CHAPTER- 8

SUMMARY AND CONCLUSION
8.1 Summary

Vegetation is one of the important constituents of any terrestrial ecosystem and plays a major role in regulating energy exchange, climate change and carbon cycles through photosynthesis, respiration, transpiration and roughness (Begue et al., 2011). The successful use of NDVI has benefited numerous disciplines interested in the assessment of biomass, vegetation health, plant stress, vegetation changes and crop production. Northeast India encompasses a range of ecological variations and different types of climatic conditions which determine the vegetation pattern of this region. The region supports various types of vegetation found in India such as tropical forests, temperate forests, alpine vegetation along with grasslands, meadows, marshes, swamps etc. It also comprises a number of sacred groves or forests managed by certain tribal communities of the region.

In this research the 10-day Systeme Pour l’Observation de la Terre (SPOT) - VEGETATION NDVI time series data from 1998 to 2013 in Northeast India were used, to analyze vegetation health and its change in Northeast India. A case study of the Amchang Wildlife Sanctuary (AWLS) situated in Kamrup district of Assam. The case study was also explored fuelwood consumption trends of the people residing in the fringe villages of the study area and a survey was conducted by using stratified random sampling method in 29 villages of AWLS.
In due consideration of the present situation in Northeast India, observing ecological balance through NDVI based change detection was used. Forest loss and improvement have been assessed by remotely sensed indicators of biomass productivity. NDVI transmits valuable information regarding vegetation change or biomass productivity can be most accurately identified by image differencing of NDVI data. The indicators show clear regional trends over the period 1998-2013, both decreasing and increasing, which may be interpreted as deforestation or improvement, respectively. To show the changes in vegetation growth and its relation with the climatic variables (rainfall and temperature) various statistical methods have been used in this study. It is analyzed whether rainfall and temperature influenced in the vegetation loss and gain in the study area. The relationship between mean growing season rainfall and NDVI maximum showed a weak linear relationship, the negative correlation between rainfall and NDVI (across 192 months during 1998-2013) found to exist in the high rainfall study area was more prominent. Thus it reveals that through systematic analysis of growing season NDVI, monthly rainfall and monthly temperature we were able to determine the temporal scales, defined by both time duration over which rainfall and temperature was incorporated and time lags that most strongly influenced NDVI. The use of NDVI time series data helps us

1. to monitor vegetation health in the entire region during the growing season
2. to monitor trend in vegetation health in the study area during non-growing season
3. to characterize the seasonal photosynthetic activity in the study area.

Overall, NDVI provides a basic estimate of vegetation health and a means of monitoring changes in vegetation over time, and it remains the most well-known and widely used index (Barbosa et.al 2016, Zang et.al 2015, Hou et.al 2015, Saikia,2009, Fensholt et.al 2012) to detect
live green plant canopies in multispectral remote sensing data. This study used a total of 540 imageries to explore spatio-temporal patterns of vegetation variability in Northeast India.

8.2 Conclusions

The major findings of the dissertation are as follows:

1. The seasonal variation of NDVI shows that there is a fluctuation of vegetation growth during the three season i.e spring, summer and autumn. The largest NDVI value increased during autumn season i.e from September to November during the period. During summer the vegetation growth decreases due to heavy rainfall over the entire region. The trend of NDVI value increased in the autumn season and spring season, and tended to decrease gradually in the summer season in Northeast India during the period of 1998 to 2013.

2. The autumn vegetation activity of Northeast India is important to an annual plant growth. Although there is healthy vegetation during the autumn season in all the 16 year but there is little fluctuation as in the year 2010, 2011, 2012 and 2013 NDVI value is low in the autumn season in comparison to the other period. In addition highest variation of vegetation occurred during the wettest months in June and July compared to the other growing season months.

3. The temporal and spatial variation of NDVI by different vegetation types in Northeast India during the period 1998-2013 indicate that the value of vegetation indices slightly decreased slightly in some parts of Arunachal Pradesh, Assam, Manipur, Mizoram and Nagaland; possibly due to agricultural intensification.

4. The interannual variations in growing season NDVI for the Northeastern region of India shows that there is considerable variation in forest loss and gain in the region during the period of 1998-2013. Highly negative NDVI value appears in large parts of Arunachal
Pradesh, Assam and Meghalaya and also in some parts of Manipur, Nagaland, Mizoram and Tripura.

5. The research indicates high loss of vegetation cover, growth of settlement, degradation of forest cover and so on. The forest land of Arunachal Pradesh, Meghalaya and Mizoram is facing high degradation which is mainly due to the extinct of shifting cultivation, illicit felling and deforestation for logging purposes or agricultural expansion.


7. The spatial distribution of vegetation cover in relation to altitude of different forest reserves of Northeast India shows that the NDVI value increases with altitude and reaches its maximum value around 2200m and decreases as the altitude increases elsewhere 2200m. Values of NDVI increased rapidly within the range of altitude of different parts of Northeast India.

8. The correlations between growing season NDVI and rainfall reveals that out of 31 study sites of landuse and landcover 29 sites reflected the negative effect of high rainfall. Only two sites comprising irrigated cropland and mixed vegetation landuse showed positive correlation. The irrigated cropland sites would benefit from higher rainfall, because wetland paddy cultivation increases in drenched conditions during the growing season. Thus it appears that the negative correlation between NDVI and rainfall gets emphasized during the growing season i.e from June to October where monsoon occur in the study
area. Thus high rainfall plays a constricting role in vegetation health and greenness in Northeast India.

9. The correlations between temperature and NDVI results that out of 31 sites only 4 sites shows negative co-relation and rest of the 27 sites shows positive co-relation. The 4 sites comprise cropland and mosaic vegetation. The correlation and coefficient were highest in closed to open broadleaved evergreen or semi-deciduous, intermediate in grassland and lower in cropland area.

10. The case study of the Amchang WLS as an instance of the role of institutional frameworks operating forest areas of Northeast India reveals that encroachment and illegal tree-felling have turned into a serious threat, with nearly one-tenth of its area under human settlement, and no government intervention in sight.

11. The landuse and landcover analysis in Amchang WLS shows that the area under dense forest category increased during the years of 1989 - 2017 by 18.16 to 25.13% respectively. However, the moderately dense forest category decreases between the period 1989 to 2011 by 16%, and increased to 26.19% in 2017. The result shows that except for the non-forest area in 2011 i.e 43.55% all of them are decreasing and so there are losses of forest cover. However in 2017 the area under non-forest category decreases to 25.46% this was due to eviction and protection program was launched by the institutions.

12. The NDVI variability of AWLS during the year 1989 and 2011 was observed which indicate vast difference in both the year. The highest NDVI value was 0.733 and -0 in 1989 and in 2011 it was and which indicates considerable variation in vegetation health.
13. The NDVI variability of Namdapha NP during the year 1989 and 2011 signifies that there was a vast difference in vegetation growth in both the period. The highest NDVI value was observed in 27 Feb 1991 and in 04 Jan 2016 it was 0.914 and -0.987 which indicates that the vegetation health in Namdapha NP is increasing.

14. The household survey on the basis of fuelwood consumption in the 33 villages of Amchang WLS reveals that the per capita fuelwood consumption is more than 68 kg per day. Out of the total population 16997 person 21% settlers used wood collected from the forest as the source of energy. This will have serious implications in the long run and immediate correctives need to be initiated by the authorities.

8.3 Suggestions

The forests of Northeast India should be protected as it is one of the biodiversity hotspot of the country. The important reasons for the decreasing trend of forest cover in the region are aggressive logging, unsustainable farming, shifting cultivation, expanding city development caused by population explosion and resulting urban sprawl. However, with the increasing demand of forest products and with rapidly increasing human populations in the region, results in loss of vast forest cover area. Initially some sort of forest management will be required to prevent their complete destruction. There are wide varieties of forest management practices often by the government institutions and indigenous community institutions in Northeast India. However, forest losses and decline cannot be explained based on a simple causal explanation (Dessie and Kinlund, 2008) and a host of factors are often operating at different scales (Geist & Lambin, 2002, Hazarika, 2011). Thus there are no easy solutions to arrest deforestation and loss of valuable trees in Northeast India as well as in Amchang Wildlife Sanctuary. So far, certain
efforts can be undertaken to minimize the rapid losses of forest cover in the study area. In this circumstance the following suggestions are forwarded,

1. The most important management practice at present is “sustainable forestry,” often allied with “selective logging” practices (Rainforest conservation fund, 2017). This type of management practice can be often seen in rainforest region of the world which can be applied in Northeast India. Sustainable forestry is the process where carefully removing the trees as can be replaced immediately and leaving others untouched, and in addition planting tree seedlings of essential species.

2. The state forest department of Northeast India should update their Joint forestry management programs after consultation with communities and local government. The Joint Forest Management (JFM) scheme was designed to implement in the reserved and protected areas of India accompanying the local communities in order to benefit in return for assistance with protection and regeneration. The JFM program should provide small grants to indigenous community institutions or non-governmental organizations to hold meetings and sustainable awareness program in other to protect the forest resources.

3. The appropriate policy reforms are urgently required to include indigenous community institutions in government programs and schemes and provide support for capacity building within the local communities. In order to encourage sustainably productive forest management there is a need to eradicate harvesting and transport permitting requirements where possible.
4. There are no easy solutions to forest loss in Northeast India or in any other part of the globe. Indeed with its growing population faces a severe test. However Northeast India and the Western Ghats must be accorded extra care and be given green incentives given that biodiversity hotspots are a rare commodity bequeathed to us.