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Anthropogenic intrusions leading to variability in Vegetated vs Non-vegetated land dynamics over the past two decades in India

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Keywords

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ABSTRACT

The increase in the human population, changing climate, natural hazards, extreme events, quest for resources has led to significant variability in the land cover dynamics. There has been a great deal of spatio temporal variability in the land use/ cover over the Indian landmass in past two decades. The study looks into the dynamics of land use/cover with focus on vegetated land vs non-vegetated land in light of human induced changes using MODIS land cover product. In order to detect the contribution of human induced changes, the dynamics of the human settlements in terms of urban area is analysed at three focal periods viz, 2001, 2010, and 2019. The difference in the decadal trend, show that the forest cover has increased by 1.1 % from 2001-10 to 2010-19. In contrast the cropland is decreased by 0.94 % from 2001-10 to 2010-19 whereas urban expansion is increased by 2.67%. Overall, the vegetated land has increased by 0.08 % and the non-vegetated land is decreased by 0.97 %. The population load requires resources to survive with concomitant decrease or reduced growth over vegetation areas.

1. INTRODUCTION

Rapid changes in ecosystems as a result of human activities, like tropical deforestation, are of great relevance to climate and global change (Arneeth et al. 2010). Scenarios of future anthropogenic land cover and land use suggest continued changes as a result of the increasing demand for food and (bio) energy. Several previous studies have indicated the interactions between global land cover, the carbon cycle, and therefore the climate system.

Continuous monitoring of vegetation dynamics is crucial for understanding the biogeochemical processes and its possible effect on our climate system (Falkowski et al. 2000; IPCC, 2019). The changing energy balance is greatly affecting the terrestrial biosphere due to the climate variability and land use changes within the recent decades (FSI, 2019). Biodiversity, natural ecosystems, forestry and agricultural production are expected to be severely impacted thanks to climate variability and anthropogenic activity influenced land use changes within the future (Miura et al. 2008). Forest

and agriculture account for nearly 80% of the geographic area of India, about 24.56% of which is forest and 55% of which is agricultural land (Reid et al. 2008). Agricultural production may be a key indicator for food security and a number of other studies have explored the connection between crop yields, NDVI and food security (Teal et al. 2006).

There has been a great deal of spatio temporal variability in the land use/ cover over the Indian landmass in past two decades. The increase in the human population, changing climate, natural hazards, extreme events, quest for resources has led to significant variability in the land cover dynamics. The major concern of this study lies in examining the dynamics of the vegetated land vs non-vegetated land in light of human induced changes in the past two decades using MODIS based land use/cover product.

2. METHOD

The Terra and Aqua combined Moderate Resolution Imaging Spectroradiometer (MODIS) Land Cover Type (MCD12Q1) Version 6 data product

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provides global land cover types at yearly intervals (2001-2019). The MCD12Q1 Version 6 data product springs using supervised classifications of MODIS Terra and Aqua reflectance data. The supervised classifications then undergo additional post-processing that incorporate prior knowledge and ancillary information to further refine specific classes. The “cropland” type within this study is that the IGBP classification scheme of the MCD12Q1 V006, and it had been used because cropland class reliability is >92% (Tucker et al. 2001).

MODIS classes are reclassified and classes pertaining to forests are merged together, likewise for the cropland. While, the rest of the classes are merged as others. The vegetated land comprises of the forest and cropland areas, while all other land use classes are termed non-vegetated land. In order to detect the contribution of human induced changes, the dynamics of the human settlements in terms of urban area is analysed at three focal points viz, 2001, 2010, and 2019. The focal period analyses, decadal change, fraction land cover change, overall change, and change in decadal trend in forest, cropland, urban and rest of the areas is analysed.

3. RESULTS

3.1. Focal Period Analyses

2001: In the year 2001, forest was estimated to cover 8.46 % of the land over in contrast to 58.09 % cropland area over the Indian landmass. The urban area occupied 1.04 % of land. Overall, it can be said that 66.55 % of vegetated area existed against 33.45 % non-vegetated area.

2010: In the year 2010, forest was estimated to cover 8.8 % of the land against 59.59 % cropland and 1.05 % urban area implying that 68.39 % of vegetated area in contrast to 31.06 % non-vegetated area.

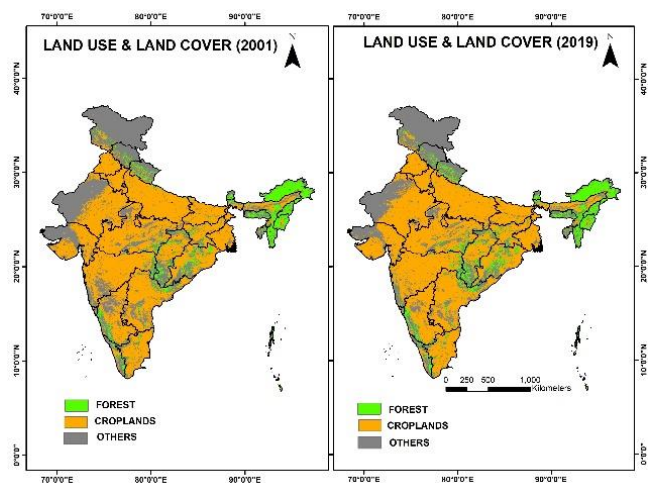


Figure 1. Land Use and Land Cover in 2001 and 2019

2019: In the year 2019, forest is estimated to cover 9.26 % of the land over the Indian landmass. The cropland made up 60.56 % of the Indian land area. The urban area occupied 1.1 % of land. Overall, it can be said that 69.82 % of vegetated area is seen and 30.16 % of the land is non-vegetated area.

3.2. Decadal Change

2001-2010: Forest cover has increased at 0.41% per year. The cropland records a lower increase at 0.257 % per year. The urban area also accounts for 0.18 % per year increase. Overall, the vegetated area cover has increased at 0.33 % per year, while the non-vegetated area termed as “others” has decreased at 0.55 % per year.

2010-2019: Forest cover has increased at 0.52 % per year. The cropland records a lower increase at 0.16 % per year. The urban area also accounts for 0.44 % per year increase. Overall, the vegetated area cover has increased at 0.34 % per year, while the non-vegetated area termed as “others” has decreased at 0.45 % per year.

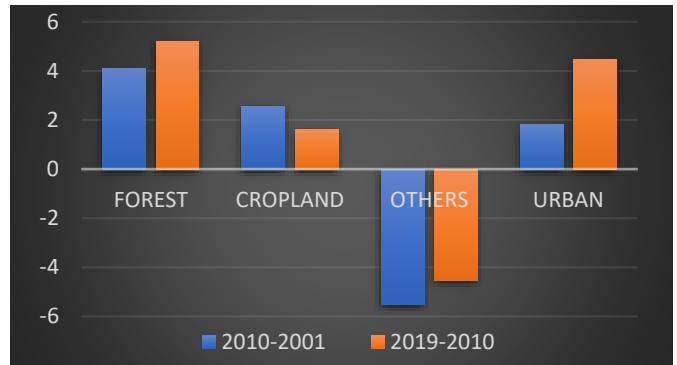


Figure 2. Decadal change in various land use & cover types in %

3.3. Change in terms of fraction of Indian land area

2001- 2010: Forest cover has increased by 0.34 % the rate of 0.03 % per year. The cropland also records a higher increase at 1.49 % at the rate of 0.149 % per year. The urban area also accounts for 0.016 % increase at the rate of 0.001 % per year. Overall, the vegetated area cover has increased by 0.915 %, at the rate of 0.09 % per year while the non-vegetated area termed as “others” has decreased by 1.84 % at the rate of 0.18 % per year.

2010-2019: Forest cover has increased by 0.45 % the rate of 0.04 % per year. The cropland also records a higher increase at 0.97 % at the rate of 0.09 % per year. The urban area also accounts for 0.04 % increase at the rate of 0.004 % per year. Overall, the vegetated area cover has increased by 0.71 %, at the rate of 0.071 % per year, while the non-vegetated area has decreased by 1.43 % at the rate of 0.14 % per year.

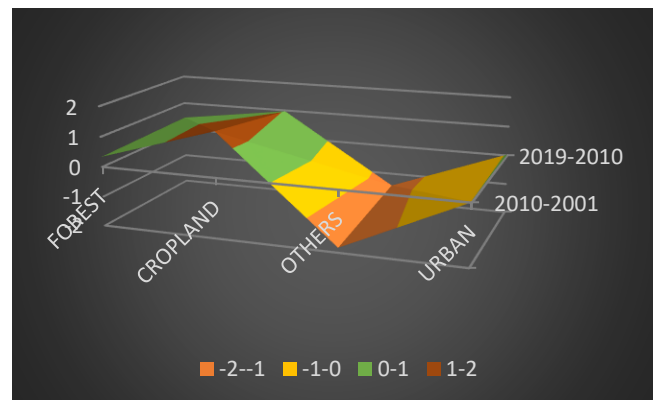


Figure 3. Decadal increase (+)/decrease (-) in fraction of Indian area in %

3.4. Gross Change

The forest cover has significantly increased by 9.52 % at the rate of 0.5 % per year over the years 2001-19. Cropland also records an increase of 4.24 % at the rate of 0.22 % per year over the last two decades. The urban area has grown by 6.35 % at the rate of 0.33 % per year. Overall, the vegetated area has increased by 6.88 % at the rate of 0.36 % per year. While, the non-vegetated land has decreased by 9.8 % at the rate of 0.51 % per year.

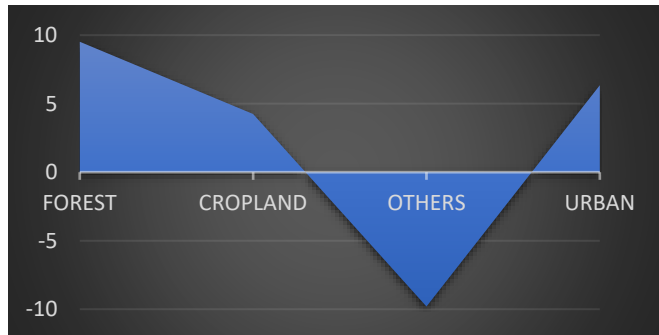


Figure 4. % Change in various land cover types (2019-2001)

The vegetated areas show an increase in the lower western Himalayas, along the eastern side in states of Jharkhand, Orissa, Chhattisgarh, MP in the central area. The parts along the western coast in Maharashtra, Karnataka, Kerala also shows increase in vegetated areas. Some patches in Andhra Pradesh and Tamil Nadu are also recorded.

The non-vegetated areas show an increase in North East in parts of Assam, Sikkim, in the western part in states such as Rajasthan, Gujrat, Maharashtra, Karnataka. Patches in eastern states such as Bihar, West Bengal, Jharkhand, Orissa, Chhattisgarh. It is also seen in areas of MP, Andhra Pradesh and TamilNadu.

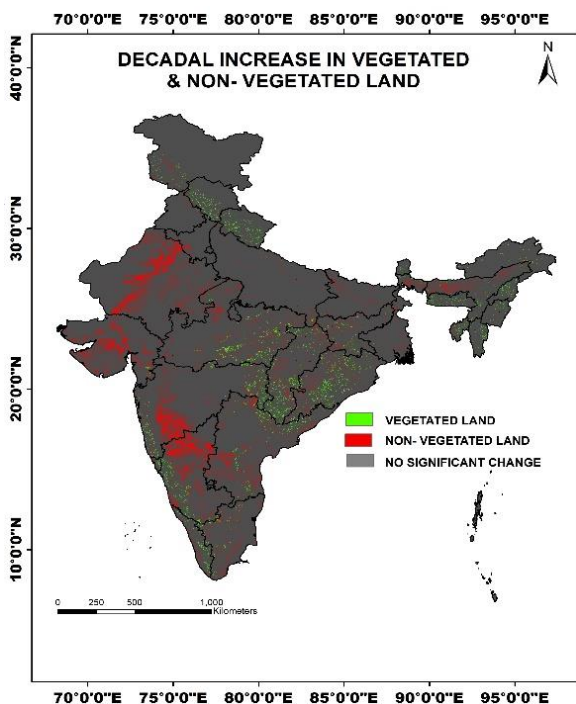


Figure 5. Decadal increase in vegetated and non-vegetated land

3.5. Trend in Decadal Change

The difference in the decadal trend, show that the forest cover increase has increased by 1.1 % from 2001-10 to 2010-19. While, the cropland increase is decreased by 0.94 % from 2001-10 to 2010-19. The increase in urban expansion is increased by 2.67 %. Overall, the vegetated land increase has increased by 0.08 % and the non-vegetated land decrease is decreased by 0.97 %.

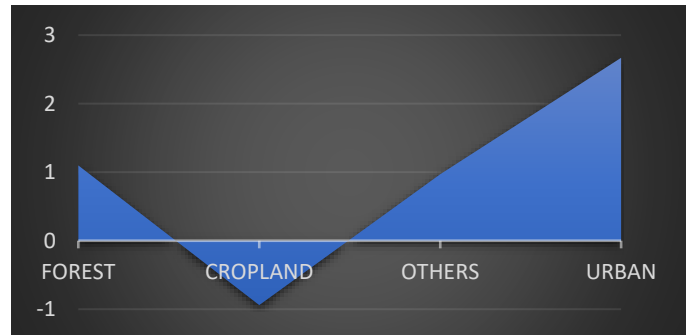


Figure 6. % Change in Decadal Change in various land cover types

4. DISCUSSION

A great deal of variability in the land cover dynamics is seen over the Indian landmass over the recent decades. Growing population and demand for resources along with the changing climate is basically the main cause triggering it. The forest cover has significantly increased by 9.52 % at the rate of 0.5 % per year over the years 2001-19. Cropland also records an increase of 4.24 % at the rate of 0.22 % per year over the last two decades. The urban area has grown by 6.35 % at the rate of 0.33 % per year. Overall, the vegetated area has increased by 6.88 % at the rate of 0.36 % per year. While, the non-vegetated land has decreased by 9.8 % at the rate of 0.51 % per year.

5. CONCLUSION

The difference in the decadal trend, show that the forest cover increase has increased by 1.1 % from 2001-10 to 2010-19. While, the cropland increase is decreased by 0.94 % from 2001-10 to 2010-19. The increase in urban expansion is increased by 2.67 %. Overall, the vegetated land increase has increased by 0.08 % and the non-vegetated land decrease is decreased by 0.97 %. Thus, a greater rate of growth in urban areas owing to greater population demand and at the same time a smaller growth rate in vegetated areas is seen over the Indian landmass over the past two decades. In order to meet the sustainable development goal, the vegetated areas should be growing at a faster rate than the urban growth. The population load requires resources to survive and these resources comes at the cost of slower growth in vegetation areas.

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