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GIS BASED GEOSPATIALANALYSIS OF URBAN CENTERS IN ROHILKHAND ZONE OF UTTAR PRADESH

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Abstract

The objective of this paper was to study the spatial pattern of urban centres and spatial variation in their GDP per capita in the Rohilkhand zone of Uttar Pradesh. To meet the objectives the data of the urban centres was collected from European commission's JRC Publications Repository. The Average Nearest Neighbor tool was used to measure the spatial pattern of the urban centres. To analyse the spatial variation in GDP per capita of the urban centres GDP/capita data of the year 2015 was used. The spatial variation in GDP/capita was analysed with the help of hot spot analysis tool of the ArcGIS platform.The results shows that the Spatial Pattern of the Urban Centres in the Rohilkhand zone is dispersed. The obtained z-score of 2.52 indicate that there is less than 5% likelihood that this dispersed pattern could be the result of random chance. The hot spots of high GDP per capita were found as 04, 08 & 04 respectively at the confidence level of 99%, 95% & 90%. The findings of the work will help the policy makers to develop the programmes to minimise the problem of the poverty in the underdeveloped urban centres.

***Keywords**: Urbanisation, NNR, Geostatistical analysis, Hot Spot Analysis.*

1. Introduction

Urban areas are integral to India's growth and development, accounting for around two-thirds of the country's GDP (Ahluwalia et.al, 2014).

According to the 2011 Census, urbanisation has increased faster than expected. This has reversed the declining trend in the growth rate of the urban population observed during the 1980s and 1990s (Bhagat, 2011).

The relatively poorer states have urbanised faster than the old industrially advanced states like West Bengal, Tamil Nadu and Maharashtra. There are diversities within the large poor states such as UP, Bihar and Madhya Pradesh. The sub-regions with heavy industrial

investments such as southern Bihar and eastern Madhya Pradesh show very high urban growth rates and correspondingly low rural growth rates. Agriculturally stagnating regions like eastern UP and northern Bihar in the northern Gangetic Plain also show high rates of urban growth but along with relatively high rural growth rates as well (Mohan, 1982).

Uttar Pradesh, the most populous state in India falls amongst the states experiencing moderate urban growth but quantum jump in the emergence of census towns, as per census 2011 (Singh, 2011).

Urbanization is arguably the most dramatic form of land transformation that profoundly influences biological diversity and human life. Quantifying landscape pattern and its change is essential for the monitoring and assessment of ecological consequences of urbanization (Luck & Wu, 2002).

Urbanisation has been studied by many scholars from distinguished fields as Urban sprawl: metrics, dynamics and modelling using GIS was studied by Sudhir et.al.. Their study attempts to describe some of the landscape metrics required for quantifying sprawl. For understanding and modelling this dynamic phenomenon, prominent causative factors are considered (Sudhira, Ramachandra, & Jagadish, 2004).

Spatial pattern of urban functional landscapes along an urban–rural gradient was studied by (Lin et al., 2015). This is the fact that Urbanisation is a dynamic complex phenomenon involving large scale changes in the land uses at local levels. Analyses of changes in land uses in urban environments provide a historical perspective of land use and give an opportunity to assess the spatial patterns, correlation, trends, rate and impacts of the change, which would help in better regional planning and good governance of the region (TV, Aithal, & Sanna, 2012).

In this work an attempt is made to study the spatial pattern of the urban centres using ArcGIS. To study the spatial variation in human development in these centers GDP per capita data was used.

It was significant to study because, the same topic has not been studied widely by geospatial experts in this region. The findings of the work will help the policy makers to develop the programmes to minimise the problem of the poverty in the underdeveloped urban centres.

2. Materials and methods

2.1 Study Area

Uttar Pradesh, the most populous and fourth largest state of India. It lies in the north-central part of the country (Mathur, 2015). Uttar Pradesh regional state of India was chosen as a

study area, it extends between latitudes 23°51'30.454"N and 30°24'44.389"Nand longitudes 77°9'14.694"E and 84°39'28.416"E(Fig. 1).It with a total area of 243,290 square kilometres is India's fourth-largest state in terms of land area. Uttar Pradesh with a population of more than 166 million holds distinction of being the most populous state in the country followed by Maharastra (97 million) and Bihar (83 million). ("Census of India" 2015). The study area is highlighted in the map of the Uttar Pradesh.

2.2 Data used

2.2.1 District Boundaries

Information on district boundaries was collected from official website of Indian Geo Plateform of IISRO, National Remote Sensing Center, Government of India (https://bhuvan.nrsc.gov.in/bhuvan_links.php#)

2.2.2Urban Center Data

For urban centres, the geospatial dataset was collected from https://publications.jrc.ec.europa.eu/repository/handle/JRC115586?mode=full(European Commission, 2015).

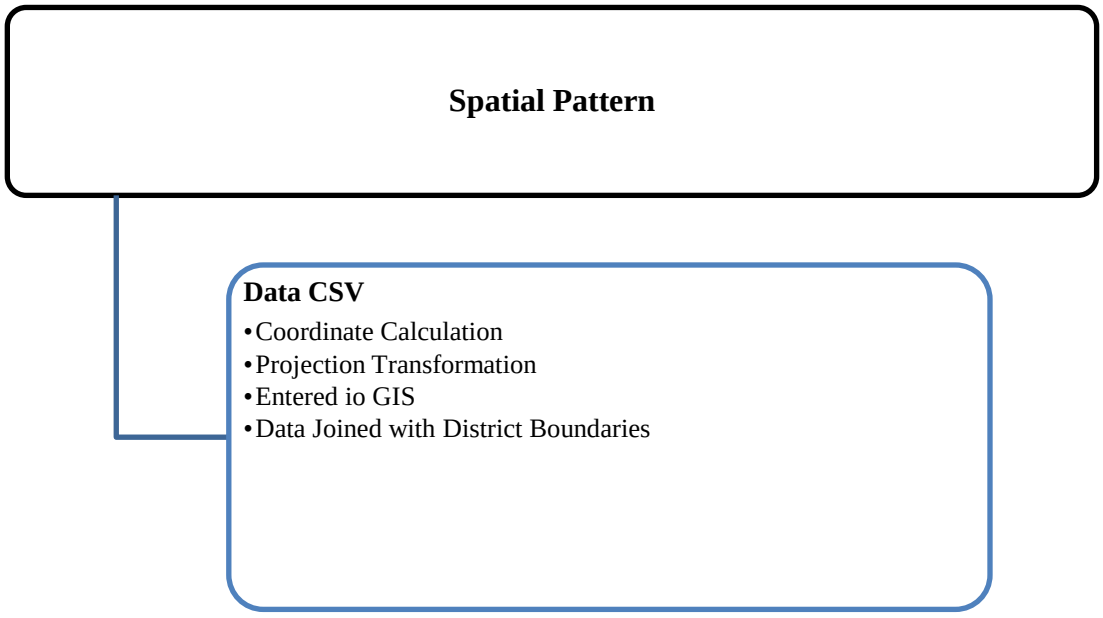

Fig. 2 the flowchart of the used methodology in the study area

2.3 Data Analysis

2.3.1 Spatial Pattern

The Average Nearest Neighbor tool measures the distance between each feature centroid and its nearest neighbor's centroid location. It then averages all these nearest neighbor distances. If the average distance is less than the average for a hypothetical random distribution, the distribution of the features being analysed is considered clustered. If the average distance is greater than a hypothetical random distribution, the features are considered dispersed. The average nearest neighbour ratio is calculated as the observed average distance divided by the expected average distance(ArcGIS, 2015).

The Average Nearest Neighbor ratio is given as:

ANN=$\overline{D}_o / \overline{D}_E$…….. (1)

Where,$\overline{D}_o$is the observed mean distance between each feature and its nearest neighbour.

$\overline{D}_o = \frac{\sum_{i=1}^{n} d_i}{n}$……..(2)

$\overline{D}_E$is the expected mean distance for the features given in a random pattern:

$\overline{D}_E = \frac{0.5}{\sqrt{n/A}}$……..(3)

In the above equationsdi equals the distance between features i and its nearest neighbouringfeature n corresponds to the total number of features, and A is the area of a minimum encloserectangle around all features, orit's a user-specified area valued as

z = $\frac{\overline{D}_o - \overline{D}_E}{SE}$……..(4)

SE = $\frac{0.26136}{\sqrt{n^2/A}}$……..(5)

2.3.2Hotspot analysis

Getis-Ord Gi* statistic was used to identify hot spots.The Getis-Ord local statistics is given as follows:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{ij}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \quad (7)$$

Where $x_j$is the attribute value for feature *j*. $w_{ij}$is the spatial weight between feature *i* and *j*. *n* is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (8)$$

$$z_I = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n}} - (\bar{X})^2 \qquad (9)$$

Getis-Ord statistic is a z-score so no further calculations are required(Manepalli et.al, 2011,).

3.Results

3.1. Spatial Pattern of the Urban Centres

The Spatial Pattern of the Urban Centres in the Rohilkhand zone is dispersed. The obtained z-score of 2.52 indicate that there is less than 5% likelihood that this dispersed pattern could be the result of random chance (Figure3).

Table 1 Nearest neighbour analysis results

Observed Mean Distance:	11573.8620 Meters
Expected Mean Distance:	10114.5638 Meters
Nearest Neighbor Ratio:	1.144277
z-score:	2.529691
p-value:	0.011416

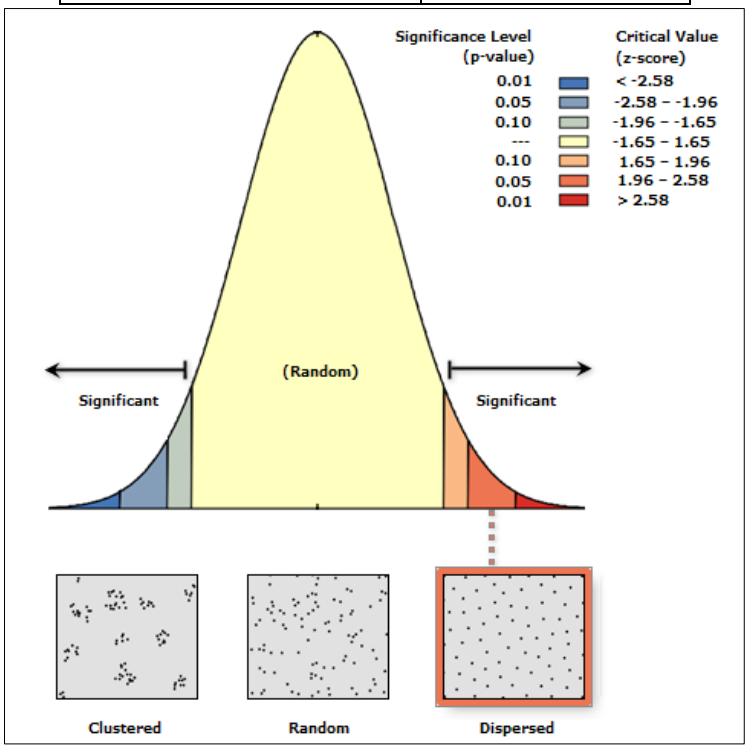

Fig. 3Spatial Pattern of Urban Centers

3.2. Hot and cold spots in term of GDP per capita

Figure 4 shows the hot and the cold spots of the urban centres in terms of GDP per capita.

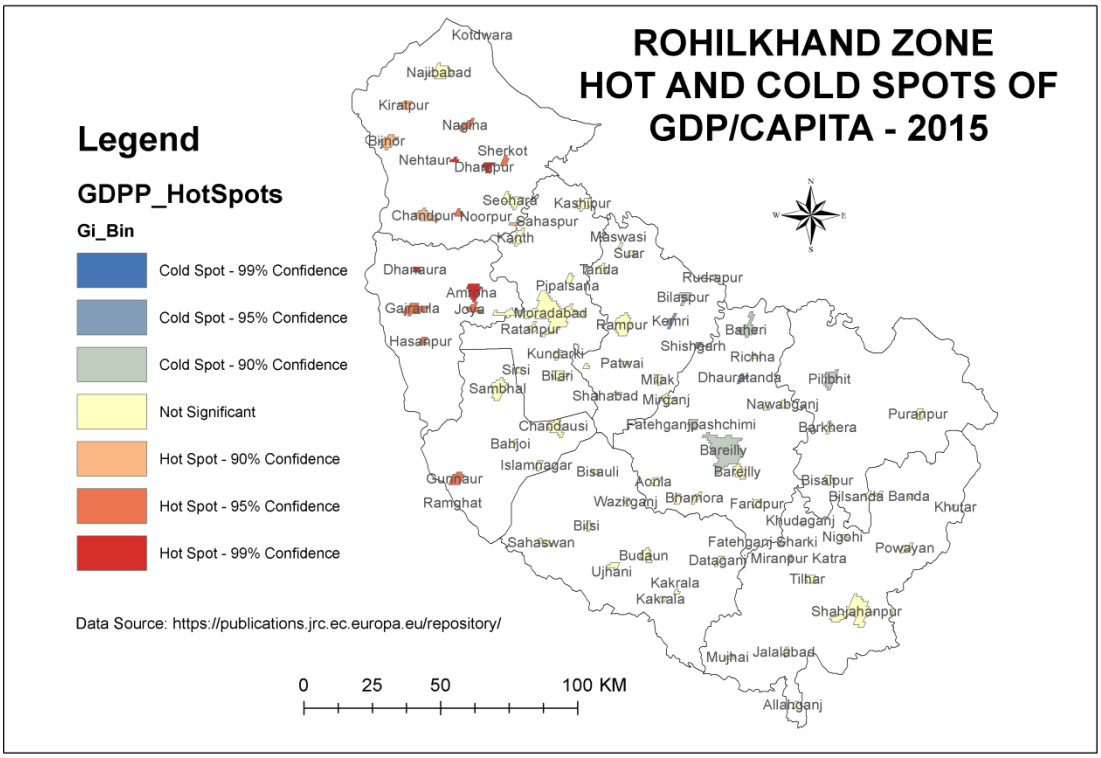

Fig. 4Hot and Cold Spots

Hot Spotsat 99% Confidence level

The urban centres identified as Hot Spots at 99% Confidence level are as Amroha, Dhampur, Dhanaura and Nehtaur.

Hot Spotsat 95% Confidence level

The urban centres identified as Hot Spots at 95% Confidence level are as Bisalpur, Faridpur, Gajraula, Hasanpur, Joya, Nagina, Noorpur and Sherkot.

Hot Spotsat 90% Confidence level

The urban centres identified as Hot Spots at 90% Confidence level are as Bijnor, Chandpur, Kiratpur and Sahaspur.

Cold Spotsat 95% Confidence level

The urban centres identified as Cold Spots at 95% Confidence level are as Dhauratanda, Kemri and Shishgarh.

Cold Spotsat 90% Confidence level

The urban centres identified as Cold Spots at 90% Confidence level are as Baheri, Bilaspur, Islamnagar, Nigohi, Pilibhit and Puranpur.

4. Discussion

The major findings of this study are first there ismore hot spots around the national capital region of India. Those urban centres which have low accessibility are under the cold spots. The findings of the work will help the policy makers to develop the programmes to minimise the problem of the poverty in the underdeveloped urban centres.

Conclusion

The major research question answered in the present work was to find the spatial and temporal variability in term of urban centres in the Rohilkhand region of Uttar Pradesh. The research explored the potential use of spatial statistics tool provided by ArcGIS platform for geospatial analysis. The findings will be helpful for all stockholders working to minimise the poverty problem in urban areas.

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Conflict of interest

The authors declare no competing financial interests.

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