Spatial and Temporal Changes of Forest Cover and Tank System in Dry Zone of Sri Lanka: A Case Study from Minneriya National Park

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***Abstract*— Forest cover change can be occurred both by combining with natural influence and also anthropogenic activities. National parks can be identified as unique and the protected area for the fauna and flora species. Both natural and anthropogenic factors may have negative impact on floral and faunal populations in the national parks of Sri Lanka. Therefore, identification of the changes and conservation of biodiversity of national parks is timely valuable. GIS is a more effective tool for identifying the change detection of forest cover. The aim of this study was to explore the spatial and temporal changes of forest cover in Minneriya National Park between 2000-2014. This research is mainly based on secondary data of land use maps especially the maps available for 2000 & 2014. The maps can be created by adopting classification and digitization. By overlaying these two maps it could be identified the changes of forest cover within the fourteen-year period from 2000 to 2014. It was possible from this exercise to observe the spatial and temporal changes of the forest area in the park. In the year 2000 forest cover was 42.67 km2 and it was 36.65 km2 in 2014 showing a reduction of 14%. The Scrub area has increased. In 2000 it was 21.2 km2 and in 2014 it came up to 27.83km2 showing an increase of 31%. In the year 2000 tank area was 22.89 km2, which was reduced down to 22.37 km2 by 2014. The real reasons for these changes need to be examined using field studies and impact on terrestrial and aquatic biodiversity should be considered carefully as the land area is devoted to a National Park of Sri Lanka.**

***Keywords*— Forest cover, Dry zone, Tank System, Minneriya National Park, Geographic Information System**

I. INTRODUCTION

Forests can be identified as the green protections that are shielding the environment and conserve natural resources. Forests provide many resources such as grazing land for animals, wildlife habitat, water resources, and recreation areas. Forestry involves the management of a broad range of natural resources within a forested area [1]. A forests bears substantial and energetic global ecological as well as socio-economic resources and it requires sustainable conservation and management. In recent studies it is evident that only a few natural forests are left undisturbed on the earth. Because of the deforestation, human presence in the forests, overuse of forests, other anthropogenic activities, and also natural causes like forest fires, acid rain, and invasive species, this devastation has happened.

Geographic Information System (GIS) is an information technology that has been used as a tool in the forest cover change detection. GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information [2]. Remote sensing together with GIS can be used as a potential device, for monitoring the changes in land cover at local as well as global scale in developing countries, mainly by identifying the conservation priorities in global hotspots, rate of deforestation, and quantification of overall forest cover loss at higher scale [3].

Minneriya National Park is a part of a cluster of protected areas. The catchment area of the Minneriya reservoir is 249km2. The forest surrounding the reservoir is home to many species of fauna and flora. The core of the Minneriya National Park is in an unoccupied area of human and the country's most varied natural systems, with intermediate forest, bamboo stands, patanas, and talawas. The park covers an area of 8889ha [4]. The forest plants population consists of tropical dry mixed evergreen forests, abandoned Chena cultivated lands, grasslands, and wetlands. The national park can be identified as a unique and protected area for the fauna and flora species [5]. Natural influences in combination with some anthropogenic activities may negatively impact these flora and fauna species population in the national parks of Sri Lanka.

With this background, the present study aimed at exploring the spatial and temporal changes of forest cover in Minneriya National Park (MNP). The following specific objectives were pursued to achieve the aim defined above:

- To identify the major causes for changes of forest cover in MNP;
- To identify the changing patterns of the forest cover in MNP; and
- Update the 2004 forest cover map using GIS and Remote Sensing.

II. RESEARCH METHODOLOGY

The methodology section outline the plan and method that how the study has been conducted. This includes study area, data and sources of data, and methodology. The details are as follows;

I. The study area

Minneriya National Park is located between latitudes 7' 5'-8' 5' North and longitude 80' 5-'81' 0' East in Polonnaruwa District in the North Central Province. The boundaries of Minneriya National Park are Habarana Polonnaruwa highway in the North, Polonnaruwa Matale District boundary from the South, Katukeliyawa- Diyabeduma road on the East, and Sigiriya- Moragaswewa road on the West. Minneriya National Park is a part of a cluster of protected areas [4].

The Tropical Dry Hot Monsoon climate is characterized by: a bimodal pattern of rainfall; relatively uniform high temperatures throughout the year (mean = 28C); a protracted dry period prior to the main rainy season (October-January) during the north-east monsoon (Maha); and desiccating winds in May-August during the long, hot south-west monsoon. Annual rainfall is about 1500 mm, with a gradient of increasing rainfall from north to south. The topography is varied, with hills, patanas and talawas, and ranging elevation from about 100 m to 500 m. Much of the area lies within the lower peneplain, above which rise rock massifs including the dominant Sudukanda ridge. Minneriya, itself, is an ancient tank, with a catchment area of 24,000 ha, and water spread area is 2,550 ha in extent when full. Geologically, the area lies within the Highland Complex or Khondalite group of rocks. Soils comprise Great Groups such as Reddish Brown Latosolic (RBL), Reddish Brown Earths (RBE), Low Humic Gley (LHG), mountain regosols, and alluvium of variable texture and drainage. [4] The Minneriya National Park was selected for the study (Fig.1).

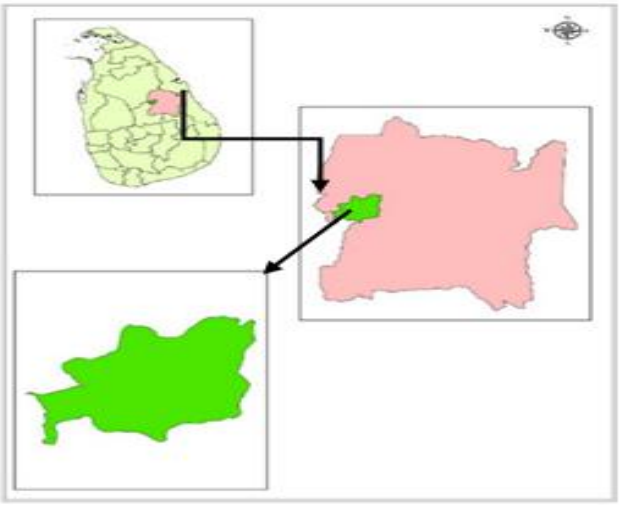

Fig. 1 Research Area

II. Data and Sources of Data

For the study, both secondary and primary data have been collected. Mapping data were collected using Google images. This research is mainly considered land use maps in the years 2000 and 2014 by taking from 2000 land sat data and 2014 Google map. Primary data were collected through field observations.

Methodology is illustrated in Fig. 2.

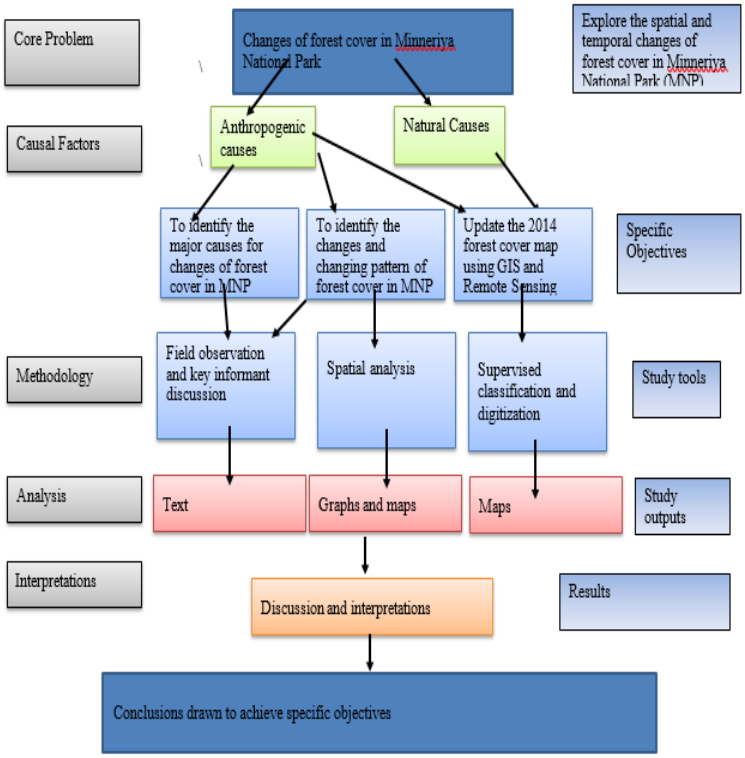

Fig 2. Methodology

III. RESULTS AND DISCUSSION

For the analysis land use types considered are only the forest area, scrub area and the tank area. The land-use map in 2000 is shown in Fig. 3 and the descriptive statistics of the land use map are summarized in Fig.4. The map and the graph show the forest area, scrubland and tank areas and their distribution in Minneriya National park in the year 2000. The total forest area was 42.67km^2 of the total land-use area. As the forest, this includes the dry mixed evergreen forest areas, primary high canopy, ridge forest, and medium canopy forest area. The scrubland of the area spreads over 21.29 km^2 of the total area of the park. The scrub area consists of a low forest with an open canopy. The densities of the trees are low. The tank area was 22.89 km^2 of the total area.

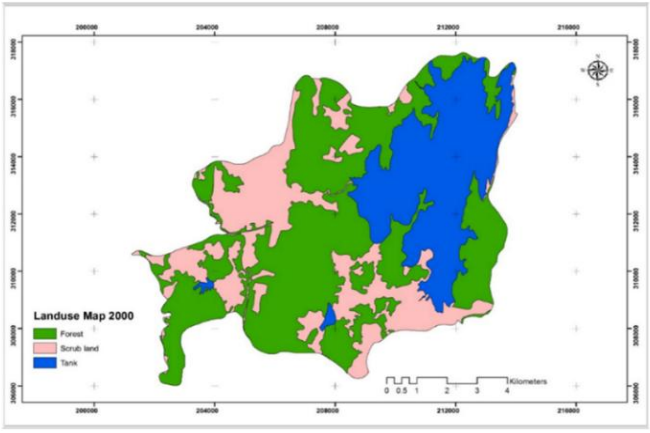

Fig 3: Land use map in the year 2000

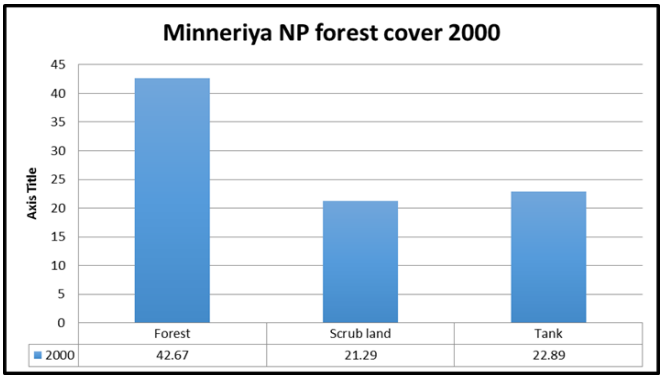

Fig 4: Land use in the year 2000

The land use map of the year 2014 is shown in Fig.5 and their descriptive statistics are summarized in Fig.6. The map and the graph clearly illustrate that the forest area coverage in MNP in 2014 was 36.65.km^2 of the total land-use area. The scrubland of the area spreads over 27.83 km^2 of the total area of the park. The scrub is a low forest with an open canopy. The densities of the trees are low. The tank area spreads within 22.37 km^2 of the total area. Here it should be mentioned that the majority of the Minneriya national park consists of the tank water spread.

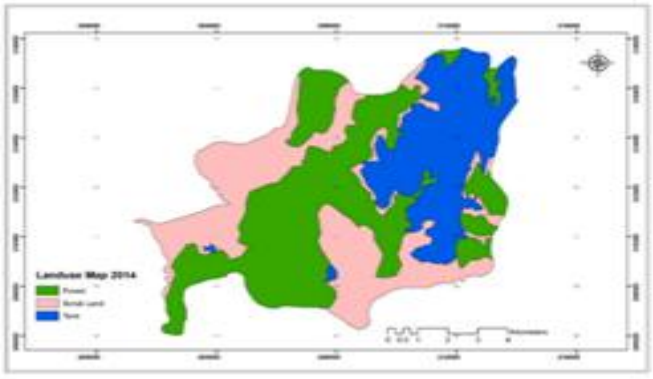

Fig 5: Land use map in the year 2014

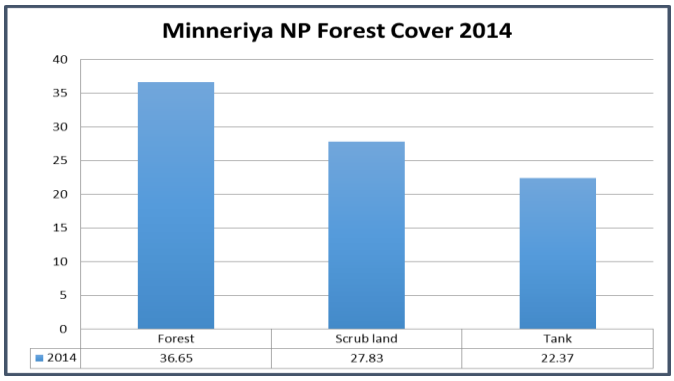

Fig 6: Land use in the year 2014

Fig.7 shows the comparison of two years of forest cover detection in MNP. When compared with the year 2000 (Fig.3) with the 2014 land use map (Fig.5), it is clear that during fourteen-year period of the time forest area has been reduced from 42.67 km$^{2\ to}$ 36.65 km^2.

With regards to the scrub area in the year 2000, it was 21.2 .km^2 and in 2014 it was 27.83 km^2 showing an increase of 31% . Also in the year, 2000 the tank area was 22.89 km^2 and it has reduced 22.37 km^2 by 2014.

The findings confirm the considerable changes in forest areas, scrub areas, and tank areas during the fourteen-year period of time in MNP. The factors affecting these changes are based on observation and interviewed data. The study further assessed the causes for these changes as both natural and anthropogenic causes. Among the natural causes, it can be highlighted forest fires and also the spreading of invasive species (Lantana Camara, bamboo trees) within the MNP area. Some of the development activities may also cause anthropogenic activities. Ex: Teak cultivation and the spread of high voltage lines within the MNP area.

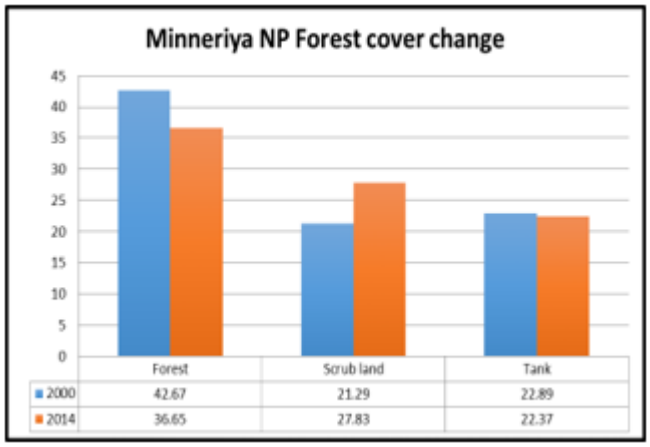

Fig 7: Forest cover change in the years 2000 & 2014

Fig 8: High voltage line within the MNP area

SSource: Field observation, 2014

IV. CONCLUSION

Certain changes have taken place from 2000 to 2014 in the forest cover of Minneriya National Park. The map comparison mainly was made using two maps during the fourteen-year time period (The year 2000 & 2014). The comparison showed considerable changes in forest areas, scrub areas, and tank areas. The study further assessed the causes for these changes. Among the natural causes, it can be highlighted the forest fires and also the spreading of invasive species (*Lantana camara* , bamboo trees) within the MNP area. Some of the development activities may also cause anthropogenic interventions. Ex: Teak cultivation and the High voltage line within the MNP area. Forest management in MNP addresses forest degradation and deforestation while increasing direct benefits to people and the environment.

With the purpose of sustainable management and conservation of the Minneriya national park it can be recommended following strategies.

- *Further continuation of sustainable forest management practices in MNP*

Present forest management in the MNP is at a higher level compared to that of other forest areas. Managing forests sustainably means increasing their benefits, including timber and food, to meet society's needs in a way that preserves and keeps forest ecosystems for the advantage of present and future generations by using some specific rules and regulations to protect the forest areas. Conservative measures such as habitat restoration are proposed for the Minneriya National Park.

- *Forest Plantation should be further promoted*

The plantation was a prime activity. Although the species such as teak, eucalyptus, and mahogany were the popular species at the time of plantation establishment on a large scale. In addition, the tree margosa (also known as neem) is another suitable species that are growing well in the drier parts of the country.

- *Forest area's legal measures must be adopted without any compensation*

Moreover, studies on increasing legal sanction must be speeded up; intensive control mechanisms against clearing must be applied. It has been known that occupation and clearing crimes against forest areas, in which cadastral registration adopted, have been decreased significantly.

- *It is necessary to adopt innovative methods to make more effective use of existing financial mechanisms and generate new and additional resources, both nationally and internationally*

It is a necessary conservation financial mechanism to conserve the MNP area and also generate the financing facility to improve the forest and biological diversity in MNP. The investment policies and regulations should aim to attract domestic investment of foreign and local communities for sustainable forest-based industries, reforestation, conservation, and protection of forests.

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