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Analysis of Settlement Patterns through NNA Technique in Bangar and Aravalli Regions of Rajasthan

Leela Kumari
Former Research Scholar,
Deptt.of Geography,
Govt. Dungar College,
Bikaner

Vinod Singh
Associate Professor,
Deptt.of Geography,
Govt. Dungar College,
Bikaner

Abstract

This study examines the rural settlement patterns in the Bangar and Aravalli regions of Rajasthan, seeking to find inter and intra regional variations, through Nearest Neighbour Technique. Bangar region is represented here by Pali district and Aravalli region by Rajsamand district. These regions have been selected for a comparative, empirical study as they show uniqueness in geographical phenomena. While Rajsamand has a hilly landscape, Pali shows a semi-arid plain towards the west of the Aravalli hills. The study shows random settlement patterns in the two regions, although due to variable reasons.

Keywords: Settlement patterns, NNA, Aravalli, Bangar, Rajsamand, Pali, Rajasthan.

Introduction

Nearest Neighbour Analysis (NNA) is a statistical technique concerning spatial distribution of geographical phenomena. It was introduced in mathematics by Hartz in 1909, but its systematic use was initiated by the American scientists Clark and Evans (1954) and later on computed by Dacey (1960, 1965) and first used by Jensen Butler (1972).

This technique is also used for identifying uniform, random and clustered settlement patterns on the basis of measurement of actual nearest neighbour distances between settlements. Rn values obtained from NNA are related to settlement distribution as follows : >= 2.15 Uniform or even, 1.5-2.15 towards even, but more regular than random, +0.5 - 1.5 Random, 0.0-0.5 Semi-clustered and +0.00 Clustered.

In India, Nearest Neighbour Technique has been commonly used on the topographical maps of the Survey of India to understand and to correlate the spatial patterns of settlements in any given area. Aerial photographs and satellite imageries are of more recent origin. Such maps and photographs provide the basis for visual observations. They can also be used for quantitative analysis to find out the patterns of settlements. This can be done by the measurement of direction and distance between neighbouring settlements. It is in this respect that the nearest neighbour technique has been widely used by geographers.

There has been much work on the rural settlements, and has generally engaged itself with types, patterns and spacing of settlements based on Nearest Neighbour Analysis. Most of this research, however, has been confined to singular regions only. This is a comparative study of the rural settlements patterns of the three typical western hilly tehsils of Rajsamand district lying in the sub-humid zone, viz., Kumbhalgarh, Rajsamand and Nathdwara, and three western tehsils of Pali district, i.e., Rohat, Pali and Jaitaran, lying in the undulating plains.

Review of Literature

There has been diverse work on the use of Nearest Neighbour Analysis (NNA) technique in geographical studies, although much work relates to the use of this technique in the study of settlement patterns. Naqshbandi *et al.* (2016) analysed the spatial distribution pattern and spacing of towns in Kashmir valley. They used Geographic Information System (GIS) and the rarely used quantitative technique of NNA. The study revealed that settlements in Kashmir valley are randomly distributed and don't exhibit any specific distribution pattern. Khan and Ahmad (2014) used NNA to analyse the organization of settlements in Aligarh district of Uttar Pradesh and discovered an uneven distribution pattern (moving towards uniformity but not exactly uniform) due to variation in the physical, socio-

economic and political factors. Sarkar (2010) used open-source high-resolution images of the different parts of West Bengal plains to perform a nearest neighbour analysis on settlement pattern found there.

Das and Samanta (2015) applied Nearest Neighbour technique to study spatial distribution of markets in Purba Medinipur district of West Bengal. The overall distribution was found to be random. But there was a blockwise variation, in which 11 blocks showed clustered pattern, 12 showed random, while 2 blocks had uniform market pattern. Nimase and Lokhande (2014) used NNA technique to find the distribution of primary health centres in Solapur district of Maharashtra, and discovered that distribution pattern was uneven in nature. Sharma *et al*. (2014) calculated spatial clustering of dengue incidence in Trinidad for individual years, and for the entire study period 1998-2004, by using the nearest neighbour index.

Zhang *et al*. (2014) used a new approach to analyzing spatial patterns of human settlements. They used Geographic Information System approach, Ripley's K function and Monte Carlo simulation in their study. Most settlements on the coastal plain showed either regular or random patterns, while hilly settlements exhibited a clustered pattern. Regression showed that influences of topographic factors (elevation, slope and aspects) on settlements locations were stronger in hilly regions. Earlier, Grossbart *et al*. (1978) described NNA statistic for analysis of spatial patterns generated by behavioural phenomena, and suggested other research applications in retail shopping patterns, ideal store locations, patterns of exploratory movement within retail stores and shopping centres etc.

NNA studies have been carried out on settlements of different regions of Rajasthan too. Based on the nearest neighbourhood technique, an analysis of rural settlements of Mewar hills of Rajasthan was done by Pathak and Dhabai (1976). Sarita (1978) applied NNA to find out the spatial distribution patterns of settlements of Jaipur region. She divided the region into four zones and concluded that it showed uniform pattern. Singh (2003) studied rural settlement patterns of Shekhawati and Matsya Union regions in Rajasthan. Rural settlements patterns were found to be highly random to random, generally following the trend of rainfall, fertility of land, and agriculture.

Study Area

The study area includes parts of Pali and Rajsamand districts of Rajasthan (Fig. 1). Pali district represents the semi-arid, undulating Bangar plains, drained by seasonal rivulets, descending westwards from the Aravallis; while Rajsamand district represents the Aravalli hills as relicts of an ancient mountain range (Fig. 2). The axis of the Aravalli runs along the border of these two districts, its major portion lying to the west and southwest of Rajsamand, though a narrow belt in the eastern parts of Pali also belongs to this physiographic unit. The western portion of Pali is a geo-cultural region with rolling, Bangar plains typified in this study by Jaitaran, Pali and Rohat tehsils. The Aravalli region of Rajsamand is a rugged, sub-humid, geo-historical and political region, represented here by Kumbhalgarh, Nathdwara and Rajsamand tehsils.

Fig. 1 : Location Map of Study Area

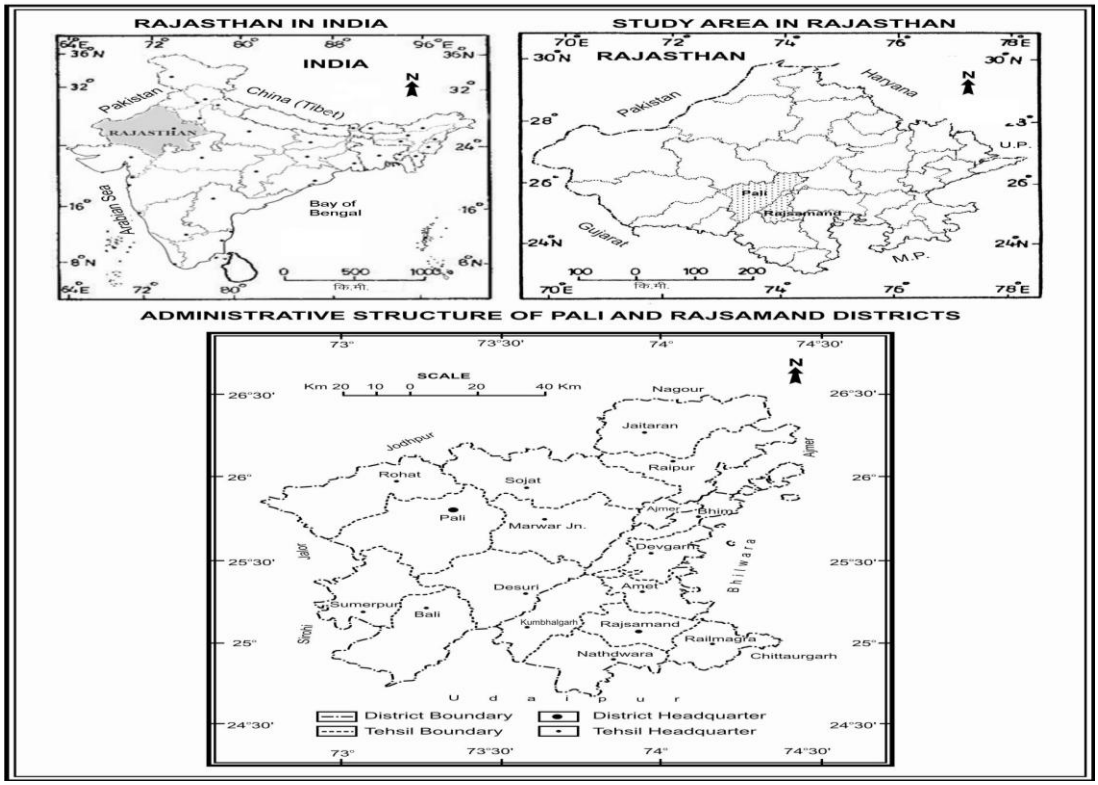

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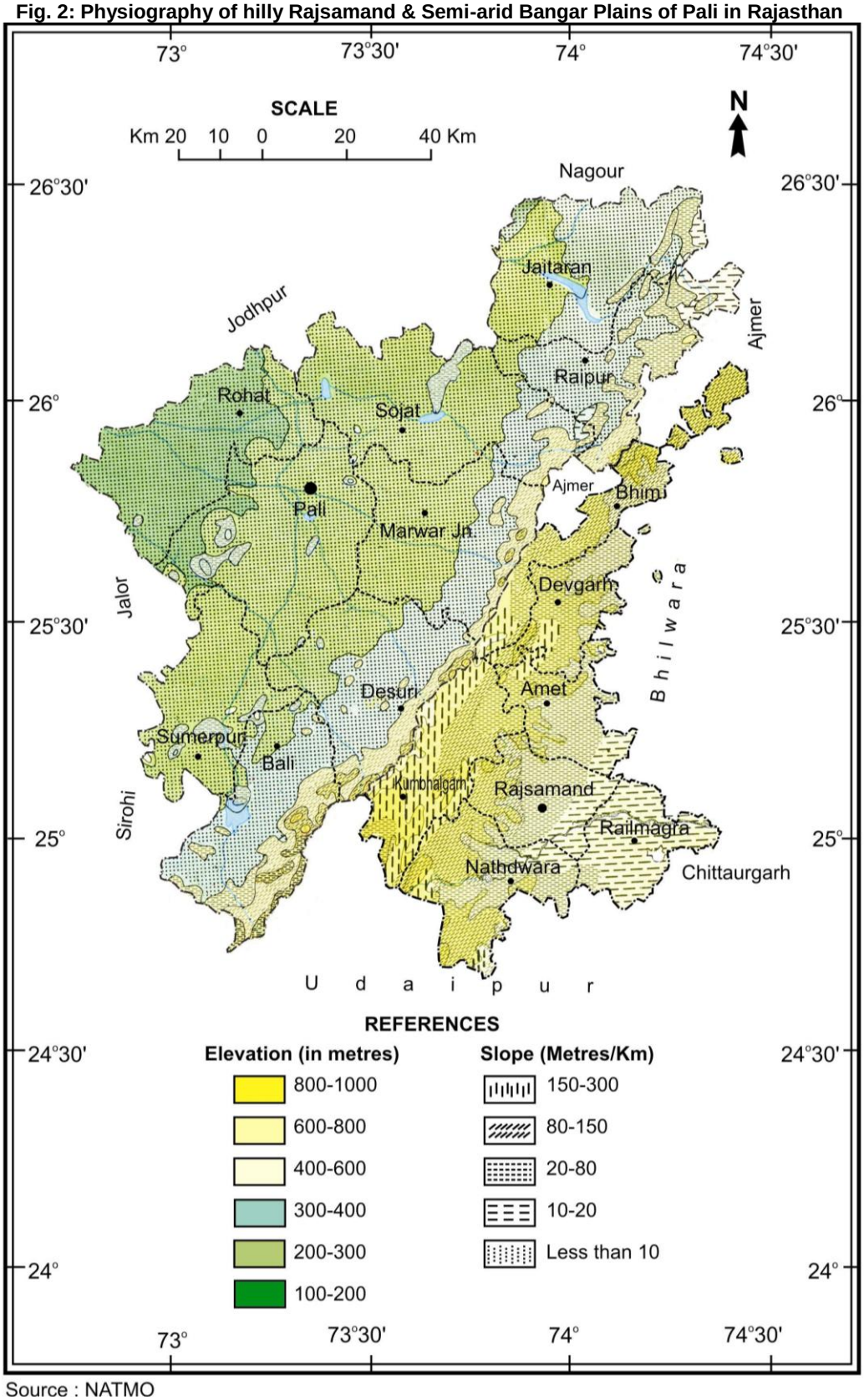
Fig. 2: Physiography of hilly Rajsamand & Semi-arid Bangar Plains of Pali in Rajasthan



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The hilly villages from Rajsamand and plain area villages of Pali were demarcated with the help of toposheets, viz., 45F/4, 45F/16, 45G/1, 45G/12, 45G/11, 45G/5, 45G/16 and 45H/9.

Aim of the Study

The objective of the study is to analyse and compare the patterns of rural settlements in semi-arid Bangar plains of Pali district and Aravalli hilly region of Rajsamand district in Rajasthan.

Methodology

The hilly villages of Rajsamand district, and plain area villages of Pali district were demarcated with the help of visual observation of toposheets of Survey of India, viz., 45F/4, 45F/16, 45G/1, 45G/5, 45G/11, 45G/12, 45G/16 and 45H/9. Out of this demarcated area, grid units were selected by random sampling method. Thus, out of a total number of eight toposheets, 20 grid units have been used for Nearest Neighbour Analysis. The grid units, ten each from three hilly tehsils of Rajsamand, and three plain tehsils of Pali have been detailed in Table no. 1 and 2.

Table No. 1
Calculation of NNA for Pali District

S.N.	Tehsil/Area	Toposheet/ Extension	r'a	r'e	Rn	S.E.	Z-test	Distribution
1.	Jaitaran-Agewa, Janashi	45F/16 26°05'N to 26°10'N 73°55'E to 74°00'E	1.0779	1.0753	1.0024	0.0681	0.0381	Random
2.	Jaitaran-Chavandiya	45F/16 26°05'N to 26°10'N 73°50'E to 73°55'E	1.6625	1.4021	1.1857	0.1158	2.2487	Random
3.	Pali-Bhalelav, Bhagesar	45G/5 25°50'N to 25°55'N 73°20'E to 73°25'E	1.9769	2.4594	0.8038	0.3565	-1.3534	Random
4.	Pali-Nimbara	45G/5 25°50'N to 25°55'N 73°15'E to 73°20'E	1.4648	1.4579	1.0047	0.1252	0.0551	Random
5.	Pali-Pipliya Ki Dhani	45G/5 25°55'N to 26°00'N 73°15'E to 73°20'E	3.1428	2.3702	1.3259	0.3310	2.3341	Random
6.	Rohat-Antan, Kalali	45F/4 26°00'N to 26°05'N 73°10'E to 73°15'E	4.6142	3.3523	1.3764	0.6621	1.9059	Random
7.	Rohat-Chotila	45G/1 25°50'N to 25°55'N 73°10'E to 73°15'E	1.7416	2.5601	0.6802	0.3862	-2.1193	Random
8.	Rohat-Chatelav, Rupawas	45G/1 25°45'N to 25°50'N 73°05'E to 73°10'E	3.0636	1.8907	1.6203	0.2106	5.5693	Towards even
9.	Rohat-Dharmdhari, Kerla	45G/1 25°45'N to 25°50'N 73°10'E to 73°15'E	2.0666	2.2899	0.9024	0.3090	-0.7226	Random
10.	Rohat-Sawaipura	45G/1 25°50'N to 25°55'N 73°05'E to 73°10'E	3.3437	2.2168	1.5083	0.2896	3.8914	Towards even

Table No. 2
Calculation of NNA for Rajsamand District

S.N.	Tehsil/Area	Toposheet/ Extension	r'a	r'e	Rn	S.E.	Z-test	Distribution
1.	Kumbhalgarh-Aret Ki Bhagal	45G/12 25°05'N to 25°10'N 73°30'E to 73°35'E	1.0830	1.2180	0.8891	0.0874	-1.5446	Random
2.	Kumbhalgarh-Charbhuja	45G/11 25°15'N to 25°20'N 73°40'E to 73°45'E	1.2391	0.7648	1.6201	0.1007	4.7100	Towards even
3.	Kumbhalgarh-Fort and Bid Ki Bhagal	45G/12 25°05'N to 25°10'N 73°35'E to 73°40'E	1.0964	1.1849	0.9253	0.0827	-1.0701	Random
4.	Nathdwara-Khamnaur	45H/9 24°55'N to 25°00'N 73°40'E to 73°45'E	1.1041	1.0450	1.0565	0.0643	0.9191	Random

S.N.	Tehsil/Area	Toposheet/ Extension	r'a	r'e	Rn	S.E.	Z-test	Distribution
5.	Nathdwara-Ratnawat Ki Bhagal	45H/9 24°55'N to 25°00'N 73°35'E to 73°40'E	1.6192	1.2297	1.3167	0.0891	4.3714	Random
6.	Nathdwara-Sirohi and Sogri Ki Bhagal	45G/12 25°00'N to 25°05'N 73°35'E to 73°40'E	1.0035	1.1849	0.8469	0.0827	-2.1934	Random
7.	Nathdwara-Sayo Ka Kheda	45G/12 25°00'N to 25°05'N 73°40'E to 73°45'E	1.7250	1.4020	1.2304	0.1159	2.7869	Random
8.	Rajsamand-Davor, Kanadev Ka Gura	45G/16 25°00'N to 25°05'N 73°45'E to 73°50'E	1.0446	1.1849	0.8815	0.0827	-1.6964	Random
9.	Rajsamand and Kumbhalgarh-Sapol, Ghata	45G/12 25°05'N to 25°10'N 73°40'E to 73°45'E	1.2790	1.3522	0.9458	0.1077	-0.6796	Random
10.	Rajsamand-Modol, Putol, Goyoliya	45G/16 25°05'N to 25°10'N 73°45'E to 73°50'E	1.2857	1.1849	1.0850	0.0827	1.2188	Random

Results and Discussion

The results of the Nearest Neighbour Analysis of study regions show that the rural settlement patterns of both the regions tend to be generally random. The settlements in hilly Rajsamand are generally random, though "high random" distribution is also seen. In Pali plains, a generally medium and high random distribution is complemented by low random distribution to a good extent, even as "more even than random" distribution is found in higher degree than in Rajsamand hills (Table 3).

Table No. 3
Distribution of Settlement Spacing in Rajsamand and Pali

Region/District	Number of grids with			
	Low randomness	Medium randomness	High randomness	More even than random
Arravalli/ Rajsamand	-	07 (70)	02 (20)	01 (10)
Bangar/ Pali	02 (20)	03 (30)	03 (30)	02 (20)

Note: Figures in parenthesis are in percent.

The degree of randomness, varies between Pali and Rajsamand districts. Surprisingly, random or "towards even, but more regular than random" settlements are frequently met within the Bangar and hilly regions. However, the random and, occasionally "more even than random" spatial patterns represent a chaotic situation, where multiplicity of factors influence settlement location.

At the regional level, the average Rn values from nearest neighbour analysis of 10 grids each for Rajsamand and Pali districts have been observed to be 1.079 and 1.1410, respectively. It means that distribution of settlements in these two areas is random, though the degree of randomness is slightly higher in Pali. One grid (10% of the sample) belonging to the high upland plateau of Kumbhalgarh-Charbhuja area of Rajsamand (toposheet No. 45G/11) shows Rn value of 1.6201, while two grids (20% of the sample of Pali district) from the more plain Rohat area of Pali district show Rn values 1.6203 and 1.5083 (toposheet No. 45G/1), thus exhibiting tendency "towards more even than random" distribution. The Rn values of the remaining nine grids from Rajsamand district are 0.85, 0.88, 0.89, 0.93, 0.95, 1.06, 1.10, 1.23 and 1.32. The first seven grids show medium level of randomness and the last represents high level of randomness. The last two belong to Nathdwara area of the district.

The rural settlements in Pali district have shown greater variability in their spacing pattern. The Rn values obtained from remaining eight grids are 0.68, 0.80, 0.90, 1.0, 1.01, 1.20, 1.33, 1.38. The first two values show low level of randomness, the next three represent medium level of randomness, while the last three show high level of randomness in settlement distribution. Low level of randomness is seen in grids from Pali (45G/5) and Rohat (45G/1) areas, while high randomness of settlement distribution has been observed from grids representing Jaitaran, Pali and Rohat tehsils of Pali district. The results are shown in table 1.

Thus, the settlement pattern is overwhelmingly random in most of the hilly area of Rajsamand district. It is highly random in some parts, while it is "more even than random" in a few pockets of the district. Rural settlements in Kumbhalgarh tehsil, particularly in Aravalli hilly tracts and along the river-bed sites, are found to be "more even/regular than random". The rugged physiography of Rajsamand district has specific influence on the rural settlements. Banas basin area in Nathdwara tehsil, with its forests, uplands, badlands and inhabitable river-valleys has produced random to highly random pattern of rural settlements, because villages are distributed in high random patterns due to hilly terrain and scarcity of fertile land (Table 3).

Conclusion

The Nearest Neighbour Analysis in the study areas shows a generally random pattern of settlements. The study areas have diverse

physiography, with plain areas in Pali district and hilly tracts in Rajsamand district. The rugged physiography of Rajsamand with its forests, uplands, badlands and inhospitable valleys has produced random pattern of rural settlements. On the other hand, villages in the undulating plains of Pali district show low to high randomness, even as around 20 percent settlement (double that of Rajsamand) show more evenness than randomness. The randomness in this semi-arid region follows the availability of sweet surface and ground water as well as fertile soil.

Thus, rural settlements in Pali and Rajsamand have random distribution pattern though due to variable factors.

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