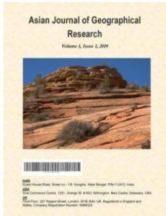

Asian Journal of Geographical Research

1(2): 1-8, 2018; Article no.AJGR.43477

A Geospatial Study to Assess the Land Use Land Cover of Mehao Wildlife Sanctuary in Arunachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration between all authors. Authors GA and KR designed the study. Authors KP and SM wrote the protocol and the first draft of the manuscript. Authors KR and SM managed the analyses of the study. Authors KP and RJ managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJGR/2018/v1i229603
Editor(s):
(1) Dr. Armando Garcia Chiang, Professor, Departamento de Sociologia, Universidad Autonoma Metropolitana-Iztapalapa, Mexico.
(2) Dr. Margaret Mwangi, Lead Scientist, Environment & Society, SESD, Pennsylvania, USA.
Reviewers:
(1) Muhammad Usman Saleem, Pakistan.
(2) Adonia K. Kamukasa Bintoora, School of Sciences, Nkumba University, Uganda.
(3) Vartika Singh, Amity Institute of Global Warming and Ecological Studies, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/26480

Short Communication

Received 3rd July 2018
Accepted 26th September 2018
Published 1st October 2018

ABSTRACT

There is inadequate knowledge of the natural resources in the remote inaccessible protected areas of North East Region (NER) of India. Arunachal Pradesh, which is one of the state in NER is extremely rich in biodiversity and forms a part of the biodiversity hotspots in the Eastern Himalayas. However its biodiversity is under threat due to various factors like infrastructure development, changing socio-economic pattern and other external pressures. Therefore the need of the hour is to map the current biodiversity of the area as well as potential threats in order to conserve the natural resources and create detailed spatial databases. The objective of the present study is to map the land use land cover (LULC) of Mehao Wildlife Sanctuary (WLS) situated in Arunachal Pradesh using

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Remote Sensing and GIS technology. IRS LISS III satellite image has been used to extract LULC, vegetation maps using hybrid classification. Further a spatial database of the WLS was created which includes contour, drainage, spot height and elevation distribution maps.

Keywords: Land use; land cover; Mehao Wildlife Sanctuary; Arunachal Pradesh; hybrid classification; natural resources.

1. INTRODUCTION

For conserving biodiversity and using natural resources for the human welfare, it is very crucial to manage the national parks and sanctuaries effectively. Being a large country with huge population, India faces daunting challenges with respect to conservation of natural resources and poverty alleviation [1]. Sustainable management of natural resources requires that ecological goods and services be used to meet current and future generations' needs by adapting to the inevitable biophysical limitations and interdependences [2,3]. Degradation of environment makes it difficult to meet the long term basic human needs of food and clean water [4]. Monitoring of the Protected areas (PAs) is the essential requirement to study and understand the ecological dynamics and impact of human beings on vegetation pattern of the area [5].

Most of the PAs In India, as elsewhere, are located in remote and inaccessible areas and hence, detailed survey of such areas is a difficult task to achieve. In such cases, acquiring reliable baseline data, for developing effective management policies, is both time consuming and expensive. However, technological advances in the field of geospatial science have overcome such physical limitations. The science of Remote Sensing (RS) and Geographic Information System (GIS) has been a new area of dimension wherein the PAs can be managed effectively ranging from local and regional to national and global level. Inventorisation and evaluation through geospatial tools can further support the decision making for conservation of biodiversity [6].

Earlier topographical maps alongwith knowledge of climate & species distributions were used to define strategies and management zones. Today one can use the digital database to analyse the information as per the need. Protected area mapping is an important aspect of protected area management. It serves as baseline for ecological modelling and future monitoring and assessment [7]. Multi-temporal high-resolution, remotely sensed data and GIS can be used to produce ecological inventories and monitor LULC changes at local, regional and global scales [8].

For monitoring & planning of natural resources, LULC mapping is cost effective method. Various studies have been conducted using geospatial tools to detect LULC like in part of south western Nigeria to detect LULC and change detection using Landsat imageries [9]; in Rize, North East of Turkey to detect changes in LULC using Landsat [10]; in Vempalli Kadapa district of Andhra Pradesh, India to analyse LULC using IRS P6 geocoded data [11]; in Kolhapur district, India to map land use using Landsat image [12]; and in Hawalbagh block, district Almora, Uttarakhand, India to understand spatio-temporal dynamics of LULC using Landsat Thematic Mapper [13].

Baseline mapping and LULC mapping using RS/GIS has been done in protected areas (Mouling and Namdapha National Parks) of Arunachal Pradesh, due to remoteness and inaccessible areas [14,15]. With this background, the study was carried out with the objectives to (i) map Land Use and Land Cover (LULC) and vegetation cover (ii) and to develop spatial database in terms of baseline maps like contour, drainage, topography etc.

2. STUDY AREA

Arunachal Pradesh lies in the eastern Himalayas in NER is extremely rich in biodiversity. However, the state's biodiversity is yet to be explored and documented scientifically to a great extent. Mehao WLS is situated in Lower Dibang valley of the state with coordinates 93º30'– 95º45'E, 28º05'–8º15'N (Fig. 1). The topography is undulating and hilly, and altitude ranges from 400 to 3,568 m above sea level [16].

Local Idu and Padam tribes of Arunachal Pradesh are the human population living around the sanctuary. Mehao is a sanctuary for numerous threatened species of the Indian flora and fauna, and much has yet to be explored and properly documented [16].

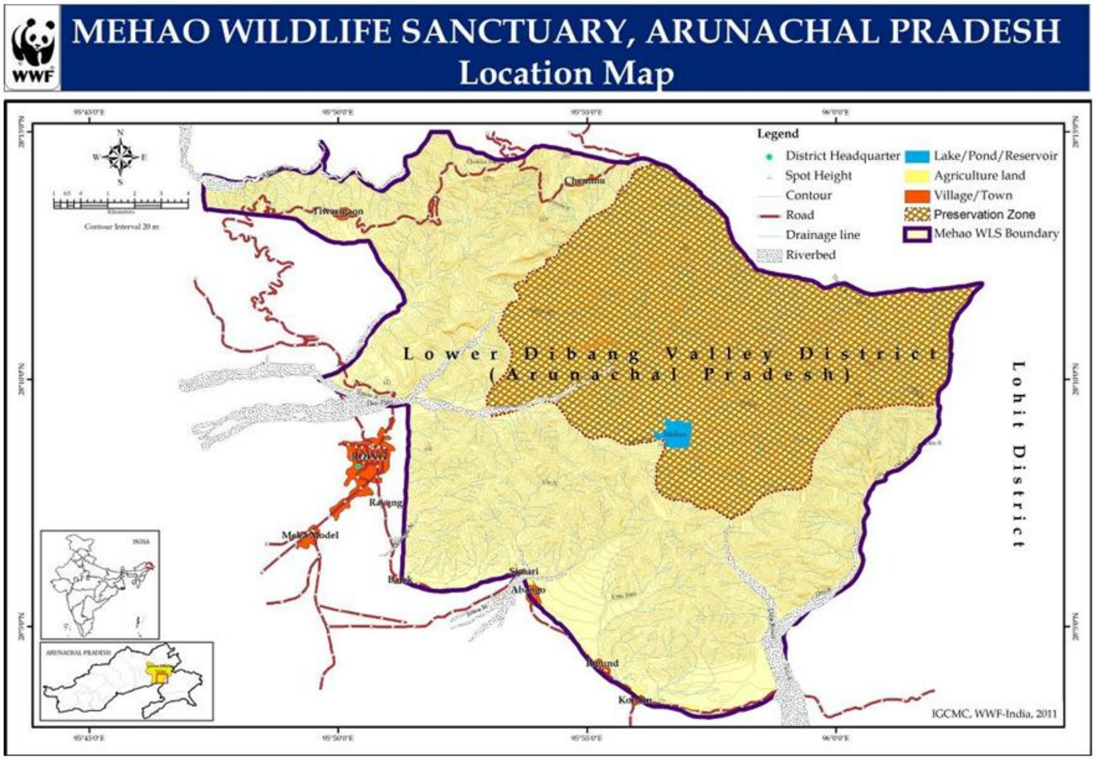

Fig. 1. Location Map

Four types of forest exist in the WLS which are Tropical Evergreen, Sub-tropical & Temperate, Temperate broad leave and Temperate Conifer. Tropical Evergreen Forests can be seen up to 900 m, Sub-Tropical & Temperate Forests are available above 900m to 1800 m, Temperate Broad Leave Forest are available from 1800 m to 2800 m and Temperate Conifer Forest can be seen from 2800 m to 3500 m [16].

3. METHODOLOGY

Spatial databases relevant to the management of sanctuary were generated including maps showing classified vegetation, land use/land cover, drainage, major contour and spot height, elevation distribution (maps enclosed in Fig. 2 to 6). Visual and digital interpretation in satellite images was done to generate such maps which were supported with adequate ground truth. The Survey of India (SOI) 1:50,000 scale topographic maps have been used for preparing the baseline data viz. drainage, road network, settlements, forest divisions and other relevant features. Indian Remote Sensing satellite IRS-P6, LISS-III data for December 2010 was procured from National Remote sensing Centre (NRSC) Hyderabad. LISS-III is a multispectral camera operating in four spectral bands, three in the visible and near infra-red and one in short wave infra-red (SWIR) region, with the Spatial resolution 23.5 m.

ERDAS Imagine and Arc GIS software were used in the study. ERDAS Imagine was used for digital image processing and for extraction of land use/land cover classes. The satellite imagery was geometrically rectified with reference to the geo-referenced topographic maps and vector data. The images were then mosaiced and clipped on the basis of the sanctuary boundary using subset technique in Erdas. Classification was done using a hybrid method, wherein the study area image was classified first using unsupervised classification and then using the recode technique the classes were merged into required number of classes. The classified images were compared with the respective satellite image and using visual interpretation technique the classified data was cleaned by recoding. For water body and built-up area, separate AOIs were prepared and then recoded.

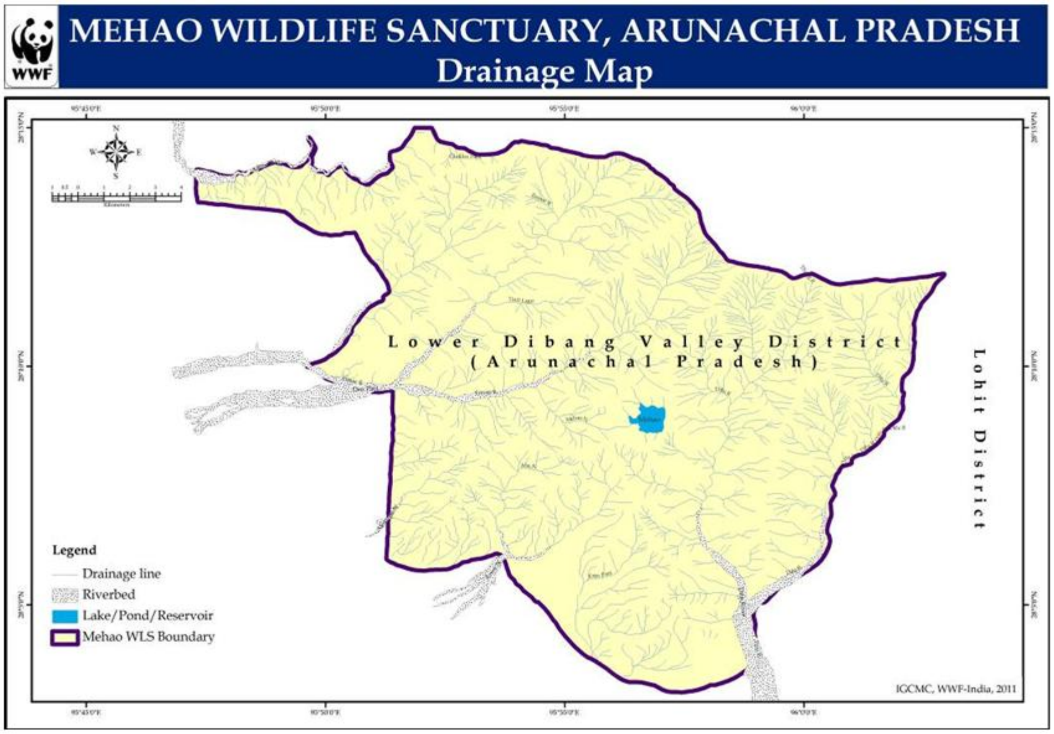

Fig. 2. Drainage map

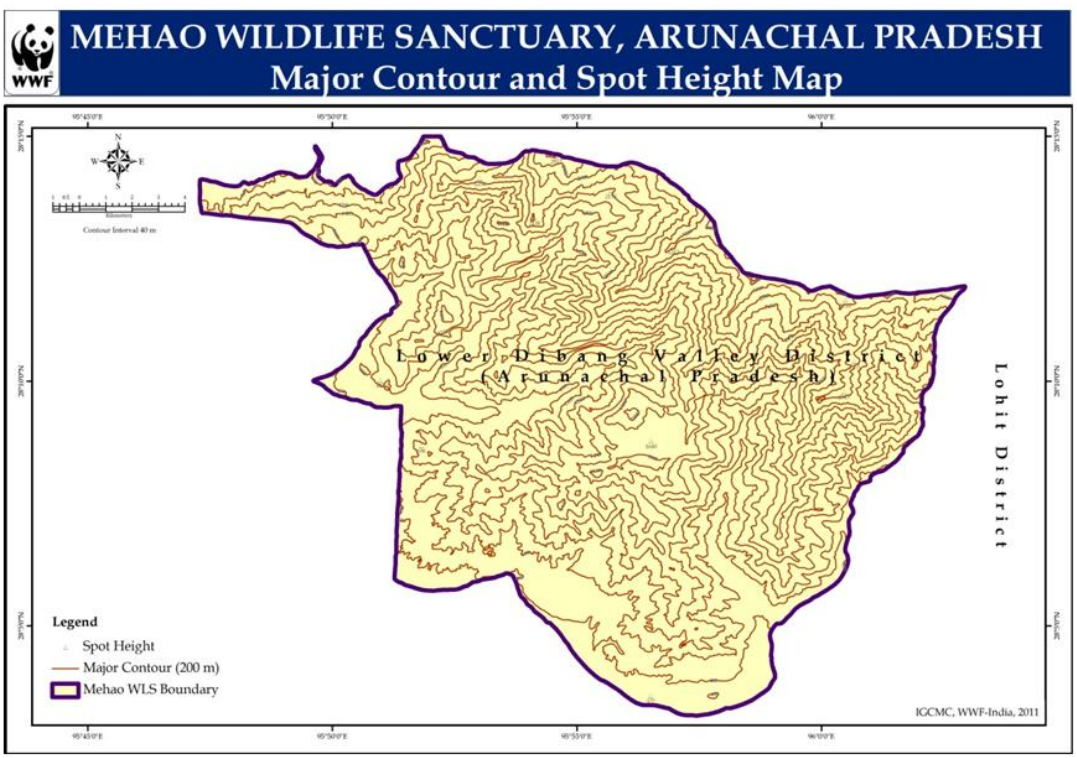

Fig. 3. Major contour and spot height map

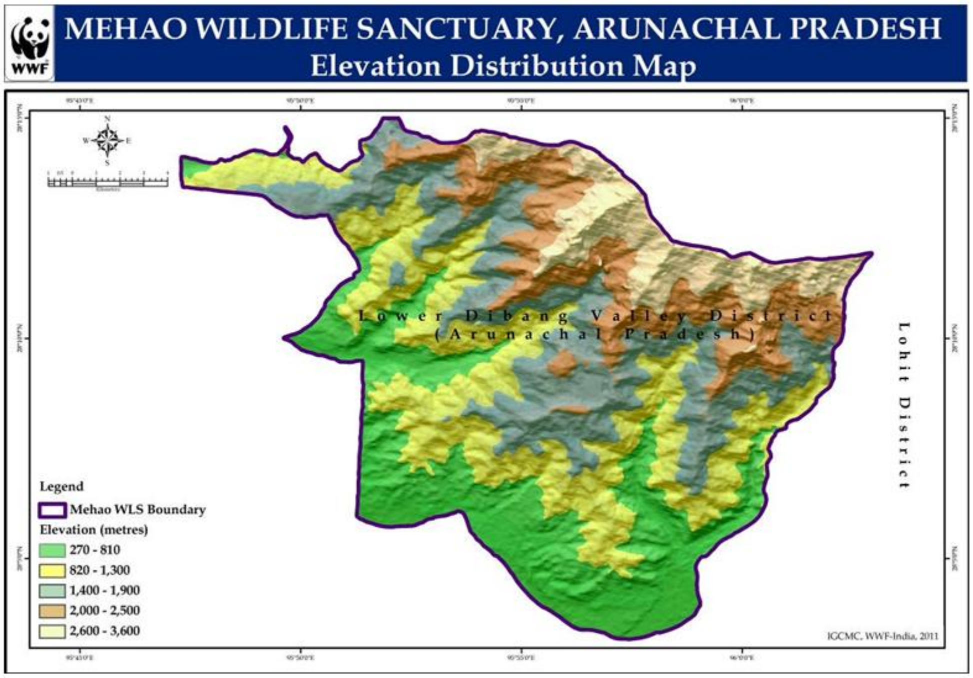

Fig. 4. Elevation distribution map

4. RESULTS

4.1 Mapping of LULC

To derive the LULC map (Fig 5), the classification was based on the density as well as type of vegetation found in the area. Four broad categories were defined namely Dense forest, Open Forest, Scrub land and non forested area. All forest cover with 40% and above density of canopy has been referred as Dense forest, forest cover with 10-40% density of canopy has been referred as Open forest, the degraded forested lands having canopy density less than 10 percent are Scrub land. Non-forested area includes riverbed, water and cultivated areas. The maximum area was under dense forest i.e 149.10 sq.km, whereas open forest and scrub land cover 80.30 sq. km and 47.82 sq.km respectively as shown in the area statistics (Table 1).

Table 1. LULC area

S.No.	Particular	Area (SQ.KM)
1	Dense Forest	149.10
2	Open Forest	80.30
3	Scrubland	47.82
4	Cultivated Areas	3.69
5	Riverbed	7.96
6	Water	2.54

4.2 Vegetation Type Mapping

Based on the satellite image interpretation and field survey, vegetation type map (Fig. 6) was classified into Sub-tropical Broad-leafed forest, Tropical Evergreen forest, Bamboo, River, River-bed, Cultivated areas, Alpine forest, Mixed Coniferous forest and Temperate Wet Evergreen forest.

Literature reveals that *Terminalia Myriocarpa, Altingia Excelsa, Terminalia Bellirica, Jalauma Phellocarpa, Abizzia Lucida, Michelai Champaca, Messua Ferra, Dillenia Indica, Castanopsis Indica, Bischfia Javanica, Magnolia species, Ailanthus Grandis, Kedia Calycina, Bombax Ceiba, Schima Wallichri, Ficus Altissima*, etc are the main associate tree species in Tropical Evergreen Forests [16].

Further the common associate tree species in Sub-Tropical & Temperate Forests are *Ainusnepalensis, Populus Amblei, Castanopsis Indica, Castanopsis Spicate, Quercus Griffithi, Quercus Amellosa, Bbetula Ainnides, Albizia Mollis, Michelia Species, Magnolia Species* etc. [16]

Whereas in Temperate Conifer Forest, the main associations are *Tsuga Abies, Pinus Roxburgii, Texas Baccata, Texas Abies, Lanx Griffithiane Forests, Picea Abies Forest and gregarious bamboo forests* [16].

The maximum area was under temperate wet evergreen forest i.e 74.38 sq.km, whereas mixed coniferous forest cover 62.45 sq. km as shown in the area statistics (Table 2).

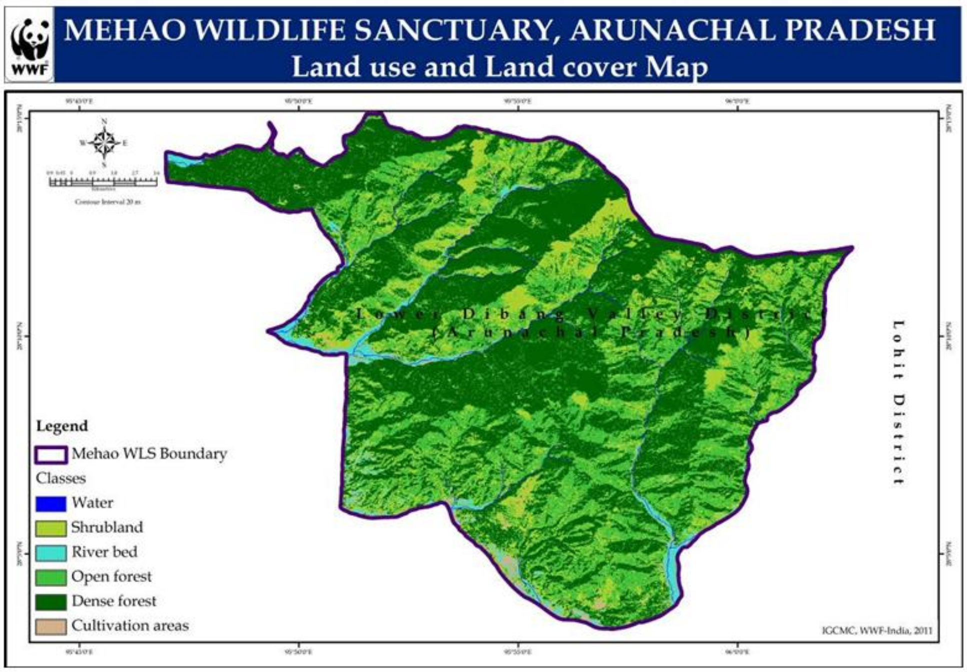

Fig. 5. LULC Map

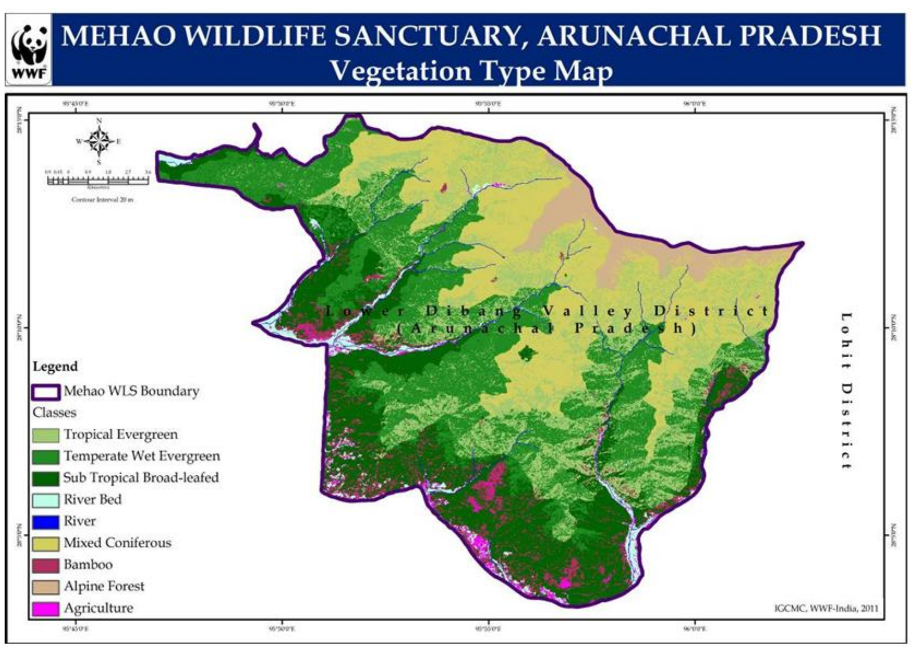

Fig. 6. Vegetation type map

Fig. 7. Degraded forest in sanctuary, picture taken during field visit on 14th – 19th February, 2011

Table 2. Area statistics

S.No.	Particular	Area (SQ.KM)
1.	Sub Tropical Broad-Leafed Forest	59.80
2.	Tropical Evergreen Forest	52.98
3.	River	2.54
4.	Riverbed	7.96
5.	Bamboo	15.04
6.	Agriculture	3.69
7.	Alpine Forest	12.57
8.	Mixed Coniferous Forest	62.45
9.	Temperate Wet Evergreen Forest	74.38

5. CONCLUSION

Basic information of the Wildlife Sanctuary is an essential prerequisite for developing effective management and conservation Plan. In this regard, studies have shown that geospatial tools i.e RS/GIS provides a cost effective tool. This WLS is pristine untouched forest area with not much human interference except on southern boundary line where there are human settlements. The deforestation for agricultural purpose has greatly disturbed the original habitat of the species. The water retention capacity of the forest floor is affected due to jhum cultivation (Fig. 7). Habitat destruction is occurring as a result of plantation activities being taken up by the residing population; wherein local species of fruit bearing trees are being planted in place of native forested areas. Further Digital Elevation Model was also generated using the digitized contour lines with an interval of 40 m to analyze the altitudinal variations in topography. It was found that the elevation ranges from a minimum of 270 m to a maximum 3600 m. The highest elevation (2600 m – 3600 m) occurs in the northern portion. Other elevation ranges can be seen in the central part of the sanctuary. This spatial database developed for WLS can be further used in advance modelling studies like predicting forest fire zones in order to have early warning systems in the area. This will help in devising management plans for PAs which are more rationale to maintain the biodiversity.

ACKNOWLEDGEMENTS

We take this opportunity to thank Mr. Ravi Singh and Dr. Sejal Worah from WWF-India for giving us the encouragement to carry out this study and for their able guidance. Special thanks to National Remote sensing Centre (NRSC) Hyderabad for providing the satellite imageries; to the Ministry of Environment, Forest and Climate Change for funding this project, and to anonymous people who have directly and indirectly helped us in completing the project within the sanctioned timeline.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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(Accessed 23 May 2018)

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/26480