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Spatio-Temporal Dynamics of Population Growth of Howrah District in India: An Experience in the 20th Century

Sanat Kumar Guchhait[1], Abhik Dasgupta[2]
[1]*Associate Professor, Department of Geography, The University of Burdwan,*
[2]*Assistant Professor in Geography, Mankar College, Burdwan,*

***Abstract**: The growth of population, especially in the developing countries shows rapid increasing trend due to higher rate of fertility and declining trend of mortality rate. It reaches to an explosive situation if the province or the region experiences high influx of population from the outside. Such a trend of growth is common phenomenon in the countries like India, wherein rural to urban migration leads mushrooming of pocket based population growth. This nucleated effect of population growth later on associated with spill over effect intends to spread of suburbs around the main city. On the other hand, higher rate of fertility in rural areas exerts a pressure on the land and push the population towards urban centre. Hence, this causal relationship between population and land capacity boosting the growth trend and diffuse growth process over the space, however growth rate turns to fall gradually due to effect of space saturation. This growth rate along with its dynamic behaviour exhibits a strong relationship among the population density, land capacity and space characteristics. In India, after achieving Independence population increased rapidly, though growth rate shows a declining trend, especially for those region wherein city population proceeds towards saturation level. This alienation of population growth and growth rate unfolds dynamic behaviour of growth process in terms of space and time. Our present investigation aims to capture this growth dynamics of Howrah district which is densest populated district of most dense populated province (West Bengal) in India.*

***Key Words:** Demographic surface, demographic relief, growth momentum, space saturation*

I. Introduction

A district or an urban area experiencing moderate natural increase coupled with huge migration normally shows rapid growth of population. It attempts to an explosive situation if population growth by vital rates as well as migration is continued over a long period of time (Guchhait, 2005). This trend of growth is common phenomenon in India, wherein rural to urban migration acts as a push factor for booming of population in the cities. Higher rate of growth in rural areas exerts a pressure on land and subsequently intensifies migration of unadjusted rural population normally to the urban areas (Khullar, 2006). Such a continuous process over a considerable period of time leads to saturation of population in the inner cities. Continued growth thereafter necessitates suburbanisation around the main city. Hence, this both way relationship between rural push and urban crowding encourages growth diffusion from the urban core; however growth rate tends to fall gradually due to effect of space saturation. Present investigation has been designed to capture the growth rate dynamics of population of Howrah district, the most densely populated district of densest populated province (West Bengal) in India.

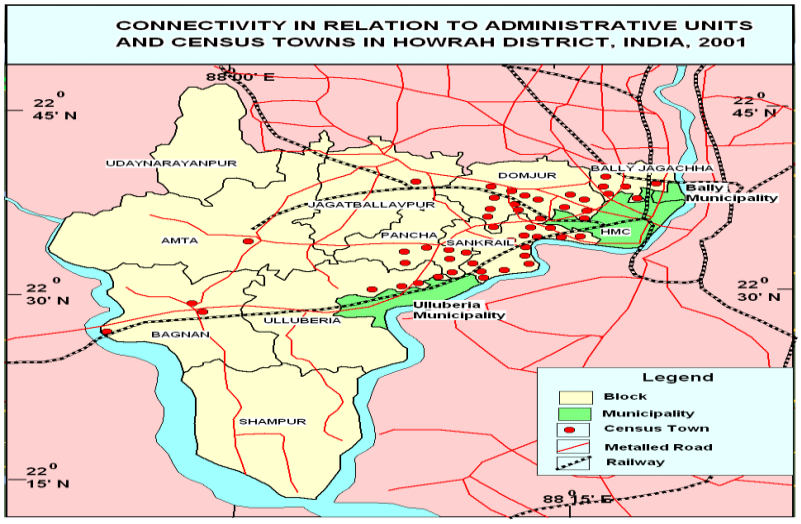

Fig 1

II. Area under Study

Howrah, most densely populated district of second densely province of India has been considered for intricate spatial demography. The district has been formed by the process of sedimentation by the Hooghly-Bhagirathi river system - the main branch flows along the eastern border of the district. Located in the humid tropical climate entire geographical area is characterized by fertile agricultural land as well as potential storage of groundwater. Geographically the area extends from $22^0$13'32" N latitude to $22^0$48'20"N latitude, $87^0$52'20"E longitude to $88^0$23'15"E longitude. The district is pronounced with industrialization and intense urbanization along the eastern part while rest of the area has an imprint of prosperous agriculture, mainly paddy and jute. In terms of railway transport system, Howrah Municipal Corporation (HMC) is the focal point of the Eastern and the south-eastern railway. G.T. road, the main artery for road transport system is extended from the main city to the western part of the district.

III. Demographic Perspective: Some Glimpses

Howrah is the densest populated district of West Bengal in India. According to census 2001, it accounts for density of 2913 persons/ km^2 against the West Bengal average of 903 and Indian average of 480. The district is reeling under population pressure as it holds 5.33 % of population of West Bengal occupying only 1.65 % of total area.

After Independence (1947), India experienced a declining death rate due to promotion of health facilities, especially in the rural areas. This considerable fall in the death rate encouraged population growth which was jerked by the partition in 1947, especially for the boarder provinces of India. As a result huge influx of population over a period of thirty years from the East Pakistan (present Bangladesh) and Punjab (Pakistan part) propelled huge growth of population, especially in the four provinces – West Bengal, Assam, Tripura (close to the boarder of East Pakistan) and Punjab (close to the boarder of West Pakistan). After 1971 due to Independence of East Pakistan, West Bengal once again received huge refugee population, especially in the industrial parts (Kolkata, Howrah, Hooghly and North 24 Parganas districts) of the province. On the contrary, birth rate didn't record any remarkable change up to 1991. This delayed response of reduced birth rate and rapid fall of death rate led to burgeoning population throughout the country. Such a huge growth of population adjoin with poverty, unemployment and refugees influx from East Pakistan initiated rapid rural-urban migration with the outcome of pocket based urban growth, especially around the metropolis and large cities (Khullar 2006). Thus, after a period of thirty to forty years these metropolis and cities reached the level of saturation and subsequent spill over towards the peripheral part of cities (Panigrahi 2005). In sequel to this, saturation at core and suburbanisation at periphery has led to a new spatial dynamics in the form diffusion of population within the district. Howrha Municipal Corporation (HMC), the primate city of the district has experienced all mentioned scenario because, after Independence influx population increased population growth and subsequently it arrives at saturation. This saturation later on instigated suburbanisation process in the peripheral blocks (rural administrative unit in India) of the city leading to rapid growth of census town (urban unit as per criterion of Indian census 1991, but not governed by Municipality). This is not verbal statement but the ground reality as number of census towns have increased from 22 in 1961 to 53 in 2001. It is interesting to note that the district had only 21.79 % of urban population in 1961. Now it has increased to 44.81 % (2001) with a hike of 23.02%, whereas net national average has increased only 9.81 %, from 17.97 % in 1961 to 27.78 % in 2001.

Before going into the inns and outs of population dynamics, it is better to focus on the density distribution first, as it acts as threshold of demographic system. The coefficient of correlation between density distribution in the 1901 (initial point) and 2001 (end point) is + 0.92 which significantly indicates higher growth of high density blocks and lower growth of low density blocks. Keeping this reality in mind the density distribution of 2001 has been represented in figure no. 2 as it is replica of density pattern for all the decades. The whole district has been categorised into three groups; low, medium and high density zones signifying distance decay from urban core to rural periphery.

Table 1: Distribution of Population Density in 2001

POPULATION DENSITY (Person/ Km^2) 2001census	FUNCTIONAL OR REGIONAL CHARACTERISTICS OF THE BLOCKS	NAME OF THE BLOCKS
Low (< 2500)	Rural	`Amta, Udaynarayanpur, Shampur, Jagatballavpur, Bagnan
Medium (2500 – 4999)	Rurban	Ulluberia, Pancha, Domjur, Sankrail
High (>4999)	Semi urban and urban	Bally Jagachha and Howrah Municipal Corporation

Source: Calculated from Census 2001

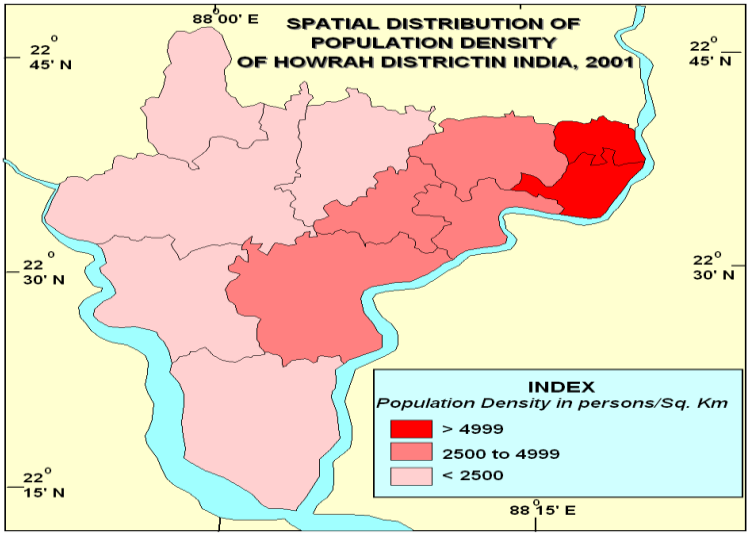

Fig. 2

IV. Materials and Methods

In articulating the spatio-temporal change of growth rate of Howrah district block-wise census data has been taken into consideration. To unfold the nature and dynamics of growth rate of the 20th century block-wise data has been framed through different demographic measures in the time span from 1901 to 2001. It is important to mention that data up to 1981 are available under heads of ten block units; whereas 1991 census has enumerated fourteen blocks due to division of Bagnan, Shyampur and Amta. To take uniformity, block division of 1981 Census has been taken into consideration. Another most important consideration is the inclusion of HMC almost as a block unit. On the other hand, Bally and Ulluberia Municipalities are separate census units located respectively in Bally Jagachha and Ulluberia blocks; however these two urban units have been included under the respective blocks. In addition to this, HMC has experienced change in area coverage from one census year to another. Its area increased significantly from 1961 to 1971 and keeps silence thereafter. In order to retain comparability we have settled for ward division of 1971. It necessarily opts for modification of ward-wise population of HMC in 1961. This enumeration is necessary for the calculation of intra-block density relief.

In order to quantify different aspects of growth rate dynamics univariate and bi-variate statistical techniques have been used in different sections. For understanding inter-block growth rate variation uni-variate statistic has been employed by coefficient of Variation (CV). Bi-variate linear regression is most preferred diagnostic tool to measure estimated growth rate (absolute), whereas curvilinear regression has been applied to glean out the relative growth rate of population of individual block. In the penultimate stage differential calculus is adopted reasonably to detect critical value of population density at the stage of saturation.

V. Temporal change of Growth rate

Now an overview of growth dynamics of Howrah district in the 20th century is essential to get the systematic idea of growth perspective. In order to asses the aspect of growth rate we have treated Howrah district as a system and blocks as the components. For better realisation, we have classified the growth rate into two; firstly absolute change of population density of the blocks and secondly relative growth of the blocks in respect to system.

In understanding absolute growth perspective, block-wise (eleven) population density has taken starting from 1901. To take a systematic glimpse, a time period of fifty years and its successive progression over time has been considered as the basis of calculation of absolute growth rate, like - 1901-1951, 1911-1961, 1921-1971 …… 1951-2001. To address absolute growth rates linear regression $y_c = a + bx$ has been assigned, wherein b stands for linear growth rate. Calculated values presented in table no 2 exhibits an increasing trend of growth rates throughout the district; however intensity of acceleration is not uniform for all the blocks. Urban and rurban blocks exhibit relatively higher increase of growth rates than the rural blocks. The reason behind this is not difficult to perceive. Over the last forty years urban areas of the district have experienced an episode of industrialization and urbanization which triggered unbridled growth of population, especially in the north-eastern part of the district.

It is interesting to note that the blocks with higher growth rate at the initial period (1901-1951) maintain almost same position throughout the different time points signifying growth beget growth. In addition to this, it is clear that inter variation of growth rates (table no -2) among the blocks are progressively reduced with a notion of attaining homogeneity. Now, CV measure is applied to asses inter variation of these growth rates, wherein increase in CV indicates pocket based concentration of growth, while decrease in CV signifies

spatial diffusion. The calculated CV presented in the same table shows a slight falling trend – an indication of spatial diffusion; however at the terminal point it shows a trend of spatial nucleation due to increase in CV value. So, progressively reduced variation over the time signifies homogenization of the growth rates

Table 2: Temporal Change of Block-wise Absolute Growth Rates

Block	Decadal Rate of Density Growth (LINEAR Coefficient)					
	1901-51	**1911-61**	**1921-71**	**1931-81**	**1941-91**	**1951-2001**
Bally	352.8	511.3	658	705.7	960.3	1378
Howrah	1183	1547	2025	1989	2053	2124
Sankrail	95.78	156.3	223	381.3	511.4	658.1
Pancha	59.58	100.1	163.7	249.1	330.9	404.9
Jagatballavpur	71.05	95.29	116.6	143.2	188.6	232.4
Domejur	66.25	98.65	157.1	237.9	328.8	438.4
Uluberia	98.8	128.3	169.7	220.6	288.1	358
Shampur	52.85	75.33	105.8	132.6	169.5	201.1
Bagnan	70.57	100.8	142.8	179	229.7	277.3
Amta	39.13	60.89	92.65	121.1	154.1	181
Udaynarayanpur	38.19	58.67	98.11	137.1	173.2	190
CV	102.4614	103.7839	94.43482	88.32969	88.97229	95.26316

Source: Calculated from Census 1961, 1971, 1981, 1991, 2001

A second tire analysis has been planned to assess the relative growth rate of the blocks. To detect possible change in the relative growth behaviour, the database of population density has been treated by system-component analysis in the same time frame as it was done earlier. The system-component growth is an attempt to address the growth of population density of individual blocks in respect to whole district. This entails the adaptation of the whole district as a system and block as a component. The relative growth rates of components are examined through the power regression in which exponent is the notion of allometry with its value of unity, more than unity and less than unity. The unity (here considers 0.9 to 1.1) denotes the balance growth of the components with respect to the system. Allometry more than one (here > 1.1) means gaining growth and allometry less than one (here <0.9) denotes losing growth with respect to system. The form of equation used in this analysis is $Y= bX^a$, where Y=component, X=system, a=allometry, b= threshold value in relative growth perspective.

Regarding relative growth rate, the calculated allometric values have been tabulated under the head of successive decades (table: 3). It is found that gaining allometric values in the initial period are located in the blocks of Bally and Howrah Municipal Corporation, urban core of the district. Whereas low population density blocks with rural character are stand with loosing allometric values. With the passage of time higher value of relative growth rate (> 1.1) is found to be decreased sharply and at the same time lower relative growth rate value (< 0.9) intends to increase. In the initial period very high (>1.3) and high (1.1 to 1.3) growth rates are concentrated mainly at the north-eastern corner with an area coverage of 6.65%, whereas lower growth relative rate is found to occur in the rest portion of the district (fig. 3a). But at the terminal period relative growth rate has been reversed in comparison to earlier as high relative growth rate is spatially diffused up to the east-central part of the district (fig. 3b). It is interesting to note that in 1951-2001 period no blocks are found to stand with lower relative growth rate and maximum blocks have recorded isometric growth.

Table 3: Temporal Change of Block-wise Relative Growth Rates

	1901-51	**1911-61**	**1921-71**	**1931-81**	**1941-91**	**1951-2001**
Bally	1.809	1.645	1.606	1.37	1.287	1.331
Howrah	1.589	1.467	1.419	1.163	0.884	0.804
Sankrail	0.531	0.637	0.728	0.992	1.073	1.15
Pancha	0.525	0.648	0.812	1.007	1.098	1.134
Jagatballavpur	1.146	1.104	1.043	0.958	1.037	1.101
Domejur	0.547	0.633	0.77	0.95	1.086	1.203
Uluberia	1.027	0.958	0.958	0.999	1.057	1.107
Shampur	0.793	0.834	0.899	0.917	0.974	0.993
Bagnan	0.856	0.894	0.965	0.974	1.027	1.048
Amta	0.546	0.63	0.744	0.82	0.879	0.918
Udaynarayanpur	0.556	0.634	0.797	0.921	0.984	1.006

Source: Calculated from Census 1961, 1971, 1981, 1991, 2001

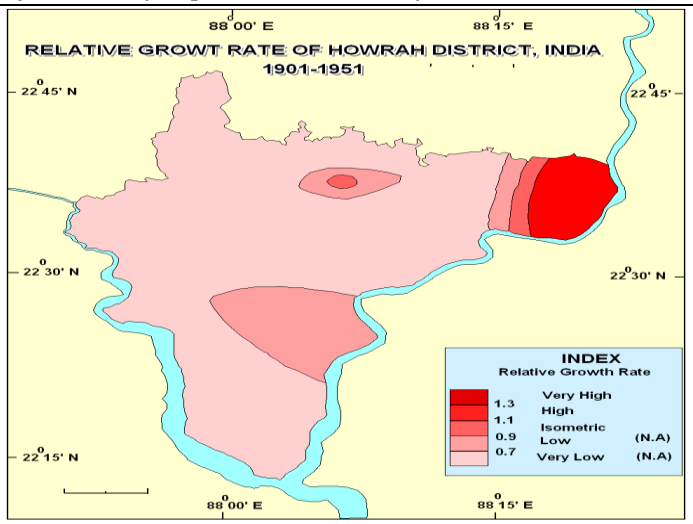

Fig. 3a

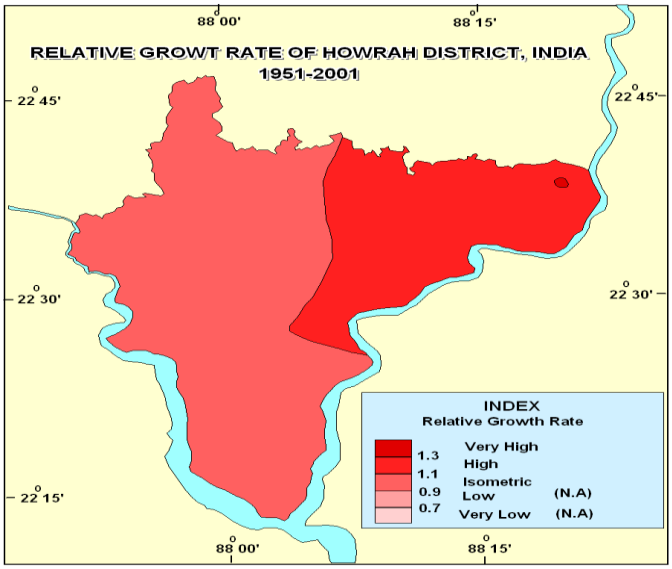

Fig. 3b

The above analysis clearly prompts the impact of urbanisation in the initial phase and this trend confined only in the north-eastern part of the district. Therefore, maximum numbers of blocks stand with lower relative growth rates are located at the western and central part of the district, characterised by agrarian economy. Thus, in respect to growth momentum industrial blocks are standing at better position within the district and represent a confined growth process. On the other hand, during the period of 1951-2001, the blocks with higher population density and higher relative growth rates record significant fall of relative growth rates as they have attained the level of saturation. Therefore, absolute growth rates of population density of those blocks continue to increase due to momentum of urbanisation; however their relative growth rates turn to decline due to space saturation. In the terminal period, on the other hand four blocks – Domjur, Pancha, Sankrail and Ulluberia which are just adjacent to the city core have recorded increasing trend of relative growth rates. This phenomenon is manifestation of suburbanisation process, signifying spatial diffusion of higher growth relatives.

Now it is clear that relative growth rate is more dynamic in comparison to absolute growth rate. The absolute growth rate follows a pattern of colinerity in all time spans, whereas relative growth rate is proofed diabolic from initial to terminal phase. The results also unfold the relationship between population density and relative growth rate. It is the general norms of population dynamics that high density blocks beget more growth rate due to its large population size and growth momentum (Tiwari, 1999). Though, with the progress of time those blocks owing to saturation and discourages growth rate. Present inquiry voices the similar findings. In the earlier periods, high relative growth rate has been found in the high density blocks and vice versa; however with the progress of time this relation turns towards opposite position. In table no 4; coefficient of correlation is measured between population density and relative growth rate to perceive this changing relationship. The correlation values reveal association (0.441, 0.521, 0525, 0.510) in the first four periods and negative

association (-0.285, -0.451) in later two periods. Once again the relationship between absolute growth rate and relative growth rate exhibits the same result. It is expected that higher absolute growth rate intends higher relative growth rate, however this relationship is also bounded by space saturation in respect to time. With the calculation of coefficient of correlation (table no 5) it is easy to perceive the changing dimension (from 0.680 to -0.141) of relative growth rates in respect to absolute growth rates. To find a rigid and logical conclusion attempts have been made to take dissection from different points, like – 1. Dynamics of population density and relative growth rate, 2. Dynamics of absolute growth rate and relative growth rate, 3. Dynamics of time and relative growth rate, where result are critically analysis to dig out the growth rate dynamics with contextual rationale.

Table 4: Association between Population Density and Relative Growth Rate

Period	1901-51	1911-61	1921-71	1931-81	1941-91	1951-2001
Cor (r)	0.44	0.52	0.52	0.51	-0.28	-0.45

Source: Calculated from Census 1961, 1971, 1981, 1991, 2001

Table 5: Association between Population Density and Relative Growth Rate

Period	1901-51	1911-61	1921-71	1931-81	1941-91	1951-2001
Cor (r)	0.68	0.69	0.69	0.60	-0.08	-0.14

Source: Calculated from Census 1961, 1971, 1981, 1991, 2001

VI. Growth rate Dynamics

6.1 Dynamics of Population Density and Relative Growth Rate

It is axiomatically true that population density is more common denominator to address the nature of growth rate either in relative or absolute from. So, to chock out the relationship between population density and relative growth rate we have employed two degree polynomial equation to find out the initial as well as terminal trend of relationship. Here, relative growth rates of six periods – 1901-1951, 1911-1961…..1951-2001 and the population density of same representative periods – 1951, 1961, ……2001 have been taken into consideration. The R square values are satisfactorily high which progressively increase over time (from 0.501 to 0.875).

Equation Set 1: Relation between Population Density and Relative Growth Rate

1901-1951: $y = - 0.395 \text{ X } 10^{-7}x^2 + 0 .00049304x + 0.3707$ (R Square: 0.501)
1911-1961: $y = - 0.204 \text{ X } 10^{-7}x^2 + 0.00031574x + 0.4798$ (R Square: 0.563)
1921-1971: $y = - 0.131 \text{ X } 10^{-7}x^2 + 0.00024657x + 0.5727$ (R Square: 0.624)
1931-1981: $y = - 0.086 \text{ X } 10^{-7}x^2 + 0.00015473x + 0.7228$ (R Square: 0.773)
1941-1991: $y = - 0.050 \text{ X } 10^{-7}x^2 + 0.00093160x + 0.8525$ (R Square: 0.837)
1951-2001: $y = - 0.052 \text{ X } 10^{-7}x^2 + 0.00009699x + 0.8698$ (R Square: 0.875)

All the regression equations show positive relation at initial phase (positive coefficient of x) and negative relation (negative coefficient of x^2) at terminal phase. To detect the exact point wherein relative growth rates turn to decline differential calculus is logically employed, where dy/dx (y_1) is the key point of judgement. By putting $y_1 = 0$, value of x (population density) and value of y (relative growth rate) are easily obtained to detect the critical value of population density beyond which relative growth rates turn out to decrease rather than increase. At the same time maximum value of relative growth rates in different periods can be obtained. All these values are presented in table no. - 5 which clearly indicate that critical population density increases up to 1971 (from 6241.013 to 9411.069); it remains almost static thereafter (within 8995.930 to 9411.069). The reason behind this is not difficult to perceive. In the first three periods, space has enough capacity in holding population, therefore critical value of population density increases. Space saturation afterwards exerts pressure on relative growth leading to fall in allometric values, where the critical value of population density is 9262.24 (average of last four values) for the district. Hence, under the static infrastructural facilities, relative growth rate of a block turns to fall gradually after achieving the population density of 9262.24. Critical value of relative growth rate, on the other is decreasing sharply progressing towards isometry, though a slight increase is found at the end point.

Table 6: Critical Values of Population Density and Relative Growth Rate

Decade	value of x at dy/dx = 0	value of y at dy/dx = 0
1901-1951	6241.013	1.909234
1911-1961	7738.725	1.701513
1921-1971	9411.069	1.732944
1931-1981	8995.930	1.41877
1941-1991	9316.000	1.286439
1951-2001	9325.962	1.322063

6.2 Dynamics of Absolute Growth Rate and Relative Growth Rate

The same process is repeated to dig out the relationship between absolute growth rate and relative growth rate. Here, two degree polynomial equation has been employed to find out the relationship at initial and end period. The R square values of regressions show a stronger association of relative and absolute growth rate and justify the fitness of models.

Equation Set 2: Relation between Absolute Growth Rate and Relative Growth Rate

1901-1951: $y = -0.359 \times 10^{-5}x^2 + .00526x + 0.3699$ (R Square: 0.8113)
1911-1961: $y = -0.145 \times 10^{-5}x^2 + .00286x + 0.5158$ (R Square: 0.7836)
1921-1971: $y = -0.720 \times 10^{-6}x^2 + .00184x + 0.6208$ (R Square: 0.7924)
1931-1981: $y = -0.450 \times 10^{-6}x^2 + .00110x + 0.7550$ (R Square: 0.8635)
1941-1991: $y = -0.380 \times 10^{-6}x^2 + .00790x + 0.8477$ (R Square: 0.8519)
1951-2001: $y = -0.446 \times 10^{-6}x^2 + .00094x + 0.8269$ (R Square: 0.8676)

The equations show positive relation in the beginning and negative relation thereafter. For detection of critical limit of absolute growth rate we have employed differential calculus and derive dy/dx of the equations. All these values exhibited in table no. - 6 signify that up to 1971 critical limit of absolute growth rate is increased; decrease is followed thereafter. The response is same as it was found earlier i.e. decrease in the intake capacity of population due to saturation of densest blocks.

Table 7: Critical Values of Absolute Growth Rate and Relative Growth Rate

Decade	value of x at dy/dx = 0	value of y at dy/dx = 0
1901-1951	732.5905	2.323313
1911-1961	988.2759	1.92907
1921-1971	1277.778	1.821911
1931-1981	1222.222	1.427222
1941-1991	1039.474	1.258292
1951-2001	1053.812	1.322191

6.3 Dynamics of Time and Relative Growth Rate

At the penultimate stage of this inquiry the focus is turn to the relative growth rate in the context of time frame. To fore see complication of dynamics, estimated population density of first half of the 21st century is employed here. This projected outcome will be helpful in understanding the temporal dynamics of relative growth rate over a fairly long period of time. Keeping statistical rationality, second degree polynomial equation has been assigned followed by calculation of relative growth rate for the periods of 1961-2011, 1971-2021……, 2011–2051 respectively. Temporal variation of relative growth rates is now treated under third degree polynomial equations in understanding contemporary (coefficient of x), upcoming (coefficient of x^2) and terminal (coefficient of x^3) growth behaviour. The following equations have been generated by using three degree polynomial equations.

Table 8: Temporal Change of Block-wise Relative Growth Rates (Existing and Projected)

Block / Urban Unit	EXISTING						PROJECTED				
	1901-51	1901-61	1901-71	1901-81	1901-91	1901-2001	1961-2011	1971-2021	1981-2031	1991-1941	2011-2051
Bally	1.809	1.645	1.606	1.37	1.287	1.331	1.353	1.402	1.406	1.18	1.052
HMC	1.589	1.467	1.419	1.163	0.884	0.804	0.758	0.717	0.834	0.799	0.811
Sankrail	0.531	0.637	0.728	0.992	1.073	1.15	1.173	1.164	1.069	1.093	1.047
Pancha	0.525	0.648	0.812	1.007	1.098	1.134	1.116	1.065	1.049	1.07	1.042
Jagatballavpur	1.146	1.104	1.043	0.958	1.037	1.101	1.036	1.003	0.965	0.977	0.955
Domejur	0.547	0.633	0.77	0.95	1.086	1.203	1.174	1.124	1.106	1.093	1.033
Uluberia	1.027	0.958	0.958	0.999	1.057	1.107	1.068	1.021	1.017	1.002	0.969
Sham	0.793	0.834	0.899	0.917	0.974	0.993	0.967	0.926	0.955	0.964	0.94

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Bagnan	0.856	0.894	0.965	0.974	1.027	1.048	1.022	0.978	1	1	0.97
Amta	0.546	0.63	0.744	0.82	0.879	0.918	0.865	0.843	0.884	0.909	0.919
Udaynarayanp	0.556	0.634	0.797	0.921	0.984	1.006	0.939	0.868	0.907	0.962	0.969

Source: Calculated from Census 1961, 1971, 1981, 1991, 2001

Bally: **:** $y = - 0.003337x^3 + 0.6374 x^2 - 0 .4006x + 2.1972$ (R Square: 0.9142)
Howrah: $y = 0.00108x^3 - 0.0004 x^2 + 0 .17269 xs + 1.8194$ (R Square: 0.9507)
Sankrail: $y = - 0.0022x^3 - 0.10405 x^2 + 0 .22476 xs + 0.2753$ (R Square: 0.9556)
Pancha: $y = - 0.0012x^3 - 0.03529 x^2 + 0 .3191x + 0.1944$ (R Square: 0.6662)
Jagatballavpur: $y = - 0.00083x^3 + 0.0156 x^2 - 0 .3158 xs + 1.2249$ (R Square: 0.6572)
Domejur: $y = - 0.000157x^3 - 0.0119 x^2 + 0 .2145x + 0.297$ (R Square: 0.9596)
Ulluberia: $y = - 0.00077x^3 + 0.01083 x^2 - 0 .03213 xs + 1.10158$ (R Square: 0.522)
Shampur: $y = 0.00485x3 - 0.01272 x^2 + 0 .10501 xs + 0.6876$ (R Square: 0.9107)
Bagnan: $y = 0.000387x^3 - 0.01144 x^2 + 0 .09868 xs + 0.757$ (R Square: 0.9025)
Amta: $y = 0.001186x3 - 0.02748 x^2 + 0 .21189 x + 0.3378$ (R Square: 0.9622)
Udaynarayanpur: $y = 0.001914x3 - 0.04301 x^2 + 0 .30778 xs + 0.2418$ (R Square: 0.92)

The above equations represent four types of growth behaviour as mentioned in the table no. 9. These trends exhibit an interesting spatio-temporal dynamics in reference to space relation. Firstly, the blocks with rural character like Udanarayanpur, Shampur, Bagnan, Amta will appear as increasing trend of relative growth rate immediately. Such a contemporary scenario is also found for Domjur, Sankrail and Pancha blocks which are rurban in character. On the other hand, rurban blocks are showing declining trend of growth rate in the upcoming as well as terminal phases due to their near saturation under existing infrastructure. Contrarily the rural blocks will exhibit decreasing trend in the upcoming phase, but it turns out with increasing trend at the terminal phase. With the progress of time maximum part of district would become dense; therefore only the rural blocks will capture the diffused population from urban core.

Table 9: Growth Rate Dynamics and Space Characteristics (Existing and Projected)

Sl no	**Growth Type**	**Blocks**	**Character**	**Population Density (persons/ KM^2)**
1	**INCREASE – DECREASE - INCREASE**	Udaynarayanpur, Shampur, Bagnan, Amta	Rural	1602
2	**INCREASE – DECREASE - DECREASE**	Domjur, Sankrail ,Pnacha,	Rurban	3583
3	**DECREASE – INCREASE - DECREASE**	Bally*, Ulluberia* ,Jagatballavpur**	Semi Urban*, Rural**	9893 2343
4	**DECREASE – DECREASE - INCREASE**	Howrah	Urban	19472

Curiously Bally Jagachha and Ulluberia blocks positioned by two dominant municipalities – Bally and Ulluberia - reveal the same trend behaviour i.e. decreasing response in the contemporary phase, increasing trend thereafter and once again decrease at the terminal phase. The reason behind this u-turn behaviour is not difficult to perceive. In the contemporary phase due to saturation within the municipal area growth rates fall gradually, though this trend turns further due to suburbanisation process along the peripheral part of these Municipalities. However, it will diminish at the terminal phase due to unbridled growth of population attaining almost saturation for entire blocks. The response of Howrah Municipal Corporation is something different. Earlier it is proofed that Howrah Municipal Corporation has reached almost in saturation level, hence it is expected to experience a shirking growth in all the three possible phases. But table no. 8 is showing little deviation because of its increased response in terminal phase, though contemporary and upcoming phases are marked by continuous fall. This seemingly unusual behaviour is relative increase of growth rate in core area (HMC) where

periphery due to its saturation will show the sign of relative stagnation, whereas core is keeping its growth process constant due to its modernised infrastructural facilities.

Panoramic view of district in terms of relative growth is something different from HMC of the urban area. The district as a whole is tending towards uniformity in relation to uniform relative growth rate. To detect this uniformity of growth rate CV is addressed considering one (system value) as the mean value of relative growth rate. The calculated (Table 10) value expressed in the fig no 4 indicates diffusion of relative growth rate up to 1991, slight trend of nucleation thereafter. Immediately after this phase diffusion is continued. This slight alternation is the reflection of rejuvenation of some blocks. It is perhaps the general norms that the blocks stand out with low relative growth rate is suppose to show increasing trend, whereas reverse situation is found for high rate (Guchhait, 2005). With the progress of time the process is reversed (Fig. 5). Afterwards minor changes in growth rate would turn towards uniformity, transforming the whole dynamics as like as a uniform terrain. At the point of uniform juncture, if some blocks rejuvenate, a u turn in growth behavior arise which leads to simultaneity of diffusion and nucleation.

Table 10: Temporal Change of Block-wise Relative Growth Rates (Existing and Projected)

Period	1901-51	1901-61	1901-71	1901-81	1901-91	1901-2001	1961-2011	1971-2021	1981-2031	1991-1941	2011-2051
CV	0.45	0.35	0.28	0.14	0.11	0.14	0.16	0.18	0.15	0.10	0.07

Source: Calculated from Census 1961, 1971, 1981, 1991, 2001

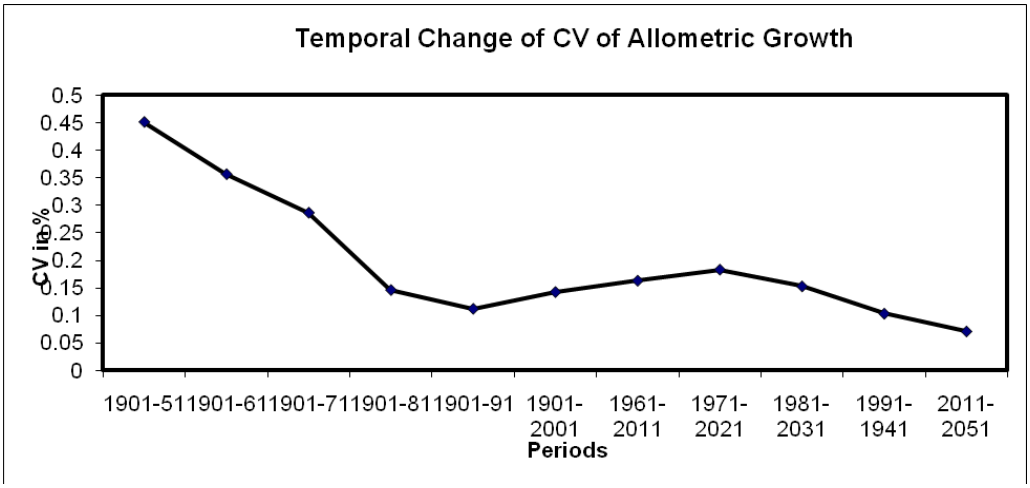

Fig. 4

VII. Conclusion

Present investigation voices the same findings. After 1991 some semi urban blocks exhibit reverse trend in growth rate and it has been estimated that after 2021 some rural blocks would show u turn in trend behavior. Perhaps this simultaneity would continue over a long period as maximum blocks of the district are far beyond from saturation. However, intensity of reverse trend (u turn) would be less with passage of time and thereafter relative growth rate would intend to move with isometry.

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