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Population dynamics of Indian Himalaya using geographic information systemb

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ABSTRACT

An attempt has been made in this research paper to study the population distribution in the Indian Himalayan region through the integration of Collateral data with Geographic information System (GIS). Such attempt provides a mechanism by which population estimates can be updated with high accuracy and better rate of frequency. For the present study the Toposheets (1: 50000 scale), Boundary maps and other collateral data, viz., time-series data of decadal growth rate, population distribution pattern, sex ratio, and literacy rate etc. has been compiled from previous primary census abstracts and provisional report of 2001census and presented in Rasterized form using GI in order to depict the Effective Dynamics of population change in the study area. Geographical information system were used for modeling the relationship among population variables and show results obtained empirical model analyses results of this study show that the Nagaland recorded the highest (64.41%) decadal growth rate whereas neighboring Tripura recorded the lowest (15.74%) decadal growth rate in the region. The growth rates of the most of the districts fall above the average growth rate of the region. A negative growth rate (-3.5%) has also been recorded in West Aizwal (Mamit) district of Mizoram. In contrast, Wokha in Nagaland recorded the highest growth rate (95.01%). In India this is very true that growth rate of human population has decreased significantly in the states with higher literacy rates. The overall density of the study area is consistent with location theories, i.e., decline in population density from the Central Business District (CBD).

KEYWORDS

Population studies;
GIS;
Decadal growth;
Trend analysis.

1. INTRODUCTION

The use of GIS for population studies ranges from creation of maps to modeling the relationship between population variables[2,4,7,8,9]. In this study, GIS is used for both options i.e. for creation of maps and modeling. The creation of maps is a straightforward process in GIS. Modeling in GIS environment has taken different approaches ranging from loose coupling to very strong coupling. Loose coupling involves importing or exporting data from separate configured software, e.g., linking ARC/INFO with epidemiological models[5]. Very strong modeling includes embedding a model entirely within GIS or vice-versa. The GIS part in this study deals with using low cost GIS software (ArcView 3.1) to carry out some modeling related to population density. Battey and Xie[1] used ARC/INFO, which is considered high cost GIS software that is not affordable by

Figure 1 (shaded portion) shows the location and extension of my study area. The Indian Himalayan Region comprising of 10 states and hill regions of 2 states of Indian Republic is my area of interest

Figure 1: Showing study area

TABLE 1: The population of Himalayan States as per 2001 provisional census figures and percentage change in contribution to the total IHR population in last decade

State	Population	% contribution to the total study area population	% Change (1991-2001)	State
		1991	2001	
Jammu and Kashmir	10069917	24.43	25.41(0.98)	Jammu and Kashmir
Himachal Pradesh	6077248	16.37	15.34(0.59)	Himachal Pradesh
Uttaranchal	8479562	22.32	21.40(0.83)	Uttaranchal
Sikkim	540493	1.29	1.36(0.05)	Sikkim
West Bengal Hills	1605900	4.11	4.05(0.16)	West Bengal Hills
Assam Hills	998509	2.58	2.52(0.10)	Assam Hills
Arunachal Pradesh	1091117	2.74	2.75(0.11)	Arunachal Pradesh
Nagaland	1988636	3.83	5.02(0.19)	Nagaland
Manipur	2388634	5.82	6.03(0.23)	Manipur
Mizoram	891058	2.18	2.25(0.09)	Mizoram
Tripura	3191168	8.73	8.05(0.31)	Tripura
Meghalaya	2306069	5.62	5.82(0.22)	Meghalaya

(Value in parenthesis is % contribution of the respective state to the total country's population). The TABLE 1 clearly depicts the contribution to the total study area population by each individual states under study area and also depicts percentage change in population of individual states of study area between the span of 1991 to 2001.

many census departments. Previous Studies have shown the importance of integrating remote sensing with GIS for population studies[3,6,10].

2. Study area

The Indian Himalayan Region comprises of 10 states and hill regions of 2 states of Indian Republic. Geographically it is spread between 21°57'-37°5'N latitudes and 72°40'-97°25'E longitude covering an area about 5.3 lakh km^2. The region occupies the strategic position of entire northern boundary (North-West to North-East) of the nation and touches almost all the international borders (7 countries) with India, (Figure 1). It contributes about 16.2% of India's total geographical area, and most of the area is covered by snow-clad peaks, glaciers of higher Himalaya, dense forest cover of mid-Himalaya. The region shows a thin and dispersed human population as compared to the national figures due to its physiographic condition and poor infrastructure development but the growth rate is much higher than the national average. The percentage contribution of its population has gone up to 3.86% in 2001 from 3.6% in 1991 due to the higher decadal growth rate (about 25.43%) as compared to national average of 21.35% during 1991-2001. According to 2001 census report (provisional) the Himalayan region states exhibit a widely diverse growth rate of population. As a result their contribution to the total Indian Himalayan population varies very widely during the decade (TABLE 1). Two north-eastern states Tripura and Nagaland shows stabilizing and increasing trends of population numbers, largely exposed to international border with Bangladesh and Myanmar respectively. Apart from political disturbances and ethnic crisis in the north-east there are several socio-economic factors causing migration/immigration to these states. For the present study the time-series data of decadal growth rate, population distribution pattern, sex ratio, and literacy rate etc. has been compiled from previous primary census abstracts and provisional report of 2001census and presented in Rasterized form using GIS.

3. Methodology

Toposheets (1: 50000 scale), Boundary maps and other Collateral data, viz., time-series data of decadal growth rate, population distribution pattern, sex ratio, and literacy rate etc. has been compiled from previous primary census abstracts and provisional report of 2001 census and was integrated with GIS (Arc View 3.1software), in order to depict the Effective Dynamics of population change in the study area.

4. RESULTS AND DISCUSSION

Population size of most of the districts of study area is less than 4 lakhs and falls below the average of the region. There are only 10 populated districts in the region with population more than 10 lakhs. Darjeeling (West Bengal hills) is the highest populated (16, 05,900) district while Upper Siang (Arunachal Pradesh) is the least populated district having a total population of 33,140 persons, (Figure 2).

4.1. Population growth

The decadal growth rate (1991-2001) of human population in the study area was recorded 25.43%, which is higher than the country's average growth rate (21.34%). Nagaland recorded the highest (64.41%) decadal growth rate whereas neighboring Tripura recorded the lowest (15.74%) decadal growth rate in the region. The growth rates of the most of the districts fall above the average growth rate of the region. However a negative growth rate (-3.5%) has also been recorded in West Aizwal (Mamit) district of Mizoram. In contrast, Wokha in Nagaland recorded the highest growth rate (95.01%) in the study area, (Figure 3).

4.2. Population density

The population density measures the human pressure on the total land of a country or a region. The average population density of the study area (74 persons/km^2) is much less than the national average (324 persons/km^2) and varied widely from 2 to above 800 persons per km^2 in the districts. At state level, Tripura is the most densely populated (304 persons/km^2) while Arunachal Pradesh has the lowest density (13 persons/km^2) in the region. The variation in density is mainly due to the physiographic condition of the region. For example, the high altitude districts of Lahul and Spiti (Himachal Pradesh), Leh (Jammu and Kashmir) and Dibang Valley (Arunachal Pradesh) have recorded a population density of less than 5 per km^2. In contrast Imphal (West and East in Manipur) and Thoubal (Manipur), west Tripura (Tripura), Haridwar (Uttaranchal), Darjeeling (West Bengal) and Srinagar and Jammu (Jammu & Kashmir) recorded a density of more than 500 per km^2. Imphal West (Manipur) is the most densely (about 847 persons/km^2) populated district, while Lahul-Spiti (Himachal Pradesh) is the least populated district (2 persons/km^2) in the study area, (Figure 4).

The low density states of north-eastern India shows a lower dispersion level of human population with Arunachal Pradesh recording minimum followed by Assam Hills, Mizoram, and Meghalaya. The higher density state Tripura might be influenced by population dynamics of Bangladesh, one of the most densely populated nations in the world. The dispersion level of districts in Manipur is highest as the population density of Imphal West and Thoubal is more than 20 times than that of Tamenglong, Ukhrul, and Chandel districts. Jammu and Kashmir also exhibit a similar picture, where

Figure 2 depicts that darjeeling is the highest populated (16, 05,900) district while Upper Siang is the least populated district having a total population of 33,140 persons

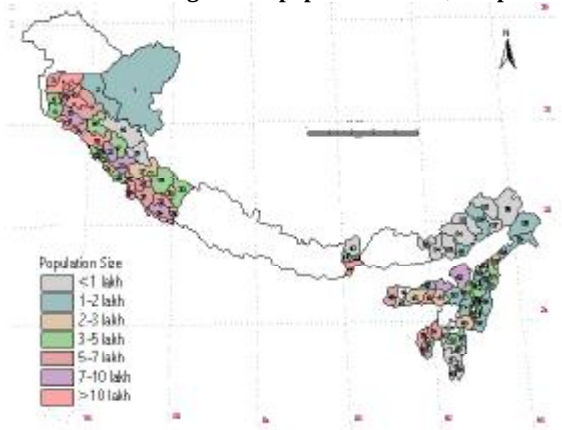

Figure 2 : Distribution of human population in the study area, 2001

Figure 3 illustrates that growth rate of the most of the districts fall above the average growth rate of the region. A negative growth rate (-3.5%) has also been recorded in West Aizwal (Mamit) district of Mizoram. Wokha in Nagaland recorded the highest growth rate (95.01%) in the study area

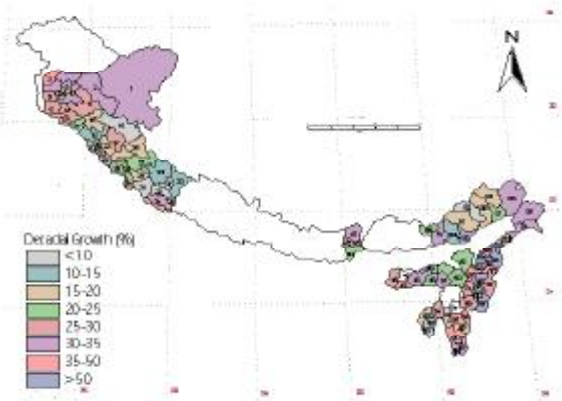

Figure 3: Showing the decadal growth rate (1991-2001) of population in the study area

Figure 4, shows that Darjeeling (West Bengal) and Srinagar and Jammu (Jammu and Kashmir) recorded a density of more than 500 per km^2. Imphal West (Manipur) is the most densely (about 847 persons/km^2) populated district, while Lahul-Spiti (Himachal Pradesh) is the least populated district (2 persons/km^2) in the study area

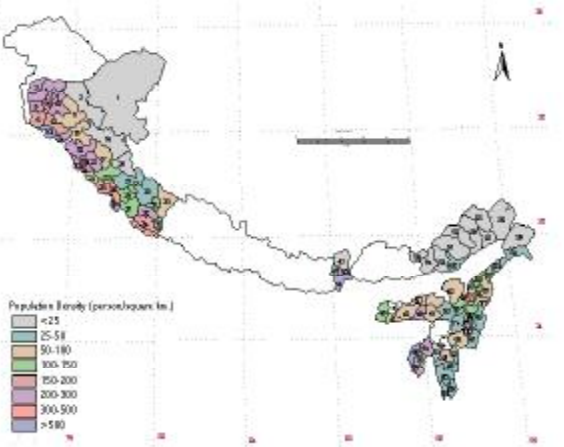

Figure 4: Depicting the diverse population density in various districts of study area

Figure 5 illustrates the distribution of sex ratio among the districts of my study area and illustrates that the sex ratio of most of districts of the study area varies between 900 and 1000

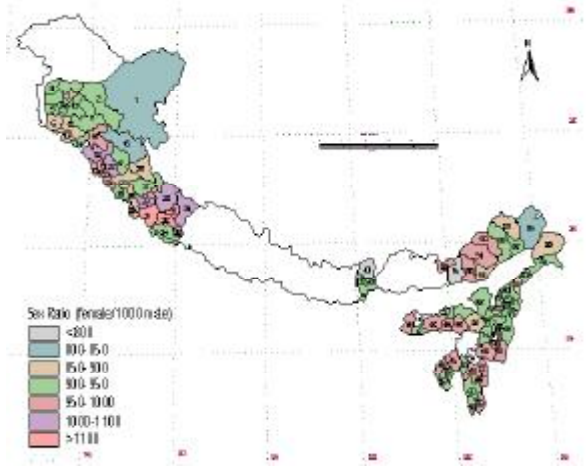

Figure 5: Distribution of sex ratio among the districts of the study area

Srinagar, Jammu districts recorded a very high population density as compared to negligible population of Leh and Kargil districts, resulting a higher SD of dispersion level, (TABLE 2).

4.3. Sex ratio

The sex ratio (females per 1000 males) is mainly the outcome of the interplay of sex differentials in mortality, selective migration and sex differential in population enumeration. Changes in sex composition largely

Figure 6 depicts state wise distribution of sex ratios and is obvious from the figure that Manipur and Sikkim recorded the highest (978) and the lowest (875) sex ratios, respectively, in the region

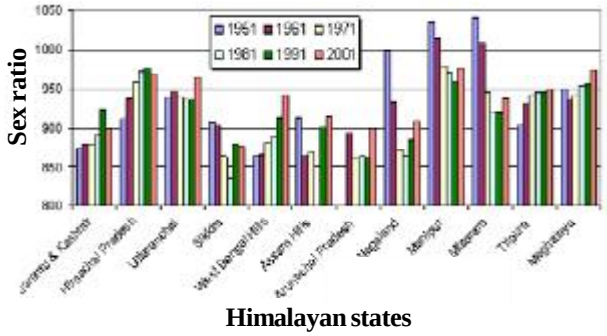

Figure 6: State wise changing sex ratio (1951-2001) in the study area

TABLE 2: Change in population density in study area

State	Geographical area	% Share of area to the	Density# (person/km^2)		Dispersion level
	(km^2)	Total area of IHR	1991	2001	
Jammu and Kashmir	222236	41.65	76	99	5
Himachal Pradesh	55673	10.43	93	109	3
Uttaranchal	53485	10.02	132	159	4
Sikkim	7096	1.33	57	76	3
West Bengal Hills	3149	0.59	413	510	1
Assam Hills	15322	2.87	53	65	1
Arunachal Pradesh	83743	15.69	10	13	1
Nagaland	16579	3.11	73	120	2
Manipur	22327	4.18	82	107	5
Mizoram	21081	3.95	33	42	1
Tripura	10491	1.97	263	304	3
Meghalaya	22429	4.20	79	103	2
IHR	533611	100.00	59	74	4

The TABLE 2 clearly shows change in population density in the study area from year 1991 to year 2001 along with the dispersion levels

reflect the underlying socio-economic and cultural pattern of a society in different ways. The impressive status of sex composition in the study area (940 as compared to 933 against the national average) seems to be under threat due to changing social norms. The sex ratio of most of districts of the study area varies between 900 and 1000 and is depicted in (Figure 5).

Two states in the north-east, i.e. Manipur and Sikkim recorded the highest (978) and the lowest (875) sex ratios, respectively, in the region, (Figure 6).

Figure 7 clearly depicts that Mizoram recorded the highest literacy (88.49%) whereas Jammu and Kashmir in western Himalaya recorded the least literacy (54.46%) among all the study area states

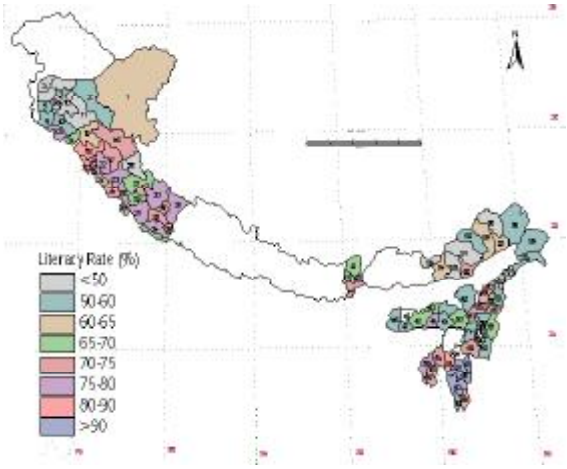

Figure 7: Literacy distribution across the districts of the study area

4.4. Literacy

The literacy rate of the study area (about 67%) is marginally higher than the literacy rate of the country (65.38%) as recorded in 2001. Majority of the districts have literacy rates higher than the region's average. In the north-east, Mizoram recorded the highest literacy (88.49%) whereas Jammu & Kashmir in western Himalaya recorded the least literacy (54.46%) among all the study area states. Districts of these states also reflected the same trends as Aizwal (Mizoram) recorded the highest (96.64%) and Badgam (Jammu & Kashmir) recorded the lowest (39.54%) literacy among the districts of the region. The distribution of literacy across the Himalayan region is as follows (Figure 7). In India this is very true that growth rate of human population has decreased significantly in the states with higher literacy rates.

5. CONCLUSION

The use of GIS in population studies plays a vital tool for policymaking and planning. Since this study utilized both collateral data and GIS, it can be said as integrated approach to study of population in the study area. This approach can be replicated for (foreign) Himalayan states. In the Indian Himalayan Region (IHR) only Jammu and Kashmir State contributes about 1% of population to the country's total. Rest of the states individually contributes less than 1%. But collectively the regions contribute 3.86% to the country's total population. While the sex ratio of the population in the states of study area increased, the alarming decline in the sex ratio of population below 6 years in Himachal Pradesh and Uttaranchal indicate the state contributed significantly to the existing unequally treatment to female child and sex discrimination before birth. This is more alarming as the literacy rates are increasing but not able to curtail such unacceptable social behavior. The drastic decline in decadal growth rate for the last decade is bound to influence the population age pyramids of the states. However, the limited scope of expansion for agriculture and inability of technology and infrastructure to support intensive agriculture in the region, such declines if continued may reduce environmental problems in the region.

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