Journal of Interdisciplinary and Multidisciplinary Research (JIMR)
E-ISSN:1936-6264| Impact Factor: 8.886| UGC CARE II
Vol. 19 Issue 08, Aug- 2024
Available online at: https://www.jimrjournal.co.in/
(An open access scholarly, peer-reviewed, interdisciplinary, monthly, and fully refereed journal.)

An Integrated Approach of Multi-Criteria Decision Analysis and Spatial Interaction on Urbanization using Geospatial Techniques - A Case Study of Barasat Sub-division, North 24 Parganas District, West Bengal, India

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Abstract

Now-a-days rapid and unplanned urbanization has become a severe problem for the developing countries. To make a proper development strategy, it is important to measure the urbanization level considering multiple urban aspects. At the time of independence, this part of North 24 Parganas district was undergone through a separation tragedy along the India-East Pakistan (Bangladesh) border. Under this circumstances, an unplanned urbanization was noticed throughout the decades. It has been observed that the number of census towns of this region were increased from 3 to 34 between 1991 and 2011. Hence, this paper emphasized on Multi-Criteria based Decision Making strategy employing the Technique for Order of Preference by Similarity to an Ideal Solution method to explore the urban development level of municipalities and census towns. Apart from that,spatial interaction of municipalities have been evaluated to assess the gravity or flow of interaction of the central places or municipalities over the surrounding census towns to validate the performance score using modified gravity model. The study was based on the analysis of secondary data (Census of India 2011) in geospatial platform. After investigating the above said observations, an attempt has been made to measure the sphere of influence of the municipalities.

Key words: Geospatial Technique,Multi-criteria Decision Making, Modified Gravity Model, Technique for Order of Preference by Similarity to an Ideal Solution, Urbanization Level.

Introduction

The term “Urbanization” refers to the social process in which a huge number of people shifted from rural areas and started to live in cities. The description of urban area was determined by 1961 census considering some basic criteria. For instance, Statutory Town or Municipality includes civic status of the area such as municipality, municipal corporations and cantonment board, notified area committee etc. On the other hand, economic as well as demographic status comprising of population size, density and percentage of population engaged in non-agricultural activity considered as major criteria to define the Census town[7].

According to the census data huge number of population explosion found in North 24 Parganas district of West Bengal since it was born. As that portion of the country was undergoing through the separation tragedy from adjoining part of British-India, people of those areas became refugees and started to come and live in this district especially under the jurisdiction of Barasat Sub-division due to its geographical location. As per Census of India 1951-2011, the urbanization of West Bengal was increased from 23.90% in 1951 to 31.89% in 2011 respectively. The appearance of huge number of census towns after 1990 in West Bengal contributed rigorously to sudden increase of urbanization[10].The number increased from 3 to 34 during this time period. However, increasing status of census towns or small towns particularly for developing countries, played a vital role in rural economic development as a service provider and helps

the national economy by regulating the growth of metropolitans. It releases the population pressure of large urban cities and indirectly assists in moderating the urban issues. But, if it remains unchecked and grows in improper way, it becomes a curse for urban life as it arises several socio-economic as well as health issues such as unemployment, low urban space, unavailability of adequate foods, shelter along with hygiene etc. Hence, it is important to execute the present condition with respect to the past using modern technology.

At present, geo-informatics has been ascertained as apowerful tool to analyse the spatial as well as temporal urbanization pattern incorporating the socio-economic aspects too.It enables the user to analyse and envisage all the essential dataset bringing together in one platform. It can be considered as real time analysis.Several works have been done previously on the capability of remote sensing and GIS for urban growth investigation[2]. Spatial interaction of central places over the surrounding villages of the district has been estimated earlier using modified gravity model of Matt. T. Rosenberg[8]. Numerous researchers have used temporal remote sensing data along with spatial metrics to analyse the spatial pattern of urbanization[9]. Later on geo-informatics and spatial metrics together with have been used to identify the nature of urban growth pattern[1].

Apart from that, Entropy-Weight and TOPSIS method have been calculated previously to compute Level of Urban Sustainable Development Index considering three aspects namely Society, Economy and Environment[4]. Besides this,some researchers have calculated the level of Urbanization and Inter-settlement spacing using census data to compare the urban growth trend for several years[6].

This paper analyses the level of urbanization of the study area usingMulti-criteria Decision Making (MCDM) method. In this study, several urban aspects such as percentage of urban area, urban population density, urban spacing and urban households associated with socio-economic status are taken into consideration as criteria, based on census of India 2011[3]. Technique for Order of Preference by Similarity to an Ideal Solution (TOPSIS) method has been found suitable in this context to analyse and estimate the urbanization level score. At the same time, modified gravity model was applied to explore theflow ofinteraction of the municipalitiesat regional level using geospatial techniques. It helps to validate the urbanization score of the census towns. Besides this, an effort has been made to estimate the zone of influence of the municipalities as a central place.
The aim of the paper is to analyse the urbanization level with an integrated approach in geospatial platform. Consequently, this multi-criteria (MCDM) based studyespecially in GIS platform would provide a positive outlookto the decision-makers and urban plannersto make a proposal of strategic management for morphological planning and dealing with the ever-increasing urbanization and its related issues for the welfare of society.
Barasat sub-division constitutes an essential part of North 24 Parganas district located at the southern part of West Bengal, India. It comprises Barasat-I, Barasat-II, Habra-I, Habra-II, Amdanga, Deganga and Rajarhat Block till 2015. As per 2011 census, 34 Census Towns and 6 Municipalities were governed by this sub-division (as shown in **Figure.1**). On 2015, Rajarhat Block including 9 Census Towns were totally transferred to Bidhannagar Sub-division after the formation of Bidhannagar Municipal Corporation . Presently, Barasat sub-division contains 5 Municipalities and 25 Census Towns along with 6 CD Blocks (Community Blocks). Latitudinal extension of Barasat Sub -division (presently) is from 22° 36' 54.22" N - 22° 57'15.73" N and longitudinal extension is 88° 25' 43 .62" E - 88°48' 32 .50" E. It is bounded by Nadia District in North; Bidhannagar Municipal Corporation and South 24 Parganas district in South; Barrackpore Sub-division in West and Basirhat Sub-division in East. It occupied 894.61 sq.km. area having 2,196,874 population with 2500 person/sq.km. population density. Some part of the study area is lying on the North Hooghly plain and rest part lies on the North Bidyadhari Plain. The study area enjoyed the Tropical Gangetic Climate. Fertile Alluvial soil and clay loam are the basic soil types of the study area as it is situated over the Ganga-Brahmaputra Delta.

Figure.1 Location Map

Materials & Methods

This study is based on secondary data sources collected from Census of India 2011,Bureau of Applied Statistics and Economics, Govt. of West Bengal. Google-Earth-Airbus and Landsat Satellite series, Open Street Map are used for data validation and ArcGIS 10.2, ERDAS Imagine 2014 software along with MS-Officeare usedfor the necessary analysis and output generation.

In this context, Census Data and ancillary administrative map data were collected and organised. Besides this,several calculation and analysis were performedalong with the database. **Figure.2** describes theprocedures, carried out to derive the level of urbanization along with the sphere of influence of the central places (M) of the study area.For calculating the urbanization level, multiple criteria were considered at municipality level as well as at census town level.

Figure.2. Schematic Diagram of Procedures

Calculation Method-

Firstly, ENTROPY-TOPSIS method was used to estimate the *LEVEL OF URBANIZATION* rank for municipality and census towns. Hence, following 15 urbanization parameters or criteria were calculated as an order.

STEP-I

Calculation of Urbanization Parameters as Order-

i. **Percentage of Urban Area to total area (UA)** –
UA= (Urban Area/Total Area)*100

ii. **Percentage of Urban Population to total population (UP)** –
UP= (Urban Population/Total Population)*100

iii. Urban Population Density (UPD) –
UPD= (Urban Population/Urban Area)

iv.Urban Spacing (US) –

Urban Spacing is inversely related with the urbanization level as it is lower in urban area and is calculated using the following equation (Sarkar's method for 1951-2001)-

$$\mathbf{US}= 2\sqrt{A/n}$$

Where, A= Area and n= number of urban settlements within the study area.

v. Percentages of Urban Households(UH)-
UH= (Urban Households/Total Households)*100.

vi. % of Urban Households Availing Banking Facility to the total household of the CD Block**.**

vii. % of Urban Households Having Electricity to the total household of the CD Block**.**

viii. % of Urban Households Having Separate Kitchen within the House to the total household of the CD Block**.**

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ix. % of Urban Households having Bathroom to the total household of the CD Block**.**
x. % of Urban Households having Latrine facility to the total household of the CD Block**.**
xi. % of Urban Households having Closed Drainage Connectivity to the total household of the CD Block**.**
xii. % of Urban Households having Drinking Water within the Premises to the total household of the CD Block**.**
xiii. % of Urban Households having LPG for cooking to the total household of the CD Block**.**
xiv. **Percentages of General Literacy Rate (GLR)-**
GLR= (Literate Population/Total Population)*100.
xv. **Percentages of Female Literacy Rate (FLR)-**
FLR= (Female Literate/Literate Population)*100.

STEP-II

Entropy calculation for determining weight value-

Entropy method is basically an object weighting method and used to calculate the probabilistic value of the outcome using the limited information about that uncertainty. In 1948, C.E. Shannon addressed the Entropy method in information theory. Before that, this theory was used as a concept in Thermodynamics.

Currently, this method is broadlyapplied in urban dynamics. In this paper, to determine the weightage value of the parameters, following equations were executed-

1. The datanormalization of i and j matrix was performed using equation (1).

$$\mathbf{P_{ij}} = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}} \text{.....(1)}$$

Where, X denotes the cell value of the parameters in**i** x **j** matrix and$\sum_{i=1}^{m}$ denotes summation of the cell value of the number of observations. And, $\mathbf{P_{ij}}$represents the project outcome or the normalized data.

2. The entropy value was calculated for each of the parameter using equation (2)

$$e_j = (-h) * \sum_{i=1}^{m} (P_{ij} * ln\ (P_{ij})) \text{..... (2)}$$

Where, **(-h) = 1/ln (m).**

lnstands for natural logarithm and **m** represents the number of alternatives or observations.

3. Degree of diversification (dj) was estimated using equation (3).

$$\mathbf{d_j = (1 - e_j) \text{..... (3).}}$$

4. Weightage value of each parameter was computed using the equation (4).

$$\mathbf{W_j} = \frac{(1-e_j)}{\sum_{j=1}^{n}(1-e_j)} \text{..... (4)}$$

Where, $\sum_{j=1}^{n}$ denotes the summation of the degree of diversification.

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STEP-III

Level of Urbanization Score calculation using Technique for Order of Preference by Similarity to an Ideal Solution (TOPSIS) model-

TOPSIS stands for the Technique for Order of Preference by Similarity to an Ideal Solution and is prevalently used as Multi-Criteria Decision Making (MCDM) method. Hwang and Yoon first implemented this method in 1981 for Multi-criteria based Decision Making approach[5]. Generally, it calculates the closeness between the measured outcome and its ideal solution.

Hence, it was found suitable in this context to reflect the urbanization level of the study area. This method was applied using following few equations such as-

1. To normalize the data matrix,before applying the equation (1), equation (5) wasused.

$$\textbf{Normalized Value } (Y_{ij}) = \sqrt{(x_1^{\,2} + x_2^{\,2} + \ldots + x\square^{\,2})} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where, x_1 , x_2 , $x\square$ are the cell value of the dataset up to n^{th} parameter. After that, equation (1) was applied to get the normalized data matrix using normalized value as-

$$P_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{m} Y_{ij}}$$

2. Weighted Assessment Matrix was established in the next stage with the help of the equation (6).

$$V_{ij} = (W_j * P_{ij}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

3. For beneficial parameters, maximum value were considered as Ideal Best solution (V^+) and minimum value considered as Ideal Worst solution (V^-). Whereas, reverse method were applied for the non-beneficial parameters which has inverse relationship with the desired outcome. For instance, in this case, Urban Spacing was considered as non-beneficial parameter.
4. Euclidean Distance (S_i^+) from the ideal best solution was calculated using equation (7).

$$S_i^+ = \sqrt{\sum_{j=1}^{m} (V_{ij} - V_j^+)^2} (i = 1, 2 \ldots . m) \ldots\ldots . (7)$$

Similarly, Euclidean distance (S_i^-) from the ideal worst solution wereestimated following the equation (8).

$$S_i^- = \sqrt{\sum_{j=1}^{m} (V_{ij} - V_j^-)^2} (i = 1, 2 \ldots . m) \ldots\ldots . (8)$$

5. Finally, using equation (9), Performance score were calculated for the Municipalities as well as census towns for determining the urbanization rank.

$$\textbf{Performance Score} = \frac{S_i^-}{S_i^+ + S_i^-} (i = 1, 2 \ldots . m) \ldots\ldots\ldots\ldots (9)$$

Secondly, to determine the flow of interaction of the municipalities i.e. an integral part, ***Gravity Analysis***or ***Spatial Interaction***was executed at local levelusing modified gravitational law. Sir Isaac

Newton was invented the Law of Gravitation in 1686 to determine the gravitational forces between two objects using the mass of the objects and distance between them. Later on, the gravity law was came into forces to estimate the flow of goods or human interaction between cities in geography during the second half of the 19th century.It was modified by the social scientists as "bodies" replaced with location of central place and "mass" with population size of the places. In case of this investigation, modified gravitational law was applied as two places are directly proportional to their population size and inversely proportional to the square of the distance between them as propounded by Matt T. Rosenberg[8].

$$\textbf{Spatial Interaction of Municipality} = \frac{(Population_1 x\ Population_2)}{Distance^2}$$

In one word, the places having larger population size are highly attracted by the nearest Municipality and as the distance increased the attraction becomes lesser and so on for the population size.

For the current study, Municipality was always considered as "**dominant City**" and represented by **Population** $_1$and population size of the associated places i.e. census towns were configured as "**smaller settlement**" which was represented by **Population** $_2$**.** The multiplied value then divided by the square of the distance between them to execute the zone of influence of the municipality.

Results and Discussion

Level of Urbanization Calculation (Municipality-level):

Calculation of Urbanization Parameters as an Order-

As per census of India 2011, Ashoknagar-Kalyangarh, Habra, Gobardanga, Barasat and Madhyamgram Municipality were considered for calculating the urbanization parameters at municipality level.

Entropy calculation for determining weight value-

Table.1 Entropy and weight value calculation for municipality using equation (2), (3) and (4).

Table.1. depicts the calculation of entropy and weight value using equation (2), (3) and (4). On the basis of the outcome, Ideal best and Ideal Worst were generated to estimate the Euclidean distance for performance score calculation. Finally, the urbanization level ranks were deliberated for municipalities as presented in **Table.2**.

Level of Urbanization Score calculation using Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) model-

Table.2. Performance Score of Urbanization Levelcalculation for municipalityusing equation (7), (8) and (9)

Figure.3 Level of Urban Development at Municipality Level.

Figure.3reveals the urbanization status of the study area at the municipality level based on census of India, 2011. In this context, maximum urbanization has been observed at Barasat Municipality whereas lower urbanization level has been noticed at Gobardanga Municipality. At the same time, Madhyamgram Municipality, Ashoknagar-Kalyangarh Municipality and Habra Municipality were placed at 2nd, 3rd and 4th positions in the corresponding spectrum.

It can be said that as Barasat and Madhyamgram municipality are under the coverage of Kolkata Metropolitan Development Authority, it boosts the respective municipalities to gain higher level of urbanization.

During investigation, census towns of Barasat –I, Barasat-II, Habra-I, Habra-II, Amdanga and Deganga Blocks have also been assessed using the same calculation at census town level to identify the nature of urbanization.

Calculation of Urbanization Parameters as an Order-

Similarly, Nebadhai Duttapukur, Chandrapur, Joypul, Shibalaya, Digha, Kulberia, Bamangachhi, Chak Barbaria, Koyra, Chatta Baria, Kokapur and Gangapur of Barasat-I Block, Deara (Barasat-II Block), Nokpul, Anarbaria, Betpuli, Purbba Narayanpur, Sadpur and Maslandapur (Habra-I Block), Guma, Bira, Bara Bamonia and Khorddabamonia (Habra-II Block), Dhania (Amdanga Block) and Deulia of Deganga block were considered for calculating the desired parameters for the census towns based on census of India 2011.

Entropy calculation for determining weight value-

Table.3. Entropy and weight value calculation for census towns using equation (2), (3) and (4).

Level of Urbanization Score calculation using Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) model-

Table.4. Performance Score of Urbanization Levelcalculation for census towns using equation (7), (8) and (9).

Figure.4 Level of Urban Development at Census Town Level.

Finally, the census towns were ranked as per their urbanization level as shown in **Table.4** aftercalculating the entropy and weight value (**Table.3)**. **Figure.4** depicts that Nebadhai-Duttapukur, the highly populated and heart of Barasat-I Block was found at Rank-1 position and Nokpul of Habra-I Block was ranked at low level of urban development. The remaining urbanization status of census towns discloses that Dhania of Amdanga Block possessed Rank-2 position whereasKhordabamonia (Habra-II) and Sadpur (Habra-I) attained a remarkable level of urbanizationafter Kokapur of Barasat-I block. Moreover, a decent urbanization level was observed throughout the census towns of Barasat-I Block.

In this paper, spatial interaction of the central places or municipalities have been assessed to analyse the possible foundation of such urbanization pattern and it has been calculated for Barasat, Madhyamgram, Habra, Ashoknagar-Kalyangarh and Gobardanga municipality using modified gravitational law.The area with high score defines the higher attraction area of the corresponding municipality where maximum movement of population as well as services took places over the period of time.Spatial interaction

basically described the flow of population, goods or information between two places. Moreover, it highlighted the basic scenario of societal interaction based on the connectivity of transport network.In this context, the transport network was generated by digitizing the roads from the Google Earth imagery.

Conclusion

After proximal analysis of the estimated spatial interaction score, finally the sphere of influence were demarcated for the municipalities of the study area(as presented in **Figure.5**) along with urbanization level score of the census towns.**Figure.5** illustrates that the census towns located nearer to the Barasat Municipality, possessed higher to moderate urbanization score due to the superior level of connectivity with other municipalities. The census towns of these area are under the dominance of Barasat and Madhyamgram Municipality as well as under the coverage of Kolkata Metropolitan Development Authority (KMDA).

Hence, the locations of Nebadhai Duttapukur, Kokapur, Digha, Chatta Baria, Bamangachhi and Shibalaya in Barasat-I Block contained a notable level of urbanization. Similarly, Khordabamonia of Habra-II block and Sadpur, Maslandpur as well as Purba Narayanpur of Habra-I block are also associated with remarkable level of urban development by securing the performance score between 0.650 and 0.336.

Figure.5 Sphere of Influence of Municipality

It has been noticed that the location of Nebadhai Duttapukur or most popular census town “Duttapukur”, is not only under the dominance ofBarasat municipality;dominance of Madhyamgram, Ashoknagar-Kalyangarh, Habra and Gobardanga Municipality also has been observed for the same. Under this circumstances, it can be concluded that the domination of all municipalities of the study area influenced the corresponding census town to achieve the highest urbanization score (0.650).Likewise, a higher rate of urbanization (0.560) also been detected at Dhania of Amdanga block i.e.associated with a well-connected transport network and dominated by Ashoknagar-Kalyangarh, Habra and Gobardanga Municipality within the study area.

Acknowledgements

Bureau of Applied Statistics and Economics, Govt. of West Bengal, OpenStreetMap (OSM) and Google Earth Pro technology are highly appreciated for this research work and we wish to thank Department of Earth Sciences and Remote Sensing, JIS University technological support.

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TABLES-

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Table.1 Entropy and weight value calculation for municipality using equation (2), (3) and (4)

Criteria	% Of Urban Area (Ua)	% Of Urban Population (Up)	Urban Population Density (Upd In Sq. Km)	Urban Spacing (Us)	% Of Urban Households (Uh)	% Of Urban Households Availing Banking Facility	% Of Urban Households Having Electricity	% Of Urban Households Having Separate Kitchen Within The House	% Of Urban Households Having Bathroom
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
$\Sigma^{m}_{i=1} r_{ij} * \ln r_{ij}$	-1.554	-1.513	-1.562	-1.582	-1.519	-1.607	-1.608	-1.609	-1.590
Entropy (e_j)	0.965	0.940	0.971	0.983	0.944	0.998	0.999	1.000	0.988
Degree of Diversification (d_j)	0.035	0.060	0.029	0.017	0.056	0.002	0.001	0.000	0.012
Weight (w_j)	0.108	0.186	0.091	0.054	0.174	0.005	0.003	0.001	0.037

Continued…..

Criteria	% Of Urban Households Having Latrine Facility	% Of Urban Households Having Closed Drainage Connectivity	% Of Urban Households Having Drinking Water Within The Premises	% Of Urban Households Having Lpg For Cooking	General Literacy Rate (Glr In %)	Female Literacy Rate (Flr In %)	Summation (Σ)
	10	*11*	*12*	*13*	*14*	*15*	
$\Sigma^{m}_{i=1} r_{ij} * \ln r_{ij}$	-1.609	-1.557	-1.598	-1.590	-1.516	-1.609	
Entropy (e_j)	1.000	0.968	0.993	0.988	0.942	1.000	
Degree of Diversification (d_j)	0.000	0.032	0.007	0.012	0.058	0.000	0.322
Weight (w_j)	0.000	0.101	0.023	0.037	0.181	0.000	1.000

Source: Computed by the author.

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Table.2. Performance Score of Urbanization Level calculation for municipality using equation (7), (8), (9)

SL NO.	CD Block	Municipality	S_i^+ (Euclidean Distance from Ideal Best)	S_i^- (Euclidean Distance from Ideal Worst)	$(S_i^+ + S_i^-)$	Performance Score $(S_i^- /(S_i^+ + S_i^-))$	RANK
1	Barasat-I	Barasat	0.021	0.146	0.167	0.874	1
2	Barasat-I	Madhyamgram	0.039	0.152	0.191	0.796	2
3	Habra-I	Ashoknagar-Kalyangarh	0.085	0.089	0.173	0.511	3
4	Habra-I	Habra	0.253	0.094	0.346	0.271	4
5	Habra-I	Gobardanga	0.158	0.025	0.183	0.136	5

Source: Computed by the author.

Table.3. Entropy and weight value calculation for census towns using equation (2), (3) and (4)

Criteria	% Of Urban Area	% Of Urban Population	Urban Population Density (In Sq. Km)	Urban Spacing	% Of Urban Households	% Of Urban Households Availing Banking Facility	% Of Urban Households Having Electricity	% Of Urban Households Having Separate Kitchen Within the House	% Of Urban Households Having Bathroom
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
$\Sigma^m_{i=1} r_{ij} * \ln r_{ij}$	-3.065	-2.337	-2.556	-3.198	-3.132	-2.553	-2.548	-2.575	-2.509
Entropy (e_j)	0.952	0.726	0.794	0.993	0.973	0.793	0.791	0.800	0.779
Degree of Diversification (d_j)	0.048	0.274	0.206	0.007	0.027	0.207	0.209	0.200	0.221
Weight (w_j)	0.017	0.095	0.071	0.002	0.009	0.072	0.072	0.069	0.077

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Criteria	**% Of Urban Households Having Latrine Facility**	**% Of Urban Households Having Closed Drainage Connectivity**	**% Of Urban Households Having Drinking Water Within The Premises**	**% Of Urban Households Having Lpg For Cooking**	**General Literacy Rate (Glr In %)**	**Female Literacy Rate (Flr In %)**	**Summation (Σ)**
	10	***11***	***12***	***13***	***14***	***15***	
$\Sigma^{m}_{i=1} r_{ij} * \ln r_{ij}$	**-2.617**	**-2.200**	**-2.546**	**-2.259**	**-2.322**	**-2.596**	
Entropy (e_j)	**0.813**	**0.683**	**0.791**	**0.702**	**0.721**	**0.806**	
Degree of Diversification (d_j)	**0.187**	**0.317**	**0.209**	**0.298**	**0.279**	**0.194**	**2.883**
Weight (w_j)	**0.065**	**0.110**	**0.072**	**0.103**	**0.097**	**0.067**	**1.00**

Source: Computed by the author.

Journal of Interdisciplinary and Multidisciplinary Research (JIMR)
E-ISSN:1936-6264| Impact Factor: 8.886| UGC CARE II
Vol. 19 Issue 08, Aug- 2024
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Table.4. Performance Score of Urbanization Level calculation for census towns using equation (7), (8) and (9).

Sl No.	CD Block	Census Town	Si^+ (Euclidean Distance From Ideal Best)	Si^- (Euclidean Distance From Ideal Worst)	$(Si^+ + Si^-)$	Performance Score ($S_i^-/(S_i^+ + S_i^-)$)	RANK
1	Barasat I	NebadhaiDuttapukur	0.042	0.078	0.121	0.650	1
2	Amdanga	Dhania	0.079	0.101	0.181	0.560	2
3	Barasat I	Kokapur	0.069	0.059	0.128	0.460	3
4	Habra II	Khorddabamonia	0.089	0.056	0.145	0.387	4
5	Habra I	Sadpur	0.064	0.038	0.101	0.370	5
6	Barasat I	Digha	0.069	0.039	0.108	0.361	6
7	Barasat I	ChattaBaria	0.082	0.046	0.128	0.359	7
8	Barasat I	Bamangachhi	0.073	0.040	0.114	0.356	8
9	Habra I	Maslandapur	0.068	0.037	0.104	0.350	9
10	Habra I	PurbbaNarayanpur	0.083	0.044	0.127	0.348	10
11	Barasat I	Shibalaya	0.080	0.040	0.120	0.336	11
12	Barasat I	Kulberia	0.074	0.036	0.110	0.330	12
13	Habra II	Guma	0.072	0.035	0.107	0.329	13
14	Barasat I	Gangapur	0.065	0.031	0.096	0.326	14
15	Habra II	Bira	0.071	0.033	0.104	0.317	15
16	Barasat I	Chandrapur	0.059	0.027	0.086	0.313	16
17	Barasat II	Deara	0.076	0.030	0.106	0.284	17
18	Deganga	Deulia	0.070	0.027	0.097	0.279	18
19	Barasat I	Joypul	0.082	0.031	0.114	0.277	19
20	Barasat I	Koyra	0.081	0.024	0.105	0.231	20
21	Habra I	Betpuli	0.080	0.023	0.104	0.226	21
22	Barasat I	ChakBarbaria	0.084	0.024	0.109	0.224	22
23	Habra I	Anarbaria	0.095	0.026	0.120	0.214	23
24	Habra II	Bara Bamonia	0.073	0.017	0.090	0.191	24
25	Habra I	Nokpul	0.075	0.011	0.086	0.123	25

Source: Computed by the author.

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FIGURES-

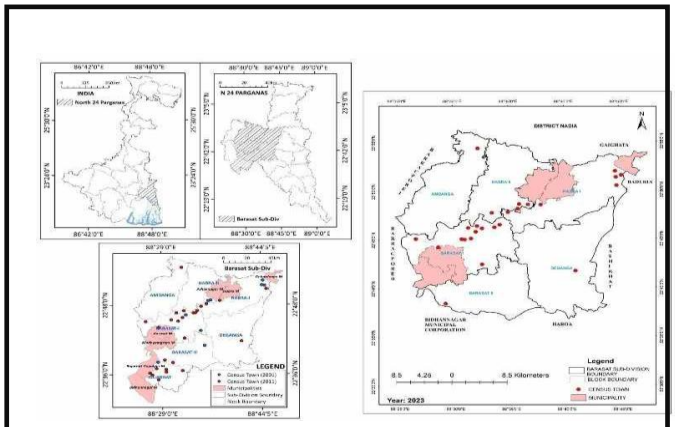

Figure.1. Location Map

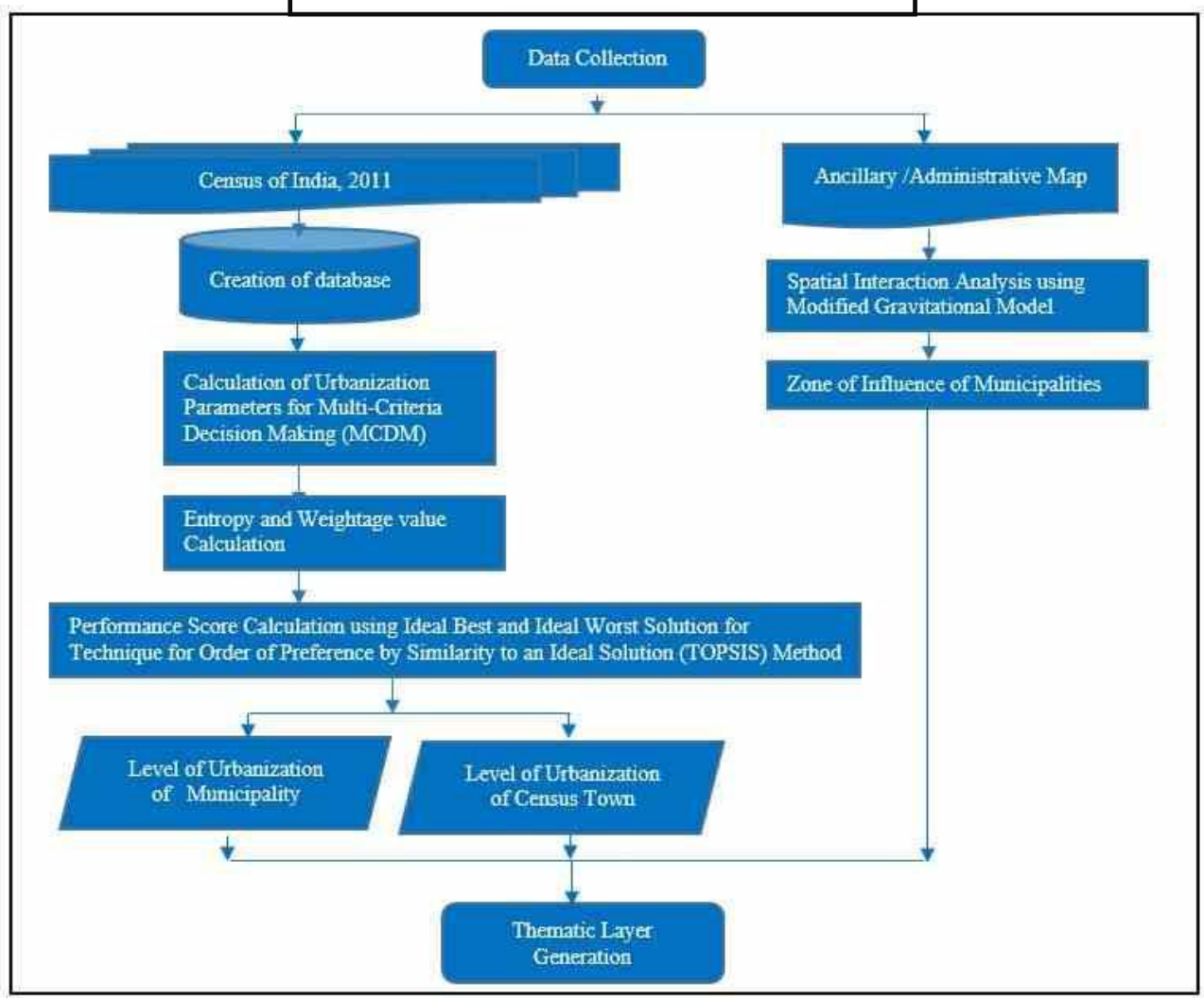

Figure.2. Schematic Diagram of Procedures

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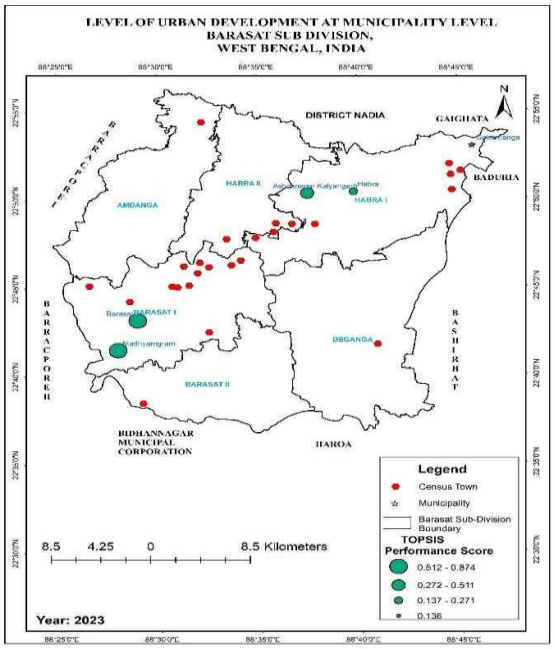
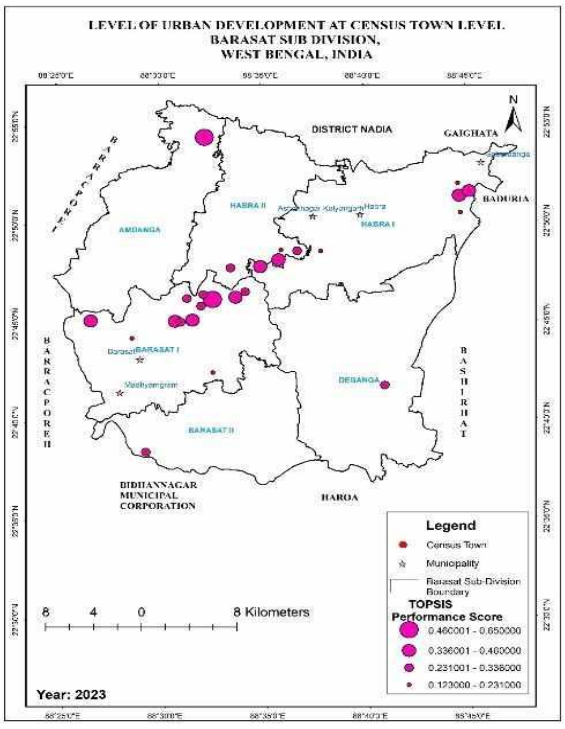


Figure.3 Level of Urban Development at Municipality Level



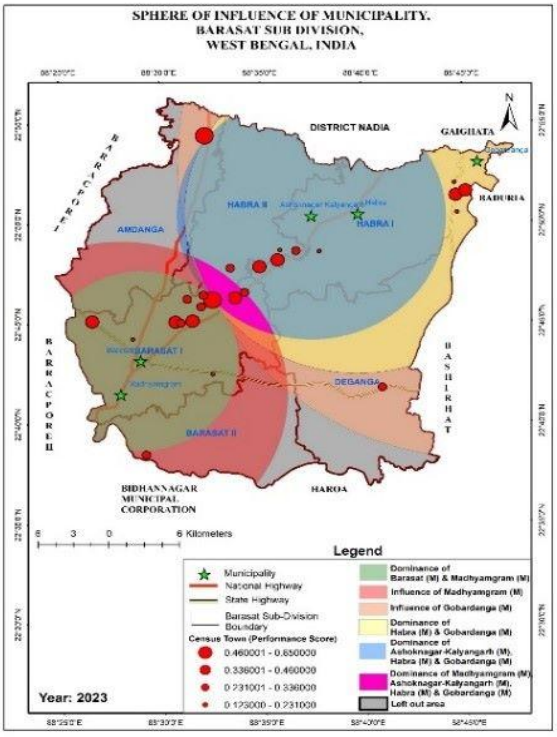


Figure.4 Level of Urban Development at Census Town Level Figure.5 Sphere of Influence of Municipality