

Land Cover Changes in Kaziranga National Park Using Remote Sensing and GIS

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INTRODUCTION

The state of Assam is a home for the one-horned rhinoceros. From the brink of extinction it has been conserved by creating Kaziranga National Park (KNP). Today almost all people bypassing the park, if not entered the park, have a urge to glance the rhinoceros from the roadside viewpoints. Among all the national parks in Assam, KNP is the biggest national park in the state covering three districts namely Golaghat, Karbi- Anglong, Sonitpur and Nagaon districts. National parks are designated protected areas use for the purpose of conservation of plants, animals and their natural habitats. The government and NGOs take initiatives to conserve such parks for animal conservation as well as sustainable ecosystem. The KNP is one of the oldest protected areas in Northeast India situated in the state of Assam which spreads across the floodplains of Brahmaputra River. Its forests, wetlands and grasslands are home to one-horned rhinoceroses, tigers, elephants etc. Various migratory birds, gray pelican roost and Gangetic River dolphins found in the park water. Thus understanding the land cover of the KNP becomes necessary to assess the reserve area as well as develop the park for sustainable ecosystem.

Land cover refers to the physical material at the surface cover or on the ground of the earth, whether it is vegetation, water, bare soil, etc. Land cover change is defined as the loss of natural areas, particularly loss of forests to urban or exurban development, or the loss of agricultural areas to urban or exurban development. Land cover change has numerous ecological, physical and socio-economic consequences. On the positive side, agricultural expansion may increase food production for a growing population. Detrimental changes in land cover are the leading contributors to terrestrial biodiversity loss. Monitoring the various elements of biodiversity at global scale is difficult. However, it is increasingly possible to measure changes in the extent and spatial structure of natural habitats. Land cover change is the best measure currently available to monitor pressures on ecosystems and bio diversities globally. The forests are identified as one of the major natural resources in Assam having immense influence directly or indirectly on the biosphere. The forest cover is disappearing due to unabated felling, extensive grazing and other human related activities. Remote sensing and GIS is found to be an effective tool for monitoring forest resources and vegetation cover.

REVIEW OF LITERATURE

The patterns of change of land cover are studied by various researchers using appropriate and effective monitoring tools. Davendra Kumar (2011), studied about the forest cover change monitoring in the Global Hotspots and mapping of the global forest cover by using Remote Sensing & GIS. In addition to animals, people residing nearby the forest area faced the consequences of any change in the natural land cover area. Dinesh (1988), studied the analysis of the forest resource utilization, its development strategies and some ecological changes in the fragile U.P Himalaya to examine the people relation with forest and problems associated with ecological changes as well measures to adapt or mitigate such problems.

Forest cover change was detected in Kalarani Round, Vadodara, Gujarat during 1970 to 1999. The area under forest was progressively reduced due to heavy grazing pressure thereby decreasing regeneration of vegetation (Karia et al. 2001). To manage the national parks in Assam the government had notified to connect Orang National Park with KNP. It is a step forward for making the two pristine habitats along with Brahmaputra riverine area a single landscape. It will help manage the river islands scientifically so that they act as a corridor as well as a habitat for transient and resident animals including tigers and its prey animals, rhino and elephant etc. (The Assam Tribune 2022).

Land cover studies are also carried out for city areas also for planning and development of urban areas. The study by Harpreet (2006), with the help of Remote Sensing and GIS monitored land cover as well as the dynamics of land use change in the city of Jammu to ascertain one to understand the structure of urban space and its surroundings. Praveen et al. (2013), studied the analysis of land use land cover changes using Remote Sensing and GIS at an urban area at Tirupati, India. The land use land cover of Guwahati city, Assam study by Rajbongshi (2017), found that land use land cover was more distinctive in the eastern and western periphery of the city and significant on both side of NH-37.

Land use land cover changes also reflect the culmination of interactions between climate, ecosystem process, biogeochemical cycles and other biodiversity indicators. Studies of LULC have therefore become vital to understanding and monitoring environmental change and related processes while these types of studies also provide valuable information that can be used to inform more sustainable natural resource management strategies. The LULC changes have significant environmental and socio-economic impacts especially for rural inhabitants involved in land-based livelihoods.

The direct and indirect impacts of land use and land cover changes have also been linked to losses in wildlife, deteriorating biodiversity, changes in plant species composition, desertification, deforestation, changes to nutrient, carbon and water cycles, as well as unplanned urban expansion (Verburg et al. 2000; Lambin et al. 2001; Brooks et al. 2002; Verburg et al. 2004; Ifamitimehin and Ufuah, 2006; Maitima et al. 2010; Ujoh et al. 2011; Kamwi et al. 2015).

Objectives

The objectives of the study are:

1. To study the land cover pattern of Kaziranga National Park using multi temporal multi spectral satellite imageries.
2. To study change in land cover pattern of Kaziranga National Park during 1998 and 2018.

METHODOLOGY

The study was conducted for the year 1998 and 2018 using Remote Sensing and GIS techniques.

Data pre-processing

Layer stack was done with LANDSAT 5 TM image from Band 1 to Band 6 and LANDSAT 8 OLI from Band 1 to Band 6. Subset images of the study area of 1998 and 2018 were created from the satellite images. Radiometric correction was done after the creation of subset and then image enhancement processes were been applied.

Land use land cover classification

Land Use Land Cover classification can be done in two ways i.e., supervised classification and unsupervised classification. For the study, unsupervised classifications have been adopted with having default classes of 150. After that the classification is done by giving different colors to each different class. Recoding was performed for the classification of features.

Data used: For the study, LANDSAT 5 TM and LANDSAT 8 OLI images of two years are used (8-12-1998 and 31-12-2018) given in Table 1, which was acquired from web portal www.earthexplorer.usgs.gov

Table 1: Details of the satellite data used

| Satellite | Year | Path/row | Spatial resolution |
|---------------|------|----------|--------------------|
| LANDSAT 5 TM | 1998 | 136/42 | 30m |
| LANDSAT 8 OLI | 2018 | 136/42 | 30m |

Study area

Kaziranga National Park is located between 26°30’N to 26°45’N latitude and 93°08’E to 93°36’E longitude between the area of Golaghat, Sonitpur, Karbi Anglong and Nagaon districts of Assam. The park is approximately 40 km in length from east to west and 13 km in breadth from north to south. KNP covers an area of 378sq.km. A total addition of 429sq.km along the present boundary of the park has been made and designated with separate national park status to provide extended habitat for increasing population of wildlife as a corridor for safe movement of animals. The average altitude of the park ranges from 40m to 80m. The park area is surrounded by the Brahmaputra River which forms the northern and eastern boundaries, and the Mora Diphlu which forms the southern boundary. The location map of the study area is shown in figure 1.

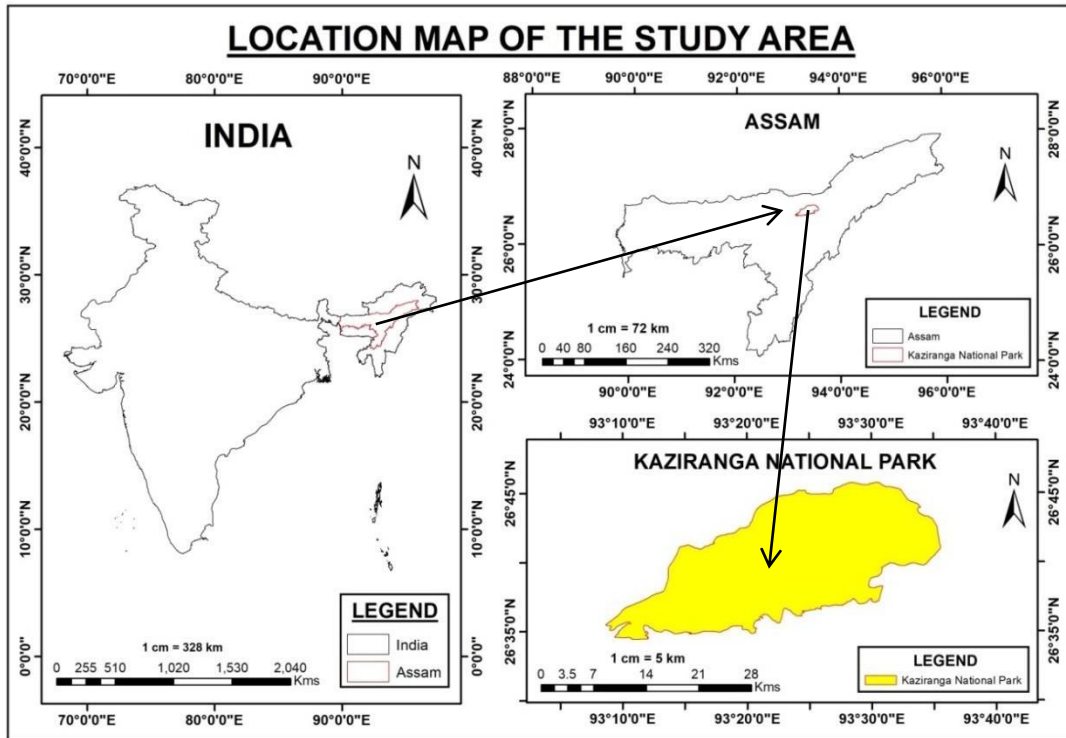


Figure 1: Location map of the study area.

For the study the KNP was visited at designated sites for the verification of the location using GPS. The GPS points of the study area visited is shown in figure 2.

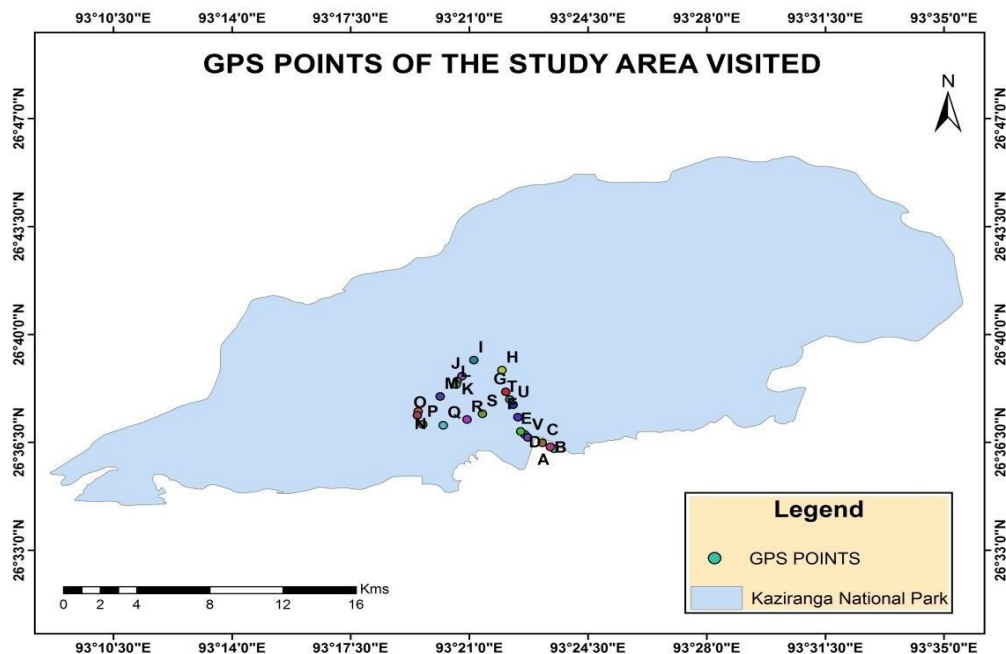


Figure 2: GPS points of the places visited

RESULTS AND DISCUSSIONS

Land use and land cover has become crucial basis work to carry the prediction to the dynamical change of land use, prevention to natural disaster, environment protection, land management and planning. Although the term land cover and land use are often used interchangeably, their actual meanings are quite distinct land cover refers to the physical material at the surface cover or on the ground of the earth, whether it is vegetation, water, bare soil, etc. KNP is a national park shared by four districts i.e., Golaghat, Sonitpur, Karbi Anglong and Nagaon district of Assam, India. The sanctuary hosts about two-third of the world's great one-horned rhinoceroses and is a World

Heritage Site. On 1 June 1905, the Kaziranga Proposed Reserve Forest was created with an area of 232 sq. km, to the banks of the Brahmaputra River. In 1908, Kaziranga was designated as “Reserve Forest”. In 1916, it was redesignated as “Kaziranga Game Sanctuary” and remained so till 1938. In the sanctuary visitors were permitted to enter the park but hunting was prohibited. The Kaziranga Game Sanctuary was renamed the “Kaziranga Wildlife Sanctuary” in 1950 by P. D. Stracey, the Forest Conservationist, later in 1968. When the state government passed the Assam National Park Act in 1968, Kaziranga was declared as a designated national park. The 430 sq. km park was given official status by the central government on 11 February 1974. In 1985, Kaziranga was declared a World Heritage Site by UNESCO for its unique natural environment.

Land cover of Kaziranga National Park in 1998

In the year 1998, the largest percentage of land in Kaziranga National Park was under Semi Evergreen with about 52 percent of total land area, followed by Swamp (15 percent), Grassland (13 percent), River (9 percent), Sandbar (7 percent), Wetlands (3 percent) and the least percentage of land use is Woodland with about only 1 percent of the total land area. Table 3 shows the land cover area of KNP in 1998 and percentage of land cover in figure 3.

Table 3: Land Cover Area of Kaziranga National Park, 1998(in ha. & %)

| Classes | Area(in hectares) | Area (in %) |
|----------------|-------------------|-------------|
| Wetlands | 1379.7 | 3 |
| Semi Evergreen | 26196.35 | 52 |
| Swamps | 7380.36 | 15 |
| River | 4607.46 | 9 |
| Grassland | 6340.14 | 13 |
| Woodland | 486.81 | 1 |
| Sandbar | 3400.29 | 7 |
| Total | 49791.11 | 100 |

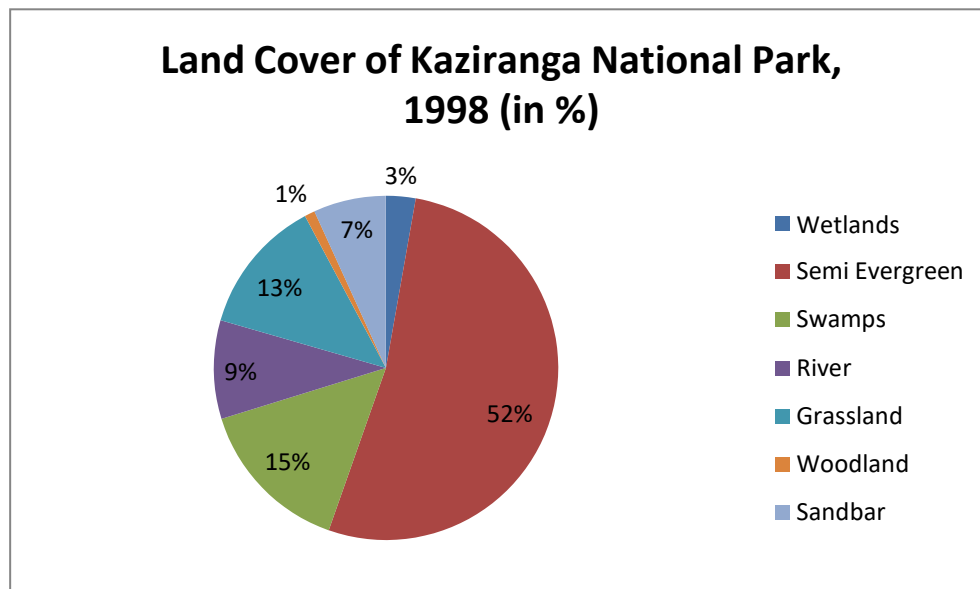


Figure 3: Percentage of land cover pattern in Kaziranga National Park, 1998

Land cover of Kaziranga national park in 2018

A total of seven classes of land cover were taken in order to conduct the study. This comprised of River, Semi Evergreen Forest, Grassland, and Woodland, Swamp, Wetland and sandbars. To carry out the study, firstly, satellite data was downloaded from USGS Earth Explorer website and image enhancement processes was incorporated. For the classification process unsupervised classification techniques was adopted because of the heterogeneous nature of the image and also the ground control points were not taken. About 429 sq. km of area was

utilized for classification into seven different classes to show the land cover of the study area. The largest amount of land of the study area was occupied by Grassland covering about 29,686 hectares which counts for about 60 percent of the study area. The grassland area consisted largely perennial grasses. The second major land cover category was the Semi evergreen forest with about 7,932 hectares, i.e. about 16 percent of land under it. The other major land cover is the River and Sandbars occupying about 3,988 hectares and 3,985 hectares respectively, which is about 8 percent of the total land of the study area each. The Wetlands i.e., land areas covered in water, seasonally or permanently occupy about 1,969 hectares (nearly 4 percent) and the Woodland where land area largely covered only with tree species occupies about 1,766 hectares (about 3 percent) of land. Lastly, the low lying wetlands covered with reasonable amount of vegetation known as swamp areas covered nearly 363 hectares of land which was about 1 percent of the total land area under observation. The pattern of land cover classification in area, graphical and percentage in the year 2018 is shown in table 4, figure 4 and figure 5 respectively.

Table 4: Land Cover Area of Kaziranga National Park, 2018(in ha. & %)

| Classes | Area(in hectares) | 2018 Area(in percent) |
|----------------|-------------------|-----------------------|
| Semi Evergreen | 7932.15 | 16 |
| Wetlands | 1969.02 | 4 |
| Grassland | 29689.6 | 60 |
| Woodland | 1766.52 | 3 |
| River | 3988.35 | 8 |
| Swamp | 362.79 | 1 |
| Sandbar | 3985.65 | 8 |
| Total | 49694.08 | 100 |

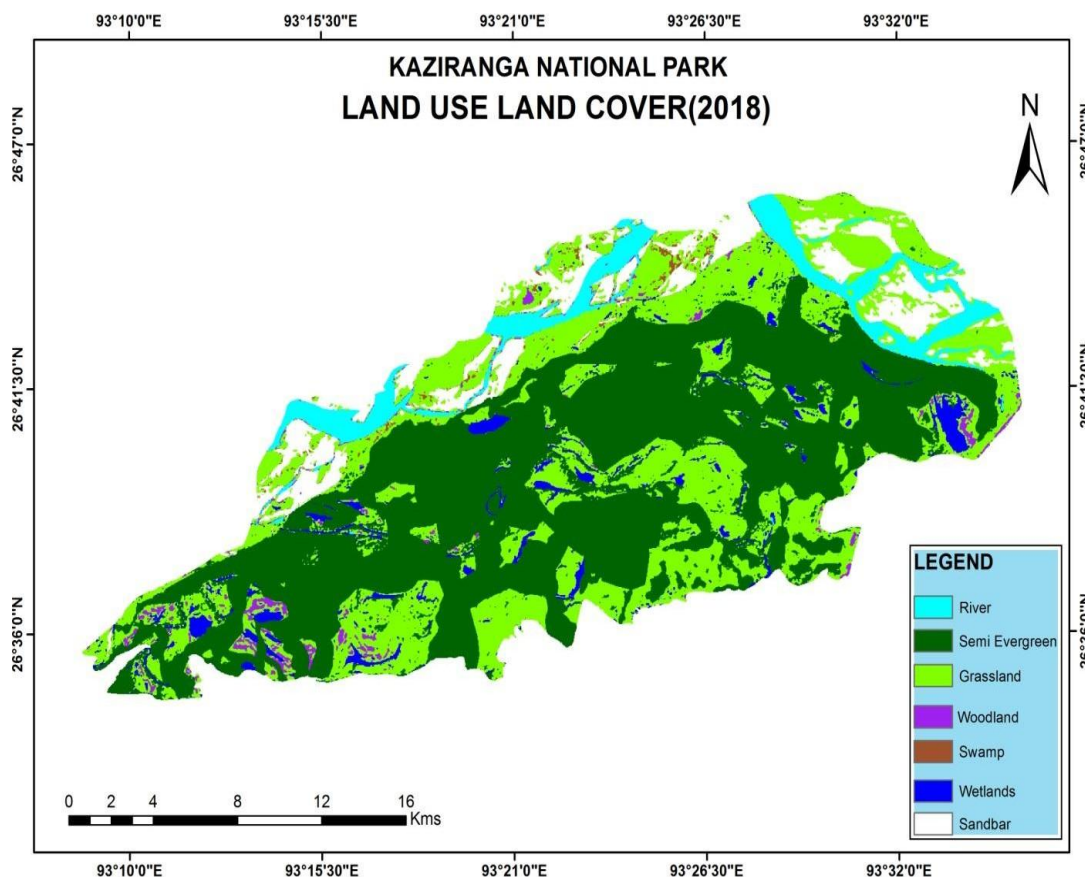


Figure 4: Land Cover Classification of Kaziranga National Park, 2018.

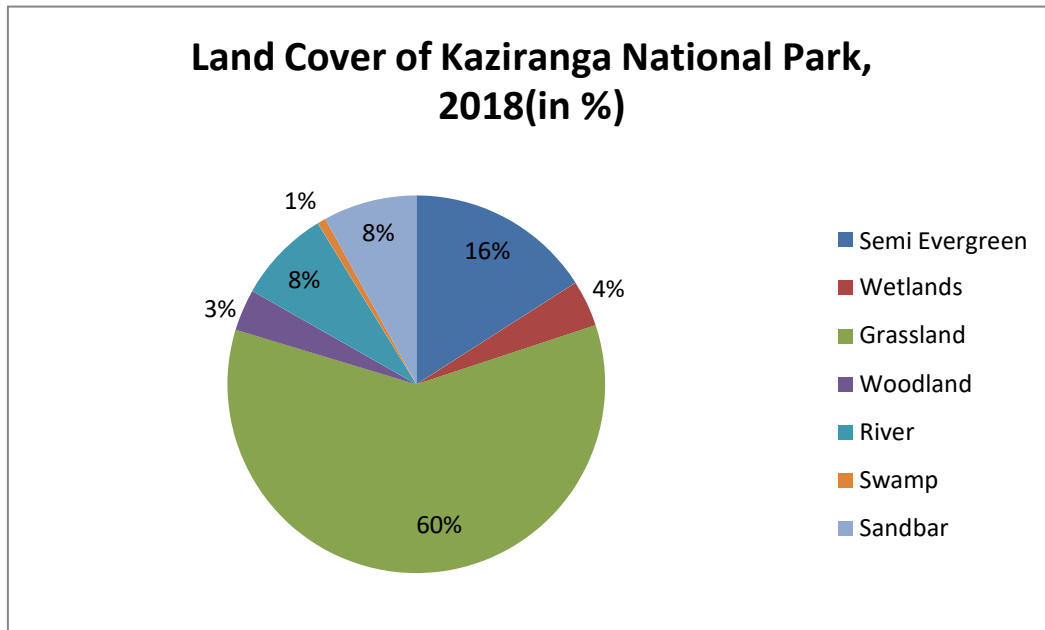


Figure 5: Percentage of land cover pattern in Kaziranga National Park, 2018

Land cover changes in 1998 and 2018

From the study it was found that there was drastic change in some classification of land cover such as Semi-evergreen, grassland and moderate change in swamps areas. Other classification such as river, sandbar, wetland and woodland had marginal changes during the period 1998 and 2018. Regarding the coverage area, semi evergreen, river and swamp had reduced the area in 2018 from 1998 whereas grassland, sandbar, wetland and woodland had increased the area coverage from 1998 to 2018. The change of land cover area is shown in table 6. The graphical representation of the change whether increased or reduced and percentage of the land cover change are shown in figure 6 and table 7 respectively.

Table 6: Land Cover Change of Kaziranga National Park during 1998 and 2018 (in ha.)

| Classes | Area (in hectares) 1998 | Area (in hectares) 2018 | Changes (in hectares) |
|----------------|-------------------------|-------------------------|------------------------|
| Semi Evergreen | 26196.35 | 7932.15 | - 18264.2 |
| Grassland | 6340.14 | 29689.6 | 23349.46 |
| River | 4607.46 | 3988.35 | - 619.11 |
| Sandbar | 3400.29 | 3985.65 | 585.36 |
| Wetlands | 1379.7 | 1969.02 | 589.32 |
| Woodland | 486.81 | 1766.52 | 1279.71 |
| Swamp | 7380.36 | 362.79 | -7017.57 |
| Total | 49791.11 | 49694.08 | |

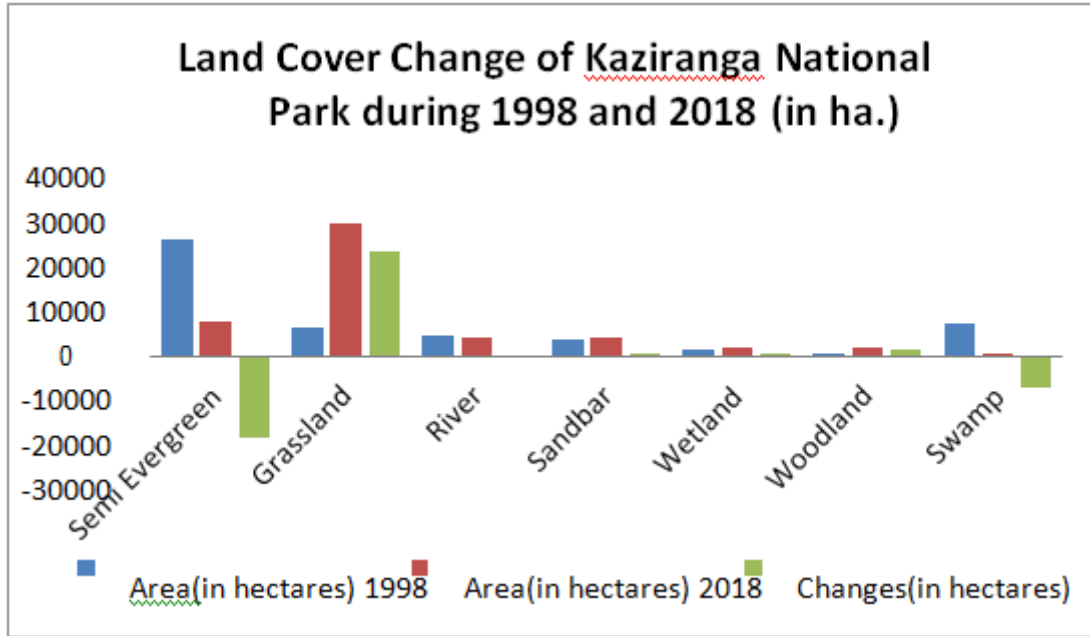


Figure 6: Change in hectares of Land Cover Change in KNP during 1998 and 2018

Table 7: Percentagewise land cover change of KNP during 1998 and 2018

| Classes | Changes in % |
|----------------|--------------|
| Semi Evergreen | -35 |
| Grassland | 45 |
| River | -1 |
| Sandbar | 1 |
| Wetlands | 1 |
| Woodland | 3 |
| Swamp | -14 |

The percentage of change and area in hectares and the probable reasons for the change in land cover in KNP is given below:

Grassland: Grassland is an area covered by grass species usually utilized for grazing. In the study area grassland is important for the habitat of one horned rhinoceros. The total area of Grassland in KNP changed since the year 1998. Total areas with size of about 23,350 hectares have added in this category of land cover till today, accounting for about 45 percent of the total land area of the Park. About 85 percent of this area mainly belonged to Semi Evergreen Forest and the rest belonged to swamp areas.

Semi Evergreen Forest: Flood is a common annual phenomenon in the area. Due to gradual increase in flood spread in recent years in the area, the larger portion of land area remains under water for a long period of time. Some of this area falls under the Semi Evergreen Forest. This submerged soil became too soft in order to sustain large and heavy tree species; this drastically reduced the size of the semi evergreen forest by about 18,264 hectares which accounts for nearly 35 percent of the total land area of the Park. Majority of this area is now converted into grassland and is utilized by one horned rhinos as their habitat.

Swamp: Swamp areas are seen relatively closer to the River Brahmaputra area of KNP. It accounts for over 7,380 hectare in the year 1998. A total land of about 7,017 hectares of swamp area disappeared because of soil deposition which is about 14 percent of the total land area. Currently, only about 363 hectares of swamp area is present in KNP.

Woodland: The area of woodland in KNP has increased nearly by 3 percent which is about 1,280 hectares in size. These areas mainly derived from Semi Evergreen Forest and are composed of different smaller tree species. They also consist of bushes and scrubs which act as a food source for various smaller animal species in the Park.

River: The major river of Kaziranga National Park is the River Brahmaputra. It currently covers about 3,988 hectares of the total land area. Since 1998, over 619 hectares of the river area degraded which is about 1 percent of the total land area, due to increase in sandbars in the area. And also the Mora Diphlu River which forms the southern boundary also has some impacts in KNP.

Wetland: Due to higher frequency of flood occurring in recent years, the flood spread also increased with it. This resulted in the increase in wetland areas in the Park. Currently, over 1 percent of wetland area increased since 1998, which counts for over 589 hectares of the total land.

Sandbar: Sandbar shows increase in area of the park with about 1 percent. This accounts about 585 hectares of the total land in the Park. This occurred due to recent temperature rise in the area, increasing the evaporation rate and leaving the rocks of the area dry and exposed for weathering.

CONCLUSION

Kaziranga National Park had undergone through an extreme change in its scenario since 1998. The changes which could be seen in the land cover of Kaziranga National Park during 1998 & 2018 was mostly in the Grasslands and the Semi Evergreen. Semi Evergreen decreased by 35 percent and Grassland had increased by 45 percent. Followed by the Swamps which was decreased by 14 percent, River decreased by 1 percent, Sandbar and Wetlands increased by 1 percent each, and Woodlands increased by 3 percent. There was a negative change in the Semi Evergreen, Swamps & River whereas a positive change was observed in the Grasslands, Sandbar, Wetlands and Woodland. Among other factors, flood was a major reason for the land cover change in KNP. As the KNP is surrounded by the River Brahmaputra from northern to eastern sides of the park, flood and erosion frequent affected the park due to overflow of the Brahmaputra River. Keeping aside the negative impact of flood, in the case of KNP flood helped in maintaining a balance in the vegetation thus providing food and shelter for animals. On the other hand, climate change and flood also contributed for reducing the size of land mass inside the park. Along with these major changes there were also many minor changes which affected land cover and are still affecting the park in many ways such as extensive animal grazing, human activities, etc. The increased in Grasslands was an advantage for the habitats of the Rhinos and other herbivores animals. Proper monitoring of land cover from time to time and protection of animals from poachers will help the government in the management of the park. Understanding the habitats of the animals, land cover, conservation of their habitats, and development of raised platforms for settlement by animals during flood and creation of animal corridors for passage by animals may be taken into consideration for sustaining the KNP as the largest national park in Assam.

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