

POPULATION GROWTH AND LAND USE DYNAMICS IN INDIA:AN ECOLOGICAL ASSESSMENT

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Abstract

The twenty first century has been a century of unparalleled population growth, economic development and environmental change. Globally per capita food availability has improved despite unparalleled population growth in this century, problems related to land degradation have increased, and these may limit future food production. In this paper, I have selected India as my study area to provide a case study to understand the current and sector wise land use and their ecological implications using historical data and describe present population-land use relationship. The study use mainly secondary data sources to study sectoral land use the pattern and dynamics and population share and growth rate of differentials for India and its states. Also for relationship between population and sector wise land use applied correlation matrix statistical technique. The paper is general beliefs that the demography has been one of the primary factors behind these important ecological implications. The study finds total ecological sector of land use in India share 33 per cent during 2010-11, but shown declining trends. In India the impact of population on land were stronger and unfavourable in indo gangetic and northern plain region states, where in arid and fragile areas of northern Himalayas and Aravalli range states have favourable impact. Also the demand of agricultural and non-agricultural land in India increased rapidly in recent past with the population growth; household density and rural economy which played major role for affect the sustainability of natural resources, ecological and agricultural land in particular. The land use aiming to meet the present needs of the people while preservation resources for the future, there for require land use policies for sustainable development.

Keywords: Budgeting Land Use Shifts, Sectoral Land Use Pattern, Sectoral Land Use Dynamics, Population Growth, Correlation Matrix

Introduction

The twenty first century has been a century of unparalleled population growth, economic development and environmental change. For which there has been broad debate worldwide on the relationship between population growth and changes of resources and land degradation in the past few decades. Land-use and land-cover change (LULCC); also known as land change) is a general term for the human modification of Earth's terrestrial surface. Though humans have been modifying land to obtain food and other essentials for thousands of years, current rates, extents and intensities of LULCC are far greater than ever in history, driving unprecedented changes in ecosystems and environmental processes at local, regional and global scales. Today the changes in the environment are because of the changes brought in land use by the man. Changes in land and ecosystems and their implications for global environmental change and sustainability are a research challenge for the human environmental sciences (Omenn, 2006; Turner et al. 2007).

According to J.L. Buck "land utilization is the satisfaction, which the form population derives from the type of agriculture developed, the provision for future production and contribution to national needs." Land use for agriculture, forestry, and settlements provides food, fiber, and other ecosystem services that satisfy immediate human needs (Millennium Ecosystem Assessment 2003). The proximate causes of land use changes constitute human activities or immediate actions that originate from intended land use and directly affect land-cover (Meyer and Turner, 1994; Ojima et al., 1994; Lambin et al., 2003). Land use of any region expresses the interaction of the operation of the whole range of environmental factors modified by the socio- economic and historical elements (Narkhed, D.S. & Gatade D.G., 2010).

Globally, it has altered the provision of ecosystem services, affected the global climate and led to vast increases in production of food, timber, housing, and other commodities but at the cost of reductions in many ecosystem services and biodiversity (Tekle and Hedlund, 2000; Wang et al., 2012; Qasim et al., 2013). According to the United Nations population statistics, the world population grew by 30%, or 1.6 billion humans, between 1990 and 2010. In the numbers of people, the increase was highest in India (350 million). While global per capita food availability has improved despite unprecedented population growth in the second half of the twentieth century, problems related to environmental degradation have increased, and these may limit future food production (Bender and Smith, 1997; Fischer et al., 2002). Global land use has significantly changed during the past decades. Whereas in the developing countries, rapid population growth, poverty and the economic condition are the main driving forces.

Continuous decay of natural resources poses severe threats to the very survival of millions of human beings. The gravity of the problem in the tropical regions of developing countries is more acute than in the rest of the world. Therefore, accurate LULC estimation is key for understanding interactions among human activities, climate systems, and ecosystem as well as for the formulation of policies at national level (Houghton and Hackler, 2003; Tian et al., 2003; Arora and Boer, 2010). India is characterized by an immense diversity in climate, topography, flora, fauna, land use, and socioeconomic conditions (FAO, 2017b). India reached 121 crore population, about 17 per cent of the world population live in just 2.4 per cent of the area while per capita availability of land about 0.12 ha, and less than half of the world average of 0.23 ha (GoI, 2015). Even though India recognised the problem of rapid population growth soon after independence, it has had limited success in controlling its growth rate (International Institution for Population Sciences and ORC Macro, 2000). Understanding the dynamics of land use change and its ecological implications is a scientific challenge of considerable importance to humanity.

In this paper, present evidence from a densely populated country of India that has been described since independence and yet has not ruined to serious environmental disaster. To better understand compare current and past land uses pattern and their ecological implications using historical data and describes present population-land use relationship in the study area. This paper is general belief that the demography has been one of the primary factors behind these important ecological implications; their relationship to demography changes has not been examined in detail in India.

Objectives:-

With this background the specific objectives of the study are:

- i. to analyse sectoral land use changes in India from 1950-51 to 2010-11.
- ii. to discuss the population dynamics in India from 1900-01 to 2010-11
- iii. to quantify states level sectoral land use changes and population dynamics in India from 1990-91 to 2010-11.
- iv. to examine the relationship between sectoral land use changes and population growth in India.

Study Area:

India is a country in South Asia. It is the seventh-largest country by area, with a total area of 3,287,263 square kilometres. The country is situated north of the equator between 8°4' to 37°6' north

latitude and 68°7' to 97°25' east longitude. India is bounded by the Arabian Sea on its west and south west and Bay of Bengal on its east and south east and the Himalayan Mountain ranges borders the country on its north. The Tropic of Cancer divides the country into two equal parts in the Northern



and Southern part, and the Vindhya Mountains cut right across the country, from west to east. India is second-most populous country (with over 1.2 billion people) in the world after China, and India's population grew from 361 million in 1951 to 1,211 million in 2011. India is a key for socio economic progress, and the Indian literacy rate is 74.04% (2011 census). India has become a fast growing major economy, a hub for information technology services, with an expanding middle class. India is a land of biodiversity; it has vast and extensive range of eco-zones like high mountains, swamplands,

deserts, grassland, tropical and temperate forest, island and rivers. India, the world's largest democracy, has made tremendous strides in economic and social development in the past two decades. The country aims to become a higher middle-income country by 2015.

Database and Methodology:

This study includes information on population growth, socioeconomic variables, land use pattern and their ecological implications. The demographic and socioeconomic data are taken from Census Publications (Registrar general of India), while the land use classification data are compiled from Ministry of Agriculture Government of India for different time periods under study. For country level the demographic data compiled from 1900-01 to 2010-11, while the land use data collected from 1950-51 to 2010-11. The states level data are taken from the demography and land use in India for two time periods i.e. 199-91 to 2010-11.

Land area in the country or states being constant it is anticipated that the land use changes only occur through inert-class transfer and hence land use changes over time periods is linearly additive. The land use statistics is generally reported (**R = Total reported area**) under the following broad Nine fold classes:

Area under forests, permanent pastures, miscellaneous tree, Barren lands, Culturable wastelands, Current fallows, Other Fallows Land, Net Sown Area and Area under non-agricultural

The first accounting identity linearly summed up the area under all land-use classes which was equal to the **Total Reporting Area (R)**. (Equation.....1)

$$\text{Total Reporting Area (R)} = Fr + P + M + B + W + F_c + F_o + C + N$$

The accounting identity for land use changes over time is expressed as followed: (Equation.....2)

$$\Delta R = \Delta Fr + \Delta P + \Delta M + \Delta B + \Delta W + \Delta F_c + \Delta F_o + \Delta C + \Delta N$$

Where Δ represent change over periods of time

The study categorized this nine land use classes into three broad sectors i.e.

1. The net changes in the **Ecological Sector ((ΔE): (Equation.....3)**

The ecological sector was further divided into two sub-sectors, viz.

a) **Enviably Ecological Sector (ΔEE)** comprising = Area under forests (ΔFr) + permanent pastures (ΔP) + miscellaneous tree (ΔM)

b) **Unenviably Ecological Sector (ΔUE)** comprising = Barren lands (ΔB)

The changes of enviably ecological sector consist of changes in forest, permanent pasture and land under miscellaneous tree and groves, while the changes of unenviably ecology represent changes in land under barren & un-cultivable uses.

2. The net changes in **Agricultural Sector (ΔA): (Equation....4)**

Agricultural Sector (ΔA) comprising = Culturable wastelands (ΔW) + Current fallows (ΔF_c) + Other Fallows Land (ΔF_o) + Net Sown Area (ΔC)

3. The net changes in the **Non-agricultural Sector (ΔN): (Equation....5)**

Non-agricultural Sector (ΔN) comprising = Area under non-agricultural (ΔN)

As there is no possibility of land use shift from the non-agricultural sector to the agricultural sector, the net changes in the agricultural sector will have serious ecological implications. If net change is positive ($+\Delta A$), it will be at the cost of the ecological sector; and if negative ($-\Delta A$), the land use shift may occur to ecological or non-agricultural or both sectors, but definitely at the cost of the agricultural sector. In addition, the changes within the agricultural sector also have some implications towards ecology and/or agricultural growth.

The overall inter-sectoral land use transfers can be budgeted as:

$$\Delta R = \Delta E1 + \Delta E2 + \Delta A + \Delta N \text{ (Equation.....6)}$$

Equation (5) is the same as equation (2), except that, being expressed in aggregate sectoral terms, facilitates quick glance at inter-sectoral transfers.

This study also makes an attempt to ascertain the factors which influence the variations in setoral land uses and demography across states in India. The study was prepared correlation matrix to test multicollinearity to explore the possibilities for re-specification of the variables in situation multicollinearity was observed among the thirteen independent variables.

Result and Discussion

A. Budgeting of Inter-Sectoral Land Use shifts

Table shows that during the last 60 years enviable ecological sector in India has increased by about 27.04 per cent, from 66985 thousand hectares in 1950-51 to 85098 thousand hectares in 2010-11, while unenviable ecological sector land have shown declined trends during all study periods of blocks. The unenviable ecological sector has declined from 13.42 per cent of total reporting area in 1950-51 to 5.59 per cent in 2010-11. Agricultural sectoral land uses, which increased during the first three decades, also witnessed a declining trend during the last three decades, where overall data shown increasing trend during the study period from 1950-51 to 2010-11. Total agricultural sector increased from about 169813 thousand hectares in 1950-51 to 181578 thousand hectares in 180-81, but then declined to 178810 thousand hectares in 2010-11 and finally overall increased about 8997 thousand hectares during the periods from 1950-51 to 2010-11. In contrast, the area under non-agricultural sector of land uses has more than doubled from about 9357 thousand hectares to 26400 thousand hectares during last six decades in India.

The budgeting of inter-sectoral analysis was carried out to find that the land use pattern and extend dynamics in land use shifts in India and its result are presented in table 1. The compound growth rate table indicate that among all the sectoral land uses (except total ecological sector) have shown significantly changes during the periods of 1951-2011 in India. The unenviable ecological sector and total ecological sector have shown negative growth rate, where the non-agricultural, agricultural and net sectoral changes have shown most significant positive growth rate. The net Sectoral changes have shown positive changes during the study periods of 1951-2011, which indicates that in India land use have shift positive direction. The budgeting of inter-sectoral land use estimated that undesirable ecological sector has indicated a significant decline during the all study periods of blocks, which

Table 1: Budgeting of Inter-Sectoral Land-use Shifts from 1950-51 to 2010-11

| | Area (000”Hectears) | | | | | | | Growth Rate of Change (%) | | | | | | | CGRC (%) |
|--|---------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------------------|-----------------|-----------------|---------------|-----------------|----------------|------------------|------------------|
| | 1950-51 | 1960-61 | 1970-71 | 1980-81 | 1990-91 | 2000-01 | 2010-11 | 1951-61 | 1961-71 | 1971-81 | 1981-91 | 1991-01 | 2001-11 | 1951-11 | |
| Enviably Ecology $\Delta EE (\Delta F_r + \Delta P + \Delta M)$ | 66985 23.56 | 72477 24.28 | 81458 26.82 | 83027 27.30 | 82921 27.19 | 83950 27.51 | 85098 27.68 | 5492 8.20 | 8981 12.39 | 1569 1.93 | -106 -0.13 | 1028 1.24 | 1148 1.37 | 18113 27.04 | 0.41** 0.009 |
| Unenviably Ecology $\Delta UE (\Delta B)$ | 38160 13.42 | 35911 12.03 | 28128 9.26 | 19958 6.56 | 19509 6.40 | 17483 5.73 | 17175 5.59 | -2249 -5.89 | -7783 -21.67 | -8170 -29.05 | -449 -2.25 | -2026 -10.38 | -307 -1.76 | -20985 -54.99 | -1.34** 0.002 |
| Total Ecology $\Delta E (\Delta UE + \Delta EE)$ | 105145 36.98 | 108388 36.32 | 109586 36.08 | 102985 33.86 | 102430 33.58 | 101432 33.24 | 102273 33.26 | 3243 3.08 | 1198 1.11 | -6601 -6.02 | -555 -0.54 | -997 -0.97 | 841 0.83 | -2872 -2.73 | -0.05 0.073 |
| Agricultural Sector $\Delta A (\Delta W + \Delta F_c + \Delta F_o + \Delta C)$ | 169813 59.73 | 175230 58.71 | 177689 58.50 | 181578 59.70 | 181374 59.46 | 180011 58.98 | 178810 58.15 | 5417 3.19 | 2459 1.40 | 3889 2.19 | -205 -0.11 | -1363 -0.75 | -1201 -0.67 | 8997 5.30 | 0.09* 0.043 |
| Non Agricultural Uses ΔN | 9357 3.29 | 14840 4.97 | 16478 5.42 | 19596 6.44 | 21220 6.96 | 23752 7.78 | 26400 8.59 | 5483 58.60 | 1638 11.04 | 3118 18.92 | 1624 8.29 | 2532 11.93 | 2648 11.15 | 17043 182.14 | 1.77** 0.000 |
| Net sectoral changes $(\Delta E + \Delta A + \Delta N)$ | 284315 | 298458 | 303753 | 304159 | 305023 | 305195 | 307483 | 14143 4.97 | 5295 1.77 | 406 0.13 | 864 0.28 | 172 0.06 | 2288 0.75 | 23168 8.15 | 0.13* 0.024 |

Source: Derived from Ministry of Agriculture Govt. of India.

In Area Bold are indicates the percentages.

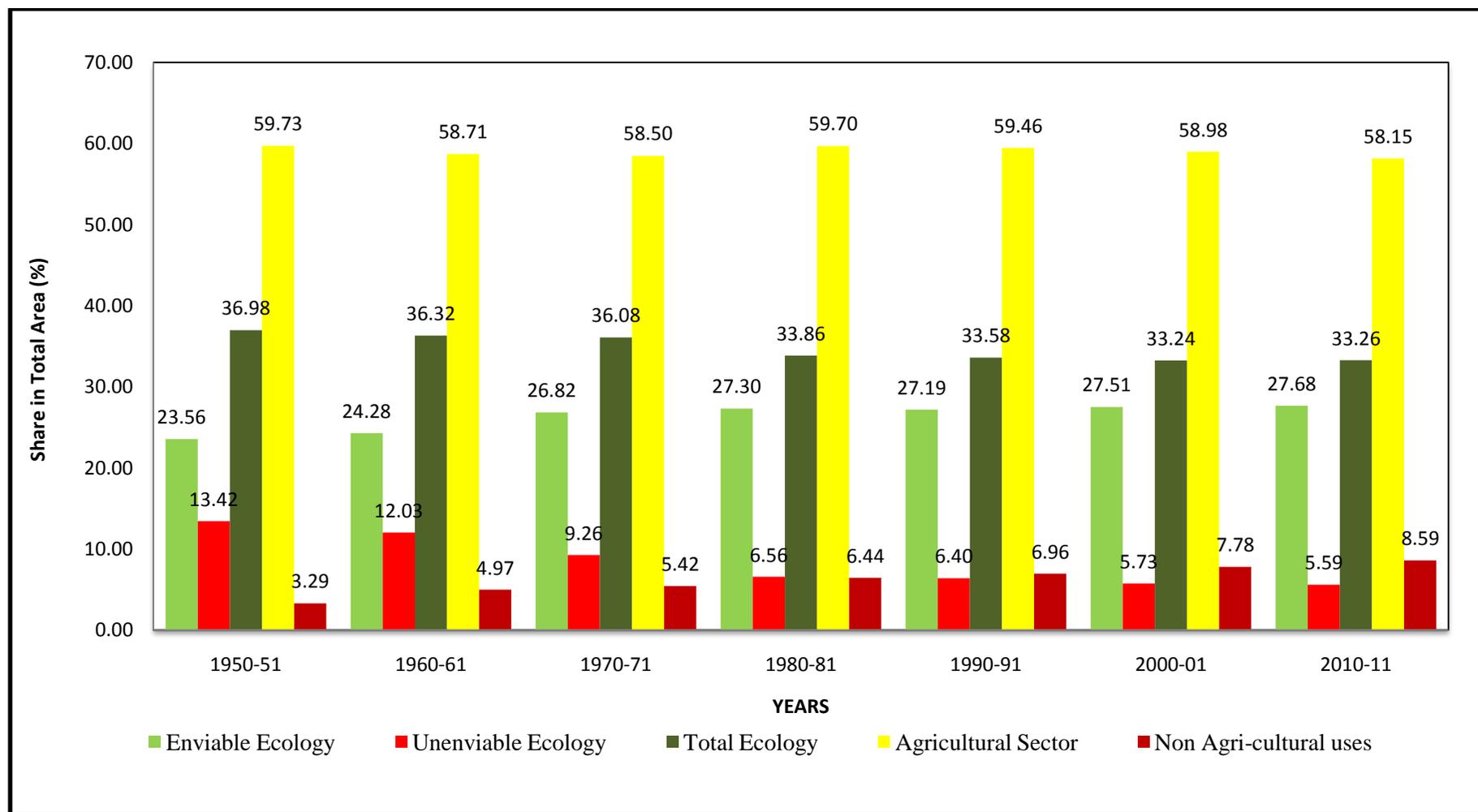
In growth rate of changes Bold are indicates annual growth rate of changes

In CAGR Bold indicates the rate of significance where

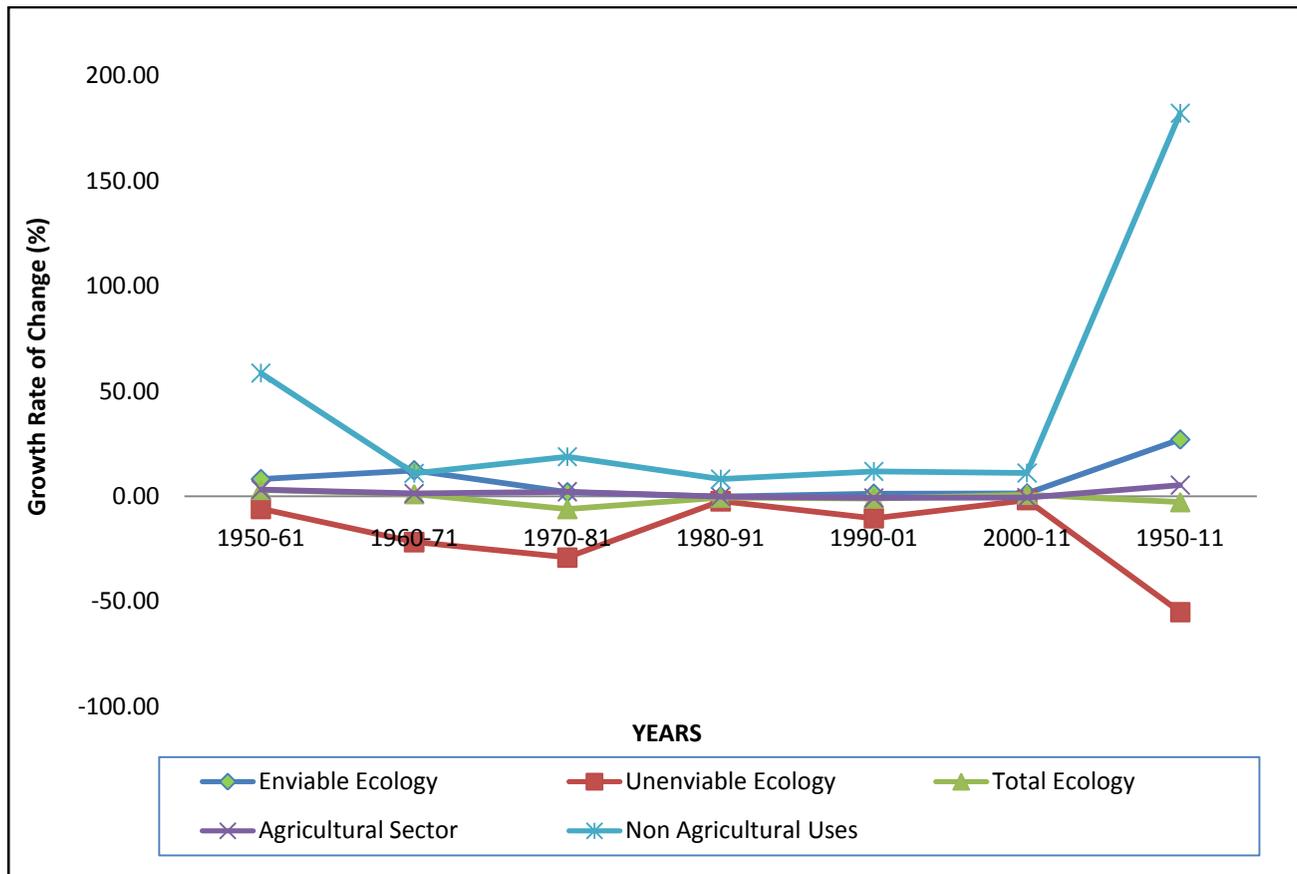
** Significant at 1per cent level

* Significant at 5 per cent level

Figure 1: Sectoral Land Use Pattern in India from 1950-51 to 2010-11 (in percentage)



Source: Based on Ministry of Agriculture Govt. of India.

Figure 2: Sector Wise Land Use Changes in India from 1950-51 to 2010-11 (in Hectares)

Source: Based on Ministry of Agriculture Govt. of India.

shown that the land has been shifted toward non-agricultural sector. This land use shifts indicates that this land is going under the construction of rural roads, urban extension, irrigation development, market area etc. Significantly changes in land use pattern have taken place during the study periods, mainly determined by biophysical and human needs.

B. Sectoral land use pattern and dynamics

We know that the study categorized nine land use classes into three broad sectors, which are briefly discuss below:

B. I. Ecological Sector Land Uses

The states wise percentage share in area under ecological sector varied in India. The states wise percentage analysis revealed that 17 states have share of area under ecological sector land more than the national average of 32.77 per cent in 2010-11. These states are mainly hilly and Himalayan regions, other than these regions the states of Chhattisgarh (54.37 per cent), Odisha (48.99 per cent), Jharkhand (37.78 per cent), Madhya Pradesh (37.03 per cent) and Andhra Pradesh (33.08 per cent) also

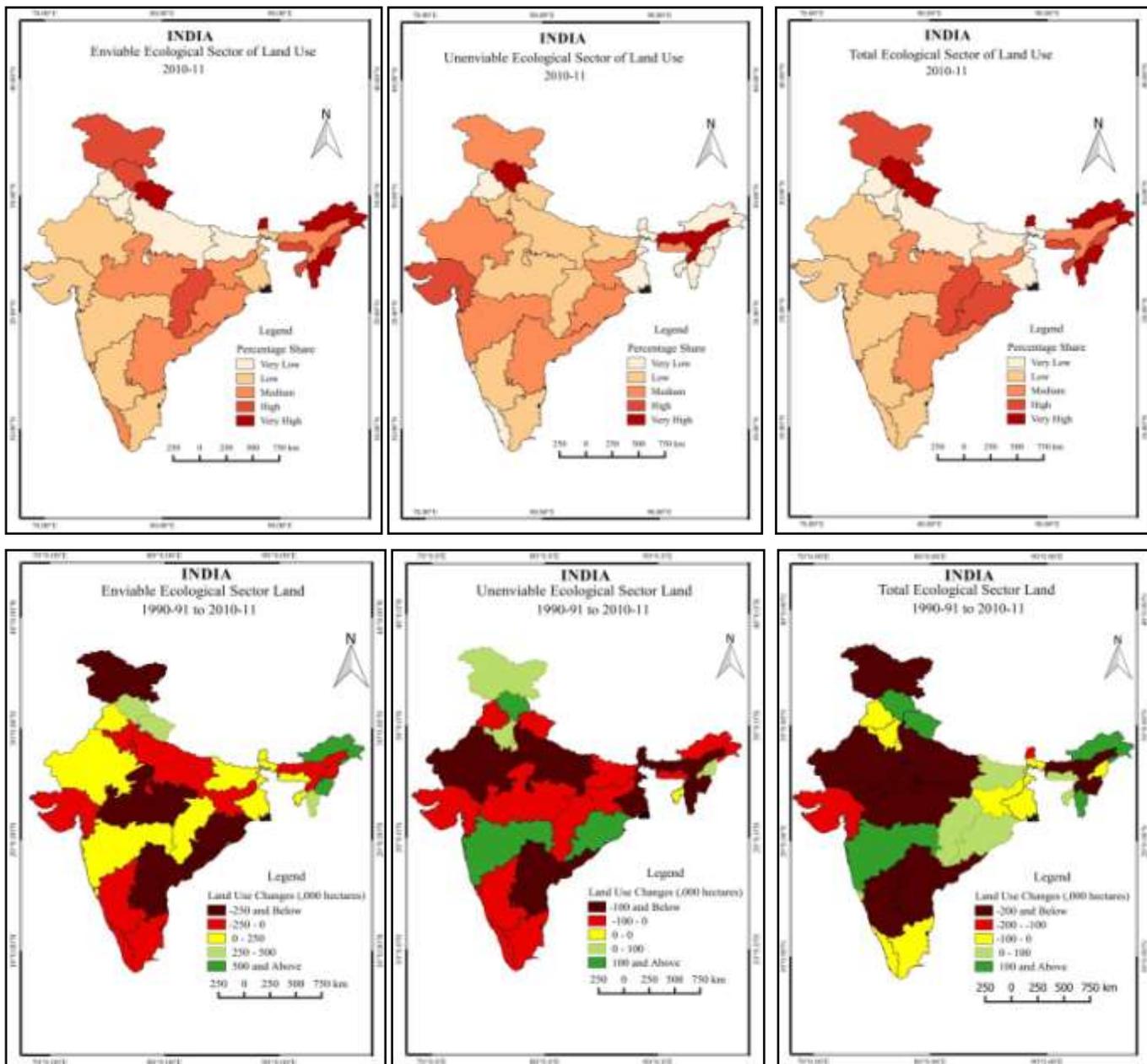
share higher than the national average. The states of Haryana (4.10 per cent), Punjab (6.50 per cent), Uttar Pradesh (10.61 per cent), Bihar (14.05 per cent) and West Bengal (14.38 per cent) cover less percentage in area under ecological sector of land during the study periods of 2010-11. The figure 3 clearly indicate that Indo gengetic regions share lesser percentage in ecological sector of land because this regions are mainly agricultural and population dominated, whereas the hilly and Himalayan region have shown high percentage share because of favourable weather and low density of population.

In order to examine the states wise growth rate in area under ecological sector land uses during the periods of 1990-91 to 2010-11 and its results are presented in figure 3. During the study periods, states wise absolute growth rate in area under ecological sector reveal that out of 29 states, 14 states have shown increase trends in India. These states includes Arunachal Pradesh (1530 thousand hectares), Himachal Pradesh (1070 thousand hectares), Uttarakhand (353 thousand hectares), Maharashtra (246 thousand hectares) and Mizoram (160 thousand hectares) have recorded highly increase growth rate in ecological sector land uses in India. Another 17 states have shown decline in area under ecological sector land uses. These states includes Assam (521 thousand hectares), Jammu & Kashmir (503 thousand hectares), Andhra Pradesh (489 thousand hectares), Manipur (337 thousand hectares), Madhya Pradesh (261 thousand hectares) and Karnataka (240 thousand hectares) have shown highly negative growth rate in ecological sector land. This negative changes is affecting climatic conditions, biodiversity and ecosystem, which is turn affect land use decision.

Ecological sector land uses are further divided into two broad classes, one are enviable ecological sector which consist of area under forest, permanent pastures & other grazing lands and land under mics. trees& groves. Other ecological sector of land use classes are unenviable ecological sector which consist of barren &unculturable land uses.This two land use classes are briefly discuss below:

B. I. I. Enviable Ecological Sector Land Uses

The states wise percentage analysis revealed that the north eastern states share higher percentage in area under enviable ecological sector during the period of 2010-11. Other states which also share more than the national average includes Himachal Pradesh (58.98 per cent) followed by Jammu & Kashmir (58.40 per cent), Chhattisgarh (52.15 per cent), Meghalaya (49.62 per cent), Odisha (42.32 per cent) and Madhya Pradesh (32.69 per cent) during same period. The states of Delhi (1.36 per cent) followed by Haryana (1.76 per cent), Punjab (6.00 per cent), Uttar Pradesh (8.60 per cent),

Figure 3: Ecological Sector Land Use Pattern and Dynamics in India from 1990-91 to 2010-11

Source: Based on Ministry of Agriculture Govt. of India.

Bihar (9.43 per cent) and Rajasthan (13.01 per cent) share lowest percentage in area under enviably ecological sector land uses in during same study periods in India.

The growth rate of changes in area under enviably ecological sector land uses have also varied among the different states during the study periods in India. It's interesting to see that most of the states have shown increasing trends in India and it presented in figure 3. The north eastern and hilly states like Arunachal Pradesh recorded the highest increased (1540 thousand hectares), followed by Manipur, Himachal Pradesh, Uttarakhand and Mizoram in area under enviably ecological sector land uses during the periods of 2010-11 to the base year 1990-91. Other states, which recorded a significant increase in

this land uses, included Rajasthan (188 thousand hectares), Maharashtra (144 thousand hectares), West Bengal (80 thousand hectares), Chhattisgarh (58 thousand hectares), Punjab (26.5 thousand hectares) and Bihar (19 thousand hectares). The enviable ecological sector increases mainly because of the definitional changes of forest area and increasing total reporting area in India during the study years. Similarly, the states of Jammu & Kashmir (514 thousand hectares), Odisha (507 thousand hectares), Andhra Pradesh (348 thousand hectares), Madhya Pradesh (258 thousand hectares), Karnataka (228 thousand hectares), Assam (172 thousand hectares) and Haryana (125 thousand hectares) witnessed an increase trends in area under enviable ecological sector land uses. This sector of land use are disturb in India mainly because of naturally of human action, like clearing forest, construction, flood, forest firing etc.

B. I. II. Unenviable Ecological Sector Land Uses

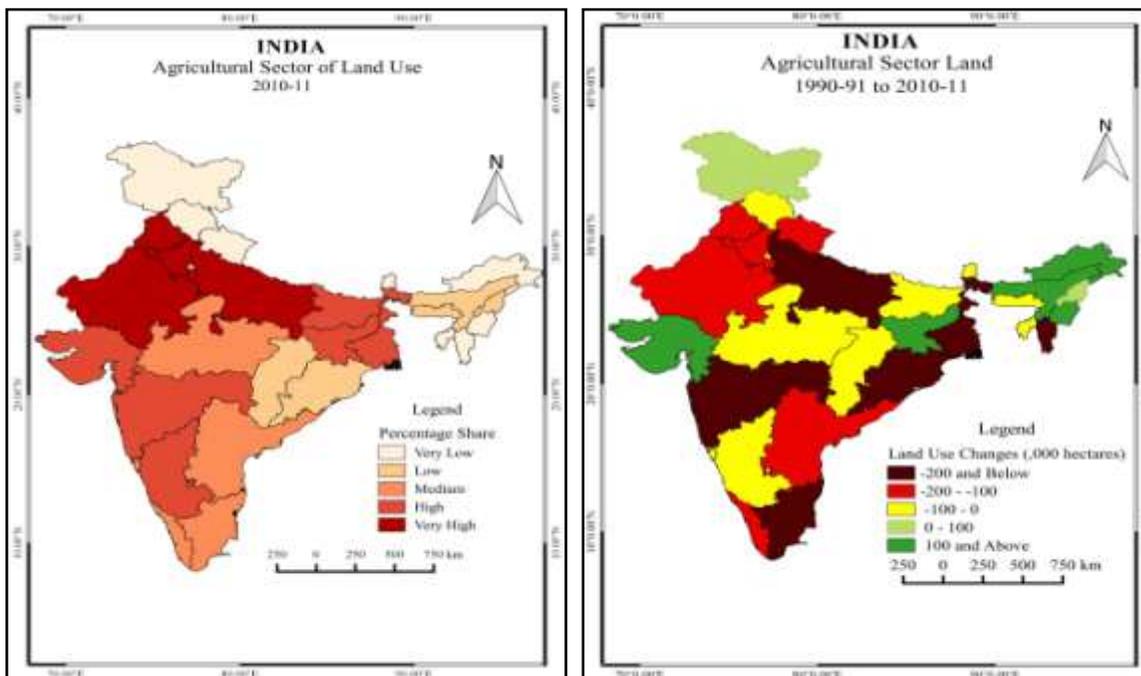
The states wise percentage analysis revealed that Assam share highest percentage (17.94 per cent) in area under enviable ecological sector land use followed by Himachal Pradesh (17.02), Gujarat (13.38 per cent), Delhi (10.88 per cent), Andhra Pradesh (7.37 per cent), Jammu & Kashmir (7.33 per cent), Jharkhand (7.14 per cent) and Rajasthan (6.94 per cent) during the periods of 2010-11 in India. On the other hand the state of Tripura share lowest percentage in area this sectoral land uses in India followed by Sikkim, Manipur, Nagaland, West Bengal, Mizoram and Punjab during same period.

Area under unenviable ecological sector land uses has declined in most of the districts during the study periods and its results presented in figure 3. For example, figure 3 shows that Manipur recorded highest decline (1417.6 thousand hectares) in area under this sectoral of land uses followed by Rajasthan (404.6 thousand hectares), Assam (348.7 thousand hectares), Mizoram (193 thousand hectares), West Bengal (175.9 thousand hectares), Sikkim (173.2 thousand hectares), Uttar Pradesh (153 thousand hectares) and Andhra Pradesh (140.4 thousand hectares) during the study periods of 1990-91 to 2010-11 in India. Similarly, the states of Himachal Pradesh recorded the highest increase (593.2 thousand hectares), followed by Odisha (553 thousand hectares) and Maharashtra (102.3 thousand hectares), where the states of Haryana followed by Jammu & Kashmir, Delhi, Nagaland and Tripura have shown marginally increases in area under unenviable ecological sector of land uses in India during the same study periods. The lands under unenviable ecological sector are declining most of the states which are good indicator if the lands are shifted enviable sector of land uses.

B. II. Agricultural Sector Land Uses

The agricultural sectoral land uses which consist of area under fallow land, culturable waste land and net sown area. Agricultural sector is the single largest user of land resources in India, accounting for nearly 60 per cent of total reporting area. Land use pattern in India reflect the interaction of human activities and the natural environment. The states wise percentage analysis revealed that the states of Haryana (83.98 per cent), followed by Punjab (83.43 per cent), Uttar Pradesh (77.67 per cent), Rajasthan (74.53 per cent), Maharashtra (67.85 per cent), Bihar (67.80 per cent), Gujarat (66.37 per cent) etc. recorded area under agricultural sector land uses cover more than national average. On the other hands the states of Arunachal Pradesh share lowest percentage (6.84 per cent), followed by Sikkim 12.84, Himachal Pradesh 16.28, Manipur 16.42, Mizoram 17.96, Uttarakhand 20.45 etc. in area under agricultural sectoral land uses during the period of 2010-11 in India, these states also share lower than national average.

Figure 4: Agricultural Sector of Land Use Pattern and Dynamics in India from 1990-91 to 2010-11



Source: Based on Ministry of Agriculture Govt. of India.

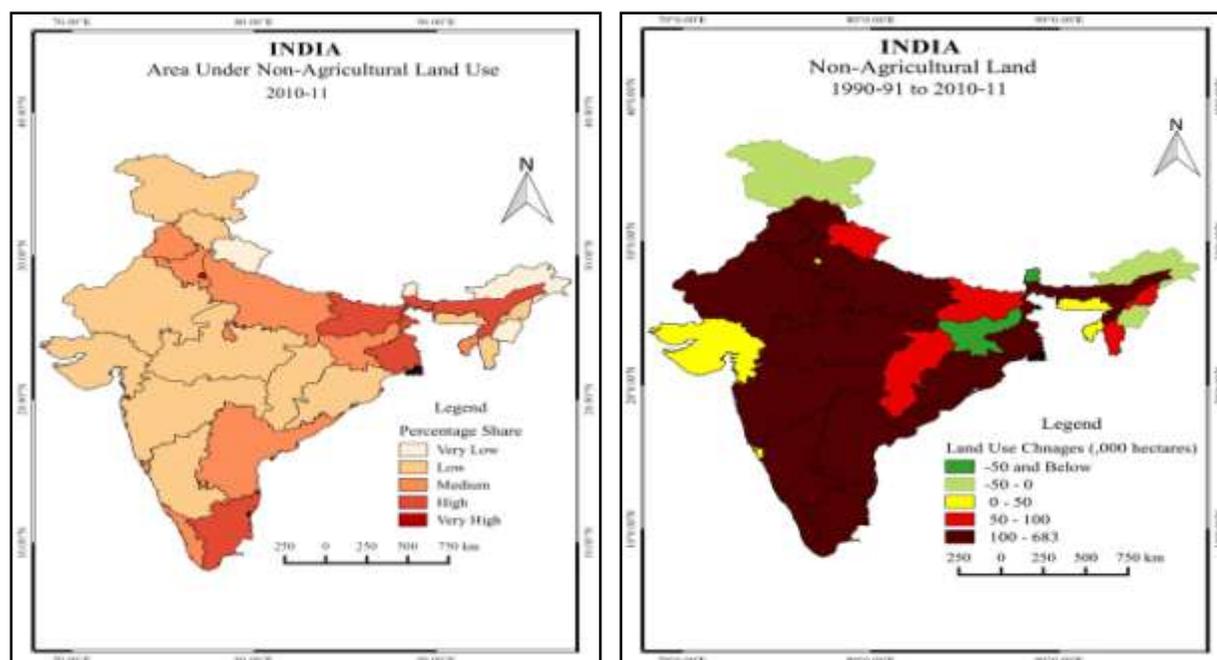
The trends in area under agricultural sector land expansion also varied among different states in India. For example, Odisha recorded highest decline (653 thousand hectares) in area under agricultural sector followed by Maharashtra (616 thousand hectares), Uttar Pradesh (419 thousand hectares), Tamil Nadu (301.8 thousand hectares), West Bengal (273 thousand hectares) and Mizoram (251.3 thousand hectares) during the periods of 190-91 to 2010-11 in India. Most of the states have shown decline trends in area under this sectoral land uses. The decline this sectoral land uses because there could be

higher demand for housing in rural areas due to increases population, beside socio-economic and technological factors also affecting on agricultural land in India. It is interesting to note that some of states have shown marginally able to bring additional land under agricultural sectoral land uses. For example, in Jharkhand, total agricultural land increased by about 1299 thousand hectares during the study periods of 1990-91 to 2010-11. Other states which recorded marginally increase in this sectoral land uses, includes Gujarat (300.8), followed by Manipur (237.9), Arunachal Pradesh (166), Assam (154.6), Nagaland (82.9) and Jammu & Kashmir (33.3) during the study periods of 1990-91 to 2010-11 in India.

B. III. Non-Agricultural Sector Land Uses

The area under non-agricultural sector land is that land which is occupied by building, roads and railways or under water, e.g. rivers and canals, and other land put to uses other than agriculture. The loss of farm lands to other uses is an unavoidable phenomenon during economic development, population growth and urbanization periods (Tan et. al., 2009). The states wise percentage share in area under non-agricultural sector land uses varied during the study periods. The states of Delhi share highest percentage (51.70 per cent), followed by West Bengal (20.99 per cent), Bihar (18.16 per cent), Tamil Nadu (16.70 per cent), Assam (15.52 per cent), Tripura (13.44 per cent) and Kerala (12.61 per cent) in area under non-agricultural sector land uses. The north eastern states share less percentage in area under non-agricultural sector of land uses during the study periods. Other states,

Figure 5: Non-agricultural Sector Land Use Pattern and dynamics in India. (1990-91 to 2010-11)



which less shares in this sector of land are Maharashtra (4.71 per cent), Chhattisgarh (5.17 per cent), Rajasthan (5.51 per cent), Gujarat (6.14 per cent) and Madhya Pradesh (6.79 per cent) in India.

The rates of land expansion in area under non-agricultural sector have also varied among different states in India. Most of the states have shown increasing trends in India. For example, Andhra Pradesh recorded the highest increase (683 thousand hectares) in area under non-agricultural sector of land uses during the period of 1990-91 to 2010-11. Other states, which recorded a significant increase in area under non-agricultural sector land, included Uttar Pradesh (591 thousand hectares), Odisha (534 thousand hectares), Rajasthan (398 thousand hectares), Tamil Nadu (369 thousand hectares), Maharashtra (369 thousand hectares) and Assam (360 thousand hectares) in India. The states of Sikkim, Jharkhand, Jammu & Kashmir, Arunachal Pradesh and Manipur which witness decline trends in this sector of land use in this country. The economic development and population growth increased the demand for land for non-agricultural sector land uses.

C. Population Scenario in India

The three most populated countries in the world are China, India and USA, together account for four of every ten persons of the world, where every six persons in the world is from India. In 2030 it is estimated that India will overtake China to become the most populous country in the world with 17.9 per cent population living here. The technological and social transformation in 20th century brought steep declines in birth rates and death rate in India. In India century began with 238.39 million populations in 1901 and ended with 1028.73 million in 2001, mainly because of unparalleled growth of population after 1960. This momentum of population growth may carry the India population past 1210.19 million by 2011. Demographic changes related policy making is difficult to predict how today's actions will affect the future size and distribution of populations.

C. I. Population Growth: India from 1901 to 2011

The population of India, at the starting of the twentieth century, was only around 238.4 million. This has increased by more than four times in a period of one hundred and ten years to reach 1210 million in 2011. The progressive growth rate of population in India over 1901 to 2011 was about 407.64 per cent. Interestingly, the growth rate before 1961 by one and half times, while after 1961 it recorded a phenomenal three-fold increase. The growth rate such as decadal growth rate, changes in decadal growth, average annual exponential growth rate and progressive growth rate over 1901 during each decade have also been presented in this study.

The population started climbing after independence and show the highest decadal growth rate of 24.8 per cent in 1961-71 and 24.66 per cent in 1971-81. One of the important features of the study is that during the periods of 1911-1921 have shown negative growth rate (cause), while after the 1980s, decadal growth rate has been falling and during the periods of 2001-11 have shown significant fall, the

first decades of the new century saw fewer people added to India's population than in the previous decades (cause). The year 1921 is often referred to as the "Year of the Great Divide," the last period in which India's population declined, due to the effects of famine.

Table 2: Population and its Growth in India from 1900-1901 to 2010-2011

| Census Years | Population | Decadal growth | | Change in decadal Growth | | Average annual exponential growth (percent) | Progressive growth rate over 1901 (percent) |
|--------------|------------|----------------|---------|--------------------------|---------|---|---|
| | | Absolute | Percent | Absolute | Percent | | |
| 1901 | 238396327 | | | | | | |
| 1911 | 252093390 | 13697063 | 5.75 | | | 0.56 | 5.75 |
| 1921 | 251321213 | -722177 | -0.31 | -14469240 | -6.05 | -0.03 | 5.42 |
| 1931 | 278977238 | 27656025 | 11 | 28428202 | 11.31 | 1.04 | 17.02 |
| 1941 | 318660580 | 39683342 | 14.22 | 12027317 | 3.22 | 1.33 | 33.67 |
| 1951 | 361088090 | 42427510 | 13.31 | 2744168 | -0.91 | 1.25 | 51.47 |
| 1961 | 439234771 | 78146681 | 21.64 | 35719171 | 8.33 | 1.96 | 84.25 |
| 1971 | 548159652 | 108924881 | 24.8 | 30778200 | 3.16 | 2.2 | 129.94 |
| 1981 | 683329097 | 135169445 | 24.66 | 26244564 | -0.14 | 2.22 | 186.64 |
| 1991 | 846421039 | 163091942 | 23.87 | 27922497 | 17.12 | 2.16 | 255.05 |
| 2001 | 1028737436 | 182316397 | 21.54 | 19224455 | 10.54 | 1.97 | 331.52 |
| 2011 | 1210193422 | 181455986 | 17.64 | -860411 | -0.47 | 1.64 | 407.64 |

Source: Census of India

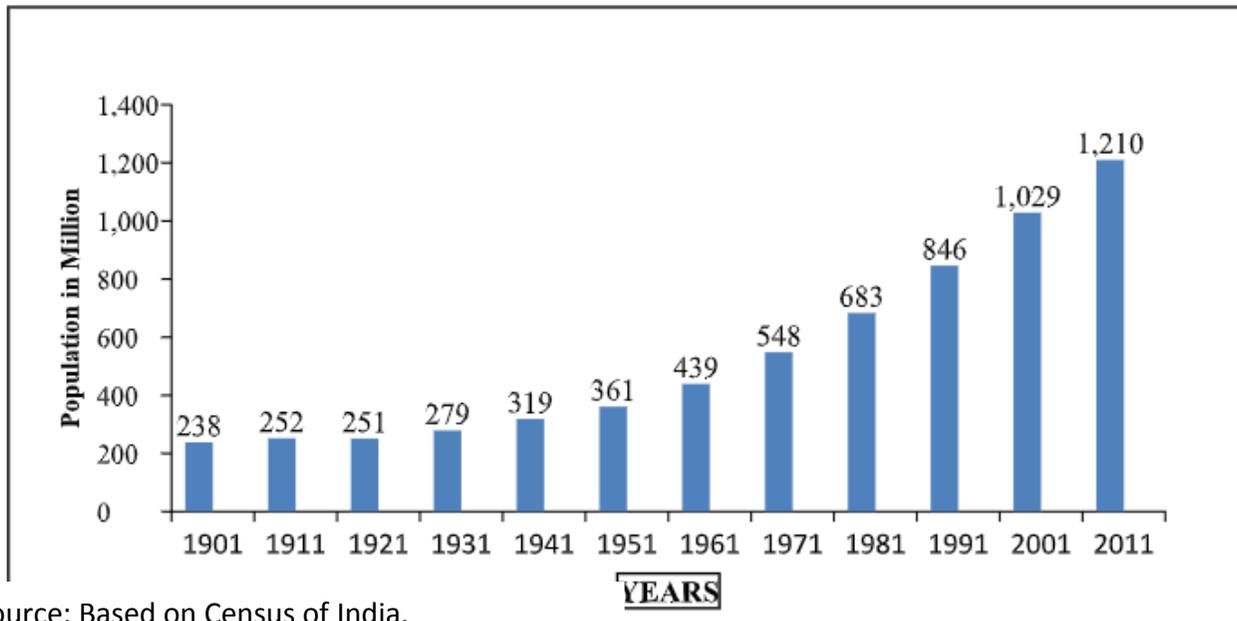
It reveals that during the first 50 years from 1901 to 1951, population grew by 12.3 crore while during the next 50 years from 1951 to 2001, it increased by more than 5 times, that is, by 66.6 crore. The population of India has increased by about 181 million (17.64 per cent) during the decade 2001-2011.

The growth of population in India can be divided into four phases as under:

1. Phase of Stagnant Population: 1901-21
2. Phase of Steady Population Growth: 1921-51
3. Phase of Rapid Population Growth or of Population Explosion: 1951-81
4. Phase of High Growth with Declining Trend: 1981-2001

Figure 6: Decadal Population in India from 1900-1901 to 2010-11 (in million)

Figure 6: Decadal Population in India from 1900-1901 to 2010-11 (in million)

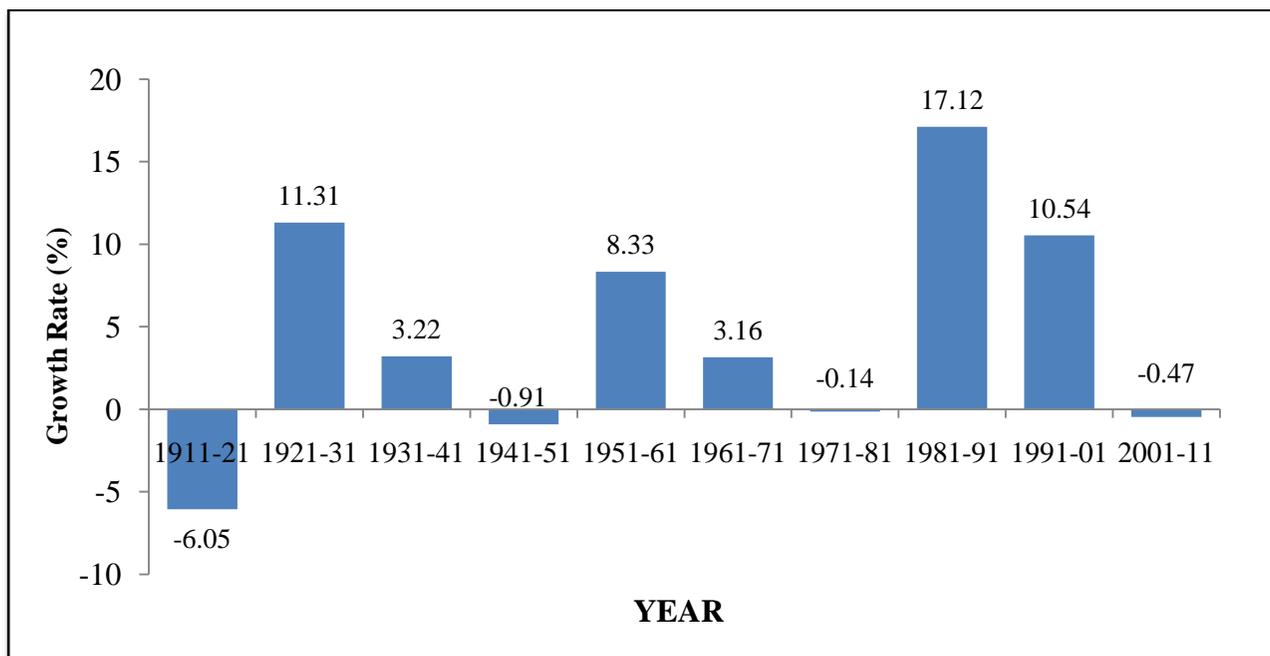


Source: Based on Census of India.

Source: Based on Census of India.

Currently estimates are that India populations will keep growing till it peaks at 1.75 billion around 2060. Long before that, by 2022, the UN estimates that India population would have crossed 1.4 billion and overtaken China as the most populous country in the world. This rapidly increasing population are facing challenges of providing health, education and employment for youth population.

Figure 7: Decadal Population Growth in India from 1990-1901 to 2010-11 (in percent)



Source: Based on Census of India

The population of India during the twentieth century was only around 238.4 million. The progressive growth rate from 1901 to 2011 was about 407.64 per cent to reach 1210 million in 2011. Interestingly, the population growth of India by one and half times in the first half of the twentieth century, while in remain half it recorded a notable three-fold increase. This indicates that as a result of the combination of population momentum and somewhat obstructed fertility, although India continues to grow in size, its speed of net addition is on the decrease. The fertility rate is falling in recent decades mainly because of the family planning efforts, women become more literate, as their status in society gets better. In particular men too prefer smaller families as they get more civilized and empower the women, and they'll defuse the bomb. With a view point of economic development and economic welfare, studying the demography of any country is very important.

C. II. Population: States and Union Territories

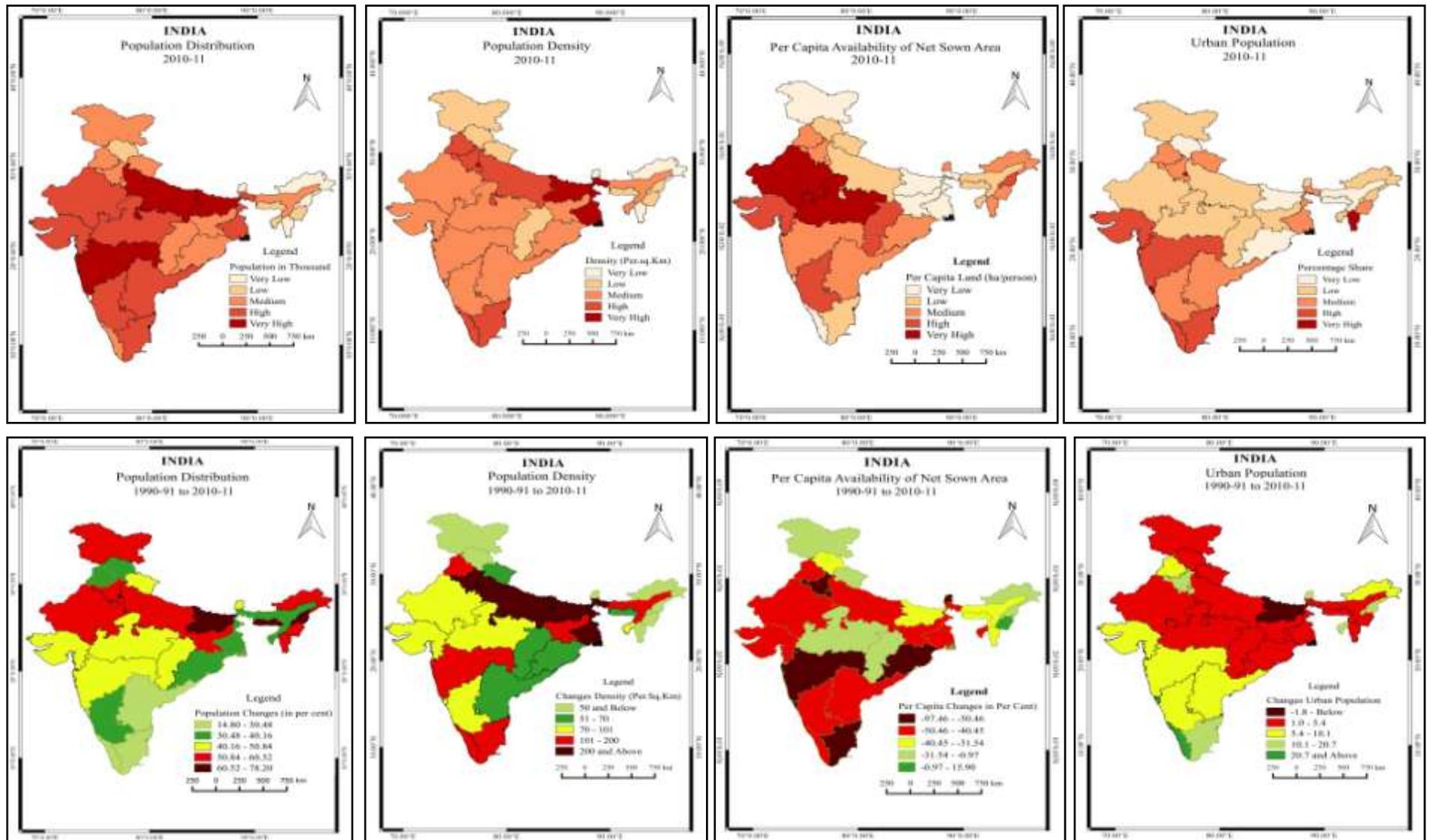
Uttar Pradesh continues to be the most populous State in the country with almost 200 million people living here, which is more than the population of Brazil, the fifth most populous country in the world. Twenty States and Union territories now have a population of over ten million. While the states of Maharashtra, Bihar, West Bengal and Andhra Pradesh have all held on to the top five slots in terms of their ranking in 2011, Madhya Pradesh, which has moved on to take the sixth positions from its seventh position, pushing Tamil Nadu now to the seventh spot. A little more than six of every ten Indians live in one of these seven States.

C. III. Population Growth: All States and Union Territories

The phenomenons of low growth have stated to spread beyond the boundaries of the southern states during 1991-11, where in addition to Andhra Pradesh. Tamil Nadu and Karnataka in the south, Himachal Pradesh and Punjab in the North, West Bengal and Orissa in the east, and Maharashtra in the West have registered a growth rate between 11 to 16 per cent in 1991-2011 over the previous decade. Nagaland is the only state which has registered a small negative growth during 2001-11 after very high growths in all the previous decades.

The percentage decadal growth of population in the inter-census period 1991-2011, among the more populous states and union territories, varied from a low of 4.86 in Kerala to a very high 25.07 in Bihar. Jammu & Kashmir with 23.71 per cent, Chhattisgarh with 22.59 and Jharkhand with 22.34 also registered very high growth rates. A decline of more than five percentage points in decadal growth rate from the previous census decade was recorded for 15 states and UT, namely, for the states Jammu & Kashmir, Punjab, Haryana, Rajasthan, Uttar Pradesh, Sikkim, Nagaland, Manipur, Mizoram, Maharashtra. Also for the UT of Goa among the larger states and UT, Delhi has registered the sharpest

Figure 8: States Wise Population Share and Growth Rate in India from 1990-91 to 2010-11



Source: Based on Census of India

drop of twenty six percentage points during the said period followed by Haryana (8.53), Rajasthan (6.74).

C. IV. Density of Population in India

The population density is expressed as number of persons per unit area which is gradually increasing with the passing of every year. The population density in India during the periods of 2010-11 is 382 persons per sq. km. The figure 8 shows the spatial variation of population densities in India while the Delhi possesses the highest of the population density 2011 among the states of India having a statistics of 11,297 per square km. and the state of Arunachal Pradesh has the lowest record of population density having just 17 per sq km. Among the states Indo-Gangetic Plain states have shown higher densities, while the hill states of the Himalayan region and North Eastern states of India (except Assam) have relatively low densities.

The density of population of India broadly varies across the states. Population density has been increased in all states of India during the study periods of 1990-91 to 2010-11 which are presented in figure 8. For growth rate also the states of Indo gangetic states have shown higher positive growth rate of population, whereas the Himalayan region noted relatively low growth rate. The growth rate of population density varied from a low of 7 per sq km in Arunachal Pradesh to very high 4945 per sq km in Delhi. It indicates that a higher density of population states would essentially mean that it is an urban area with high buildings and other modern aspect. On the other hand low density of populated states would mean that it rural area with a probability there lack of modern amenities in the region. It also noted that in these states, increase in the population density is a serious matter of concern as it put great pressure on our natural resources and it affects the quality of life.

C. V. Urban Population in India

Urban Population played a very important role for changes in pattern of human settlement in India, its important social transformation in recent times. For urban population distribution figure 8 shows that Mizoram in north eastern state and southern states like Tamil Nadu, Kerala, Maharashtra and Karnataka were the most urbanize states during the periods of 2010-11. The northern states shares of urban area are particularly low like Himachal Pradesh, Bihar, Assam, Orissa, Meghalaya, and Uttar Pradesh.

Urban Population in India has continuously been increasing during the last two decades in almost all states because of the development happen in India. During the periods of 1990-91 to 2010-11, figure 8 shows that the states of Sikkim followed by Kerala, Arunachal Pradesh, Tripura, Nagaland and Goa

Table 3: Analyses of the relationship Between Population Variables and Sectoral Land Uses in India 1990-91 to 2010-2011

| CORRELATION MATRIX | | | | | | | | | | | | | |
|--------------------|---------|---------|----------|---------|---------|----------|----------|----------|---------|----------|--------|--------|-----|
| VARIABLES | EE | UE | E | A | NA | NO_HH | TOT_P | HH_D | LITRACY | DENSITY | F_L | R_P | U_P |
| EE | 1 | | | | | | | | | | | | |
| UE | -0.058 | 1 | | | | | | | | | | | |
| E | 0.826** | 0.111 | 1 | | | | | | | | | | |
| A | 0.046 | 0.739* | -0.015 | 1 | | | | | | | | | |
| NA | -0.018 | 0.587** | -0.022 | 0.338 | 1 | | | | | | | | |
| NO_HH | -0.482* | -0.017 | -0.098 | -0.368* | -0.17 | 1 | | | | | | | |
| TOT_P | -0.029 | 0.255 | 0.014 | -0.465* | 0.134 | 0.747** | 1 | | | | | | |
| HH_D | -0.482* | -0.017 | -0.098 | -0.368 | -0.17 | 0.970** | 0.747** | 1 | | | | | |
| LITRACY | 0.046 | 0.119 | -0.091 | 0.003 | 0.236* | 0.199 | 0.243 | 0.199 | 1 | | | | |
| DENSITY | -0.037 | 0.634* | 0.007 | 0.260 | 0.290* | 0.565** | 0.923** | 0.565** | 0.282 | 1 | | | |
| F_L | 0.039 | 0.157 | -0.106 | 0.022 | 0.208 | 0.326 | 0.336* | 0.326 | 0.959** | 0.357* | 1 | | |
| R_P | -0.012 | -0.046 | -0.465** | 0.116 | 0.589** | 0.352 | 0.256 | 0.352 | 0.348* | 0.287 | 0.387* | 1 | |
| U_P | -0.004 | -0.451* | -0.522* | -0.083 | 0.09 | -0.528** | -0.541** | -0.528** | 0.07 | -0.564** | -0.048 | -0.294 | 1 |

Abbreviation: EE- Enviable Ecological Sector, UE- Unenviable Ecological Sector, E- Ecological Sector, A-Agricultural Sector, NA- Non-agricultural Sector, NO_HH- Number of Household, TOT_P- Total Population, HH_D- Household Density, Literacy Rate, Density of Population, E_L- Female Literacy, R_P- Rural Population, U_R- Urban Population

** Significant at 1per cent level

* Significant at 5 per cent level

registered highly increasing of urban population in India. The percentage shares of urban population are low as compared to the rural population but its rate of increasing are high. The states like Meghalaya, Jharkhand, Delhi, Bihar and Rajasthan rate of increasing urban population are low compare to the other states I this country.

D. Correlation Matrix

The area under enviable ecological sector land depicts positive correlation with ecological sector of land ($r=0.826$) at 1.0 per cent level of significance. It is negatively correlated with number of household and household density at 5.0 per cent level of significance in ecological sector land uses. Unenviable ecological sector of land in India is positively correlated with agricultural land ($r=0.739$) and population density ($r=0.634$) at 5.0 per cent level of significance, whereas, non-agricultural land have also positive correlation ($r=0.587$) at 1.0 per cent level of significance. It is negatively correlated with urban population ($r=0.683$) at 5.0 per cent level of significant.

Total ecological sector land is negatively correlated to Rural and Urban; r values begins 0.465 and 0.522 respectively at 5.0 and 1.0 per cent level of significance, there by implying that population growth replace by ecological sector of land in India. The agricultural sectoral land use also negatively correlated to number of household and total population (r values being -0.368 and -0.465 respectively) at 5.0 per cent level of significance in India. This shows that population growth, number of household, urban population are the phenomena in India which played major role for affect the sustainability of natural resources, ecological and agricultural favourable land in particular. The constructions that support small industries development and links rural areas with urban centres contribute to loss of ecological sector of land. The non-agricultural sector land has positive correlation with literacy rate ($r=0.236$) and density of population ($r=0.290$) at 5.0 per cent level of significance while the rural population ($r=0.589$) at 1.0 per cent significant in India.

Other variables expect sectoral land uses like number of house hold, total population, house hold density and rural population have significantly positive correlation with each other, while only urban population is negatively correlated with them during the sample periods in India. It is estimated that high growth in urban population would lead to higher negative impact for sector land use; hence the urban population would employ more pressure on agricultural land and ecological sector land to divert to non-agricultural land uses.

Conclusions

The study finds total ecological sector of land use in India share 33 per cent during 2010-11, but shown declining trends. The agricultural sector land use shown increasing trends where agriculture is the main source of income in rural villages, also it's the primary source of income in India, other hand non-agricultural sector of land has increased which is a serious matter of concern. The unenviable ecological sector and total ecological sector have shown negative growth rate, where the non-agricultural, agricultural and net sectoral changes have shown most significant positive growth rate. This land use shifts indicates that this land is going under the construction of rural roads, urban extension, irrigation development, market area etc. Significantly changes in land use pattern have taken place during the study periods, mainly determined by biophysical and human needs. This sector of land use are disturb in India mainly because of naturally of human action, like clearing forest, construction, flood, forest firing etc.

In conclusion, also noted that in India the impact of population on land were stronger and unfavourable in indo gangetic and northern plain region states compare than other areas, mainly because of the favourable conditions for settlement, transportation, communication etc., where in arid and fragile areas of northern Himalayas and Aravalli range states have favourable impact, as it is of great significance for ecological balance in India. India has witnessed rapid population slowing down from last two decades, improvement of social and economic condition, but impacts of changes in land use pattern remain same since independence.

The demand of agricultural and non-agricultural land in India increased rapidly in recent past with the population growth, household density and rural economy. This increasing demand of land hunger by population growth and development activity with happen in India are the main causes of deterioration in sectoral land uses. This study finds that population growth, number of household, urban population are the phenomena in India which played major role for affect the sustainability of natural resources, ecological and agricultural favourable land in particular. Hence these indicators would employ more pressure on agricultural and ecological sector to divert to non-agricultural land uses. The study shows that human have transformed huge portion of the land surface in India, these changes in land use have important implications for the future changes.

Land use planning aims at selecting and put into practice land uses aiming to meet the present needs of the people while preservation resources for the future. Thus land use polices will have play important role in sustaining ecological balance, environmental health and at the same time meet the basic requirements of the population.

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