

Spatio-Temporal Variation in Population Growth of South Bihar Plain: A District Level Study (1901 - 2011)

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Abstract: *Growth of population is an imperative concern, because it is responsible for the management and development of the region. Hence population growth of any region is a crucial factor in the development of its economy. Increasing population helps in providing additional hands to work as well as buyer to the newly produced goods, but beyond a limit extra population becomes burden on the limited resources. Population growth is associated with variety of demographic, socio-economic and cultural factors, and is an important part of population studies. In a developing country like India, and specially state like Bihar and South Bihar plain rapid population growth, caused by high fertility is a big problem. In this research paper we will examine the district wise spatio-temporal variation in growth of population in South Bihar plain and will also project growth of population for each district in future upto 1951, by a suitable method of population forecasting. Through this research paper we will also try to find out the causes behind this unprecedented growth in the study area. South Bihar plain has been formed by the sediments brought down by several rivers, especially river Ganga, therefore, it is very fertile area. Because of the fertility, people attracted to this plain region, and settled over there. It is only because of this fact agriculture has become the main economic activity of this region, especially the food crops, in which paddy is the main crop. In spite of the high growth of population, there is ray of hope, because Bihar's population growth has gone down from 28.62 percent in 2001 to 25.42 percent in 2011, there is a decrease of 3.2 percent, but the density has increased to 1102 persons/square kilometer in 2011 as compared to 881 persons/sq.km in 2001.*

Keywords: Bihar, South Bihar Plain, Spatio-temporal variation, Growth of Population, forecasting

1. Introduction

In 2012 total population of the world exceeded seven billion people, whereas it reached 7.8 billion in 2020, and has been predict to reach 9.6 billion by the year 2050. All these extra people put a strain on our environment, economy, government, social institutions as well as infrastructures. Over population has been a worldwide phenomena, though in some developed countries growth of population has been slowed down. Population growth and their distribution are the key concerns in the study of population in any area. To understand the dynamism as well for planning at the local and regional level, the geographical studies of population growth plays an important role. Population growth refers to the change in size of population, which can be positive and negative because it depends upon the operation of fertility, mortality and migration. If there are many deaths the population will grow very slowly, even it can decline, therefore, it depends upon the balance between birth and death rates. The effect of migration is not so influential as compared to fertility and mortality. High population growth is problem in a less developed country like India, but the low or zero population is also a big problem in highly developed countries. Population is one of the valuable resources for the growth and development of the society and country as a whole and it must be viewed in relation to its natural resources. A country is said to have an optimum population, when the population is in equilibrium with the available resources. In demographic studies growth of population occupy an important place, because it has got direct impact on available resources. This growth of population is easy to measure, because it can be calculated by means of difference between the numbers of population present at two different times.

In population geography, which is a branch of human geography, population growth is simply the increase in the number of people in any area over a period of time. Since the end of the cold war, there has been a sharp rise in the population of sub-Saharan, African, the Middle East, South Asia and South East Asia, which is putting further strain on limited natural resources, fuel supplies, food, employment and housing facilities. The rate of population growth is the rate of natural increase which is also combined with effects of migration.

Contrary to the trend in other states and country as a whole, Bihar as well as South Bihar register a high growth rate, but during 2015-2016 the birth rate in Bihar rose marginally from 26.3 to 26.8. It is obvious when the birth rate reduces, population will grow at lower pace, as has been happening in other Indian states, and India's birth rate is continuously going down from 21.8 to 20.4, in the five years upto 2016. On the contrary Bihar added 2.63 million in 2015 and 2.68 million in 2016, whereas other state added very less as compared of the state of Bihar. Its only because of the fact that the fertility rate i.e., the average number of children born per woman is much higher than the national average, with 3.4 children per woman in Bihar and 2.2 at national level, but the good thing is that it is gradually reducing. In spite of this Bihar makes high in growth rate at nearly 25% which is eight percentage point higher than the national average. One of the interesting thing is that the high birth rate is found in a narrow pocket of Bihar, not across the state. Due to this high growth of population, Bihar is situated in the lower ranges of human development, which has been represented by the indicators of health and education. Alarming population growth in Bihar and South

Bihar plain is a matter of great concern. Professionals should inform people about various approaches to implement family planning and only because of this fact, statistical report of Sample Registration System (SRS) in 2016 registered a decline of in fertility rate from 4.3 children per woman to 3.3, however it is higher than the national ratio of total fertility rate of 2.3.

2. Study Area

South Bihar plain is the southern part of Bihar state, and is located in eastern part of India. South Bihar is located between 25°30'21" north to 24°46'48" north latitude and 83°36'20" East to 86°59'20" East longitude, It is bounded by river Ganga, and North Bihar plain on the northern side of river Ganga, whereas, Chotanagpur plateau in the south, Bengal Basin in the east and Ayodhya plain in the west. It extends across central part of Bihar and covers an area of nearly 44900 square kilometer. This area, once has been a centre of Buddhism, and has also been referred in the Hindu epics Ramayan and Mahabharata, South Bihar plain is a part of Indo-Gangetic trough, where the elevation decreases from 500 feet in the south to only 100 feet towards North. Main river in this plain area is river Ganges, which receives other rivers criss crossing the area. Due to the plain area, it has become the site of major centre of population, industry, transport and commerce, etc. and is a land of agriculture, because it can be cultivated easily due to productive soil brought down by the Ganges as well as other rivers. South Bihar plain experiences continental climate with three district seasons. Cold weather season is characterized by low temperature and, with clear sky and low humidity, whereas, hot weather season is characterized by high temperature ranging between 29°C to 40°C. Monsoon season characterized by low pressure developed over plain, which causes sudden arrival or monsoonal wind with heavy shower. More than 70% rainfall occurs in this season. Hence, the climate of Bihar may be called as monsoonal type.

As the south Bihar plain is formed due to the deposition of sediments, brought by river Ganges and other rivers, therefore, this region is dominated by alluvial soil, which is very fertile and leads to agriculture as the main stay of economy.

3. Objective of the Study

This research paper has been designed to understand the spatio-temporal variation in Growth and Trend of population in South Bihar plain, at district level from 1901 to 2011, as against state as a whole, which influences the overall socio-economic structure of the study area. We will also try to find out different causes behind the unprecedented growth in population, and will also forecast the growth of population upto 2051, so that it may help the planners in designing future plan of this region. Therefore, present study is based on two fold objective, first to have a comprehensive demographic study in the context of population growth at district level and second to analyse the spatial and temporal variation in growth of population.

4. Database and Methodology

The present study shows the district wise comparative analysis of decadal variation in population from 1901-2011. Therefore, this research paper will be based primarily on the secondary source of data in published from specially, different census reports, NITI Ayog report on birth and death rate, District census handbook of different districts of South Bihar plain, as well as office of Director, Census of Bihar. The study area extends over seventeen districts in the South of Bihar Plain. Therefore, for the purposeful organization of data, the relevant data has been tabulated, computed and analysed with suitable statistical methods and cartographic technique which includes choropleth map, Bar graph and line graph.

Spatio temporal analysis of population growth must be studied temporally, apart from spatially. Therefore, it must be analysed in five perspective too. The present research paper covers a time period right from 1901 to 2011, but the census year of 1951 should be considered as a cutoff year in the population growth, because after 1951, growth of population occurred at faster pace. In 1951 India witnessed a growth rate of 13.31 percent which was lesser than the growth rate of 1941, but from 1961 there has been a phenomenal increase in the growth rate. If we see the growth rate of population in Bihar it was 10.58 percent in 1951, but after 1961, it increased at faster pace and reached upto 25.42 percent in 2011, almost same conditions prevail in South Bihar plain, 1961 witnessed a growth of rate of 17.42 percent which increased upto 23.64 percent, therefore, 1951 should be taken as a cutoff point, but we have tried to explain from 1901 onward.

Due to unavailability of data on death rate and birth rate it will be analysed within limited period, but will show, how death rate and birth rate influences the growth of population of the study area.

In the present research paper population forecasting will be done by means of Arithmetical Increase Method. This method is suitable for the area, which has done considerable development, and are old and large. This method is based on the assumption that the population is increasing at a constant rate, it means that the rate of change of population with time is constant. In this method per decade average increase in population is calculated from the past census report. To find out the population of the next decade, this increase is added to the present population, therefore, it has been assumed that the population is increasing at a constant rate.

Hence, $dP/dt = C$ (Constant)

Now the population after n^{th} decade can be determined by formula.

$$P_n = P + n \cdot C$$

Where,

P_n is the population after n^{th} decade

P is the present population

n is the number of decade

C is the average increment (Constant)

5. Spatio-temporal variation

On the basis of the census data available we will analyse growth of population since 1901 to 2011 in South Bihar plain as against state as a whole. Since the census data regarding population growth from 1901 to 1951 is not regular, and there is fluctuation in the growth of population

during this period, therefore, we will not go into detail account during this period, but a detailed account will be presented after 1951. An analysis of the district level data of growth of population, since 1901 shows a significant variation in population growth rate, due to variation in socio-economic and cultural characteristics, which influence the fertility and to some extent migration.

Table 1: Decadal Growth of Population

S. N.	State/District	1901		1911		1921		1931		1941		1951	
		Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth
	Bihar	21,243,632		21,567,159	+1.52	21,358,905	-0.97	23,438,371	+9.74	26,302,771	+12.22	29,085,017	+10.58
	South Bihar	7,726,840		7,744,260	+0.23	6,726,154	-13.14	8,565,009	+27.34	9,107,015	+6.33	11,278,848	+23.84
1	Banka	418,997		426,110	+1.70	397,570	-6.70	458,161	+15.24	523,596	+14.28	587,760	+12.25
2	Bhagalpur	599,746		609,927	+1.70	569,075	-6.70	655,803	+15.24	749,465	+14.28	841,309	+12.25
3	Munger	339,678		350,312	+3.13	333,110	-4.91	375,095	+12.60	424,049	+13.05	468,646	+10.52
4	Lakhisarai	229,288		236,466	+3.13	224,854	-4.91	253,195	+12.60	286,239	+13.05	316,343	+10.52
5	Sheikhpura	152,726		157,460	+3.10	149,761	-4.89	168,687	+12.64	190,743	+13.08	210,915	+10.58
6	Nalanda	595,009		589,310	-0.96	577,663	-1.98	676,424	+17.10	785,619	+16.14	926,189	+17.89
7	Patna	1,028,073		1,018,226	-0.96	998,101	-1.98	1,168,744	+17.10	1,357,416	+16.14	1,600,295	+17.89
8	Bhojpur	641,566		609,751	-4.96	593,796	-2.62	652,468	+9.88	762,131	+16.81	879,888	+15.45
9	Buxar	391,371		371,963	-4.96	362,231	-2.62	398,022	+9.88	464,919	+16.81	536,754	+15.45
10	Kaimur (Bhabua)	317,384		301,646	-4.96	293,753	-2.62	322,778	+9.88	377,028	+16.81	435,283	+15.45
11	Rohtas	606,016		575,964	-4.96	560,894	-2.62	616,315	+9.88	719,901	+16.81	831,133	+15.45
12	Aurangabad	467,445		489,924	+4.81	488,092	-0.37	541,490	+10.94	629,204	+16.20	696,115	+10.63
13	Gaya	791,096		829,139	+4.81	826,039	-0.37	916,408	+10.94	1,064,854	+16.20	1,178,093	+10.63
14	Nawada	412,119		412,119	+0	430,323	4.42	477,400	+10.94	554,733	+16.20	613,724	+10.63
15	Jamui	345,129		355,934	+3.13	338,455	-4.91	430,855	+12.60	476,167	+13.05	573,834	+10.52
16	Jehanabad	237,802		249,238	+4.81	248,306	-0.37	275,471	+10.94	320,093	+16.20	354,133	+10.63
17	Arwal	153,395		160,771	+4.81	160,170	-0.37	177,693	+10.94	206,477	+16.20	228,434	+10.63

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	State/District	1961		1971		1981		1991		2001		2011	
		Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth	Persons	Percentage Growth
	Bihar	34,840,968	+19.79	42,126,236	+20.91	52,302,665	+24.16	64,530,554	+23.38	82,998,509	+28.62	104,099,452	+25.42
	South Bihar	13,243,935	+17.42	16,148,533	+21.93	20,073,076	+24.30	24,399,221	+21.55	31,181,241	+27.79	38,551,925	+23.64
1	Banka	688,814	+17.19	840,749	+22.06	1,038,674	+23.54	1,292,504	+24.44	1,608,773	+24.47	2,034,763	+26.48
2	Bhagalpur	1,022,322	+21.52	1,250,354	+22.31	1,582,753	+26.58	1,909,967	+20.67	2,423,172	+26.87	3,037,766	+25.36
3	Munger	555,833	+18.60	657,390	+18.27	801,071	+21.86	943,583	+17.79	1,137,797	+20.58	1,367,765	+20.21
4	Lakhisarai	352,448	+11.41	439,256	+24.63	533,840	+21.53	646,395	+21.08	802,225	+24.11	1,000,912	+24.77
5	Sheikhpura	246,528	+16.89	294,826	+19.59	350,677	+18.94	420,260	+19.84	525,502	+25.04	636,342	+21.09
6	Nalanda	1,086,972	+17.36	1,304,832	+20.04	1,639,922	+25.68	1,996,257	+21.73	2,370,528	+18.75	2,877,653	+21.39
7	Patna	1,861,811	+16.34	2,250,883	+20.90	3,019,201	+34.13	3,618,211	+19.84	4,718,592	+30.41	5,838,465	+23.73
8	Bhojpur	1,021,109	+16.05	1,230,052	+20.46	1,490,714	+21.19	1,792,771	+20.26	2,243,144	+25.12	2,728,407	+21.63
9	Buxar	635,988	+18.49	765,094	+20.30	916,886	+19.84	1,087,676	+18.63	1,402,396	+28.94	1,706,352	+21.67
10	Kaimur (Bhabua)	526,251	+20.90	656,905	+24.83	783,045	+19.20	972,949	+24.25	1,275,579	+31.10	1,626,384	+27.50
11	Rohtas	1,024,133	+23.22	1,286,983	+25.67	1,583,280	+23.02	1,927,736	+21.76	2,464,243	+27.83	2,959,918	+20.11
12	Aurangabad	830,989	+19.38	1,016,094	+22.28	1,237,072	+21.75	1,539,988	+24.49	2,013,055	+30.72	2,540,073	+26.18
13	Gaya	1,392,472	+18.20	1,725,583	+23.92	2,150,406	+24.62	2,664,803	+23.92	3,473,428	+30.34	4,391,418	+26.43
14	Nawada	741,633	+20.84	893,937	+20.54	1,099,177	+22.96	1,359,694	+23.70	1,809,696	+33.10	2,219,146	+22.63
15	Jamui	573,834	+20.51	713,736	+24.38	862,589	+20.86	1,051,527	+21.90	1,398,796	+33.03	1,760,405	+25.85
16	Jehanabad	415,062	+17.21	495,614	+19.41	599,143	+20.89	709,862	+18.48	926,489	+30.52	1,125,313	+21.46
17	Arwal	267,736	+17.20	326,245	+21.85	384,626	+17.89	465,038	+20.91	587,826	+26.40	700,843	+19.23

Source: Census

5.1 Growth of population (1901-1921)

Trends of population on growth in Bihar and South Bihar plain has been given in Table 1. A close look at the table shows that there has been a significant divide in the trends of population growth in the study area and State as a whole. From 1901-1921, Bihar plain as well as state of Bihar witnessed sporadic, irregular and very slow growth of population, which can be better known as period of stagnation. In 1911 the percentage decadal growth of population in Bihar was 1.52 percent, whereas, in South Bihar plain it was only 0.23 percent, which is far lesser than the state growth rate. If we see the district wise growth rate in South Bihar plain, out of seventeen districts six districts recorded negative growth rate. These are four districts which recorded maximum growth rate upto 4.81 percent, which includes districts of Aurangabad, Gaya, Jehanabad, and .

If we see the percentage decadal growth rate in 1921 it witnesses a negative growth rate in Bihar with a percentage negative growth of -0.97 percent, whereas, Bihar plain records much higher negative growth rate of -13.14 percent. If we go through the districts of South Bihar Plain, we find that there is only one district, Nawada, which has observed a positive growth rate of 4.42 percent and rest of the districts recorded a negative growth rate. This low growth of population was only because of high birth rate which was counterbalanced by high death rate. The census 1921 registered a negative growth rate, which happened only once throughout the demographic history of India, as well as in Bihar and North Bihar plain. It is only because of this fact that year 1921 is known a great divide. This negative growth of population during 1901 to 1921 may be attributed to abnormal deaths due to epidemics like influenza, plague, smallpox and cholera etc. Apart from this there was a regular drought in 1911, 1913, 1915, 1918 and 1920, which causes shortage of food which took heavy toll of life. The Spanish influenza pandemic 1917/18 took millions of lives, which also reduced the number of people in their reproductive age.

5.2 Growth of population (1921-1951)

During 1921-51, the growth of population has been quite high, it is only because of the fact that 1921 witnessed a decline in growth rate. In 1931, Bihar registered a decadal growth rate of 9.74 percent, but South Bihar registered a growth rate of 27.34 percent which is three times higher than the state growth rate of only 9.74 percent. If we go through the growth rate of all the districts in South Bihar plain, we come across that almost all the district registered positive growth rate that is higher than 9 percent in all the districts. Out of the seventeen districts, Banka and Bhagalpur registered highest growth rate of 15.24 percent, both. Almost same trend prevails in 1941, Bihar recorded a growth rate of 12.22 percent which is 2.48 percent higher than the previous decade, but South Bihar plain registered a growth rate of 6.33 percent, which shows a decline of 21.01 percent. If we look at all the district we find that almost all districts have registered a growth rate which is higher than 13 percent, but highest percentage has been recorded by four districts, namely, Bhojpur, Buxar, Kaimur and Rohtas with a growth rate of 16.81 percent.

In the year 1951, Bihar recorded a growth rate of 10.58 percent, which is again lesser than previous decade, when 1941 registered, 12.22 percent. It means there is a decrease of 1.64 percent, but surprisingly South Bihar plain registered a growth rate of 23.84 percent, which is much higher than Bihar and 17.51 percent higher than the previous decade 1941. If we look at the districts of South Bihar plain we find that two districts have registered a growth rate of 17.89 percent, and the name of the district are, Patna and Nalanda.

During this period from 1921-1951 North Bihar plain and State of Bihar witnessed sporadic and irregular growth, but during this thirty years, Bihar and North Bihar plain registered a positive growth rate, and it may be called as a period of steady growth rate, in spite of the fact that there has been a decline of growth rate in 1941 in Bihar plain. This steady growth of population during these 30 years may be attributed to the fact that mortality rate started showing downward trend, which is simply due to the improvement in general health and awareness towards sanitation conditions, which helped in controlling epidemics like plague, cholera and malaria. Decline in death rate may also be attributed to the improvement in the public distribution system, by means of improved transportation system, which helped in supply of food to drought and famine stricken area.

5.3 Growth of population during 1951-61

This period of 1951-61 may be regarded as a period of rapid growth in the state of Bihar, because percentage growth rate has increased from 10.58 in 1951 to 19.79 in 1961, but South Bihar plain recorded 17.42 percent in 1961 as compared to 23.84 in 1951, there is a decline of 6.42 percent, which may be attributed to the socio-economic backwardness, but, higher growth rate in state of Bihar may be attributed to the development of trade, transport, employment, education and medical facilities. The living conditions of the people improved enormously. Death rate also declined at faster rate, which resulted in high natural increase of population in the state as a whole. If we go through the districts of South Bihar plain only Rohtas recorded the highest growth rate of 23.22 percent which is followed by Bhagalpur with 21.52 percent and Nawada 20.84 percent, whereas the lowest growth rate was recorded in Lakhisarai with a growth rate of only 11.41 percent. This increase in population in Rohtas may be imparted to literacy and awareness towards the health and sanitation facilities. If we see the growth pattern in 1961, we will find that most of the southern districts recorded highest growth rate like Rohtas, Nawada, Jamui, even Gaya, whereas eastern districts Bhagalpur also recorded high population growth of 21.52 percent.

If we classify the South Bihar plain according to decadal percentage growth in 1961 into low (below 15), moderate (15-20) and high (20-25), there is only one district which recorded low population growth, named as Lakhisarai with a growth rate of only 11.41 percent, whereas eleven districts named as Banka, Munger, Sheikhpura, Nalanda, Patna, Bhojpur, Buxar, Aurangabad, Gaya, Jahanabad and Arwal, show a moderate decadal growth of population. On the other hand only five districts, named as Bhagalpur, Kaimur, Rohtas, Nawada and Jamui recorded a highest growth rate between 20-25 percent.

5.4 Growth of Population during 1961-71

Table 1 shows that in 1971 the decadal percentage growth of population in Bihar is 20.91 percent as compared to 19.79 in 1961, it means there is an increase of 1.12 percent, but the growth rate of Bihar plain in 1971 is greater than the state of Bihar, with a growth rate of 21.93 percent which is 4.51 percent more than the growth rate of 1961. This increase in population may be due to better technique of farming, communication and transport facilities, urbanization, development of industries and acceleration in agricultural activities, as well as decline in death rate due to health facilities. If we go through the district wise growth rate in South Bihar plain we find that all the districts except three districts namely Munger, Sheikhpura and Jehanabad have registered growth rate below 20 percent. Amongst all the seventeen districts of South Bihar plain, Rohtas recorded highest growth rate with a percentage growth of 25.67 percent which is followed by Kaimur which recorded decadal percentage growth of 24.83 percent, Lakhisaran with a growth of 24.63 percent and Jamni with a percentage growth of 24.38 percent, whereas the lowest growth rate was observed by Munger with a growth rate of 18.27 percent only. Apart from the three districts which recorded highest growth rate, Lakhisaran recorded highest growth rate from the previous decade of 1961, when it recorded only 11.41 percent, it means there is a growth difference of 13.22, which is much higher than the difference in any other districts from the previous decade. This variation may be due to local socio-economic conditions. There was a steep fall in the mortality rate but the fertility remained high, and only because of this, high rate of population growth upto 24.83 percent was recorded. It may be also attributed to post war development, which led to better medical facilities, and due to this death rate had fallen considerably during this decade.

If we divide the districts of South Bihar plain according to the percentage decadal growth into low (below 20), moderate (20-25) and high (above 25). There are only three districts, namely Munger, Sheikhpura and Jehanabad come under below 20 percent growth rate, whereas, 13 districts namely, Nalanda, Patna, Bhojpur, Buxar, Kaimur, Aurangabad, Gaya, Nawada, Jamui, Arwal, Banka, Bhagalpur and Lakhisaran recorded moderate level of decadal percentage growth of population; Rohtas is the only one district which comes under high growth of population with a growth rate of 25.67 percent. It is also important to note that in the previous decade Rohtas had already recorded highest growth rate of 23.22 in 1961, with an increase of 2.45 percent.

5.5 Growth of population during 1971-81

During this decade Bihar witnessed highest growth rate since 1901, with a growth rate of 24.16 percent, whereas South Bihar plain also shows almost same growth rate of 24.30 percent which is 2.37 percent higher than the previous decade of 1971. Similarly Bihar has also recorded 3.25 percent higher growth than 1971, which is also greater than South Bihar plain. Amongst all the seventeen districts there are only four districts, namely Sheikhpura, Buxar, Kaimur and Arwal, which have recorded growth rate below 20 percent. This unprecedented growth rate was due to

accelerated developmental activities as well as improvement in the health facilities. There have been an enormous change in the living condition of the people and death rate started declining faster, which resulted into high growth of population not only in Bihar but in South Bihar plain.

If we carefully look at the growth rate of all the districts of the study area we find that, Patna recorded the highest growth rate of 34.13 percent which is much higher than the previous decade with a growth rate of 20.90 in 1971, which is 13.23 percent higher. Patna is followed by Bhagalpur with a growth rate of 26.58 percent, and Nalanda with a growth rate of 25.68 percent, but the lowest growth of population was recorded by Arwal, with a growth rate of only 17.89 percent, which is almost half of Patna. The stratification of growth rate shows that there are four districts, namely, Buxar, Kaimur, Arwal and Sheikhpura come under low population growth (below 20), whereas, ten districts, namely, Munger, Lakhisarai, Bhojpur, Rohtas, Aurangabad, Gaya, Nawada, Jamui, Jehanabad and Banka come under moderate growth of population (20-25 percent). Apart from these ten districts, two districts namely Bhagalpur and Nalanda come under high growth rate (25-30 percent), whereas only one district namely Patna recorded very high growth rate (above 30).

5.6 Growth of population during 1981-91

Bihar recorded a growth rate of 23.38 percent, which is little lesser than the previous decade 1981, almost same pattern has been observed in South Bihar plain with a growth rate of 21.55 percent which is 2.75 percent lesser than the previous decade. If we look at the growth rate of districts of the study area we find that the same pattern has been observed here. Most of the districts have recorded lower growth rate as compared to the previous decade 1981. In 1991, the highest growth rate has been registered by Aurangabad, with a growth rate of only 24.49 percent whereas in 1981 Patna recorded 34.13 percent, which has been reduced to only 19.84 percent in 1991. Aurangabad with highest growth rate has been followed by Banka (24.44 percent) and Kaimur (24.25 percent) whereas the lowest growth rate has been observed by Munger, with a growth rate of 17.79 percent, which is 4.07 percent lesser than the previous decade of 1981. If we go through the district level growth in 1991. We find that there are five districts, namely, Munger, Sheikhpura, Patna, Buxar and Jehanabad, have registered growth rate below 20 percent.

This second last phase of 20th century, that is between 1981-91 shows a definite sign of slowing down, because the rate of growth was higher in 1981, but it declined after 1981 right from Bihar to South Bihar plain, as well as at district level. This declining trend may be called as the beginning of the new era, in the state as well as South Bihar plain, because the birth rate declined rapidly and death rate continued to be at slower pace. This declining trend is a positive indicator of birth control and people's own inclination towards small families. District wise growth rate reflects that only five districts namely Munger, Patna, Sheikhpura, Buxar and Jehanabad recorded low growth of population (below 20 percent) whereas, twelve districts,

namely, Banka, Bhagalpur, Lakhisarai, Nalanda, Bhojpur, Kaimur, Rohtas, Aurangabad, Gaya, Nawada, Jamui and Arwal registered moderate growth of population (20-25 percent), but amongst these seventeen districts no one recorded high population growth (25-30 percent).

5.7. Growth of Population during 1991-2001

There is a sharp increase in the decadal growth of population in Bihar from 23.38 percent in 1991 to 28.62 percent, an increase of 5.24 percent. It is the highest growth rate since 1901 in Bihar. Almost same condition prevails in South Bihar plain with a decadal increase of 27.79 percent which is also highest since 1901. If we go through the district level growth we find that highest growth rate has been registered by Nawada, with a growth rate of 33.10 percent, which is followed by Jamui (33.03 percent) and Kaimur (31.10 percent). It is important to note that during this decade only one district has recorded low growth of population (below 20 percent), named as Nalanda (18.75 percent). It may be due to continued surge in the past decade, with the state being among the top three populated states of the country. The population density per square kilometer is also very high 881 persons/sq.km. in 2001 which has been increased to 1102 persons/sq.km. in 2011. It is important to note that Patna, Gaya, Nawada, Jamui and Jehanabad have contributed much to the growth of population in South Bihar plain. Patna is a capital and primate city of Bihar. The capital and division headquarters have more pull factors for the migrants. In the same way Gaya is also a tourist place for Hindus and Buddhist, as well as a centre of learning, therefore it attracted people from different area.

There is only one district, namely Nalanda recorded low growth of population (below 20 percent), whereas only three districts namely, Banka, Munger and Lakhisarai recorded moderate growth rate of population (20-25 percent). On the other hand as many as six districts reported high growth rate (25-30 percent). These districts are, Bhagalpur, Sheikhpura, Bhojpur, Buxar, Rohtas and Arwal. Very high growth rate (30-35 percent) was recorded by seven districts, namely, Patna, Kaimur, Aurangabad, Gaya, Nawada, Jamui, and Jehanabad.

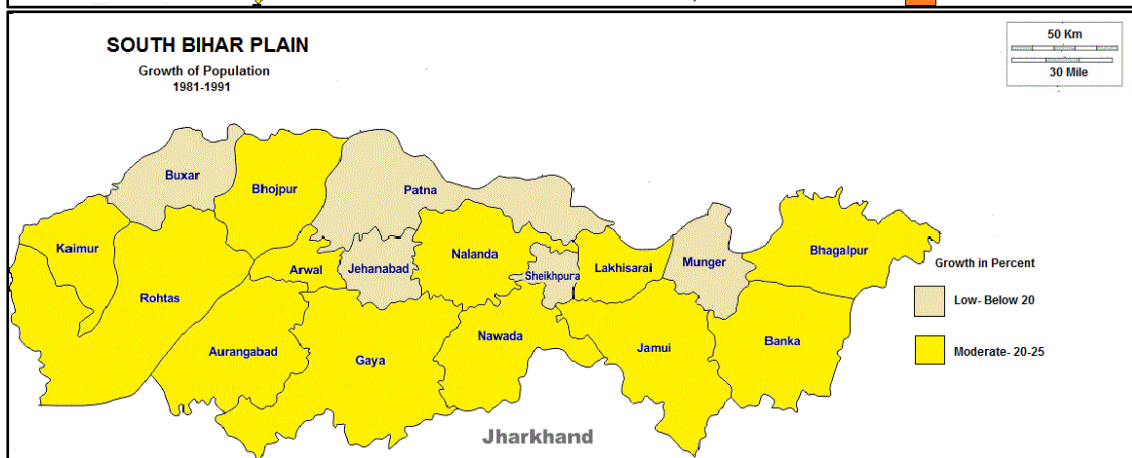
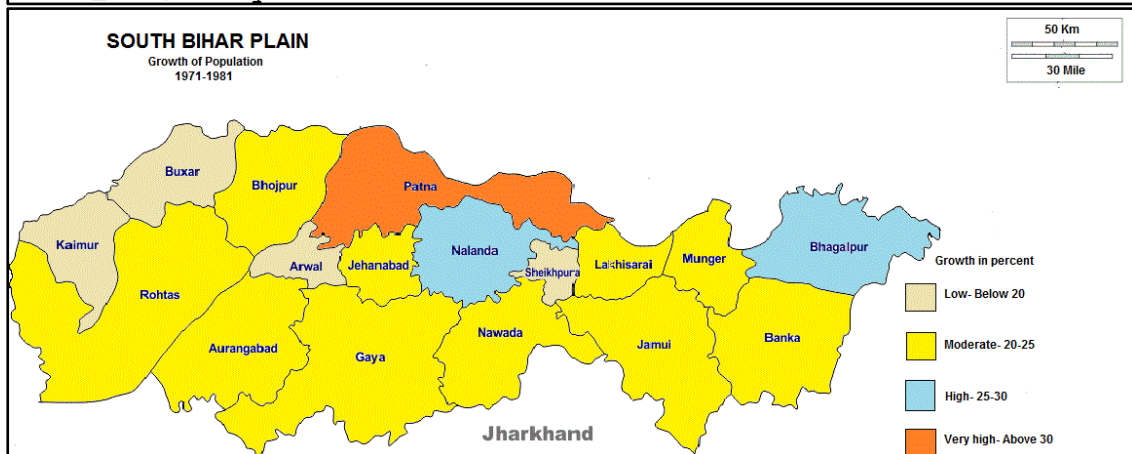
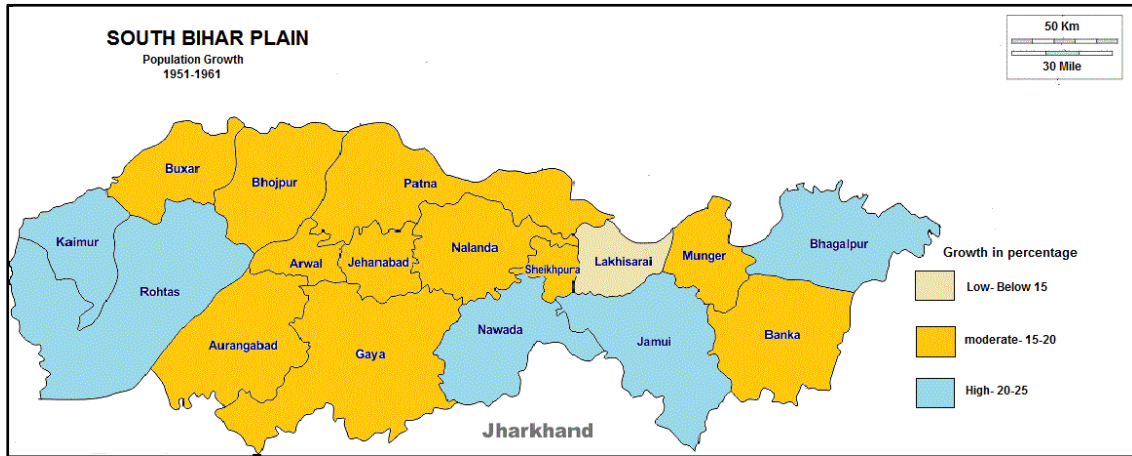
5.8 Growth of Population during 2001-2011

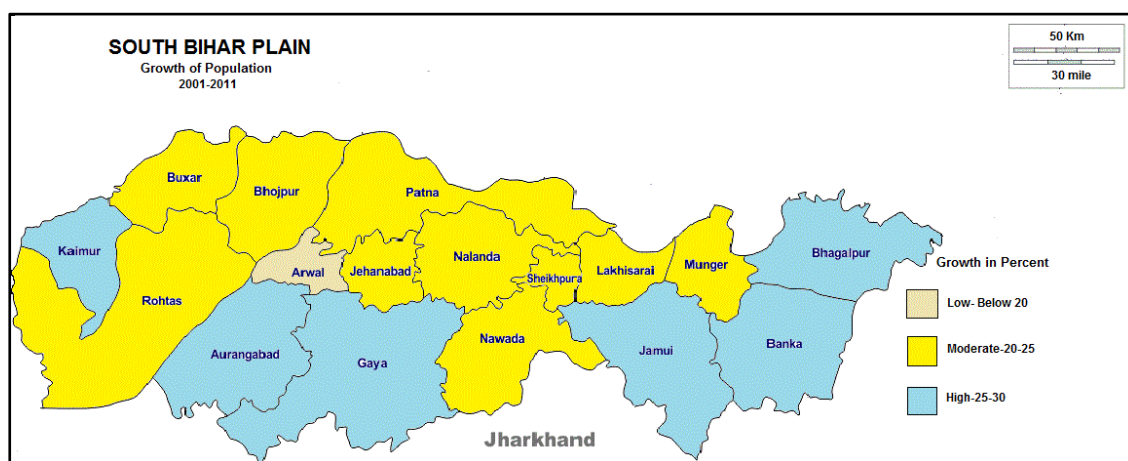
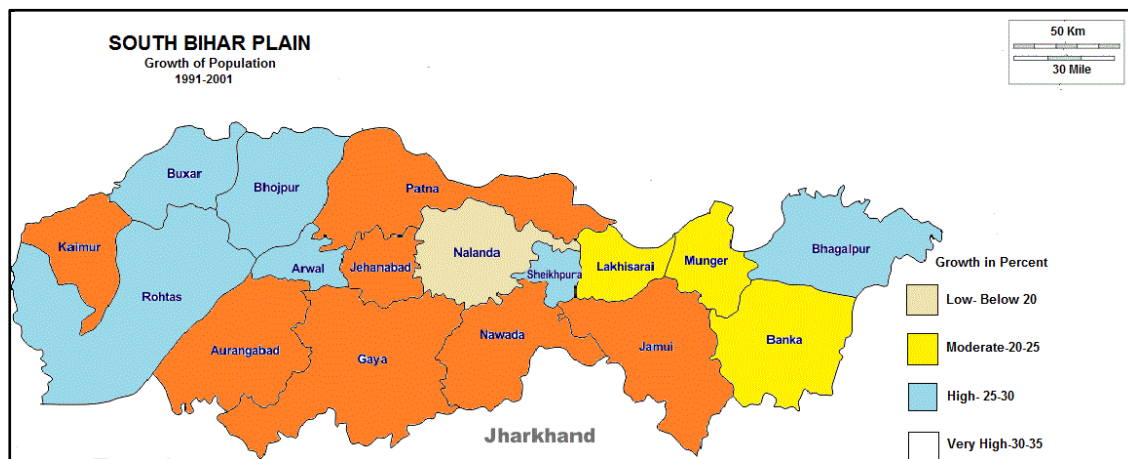
There has been decline of percentage growth of population in 2011 from the previous decade, with growth rate of 25.42 percent in Bihar, which is 3.2 percent lesser than the previous decade. South Bihar plain also shows the same

trend with a growth rate of 23.64 percent which is 4.15 percent lesser than the previous decade of 2001. If we go through the district level growth in South Bihar plain we find that, Kaimur recorded the highest growth rate of 27.50 percent, which has been followed by Banka, with a growth rate of 26.48 percent, and Gaya (26.43 percent) but the lowest growth rate was observed by Arwal with a growth rate of 19.23 percent only. As India witnessed a steepest decline in decadal growth rate since independence. Bihar as a whole and South Bihar plain have also posted a decline in decadal growth rate in 2011. In Bihar as whole and south Bihar plain in 2001 was increasing at a higher pace, than before, this spurt in Bihar's population was really surprising. If we keep increasing our population, how will we provide employment, food and other health facilities as well as infrastructures, but 2011 witnessed decline in decadal growth rate both at state level as well as South Bihar plain, and in districts too. One of the biggest reason for the decline of population growth may be due to migration of the people to National Capital Region and other states in search of employment. In spite of the fact that India after independence added least number of people in the country's population, during 2001-2011. On the other hand Bihar showed the highest decadal growth rate, but it shows a decline from the previous decade in Bihar as a whole and south Bihar plain too.

Taking similar classification approach there is only one district, that is, Arwal, which recorded low population growth (below 20 percent), whereas the districts namely, Munger, Lakhisarai, Sheikhpura, Nalanda, Patna, Bhojpur, Buxar, Rohtas, Nawada and Jehanabad reported moderate rate of population growth (20-25 percent) and only six districts, namely, Banka, Bhagalpur, Kaimur, Aurangabad, Gaya and Jamui reported high growth rate (25-30 percent).

The changes in the size of population, typically affected by fertility rates, mortality rate and migration, therefore, the rapid growth of the population over the past hundred years resulted from the difference between the birth rate and death rate. Due to advancement in medicine, human being has found cure from the dreaded diseases, there has been improvement in treatment in various types of illnesses, which has resulted into reduction in death rate. After independence mortality has declined faster than fertility, which has increased the gap between birth and death rates, which resulted into the natural increase of population. In the year 2011, the growth rate of population has been reduced from the previous decade 2001. It can be clearly understood





from Table 2 that the birth rate has been continuously declining in Bihar as a whole, from 2006 to 2011, whereas the death rate has been fluctuating around 7 per cent. In

2006, the birth rate was 29.9 percent, which continuously started decreasing and reached upto 26.3 percent in 2011, there is a difference of 3.6 percent from 2006 to 2011.

Table 2: Birth and Death Rate

Year	2006		2007		2008		2009		2010		2011	
	B.R	D.R	B.R	D.R	B.R	D.R	B.R	D.R	B.R	D.R	B.R	D.R
Bihar	29.9	7.7	29.7	7.5	28.9	7.3	28.5	7.0	28.1	6.8	26.3	7.0

Source: Sample Registration Bulletin and NITI Ayog

6. Causes of Population Growth

India achieved one billion population in 1990, and it may increase to 1.63 million by 2050, if current growth rate remains continue. In 1991 total population of Bihar was 34840968, whereas in South Bihar Plain, it was 13243935. In 2011 in Bihar it increased to 104099452, and in South Bihar plain, it was 38551925. Bihar's high population growth is really a matter of concern, and it has been expected that it will be doubled by 2051, and will put extra pressure on the limited resources and infrastructure of Bihar. Government will face difficulties in dealing with food and nutrition security of the population. Bihar has been lagging when it comes to controlling population growth. In 2018, total fertility rate of Bihar was 3.2, which is higher amongst the eight large states, even the latest statistics of National Family Health survey shows that the fertility rate in Bihar is highest in India, it means woman from Bihar is likely to give birth to more children as compared to woman in other states. During 2015-16 total fertility of the women aged between 15-19 years was 3.4 children in Bihar, whereas it was 2.18

in India. Causes for high growth rate in Bihar as a whole and south Bihar plain are given below.

6.1 Age at marriage

The percentage of women married before legal age is greater in Bihar, which gives a longer reproductive period.

6.2. Socio-economic conditions:

Bihar is the state with the lowest per capita income, and nearly one third of the population lives below poverty line. According to census 2011, roughly 88.71 percent of Bihar's population resides in rural areas. Therefore, most of the Bihar as a whole is facing mass poverty, which leads to more children more earning hand.

6.3. Tropical climate

Variation in climate shapes every aspects of human life. In the same way tropical climate in Bihar as a whole and in

South Bihar plain increases the fertility rate, which can magnify the inequality. Tropical climate is also responsible for early puberty, which again gives longer reproductive period.

6.4. Joint family system

In the joint family, wife wants to have children as early as possible, just to strengthen the family lineage as well as for her own status in the family. On the other hand elder's authority in the family, reduces the chances of family planning. Even some times elders prevail upon early age marriage, which ultimately leads to high fertility rate.

6.5. Lack of family planning

Family planning is a practice through which number of children can be reduced. The need of using contraceptives can not be neglected in Bihar and South Bihar plain. Illiteracy, lack of knowledge and other socio-cultural factors becomes obstacles in practicing family planning, which ultimately leads to high fertility rate. Apart from the above factors death rate has also declined, due to improved medical and health facilities, improved economic conditions have also led to improved hygiene, as well as control on diseases. On the other hand due to government's efforts famines have been controlled and several dreaded diseases have been eradicated.

7. Population Projection

Population projection is based on the past trend in population growth and gives a picture of that how the future size of the population will look. In other words population projection shows how human population will change in future. Demographer typically refers to information about future as projection or forecast, but they can be differentiated. On the basis of their outcome, projection is referred to that the future population would be correct, if particular sets of conditions hold true, it means it may not be always correct. But on the other hand population forecast is most likely to provide an accurate prediction.

Population projection can be used for number of purposes population projection can help us in understanding the factors of population change. It can also help us in understanding the future scenarios in every aspects of human life, and can help in decision making. Population projection is important since it helps us to estimate the basic needs of human life, like food, water, transportation facilities and power etc. Government policy making and planners use population projection for the construction, like housing, highways etc. It also helps us in making estimates of labour force, potential consumption of various products in different region, as well as it provides estimated data for researchers, like sex ratio, age structure and other demographic attributes. Population projection are simply a

mathematical formula, which uses current population and rate of population growth to predict the future population. The population projection of Bihar and South Bihar plain has been done by means of Arithmetical Increase method, which is suitable for large areas and old city which has done considerable development. In this method the average increase in population per decade is calculated from the past census reports, and has been assumed that the population is increasing at a constant rate.

Therefore, population after n^{th} decade will be $P_n = P + n.C$

Where,

P_n is the population after n decade

P is present population

C is rate of change of population with respect to time, which is constant, in other word average increment

n is the number of decade.

If we go through table 4 of projected population, there is a clear cut perception that the growth rate has declined sharply not only in Bihar and South Bihar plain but, in all the districts of south Bihar Plain. In Bihar, the growth rate according to actual population in 2011 is 25.42 percent which has declined to 7.23 percent in 2021, according to projected population, and almost same trend remained continue and reached even 5.96 percent in 1951. Similarly in South Bihar plain growth rate goes down to 7.26 percent from the actual growth rate and reaches upto 5.96 percent in 1951. Almost all the districts of South Bihar plain recorded projected growth above 7 percent in 2021, except four districts Sheikhpura, Nalanda and Bhojpur, and Munger. Amongst all these four districts Nalanda recorded least growth rate that is 0.65 percent and it remained continue till 2051, when it reduced to even 0.64 percent, which is very less as compared to other districts. In 2031 all districts recorded projected population growth rate in between 6 and 7 percent, except two district namely Munger (2.80 percent) and Nalanda (0.65 percent). Almost same trends are found in 2041, but in 2051, there has been further decline in the projected growth rate of population. The highest growth rate has been observed by Patna with a growth rate of 6.11 percent, which is not much higher than the other districts because most of them have recorded projected growth rate between 5 to 6 percent, except one district, Nalanda, which has continuously recorded lowest growth rate throughout projected period from 2021 to 2051. This continuous decrease in the projected growth can be attributed to continuous decrease in birth rate due to higher education, late marriage, mobility, financial independence of woman, health facilities, improved educational opportunities for women, low child mortality, family planning, and overall prosperity. It can be easily reflected from the percentage growth rate of Bihar in 2011, which has decreased from 28.62 percent in 2001 to 25.42 percent in 2011. Almost same is true about South Bihar plain where the growth rate decreased from 27.79

Year	Banka		Bhagalpur		Munger		Lakhisarai		Sheikhpura		Nalanda	
	Population	Increment	Population	Increment	Population	Increment	Population	Increment	Population	Increment	Population	Increment
1901	418,997		599,746		339,678		229,288		152,726		595,009	
1911	426,110	+7,113	609,927	+10,181	350,312	+10,634	236,466	+7,178	157,460	+4,734	589,310	-5,699
1921	397,570	-28,540	569,075	-40,852	333,110	-17,202	224,854	-11,612	149,761	-7,699	577,663	-11,647
1931	458,161	+60,591	655,803	+86,728	375,095	+41,985	253,195	+28,341	168,687	+18,926	676,424	+98,761
1941	523,596	+65,435	749,465	+93,662	424,049	+48,954	286,239	+33,044	190,743	+22,056	785,619	+109,195
1951	587,760	+64,164	841,309	+91,844	468,646	+44,597	316,343	+30,104	210,915	+20,172	926,189	+140,570
1961	688,814	+101,054	1,022,322	+181,013	555,833	+87,187	352,448	+36,105	246,528	+35,613	1,086,972	+160,783
1971	840,749	+151,935	1,250,354	+228,032	657,390	+101,557	439,256	+86,808	294,826	+48,298	1,304,832	+217,860
1981	1,038,674	+197,925	1,582,753	+332,399	801,071	+143,681	533,840	+94,584	350,677	+55,851	1,639,922	+335,090
1991	1,292,504	+253,830	1,909,967	+327,214	943,583	+142,512	646,395	+112,555	420,260	+69,583	1,996,257	+356,335
2001	1,608,773	+316,269	2,423,172	+513,205	1,137,797	+194,214	802,225	+155,830	525,502	+105,242	2,370,528	+374,271
2011	2,034,763	+425,990	3,037,766	+614,594	1,367,765	+229,968	1,000,912	+198,687	636,342	+110,840	2,877,653	+507,125
Average Increment	146887			221638		39462		70147		43965		18864

Table 3: Projection of Population by Arithmetic Increase Method

Year	Patna		Bhojpur		Buxar		Kaimur		Rohtas		Aurangabad	
	Population	Increment	Population	Increment	Population	Increment	Population	Increment	Population	Increment	Population	Increment
1901	1,028,073		641,566		371,371		317,384		606,016		467,445	
1911	1,018,226	-9,847	609,751	-31,815	371,963	-19,408	301,646	-15,738	575,964	-30,052	489,924	+22,479
1921	998,101	-20,125	593,796	-15,955	362,231	-9,732	293,753	-7,893	560,894	-15,070	488,092	-1,832
1931	1,168,744	+170,643	652,468	+58,672	398,022	+35,791	322,778	+29,025	616,315	+55,421	541,490	+53,398
1941	1,357,416	+188,672	762,131	+109,663	464,919	+66,897	377,028	+54,250	719,901	+103,586	629,204	+87,714
1951	1,600,295	+242,879	879,888	+117,757	536,754	+71,835	435,283	+58,255	831,133	+111,232	696,115	+66,911
1961	1,861,811	+261,516	1,021,109	+141,221	635,988	+99,234	526,251	+90,968	1,024,133	+193,000	830,989	+134,874
1971	2,250,883	+389,072	1,230,052	+208,943	765,094	+129,106	656,905	+130,654	1,286,983	+262,850	1,016,094	+185,105
1981	3,019,201	+768,318	1,490,714	+260,662	916,886	+151,792	783,045	+126,140	1,583,280	+296,297	1,237,072	+220,978
1991	3,618,211	+599,010	1,792,771	+302,057	1,087,676	+170,790	972,949	+189,904	1,927,736	+344,456	1,539,988	+302,916
2001	4,718,592	+1,100,381	2,243,144	+450,373	1,402,396	+314,720	1,275,579	+302,630	2,464,243	+536,507	2,013,055	+473,067
2011	5,838,465	+1,119,873	2,728,407	+485,263	1,706,352	+303,956	1,626,384	+350,805	2,959,918	+495,675	2,540,073	+527,018
Average Increment	437308			189712		119543		119000		213991		188420

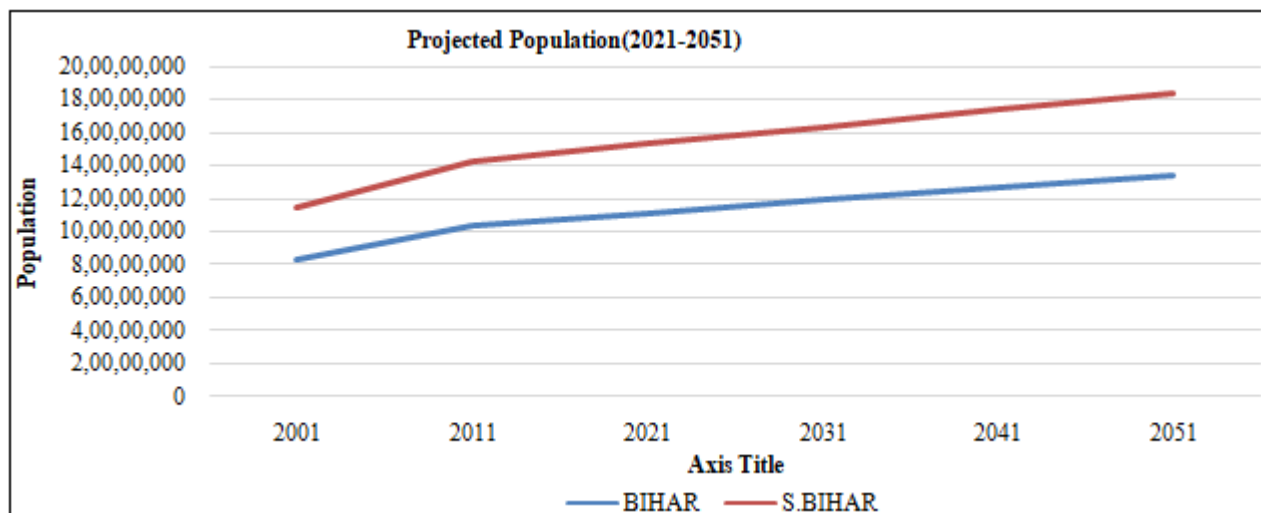
Year	Gaya		Nalanda		Jamui		Jehanabad		Arwal		Bihar		S.Bihar Plain	
	Popu.	Increment	Popu.	Increment	Popu.	Increment	Popu.	Increment	Popu.	Increment	Popu.	Increment	Popu.	Increment
1901	791,096		412,119		345,129		237,802		153,395		21,243,632		7,726,840	
1911	829,139	+38,043	431,938	+19,819	355,934	+10,805	249,238	+11,436	160,771	+7,376	21,567,159	+323,527	7,7440,260	17,420
1921	826,039	-3,100	430,323	-1,615	338,455	-17,479	248,306	-932	160,170	-601	21,358,905	-208,254	6,726,154	-1,018,106
1931	916,408	+90,369	477,400	+47,077	381,115	+42,660	275,471	+27,165	177,693	+17,523	23,438,371	+2,079,466	8,565,009	1,838,855
1941	1,064,854	+148,446	554,733	+77,333	430,855	+49,740	320,093	+44,622	206,477	+28,784	26,302,771	+2,864,400	9,107,015	542,006
1951	1,178,093	+113,239	613,724	+58,991	476,167	+45,312	354,133	+34,040	228,434	+21,957	29,085,017	+2,782,246	11,278,848	2,171,833
1961	1,392,472	+214,379	741,633	+127,909	573,834	+97,667	415,062	+60,929	267,736	+39,302	34,840,968	+5,755,951	13,243,935	1,965,087
1971	1,725,583	+333,111	893,937	+152,304	713,736	+139,902	495,614	+80,552	326,245	+58,509	42,126,236	+7,285,268	16,148,533	2,904,598
1981	2,150,406	+424,823	1,099,177	+205,240	862,589	+148,853	599,143	+103,529	384,626	+58,381	52,302,665	+10,176,429	20,073,076	3,924,543
1991	2,664,803	+514,397	1,359,694	+260,517	1,051,527	+188,938	709,862	+110,719	465,038	+80,412	64,530,554	+12,227,889	24,399,221	4,326,145
2001	3,473,428	+808,625	1,809,696	+450,002	1,398,796	+347,269	926,489	+216,627	587,826	+122,788	82,998,509	+18,467,955	31,181,241	6,782,020
2011	4,391,418	+917,990	2,219,146	+409,450	1,760,405	+361,609	1,125,313	+198,824	700,843	+113,017	104,099,452	+21,100,943	38,551,925	7,370,684
Average Increment	327302		164275		128661		80682		49768		7532347		2802280	

Calculated by Author based on Census data

Table 4: Projected Population

S.N	State/Districts	Actual Population			Projected population							
		2001	2011	Growth rate	2021	Growth rate	2031	Growth rate	2041	Growth rate	2051	Growth rate
1	Banka	1,608,773	2,034,763	26.47	2181650	7.21	2328537	6.73	2475424	6.30	2622311	5.93
2	Bhagalpur	2,423,172	3,037,766	25.36	3259404	7.29	3481042	6.79	3702680	6.36	3924318	5.98
3	Munger	1,137,797	1,367,765	20.21	1407227	2.88	1446689	2.80	1486151	2.72	1525613	2.65
4	Lakhisarai	802,225	1,000,912	24.76	1071059	7.00	1141206	6.54	1211353	6.14	1281500	5.79
5	Sheikhpura	525,502	636,342	21.09	680307	6.90	724272	6.46	768237	6.07	812202	5.72
6	Nalanda	2,370,528	2,877,653	21.39	2896517	0.65	2915381	0.65	2934245	0.64	2953109	0.64
7	Patna	4,718,592	5,838,465	23.73	6275773	7.49	6713081	6.96	7150389	6.51	7587697	6.11
8	Bhojpur	2,243,144	2,728,407	21.63	2918119	6.95	3107831	6.50	3297543	6.10	3487255	5.75
9	Buxar	1,402,396	1,706,352	21.67	1825895	7.00	1945438	6.54	2064981	6.14	2184524	5.78
10	Kaimur	1,275,579	1,626,384	27.50	1745384	7.31	1864384	6.81	1983384	6.38	2102384	5.99
11	Rohtas	2,464,243	2,959,918	20.11	3173909	7.22	3387900	6.74	3601891	6.31	3815882	5.94
12	Aurangabad	2,013,055	2,540,073	26.18	2728493	7.41	2916913	6.90	3105333	6.45	3293753	6.06
13	Gaya	3,473,428	4,391,418	26.42	4718720	7.45	5046022	6.93	5373324	6.48	5700626	6.09
14	Nawada	1,809,696	2,219,146	22.62	2383421	7.40	2547696	6.89	2711971	6.44	2876246	6.05
15	Jamui	1,398,796	1,760,405	25.85	1889066	7.30	2017727	6.81	2146388	6.37	2275049	5.99
16	Jehanabad	926,489	1,125,313	21.45	1205995	7.16	1286677	6.69	1367359	6.27	1448041	5.90
17	Arwal	587,826	700,843	19.22	750611	7.10	800379	6.63	850147	6.21	899915	5.85
18	Bihar	82,998,509	104,099,452	25.42	111,631,799	7.23	119,164,146	6.74	126,696,493	6.32	134,228,840	5.94
19	S. Bihar Plain	31,181,241	38,551,925	23.63	41,354,205	7.26	44,156,485	6.77	46,958,765	6.34	49,761,045	5.96

Calculated by Author



percent in 2001 to 23.64 percent in 2011. It is also clear from the table 2 about birth and death rate from 2006 to 2011, where, birth rate declined from 29.9 percent to 26.3 percent but the death rate remained around 7 percent only.

8. Conclusion

South Bihar plains covers an area south of river Ganga and is a fertile alluvial plain. South Bihar plain is characterized by high population growth. This high growth of population has hampered economic growth, and prevented reduction in poverty of the amsses. But this increase of growth in population, aggravated the poverty and reduced the employment oppurtunities. Bihar’s population continued to increase in the past decade, with state being among top three populated states of the country. South Bihar plain is characterized by large size of population with high growth rate of 27.79 percent in 2001 and 23.64 percent in 2011, with a decrease of 4.15 percent. This decrease of growth of population from 2001 to 2011 has been observed almost in

all the district except few district, which has observed higher growth rate in 2011 than 2001. Above all these decrease during last decade in South Bihar plain as well as Bihar as a whole, recorded high population growth rate, and decline in the population in the 2011 was surprising. This decline in growth rate may be due to women are now using contraceptives for birth control and are inclined towards family planning. But child marriage in Bihar and South Bihar plain remains a great problem. This decline in growth rate is sharper than as expected. One of the main factor may be the improvement in living condition and educational attainment.

Population growth hardly appears as an encouraging factors for projection of resources in future, and how much it can affect the environment. In this concern significant measures can be taken, and the key issue is not the growth of population, but how this growing population can sustain on the limited resources. But there is a hope from last decade decrease in growth rate, and its ripe time that government should adopt two child policy.

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