Change detection analysis using multi temporal satellite data of Poba reserve forest, Assam and Arunachal Pradesh

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ABSTRACT

Information on landuse/cover change is a critical input for natural resource management policy decisions. The land use/ land cover pattern of a region is an outcome of natural and anthropogenic process. Land use/ land cover change has become a central component of current strategies in managing natural resources and monitoring environmental changes. Remote Sensing data under GIS domain were utilized to evaluate the changes in land use/ land cover spanning period of five years during 2005 to 2010 along the Siang River in Poba reserve forest Assam. Six different types of land use/ land cover were categorized and out of them semi evergreen dense forest was evident as the most important land use/ land cover practice followed by semi evergreen open forest in and the agriculture in 2010. The changes in the areas of agriculture land is evident from the present study in turn will impact the environment quality around leading to more open forest. The area of semi evergreen open forest increased from 13.43 sq.km to 17.6 sq.km, which is sign of deforestation and illegal tree cutting by local people. The study shows that the increase of anthropogenic activities has led to a serious trouble in the region.

Keywords: Land use/land cover, satellite image, Remote Sensing, Change detection

1. Introduction

Land use and land cover is an important component to understand global land status; it shows present as well as past status of the earth surface. Land use and land cover are two separate terminologies which are often used interchangeably (Dimyati et al 1994). Land cover is a basic parameter which evaluates the content of earth surface as an important factor that affects the condition and functioning of the ecosystem. Land cover is a biophysical state of the Earth surface, which can be used to estimate the interaction of biodiversity with the surrounding environment. Nowadays, land use land cover analysis plays an important role in the field of environmental science and natural resource management. The change is land cover occurs even in the absence of human activities through natural processes where as land use change is the manipulation of land cover by human being for multiple purposes- food, fuel wood, timber, fodder, leaf, litter, medicine, raw materials and recreation. So many socio-economic and environmental factors are involved for the change in land use and land cover .Land use and land cover change has been reviewed from different perspectives in order to identify the drivers of land use and land cover change, their process and consequences. Land use and land cover is dynamic in nature and provides a comprehensive understanding of the interaction and relationship of anthropogenic activities with the environment (Prakasam, 2010). Land use/ land cover changes also involve the modification,

either direct or indirect, of a natural habitats and their impact on the ecology of the area. Land use/ land cover change has become a central component in current strategies for managing natural resource and monitoring environmental changes (Tiwari and Saxena, 2011). Land use/ land cover pattern of a region gives information about the natural and socio-economic factors, human livelihood and development. Like other resources, land resource is also delimiting due to very high demand of agricultural products and increasing population pressure day by day. Hence, information of land use/ land cover and possibilities of their optimal use is essential for the selection, planning and implementation of the land use schemes to meet the increasing human needs and welfare. This also provides the information for managing dynamics of land use and meeting the demands of increasing human population.

Remote sensing and Geographical Information Systems (GIS) are powerful tools to derive accurate and timely information on the spatial distribution of land use/land cover changes over large areas (Carlson et al 1999, Guerschman et al 2003, Rogan and Chen 2004, Zsuzsann et al 2005). Remote sensing imagery is the most important data resources of GIS. Satellite imagery is used for recognition of synoptic data of earth's surface (Ulbricht and Heckendorf 2008) .Recent improvements in satellite image quality and availability have made it possible to perform image analysis at much larger scale than in the past. GIS has enormous possible as an environment for the conception of dynamic models of physical environmental processes. Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics- detect, identify, map, and monitor differences in land use and land cover patterns over time, irrespective of the causal factors (Jensen 1996) .

Therefore, attempt will be made in this study to map out the status of land use land cover of Poba reserve forest between 2005 and 2010 with a view to detecting the land consumption rate and the changes that has taken place in this status particularly in the dense forest area using both Geographic Information System and Remote Sensing data.

1.1 Statement of the Problem

This lone reserve forest of the district, located on the outskirts of Jonai town and the entire eastern part of Dhemaji district, is in a critical state due to encroachment, erosion, flood, damaged seedlings in the forest nursery, unabated felling of trees, illegal cultivation etc. Poba is a deep green forest with valuable trees, orchids, medicinal plants, varieties of birds and wild animals including elephants. Poba is famous for ground orchids and elephant corridor of Ruskin forest range, under East Siang district of Arunachal Pradesh. It is a treasure trove of natural flora and fauna, model habitat of wildlife, natural beauty with the numerous streams flowing from the foothills of Arunachal Pradesh. Large-scale cutting of trees and deforestation and illegal cultivation is affecting its biodiversity. Around 2000 hectares of forest land has been encroached for illegal cultivation near the villages of Leku, Natun Jelom, Rigbi, Sile, Bera Chapari under Leku and Tinimile forest beat office of Poba RF. The study area can represent natural forest cover change in some parts of the Ruksin forest range, under East Siang district of Arunachal Pradesh and Dhemaji division Assam in particular for reasons below

1. Rapid population growth and land scarcity has forced farming families to expand their agricultural fields even in the fringe of the reserve forest.
2. As a result, large areas, which were under dense forest cover, now exposed to deforestation, which leads into environmental degradation and serious threat to wild life habitat loss.

3. Furthermore, the loss of the vegetative cover could result in biodiversity loss, which could lead to species extinction even though the rate differs with type of species due to its geographic distribution and abundance.

4. Local vegetation cover change, specifically forest cover change has significant and cumulative impact on regional and global climate changes, since environmental problems have no boundaries and are interrelated.

1.2 Objectives of the study

1. To study the Land use and Land cover of Poba reserve forest for two time frames (2005 - 2010) from the satellite data.
2. Spatio-temporal Change Detection Analysis

2. Study area

Poba Reserved Forest (27°50'11"N and 95°17'45"E) is situated in Jonai Subdivision of Dhemaji District, Assam (figure-1). The Reserved Forest (RF) was created in the year 1924 and covers an area of 10,221 hectares. The forest receives annual rainfall of 3600 mm to 4000 mm; highest temperature so far recorded is 35^0 C in summer and lowest 70^0 C in winter. It is bounded by Daying Ering Wildlife Sanctuary, NH-52 and foot-hills of Arunachal Pradesh in the North, Dibru-Saikhowa National Park and the Siang, Dibang and Lohit rivers in the East, Laly river (referred as Brahmaputra downstream) in the South, and a few revenue villages to the West.
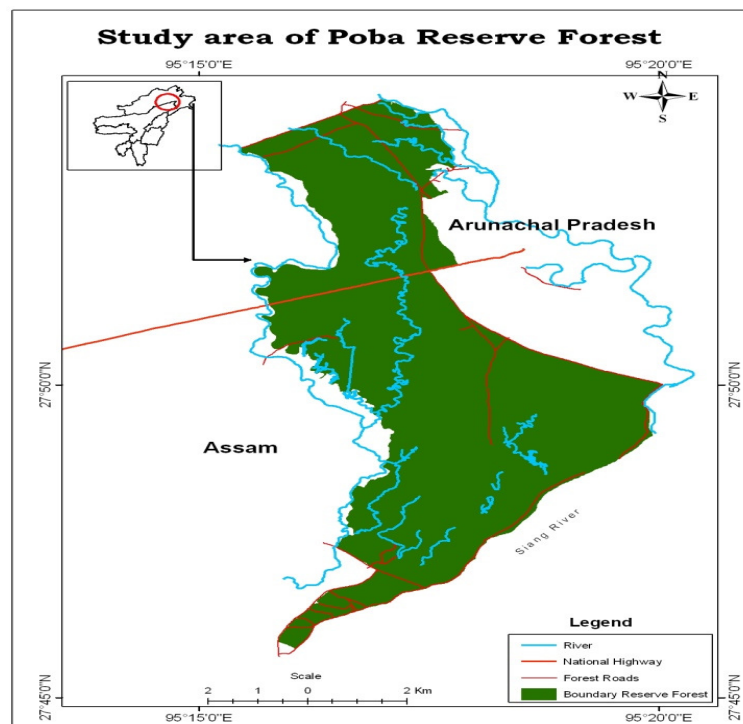

Figure 1: Study area: Poba Reserve Forest

Poba RF is an important elephant corridor linking the foot hills of Arunachal Pradesh and Dibru Saikhowa National Park via the proposed Kobu Chapori Reserve Forest. A few ethnic groups such as Mising, Bodo, Sonowal Kachari and Hajong (Rabha) inhabit fringe area of the RF. These communities are dependent on forest for habitat and other needs for well-being;

the forest contributes livelihoods to many households as well. Poba RF is the only repository of wild edible plants in the entire Jonai Subdivision, Dhemaji district, Assam but its biodiversity has not been scientifically evaluated. Poba forest is under serious threats from anthropogenic activities and natural calamities particularly erosion by the Laly river. If the present trend of deforestation continues and conservation measures not initiated, it will not be long when Poba RF will be rendered to oblivion. The objective of the present investigation is to study the land use and land cover change of the forest.

3. Methodology

Flowchart of the broad steps followed in this work for deriving statistics of land use pattern of the area is shown below:
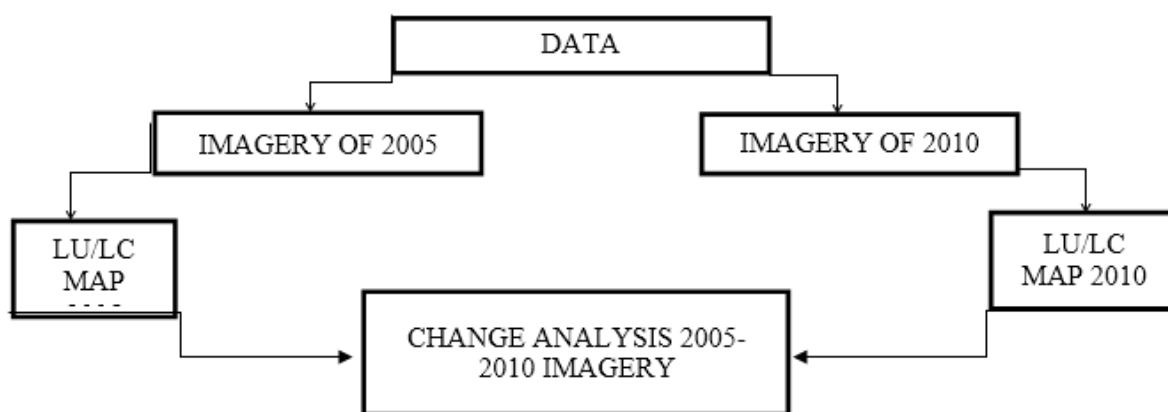

Figure 2: Methodology

4. Results and Discussion

4.1 Land Use and Land Cover Classification For 2005

The study area has been defined to have six land use land cover categories, which were semi evergreen dense forest, semi evergreen open forest, scrub forest agriculture, water body, and river sand/boulders. The description of these land cover categories was presented previously in Table .The land use land cover classification for 2005 showed the majority of the study area was under semi evergreen dense forest and semi evergreen open forest accounting for 32.74 sq.km (56.448 %) and 13.43 sq.km (23.155%) respectively while scrub forest, agriculture, water body, river-sand /boulder amounted to be about 2.46 sq.km (4.241%), 7.22 sq.km (12.448%), 0.3 sq.km (0.519 %), 1.85 sq.km(3.189%) respectively. This results of land cover and land use analysis of multi-temporal satellite image 2005are shown in Table 1.

Table1: Land Use/ Cover of 2005

Land use/ land cover Class	Area in sq. km	Area in %
Semi Evergreen Dense forest	32.74	56.448
Semi Evergreen Open forest	13.43	23.155

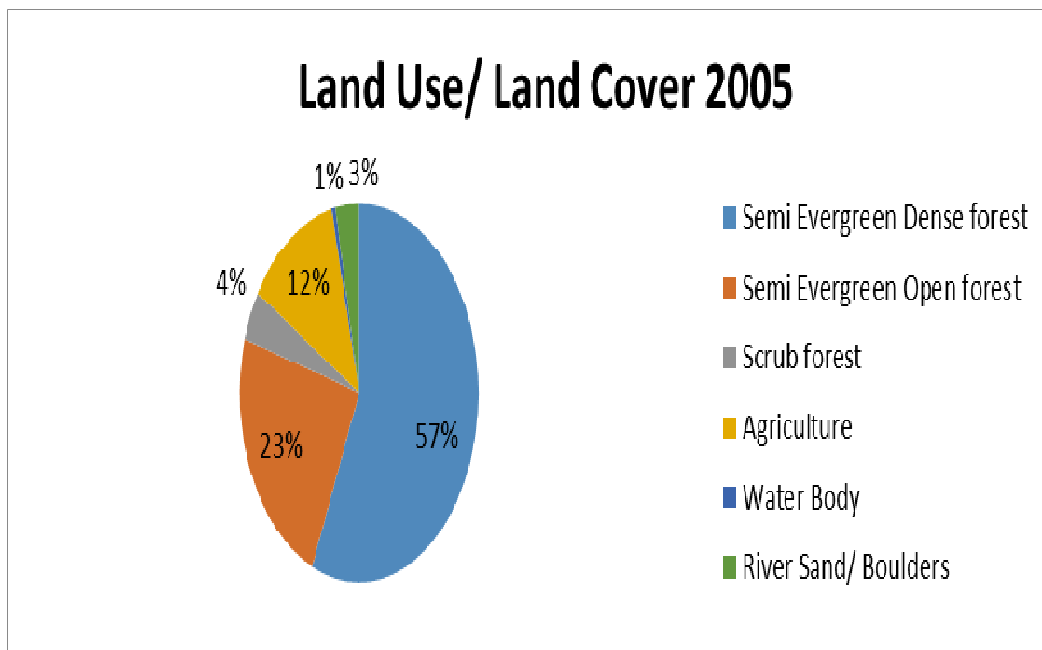| Scrub forest | 2.46 | 4.241 |
Agriculture	7.22	12.448
Water Body	0.3	0.519
River Sand/ Boulders	1.85	3.189
Total	**58**	100

Figure 3: Land Use/ Cover 2005

4.2   Land use and land classification for 2010

The landuse classification for the 2010 shows that the areas of semi evergreen dense forest decrease from 32.74sq.km to 22.29sq.km.The main reason of land depletion is due to rapid erosion by Siang River and the cause of flood during monsoon. The recent flash floods in Jonai subdivision in Dhemaji district have caused extensive damage to the Poba Reserve Forest at its different portions, where several hundred hectares of plantation including two nurseries were washed away. The floods also created havoc in the nearby villages and caused extensive damage of lives and household properties in the nearby villages. "The flash floods washed away about 80 hectares reserve dense forest plantation at Lali, Bahir Silley portions under Tinmail beat while it damaged two forest nurseries, one at Berachapori and the other at Kobu besides killing of two lakh polypot seedlings kept in the nurseries. The flood also damaged two forest roads passing through Tinmail to Berachapori and Tinmail to Baromile, with a stretch of 16 kilometers .The area of semi evergreen open forest increased from 13.4 km^2 to 17.6 km^2, which is a sign of deforestation and illegal tree cutting by local people. The majority of area which shows increase are agriculture near the forest fringe .It was increased from 7.22 km^2 to 10. 61 km^2.This shows that the increase of anthropogenic activities has led a serious trouble in the region. The result of Land use/ land cover classification of 2010 is shown in the table 2.
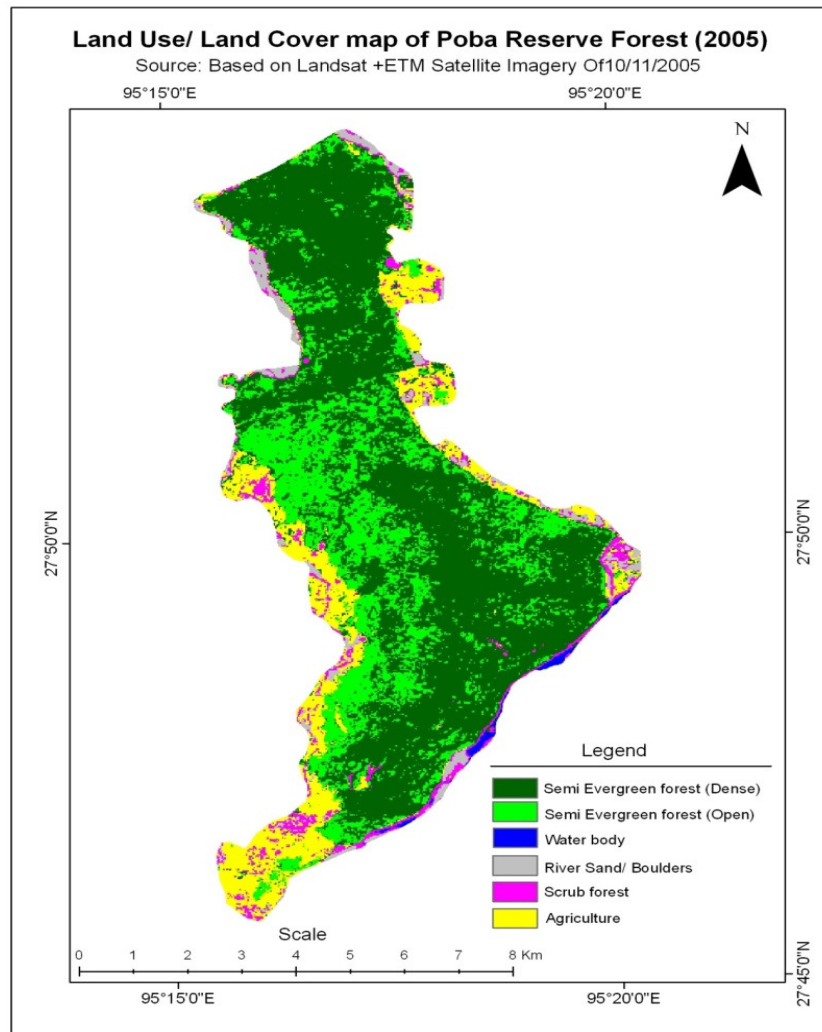
Figure 4: Land use/ land cover classification map of study area for 2005

Table 2: Land use/ land cover of 2010

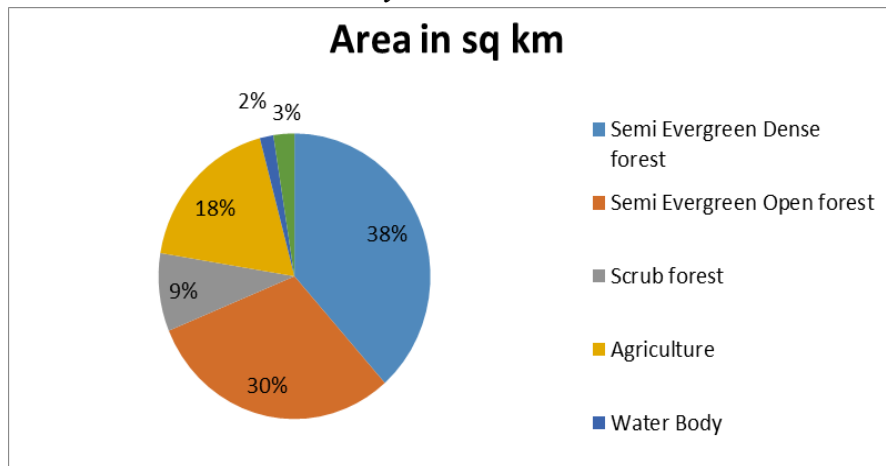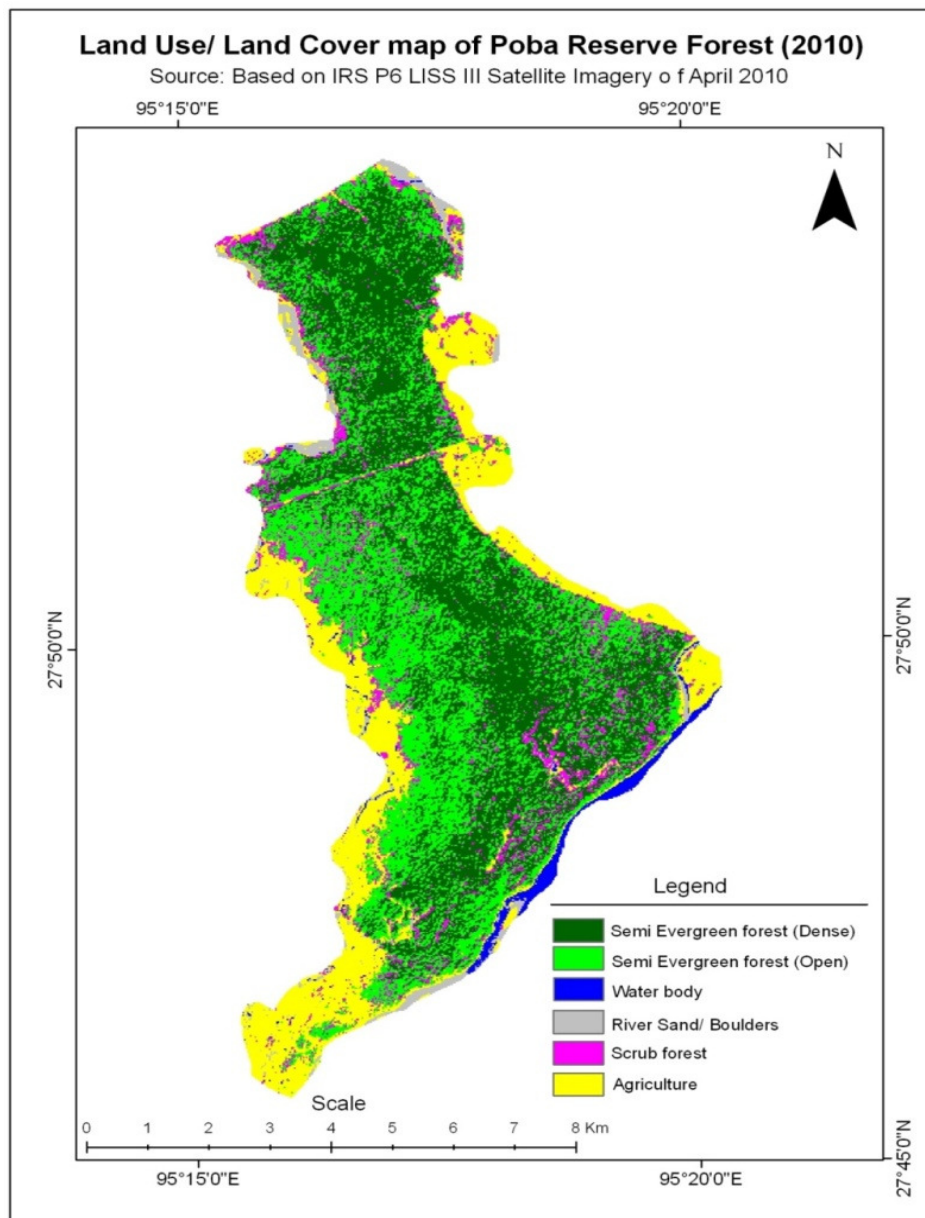| Land Use/ Land Cover Class	Area in sq km	Area in %
Semi Evergreen Dense forest	22.29	38.43
Semi Evergreen Open forest	17.6	30.36
Scrub forest	5.12	8.82
Agriculture	10.61	8.29
Water Body	0.94	1.62
River Sand/ Boulders	1.44	2.48
Total	**58**	100

Figure 5: Land Use/ Cover 2010

Figure 6: Land Use and Land Cover Change Detection

The change detection was performed based on the classified maps of 2005 and 2010. The land use land cover categories that show increase are in area from 2005 to 2010 are open forest, shrub forest and agricultural land indicating towards depletion of dense forest.

Table 3: Land covers classes, their corresponding areas and change for 2005 -2010

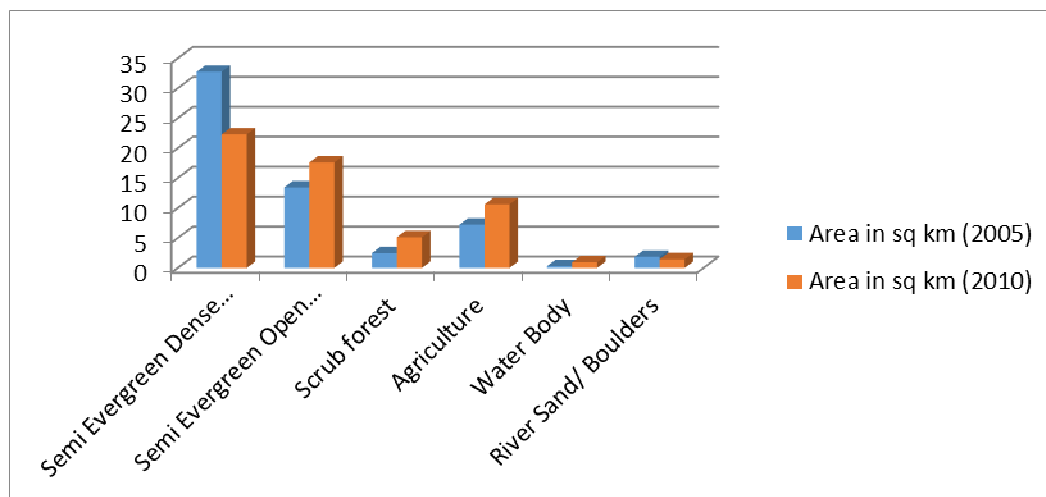| Land Use/ Land Cover Class	Area in sq km (2005)	Area in sq km (2010)	Net Change
Semi Evergreen Dense forest	32.74	22.29	10.45
Semi Evergreen Open forest	13.43	17.6	-4.17
Scrub forest	2.46	5.12	-2.66
Agriculture	7.22	10.61	-3.39
Water Body	0.3	0.94	-0.64
River Sand/ Boulders	1.85	1.44	0.41
Total	**58**	**58**	

Figure 7: Land use cover change analysis for 2005 to 2010

5. Conclusion

Poba RF provides indispensable provisioning, regulating, cultural and supporting services to local communities. Being only natural forest in the entire Jonai Sub-divisional area, Poba is the source of wild foods, and livelihoods and socio-religious needs to local populace. Ecological role Poba RF as natural barrier against erosion by the Laly River is acknowledged and appreciated by everyone in the region. However, the forest has been facing threats due to overexploitation of resources and illegal felling for timber and due to poaching. The National

Highway-52 in the North of the reserved forest has already fragmented the habitat preventing movement of wildlife and loss of ecosystem services provided by them. Resource use needs to be optimized to ensure sustainability of the forest. Poba RF needs urgent conservation initiatives for ecological stability, human well-being and as local heritage. Land Use and Land Cover dynamics is a result of complex interactions between several biophysical and socio-economic conditions. The effects of human activities are immediate and often radical, while the natural effects take a relatively longer period. The difference in increase of households and land cover change indicates the pressure on forestland cover and related biodiversity. This implies that population pressure is believed to be one of the major driving forces for the changes in the study area. In order to make relevant conclusions and recommendations of an area, one has to therefore properly consult situations of the past and present, i.e. socio-economic and biophysical aspects of the area. Hence, in the case of this analysis, the major driving force to changes in LULC is increased population change.

6. References

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