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RESEARCH ARTICLE

NATURE AND DYNAMICS OF POPULATION GROWTH OF THE INDIAN SUNDARBANS: AN EXPERIENCE IN THE 20th CENTURY

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ABSTRACT

The mosaic of demographic surface experiences a continuous change over time, if the area is frequented by constant influx of population from outside. The Sundarbans of India is such a region, wherein influx population in different periods settled down, especially in the 20th century. After the independence of India, drastically reduced rate of mortality and slightly reduced birth rate have instigated booming of population of the region. The influx population from the west and East Pakistan added an extra momentum to the population growth due to partition of India in 1947. All these events are continuously modified demographic surface of the region and so likely have widened the gap of demographic relief. The present investigation has been made to unfold nature and dynamics of population growth of the Indian Sundarbans and at the same time it aims to find out the tremendous growth zones of the region.

INTRODUCTION

Changes in demographic surface occurs in two ways; first one is internal growth i.e. natural increase of population expressed in terms of difference of birth rate and death rate and second one is migration – which is a spatial process fabricated with the invasion and retreat of population. A state or a region experiencing moderate natural increase coupled with huge migration normally shows huge growth of population. It reaches in tremendous situation if growth of population is being continued over a fairly long period of time (Guchhait, 2005). Present investigation has been dealt with the Indian Sundarbans which bears such imprints of rapid growth since the beginning of the 20th century due to continuous influx from the surrounding districts of West Bengal. It experienced burgeoning growth especially after partition of India in 1947 as well as partition of East Pakistan in 1971. These circumstances have widened the gap of demographic relief as growth is being localized in some pockets of the region. The present study aims to capture dynamics of population growth with special reference to partition episodes in the 20th century as well as it unfolds the changing nature of inter-block population density of the region.

MATERIALS AND METHODS

In articulating the spatio-temporal change of growth of Indian Sundarbans, the inquiry has to rely on block-wise census data.

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To unfold the nature and dynamics of growth rate of the 20th century block-wise data has been framed for different demographic measures in the time span of 1901 to 2001. It is important to mention here that data up to 1981 are available under heads of fifteen blocks, whereas 1991 census has enumerated nineteen blocks due to division of Canning, Muthurapur, Jaynagar and Sandeshkhali. The *mouza* level (smallest census unit) data is not systematically available before 1951. Thus there is no scope to articulate block-level population size as per present division. So, fifteen blocks have been taken into consideration to calculate the population density as well as adoption of system-component technique. But for computing population packing and demographic relief, database of 1951 (*mouza* level) has been rearranged into nineteen blocks instead of fifteen blocks to make a parity with the census enumeration of 1991.

In order to quantify the different aspects of population dynamics we have adopted uni-variate and bi-variate techniques. For understanding of spatial process of population growth we use uni-variate statistic by employing Coefficient of Variation (CV). The bi-variate regression of curvilinear form i.e. $Y= aX^b$ has adopted while dealing with system-component technique, where system represents whole district and block has been treated as a component. The same form of equation has been applied for the computation of packing and spilling rate of population growth, wherein population is treated as an exponential function of area. In addition to this, linear equation ($Y = a + bx$) has been applied to glean out the association between several demographic parameters.

RESULTS

Ecological Succession of Density Zone

In understanding the ecological succession of settlement development with respect to time and place, database of population density of the twentieth century has been computed and analyzed. Taking a look at the density growth of the 20th century, the population density of 1951 has been granted subjectively to exhibit the density mosaic of the century. The year 1951 is taken to perceive population influx due to partition of Bengal in 1947 and at the same time it represents mid-term period of the 20th century. All the blocks have been classified into three equal zones (five blocks in each zone) based on high, medium and low population density in the said decade. Now, for better analysis, the density zoning of 1951 has been employed into Fig. 1, which reveals the clear-cut understanding of ecological succession of the population growth in the Sundarbans.

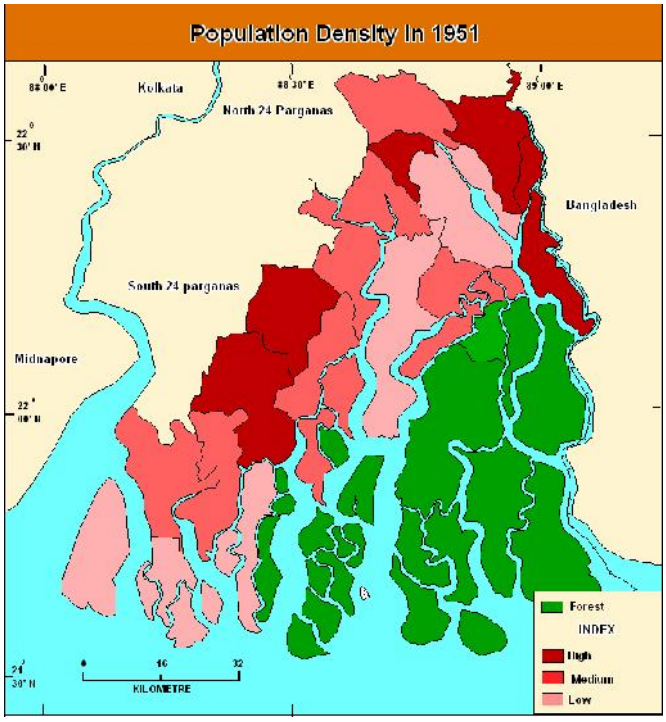

Fig. 1.

The higher density zone includes the blocks of Hasnabad, Jaynagar, Hingulgunge, Minakhan, Muthurapur; the medium density zone consists of blocks of Kultali, Haroa, Gosaba, Kakdeep and Canning; whereas blocks like Sandeshkhali, Basanti, Sagar, Patharpratima, Namkhana belong to the low density zone. The blocks showing higher ranks in population density Table 1 are located in the northern edge of the Sundarbans.

It is interesting to note that the reclamation work was started first in the northern edge of the Sundarbans. So it can be inferred that the blocks with initial settlement development, are now the densest blocks of this region. The blocks belong to the medium density zone lie just south of higher density blocks, where reclamation had done thereafter. The last density zone i.e. low density zone is found in the southern part of the Sundarbans. Here development of settlement was started just after 1870s (except Sagar and other few lots in Kakdwip, Patharpratima blocks). So, it can be concluded that the settlement development in the Sundarbans in respect to time and place makes a conformity with density distribution of the blocks from North to South.

Migration Trend after Partition of Bengal

Migrations, clearing of forest and settlement development – all those events were occurred at a slow to moderate pace before the 20th century. The rate was moderately accelerated during 20th century, which was peaked up after 1947 and ultimately attended the climax stage during 1980s. So following section highlights the settlement development in the Sundarbans after the partition of Bengal. Constant influx of people from the eastern border is the root cause for this separate analysis. Due to lack of concrete database of settlement statistics and absence of census migration data in block level, we have to rely on the block wise population data from 1901 to 2001. This population data has been examined through different statistical techniques; firstly through system-component growth, secondly by population packing and lastly technique of CV calculation for measuring demographic relief.

System-Component Growth

The system-component technique is an attempt to address the growth of the population of individual block in respect to total region of the Sundarbans. This entails the adoptation of the whole region as a system and blocks as its components (Guchhait, 2005). The relative growth of the components is examined through the geometric regression in which exponent is the notion of allometry with its value of unity, more than unity and less than unity. The unity denotes the balance growth of the components with the system. Allometry more than one indicates gaining growth and allometry less than one denotes losing growth in respect to system. The form of the equation used in this analysis is $Y= aX^b$, where Y = component, X = system, b = allometry, a = threshold value in relative growth perspective. The data since 1901 and onwards have been employed for system-component technique. In the Table 2, the allometry of the blocks under consideration has been examined in two time span 1901-1951 and 1951-2001. From the table and figure (Fig. 2 and 3) it is quite clear that during 1951-2001, the blocks located in the western part (except Gosaba block) show gaining growth with the value of more than 1.1.

Table 1. Block-wise Population Density (in Km^2) of the Sundarbans, 1951

Grade	Block	Population Density	Grade	Block	Population Density	Grade	Block	Population Density
High	Hasnabad	473.35	Medium	Kultali	330.46	Low	Sandeshkhali	248.13
	Jaynagar	385.70		Haroa	327.79		Basanti	215.18
	Hingulgunge	372.66		Gosaba	313.22		Sagar	200.61
	Minakhan	352.57		Kakdwip	294.92		Patharpratima	194.52
	Muthurapur	330.98		Canning	267.15		Namkhana	152.11

Table 2. Block-wise Distribution of Allometric Values in Two Different Phases in the 20th Century

Blocks	1901-1951	1951 – 2001	Blocks	1901-1951	1951 – 2001
Basanti	0.7514	1.1368	Muthurapur	1.1854	0.944
Canning	0.751	1.2138	Namkhana	1.0732	1.321
Gosaba	1.5304	0.8219	Patharpratima	1.1817	1.024
Hingalgunj	0.9535	1.121	Sagar	1.3863	1.049
Hasnabad	0.9553	0.5112	Sandeshkhali	0.9863	1.152
Jayanagar	1.1842	0.8847	Haroa	0.9634	1.0869
Kakdeep	1.0672	1.0345	Minakhan	0.7584	1.3299
Kultali	0.712	0.8463	-	-	-

Note: Bold letters indicate gaining allometric growth

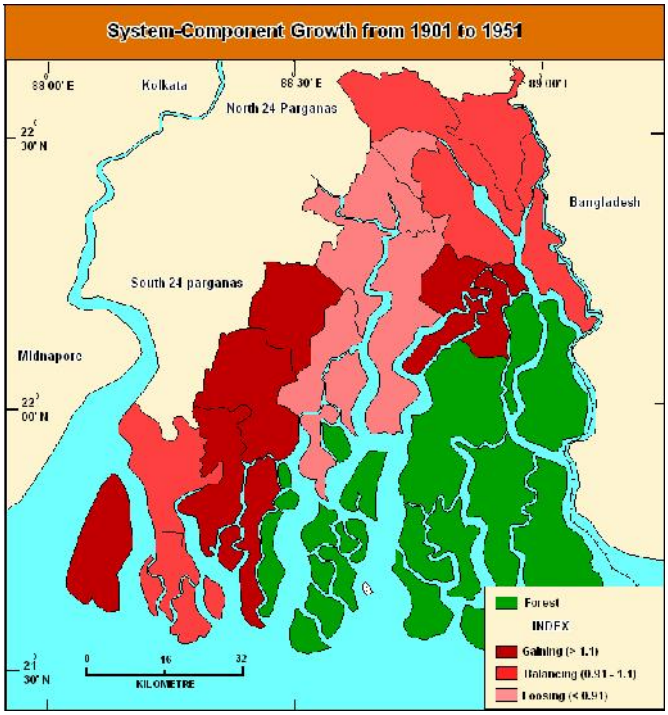

Fig. 2.

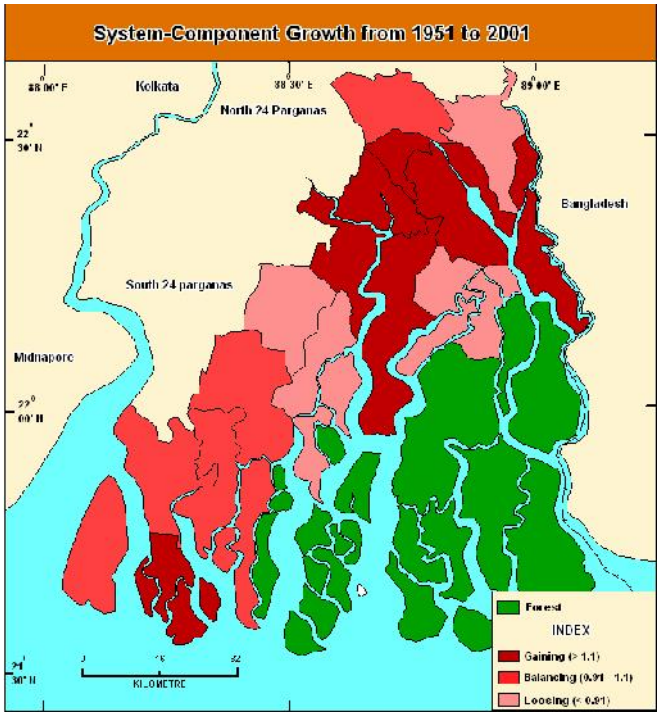

Fig. 3.

The blocks like Kakdwip, Namkhana, Haroa, Hasnabad, Sandeshkhali and Hingulgunge (eastern part of the Sundarbans except Kakdeep and Namkhana) stand with balancing growth (0.91 to 1.1), while blocks like Basanti, Canning, Minakhan, Kultali (central part) show declining growth in respect to the total region. The allometry during the period of 1951-2001 stands against the past scenario (1901 to 1951). The blocks with gaining growth in 1901-1951 are showing either balancing or declining growth in the period 1951-2001. And surprisingly, the eastern blocks has accelerated its allometric values in 1951-2001 and exhibit gaining growth rate. The reason behind such dynamics is not difficult to perceive. In the first half, population mainly from the western districts (Midnapore, Howrah) migrated here and occupied the western part of the Sundarbans. However, in the later part due to effect of partition, huge exodus from Bangladesh settled in the eastern part leading to sound response of allometric values in the period of 1951-2001.

A Focus on Spatial Packing

This stage of this enquiry is concerned with spatiality of packing and spilling. The growth of population here has been employed through population packing technique (Guchhait, 2005; Dasgupta and Majumdar 2011), which is important to infer the amount of migration in respect to time and place. In order to assess the required relative change of population (P) in respect to area (A), a geometric equation in the form of $P= aA^b$ has been applied, where population (P) is considered as an exponential function of the area (A). In this analysis the a stands for level of inter-blocks packing or concentration of population within a high density area and *b* points up the rate of unpacking or overspill i.e. filling of population in low density area. According to Guchhait (2005), the area or the block exhibiting higher packing value coupled with increased rate of spilling signifies a trend of booming or tremendous growth. The *mouza* (smallest census unit of the rural area that constitutes block) level data of two time points have been regressed in respect to their area and thereafter the value of packing (a) and spilling (b) have been calculated block-wise (Table 3).

For better understanding of the change of spatial process due to partition effect, two time points have been selected. The first one is 1951 as a mid-decade of the century and simultaneously signifies post Independence period. Another point is 2001, representing present situation. The block-wise packing rate has been categorized into four zones based on quartiles values employed in Fig. 4 and 5. The figures indicate a gradual spread of packing process from 1951 to 2001. In the first period (pre- Independence) packing rate was higher ($> Q_2$) mainly in the three pockets. These are located in the northern part (Hasnabad, Haroa, Sandeshkhali), central part (Basanti, Canning I, Jaynagar I) and in the southern part (Namkhana, partly Kakdeep and Patharpratima). After Independence, spatiality is extended, especially in the central part (in Jaynagar II, Kultali, Muthurapur I, and Muthurapur II) and covers more area than it was earlier. It is clear from the figure that in 2001 higher packing rate is associated with the blocks of higher density, signifying nucleation of population growth. Another attempt has been made in Fig. 6, wherein change of spilling rate has been calculated from 1951 to 2001 and categorized by taking 1.5 (both direction) value subjectively.

Table 3. Block-wise Distribution of Packing and Spilling Rate in Two Time Points in the 20th Century

Blocks	1951		2001		Spilling Rate Change (1951 to 2001)
	Packing	Spilling	Packing	Spilling	
Basanti	35.11	0.541	13.03	0.925	0.384
Canning I	20.68 (Q3)	0.607	18.26	0.888	0.281
Canning II	0.431	1.23	3.68	1.126	-0.104
Gosaba	3.264	0.964	11.93 (Q2)	0.925	-0.039
Hingalgunj	0.746	1.229	2.779	1.153	-0.076
Hasnabad	28.57	0.648	92.03	0.601	-0.047
Jayanagar I	21.91	0.671	56.11	0.775	0.104
Jayanagar II	10.94	0.764	24.49	0.856	0.092
Kakdeep	1.964 (Q1)	0.991	7.813 (Q1)	1.004	0.013
Kultali	0.618	1.141	7.832	0.933	-0.208
Muthurapur I	14.53	0.732	31.53 (Q3)	0.778	0.046
Muthurapur II	2.876	0.934	6.297	1.029	0.095
Namkhana	20.87	0.621	46.17	0.713	0.092
Patharpratima	3.127	0.909	8.865	0.952	0.043
Sagar	0.486	1.196	5.018	1.051	-0.145
Sandeshkhali I	3.274	0.959	8.958	0.983	0.024
Sandeshkhali II	11.52	0.781	8.966	0.978	0.197
Haroa	20.29	0.628	78.49	0.62	-0.008
Minakhan	9.997 (Q2)	0.769	27.55	0.686	-0.083

The positive value denotes diffusion process and negative signifies vice versa. The figure clearly prompts higher rate of spilling (> Q_2) in the entire region, but highest (> Q_3) in the Basanti and Canning blocks. Hence, it is clear from the spatial reflection that mainly six blocks – Basanti, Canning I (along the Matla river), Jaynagar I and II, Muthurapur I and II exhibit higher rate of packing as well as increase rate of spilling in the second half of the 20th century. This is the notion of tremendous growth (Guchhait, 2005) of population of these blocks exerting continuous pressure on the land. To confirm tremendous growth of population in the second half, a regression analysis between packing and spilling rate has been adopted in two time points. Generally, positive association between packing and spilling rate is the notion of tremendous growth. Though, in the present inquiry regression trends exhibit negative association (Fig. 7 and 8) but, a fall of trend value (-0.0188 to -0.0054) has been noticed from 1951 to 2001. It confirms diffusion of population over the study period.

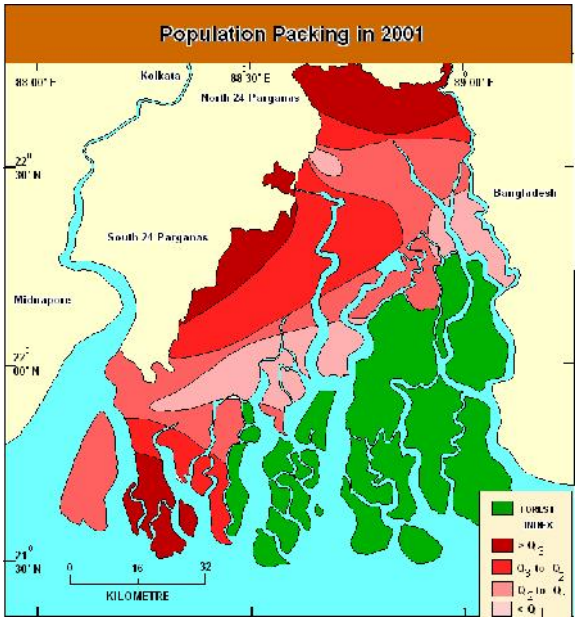

Fig. 5.

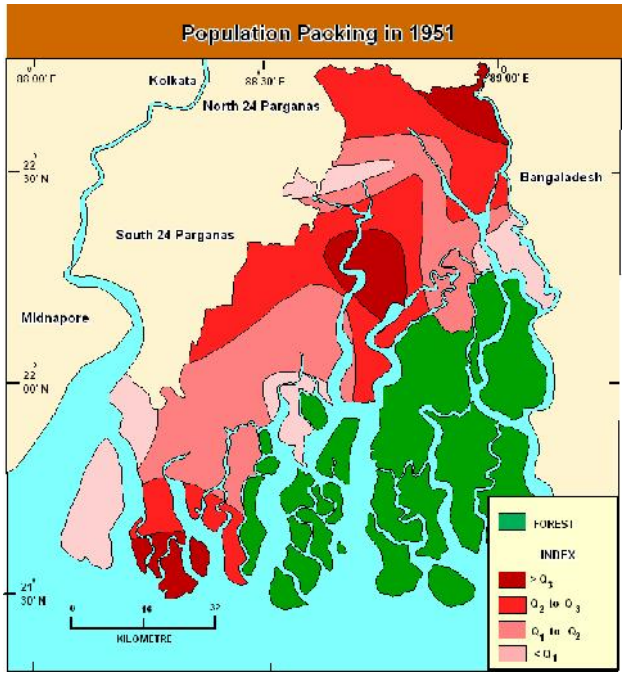

Fig. 4.

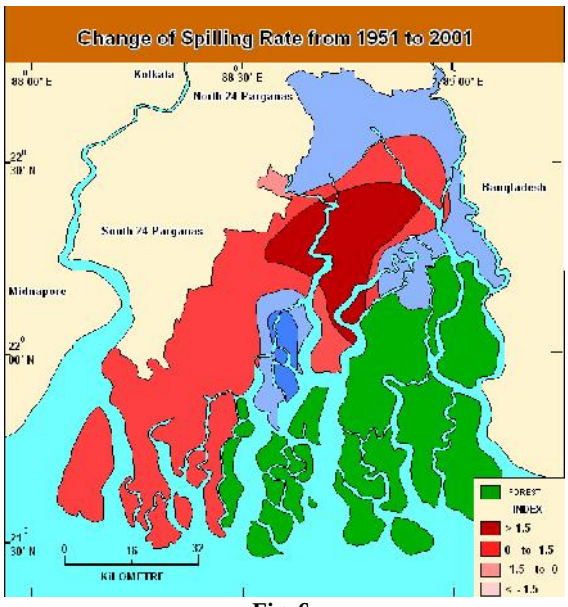

Fig. 6

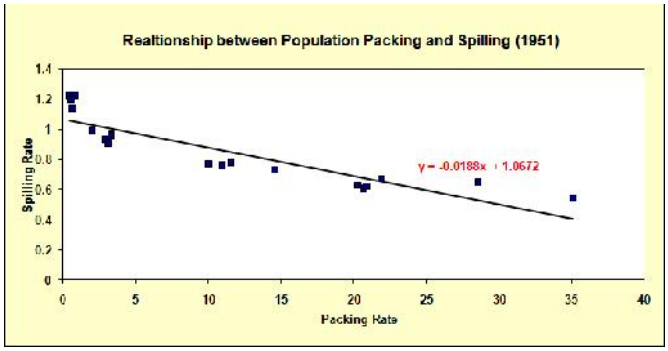

Fig. 7.

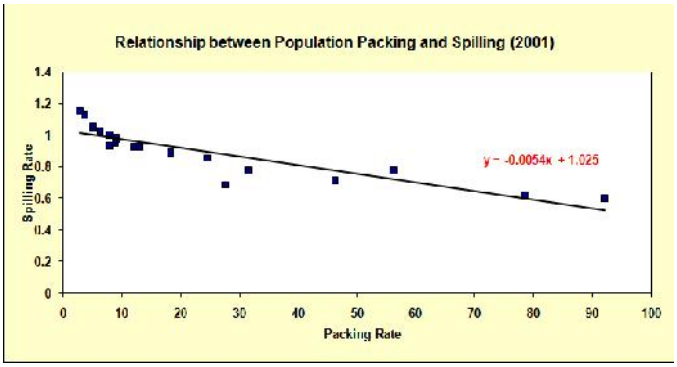

Fig. 8.

A Focus on Demographic Relief: Nucleation or Diffusion

The preceding part harps on the spatial process of nucleation and diffusion considering population as an exponential function of the area. In this part *mouza*-level population density has been calculated directly to measure demographic relief (Guchhait, 2005) and at the same time dynamics of nucleation or diffusion has been examined under the block level. Keeping this point in mind, population density data has been treated through CV (coefficient of variation) calculation in the said time points (Guchhait, 2005). The dataset of each block has been transformed into single CV value for the two time points and subtracting the value of 2001 from 1951 (Table 4) the result embarks on demographic relief.

Table 4. Intra-Block-wise Demographic Relief in Two Time Points in the 20th Century

Blocks	Population Density in 1951 (X)	CV Value in %		Rate of Diffusion (1951 to 2001) [Y]
		1951 (initial Disorder) [X]	2001	
Basanti	215.177	139.47	49.21	90.26
Canning I	274.990	72.68	56.06	16.62
Canning II	238.171	81.12	65.01	16.11
Gosaba	313.222	26.22	24.52	1.70
Hingalgunj	372.067	72.53	66.32	6.21
Hasnabad	472.995	79.38	60.78	18.60 (Q3)
Jayanagar I	567.808	62.50	24.70	37.80
Jayanagar II	341.716	63.17	53.95	9.22
Kakdeep	294.923	126.10	98.26	27.83
Kultali	141.929	48.34	33.78	14.56
Muthurapur I	418.520	47.05	44.31	2.74
Muthurapur II	252.204	83.65	67.44	16.21
Namkhana	151.915	64.53	57.95	6.59
Patharpratima	194.524	77.76	73.49	4.27(Q1)
Sagar	200.607	56.78	44.64	12.14 (Q2)
Sandeshkhali I	263.175	32.30	24.08	8.22
Sandeshkhali II	274.413	22.32	19.73	2.60
Haroa	327.360	84.11	80.18	3.93
Minakhan	351.534	72.38	43.12	29.26

The positive differences are logically addressed as diffusion and converse is the nucleation. From the Table 4, it is clear that all the blocks are showing diffusion in terms of intra-block variation. It is also evident that significant change of CV (diffusion rate) has been found in those blocks where CV was very high initially (high initial disorderness) and insignificant change where it was low in 1951 (Table 4). Thus, a linear trend has been found between the initial disorderness and rate of diffusion. To establish this relationship, linear regression between initial disorderness (X) and rate of diffusion (Y) is employed in Fig. 9, wherein diffusion has been treated as a function of disorderness (Dasgupta & Guchhait, 2012). Here the relationship is discernable because of coefficient of determination is quite enough (0.466). The slope of the regression is 50.81% (0.5081), making a positive influence of disorderness on rate of diffusion.

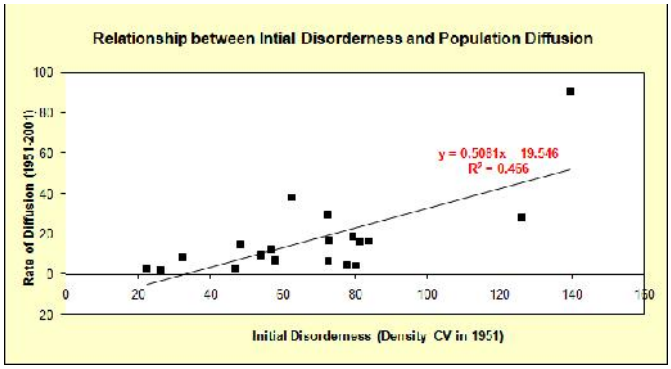

Fig. 9.

The values of diffusion rate are exhibiting quite dissimilar from each other. Hence, the database has been employed in Fig. 10 to get the spatial mosaic of diffusion process. It shows that diffusion process is stronger towards the south of the region and decreases rapidly towards the North. The figure also exhibits a negative association between population density and diffusion rate.

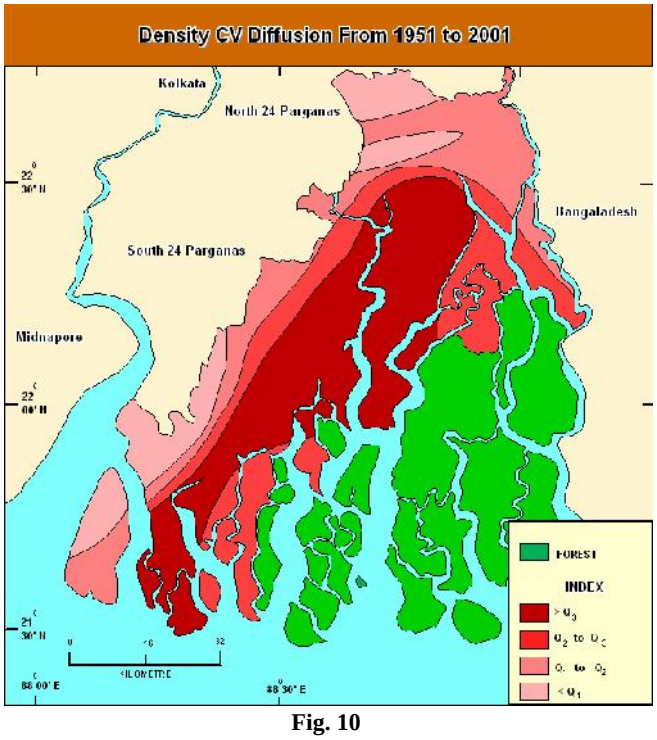

Fig. 10

The blocks with higher population density show low rate of diffusion and low density blocks of south show vice versa. To establish the relationship firmly, regression analysis has been made (Dasgupta & Guchhait, 2012) between initial population density (in 1951) and diffusion rate, wherein diffusion rate (Y) is treated as the function of initial population density (X). A negative trend line (Fig. 11) has been resulted with considerable amount of slope (8.8/ 100 population density) confirming that population is spatially diffused rapidly in the low density blocks. Thus, the blocks reclaimed earlier reached at saturation and eventually people migrated to the southern low density blocks.

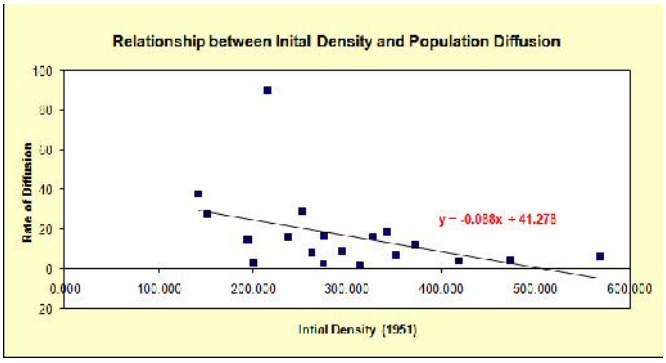

Fig. 11.

DISCUSSION

The whole inquiry includes three-fold analyses by which some blocks have been spotted, wherein momentum of population growth is significantly higher. The first attempt was adoptation of system-component technique by which gaining allometric values have been found in - Basanti, Canning (present Canning I and II), Minakhan, Sandeshkhali (present I and II) and Hingulgunge during the second half of the 20th century. The next attempt of population packing exhibits six blocks – Basanti, Canning I (along the Matla river), Jaynagar I and II, Muthurapur I and II, wherein tremendous growth of population has been observed in the same period. At the last stage of inquiry five blocks show significant higher population diffusion rate (> Q_3) from 1951 to 2001. These are Basanti, Canning I, Jaynagar II, Muthurapur II and Namkhana. Considering these results altogether, only three blocks can satisfy (Table 5) the conditions of implausible growth in the second half of the 20th century. So, the result conclusively signifies the notion of diffusion process and unbridled growth of population, especially in Basanti, Canning I and Canning II.

Table 5. Blocks Showing Tremendous Growth in the 20th Century

Technique	Blocks Response Soundly	Common Blocks
System-Component Growth	Basanti, Canning (include I and II), Minakhan, Sandeshkhali and Hingulgunge	Basanti, Canning I and Canning II (Along Matla River)
Population Packing	Basanti, Canning I, Jaynagar I and II, Muthurapur I and II	
CV Technique	Basanti, Canning I, Jaynagar II, Muthurapur II and Namkhana.	

The most important outcome of this inquiry is concerned with burgeoning growth of population due to affect of partition. The dynamics of growth rate and subsequent diffusion process clearly voice the significant change in the demographic process. If the population would have been increased mainly by internal growth, then growth rate as well as spatial process would remain stationary in the earlier position (in 1951); only magnitude of the growth and process would have been altered. But the result confirms notable change of allometric growth rates and spatial diffusion of population considerably. Thus the reality of partition effect on population dynamics has been grounded from this investigation.

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