Chapter - IV

LAND-USE/LAND-COVER IN SONAI-RUPAI WILDLIFE SANCTUARY

4.1. Introduction

The terms land-use and land-cover are often used interchangeably, although their actual meanings are quite distinct. Land-use refers to human activities that take place on the earth's surface whereas land-cover refers to the natural or manmade physical properties of the land surface (Maurya *et al.,* 2013). The term land-cover is defined as observed physical features on the earth's surface and when an economic function is added to it, it becomes land-use. Land-use/Land-cover has become an important parameter which is used for managing natural resources and environmental changes in a particular region (Foody, 2002; Sreenivasulu and Bhaskar, 2010). Changes of land-use/land-cover play an important role in the observation of global changes (Nisar and Lone, 2013), deforestation and biodiversity loss as well as it increases the volume and magnitude of disasters (Lambin *et al.,* 2003 and Reis, 2008). It is important to note that the land-use/land-cover changes have direct or indirect impact on its natural resources, agricultural practices, economic growth etc.

Land-cover change is considered as one of the most significant anthropogenic disturbance to the environment. It has been seen that the land-use/land-cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space (Mengistu and Salami, 2007). The increasing population growth has led to the decreasing trends in land-cover in the forest areas (Chebet, 2013; Yadav *et*

al., 2013). Due to increase destructive rate by men on natural resources, the land-man ratio, agricultural pattern, economic growth and day-to-day life style of human being are being changed (Sandoval *et al.,* 2007; Manonmani and Suganya, 2010; Sarma *et al.,* 2008). Land-use/land-cover changes have been resulted in various processes such as – desertification, biodiversity loss, global warming and increase of natural disaster such as flooding (Wijitkosum, 2012). Presently, land-use/land-cover change played an important role globally to observe, implement and monitor all type of problems whether it is natural or man-made. Therefore, land-use/land-cover change detection and assessment is very essential in examining various ecological and developmental consequences of land-use change over space and time (Ademiluyi *et al.,* 2008). It provides various comprehensive information of natural and anthropogenic characteristic of the area which also helps us to understand their phenomena (Al Huda *et al.,* 2014). Information on the land-use/land-cover change is a critical input for natural resource management and has also an important impact on a wide range of environmental and landscape attributes (Mundia and Murayama, 2009).

Remote sensing, Geographical Information System (GIS) and Global Positioning System (GPS) are well established and sophisticated techniques that can be used to study land-use/land-cover changes (Al Huda *et. al.,* 2014; Pandian *et al.,* 2014). Now-a-days, GIS and remote sensing technique is extensively used by many workers for analyzing land-use/land-cover changes throughout the world (Manjula *et al.,* 2011). Remote sensing data was used by Kushwaha *et al.,* (2000) in mapping the forests of Kaziranga National Park (Assam) for evaluating the habitat changes that occurred in the park after flood. Chauhan *et al.* (2003) used aerial photographs of 1976 and satellite data of IRS- 1C,- LISS- III of 1999 to evaluate the changes in density of "Sal" forest.

Lele *et al.,* (2005) used remote sensing data for analyzing forest cover dynamics in northeast India.

Digital change detection is the process that helps in determining the changes associated with land-use and land-cover properties with reference to geo-registered multi-temporal remote sensing data. It helps in identifying change between two (or more) dates that is uncharacterised of normal variation. Change detection is useful in many applications such as land-use changes, habitat fragmentation, rate of deforestation and other cumulative changes through spatial and temporal analysis techniques such as GIS and remote sensing (Manjula *et al.,* 2011).

Rapid population growth and increase demand of agricultural land and forest products had accelerated the rate of deforestation process in the study area. Understanding the land use and land cover change has an important role in understanding human pressures on protected area. Till now no studies on land-use and cover changes for different year have been undertaken in the Sonai-Rupai Wildlife Sanctuary. The knowledge of spatial land-cover information is essential for proper management, planning and monitoring of natural resources (Zhu, 1997). The land use/land cover classification and mapping will play an important role in monitoring and effective utilization of the natural resources.

4.2. Materials and Method

The study was based on LANDSAT satellite data having 30m spatial resolution, Survey of India (SOI) topographic maps (83 B/5 and 83 B/9) having 1:50,000 scales (1959-60 and 1960-61) and the ground truthing data collected through field survey. LANDSAT TM (30 January, 1988 and 24 December, 2001) and ETM+ (30 Jan, 2005)

images of path 136 and row 41 were used to prepare the land-use/land-cover maps. The images were downloaded from GLCF. The images are ortho-rectified and therefore, geometrical corrections are not needed (Selcuk, 2008; Sarkar *et al.,* 2012; Alireza and Mansoor, 2012). Layer stacking of the Landsat images was done in Erdas 9.1 software. For convenience, 1960 has been put in place of 1959-1960 image and 1961-1962 toposheets. LANDSAT data acquired during monsoon and post-monsoon were used for land-use classification. Monsoon and post-monsoon data were used to check the hydrological variability. The spatial resolution of LANDSAT imagery is sufficient to identify and monitor the changes in land-use/ land-cover change.

The preparation of base map of the study area is the first step in the analysis of land-use/land-cover. The base map of the study area was prepared by using survey of India toposheets. The toposheets were geometrically corrected in the Arc GIS 10 software. Kalianpur 1975 geographic coordinate system was used for geo-referencing, as survey of India toposheets have been prepared by using Kalianpur 1880 Datum. Then the toposheets were transformed to WGS84 Geographic Coordinate system which was than projected in Universal Transverse Mercator projection WGS 1984 UTM Zone 46N. Various features like roads, track, location or any other land based features were transferred to the base map. For this personal Geo-database were created in Arc GIS 10.0 in which different feature classes were created. An onscreen digitization approach was adopted to prepare the different spatial layers. All the digitization was done using Arc GIS 10.0 software.

The land-use/land-cover map of 1988, 2001 and 2005 was derived from the visual interpretation of satellite data. The interpretation key was based on the relationships between ground features and image elements like texture, tone, shape,

location, and pattern. Land-use/Land-cover categories such as - forest cover; river, oxbow lake, grassland, etc. were identified. Land-use/Land-cover maps were prepared in 1:80,000 scales.

4.3. Results and Discussion

The land-use/land-cover pattern of a region is an outcome of natural and socioeconomic factors as well as their utilization by man in time and space. It depicts an idea of overall areal utilisation of resources either by natural or cultural aspects. The land-use/land-cover of 1960 was mapped, classified and calculated accurately from the toposheets and it was compared with those prepared from the satellite imageries. Base map for the study has been shown in Fig 4.1. The Land-use/land-cover map of the Sanctuary for the year 1960, 1988, 2001 and 2005 are shown in Fig 4.2, Fig 4.3, Fig 4.4 and Fig 4.5 respectively. The various land-use/land-cover classes interpreted in the study area include forest (dense, moderate and open forest), degraded land (deforested area), built-up area (for example Kalamati range office within the Sanctuary), grassland and rivers (water bodies).

The Land-use/Land-cover categories and their areal extents in various years have been tabulated in *Table 4.1.* Changes in land-use/land-cover were evaluated from the differences among the maps prepared for the years 1960, 1988, 2001 and 2005. The results are shown in *Table 4.2.* Change detection of land-use/land-cover gives the information of changes of specific classes of land-use/land-cover within specific time period. It depicts the location of changes in the study area.
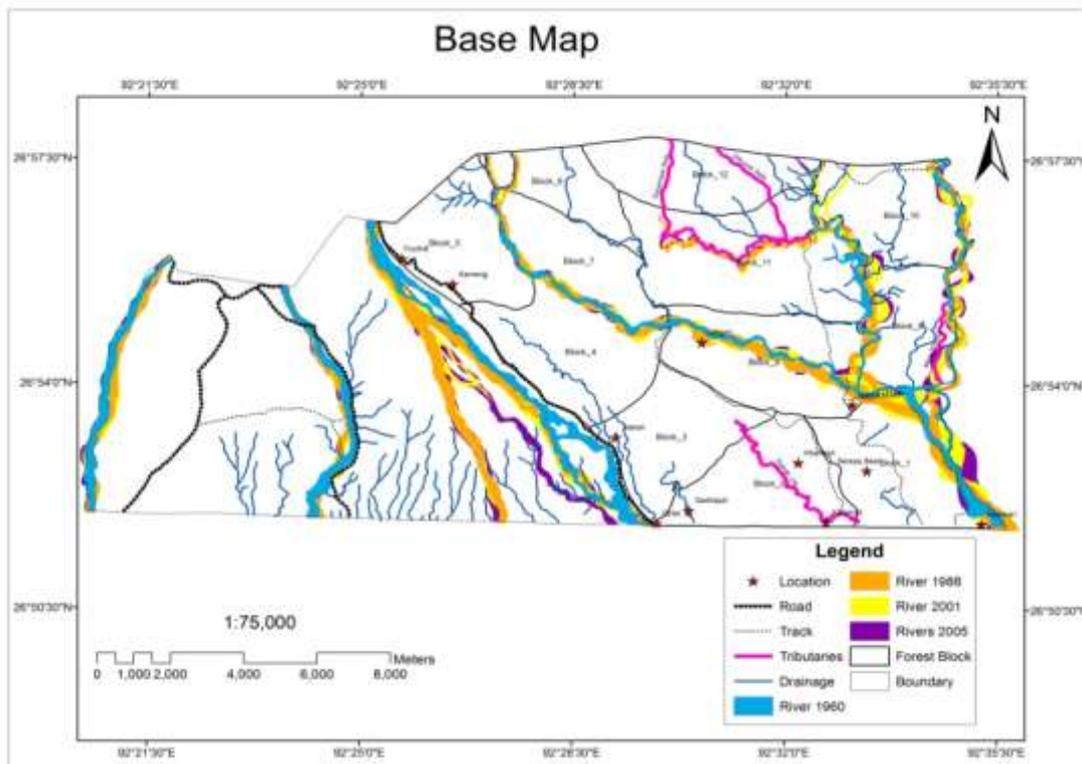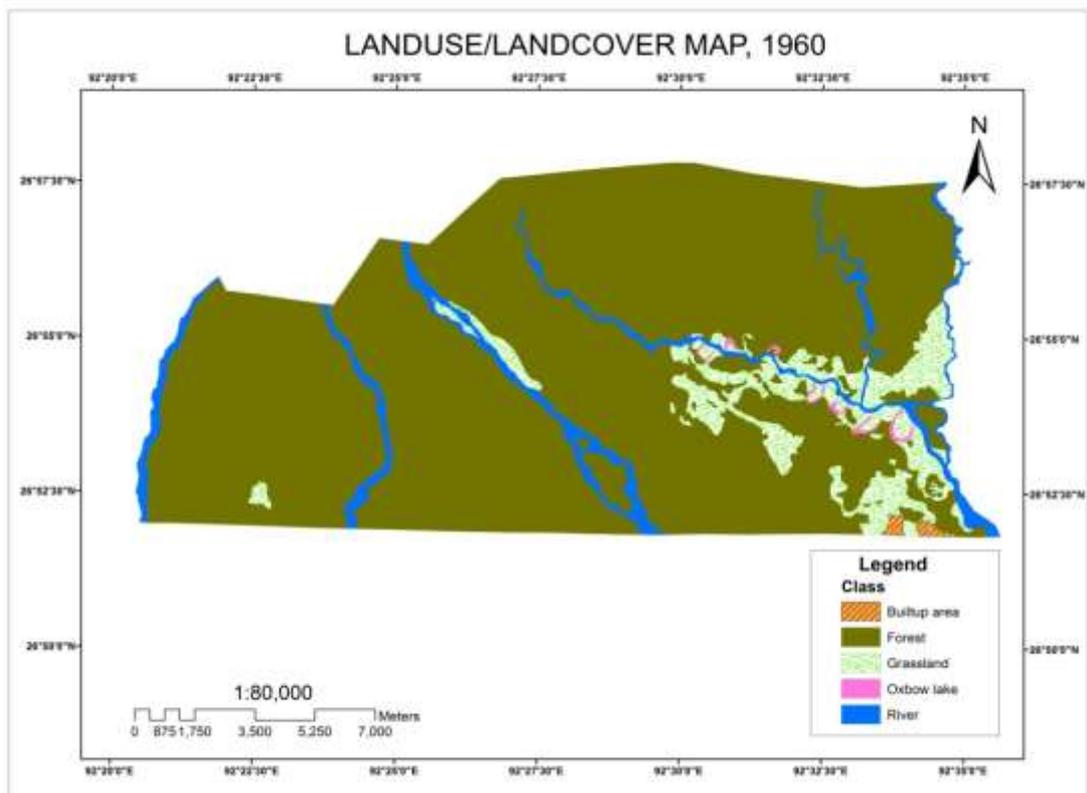
Fig 4.1: Base Map of the study area

Fig 4.2: Land-use/Land-cover Map for the year 1960
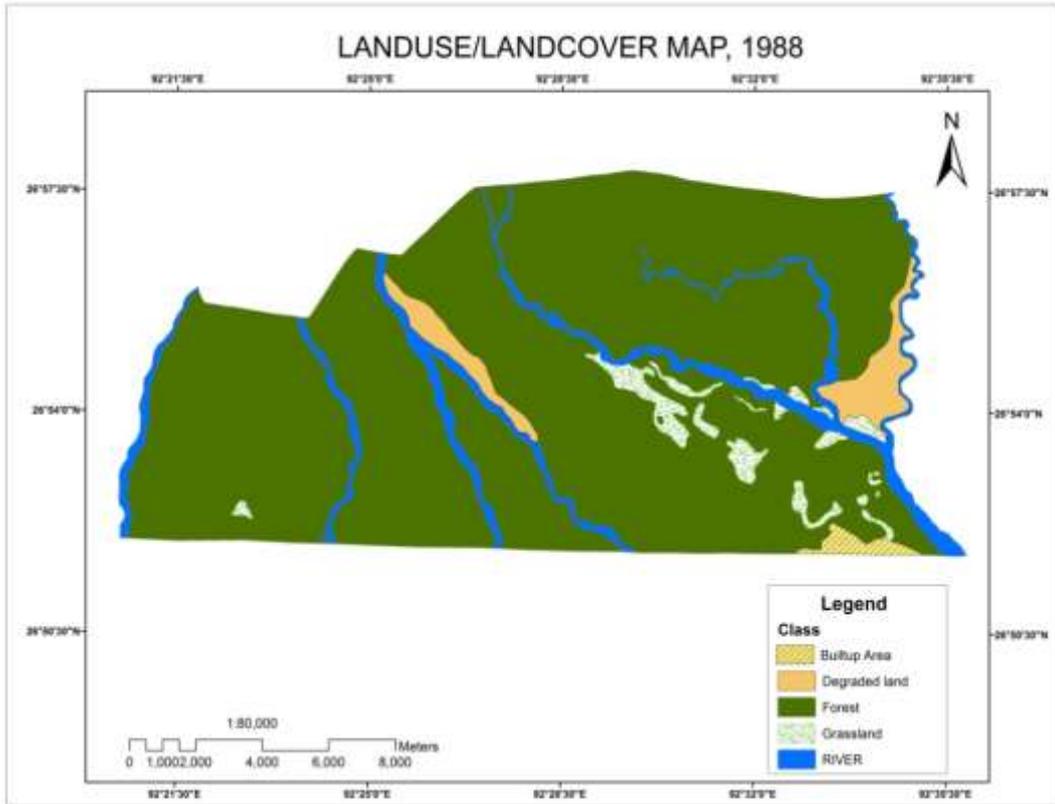
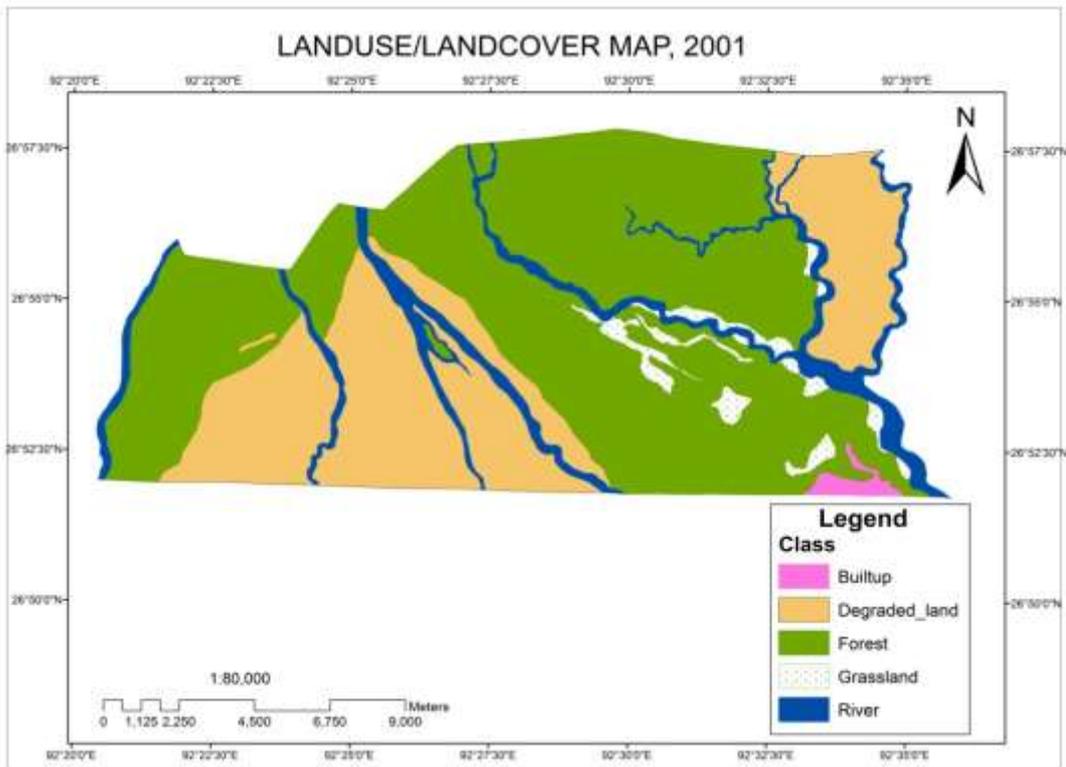**Fig 4.3:** Land-use/Land-cover Map for the year 1988

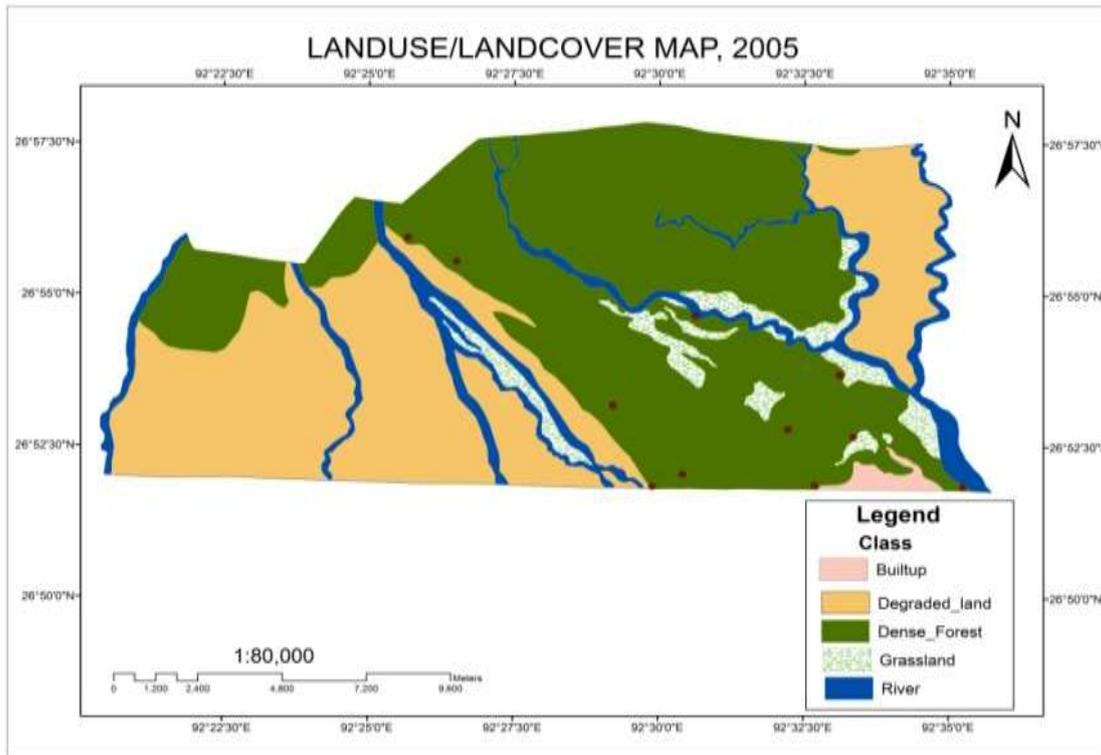**Fig 4.4:** Land-use/Land-cover Map for the year 2001

Fig 4.5: Land-use/Land-cover Map for the year 2005

Table 4.1: Land-use / Land-cover Classification (1960-2005)

Categories	1960		1988		2001		2005	
	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)
Forest	188.22	85.9	188.05	85.8	125.94	57.3	109.69	49.8
Builtup Area	0.55	0.3	1.49	0.7	1.67	0.8	1.67	0.8
Oxbow lake	0.61	0.3	-	-	-	-	-	-
Grassland	18.03	8.2	6.07	2.8	6.36	2.9	10.88	4.9
River	11.68	5.3	16.12	7.4	19.25	8.8	19.07	8.7
Degraded Land	-	-	7.56	3.4	66.4	30.2	78.74	35.8

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Table 4.2: Change in Land-use/land-cover during 1960-2005

Class	1960-1988 (km^2)	1988-2001 (km^2)	2001-2005 (km^2)
Forest	- 0.17	- 62.11	- 16.25
Degraded Land	7.56	58.84	12.34
River	4.44	3.13	- 0.18
Grassland	- 11.96	0.29	4.52

The total area covered by the Sanctuary was 220 km^2 as notified in 1998. During 1960 and 1988 it was found that out of 220 km^2 of the Sanctuary 188 km^2 was forest cover which is 86% of the total area of the Sanctuary. During this period, not much change has been found in land-use/land-cover of the Sanctuary. The most striking change in land-use/land-cover was the sharp decrease in forest cover within the Sanctuary during the period 1988 - 2001. In 1988, it was found that 7.56 km^2 of forest land in the Sanctuary was converted to degraded land which increased to 78.74 km^2 in 2005. When compared to the land-use/land-cover map derived from 1960 and 2005, it was found that there has been a decrease of 75.8 km^2 areas in dense forests and 7.15 km^2 in grassland-cover. On the other hand, an increase of 78.74 km^2 in degraded land and 7.4 km^2 in river area were also observed.

The forest area in the catchment of rivers has been reduced considerably during the last few decades mainly because of bankside erosion and deposition. Rivers were being braided and most parts of the sand deposits remain dry, especially during winter. Dry river with sand is a common feature in the Sanctuary. So, river sand is an important habitat pattern in the wildlife life Sanctuary. The total area covered by the riverbeds in

1960 was 11.68 km^2 which increased to 16.12 km^2 in 1988; but there was not much change in the riverbed areas in 2001 and 2005 where it was found to be 19.25 km^2 and 19.07 km2. It was found that river Belseri flowing across the Sanctuary is the most meandering river, which opens up new channel leading to bifurcation and shift towards west. The migration of the river subsequently caused fragmentation, degradation and loss of forest.

Roberts *et al.,* (1998) have reported land-cover change as the most significant regional anthropogenic disturbance to the environment. Forest loss and degradation are occurring due to various human activities such as expansion of agricultural area, urbanization and cattle grazing (Yadav *et al.,* 2013). It has been observed that the land-use and land-cover changes are mainly because of prevailing interacting natural and anthropogenic processes by human activities. Deforestation, land fragmentation, channel migration and rapid increase in human settlements inside the Sanctuary have negative impact on the biodiversity of the Sanctuary by causing habitat loss. The main cause behind this forest degradation is encroachment of the forest land by the immigrants for agriculture and livelihood opportunities. The populations of many species particularly large mammals are also affected due to reduce in habitat size (Ademiluyi and Okude, 2008). From the present study, it is evident that there occurred considerable loss of forest cover (dense, moderate and open forest) in the Sanctuary during the period 1988-2005 which resulted in habitat loss and affected the biodiversity of the Sanctuary. Srivastava *et al.,* (2002) have also reported that the spatial distribution of different forest types from 1994 to 2001 in Sonitpur district is undergoing massive reduction with time.

Land-use/land-cover changes reflect the dynamics observed in the socioeconomic condition of a given area. So, the changes in the socioeconomic situations can cause land-use/land-cover changes through their influence on land management techniques and other various aspects such as agriculture farming systems, institutional settings and environmental policy. Mengistu and Salami (2007) reported several factors such as agricultural colonization, spread of rural settlements, evolution of rural road networks and government policy in Nigeria that are affecting and modifying the original form of land-cover.

Human settlements are known to be the most profound alteration of the natural environment through their different land-use practices. With increasing population pressure, the forest cover in the Sanctuary has been deteriorating continuously. It has been observed that vast changes occurred due to migration of people to the forest area. Agriculture with sparse habitation has increased during the last two decades. The change in the economic system of the region puts pressure on the agricultural sector. This in turn leads to the opening up of more natural forests for cultivation. Hence, the expansion of agricultural land was partially responsible for the disappearance of the tropical rainforest of the area during the study period. Geist and Lambin (2002) reported that agricultural expansion is one of the proximate causes of land-use/land-cover change.

It has been seen that in many parts of the world, most of the landscape is being used for growing crops or for grazing cattle. Major changes in human activities, particularly through large scale agriculture have been identified as the major cause of the dramatic changes in land-cover and land-use patterns globally. Clearing of vegetation increases the risk of drought. Damming of rivers and draining of wetlands

reduces the environment's natural ability to absorb excess water increasing the impacts of floods.

Other important factors causing land-use/land-cover change in the region as seen in the present study are the expansion of settlement and illegal logging which has an adverse effect on the forest resources of the area. Illegal logging is a major environmental and economic problem. In the study area, particularly illegal logging is largely responsible for the ever decreasing forest cover. Similarly, Mengistu and Salami (2007) also found that settlement expansion and illegal logging are the major factors behind the land-use/land-cover changes observed in south western Nigeria. Batar *et al.* (2017) reported that forest cover is likely to decrease because of commercial exploitation, expansion of agricultural land, and human settlements and anthropogenic activities in Garhwal Himalayan Region. In the South Garo Hill district of Meghalaya also, the increasing rate of shifting cultivation, encroachment in forest land, illegal timber businesses, traditional agricultural practices, lack of knowledge are found to be the main causes of decreasing forest cover (Al Huda *et al.,* 2014). Similarly, in Chandoli National Park, most of the villagers were dependent on forest resources to meet their requirement of fuel, timber, habitation and fodder for their livestock. This dependency on the forest resources in the Chandoli National Park resulted in depletion of forest resources and changes in the land-use/land-cover of the park (Imam, 2011). Todakari and Patil (2010) also observed that deforestation in the Solapur district was taking place rapidly because of over population, lack of alternative fuel instead of wood, ignorance about deforestation among the people etc.

It has been observed that forests cover in the study area changed notably during 1960 to 2005. The study also indicates that the areas under agriculture and human

habitation were increased substantially due to population pressure and forests degradation. The loss of forest resources in the Sanctuary was mainly due to encroachment of land by the people for agriculture and livelihood opportunities, illegal logging and open grazing by cattle. Rapid population growth and land scarcity forced people to expand their agricultural fields. As a result, large areas of the Sanctuary which were under dense forest cover are now exposed to deforestation leading into environmental degradation and serious threat to wild life habitats.

4.4 Conclusion

The land-use and land-cover study showed that Sonai-Rupai wildlife Sanctuary has undergone tremendous change over the last 45 years (1960-2005). The land under forest cover experienced a declining trend during the study period. It has been found that 85.9% of the total of 220 km^2 area of the Sanctuary was forest cover during the period 1960 to 1988 and it has been reduced to 49.8% in 2005. The total decline in forest cover during the period 1960 to 2005 was 35.7%, which results in loss of biodiversity in the Sanctuary. It has been found that there occurred vast changes in land-cover in the Sanctuary due to encroachment of forest land by neighbouring people. The encroached forest land was primarily converted to agricultural fields. This resulted in the formation of degraded land affecting the habitats of the Sanctuary. Due to this, there is loss of natural ecosystem and biodiversity of the Sanctuary. Forest areas in the bank of river have also been reduced considerably during the period of 1960 to 2005 due to channel migration.

Deforestation, land fragmentation, agriculture expansion, human settlements and channel migration have negative impacts on the habitat and biodiversity of the

Sanctuary. Hence, both natural and anthropogenic activities has resulted in land-use and land-cover change within the Sanctuary. So, proper management practices should be adopted for conservation of forest and biodiversity in the Sanctuary.

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