

# A Spatial Approach on Delineation of the Sphere of Urban Influence of Six Municipalities of Koch Bihar District, West Bengal, India

<sup>1</sup>Arjun Saha, <sup>2</sup>Tapan Debnath and <sup>3</sup>Dr. Ranjan Roy

<sup>1</sup>UGC-JRF Research Scholar, Deptt. of Geography and Applied Geography, North Bengal University, Darjeeling, 734013, India

<sup>2</sup>Student, Department of Geography and Applied Geography, North Bengal University, Darjeeling, 734013, India

<sup>3</sup>Professor, Department of Geography and Applied Geography, North Bengal University, Darjeeling, 734013, India

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## ABSTRACT

Growth of an urban centre and the regional development of that place are correlated to each other. Availability of different facilities affect the people of that place by changing their socio economic condition and also its benefit spread over the people on those who resides in the hinterland of that urban centre. Optimum level of urban growth mainly depends on the capacity to provide the required facilities to peoples. Hierarchical growth of urban centres in associated with available basic amenities help in regional development in a hierarchical way. But in case of developing countries, like India, some urban centres have more facilities with the higher regional influence whereas some are deprive for the facilities though having a large number of population.

This paper is an attempt to calculate the functionality and delineating the extension of influence with radius over the rural part of six municipalities of Koch Bihar district which was a princely state in pre independence period. The result shows that, the highest radius (km.) of circle indicating the sphere of influence is for Koch Bihar municipality and the least is for Mekhliganj municipality. Along with this, this paper also examines the adequacy and inadequacy of facilities for the urban centres which will be helpful for the future planning of these urban centres and a balanced regional development would be achieved.

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## 1. Introduction

India from beginning experiences a rural culture where most of the people lived in small villages, huts, hamlets with a small quantity (Verma, 2006). According to the Census of India, 2001, only 27.78 percent people lives in urban area which is 31.16 in 2011 and the rests are live in villages who are mostly depend on nearby cities or towns for their livelihood. The process of urbanization is a complex matter which involves a set of parameters, but for the India, it is mainly due to the development of industrialization (Bhagat, 2002).

Urban Growth happens due to the movement of people from rural areas to towns or cities due to different pull factors of those towns or cities (Ahmed & Ali, 2006). An urban centre with various governmental, educational, medical, financial and industrial facilities expands its growth towards outward and brings a significant economic change in that region (Mandal, 2000). But the optimum level of any urban growth depends on the capacity of that urban centre to provide different civic facilities to all the people in a fair way. High capacity enhances the growth of an urban centre while lower capacity than the inflow of migrants cause overburden on the civic amenities and restrict its growth in a proper and sustainable way (Ali & Varshney, 2012).

The spatial impact of towns, cities on the surrounding rural areas is an important point that discussed by different geographers. Any town or city either it is big or small do not exist only to serve the people living within their boundary, they are also intimately connected with the surrounding areas and for this type of characteristic towns or cities are called 'Foci' for their respective surrounding area. These surrounding areas which are dependent and connected with the nearest central

place are often called 'the zone of influence' or popularly known as 'Umland'. Many other expressions such as 'Catchment area', 'Urban field', 'City region' have appeared in different published literatures in the field of urban geography.

In West Bengal, Koch Bihar district has a total of six statutory towns or municipalities which is highest among the districts of northern part of this state. The main reason behind this is, it was a princely ruled state before the independence and princes were intellectual and visionary persons who developed this district from earlier time. The population of these urban centres ranges from 9127 in Haldibari to 77935 in Koch Bihar municipality. Being a statutory town, these municipalities offer different facilities to its population. Beside of its own population, it is necessary to find out the area and population which are being served by these municipalities. So, for this, the main thrust of this study is to gain some ground realities related to the functional hierarchy of urban centres, their differential influences over the respective surrounding areas which are the characteristic features of developing economy with the growth potentialities of these six urban centres.

## 2. Objectives and hypothesis

This work has been carried out to fulfil two objectives. First one is to delineate the zone of influence by socio-economic functional score of the aforesaid six municipalities of Koch Bihar district and then to examine the adequacy or inadequacy of socio-economic function in relation to the existing population of that municipalities of this district.

For this research work one simple hypothesis has been taken into consideration and that is, higher order municipalities with higher functional score have larger area of influence.

**3. Study area**

Koch Bihar, a district of northern part of West Bengal with an extension of approx. 26°00' N to 26°31' N latitude and 88°44' E to 89°51' E longitude with six municipalities has been taken for this work. It was a princely state before the Independent of India and merged with West Bengal as a district in the year 1949. Maharajas of the then state built this Koch Bihar city with a planned way and developed the others parts of this district, like, construction of railway tracks for trading, making parallel spur of Torsa river to check erosion of embankments, square pattern shape of roads for easily movement of traffic, state transport, post offices, different trading points to boost up the economy etc. Presently this district has been bounded by Bangladesh in south and west, Alipurduar district in North and Assam in East. At Present it has six municipalities, namely Koch Bihar, Dinhata, Tufanganj, Mathabhanga, Mekhliganj and Haldibari with a total urban population of 289434 which are the foci of our study.

**4. Materials and methods**

**Data sources**

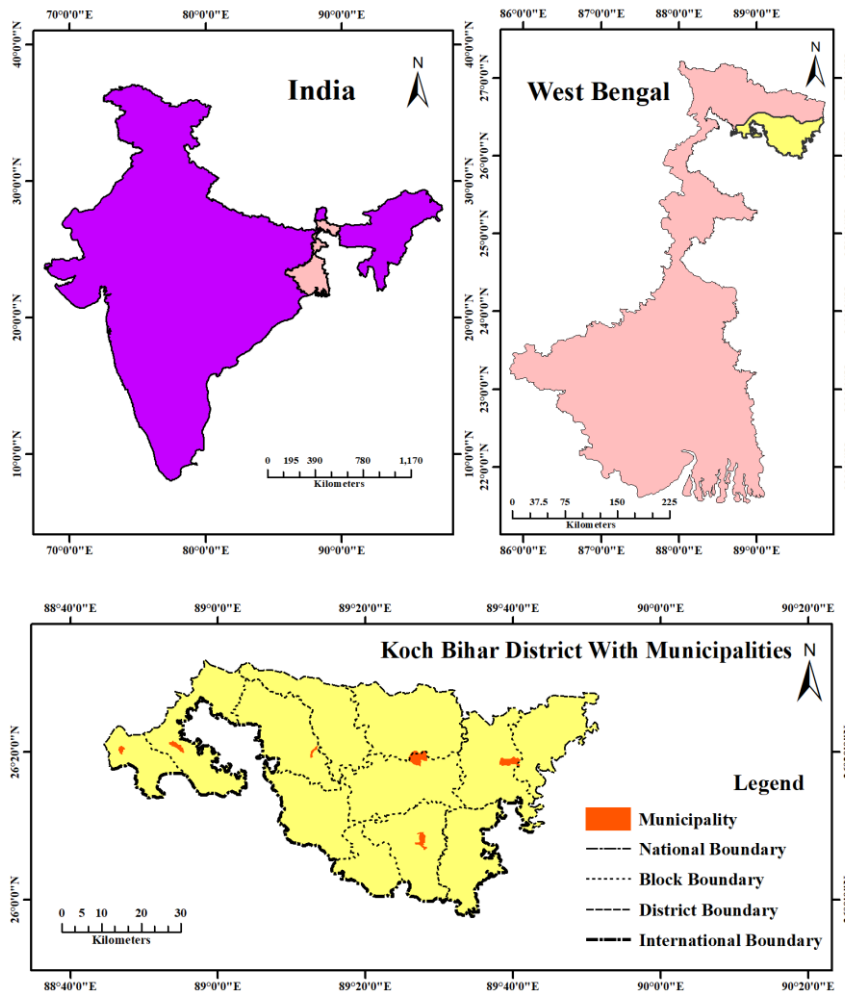
To fulfil the above objectives, data collection has done from different secondary sources. It includes Census Digital Library, 2011 (Govt. of India), District Statistical Handbook of Koch Bihar, 2011 (Bureau of Applied Economics & Statistics, Govt. of West Bengal), District Census Handbook of West Bengal (Town release, 2011, Govt. of India).

**Statistical analyses**

The primary objective of this work is to delineate the sphere of influence of six municipalities of Koch Bihar district and then to find out the adequacy or inadequacy of different socio-economic facilities that those towns have in relating with their existing population.

The facilities that have taken for this study are broadly classified into six categories and then sub categorised into a total of nineteen facilities. Table 1 shows the details of those facilities.

Sphere of influence of different municipalities has been calculated by some steps. These are,



**Fig 1: Location Map of The Study Area**

**Mean threshold population:** Mean threshold population of a particular facility has been calculated by dividing total population of any town with the number of facility of a particular category (Haggett & Gunwardena, 1965)

$$MT_i = TP/NF_i$$

(Where,  $MT_i$  – Mean threshold population,  $TP$  – Total population,  $NF_i$  – Number of facility of a category)

**Functional weightage of facility:** Functional weightage of a particular facility has been derived by dividing the mean threshold population of that facility with the lowest mean threshold population (Bhat, 1976).

$$WFi = MTi/MTI$$

(Where, WFi – Functional weightage of facility, MTi – Mean threshold population, MTI – Lowest mean threshold population)

**Composite functional score:** It is calculated by adding all the functional weightage of facilities.

$$CFs = \sum WFi$$

(Where, CFs – Composite functional score, WFi – Total functional weightage)

Table 1: Details of the facilities taken for analysis

| Categories                          | Facilities                                    | Variables |
|-------------------------------------|---|-----------|
| Educational Institutes              | No. of Primary School                         | X1        |
|                                     | No. of Middle School                          | X2        |
|                                     | No. of Secondary School                       | X3        |
|                                     | No. of Senior Secondary School                | X4        |
|                                     | No. of Degree College                         | X5        |
|                                     | No. of University                             | X6        |
|                                     | No. of Technical School                       | X7        |
|                                     | No. of Technical College                      | X8        |
|                                     | No. of Non-Formal Centre                      | X9        |
| Recreational Facilities             | No. of Cinema Hall                            | X10       |
|                                     | No. of Libraries                              | X11       |
|                                     | No. of Reading Rooms                          | X12       |
| Health Facilities                   | No. of Hospital                               | X13       |
|                                     | No. of Sub-centre                             | X14       |
|                                     | No. of Family Welfare Centres                 | X15       |
| Financial and Commercial Institutes | No. of Nationalized and Non Nationalized Bank | X16       |
|                                     | No. of Co-operative societies                 | X17       |
| Communication Facilities            | No. of Post Offices                           | X18       |
| Administrative Facilities           | No. of Police Stations                        | X19       |

**Sphere and radius of urban influence:** The zone and radius of influence of each town on the basis of its composite functional score has been calculated using modified quantitative technique formulated by V.L.S. Prakash Rao (Lokhande & Pawar, 2004).

$$SI = CFs \text{ of town} / CFs \text{ of district} * \text{Area of district}$$

$$R = \sqrt{SI}$$

(Where, SI – Sphere of influence, R – Radius of the sphere)

**Relative level of functional ratio:** To examine the adequacy or inadequacy of urban basic functions in related with existing population, the following formula has been used which was derived by Julfikar Ali and Deepika Varshney (Ali & Varshney, 2012).

$$Rij = Ps / Pt * Ft / Fs$$

(Where, Rij – Relative level of urban function between a town and the study area, Ps – Urban population of the study

area, Pt – Population of the town, Ft – Functional score of the town, Fs – Total urban functional score of the study area)

The ratio of more than 1 refers the adequacy where less than 1 refers the inadequacy of functions of that town with existing population.

**Hypothesis test:** To establish the hypothesis that is stated above, Pearson’s correlation coefficient and Pearson’s t test has used to find out the relation between variables and to accept or reject the statement.

**Tools used for analysis**

Tools are complementary part in any research work to calculate and present the outcomes. Tools that are used here is mainly two types, one is statistical tool that is MS Excel which is used for data tabulation, calculation and second one is GIS tool, and here ESRI ArcMAP 10.2.2 has been used for spatial representation of the calculated results.

Table 2: Number of facilities and total population of different municipalities

| Facilities | Municipalities with their no. of facilities and total population (TP) |       |     |       |     |       |     |       |     |      |     |       |          |         |
|------------|---|-------|-----|-------|-----|-------|-----|-------|-----|------|-----|-------|----------|---------|
|            | KCB   |       | DHT |       | TFG |       | MTB |       | MKG |      | HDB |       | District |         |
|            | No.   | TP    | No. | TP    | No. | TP    | No. | TP    | No. | TP   | No. | TP    | No.      | TP      |
| X1         | 36  | 77935 | 14  | 36124 | 14  | 20998 | 13  | 23890 | 7   | 9127 | 11  | 14404 | 1826     | 2819086 |
| X2         | 0   |       | 2   |       | 2   |       | 0   |       | 0   |      | 0   |       | 101      |         |
| X3         | 1   |       | 4   |       | 1   |       | 1   |       | 0   |      | 0   |       | 93       |         |
| X4         | 14  |       | 5   |       | 5   |       | 4   |       | 2   |      | 2   |       | 159      |         |
| X5         | 4   |       | 1   |       | 1   |       | 0   |       | 0   |      | 1   |       | 13       |         |
| X6         | 0   |       | 0   |       | 0   |       | 0   |       | 0   |      | 0   |       | 1        |         |
| X7         | 1   |       | 3   |       | 3   |       | 6   |       | 0   |      | 1   |       | 26       |         |
| X8         | 16  |       | 0   |       | 0   |       | 0   |       | 0   |      | 0   |       | 14       |         |
| X9         | 27  |       | 13  |       | 12  |       | 6   |       | 5   |      | 6   |       | 4354     |         |

|     |    |  |   |  |   |  |   |  |   |  |   |  |     |
|-----|----|--|---|--|---|--|---|--|---|--|---|--|-----|
| X10 | 2  |  | 2 |  | 2 |  | 2 |  | 0 |  | 0 |  | 8   |
| X11 | 2  |  | 1 |  | 2 |  | 1 |  | 1 |  | 1 |  | 122 |
| X12 | 2  |  | 1 |  | 2 |  | 1 |  | 1 |  | 1 |  | 122 |
| X13 | 3  |  | 1 |  | 2 |  | 1 |  | 1 |  | 1 |  | 9   |
| X14 | 0  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |  | 406 |
| X15 | 7  |  | 4 |  | 3 |  | 3 |  | 1 |  | 1 |  | 33  |
| X16 | 17 |  | 6 |  | 3 |  | 3 |  | 2 |  | 4 |  | 127 |
| X17 | 2  |  | 1 |  | 1 |  | 3 |  | 0 |  | 1 |  | 708 |
| X18 | 8  |  | 2 |  | 2 |  | 2 |  | 1 |  | 1 |  | 361 |
| X19 | 2  |  | 1 |  | 1 |  | 1 |  | 1 |  | 1 |  | 17  |

KCB- Koch Bihar, DHT- Dinhata, TFG- Tufanganj, MTB- Mathabhanga, MKG- Mekhliganj, HDB- Haldibari

Source: District Statistical Handbook of Koch Bihar (2011), District Census Handbook of West Bengal (Town release, 2011, Govt. of India)

5. Results and discussion

Mean threshold population and functionality of urban centres

Different socio-economic facilities are essential in a great extent for the people as it helps for socio-economic transformation of that society to change their livelihood and also to upgrade their quality of life to develop (Sharma, 1972). So, the nature of distribution of population and different socio-economic facilities happens parallel as they are interdependent to each other. Peoples usually tend to settle in a place where different facilities are easily available.

On the other hand, proper functioning of those facilities depends on the size and purchasing power of population of that region. That is why higher important facilities are very few in a number and located only in higher class cities whereas lower important facilities are mostly available in all types of urban centres.

In the present study as a total of twenty functions under six broad categories have been taken into account. To find out the functional weightage of each function, Mean threshold population of each function has been estimated. It is basically

a mean of average population that served by the respective function (Maithini, 1986). It has been calculated by dividing total population of any urban centre with the total number of facility under any particular function (Haggett & Gunwardena, 1965).

After calculating the Mean threshold population, functional weightage of each function has been calculated. Functional weightage of a function is inversely related with the number of its availability (Mandal et al, 2015). This means the function which has a highest number in their availability has lowest of its functional weightage and vice versa. For example, functional importance of a university is much more than a primary school or secondary school which occurs in a more number in a particular settlement (Sharma, 1972).

At last composite functional score of Koch Bihar district and six municipalities have been calculated by summing up each functional weightage of that respective municipality. Table 3 shows the details of Mean threshold population and functional weightage of different functions of six municipalities as well as the whole district.

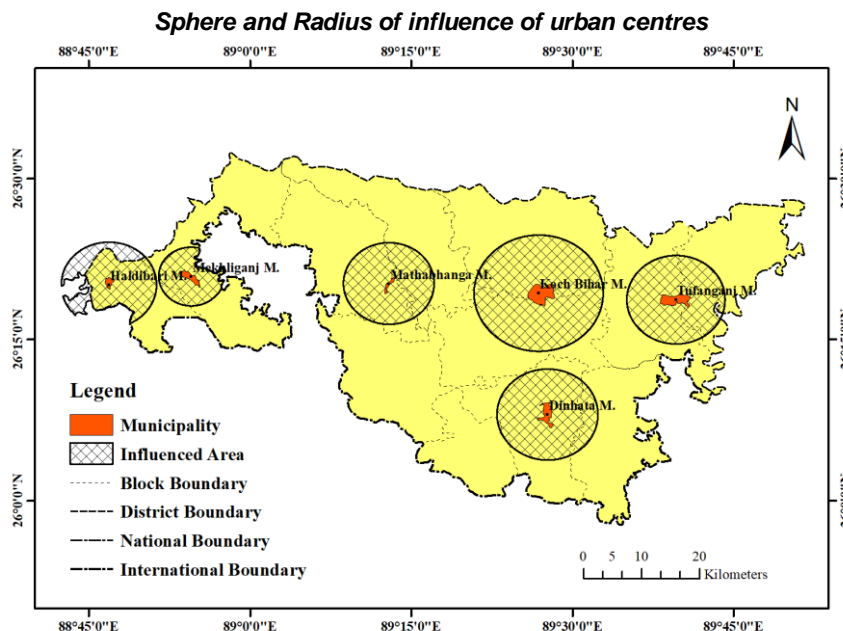


Fig 2: The Zone of Influence of Municipalities of Koch Bihar District

Each town or urban centre has an impact on its surrounding area. People of surrounding areas of any urban centre mostly depend in many terms on that urban centre. They come to the urban centre to avail the required facilities that any urban centre has more than the surrounding area and

they mainly visit from a certain distance. This distance mainly depends on the availability of functions and functional importance of that urban centre. So the importance of functions and the distance travelled by peoples are positively related to each other (Ali & Varshney, 2012). Any town having a large

number of facilities is being visited by people from a long distance. It can be said that, an urban centre with higher functional importance spreading its influence over a larger area of its surrounding (Lokhande & Pawar, 2004). This influenced area with interaction and interdependence with its nodal urban centre makes a functional region (Glasson, 1978).

Now to find out sphere and radius of influencing area, V.L.S. Prakash Rao's modified quantitative technique has been adopted. Sphere of influence of six municipalities of Koch Bihar has been delineated on the basis of composite functional score of each municipality with respect to all over district. As it is stated above that, higher the functional importance or functional score, higher the influenced area, Koch Bihar municipality shows here larger influenced area, that is 100.00 sq. km. with a radius of 10 km. It is because Koch Bihar municipality is the district headquarters with an ample of facilities. Table 4 shows other municipalities with their influenced area and radius. Dinhatra municipality exerts its influence up to 7.83 km. with an area of 61.35 sq. km. which is second in this district followed by Tufanganj municipality that is 7.61 km. and an area of 57.93 sq. km. The lowest value of radius has been found in Mekhliganj municipality that is 5.05 km. with an area of 25.46 sq. km. because of absence of basic facilities like general degree colleges, technical colleges like, ITI, cinema hall etc. in the municipality area.

**Analysis of adequacy and inadequacy of urban facilities**

The number of residents in an urban centre and availability of urban facilities should be in a balanced way. The distribution of these facilities should be in such a way that their location ensure to access easily for the people of that urban centre and its influenced area. To keep up the standard of living of peoples, different types of facilities, it may be higher order or lower order should be allocated in those urban centres where it is unavailable or in a lower quantity.

This part of our study actually analyzes the gap of facilities in six municipalities of Koch Bihar district. In order to find out this gap, either the different facilities are surplus or deficit with the existing population, the formula of Julfikar Ali and Deepika Varshney (2012) has been used here. The ratio of absolutely 1 means the balanced level of facilities in accordance with population and above or below 1 means adequate or inadequate facilities respectively has been served by that urban centre. An urban centre which has a ratio of more than 1 means adequate facilities can attract more people from the surrounding and any urban centre which has a ratio of below 1 should provide more facilities to attain the standard of living (Ali & Varshney, 2012).

In our study, two municipalities Koch Bihar and Dinhatra shows a ratio of less than 1 that is 0.67 and 0.89 respectively which defines inadequate amount of facilities. This is because of the population of these two municipalities are higher than the others. Mathabhanga municipality with 1.08 only shows a result which is nearer to the ideal value with its population. Rest three municipalities' show a result of more than 1 and these are Tufanganj (1.44), Mekhliganj (1.46) and Haldibari (1.98) which can attract more people from surrounding area in near future.

**Validation of hypothesis**

To justify the above stated hypothesis, two sets of variables have taken. Composite functional score of six municipalities is independent variable and their area of influence is dependent variable. Relations between these two variables are highly positive as their Pearson's correlation coefficient value (r) is 0.99. To accept or reject the hypothesis, Pearson's t test has been used here. The result shows that, the calculated value is much higher than the tabulated or critical value at 0.01 level of significance at (n-2) means 4 degree of freedom, which accepts that 'higher order town with higher functional score has larger area of influence'.

Table 3: Mean threshold population (MTP) and Functional weightage (FW) of municipalities

| Facilities | Municipalities with their mean threshold population (MTP) and functional weightage (FW) |       |       |       |       |       |       |       |      |      |       |       |          |         |
|------------|---|-------|-------|-------|-------|-------|-------|-------|------|------|-------|-------|----------|---------|
|            | KCB   |       | DHT   |       | TFG   |       | MTB   |       | MKG  |      | HDB   |       | District |         |
|            | MTP   | FW    | MTP   | FW    | MTP   | FW    | MTP   | FW    | MTP  | FW   | MTP   | FW    | MTP      | FW      |
| X1         | 2165  | 1.00  | 2580  | 1.00  | 1500  | 1.00  | 1838  | 1.00  | 1304 | 1.00 | 1309  | 1.00  | 1544     | 2.38    |
| X2         |   |       | 18062 | 7.00  | 10499 | 7.00  |       |       |      |      |       |       | 27912    | 43.11   |
| X3         | 77935   | 36.00 | 9031  | 3.50  | 20998 | 14.00 | 23890 | 13.00 |      |      |       |       | 30313    | 46.82   |
| X4         | 5567  | 2.57  | 7225  | 2.80  | 4200  | 2.80  | 5973  | 3.25  | 4564 | 3.50 | 7202  | 5.50  | 17730    | 27.38   |
| X5         | 19484   | 9.00  | 36124 | 14.00 | 20998 | 14.00 |       |       |      |      | 14404 | 11.00 | 216853   | 334.92  |
| X6         |   |       |       |       |       |       |       |       |      |      |       |       | 2819086  | 4354.00 |
| X7         | 77935   | 36.00 | 12041 | 4.67  | 6999  | 4.67  | 3982  | 2.17  |      |      | 14404 | 11.00 | 108426   | 167.46  |
| X8         | 4871  | 2.25  |       |       |       |       |       |       |      |      |       |       | 201363   | 311.00  |
| X9         | 2886  | 1.33  | 2779  | 1.08  | 1750  | 1.17  | 3982  | 2.17  | 1825 | 1.40 | 2401  | 1.83  | 647      | 1.00    |
| X10        | 38968   | 18.00 | 18062 | 7.00  | 10499 | 7.00  | 11945 | 6.50  |      |      |       |       | 352386   | 544.25  |
| X11        | 38968   | 18.00 | 36124 | 14.00 | 10499 | 7.00  | 23890 | 13.00 | 9127 | 7.00 | 14404 | 11.00 | 23107    | 35.69   |
| X12        | 38968   | 18.00 | 36124 | 14.00 | 10499 | 7.00  | 23890 | 13.00 | 9127 | 7.00 | 14404 | 11.00 | 23107    | 35.69   |
| X13        | 25978   | 12.00 | 36124 | 14.00 | 10499 | 7.00  | 23890 | 13.00 | 9127 | 7.00 | 14404 | 11.00 | 313232   | 483.78  |
| X14        |   |       |       |       |       |       |       |       |      |      |       |       | 6944     | 10.72   |
| X15        | 11134   | 5.14  | 9031  | 3.50  | 6999  | 4.67  | 7963  | 4.33  | 9127 | 7.00 | 14404 | 11.00 | 85427    | 131.94  |
| X16        | 4584  | 2.12  | 6021  | 2.33  | 6999  | 4.67  | 7963  | 4.33  | 4564 | 3.50 | 3601  | 2.75  | 22198    | 34.28   |
| X17        | 38968   | 18.00 | 36124 | 14.00 | 20998 | 14.00 | 7963  | 4.33  |      |      | 14404 | 11.00 | 3982     | 6.15    |
| X18        | 9742  | 4.50  | 18062 | 7.00  | 10499 | 7.00  | 11945 | 6.50  | 9127 | 7.00 | 14404 | 11.00 | 7809     | 12.06   |
| X19        | 38968   | 18.00 | 36124 | 14.00 | 20998 | 14.00 | 23890 | 13.00 | 9127 | 7.00 | 14404 | 11.00 | 165829   | 256.12  |

Source: Calculated by authors from table 2

**Table 4: Composite functional score, Influence area and Radius of municipalities**

| Municipalities | Composite functional score | Influence area | Radius of circle |
|----------------|----------------------------|----------------|------------------|
| Koch Bihar     | 201.92                     | 100.00         | 10.00            |
| Dinhata        | 123.88                     | 61.35          | 7.83             |
| Tufanganj      | 116.97                     | 57.93          | 7.61             |
| Mathabhanga    | 99.58                      | 49.32          | 7.02             |
| Mekhliganj     | 51.40                      | 25.46          | 5.05             |
| Haldibari      | 110.08                     | 54.52          | 7.38             |
| District       | 6838.76                    |                |                  |

Source: Calculated by authors from table 3

**Table 5: Relative functional ratio of municipalities**

| Municipalities | Population | Relative level of functional ratio |
|----------------|------------|------------------------------------|
| Koch Bihar     | 77935      | 0.67                               |
| Dinhata        | 36124      | 0.89                               |
| Tufanganj      | 20998      | 1.44                               |
| Mathabhanga    | 23890      | 1.08                               |
| Mekhliganj     | 9127       | 1.46                               |
| Haldibari      | 14404      | 1.98                               |
| District       | 2819086    |                                    |

Source: Calculated by authors based on table 2 and table 3

## 6. Recommended suggestions and conclusion

After analysing different municipalities with different indices by their functional score and current population and to attain regional socio-economic development, some planning and recommendations have been made for the well being of all the peoples of this Koch Bihar district. These are as follows,

The above analysis has carried on some municipalities which gives facilities to its peoples and the surrounding peoples up to some extent. But maximum areas which are too apart from these urban centres are lacking of different services or they have to travel a great distant to avail those facilities. In order to balance the proper regional development different facilities like higher secondary schools, general degree colleges, technical colleges, nationalized banks etc. should provide in the void places. Though some rural areas already have some sorts of facilities like higher secondary schools, general degree colleges, police stations, nationalized banks in Sitalkuchi, Ghokshadanga, Banerwar, Bakshirhat area, but some places are still lacking behind these facilities. These places are mainly Jamaladaha of Mekhliganj block, Sahebganj of Dinahta II block, Sitai of Sitai block. Govt. should provide some basic facilities to these backward places to upgrade the quality of life of local peoples.

Relative level of functional ratio of two municipalities, Koch Bihar and Dinhata are 0.67 and 0.89 respectively, which states about their inadequacy of facilities in accordance with their existing population. So govt. should provide different facilities to these two municipalities. Up to 2011 Dinhata municipality

only have one college and don't have any technical schools or colleges which are very much needed for this municipality.

Those municipalities which have a relative ratio of function of more than 1 are Tufanganj, Mathabhanga, Mekhliganj and Haldibari can expand their area to their immediate surroundings to maintain the ratio value in balance. If this happen then peoples of surrounding areas of these municipalities can also get some civic facilities.

As a total of 12 census towns (CTs) are there in Koch Bihar district according to 2011 census. Some census towns are close to some municipalities which can avail facilities from their near about municipalities but some CTs like Dhaliabari, Banerwar, Baisguri, Nagar Changrabandha, Kamat Phulbari, Chhota laukuthi which are away from these municipalities should increase their facilities by the help of govt. to maintain the regional balance of development.

Urban growth is a natural process, with due time the population of all urban centres will increase. The concentration of population depends on the availability of basic amenities that an urban centre provides. This quantitative analysis clearly states that, urban growth happens in a hierarchical way and an urban centre with higher functional score exerts a larger area of influence on its surrounding. For this the rural areas associated with any urban centre can take the benefits and can upgrade their standard of living. This type of empirical study is imperative for city planning strategies and policy making to enhance the quality of life of the peoples and to overall regional development.

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