ENSEMBLE
A bi-lingual peer reviewed academic journal
ISSN: 2582 - 0427 (Online)
Vol. 3, No. 1
March, 2021
http://www.ensembledrms.in

Article Type: Research Article
Article Ref. No.: 21081400689SF
https://doi.org/10.37948/ensemble-2021-0301-a028

SIZE AND SPACING OF RURAL SETTLEMENTS IN MALDA DISTRICT: A QUANTITATIVE ANALYSIS

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Abstract:

Rural settlement, as man's living and practical space dabs the field since ancient time and structures an indispensable part of human life. A rural settlement, as the purpose of cause and main living place of human culture is the connecting string and life blood of every geographical study. An attempt has been made to analyse the spatial distribution of rural settlement according to their size. The size of settlement helps to identify the population threshold of social amenity, which is an important aspect of location studies as human settlements produce a certain degree of order in their distributional pattern over the space.

Keywords: Population, Villages, Space, Distribution

1.0 Introduction:

In rural areas the aggregate of houses for the purpose of agricultural operations, storage of grains and tethering cattle is known as rural settlements. Human beings obtain food, clothing and shelter with the help of their technological know-how from the land and surrounding environment. They work under natural environment and use natural resources to get a certain type of shelter, food and clothing. Hence, shelter has a dominant impact on the built environment while at the same time its characteristics are influenced by the natural environment. Human settlements can influence the environment by consumption of natural resources, adding physical elements to the environment, and acting as an intermediary between human being and nature. The form of human settlements generally determine social requirements and the physical environments as origin of settlements take place near cross roads, houses of landlords and hermits which starts depleting natural resources and its metabolic processes pollute the land, air and water at the same time, because all these are related with process of feedback mechanism. Hence, the productivity of land, labour and metabolic processes of settlements determine the environmental conditions for human comfort.

Rural settlement is the main stay of human society throughout the World. It is the topographic expression of houses and highways as the home of man for safeguarding against environmental

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hazards. In such a situation the areas having fertile land and free from environmental threat have dense population with compact rural settlement whereas areas having infertile land and less safety from environment have given rise to low population density with scattered human settlements.

Rural settlements show the reciprocal relationship of human occupance features and environment. A rural settlement is mainly an agricultural workshop and it can't be separated from the land whose use it ensure.

Settlement geography deal with the facilities built in the process of human occupancy of land and their grouping. The nature and distribution of their facilities are related to the art and mode of living on the one hand and the other hand to such physical factors as water supply, slopes, forest and swamps (Singh, 1961).

The size (area and population) and density of rural settlements is closely related to spacing, with an increase in distance between settlement, the density of villages tend to decrease. The spacing of rural settlements denotes the locational arrangements of villages with respect to one another. The variation in size and spacing of rural settlements is a physically established fact on the earth surface due to variations in environmental conditions (Mandal, 2001). The covariance of spacing of rural settlements depends on such fundamental factors as fertility of land, productivity of crop, nature of crops grown, agronomic characteristics, distribution and availability of water, density of rural population, population size and types of rural settlements, mode of living and several other factors (Mukherjee, 1970). According to Donglass, the spacing of rural settlement depends on three factors e.g. i) the agricultural prosperity, ii) surface relief of the land and iii) historical perspective of the area. Donglass was of the opinion that rural settlements are rural luxury and they are densest where greatest agricultural prosperity is found (Mandal, 2001).

The idea of spacing makes settlers to occupy a particular area. The need to spacious or packed settlements is related to the principle of making optimum use of space available. The optimum use of space is also connected with the principle of least effort, viz. the best spacing of settlements in an area implies that the inhabitants using them well, on the whole, spend least amount of effort required in doing so (Sing, 2007). The significance of spacing in terms of linear distance is realised in all geographical studies. Spacing is not a static phenomenon as existing today but it indicates dynamic processes responsible for present spacing of settlements. Various physic-cultural and historical factors in isolation or combinedly create a rural landscape. Spacing is also related to the packing theory which studies packing of things in various dimensions.

2.0 Objectives:

The main objectives of the study are as follows:

- To identify the regional pattern of settlements in terms of size, spacing and concentration in Malda district.
- To show correlation between average village size (area) and inter village spacing and average village size (population) and inter village spacing of rural settlement.

3.0 Database:

The present study is entirely based on secondary sources of data obtained from various offices and agencies such as Bureau of Applied Economics and Statistics- West Bengal, Office of the Census of India. All the statistics are meant for the year 2011.

4.0 Methodology:

The various quantitative methods have been used in the present study are as follows:

- **For average population size:**

$$S = \frac{P}{N}$$

Where,

S= Average population

P= Rural Population

N= Number of Settlemets

- **For Spacing of rural settlement Mather's model** (Mather, 1944) **of mean spacing have been used**

$$D = 1.0746 \sqrt{A/N}$$

Where,

D= hypothetical distance between settlement or mean spacing in unit distance

A= Area of given area

N= Number of Settlement in a given area

1.0746= Spacing constant

- **The rule of computing 'Gini's Coefficient of Concentration' is as follows:**

$$Gi = 1/10000 \sum_{i-1}^{N} (X1 * Y1 + 1) - (X1 + 1 * Y1)$$

Where,

X1 = the cumulative percentage distribution of attribute x.

Y1 = the cumulative percentage distribution of attribute y.

N = the number of observations.

Gi = Gini's Coefficient Ratio.

Scale of Gi Ratio:

Gi =0 (uniform distribution)

Gi =1(highest concentration)

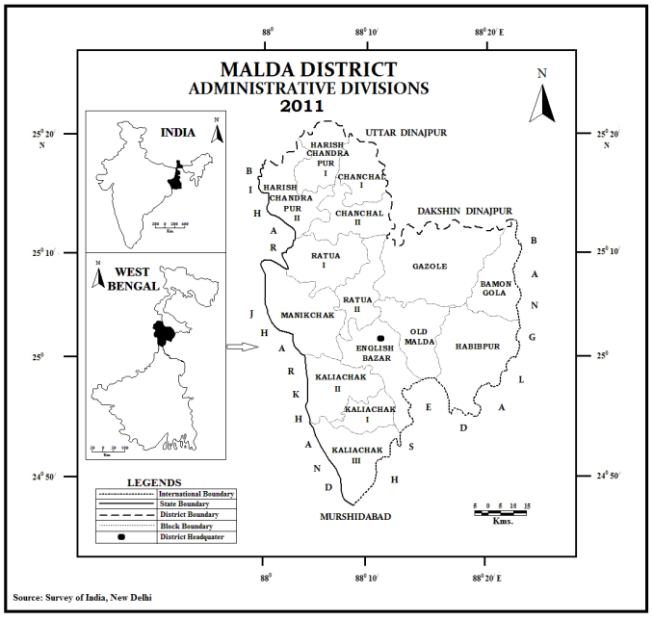
- The causal relationship between dependent and independent variables have been analyzed using Karl Pearson's technique of correlation of coefficient and linear regression technique.

5.0 Study Area:

Malda is the southernmost district of North Bengal and it comes under the Jalpaiguri Division. It lies between latitudinal and longitudinal figures of 24^0 40'20″ N to 25^0 32'08″ N and $87^0$45'50″ E to $88^0$28'10″E respectively. It is surrounded by Bangladesh and Dakhsin Dinajpur in East, Santhal Parganas of State of Jharkhand in West, Uttar Dinajpur in North and Murshidabad in South. The The district of Malda has total area of 3733 sq.km (census 2011). The total population of Malda district is 3988845. The population density and sex ratio of the district were 1069 persons per sq. km. and 944 respectively. The rural population and urban population of Malda district are 3447185 and 541660 respectively. Literacy rate of the district is 61.73 % and it ranks 18th in the

state (Census 2011). For administrative purpose the district has been divided into fifteen Community Development Blocks. It has two municipalities i.e. English Bazar (M) and Old Malda (M) and 27 census towns. The 15 C.D. Blocks contain 1771 villages of the district out of which 158 villages are uninhabited. Physiographically, Malda district has three sub regions- Tal, Barind and Diara. The district has five important river systems namely, Punarbha, Tanguun, Mahananda, Kalindri and Ganga.

Fig. 1: Locational map of the study area



6.0 Result and Discussion:

6.1 Size of Settlement (in terms of Area):

In general, rural settlements are of varying sizes, densities, patterns etc. and these factors have great implications for planning and policies. Size of settlement is one of the key parameters in delineating settlement regions others being landscape features, climatic conditions, and functional linkages of rural settlement etc. In this study, average size of settlement in terms of areal extent and population of Malda district has been analysed considering blocks as units of study.

Analysis of average settlements sizes in terms of areas is important because this factor has vital impact on settlement density (number of settlements present in per unit area). Higher the settlement density, higher is people's pressure on land and vice versa. The pattern of average size of settlement (sq. km.) is discussed below (Fig. 2):

6.1.1. Settlements with very less areal size (< 1.69 sq. kms.):

The least areal size settlement (village) found in 3 blocks namely, Bamangola (1.46 sq. kms.), Chanchal-I (1.65 sq. kms.) and Harishcandrapur-I (1.65 sq. kms.) with indices less than 1.69 sq. kms. area per village.

6.1.2. Settlement with less areal size (1.70 - 1.99 sq. kms.):

Habibpur (1.70 sq. kms.), Gazole (1.80 sq. kms.) and Old Malda (1.93 sq. kms.) come under this category with an indices between 1.70 and 1.99 sq. kms. per settlement in all three blocks.

6.1.3. Settlement with medium areal size (2.00 - 2.49 sq. kms.):

Kaliachak-I (2.15 sq. kms.), Chanchal-II (2.28 sq. kms.), English bazar (2.33 sq. kms.) and Ratua-I (2.43 sq. kms.) fall under this category ranging between 2.00 and 2.49 sq. kms. per village.

4. Settlement with largest areal size (> 2.50 sq. kms.):

Harishchandrapur-II (2.98 sq. kms.), Ratua-II (3.62 sq. kms.), Kaliachak-III (4.00 sq. kms.), Manikchak (4.47 sq. kms.), and Kaliachak-II (5.57 sq. kms.) all these blocks possess highest area per settlement with an indices more than 2.5 sq. kms. area per village.

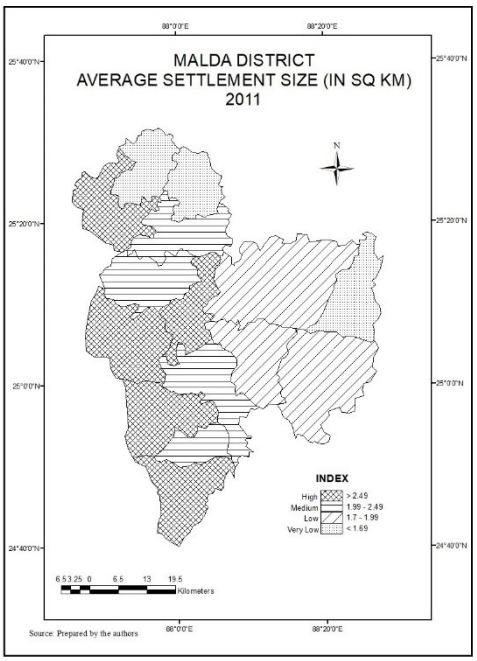
Table 1: Block wise Distribution of Average Area per Village (Sq. km.) in Malda District

Blocks	Area in sq. km.	No. of settlements (villages)	Average settlement size (in sq. km.)
Bamangola	205.91	141	1.46
Chanchal I	162.14	98	1.65
Chanchal II	205.22	90	2.28
English Bazaar	251.52	108	2.33
Gazole	513.65	286	1.80
Habibpur	396.07	233	1.70
Harishchandrapur I	171.41	104	1.65
Harishchandrapur II	217.21	73	2.98
Kaliachak I	105.37	49	2.15
Kaliachak II	222.73	40	5.57
Kaliachak III	260.12	65	4.00
Old Malda	215.66	112	1.93
Manikchak	321.78	72	4.47
Ratua I	230.53	95	2.43
Ratua II	173.93	48	3.62
Total District	3653.24	1614	2.26

Source: Computed by the authors from village Directory, Malda District

Table 1 shows the average settlement size (in sq. kms.) at block level in Malda district. The average settlement size of the district is 2.26 sq. kms. The total number of inhabited villages in the district is 1614 spread over 15 community development blocks. Among them Gazole block has the highest number of inhabited villages with 286 and Kaliachak-II block has lowest number of villages with 40.

Fig. 2: Average settlement size



6.2 Size of Settlement (in terms of Population):

One of the important means of analysing and understanding the spatial organisation of settlement is the settlement size based on population. In this study, size of settlement has been analysed and dividing the total settlements into 7 categories in correspondence to population size (Table 2).

Table 2: Distribution of Rural Settlement and Population under different range in Malda District (2011)

Range of Population	Rural Settlements			Rural Population		
	No	%	Cumulative Percentage	No	%	Cumulative Percentage
<200	96	5.95	5.95	10978	0.32	0.32
200-499	310	19.21	25.16	107958	3.13	3.45
500-999	350	21.69	46.85	256638	7.44	10.89
1000-1999	345	21.38	68.23	493562	14.32	25.21
2000-4999	344	21.31	89.54	1085761	31.50	56.71
5000-9999	129	7.99	97.52	905129	26.26	82.97
>10,000	40	2.48	100	587159	17.03	100
District total	1614	100.00		3447185	100.00	

Source: Computed by the authors

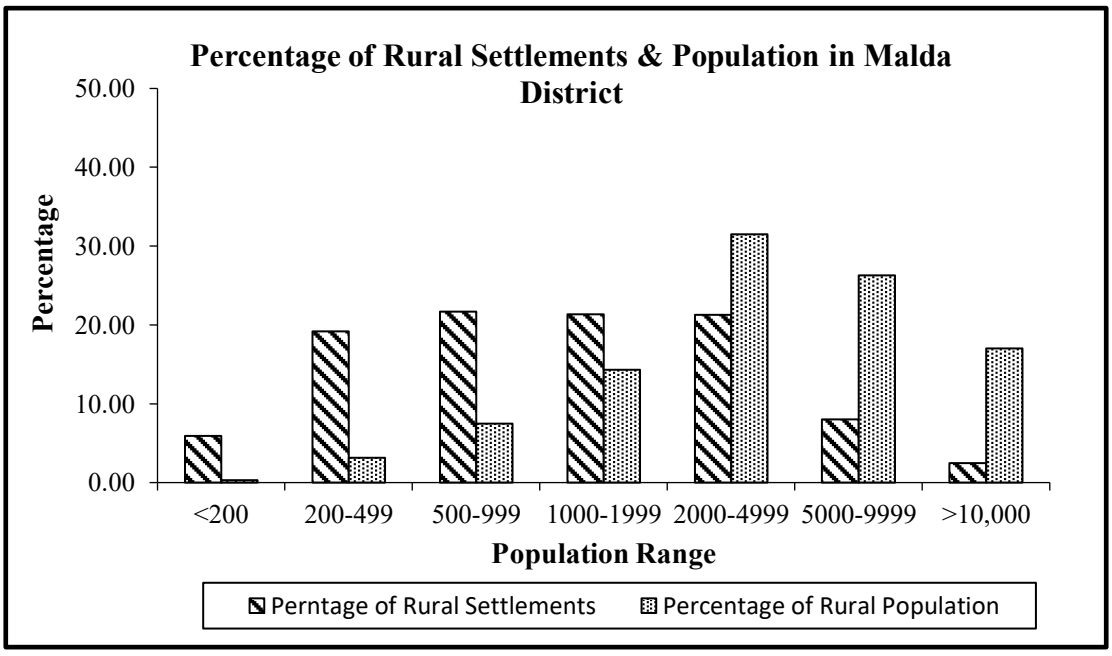


Fig. 3: Percentage of rural settlement and population

Source: Prepared by the authors

Fig. 3 distinctly reflects the fact that in Malda district, there is great inequality in the distribution of population with the number of settlements (villages). It is observed from the Table 2 that the population ranging 500 – 999 occupies the highest position in terms of number of villages i.e. 350 settlements which shares 21.69 per cent to the total number of rural settlements. On the other hand, population ranging above 10000 holds the lowest position with 96 numbers of settlements (2.48 per cent).

The population ranging between 2000 – 4999 holds the highest position in terms of number of population (31.50 per cent), whereas, population ranging below 200 occupies lowest position with 0.32 per cent of rural population.

Table 3: Block wise percentage of Rural Settlement under particular Population Range

Blocks	Percentage of Rural Settlements under the given Population Range						
	<200	200 - 499	500 - 999	1000 - 1999	2000 - 4999	5000 - 9999	>10000
Bamangola	4	26	34	22	14	0	0
Chanchal I	5	8	18	29	37	3	1
Chanchal II	6	6	21	26	32	9	1
English bazar	9	18	17	24	19	9	4
Gazole	7	27	29	22	12	2	0
Habibpur	12	39	24	16	7	1	0
Harishchandrapur- I	3	9	14	26	31	4	1
Harishchandrapur-II	3	7	27	25	25	23	4
Kaliachak I	0	2	6	20	31	27	14
Kaliachak II	5	0	5	18	38	25	10
Kaliachak III	5	6	11	15	34	14	15
Manikchak	4	7	8	24	32	18	7
Old Malda	4	37	26	19	12	4	0
Ratua I	5	7	17	17	37	14	3
Ratua II	0	0	15	21	29	33	2
District	6	19	22	21	21	8	2

Source: District Statistical Handbook of Malda District

Table 3 and Fig. 4 illustrate the variation of number of settlements under each block of Malda district supporting population of different sizes ranging from less than 200 to more than 10000. The analysis reveals that 13 blocks out of 15 blocks of Malda district except Kaliachak-I and Ratua-II block possess the settlements less than 200 and the highest number of settlements under this category found in Habibpur with (12 % settlements) Followed by English bazar with (9 % settlement) and Gazole with (7 % settlements). The district shares 19 % of rural settlements under the category of 200-499 and the highest number of settlements under this category found in Habibpur with (39 % settlements).

Settlements (villages) with population within the range of, (500-999), (1000-1999) and (2000-4999) fall under all 15 blocks of the district and these three categories covered nearly 64% of rural settlements. Bamongola blocks do not have the settlement falling under (5000-9999) category whereas Ratua-II block have the highest percentage of settlements in this category. Only 2 % settlements supporting more than 10,000 population in the district. Kaliachak-I, Kaliachak-II and Kaliachak-III blocks shares 34 % settlements in this category whereas it is totally absent in Gazole, Old Malda, Habibpur and Bamangola.

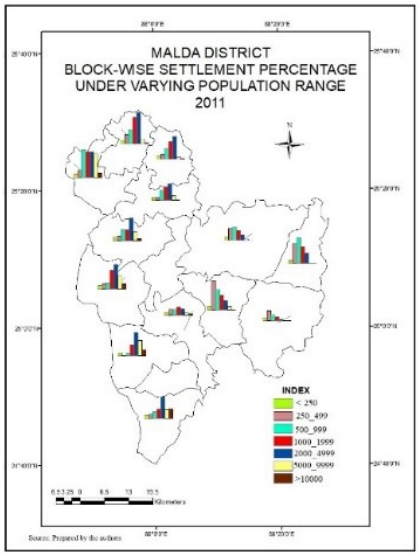


Fig. 4: Settlement under varying population range

6.3 Settlement Density and Space Size:

The density of settlement is the outcome of association of physical, social and economic condition of the locale. It explains the range of the settlement distribution and spacing dynamics. The existing assessment is based on the analysis of density of settlements subject to the number of settlements per 10 sq. km.

Table 4: Block wise Density of Settlement and mean spacing of Settlements of Malda district, 2011.

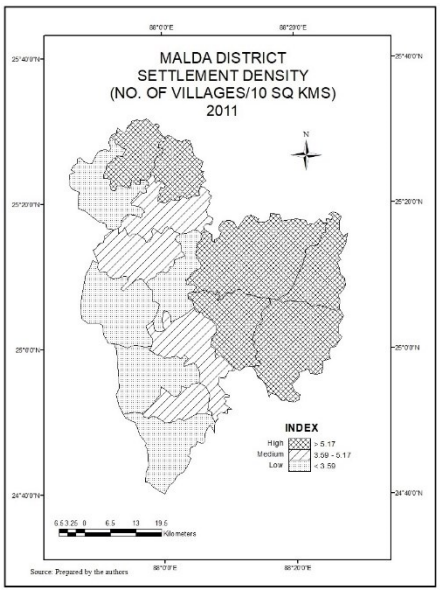
Blocks	Density of Settlement per 10 sq. km.	Inter Village Spacing in km.
Bamangola	6.85	1.30
Chanchal I	6.04	1.37
Chanchal II	4.39	1.62
English Bazaar	4.29	1.60
Gazole	5.57	1.44
Habibpur	5.88	1.39
Harishchandrapur I	6.07	1.38
Harishchandrapur II	3.36	1.85
Kaliachak I	4.65	1.41
Kaliachak II	1.80	2.53
Kaliachak III	2.50	2.09
Old Malda	5.19	1.47
Manikchak	2.24	2.27
Ratua I	4.12	1.67
Ratua II	2.76	2.05
District	4.42	1.62

Source: Calculated by the author

The average density and average space size of settlements in the district are 4.42 settlements per 10 sq. km. and 1.62 km. respectively. Eight community development blocks have low density of settlements in comparison to district's average (4.42 settlements).

Table 4 represents block wise average density and average space size of settlements of Malda district as per 2011 census data. In terms of settlement density, Bamongola block (6.85 villages/ 10 sq. km.) holds first rank followed by Harishchadrapur-I (6.07 villages/ 10 sq. km.), Chanchal-I (6.04 villages/ 10 sq. km), Habibpur (5.88 villages/ 10 sq. km.) and the least is recorded in Kaliachak-II (1.80 villages/ 10 sq. km.), followed by Manikchak (2.24 settlements /10 sq. km.), Kaliachak-III (2.50 villages/ 10 sq. km.) and Ratua-II (2.76 villages/ 10 sq. km.).

Fig. 5: Settlement density



From fig. 5 it can be seen that out of 15 blocks only 5 blocks namely, Manikchak, Kaliachak-II, Kaliachak-III, Ratua-II and Harishchandrapur-II fall under low category with less than 3.59 villages per 10 sq. km. Chanchal-II, Ratua-I, English bazar and Kaliachak-I comes under medium category with the number of villages within the range of 3.59 – 5.17 per 10 sq. km. Bamangola, Gazole, Habibpur, Old Malda, Harishchandrapur I and Chanchal I fall under the high settlement density blocks in Malda district with more than 5.17 villages per 10 sq. km.

7.0 Inter-Village Spacing:

Inter village spacing is a technique to analyse the degree of density of settlements (villages), it however doesn't reflect the geometrical pattern of the settlements. In this study, this technique is applied to analyse block wise spacing patterns of rural settlements. The village spacing has been calculated using Mather's formula of 1994. The formula is as follows: **$D=1.0746\sqrt{A/N}$.**

From table 4, it can be interpreted that the block wise mean village spacing of Malda district ranges from 1.30-2.53 km. The highest mean inter space between villages found in Kaliachak II (2.53 km) followed by Manickchak (2.27 km.), Kaliachak-III (2.09 km.) and Ratua II blocks (2.05 km.) and the least in Bamangola (1.30 km). However, the all the community development blocks have been divided into following four categories. These are as follows:

7.1 Very Low Spacing (<1.40 km)

Very low spacing of the settlements found in four blocks i.e., Bamangola, Chanchal-I, Habibpur and Harishchandrapur I which covers 25.52 percent (932.53 sq. km.) area and contains 21.11 percent population of the district, lying in northern and eastern part of the district (Fig. 6) and having 35.68 percent of total settlements of the district. Well drained and uniform fertility of soil over the region are causative factors for the development of compact settlements. Most of the small size settlements are found along the means of transportation.

7.2 Low Spacing (1.40 -1.59 km)

Three development blocks of the district fall under low spacing of settlements, these are Kaliachak-I, Gazole and Old Malda. It covers 834.68 sq. km. (22.84 %) of the total area consisting of 447 settlements (27.69 %) of the district. It also accounts 21.38 percent population of the district. Low spacing of settlements are mainly found in two different parts of the study area i.e., northern, and central part of the district (Fig .6). The availability of better irrigation facilities especially shallow tube-well irrigation have endorsed to the low spacing of settlements.

7.3 Moderate Spacing (1.60 - 1.79 km)

Under this category, there are three development blocks i.e., English Bazar, Chanchal-II and Ratua-I. A total 293 (18.15%) of district's settlements shows mean spacing ranging in between 1.60 km. to 1.79 km. It covers nearly 19 per cent of total area and about 21 per cent of total population mainly lying in the north and north-eastern part of the district.

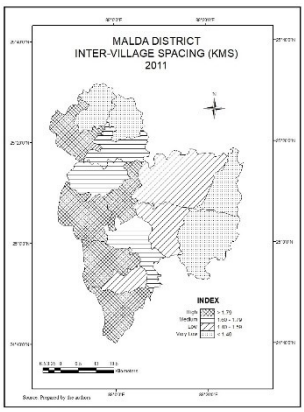


Fig. 6: Inter village spacing

7.4 High Spacing (> 1.80 km)

The settlements which are located at more than 1.80 km. apart from each other are included in this group (Table 4). Such a high spacing prevails in five blocks of the district viz--Manikchak, Ratua-II, Kaliachak-II, Kaliachak-III and Harishchandrapur-II which form a compact region stretching from north to south in the western part of the district (Fig.6). It encompasses 1195.77 sq. km. (32.83 %) area consisting of 298 settlements (3.12 %) and 36.53 percent population of the district. This is attributed to infertility of soil, lack of irrigational facilities and means of transportation and communication. Highest mean spacing i.e. 2.53 km. has been recorded in Kaliachak-II followed by Manikchak (2.27 km.) mainly due to the recurrence of devastating floods every year.

8.0 Correlation Between Size and Spacing of Rural Settlement:

Size (area and Population) and density of settlements are largely governed by inter settlement spacing. The general hypothesis is that the relationship between the size (area and population) and space of rural settlements are directly proportional to each other i.e- more the mean space between the villages, higher is the population and areal size of each settlement.

Table 5: Correlation between Inter-Village Spacing and Size of Settlement (area and population)

Blocks	Inter Village Spacing in km.	Average Village size (sq. km.)	Average Village Size('00" persons)
Bamangola	1.30	1.46	10.21
Chanchal I	1.37	1.64	20.32
Chanchal II	1.62	2.28	22.81
English Bazaar	1.60	2.22	22.48
Gazole	1.44	1.79	11.62
Habibpur	1.39	1.68	7.95
Harishchandrapur I	1.38	1.65	19.18
Harishchandrapur II	1.85	2.98	34.43
Kaliachak I	1.41	1.72	54.91
Kaliachak II	2.53	5.54	51.57
Kaliachak III	2.09	3.79	50.64
Old Malda	1.47	1.87	12.13
Manikchak	2.27	4.47	37.47
Ratua I	1.67	2.43	28.99
Ratua II	2.05	3.62	42.10
		R^2= 0.996	R^2= 0.705

Sources: Calculated by the authors

In this study, the relationship between the mean spacing of settlements on the one hand and settlement size in terms of population and area on the other have been analysed using Karl Pearson's correlation coefficient technique. Correlation helps to examine the nature and degree of relation between the variables.

9.0 Coefficient of Correlation:

Coefficient of correlation (r) is the statistical measure of degree of relation between the variables **(Mahmood, 2017).** The value of r (coefficient of correlation) ranges from +1 to -1 depicting perfectly positive and perfectly negative respectively. The calculated r value or the coefficient value in both cases is positive. The value of r in correspondence to mean spacing of settlements and areal size is r=0.996 which implies almost perfect positive relationship whereas in case of mean space and population size, r=0.705 implying positive relation but not perfect.

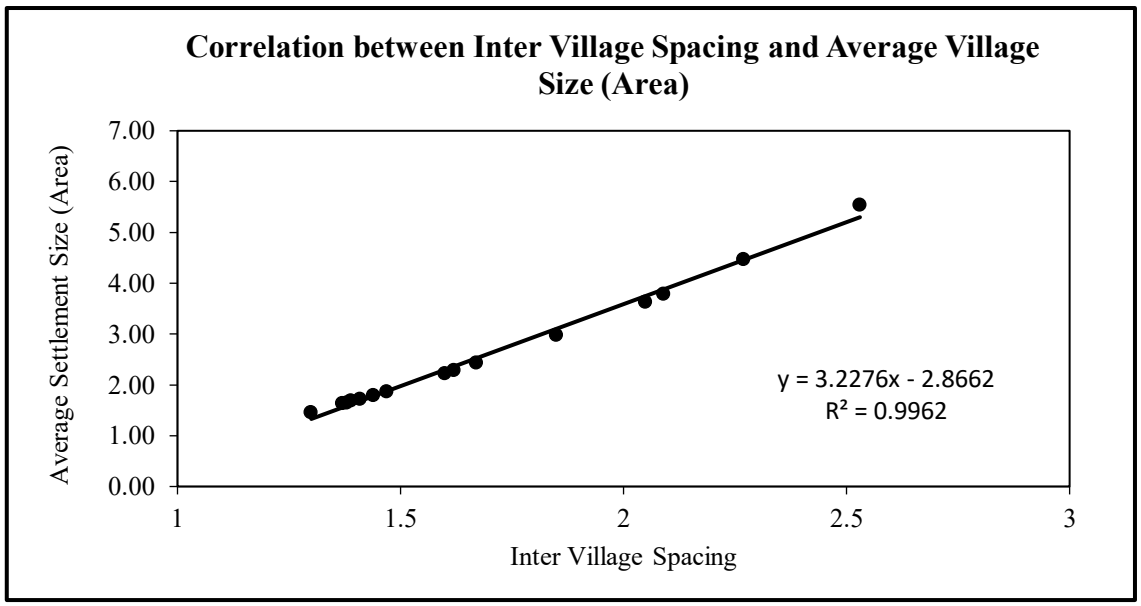


Fig. 7: Correlation between spacing and size (Area)

Source: Prepared by the authors

Fig. 7 depicts nearly perfect positive relationship (r= 0.9962) between the mean inter-village spacing and mean settlement size based on area. Higher the mean inter -settlement (village) spacing, larger is the village size in terms of areal extent. E.g -in Bamangola and Manikchak, the average areal sizes of villages are 1.45 sq. km. and 3.62 sq. km. in correspond to an average inter-village spacing of 1.29 km. and 2.04 km. respectively.

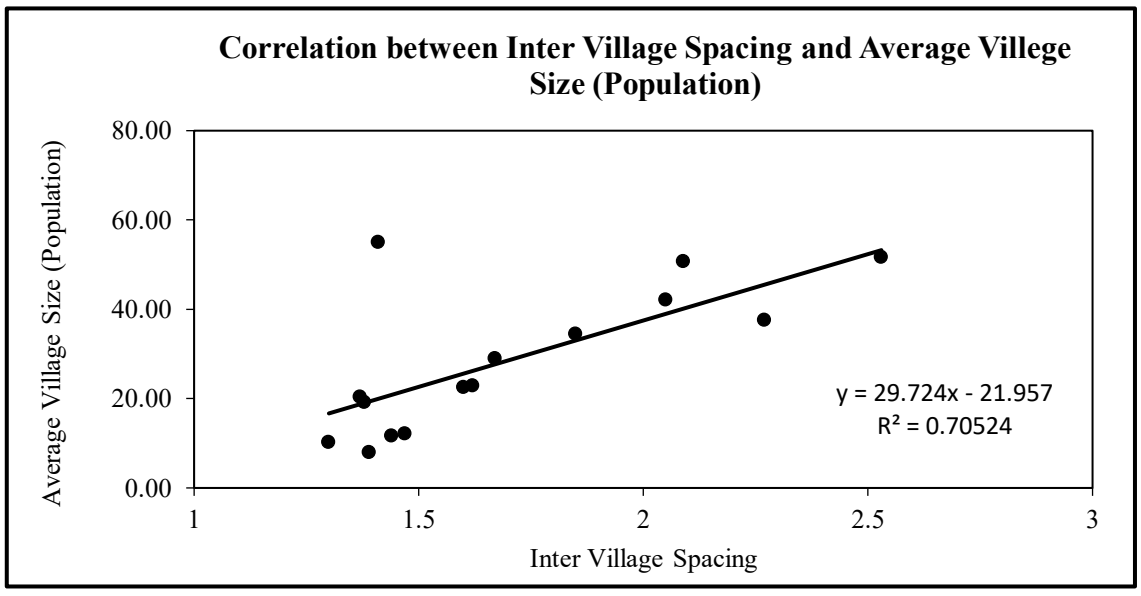


Fig. 8: Correlation between spacing and size (Population)

Source: Prepared by the authors

Fig. 8 depicts slightly positive relation between population size and mean spacing between the settlements (villages), (r=0.70524) which means higher the mean-inter village spacing, larger is the mean size settlements in terms of population. In Habibpur and Manikchak the average inter-village spacing is 1.26 km. and 2.04 km. respectively whereas the average village population size over the respective blocks are 646 and 3032 respectively. But it is not relevant in all blocks as the relation is not perfectly positive, e.g. in Harishchandrapur-II, despite of inter-mean village

spacing of 1.84 km. lesser than in Manikchak (2.04 km.) average population are 3396 and 3032 respectively.

10.0 T-Test Analysis:

The null hypothesis in Pearson's coefficient correlation is that the samples are random and any ostensible correlation in the sample data might be by chance and the correlation between variables in actual study population is 0. T-test is done to verify this hypothesis. T-test is mainly calculated to test the level of significance of coefficient or "r" value and helps to determine whether the computed sample correlation coefficient (r) represents the accurate measure of the population correlation coefficient i.e. the degree of correlation is valid only in that particular sample or it is also in terms of entire study population too. Thus, t -test also helps to reflect degree of sample validity.

Here the alternative hypothesis is that there is positive relation between the mean inter-village spacing and area and population of village and the r value depicting its positive correlation is significant.

The level of significance of correlation or "r" value through t-test is mainly determined by "t" value and "P" value---

In case the calculated "t" value is lesser than the corresponding tabulated value at certain degree of freedom (n-2) then the correlation coefficient between variables is said to be insignificant ,it means the present correlation among those variables might be only by chance and in case of larger number of similar observations ,these variables will be independent and if the computed "t" value is greater than the table value at certain degree of freedom then the calculated correlation is significant . Thus, the significance of coefficient is directly proportional to not only "r" value but also to degree of freedom (n-2) which mainly depends on sample size because here *' n'* represents sample size and in some cases, because of sufficient sample *'n'* a smaller correlation coefficient may become significant ,whereas in some cases a larger correlation coefficient may become insignificant because of insufficient or smaller value of samples.

The "P" value or probability value helps to determine whether to accept or reject null hypothesis. In one tailed test, if P value (Probability value) is lesser than alpha i.e. level of significance then the null hypothesis is rejected and vice versa.

- In context of the relationship between the mean settlement space and settlement size in terms of area, the computed "P" value (0.0028) is lesser than alpha value or level of significance (0.05), leading to rejection of null hypothesis of Pearson's correlation i.e. the population correlation coefficient is 0 and implication of significance of correlation between the concerned variables. Thus the "r" value is significant and the positive relation between inter-village spacing and average village size in terms of area is accepted.
- The calculated P value (7.03756E-08) in case of t-test in context of the relationship between the mean settlement space and settlement size in terms of population is lesser than 0.05 (level of significance or alpha). Thus, in this case too, null hypothesis is rejected and the alternative hypothesis i.e. significant correlation coefficient between variables are accepted i.e. higher the mean inter settlement spacing, higher the per settlement population and vice versa as spacing decreases.

Thus, the hypothesis which claims direct relationship between the size of village (area and Population) and mean spacing of settlement is well accepted in case of Malda district.

11.0 Coefficient of Concentration of Population:

The word coefficient in statistics shows an average change in Y (dependent variable) for a unit change in X (independent variable). In this study, Coefficient of concentration has been analysed for settlement and area (Table 6) and settlement and population in correspondence to range of population (Table 7). This technique also known as Gini Index is a statistical measure of distribution of variables. It was first developed by the Italian scientist and Sociologist Corrado Gini as a measure of inequality of wealth or income. The value of Gini coefficient ranges from 0 to 1. Value close to zero indicates uniformity in distribution and dispersion increases as we proceed towards the value of 1.

Table 6 represents block wise coefficient of concentration of settlement in correspondence to the size of settlement in terms of area. Since the Gini coefficient value is 0.11, close to zero, it implies that the distribution of settlement is uniform throughout the district and not concentrated at a particular place.

Table 7 represents coefficient of concentration of population over villages or settlements in Malda district. Since the Gini's coefficient value in this case is 0.603, it implies disproportional distribution of population with higher percentage concentrated over particular settlements.

TABLE 6: Block wise Coefficient of Concentration of Settlement and Area in Malda District, 2011

Blocks	Settlements(S)	Area in sq.km (A)	Percentage		Cumulative Percentage		Xi.yi+1	Yi.Xi+1
			S	A	S	A		
Bamangola	141	205.49	8.74	5.72	8.74	5.72	89.07	84.79
Chanchal I	98	160.35	6.07	4.47	14.81	10.19	235.63	207.78
Chanchal II	90	205.22	5.58	5.72	20.39	15.91	460.43	430.79
English Bazaar	108	239.62	6.69	6.68	27.08	22.58	997.29	1011.73
Gazole	286	511.34	17.72	14.24	44.80	36.83	2139.12	2181.54
Habibpur	233	392.01	14.44	10.92	59.24	47.75	3111.29	3136.10
Harishchandrapur I	104	171.41	6.44	4.78	65.68	52.52	3847.15	3687.30
Harishchandrapur II	73	217.21	4.52	6.05	70.20	58.57	4276.52	4289.91
Kaliachak I	49	84.08	3.04	2.34	73.24	60.92	4913.84	4612.43
Kaliachak II	40	221.73	2.48	6.18	75.72	67.09	5599.10	5350.33
Kaliachak III	65	246.04	4.03	6.85	79.74	73.95	6361.07	6410.05
Old Malda	112	208.94	6.94	5.82	86.68	79.77	7691.63	7270.45
Manikchak	72	321.78	4.46	8.96	91.14	88.73	8672.78	8609.75
Ratua I	95	230.52	5.89	6.42	97.03	95.15	9702.99	9712.19
Ratua II	48	173.93	2.97	4.85	100	100		
District	1614	3589.67					58097.92	56995.15
Ginni's Coefficient= (58097.92-56995.15)/10000 = 0.110								

Source: Calculated by the authors

Table 7: Coefficient of Concentration of Population by Size group of Settlement in Malda District

Population Range	No.of Settlements	Total Population	Percentage		Cumulative percentage		Xi.Yi+1	Xi+1.Yi
			Total Settlement (X)	Total Population (Y)	X	Y		
<200	96	10978	5.95	0.32	5.95	0.31	20.53	8.01
200-499	310	107958	19.21	3.13	25.16	3.45	274.12	161.64
500-999	350	256638	21.69	7.44	46.85	10.89	1181.23	743.37
1000-1999	345	493562	21.38	14.32	68.23	25.21	3869.32	2257.56
2000-4999	344	1085761	21.31	31.50	89.54	56.71	7428.87	5530.35
5000-9999	129	905129	7.99	26.26	97.52	82.96	9752.00	8296.70
>10,000	40	587159	2.48	17.03	100	100		
District Total	1614	3447185	100.00	100.00			22526.06	16997.65
Ginni's Coefficient= (22526.06-16997.65)/10000 = 0.552								

Source: Calculated by the authors

12.0 Conclusion:

Areal size, population size, inter-village spacing, sites, shapes are the basic traits of settlement, both rural and urban and plays vital role in regional planning and development. As per the main objectives of this study, from the carried calculations and analysis, it can be remarked that in Malda district, till 2011, there seem to be great block-wise variation of settlement size in terms of an average area and population. It is apparent that the pivotal factor controlling the size of settlement both in terms of area and population in Malda district is the inter-village spacing which is clearly interpreted with the help of scatter diagram and coefficient correlation. There is nearly perfect positive relationship (r= 0.988) between the mean inter-village spacing and mean settlement size based on area. Higher the mean inter -settlement (village) spacing, larger is the village size in terms of areal extent. On the other hand, positive relation between population size and mean spacing between the settlements (villages), (r=0.6197) which means higher the mean inter village spacing, larger is the mean size settlements in terms of population to certain extent because the relation is not perfectly positive. It can be stated that the compact, small size villages both in terms of area and population are mainly found over eastern, north-eastern and one block viz. Kaliachak-I in the south of the Malda district with (<1.4 km.) inter-village spacing whereas the most dispersed, large size settlements are mainly found over the western, south-western and north-western part of the district (>1.8 km.). In general, small agglomerated rural settlement is said to be the outcome of favourable and convenient sites, controlled by environmental and socio-economic factors and vice versa.

The comparative analysis of inter-village spacing mainly in temporal context helps to know the rate of change of number of households, villages over particular region over particular time period and the reasons behind either uphill or downhill trend of spacing which helps in planning. It helps to investigate both the negative factors like illegal migration, illegal occupancy of lands etc. on one hand and the positive factors like fertile agricultural lands, favourable topography, hazard-safe location both fostering increase in number of settlements (villages) and decrease in inter-village spacing and also to analyse future potentiality of these positive factors. Thus, this kind of study bringing the nature of inter-village spacing, population and areal size into view should be encouraged at micro-level to assist regional planning and development.

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