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LAND USE LAND COVER MAPPING OF MOULING NATIONAL PARK IN ARUNACHAL PRADESH, INDIA USING GEOSPATIAL TOOLS

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Abstract: Land use land cover mapping using geospatial tools is an area of interest that has been conducted for proper management, planning and monitoring of natural resources. This paper attempts to map land use land cover of Mouling National Park in Arunachal Pradesh. Knowledge of this little explored region is grossly inadequate and necessitates its detailed exploration. It is therefore crucial to create spatial database that can contribute to the conservation of its unique natural resources. The study uses IRS LISS III satellite imagery of the period 2010. Images were classified using hybrid classification. ERDAS Imagine and Arc GIS software have been used in the study. The result showed that the national park is mostly covered with temperate broad leafed forest covering area of around 730.79 sq.km. Further the spatial database developed can be used for mapping and formulation of conservation and management plans.

Keywords: Land use, land cover, Mouling National Park, Arunachal Pradesh, Hybrid classification, natural resources.

Introduction

One of the most important natural resource which embodies soil, water and associated flora and fauna is Land. The growing pressure of population coupled with increasing demands made on land resources have brought extra pressure on the available land (Rao et al., 1990). Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures. It is defined as the assemblage of biotic and abiotic components on the earth's surface and is one of the most crucial properties of the earth system. Land use refers to man's activities and the varied uses which are carried on over land and includes agricultural land, built up land, recreation area, wildlife management area etc (Fresco 1994). Land use Land cover (LULC) pattern is the result of anthropogenic interaction with the natural environment. Information on LULC is necessary for effective management and planning of the resources for sustainable development (Alphan 2003; Muttitanon et al. 2005). For sustainable utilization of the land ecosystems, it is

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essential to know the natural characteristics, extent and location, its quality, productivity, suitability and limitations of various land uses. LULC assessment is one of the most important parameters to meaningfully plan for land resource management. The knowledge of spatial land cover information are assuming increasing importance in various resource sectors like agricultural planning, settlement surveys, environmental studies, planning and monitoring of natural resources (Zhu, 1997).

The biological importance of North-east region (NER) which is one of the biodiversity hotspots of the world of India is recognised, although the region remains deficient in baseline, area-specific biological data (Van Dijk et al., 1999). Climatic features of the region have created natural boundary making it abode for number of endemic species, providing profusion of habitats featuring diverse biota. The biodiversity of NER is under threat due to a number of factors such as planned infrastructure development, changing socio-economic patterns, and other external pressures. It is therefore crucial to map the LULC which can contribute to the conservation of its unique natural resources. Geospatial tools has been used for environmental monitoring including forest cover and is helpful to obtain data on land use/land cover for inaccessible dense forest on mountains. The present study aims to obtain the information on the land use land cover pattern in Mouling National park (NP) in Arunachal Pradesh which includes major portion of Eastern Himalayas, using remote sensing and Geographic Information System (GIS).

Study Area

Mouling NP (Fig 1), one of the two national parks in the state of Arunachal Pradesh is situated in Upper Siang district of the state in the Eastern Himalayas phyto-geographical province (Singh et al., 2005). The park forms the eastern part of the Dihang-Dibang Biosphere Reserve. The park was created in 1986 with an area of about 483 sq km. The name Mouling has been derived from the highest peak named Mouling as per local faith and belief.

The word Mouling has got a lot of curiosity among the people. As far as etymology is concerned it is an “Adi” word, which means red poison, derived or extracted from a plant, which is found in the park area only. The genetic and ecological features of NP are one of the unique and classic examples of the wide bio-diversity of eastern Himalayas. The richness of flora and fauna is perhaps unparallel and such characteristic genetic and ecological diversity is a very rare phenomenon.

(http://arunachalforests.gov.in/Mouling%20National%20Park.html).

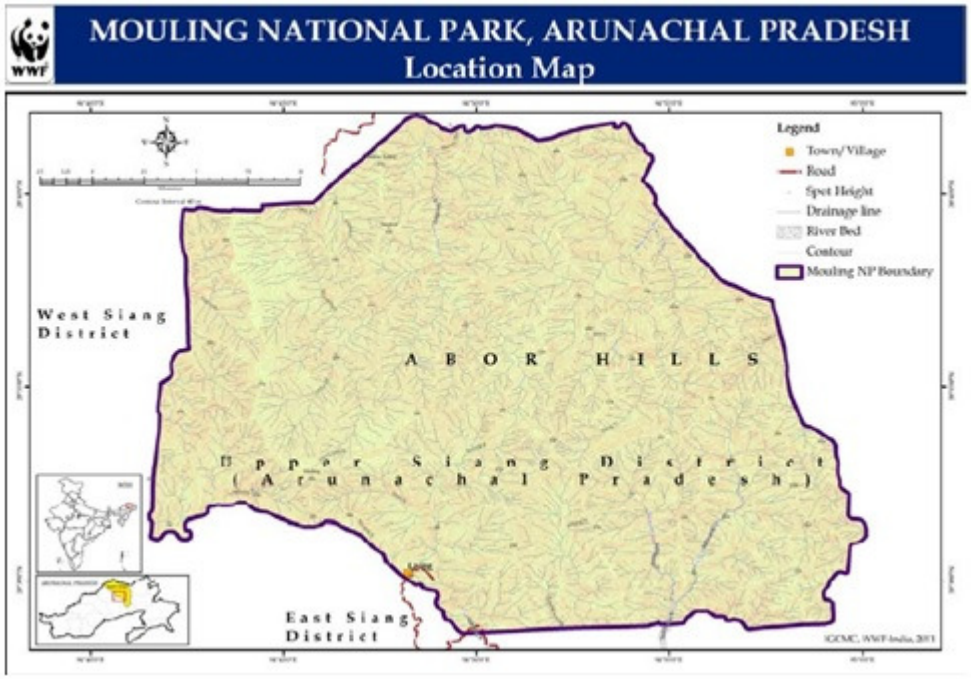

Fig 1: Location Map of Mouling NP

NP is characterized by rugged mountainous terrain with sharp cliffs. The altitude ranges from 600 m to 3064 m. The entire national park is irrigated by a number of perennial brooks and streams. Thirteen major perennial streams flow down the slopes of Mouling ranges and all voids in the mighty Siang River (Sen and Mukopadhyay, 1999). The Siang river is an imposing feature in the landscape, and carves deeply through high, rugged mountains (which peak at 4593 m) creating a valley as low as 300 m in the vicinity of the park. The steep valley slopes are well drained by a number of fast flowing streams (Birand and Pawar, 2004). In the lower altitudes, temperature ranges between 15°C to 38°C, winter snowfall is experienced in higher altitudes. Temperature varies from 4°C to 17°C at altitudes ranging from 2200 m onwards. Maximum amount of rainfall is received during May to October during the south-west monsoon season, which is about 80% of the total annual rainfall. Nearly 15% of rainfall is received during winter months from December to March. Humidity levels remain high throughout the year and ranges from 60% to 80%.
(http://arunachalforests.gov.in/Mouling%20National%20Park.html).

The low to middle altitudes in the valley, and along the tributaries of the main river, are dominated by tropical wet evergreen and semi-evergreen forests, tending towards wet sub-tropical broad-leaved and temperate forest at the upper reaches. The vegetation along streams is moist and luxuriant, with moss-laden trunks and branches. Patches of canes and wild

bananas abound especially along the streams. Much of the protected area supports undisturbed primary forest, albeit with some disturbance at the fringes, mainly in the form of cane extraction (Birand and Pawar, 2004). Very thick cane and bamboo brakes along the wet banks of the streams at lower altitudes and high water current and unpredictable drainage load in these streams are a source of major hindrance in approaching the park (Sen and Mukopadhyay, 1999).

Methodology

The project intended to generate spatial database relevant to the management of National Park which include maps showing classified vegetation, land use/land cover, major contour and spot height, elevation distribution (maps enclosed in Figure 2 to 5). Satellite data was acquired and interpreted (visually/digitally) to generate such maps. The interpretation has been fully supported with adequate ground truth. Vegetation strata observed on satellite image was verified on the ground for accuracy assessment. The Survey of India (SOI) 1:50,000 scale topographic maps have been used for preparing the baseline data viz. drainage, road network, settlements including village boundaries, forest divisions, range, block and compartment boundaries, location of forest offices, chauki/post offices and other relevant features. The topographic maps were procured from the respective Forest Departments. In addition protected area management maps from Forest Department was used as ancillary data, especially for tracing administrative boundaries, such as division boundaries, range boundaries, block boundaries and compartment boundaries which were digitized and converted into digital format for overlaying. All the maps have been converted into digital format and overlaid on the same scale.

Indian Remote Sensing satellite IRS-P6, LISS-III data for December 2010 was procured from National Remote sensing Centre (NRSC) Hyderabad. The satellite was launched in October 2003 and the life of the mission has been planned to be five years. The payload system of IRS-P6 consists of three solid state cameras, viz. a high resolution multispectral sensor (LISS-IV), a medium resolution multispectral sensor (LISS-III) and an Advanced Wide Field sensor (Awifs). 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.

Thematic data extraction from satellite imageries

ERDAS Imagine image processing and Arc GIS software have been used in the study. ERDAS Imagine was used for digital image processing and for extraction of land use/land

cover classes. Geometric correction was done to correct geometric distortions due to sensor, earth geometry variations and conversion of the data to real world coordinates (e.g. latitude and longitude) on the earth's surface. The satellite imagery was geometrically rectified with reference to the geo-referenced topographic maps and vector data. Classification was done using a hybrid method, where by 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.

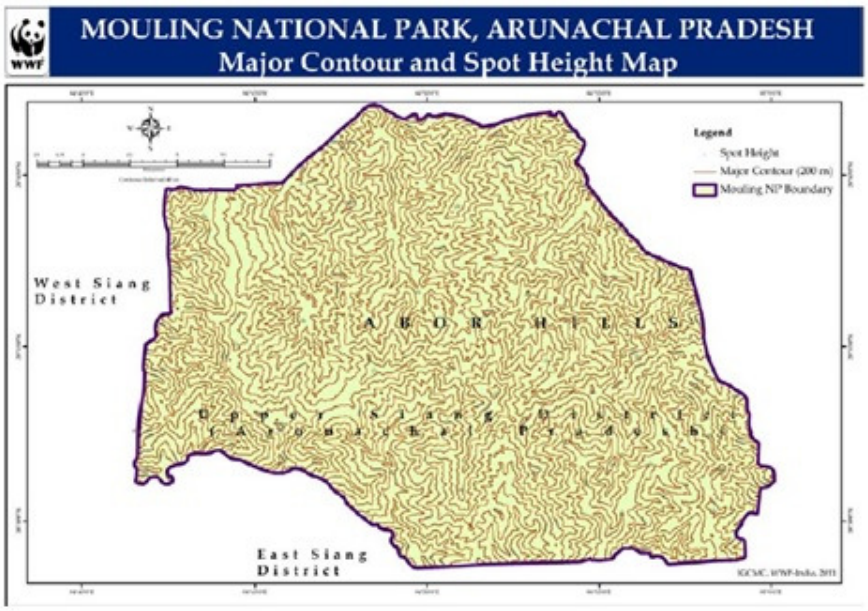

Fig 2: Map depicting major contours and spot height

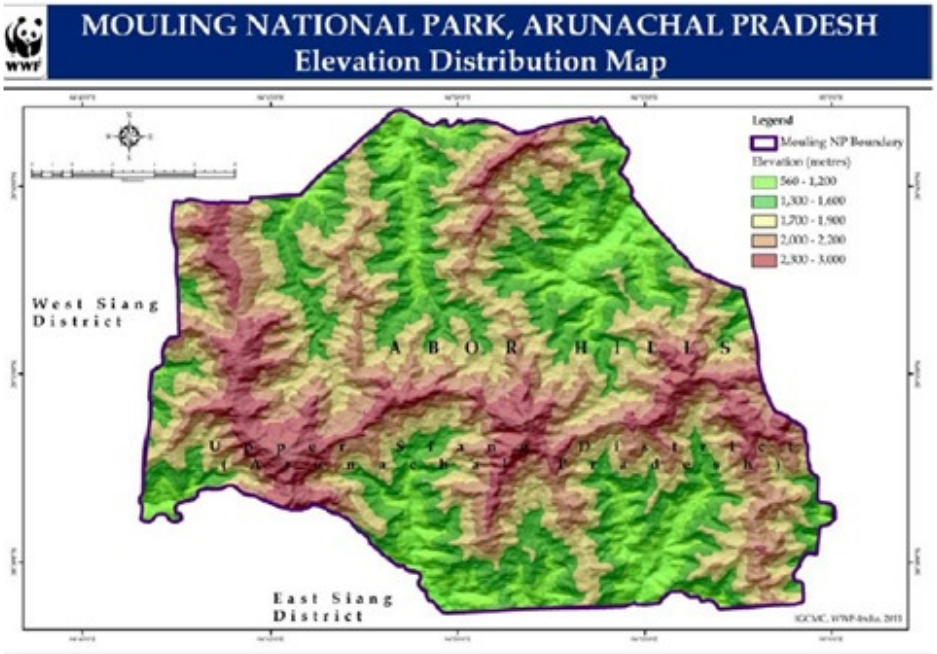

Fig. 3: Map depicting Elevation Distribution in NP

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.

RESULTS

Land use land cover mapping: The term land cover is distinct from land use despite the two terms often being used interchangeably. Land use is a description of how people utilize the land and Land cover is the physical material at the surface of the earth. The LULC map (Fig 4) of the national park has been classified in terms of density as well as type of vegetation found in the park area. The area was classified into Dense forest, Open Forest, Scrub land and non forested area. Dense forest refers to all lands of forest cover having a canopy density of 40 percent and above, Open forest refers to lands with forest cover having a canopy density between 10 – 40 percent, Scrub land are degraded forested lands having canopy density less than 10 percent. Non-forested area includes land without any kind of forest cover, in this case the nonforested areas derived are river and alpine grassland. Area statistics (table 1) shows that the maximum area was under dense forest i.e 250.62 sq.km, whereas open forest and scrub land cover 149.39 sq. km and 78.89 sq.km respectively..

Table 1: LULC area in Mouling NP

S.No.	Particular	Area (sq.km)
1	Dense Forest	250.62
2	Open forest	149.39
3	Scrubland	78.89
4	Alpine grassland	40.47
5	River	5.11

Fig 4: Map depicting Land Use/Land Cover Map

North east region practice the culture of jhum / shifting cultivation wherein the forests patches are burnt resulting in forest fires which has become a threat to biodiversity in north eastern states. It can have unwelcome consequences, and can't be ignored. Literatures reveal that the cycle of shifting cultivation in Northeastern states was reduced from 25–30 years to 2–3 years breaking the resilience of ecosystem and increasingly deteriorating. With the population increase in Northeastern states along with decrease in land-man ratio at an alarming rate, the jhum cultivation has lead to destruction of forest wealth. One important aspect for preventing future fire disasters is the level of awareness that can be gained by an early warning system. These maps can be used as inputs in identifying the forest fire prone areas and hence developing early warning system. Further Digital Elevation Model (DEM) analysis was carried out and it revealed that lowest elevation (560 m – 1200 m) occurs in the northern and southern part of the park. The highest elevation (2300 m – 3000 m) occurs in the central portion of the National Park and also in the north-eastern and extreme eastern part. Most part of the park lies in the range of 1700 m – 1900 m (27%) while least area falls in the highest elevation category of 2300 m – 3000 m, which is only 12% of the total area. Nearly 24% and 23% of the area falls within the 1300 m – 1600 m and 2000 m – 2200 m range, respectively.

Vegetation type mapping: Vegetation cover mapping was also done to document the vegetation status of the area. These data can be useful in future monitoring and assessment. Vegetation type map (Figure 5) was classified into Tropical Evergreen forest, Sub-tropical Evergreen forest, Temperate Coniferous forest, Water, Bamboo forest, Alpine forest, Temperate Broad-leafed forest, Temperate Wet forest. Sen and Mukopadhyay, 1999 has reported that the notable species include *Terminalia myriocarpa, T. Citrina, Altingia excelsa, Canarium strictum, Albizia sapium,Chukrasia tabularis, Tooan ciliata, Cinnamomum glanduliferum, Musa spp., Quercus spp., Betula alnoides, Bambusa pallida and Calamus erectus.* Area statistics have been given in table 2. Vegetation pattern in the study area is influenced strongly by altitude, slope, aspect and other climatic factors. Maximum area is covered with tropical broad leafed forest with 730.79 sq.km and temperate conifer forest with 256.30 sq.km. Area statistics also reveal that the 54.65 sq.km is covered by Bamboo forests.

Table 2: Area statistics

S.No.	**Particular**	**Area (sq.km)**
1	Tropical Evergreen forest	86.50
2	Sub tropical evergreen forest	79.90
3	Temperate conifer forest	256.30
4	Water	415.06
5	Bamboo	54.65
6	Alpine	165.89
7	Temperate Broad leafed forest	730.79
8	Temperate wet forest	75.93

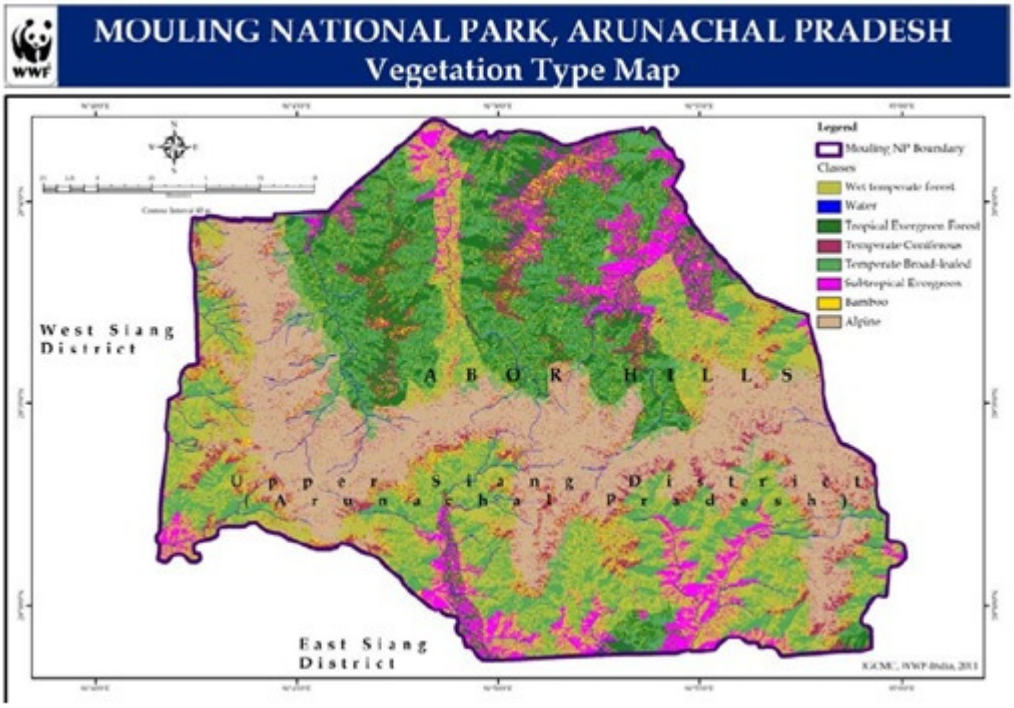

Fig 5: Map Depicting Vegetation type of NP

Conclusion

Knowledge of this little explored region is grossly inadequate and necessitates its detailed exploration. It is therefore crucial to create spatial database that can contribute to the conservation of its unique natural resources. This study has been classified as per the major land use /land cover types. The project has demonstrated the utility of LISS III satellite images in land use/landcover and infrastructure mapping of inaccessible, rugged terrain. It is helpful for further macro and micro level planning. Satellite data in association with GIS provides cost effective tool for mapping and formulation of conservation and management plans. There are various threats to the National Park like changing land use pattern by conversion of prime forest areas to agricultural purposes, shifting cultivation, hunting (survey team recorded several incidences of hunting of different wild animals by different local community) and extraction of non-timber products like cane, bamboo and medicinal plants. The changing demographic patterns of local communities may lead to newly emerging pressures on the national park. This spatial database can be further used to understand the underlying ecological dynamics impact of human pressure on changing vegetation patterns of NP and thereby providing better land management options for maintaining its unique richness of biodiversity.

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