**P07.04**

**Vulnerability of fragile forest ecosystem of North East India in context with the global climate change: an ecological projection**

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Climate Change is one of the most important global environmental challenges affecting all natural tropical and subtropical forest ecosystems. Forests are of fundamental importance to environmental function and to sustainability, and they provide many goods and services critical to individuals and societies besides acting as a natural carbon sinks.The response of communities and ecosystems to global climate change is highly unpredictable because of the interactions between local (e.g. local and site specific threats) and global (e.g. biological invasions,) stressors. Northeast India consisting of eight states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim comprising an area of about 2, 62, 179 km2 is known for its rich biological and cultural diversity .Based on its physiography and biological composition, the region can broadly be categorized into the Eastern Himalaya, Northeast hills and Brahmaputra plains. Its unique location at the confluence of the Indo-Malayan, Indo-Chinese and Indian biogeographical regions coupled with its physiography has generated a profusion of habitats, which harbors diverse biota with high-level of endemism. The entire region is part of Himalaya and Indo-Burma biodiversity hotspots, two of 25 such hotspots in the world. The region is also home of over one hundred tribal communities and a large percentage of the population is dependent on traditional natural resource-based livelihoods. The entire northeast region is characterized by high rainfall and humidity. This along with varied altitudinal gradients influence the climate that ranges from tropical plains to temperate and alpine hills. These diverse climates supports almost all types of vegetation from cultivated plants to grasslands, meadows, marshes, swamps, scrubs, mixed deciduous and humid evergreen forest, temperate and even alpine vegetation. Recognizing the importance of ecological richness of the region, an attempt has been made to investigate the vulnerability of the forest ecosystems in terms of the extent of loss of forest cover in Northeast India and the probable influence of the changing local climatic factors in context with the global climatic change over a period of 18 years. Method: We analyzed 18 years (1987-2005) forest cover statistics of Northeast India and tried to find out a trend and correlate this with various issues that are responsible for the change in forest cover and address the vulnerability issues for a possible climate change. Indian forest statistics are available since 1987 through periodic satellite base forest monitoring programme implemented by the Forest Survey of India. The Forest Survey prepares comprehensive State Forest Report (SFR) published every two years since 1987. Till now forest survey records are available upto the year 2005. Results: North Eastern region of India has a complex environmental gradient involving changes in physiography, forest structure, climate, geology and natural disturbances An analysis of the forest cover statistics of Northeast India reveals some unexpected and contradictory trend ( Table 1 ). Data from the Forest Survey shows an increase in forest cover of 7896 km2, at an annual rate of increase of 0.25% for Northeast India between 1987 and 2005. However, the trend analysis of the forest cover data since 1987 onwards to 2005 reveals a declining trend ( Fig 1). To have a better picture of where exactly the increase in forest cover took place, we divided the entire period from 1987-2005 into 3 (three) divisions) i.e. 1987-1991, 1991-2001 and 2001-2005. During the period 1987-1991, the region witnessed an increase in forest cover of 3371 Km2 or annual growth of 0.4%. Increase in forest cover in the states of Arunachal Pradesh (4870 Km2), Sikkim (285 Km2) and Manipur (210 Km2) in 1989 and Meghalaya (2130 Km2) and Mizoram (683 Km2) in 1991 are the main drivers of growth during this period, while Assam, Meghalaya and Tripura along with the states like Arunachal Pradesh, Sikkim and Nagaland also witnessed considerable loss in the forest cover during that period (Table 2). The growth of forest cover in between 1987-1991 in the region could not be maintained in the next decade as a result during the period 1991-2001, only 575 Km2 forest cover was increased in the region with an annual growth of 0.03%. During this period, the growth of forest in the states of Assam and Tripura was maximum than any other states in the region. However, during the period from 2001-2005, there is maximum increase in forest cover of 3950 Km2 with an annual growth rate of 0.46%. Thus the individual state level data provide a clearer indication on the areas where exactly the forest cover decreases over the period. The overall interpretation of regional forest statistics suggest the drivers of loss of forest cover in terms of threats and pressures being enhanced by erratic changes in local climatic factors due to global change. Discussion: While precise direction, timing and magnitude of climate changes still remain uncertain, it is clear that

 

climate change would affect many ecosystems particularly the terrestrial forest ecosystems and human activities in the remote eco-region of North East India at the foot hills of Himalayas. One of the major factors affecting forest cover is the growth of human populations throughout the Northeast India and the forests are the best place to accommodate the growing pressure of additional people. According to Census statistics, the population density in many states grew by approximately 30% between 1991 and 2001 (Table 3). Other significant drivers of the change include clearance of forests for agriculture, Tea cultivation, slash and burn mode of cultivation with ever reducing 'jhum' cycle, alteration of prime natural habitat for developmental and industrial activities (Oil and Gas, Coal mining ), forest fire and other biotic interferences have led to the rapid loss of forest cover. According to a report of IPCC, land use change (primarily deforestation) was responsible for about 20 % of the CO2 released to the atmosphere worldwide from 1989-1998. It may be mentioned that deforestation is responsible for nearly 26% of India's greenhouse emissions. Besides, the growing human population and livestock pressure gradually widening the gap between demand and supply of natural resources. These impacts will cut across multiple dimensions of day to day life affecting not just the environment but the communities as well. Climate change thus could impose a variety of stress on sustainable livelihood of the poor inhabitants of Northeast India through stresses on ecosystem function. The major concerns are erratic & irregular rainfall patterns, longer dry spells, and implications on agriculture calendar, productivity, new pests; food security; health and disasters like flash floods. It is presumed that there would be a change in distribution, abundance of species, more particularly wild, endemic species, crop plants, pests and vectors. Due to change in habitat condition, displacement both human and other wilderness would take place. Apart from these, the food security, mitigation of hazards and addressing the epidemics like malaria, encephalitis etc are other issues of major concerns for the region. Under such circumstances, there is possibility of conflicts over reduced natural resources causing strained social relations taking toll on to the cultural and spiritual services provided by ecosystems. The gap in information and lack of scientific comprehensive data base on climate change and its implications has become a hindrance for taking up appropriate site specific adaptation and mitigation strategies and action plan.

**Table-1: Forest Cover of the states of by Northeast India**

| STATE | GEOGRAPHIC AREA (Km2) | FOREST COVER (Km2) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1987 | 1989 | 1991 | 1993 | 1995 | 1997 | 1999 | 2001 | 2003 | 2005 |
| Arunachal Pradesh | 83,743 | 64,132 | 69,002 | 68,757 | 68,661 | 68,621 | 68,602 | 68,847 | 68,045 | 67,692 | 67,777 |
| Assam | 78,438 | 25,160 | 24,832 | 24,751 | 24,508 | 24,061 | 23,824 | 23,688 | 27,714 | 27,735 | 27,645 |
| Manipur | 22,327 | 17,475 | 17,685 | 17,685 | 17,621 | 17,558 | 17,418 | 17,384 | 16,926 | 17,259 | 17,086 |
| Meghalaya | 22,429 | 16,466 | 15,645 | 15,875 | 15,769 | 15,714 | 15,657 | 15,633 | 15,584 | 16,925 | 16,988 |
| Mizoram | 21,081 | 19,084 | 18,170 | 18,853 | 18,697 | 18,576 | 18,775 | 18,338 | 17,494 | 18,583 | 18,684 |
| Nagaland | 16,579 | 14,394 | 14,399 | 14,321 | 14,348 | 14,291 | 14,221 | 14,164 | 13,345 | 14,015 | 13,719 |
| Sikkim | 7,096 | 2,756 | 3,041 | 3,014 | 3,119 | 3,127 | 3,129 | 3,118 | 3,193 | 3,262 | 3,262 |
| Tripura | 10,486 | 5,953 | 5,535 | 5,535 | 5,538 | 5,538 | 5,546 | 5,745 | 7,065 | 8,123 | 8,155 |

*Source: Forest Survey of India*

**Table 2: Percent annual change in forest cover between 1987-2005**

| State | 1987-1989 | 1989-1991 | 1991-1993 | 1993-1995 | 1995-1997 | 1997-1999 | 1999-2001 | 2001-2003 | 2003-2005 |
|---|---|---|---|---|---|---|---|---|---|
| Arunachal Pradesh | 3.53 | -0.18 | -0.07 | -0.03 | -0.01 | 0.18 | -0.59 | -0.26 | 0.06 |
| Assam | -0.66 | -0.16 | -0.50 | -0.93 | -0.50 | -0.29 | 7.26 | 0.04 | -0.16 |
| Manipur | 0.59 | 0.00 | -0.18 | -0.18 | -0.40 | -0.10 | -1.35 | 0.96 | -0.51 |
| Meghalaya | -2.62 | 0.72 | -0.34 | -0.18 | -0.18 | -0.08 | -0.16 | 3.96 | 0.19 |
| Mizoram | -2.52 | 1.81 | -0.42 | -0.33 | 0.53 | -1.19 | -2.41 | 2.93 | 0.27 |
| Nagaland | 0.02 | -0.27 | 0.09 | -0.20 | -0.25 | -0.20 | -3.07 | 2.39 | -1.08 |
| Sikkim | 4.69 | -0.45 | 1.68 | 0.13 | 0.03 | -0.18 | 1.17 | 1.06 | 0.00 |
| Tripura | -3.78 | 0.00 | 0.03 | 0.00 | 0.07 | 1.73 | 9.34 | 6.51 | 0.20 |
| NE Total | 0.86 | 0.14 | -0.16 | -0.23 | -0.09 | -0.08 | 0.72 | 1.22 | -0.08 |

**Table 3: Population change in the Northeast region**

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| State | Population density 1991 (per km$^2$) | Population density 2001 (per km$^2$) | Total Population 1991 | Total Population 2001 |
|---|---|---|---|---|
| Arunachal Pradesh | 10 | 13 | 864558 | 1091117 |
| Assam | 184 | 320 | 22414322 | 26638407 |
| Manipur | 82 | 107 | 1837149 | 2388634 |
| Meghalaya | 79 | 103 | 1774778 | 2306069 |
| Mizoram | - | - | 689756 | 891058 |
| Nagaland | 73 | 120 | 1209546 | 1988636 |
| Sikkim | - | - | 406457 | 540493 |
| Tripura | 263 | 304 | 2757205 | 3171168 |
| | | | **31953771** | **39015582** |

Not available
Source: Census of India 1901, 1991, 2001.

**Fig 1: Trend of Forest cover in Northeast India**