

Spatial Analysis of Settlements

(A Case Study of Pratapgarh District, Rajasthan)

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Abstract

The spatial analysis of settlement has an essential place in recent geographical studies. The study mainly relates to the network of locational arrangement of settlements and their interlinkage with each other. The evolution of settlement patterns in an area is governed by the number of factors, i.e. physical, cultural, etc., and hence, varied patterns in the spatial distribution of settlement are found. This paper includes various quantitative methods like Village Density Pattern, Lorenz Curve, Nearest Neighbour Analysis, and Quadrat Analysis. Two types of settlements are found in this district: Low Spacing area and Moderate Spacing area. In normal cases of Lorenz curve technique, more concentration is mainly found in and around the city center, and concentration continuously decreases as we go away from the city center. But in this case of the above research of Pratapgarh district, the situation is totally reverted. It is noticed that except for the North-western plain, the NNA value of 2 is significant at a 1 percent level of significance in all other regions. Thus there is uniformity in the distribution pattern all over the district except in the North-western plain. The district has a larger number of middle-sized villages (population up to 1000) than any other category. It may also be seen that the highest number of villages are found in Pratapgarh tehsil and the lowest in Arnod.

Keywords: Settlement, Distribution, Spatial Analysis, Spatial Pattern, Nearest Neighbour Analysis.

Introduction

According to Professor J. Wreford Watson (1965), Geography has been recognized as the discipline in the distance. A similar view has also been expressed by Berry "Geography is only one of the disciplines concerned with the spatial distribution of phenomena" (1964). These phenomena can be physical, social, or economic such as distribution of natural resources, population, financial activities, etc. The locational arrangement of a region has its significance as they contribute a lot in forming the character of the areas and their development pattern. The study of distance implies inherently in all these phenomena of distribution, dispersion, and pattern and is very well realized in all geographical studies. It may clarify that spacing is only the transformation of the idea of distance and has a broader scope as it includes the interlinkages of various phenomena and factors governing their spatial arrangement in a region.

Review of Literature

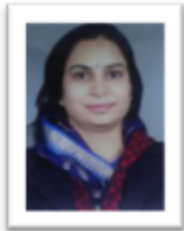
During the recent years quite a number of studies have been carried out regarding the distributional pattern of settlements in a region. The pioneering work in this direction was done by German Geographer, Christaller (1933), who suggested that settlement patterns follow a definite principle. There is a high degree of correlation between the size of the service centers. Matui a Japanese geographer, did good work on quantitative rural settlements geography in 1932. Some other geographers who also worked on this topic are Chambers, R. 2013, Michael, P. (Ed.), (2013), Mitchell, B. (1979), Sabins, F. (1978), Simons, I.G. (1981), Smith, R.W, Taeffe, E.J and King, L.J (1969), Webb, J.M. (1959). In India Despande, S.M. Ali, Ahmad, R.L. Singh, (1976), A.B. Mukerjee, (1970), Lahiri, (1971), Bhat, L.S. (1972), N. Thakur, Mandal, R.B. (1979), R.N. Mishra (1981), Kumar, A. (1986), Jain, P.C. (1989), Prachi Shastri, R.B. Mandal, (2001), Monika Roat, Roy, Dulal Chandra & Thomas, B. (2014), Sharma P.K. (2015), Kathaeina Henn (et.al.) 2020 and Michael P. (et.al) (2020) published good research work on a rural area in India. According to Donglass, the size and spacing of settlements depend upon three principle items: a) The agricultural prosperity, b) Surface configuration, and c) Historical habits.

Objectives of the Study

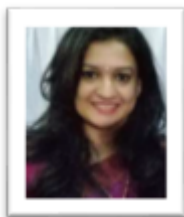
1. To study the spatial analysis of Tribes Settlements..
2. To identify the various aspects of tribal settlement pattern.

Study Area

Pratapgarh district came into existence on 26th January 2008 as the 33rd District of Rajasthan. It has been carved out from the districts Chittorgarh, Udaipur, and Banswara. Three tehsils of Chittorgarh, namely Pratapgarh, Chhoti Sadri, Arnod

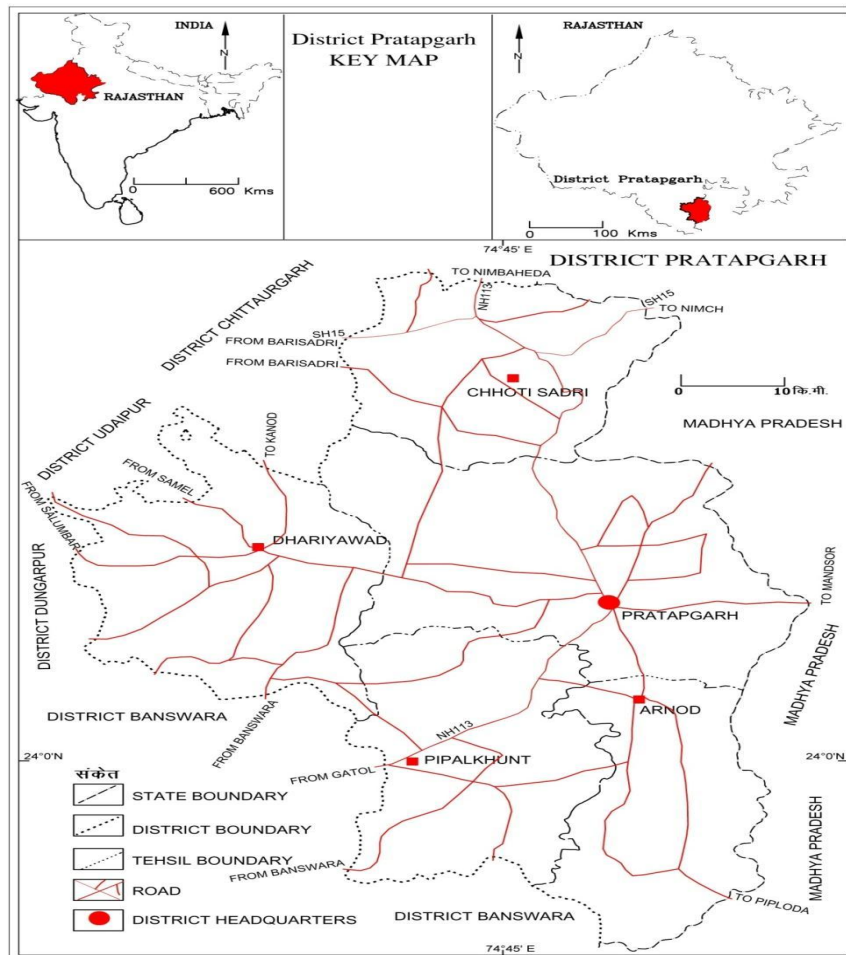


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and Dhariawad from Udaipur district, have been transferred to the new Pratapgarh district. Pratapgarh district is located in the southern part of Rajasthan, which has hilly and forest area, where rural settlement study is significant. It is bounded in the northwest by Chittorgarh district, in the west by Udaipur and Dungarpur districts, southwest by Banswara district, east, and southeast by the state of Madhya Pradesh. It stretches between 23° 31' 49" to 24° 30' 16" North latitude and 74° 13' 19" to 74° 58' 59" East longitude covering an area of 4,117sq km. There are five tehsils namely Chhoti Sadri, Pratapgarh, Arnod, Peepalkhunt and Dhariawad (Map no. 1).



Map No.: 1

Data Sources and Methodology

The whole paper is based on secondary sources of data. Among the available sources of settlements in Pratapgarh District, the census of India and toposheets are the most vital secondary data sources. An attempt has been made here to find out the actual status of the settlement pattern. Four techniques have been applied for the spatial analysis of settlements in the Pratapgarh district. They are Village Density Pattern, Lorenz Curve, Nearest Neighbour Analysis, Quadrat Analysis.

Discussion

In the present study, four methods have been used for spatial analysis of the settlements in the Pratapgarh district. These are as follows :

1. Village Density Pattern.
2. Lorenz Curve
3. Nearest Neighbour Analysis.
4. Quadrat Analysis.

Village Density Pattern

In a purely theoretical approach, the spatial pattern can be observed in terms of the density of rural settlements in relation to the area. In the case of Pratapgarh district there are 1008 villages in a total area of 4117 sq km. This gives an average of 4.08 sq km of area per village. If this method is applied to the different tehsils of the district, the results will be as follows :

Table No.1 Villages Density Pattern

| S.No | Name of Tehsils | Area in sq.kms | No. of settlements | Average area per village | Ranking |
|------|-----------------|----------------|--------------------|--------------------------|---------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | Dhariawad | 743.61 | 168 | 4.40 | II |
| 2. | Arnod | 655.72 | 181 | 3.56 | V |
| 3. | Chhoti Sadri | 709.99 | 155 | 4.53 | I |
| 4. | Peepalkhunt | 843.99 | 207 | 4.02 | III |
| 5. | Pratapgarh | 1,163.89 | 297 | 3.91 | IV |
| | Total | 4,117 | 1008 | | |

Source:- Computed by Scholar

From the above table, it is clear that the area per village is the highest in the Chhoti Sadri tehsil, which means that the villages in this area are placed far apart. The area per village is the lowest in the Arnod Tehsil, the intervening distance among the villages in the tehsil would be the lowest. Thus on this basis, the area is inversely related to the density of villages. In this way, the tehsils are ranked as given in Column no. 6.

In the method mentioned above only, the average area per village in the tehsil has been considered. But in the spatial studies, the intervening distance between the villages is significant as the densities of villages are inversely proportionate to the distances between villages. That is, the lesser the distance, the higher the density of villages and vice versa.

To obtain the linear distance between villages, the area per village is to be converted into the average size of a hexagon. The hexagon is the perfect form that covers the entire space in the district, and no intervening space is left out, as is the case with circles.

To obtain the distance between two villages (D), the average size of a hexagon may be obtained by dividing the total area of the region by the total number of villages in that region i.e.,

$D = \frac{A}{N}$. The same has been applied by Rana P.B. Singh in his study of "pattern analysis of rural settlement distribution and their types in Saran Plain, a quantitative approach."

The same formula is applied here in this for calculation of D in various tehsils of Pratapgarh district and the values of D have been worked out shown as below ;

Table No. 2 Spacing of rural settlements

| S.No | Tehsils | Area in sq. km. | No. of settlements | D |
|------|--------------|-----------------|--------------------|------|
| 1 | 2 | 3 | 4 | 5 |
| 1. | Dhariawad | 740.11 | 168 | 4.11 |
| 2. | Arnod | 645.72 | 181 | 3.33 |
| 3. | Chhoti Sadri | 703.99 | 155 | 4.23 |
| 4. | Peepalkhunt | 833.99 | 207 | 4.14 |
| 5. | Pratapgarh | 1163.89 | 297 | 3.65 |
| | Total | 4117 | 1008 | 4.08 |

Source:- Computed by Scholar

From this table, two types of spacing of settlements can be observed.

Low Spacing Areas

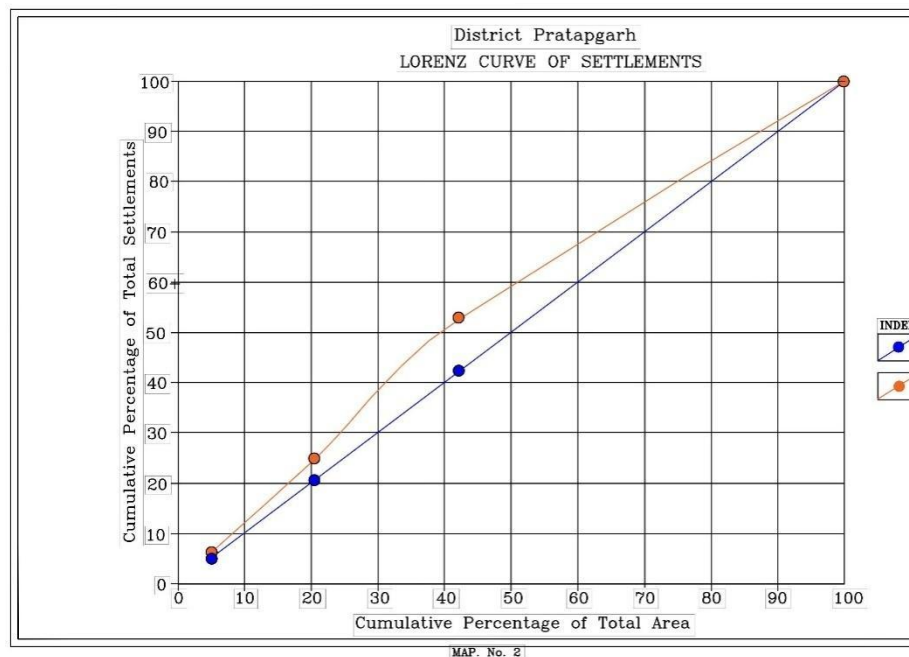
The spacing value is less than 2 km in the Dhariawad tehsil, which mostly consists of small size semi-compact settlements. The average population per village is less than 200 persons. The fertile land of Dhariawad tehsil has favored a more regular distribution pattern of settlement, and hence the spacing is closer.

Moderate Spacing Areas

In the rest of the Pratapgarh district i.e., in the Pratapgarh tehsil, the value of D lies between 2 and 3. Hence the settlement distribution in these areas can be taken as moderately spaced. The dominance of moderate spacing of settlements is obviously due to the underdeveloped tribal countryside associated with undulating terrain, forest patches, hillocks, etc. As the Plain region is often subjected to floods, the settlements developed on elevated grounds.

Lorenz Curve

The Lorenz Curve, first devised in 1905 by Max O. Lorenz, has long been used for measuring inequality in the distribution of wealth or income. It has also been used to depict the state of population concentration and for showing the concentration of settlements. It deals with the cumulative percentage distributions of the two attributes at a different point. The cumulative percentage of one variable up to certain points is plotted on a graph against the cumulative percentage of the other variable up to the same points. The different points so obtained are then joined by a smooth freehand curve. For comparison, a diagonal line is also drawn from the origin to the last point showing the line of equal distributions. The deviation of the curve from this diagonal shows the proportion to the level of inequality in the distribution of one attribute in relation to the other (Map No. 2).



Generally, two extremes are found through this curve. First, suppose the curve follows the diagonal. In that case, a uniform distribution of settlements may be observed. Second, if the curve coincides with the X or Y-axis, then the settlements are concentrated at a particular point in the given region. Between these two extremes, the degree of uneven distribution of settlements are depicted by the degree of departure of the curve from the diagonal.

In the present analysis, concentric circles at intervals of 10km have been drawn with Pratapgarh town as the center. Thus four circular zones have been identified according to the above radial distances. Two variables, namely the number of settlements in the zone and the zone area, have been considered. The results have been shown below.

Table No. 3 Showing concentration of settlements by Lorenz Curve

| Distance from city | Percent of total settlements | Cumulative percentage of settlements | Percentage of Area | Cumulative percentage of area |
|--------------------|------------------------------|--------------------------------------|--------------------|-------------------------------|
| Up to 10 | 04.07 | 04.07 | 5.23 | 5.23 |
| 10-20 | 14.42 | 18.49 | 16.72 | 21.95 |
| 20-30 | 21.87 | 40.36 | 28.92 | 50.87 |
| Above 30 | 59.64 | 100 | 49.13 | 100 |

Source:- Computed by Scholar

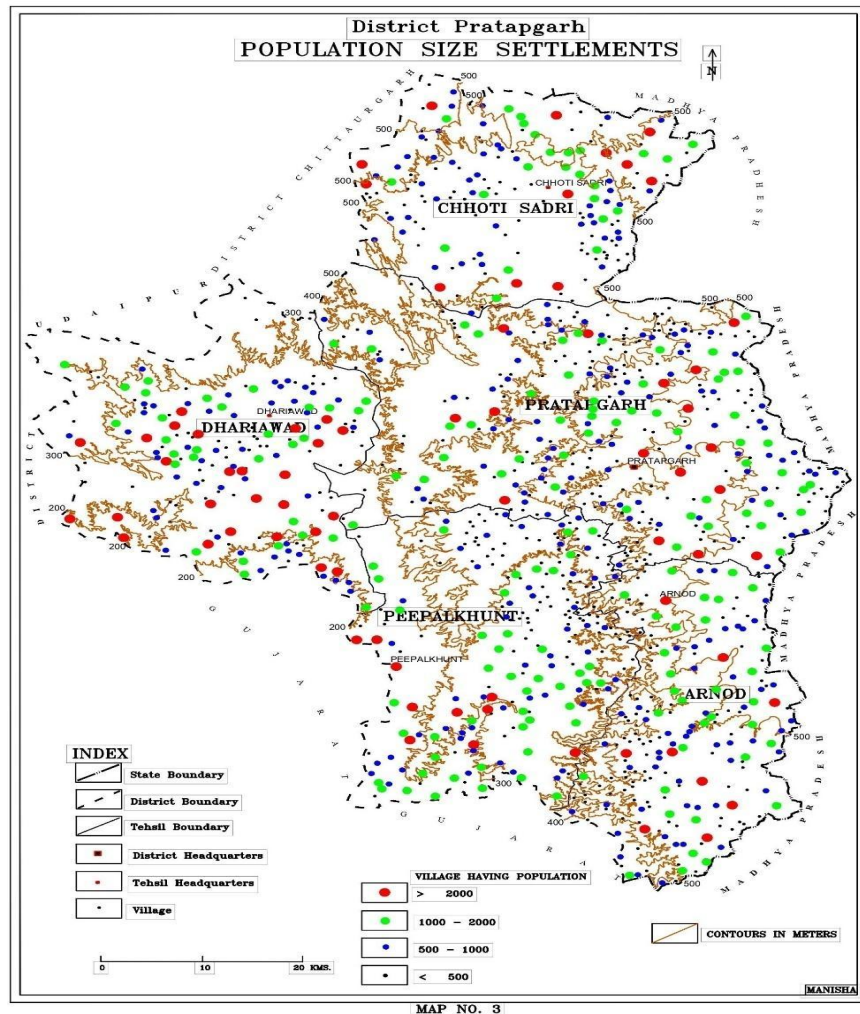
In normal cases of the Lorenz curve technique, more concentration is mainly found in and around the city center. Concentration continuously decreases

as we go away from the city center. But in the case of the above research of Pratapgarh district, the situation is totally reverted.

In Pratapgarh district, the concentration of settlements is in a revert situation from the normal condition. That's why less attention is found near the Pratapgarh city center, and similar conditions are found in the case of the second and third zones also. It indicates that in the Pratapgarh district, the settlements' main size is more than the number of settlements. So that in this case, when we take the number of settlements, the situation is found the reverse. The leading cause behind this fact is the nature of settlements in Pratapgarh district. Due to Pratapgarh tribal habitats situation, it reverted from the normal condition. In tribal habitats, settlements usually are not found in the city center. They are mainly associated with the distribution of natural resources like forests and water. That's why settlements develop near natural sites, which are mainly found far from the city center.

Nearest Neighbour Analysis

An attempt has been made to measure the degree of dispersion of the settlements in different tehsils of Pratapgarh district by the Nearest Neighbour Analysis. This analysis was initially developed by plant ecologists, Clark and Evans (1954), to measure the spatial relationship of various plant species. According to them, "Nearest Neighbour Analysis" indicates the degree to which any observed distribution of points deviates from what might be expected if the points were distributed randomly within the same area. A random distribution of points defined as a set of points on a given area which any point or any sub area of specified size has had the same chance of receiving a point as any other sub area of that size, and the placement of each point has not been influenced by that of any other point (Map No.3).



This method is now extensively used for determining the distribution pattern of the settlements in the district. In this technique, we measure the distance

from an individual point to its nearest neighbor irrespective of direction. Generally, the settlements are not always evenly spaced in a strictly random manner. Complete randomness is hardly found because several geographical factors disturb the uniform pattern. The greater the diversity amongst different characteristics in a different part of the region, the higher the variation in the distribution of settlements.

This method defines quantitatively a scale that measures the degree of departure of an observed from a theoretical random distribution. The scale used in this analysis is known as Nearest Neighbour Scale: known as Rn Scale.

Rn value can be calculated by the following formula:

$$Rn = \frac{r\bar{o}}{r\bar{e}}$$

Where Rn = Nearest Neighbour Statistic for measuring the degree of randomness.

r̄o = Observed mean distance of existing pan.

r̄e = Expected mean distance if points were distributed at random.

Further $r\bar{o} = \frac{\sum d}{N}$

Where d = the distance of a settlement from its nearest neighbor.

N = the total number of settlements.

Further $r\bar{e} = \frac{1}{2\sqrt{N/A}}$

N = the total number of settlements.

A = the total area under study.

As suggested by Clark and Evans the value of Rn values from zero to 2.15.

Show the nature of the distribution of settlements in a given space. Observed distances have been measured from Map No. 3.

0.0 - 0.09 - Absolute concentration.

0.1 - 0.50 - High concentration.

0.51 - 0.99 - Clustered pattern.

1.00 - 1.19 - Random pattern.

1.20 - 1.49 - Approaching uniform.

1.50 - 2.14 - Dispersed pattern.

> 2.14 - Perfect hexagonal.

Table No.4 Nearest Neighbour Analysis score of Settlements having Population > 2000

| Tehsil | Rn Value | V Score | Di Score | Z Score |
|--------------|----------|---------|----------|---------|
| Chhoti Sadri | 1.34 | 4.03 | 37.05 | 0.57 |
| Pratapgarh | 1.24 | 5.27 | 44.00 | 1.91 |
| Arnod | 1.21 | 7.61 | 63.76 | 1.86 |
| Peepalkhunt | 0.78 | 6.23 | 1.74 | 1.28 |
| Dhariawad | 1.14 | 1.95 | 15.27 | 0.63 |

Source:- Computed by Scholar

When we compare the Rn values of five tehsils of Pratapgarh district, the results come out the settlements having population more than 2000 Peepalkhunt tehsil have Clustered pattern and Dhariawad tehsil come under Random pattern. Rest three tehsils have Approaching Uniform pattern. There is not any drastic change in the pattern. When Rn value is crossed, check with the Z score value, the result comes the same.

Table No. 5 Nearest Neighbour Analysis score of Settlements having Population 1000-2000

| Tehsil | Rn Value | V Score | Di Score | Z Score |
|--------------|----------|---------|----------|---------|
| Chhoti Sadri | 1.15 | 1.91 | 16.05 | 1.61 |
| Pratapgarh | 1.14 | 1.59 | 13.38 | 2.17 |
| Arnod | 1.34 | 1.39 | 12.96 | 3.95 |
| Peepalkhunt | 1.24 | 1.28 | 10.57 | 3.11 |
| Dhariawad | 1.08 | 1.71 | 12.60 | 0.91 |

Source:- Computed by Scholar

In the Pratapgarh district, the villages with a population from 1000 to 2000 have two settlement patterns. The Chhoti Sadri, Pratapgarh, and Dhariawad tehsils have Random patterns, and Arnod and Peepalkhunt tehsils come under the Approaching Uniform pattern. If Rn values compare with Z Score, Di value and V values results come approximately the same.

Table No. 6 Nearest Neighbour Analysis score of Settlements having Population 500-1000

| Tehsil | Rn Value | V Score | Di Score | Z Score |
|--------------|----------|---------|----------|---------|
| Chhoti Sadri | 1.11 | 1.08 | 8.24 | 1.46 |
| Pratapgarh | 1.17 | 1.02 | 2.94 | 2.98 |
| Arnod | 1.16 | 0.86 | 6.83 | 2.36 |
| Peepalkhunt | 1.10 | 1.06 | 8.44 | 0.11 |
| Dhariawad | 1.11 | 1.07 | 8.14 | 1.57 |

Source:- Computed by Scholar

The above table reveals that uniformity of Rn value is found in all tehsils of Pratapgarh district. The settlements having a population from 500 to 1000 come under a Random pattern. To verify the above mentioned value of Rn is also supported by the Z score value.

Table No.7 Nearest Neighbour Analysis score of Settlements having Population < 500

| Tehsil | Rn Value | V Score | DI Score | Z Score |
|--------------|----------|---------|----------|---------|
| Chhoti Sadri | 0.99 | 0.68 | 4.50 | 10.53 |
| Pratapgarh | 0.96 | 0.53 | 3.52 | 0.84 |
| Arnod | 1.03 | 0.52 | 3.64 | 0.38 |
| Peepalkhunt | 0.80 | 0.55 | 3.05 | 3.83 |
| Dhariawad | 0.90 | 0.83 | 5.14 | 1.45 |

Source:- Computed by Scholar

The Arnod tehsil has a 1.03 Rn value which goes with the Random pattern. Otherwise, all other four tehsils have Rn values from 0.80 to 0.99. It means that the settlements that have a population of less than 500 have clustered pattern. Therefore, From the above-mentioned table and text, it is clear that all settlements in Pratapgarh district have the same pattern with minor Rn value differences.

To test the validity of the above result, the Rn values in different regions have been further testified by using a standard curve and testing the hypothesis. In a normal random distribution pattern, the difference between the observed mean value and the expected mean value is significant, but in the case where the difference is significant, the value deviates from random, and the distribution pattern is subject to chance factor. Clark and Evans also used this test of significance for measuring the departure of $r\bar{o}$ and $r\bar{e}$ from the normal curve.

The statistic Z can be given in the formula: $Z = \frac{r\bar{o} - r\bar{e}}{\sigma r\bar{e}}$

Where $\sigma r\bar{e}$ is the standard error and can be calculated by the following formula

$$\sigma r\bar{e} = \frac{0.26136}{N/A}$$

Where N = denotes the number of total villages in the region.

A = the total area of the study region.

The value of Z obtained from the analysis has been shown in Table 7. It is noticed that except the North-western plain, in all other regions, the value of 2 is significant at a 1 percent level of significance. Otherwise, there is uniformity in the distribution pattern all over the district except in the Arnod tehsil.

The aforesaid methods explain the distribution of villages which means the total area of the abadi and the farms i.e. the revenue villages. But when we talk about the distribution of settlements, it means the locations of Abadies. Within the village's total area, the Abadi may be located either in the center of the village or in any part of the village. This very idea is not taken into consideration in any of the aforesaid methods. The Nearest Neighbour Technique simply involves a comparison between the two mean magnitudes of the observed and the expected distances.

Quadrat Analysis

The process of examining the location's attributes and relationships of features in spatial data through overlay and analytical techniques to gain useful knowledge. In other words, it may be defined that spatial analysis is a tool to extract and create new information from spatial data. Settlement is defined as a place, which has previously been uninhabited and now where humans establish a community. It's a result of economic and social development. The identification of settlement concentration has an important place in recent geographical studies. The study mainly relates to identifying settlement concentration levels to know the actual status of settlements in the study area to suggest better planning. The evolution of settlement patterns in an area is governed by a number of factors i.e., physical, cultural, etc., and hence, varied patterns in the spatial distribution of settlement are found.

Table No. 8 Settlements according to population size

| S.No. | Tehsil | Settlements according to population size | | | | Total |
|-------|--------------|--|---------------|---------------|--------------|--------------|
| | | < 500 | 500 - 1000 | 1000-2000 | > 2000 | |
| 1. | Dhariawad | 62 36.90% | 49 29.17% | 31 18.45% | 26 15.48% | 168 100% |
| 2. | Peepalkhunt | 101 48.79% | 52 25.12% | 44 21.26% | 10 4.83% | 207 100% |
| 3. | Chhoti Sadri | 73 47.10% | 45 29.03% | 25 16.13% | 12 7.74% | 155 100% |
| 4. | Pratapgarh | 144 48.48% | 85 28.62% | 52 17.51% | 16 5.39% | 297 100% |
| 5. | Arnod | 85 46.96% | 53 29.28% | 34 18.78% | 9 4.98% | 181 100% |
| | Total | 465 46.13% | 284 28.17% | 186 18.45% | 73 7.25% | 1008 100% |

Source- The census of India, 2011

Most of the population of the district is agricultural and rural that lives in rural settlements. Enumerations show that the district has a total of 1008 inhabited villages. The population in each village varies from less than 200 to 2000 and above. Based on their population size, these villages can be classified as under (Table No.8). It is noticeable that the district has a more significant number of middle-sized villages (population up to 1000) than any other category. It may also be observed that the highest number of villages are found in Pratapgarh tehsil and the lowest in Arnod. But the concentration of villages is affected by several factors e.g., the area of the tehsil, the climate, availability of resources, transport. etc.

Conclusion

To obtain spacing in any district, the area may be divided into squares and calculate the area of the square, and the total number of settlements (D value). Through this method, Pratapgarh district split into two categories. The first is the low spacing area, and the second is a moderate spacing area. The Dhariawad tehsil stands first in the low spacing category, and Pratapgarh tehsil gets the first rank in the moderately spacing category. Withheld of Lorenz Curve, it is concluded that tribal settlements are not found in the city center as usual. They are mainly associated with the distribution of natural resources like forests, water, and fertile land. As per the result of Nearest Neighbor Analysis, it is found that Arnod tehsil has R_n value of 1.03, which means the distribution of settlements is a Random pattern. Otherwise, all four remaining tehsils of Pratapgarh district have R_n value between 0.80 to 0.99 with the clustered pattern. As per population size settlements, it is observed that Pratapgarh district has a large number of middle-sized settlements (Population up to 1000 than other categories). The Pratapgarh tehsil has the highest settlements, and Arnod tehsil has the lowest of this category. The Pratapgarh tehsil has maximum government offices, all types of facilities, a good level of groundwater, rail and road tracks, fertile soil, and accessibility to trading centers. This fact indicates that it is a general tendency that maximum numbers of settlements try to settle on an appropriate location, which has maximum numbers of facilities.

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