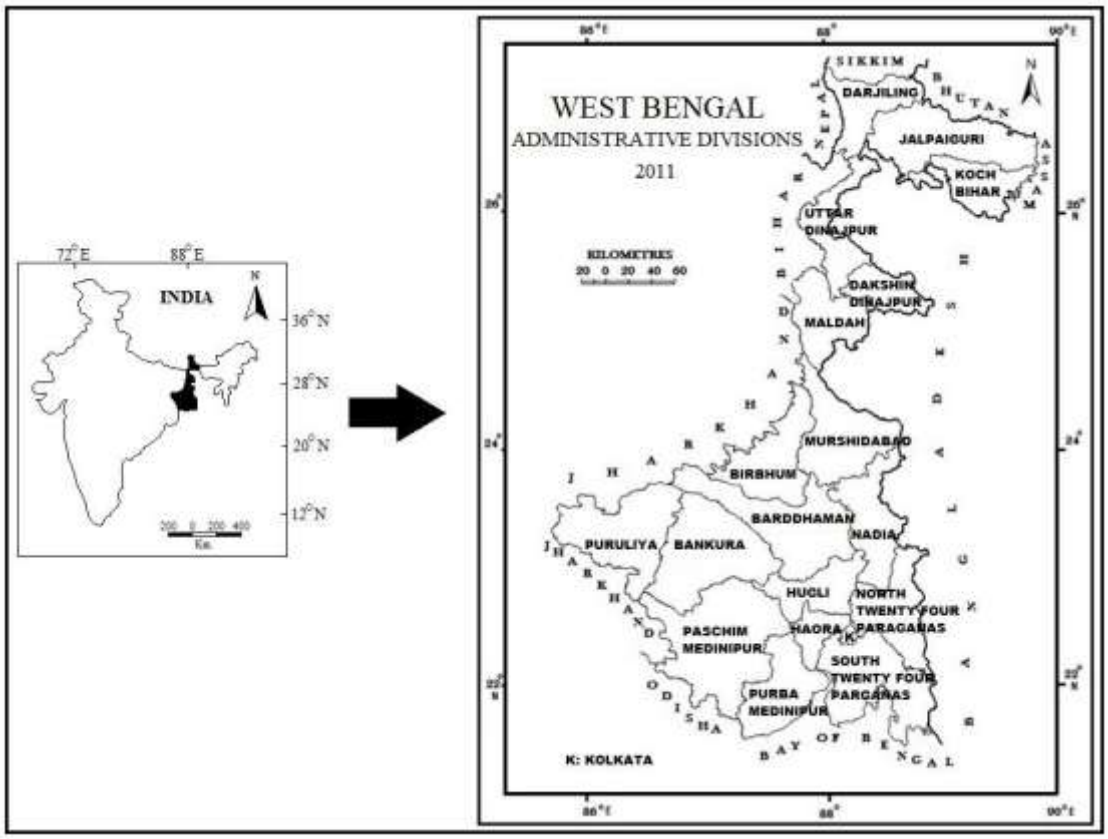

Figure 1

Data and Methodology

The present research is entirely based on secondary source of data. In this research work data regarding drinking water have been collected from Census of India publications, 2011, New Delhi. Other relevant socio-economic data are acquired from Economic Review of West Bengal (2012-13), Statistical Abstract of West Bengal (2012-13) and State Statistical Handbook (2014). In this study, a set of forty-seven variable have been taken into account to determine the levels of socio-economic development in the nineteen districts of West Bengal (Table 1).

In the first step, the raw data for each variable which determines the areal variation of levels of socio-economic development have been computed into standard score. It is generally known as *Z* value or *Z*-score. The score quantifies the departure of individual observations, expressed in a comparable form. This means it becomes a linear transformation of the original data (Smith, 1973). It may be expressed as:

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$$Z_{ij} = \frac{X_{ij} - \overline{X_i}}{\sigma_i}$$

Where,

Z_{ij} = Standardized value of the variable *i* in District *j*.

X_{ij} = Actual value of variable *i* in district *j*.

X_i = Mean value of variable *i* in all districts.

σ_i = Standard deviation of variable *i* in all districts.

In the second step, the z-scores of all variables have been added district wise and the average has been taken out for these variables which may be called as composite score (CS) for each district and may be algebraically expressed as:

$$CS = \frac{\sum \quad Zij}{N}$$

Where,

CS = composite Mean Z- Score

Zij = Standard Score of i^{th} Variable at j^{th} district

N = No. of Variables

The correlation co-efficient is worked out among dependent variables (z-scores of treated tapwater) and independent variables (composite scores selected variables of socio-economic development). The Coefficient correlation is calculated with the following formula:

$$r = \frac{\sum \quad XY - (\sum \quad X).(\sum \quad Y)/N}{\sqrt{\left[\sum \quad X^2 - (\sum \quad X)^2/N\right]\left[\sum \quad Y^2 - (\sum \quad Y)^2/N\right]}}$$

Where,

r = Coefficient of Correlation

X,Y = the two given Variables

N = Number of Observations

The correlation coefficient varies from +1 to -1 where +1 indicates perfectly positive correlation while -1 shows perfect negative correlation. When the value is not so, the relationship between the variables is not perfect and the correlation coefficient is somewhat between – 1 and + 1.

Table 1. List of Selected Variables for socio-economic development

Category	Definition	Variables
Demographic Characteristics	Sex Ratio	X_1
	Percentage of Population Above 15 Years of Age to Total Population	X_2
	Growth Rate of Population (2001 To 2011)	X_3
	Male Infant Mortality Rate	X_4
	Unidirectional Female Infant Mortality Rate	X_5
Level of Urbanization	% of Urban Population to the Total Population	X_6
Educational Development	Total Literacy	X_7
	Male Literacy	X_8
	Female Literacy	X_9
	Rural Literacy	X_{10}
	Urban Literacy	X_{11}
	Primary Schools Per Lakh Population	X_{12}
	Primary Schools Per 100 Sq. Km. of Area	X_{13}
	Junior High Schools Per Lakh Population	X_{14}
	Junior High Schools Per 100 Sq. Km. of Area	X_{15}
	High & Higher Secondary Schools Per Lakh Population	X_{16}
	High & Higher Secondary Schools Per 100 Sq. Km. of Area	X_{17}
	Colleges Per Lakh Population	X_{18}
	Colleges Per 100 Sq. Km.	X_{19}
	Number of Students Per School	X_{20}
	Number of Students Per Teacher	X_{21}
Agricultural Development	Percentage of Net Cropped Land	X_{22}
	Cropping Intensity	X_{23}
	Agricultural Productivity	X_{24}
Employment Facilities	Per Capita Income	X_{25}
	Employment Rate	X_{26}
	Male Employment Rate	X_{27}
	Female Employment Rate	X_{28}
	Rural Employment Rate	X_{29}
	Urban Employment Rate	X_{30}
	Percentage of Workers in Non-Cultivation	X_{31}
	Percentage of Workers as Non-Agriculture Labour	X_{32}

	Percentage of Workers in Household Industries	X_{33}
	Percentage of Workers in Other Works	X_{34}
	No of Registered factory worker per lakh population	X_{35}
	Number of Registered Factories per 100 sq.km. of Area	X_{36}
	Number of Small Scale Industries per 100 sq. km. of Area	X_{37}
Health Facilities	Number of Hospitals and Health Centres per Lakh of Population	X_{38}
	Number of Hospitals and Health Centres per 100 sq. km. of area	X_{39}
	Number of Beds in Hospitals per Lakh of Population	X_{40}
	Number of Beds in Hospitals per 100 sq.km. of area	X_{41}
	Number of Hospitals per Lakh of Population	X_{42}
	Number of Hospitals per 100 sq.km of area	X_{43}
Transport and Communication Facilities	Number of Post and Telegraph Offices per Lakh of Population	X_{44}
	Density of Surface Road per 100 sq. km. of Area	X_{45}
	Number of Motor Vehicles on Road per lakh of Population	X_{46}
Banking Facilities	Number of Commercial Banks per Lakh of Population	X_{47}
	Number of Credit societies per Lakh of Population	X_{48}

Result and Discussion

Census of India categorized the sources of drinking water into tapwater from treated source, tapwater from un-treated source, covered well, un-covered well, handpump, tubewell/borehole, spring, river/canal, tank/pond/lake and other sources. In West Bengal half of the households (50.1 percent) use handpump for collecting water (Table 2). For better understanding, here the sources of drinking water have been grouped into Tapwater from treated source, Tapwater from un-treated source, Handpump, Tubewell/Borehole and others. Only one fifth of the total households have access to treated tap water. To the 16.7 percent of households main sources of drinking water are Tubewells/Boreholes. On an average 4.4 percent and 7.8 percent of households get drinking water from untreated tap and other sources respectively.

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Table 2: District Wise Percentage Distribution of Main Sources of Drinking Water to the Total Households in West Bengal, 2011

Districts	Tap water from treated source	Tap water from un-treated source	Handpump	Tubewell/ Borehole	Others
Darjiling	21	13.1	7.5	7.3	51.1
Jalpaiguri	15.3	6.4	24	11.3	43
Koch Bihar	6.4	6.3	58.7	19.3	9.3
Uttar Dinajpur	3.4	1.9	75.4	16	3.3
Dakshin Dinajpur	4.6	3.1	68.9	21.8	1.6
Maldah	11.3	4.2	52.4	21.7	10.4
Murshidabad	5	2	75.7	15.1	2.2
Birbhum	12.6	3.3	59.7	18.2	6.2
Barddhaman	31.2	4.9	42.6	14	7.3
Nadia	11.4	4.8	67.3	14.7	1.8
North 24 Parganas	32.3	6.6	40.2	19.2	1.7
Hugli	29.1	5.7	43.7	19.6	1.9
Bankura	7.7	4.3	52.2	23.3	12.5
Purulia	11	1.2	35.3	20.1	32.4
Haora	28.1	3.9	45.3	21.1	1.6
Kolkata	84.9	3.2	4.2	5.7	2
South 24 Parganas	21.2	2.2	60.5	15.4	0.7
Paschim Medinipur	13.9	5.6	47.5	18.4	14.6
Purba Medinipur	8.4	2.9	72.4	15	1.3
West Bengal	**21**	**4.4**	**50.1**	**16.7**	**7.8**

Source: Census of India, 2011, Data on Housing, Table HH-Series, Data Dissemination Wing, Office of the Registrar General, New Delhi.

The variation in the availability of treated tap water is huge among the districts of West Bengal. It varies from 3.4 percent in Uttar Dinajpur to 84.9 percent in Kolkata. Though the share of households with having treated tap is quite satisfactory in Kolkta but this proportion is limited to nearly twenty to thirty percent in only six districts, namely North Twenty Four Parganas (32.3), Barddhaman (31.2), Hugli (29.1), Haora (28.1), South Twenty Four Parganas (21.2) and Darjiling (21). Moreover, Purba Medinipur (8.4), Bankura (7.7), Koch Bihar (6.4), Murshidabad (5), Dakshin Dinajpur (4.6) and Uttar Dinajpur (3.4) are such districts where less than ten percent of households are getting treated tap water (Figure 2). The percentage of households using handpump as source of

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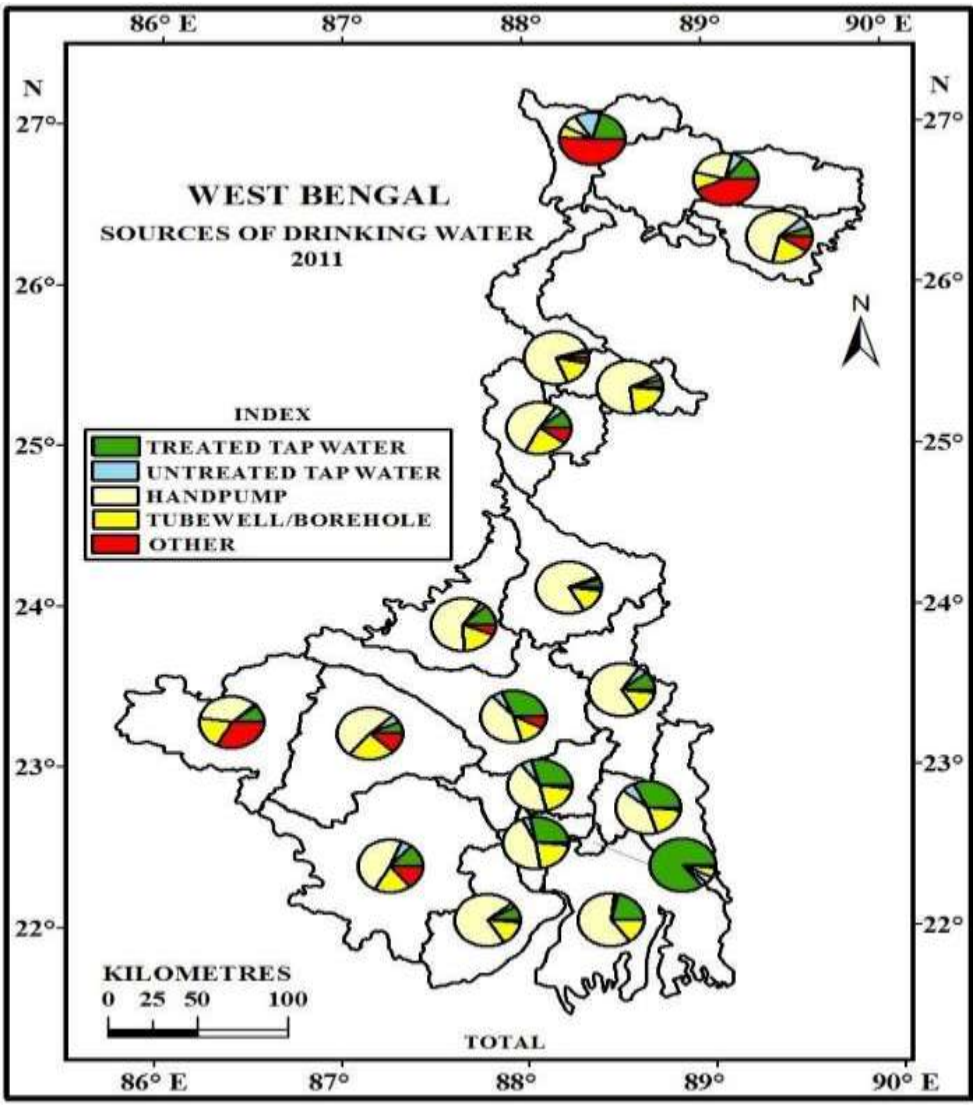
drinking water varies from 4.2 percent in Kolkata to 75.7 percent in Murshidabad. More than seventy percent of households in Murshidabad (75.7), Uttar Dinajpur (75.4) and Purba Medinipur (72.4) take drinking water from handpump. In nearly thirty seven percent of districts this percentage varies from fifty to seventy percent. Bankura (23.3 percent) stands at top and Kolkata (5.7 percent) at bottom among the districts of the state in terms of households using tubewells/boreholes as source of drinking water. In more than seventy percent of districts, nearly fifteen to twenty five percent of households' access drinking water from tubewells/boreholes. In Darjiling two important sources of drinking water are un-covered well (20.5) and spring (23.1) and in Jalpaiguri also 37.3 percent of households use drinking water from uncovered wells.



Treated tap water is considered as the best source of drinking water. Therefore, a detailed account of distributional pattern of treated tap water has been given in this section. The percentage of total households using treated tap water as source of drinking water varies from 3.40 percent in Uttar Dinajpur to 84.90 percent in Kolkata. The wide range of difference can be grouped into high (57.74 to 84.90 percent), medium (30.58 to 57.73 percent) and low (3.40 to 30.57 percent) categories. Only Kolkata is in the high (57.74 to 84.90 percent) category of use of treated tap water (Figure 3). Bardhaman and North Twenty Four Parganas have medium (30.58 to 57.73 percent) level of availability of treated tap water. In nearly eighty five percent districts of West Bengal the availability of treated tap water is of low (3.40 to 30.57 percent) grade.

In rural areas, the condition is worse. The lowest share of rural households using treated tap water is 2.60 percent in Uttar Dinajpur, while the figure is highest in 13.50 percent in South Twenty Four Parganas. Though the variation is not wide and in even the top ranked district the share of rural households using treated tap water is of unsatisfactory level, still for the comparative analysis among the different districts in this regard, the range has been grouped into high (9.88 to 13.50 percent), medium (6.24 to 9.87 percent) and low (2.60 to 6.23 percent). In four districts, namely, Jalpaiguri, Bardhaman, Hugli and South Twenty Four Parganas high (9.88 to 13.50 percent) level of availability of treated tap water is found. Medium (6.24 to 9.87 percent) level of availability of treated tap water is found in two fifth of the districts with rural households. Five districts namely Purba Medinipur, Paschim Medinipur, Haora, North Twenty Four Parganas and Nadia form a contiguous region in the south-eastern part of the state (Figur 4). One third of the districts with rural households experience low (2.60 to 6.23 percent) level of availability of treated tap water. These districts are Purulia, Bankura, Dakshin Dinajpur, Koch Bihar, Murshidabad and Uttar Dinajpur. Among these districts Purulia and Bankura in the west and Uttar Dinajpur and Dakshin Dinajpur in the north form two identifiable regions.

Even among the urban households, the lowest figure is 7 percent which is found in Uttar Dinajpur. Kolkata has the highest (84.90 percent) share of urban population who are using treated tap water for drinking purpose. This extensive range of variation can be categorized into high (58.94 to 84.90 percent), medium (32.98 to 58.93 percent) and low (7.00 to 32.97 percent) groups. In the high (58.94 to 84.90 percent) category there are four

districts namely Kolkata, Paschim Medinipur, Barddhaman and Hugli and they are concentrated in a single contiguous region. Nearly two fifth of the districts have medium (32.98 to 58.93 percent) level of availability of treated tap water. Except Darjiling, Maldah and Birbhum, all the districts of this category are distributed over western and south-eastern part of the state making two distinct regions (Figure 5). Use of treated tap water as source of drinking water is of low (7.00 to 32.97 percent) grade in seven districts. Out of these districts, Jalpaiguri and Koch Bihar and Uttar Dinajpur and Dakshin Dinajpur constitute two contiguous regions in the north and Murshidabad

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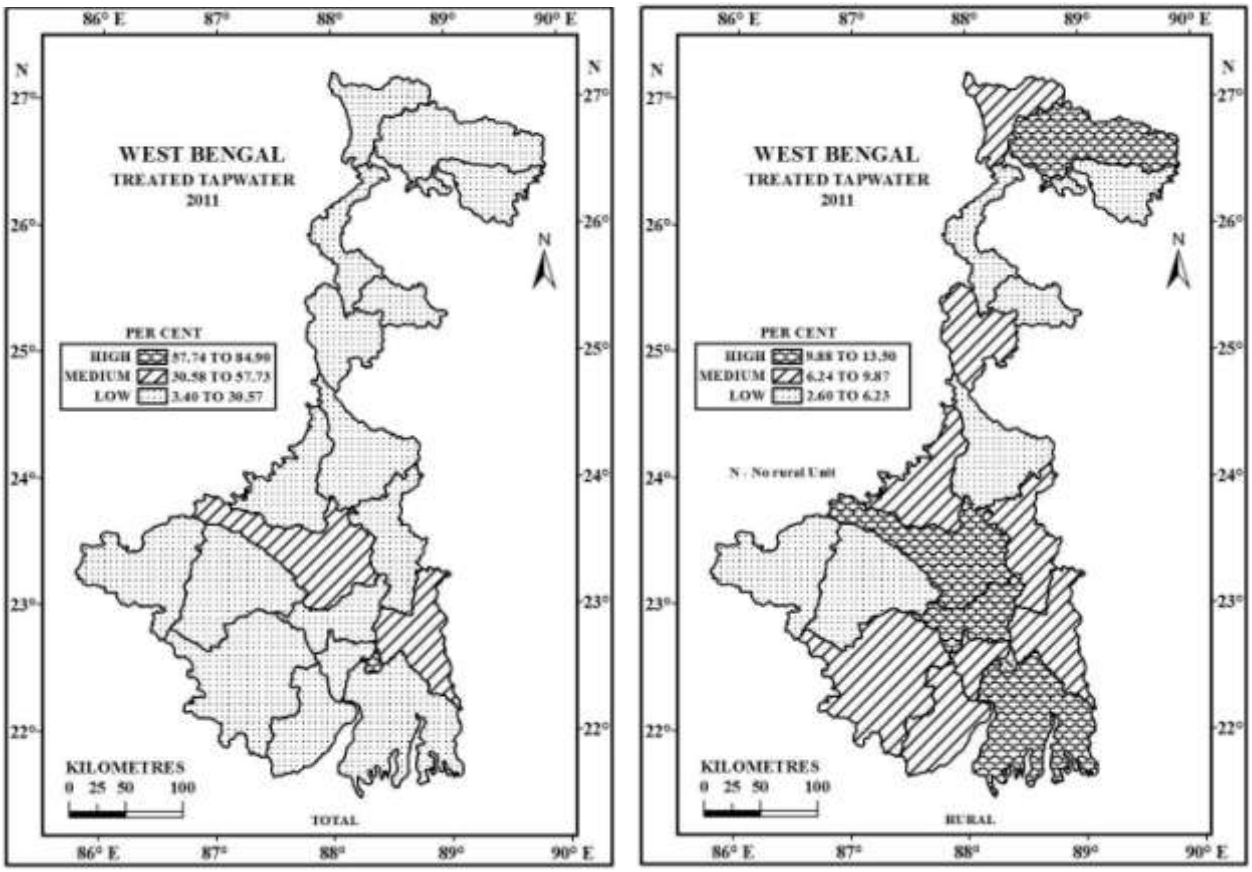

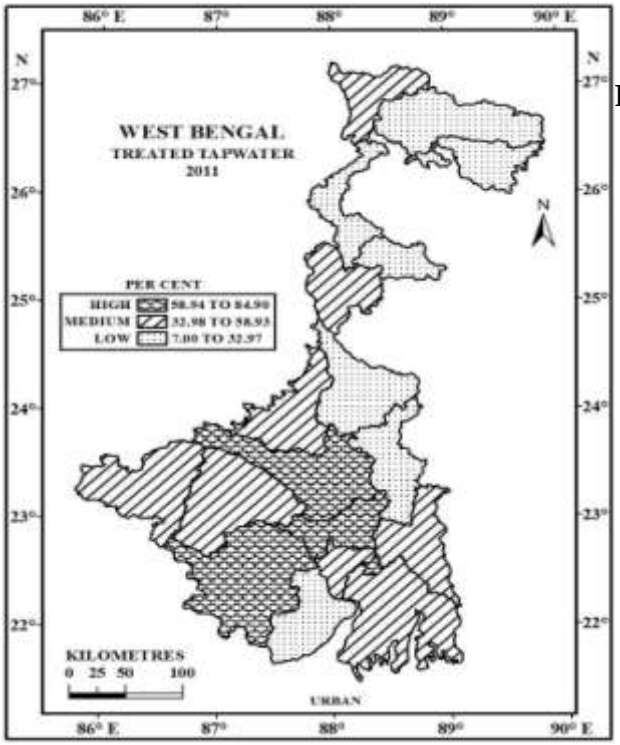

Figure 3

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and Nadia form another region in the central part of the state, while, Purba Medinipur doesn't share common boundaries with any other district of this category.

Levels of socio-economic development

Some of the districts of West Bengal are socially developed but economically backward, while, there are still some districts which are economically advanced but socially backward. Moreover, there are some districts where levels of social and economic development are more or less similar. So, in order to get the overall picture about the socio-economic development among the districts it is better to combine the social and economic development to together. For this purpose, forty-seven variables (twenty-seven variables of social and twenty variables of economic development) of social and economic development have been taken into consideration. The composite scores of socio-economic development have been achieved with the use of composite mean z-score technique. There is a wide variation of composite score of socio-economic development among the districts of West Bengal. It ranges from -0.60 scores in Uttar Dinajpur to 1.49 scores in Kolkata. This wide range has been further categorised into high (above 0.23 scores), medium (-0.23 to 0.23 scores) and low (below -0.23 scores) levels of socio-economic development (Table 3).

Table 3: Category wise distribution of composite z-scores of levels of socio-economic development in the districts of West Bengal

Category	Composite z-scores	Districts
High	Above 0.23	Kolkata, Darjiling, Hugli and Haora
Medium	-0.23 to 0.23	North Twenty Four Parganas, Paschim Medinipur, Bankura, Purba Medinipur, Koch Bihar, Puruliya, Jalpaiguri, Birbhum, Nadia, Dakshin Dinajpur, Barddhaman and South Twenty Four Parganas
Low	Below -0.23	Murshidabad, Maldah and Uttar Dinajpur

Source: Based on calculation from the collected data of Economic Review of West Bengal (2012-13), Statistical Abstract of West Bengal (2012-13) and State Statistical Handbook (2014).

Kolkata, Darjiling, Hugli and Haora are only the districts with high (above 0.23 scores) of socio-economic development. Out of these four districts, Kolkata, Hugli and Haora form a

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contiguous region in the south-central part of the state while, Darjeeling lies separately in the northern part of the state (figure 6)

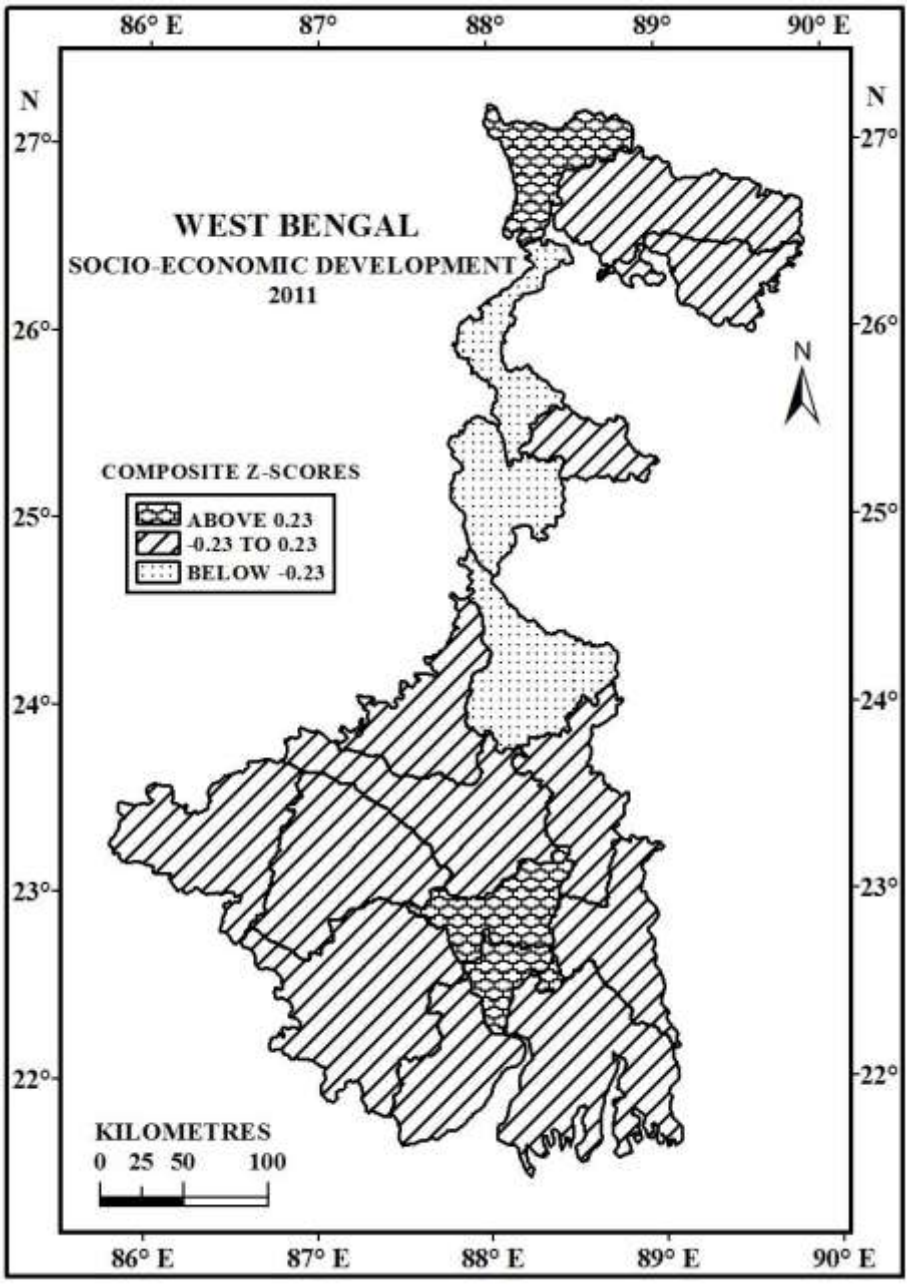

Figure 6

More than sixty three percent of districts West Bengal experience medium (-0.23 to 0.23 scores) levels of socio-economic development. One third of these districts are surrounding

the districts with high level of socio-economic development in a contiguous belt in the southern part of the state. The other region under the category of medium level of socio-economic development is found in the northern part of the state which is constituted by Jalpaiguri and Koch Bihar. Dakshin Dinajpur also has medium level of socio-economic development but it does not share common boundaries with other districts with medium level of socio-economic development.

Low (below -0.23 scores) level of socio-economic development is found in the districts of Uttar Dinajpur, Malda and Murshidabad. All these three districts are stretched in the central part of the state in the form of a single region.

Relationship between safe drinking water and socio-economic development

The association between safe drinking water and socio-economic development in West Bengal has been shown in Figure 7. Out of nineteen districts of the state, ten districts fall under same grade score and nine districts have different grade scores. It can be clearly seen from the figure that there are four districts where high (above 0.500 z- scores) level of safe drinking water is found and out of these districts in Kolkata and Hugli socio-economic development is also of high (above 0.23 scores) level, while North Twenty Four Parganas and Barddhaman have medium (-0.25 to 0.23 scores) level of socio-economic development.

Medium level (-0.50 to 0.50 z-scores) of development in terms of safe drinking water can be observed in nine districts, among which one (Maldah), six (Birbhum, Jalpaiguri, Nadia, Paschim Medinipur, Puruliya and South Twenty Four Parganas) and two (Darjiling and Haora) districts have low, medium and high level of socio-economic development.

Remaining six districts of West Bengal experience low level (below -0.50 z-scores) of safe drinking water and out of these six districts in only Uttar Dinajpur and Murshidabad socio-economic development is also of low grade while in Bankura, Dakshin Dinajpur, Koch Bihar and Purba Medinipur have medium level (-0.23 to 0.23 score) of socio-economic development.

From the above discussion it can be said that the level of safe drinking is related to the level of socio-economic development because there is not even a single district where level of availability of safe drinking water is low and socio-economic development is high and vice versa. In general, we can say that south-central and northern districts are more developed than

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rest of the districts of the districts both in terms of safe drinking water and socio-economic development. This could be mainly because better demographic, educational and health characteristics.

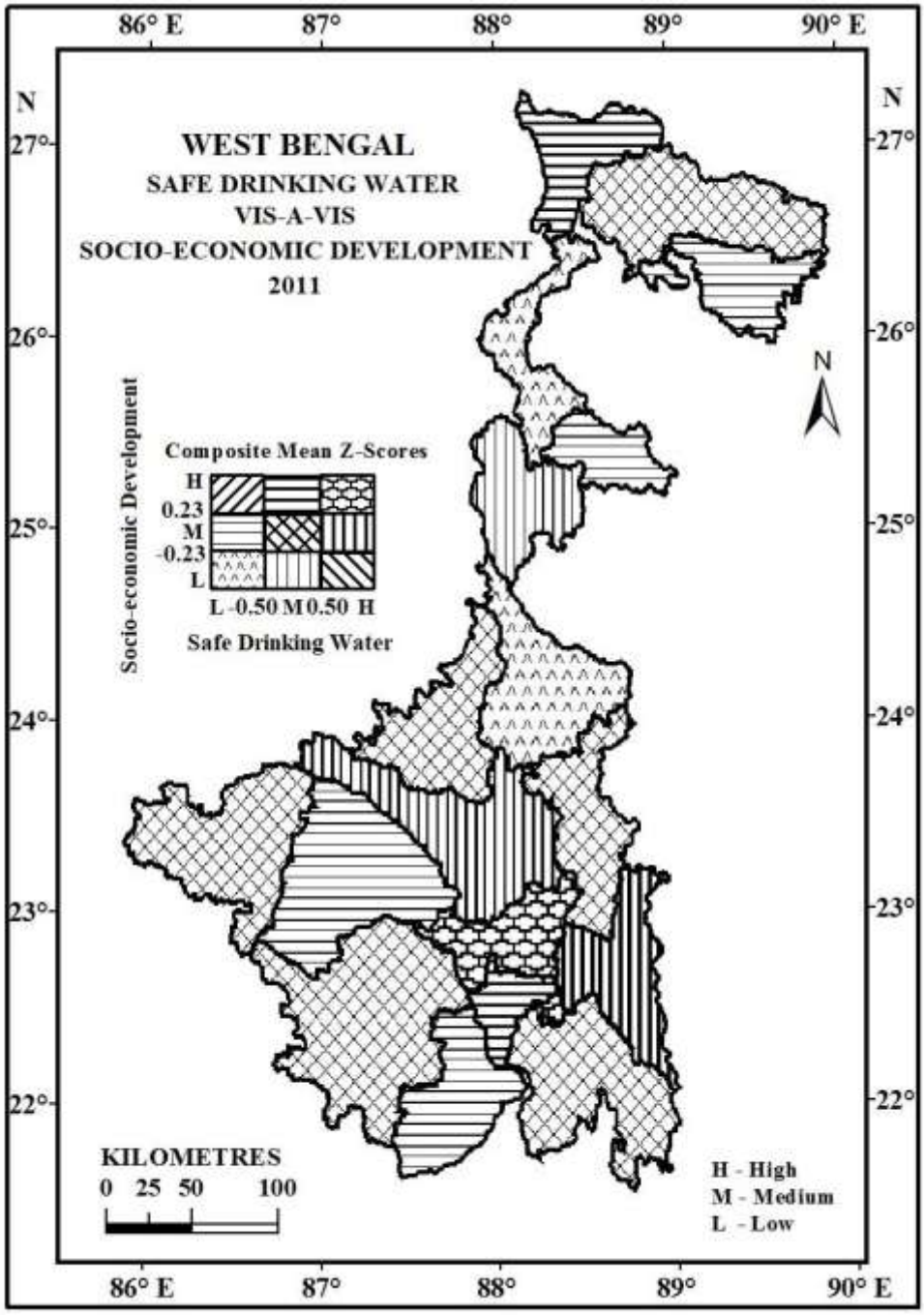

Figure 7

Correlation of treated tap water with Socio-Economic Development

The analysis of correlation of households having treated tap water (dependent variables) with overall socio-economic development (independent variables) exhibits that among the availability of treated tapwater is strongly positively correlated to overall socio-economic development (r=+.874).

Conclusion

The geographical patterns of levels of availability of safe drinking water and levels of socio-economic development and their relationship clearly depict that there is a large variation among districts of the study area. Though throughout state the levels of development in terms of availability of safe drinking water is low, the south-central districts have high levels of development. Medium to high levels of socio-economic development can be found in the southern and northern parts of the state while, the central part is experiencing low level of development. The association between availability of treated tapwater and levels of socio-economic development shows that they are positively correlated.

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