

## Quantifying the dynamic changes of landuse and landcover in Neil Island, Andaman and Nicobar, India

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### ABSTRACT

The present study aims at assessing the dynamics of land use land cover change of Neil Island in Andaman using remote sensing and GIS. Survey of India (SOI) toposheet (1979) was used to prepare the base map. Geocoded satellite imageries 1D LISS III (1998) and IRS – P6 LISS III (2010) on 1:50,000 scales were visually interpreted based on image characteristics. The image characteristics were studied using interpretation keys. Neil Island covers a total area of 18.90 sq. km. and a shore length of 18.6 km. It possesses various resources such as forests, corals, mangroves, creeks, sandy beaches and agricultural lands. The present status of these resources is as follows: Coral reef has an areal extent of 402.03 ha. km., sandy beaches cover 21.60 ha., mangroves have an areal extent of 5.27 ha., reserved forests cover 959.03 ha., and settlement with agricultural land covers an area of 350.98 ha. Coral reefs and mangroves are extremely productive ecosystems with a rich biodiversity. While the fringing reef of this island has decreased by 17.00 ha., the mangrove forests exhibit a decreasing trend with a loss in area of 2.64 ha. Sandy beach area has increased by 10.12 ha., This study shows many of the resources are on the decline and change in the landuse. Thus this study reveals that GIS and remote sensing are extremely useful tools for assessing LULC within limited time durations.

**Keywords:** landuse/landcover mapping, GIS, Remote sensing, Neil Island, landuse dynamics

### 1. Introduction

Land use and land cover (LULC) is an important component in understanding the interaction of the human activities with the environment. Land use refers to man's activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land classification (NRSA, 1989). Information on land use/land cover in the form of maps and statistical data is very important for spatial planning, management and utilization of land. According to Thomas (1956) humans have altered the natural environment, land use and land cover is dynamic in nature and is an important factor for the comprehension of the interaction and relationship of anthropogenic activities with the environment. Increasing population growth with unsustainable resource use is a major factor responsible for change in landscape pattern. The information generated on landscape change and configuration help to analyze global ecological and environmental change (Lunetta, 1998). Population growth and human activities in Neil Island important factor that cause LULC change environmental degradation. The rapid population growth has resulted in increase of agriculture lands at the expense of forest. The aim of this study is to produce a land use land cover map of Neil Island at

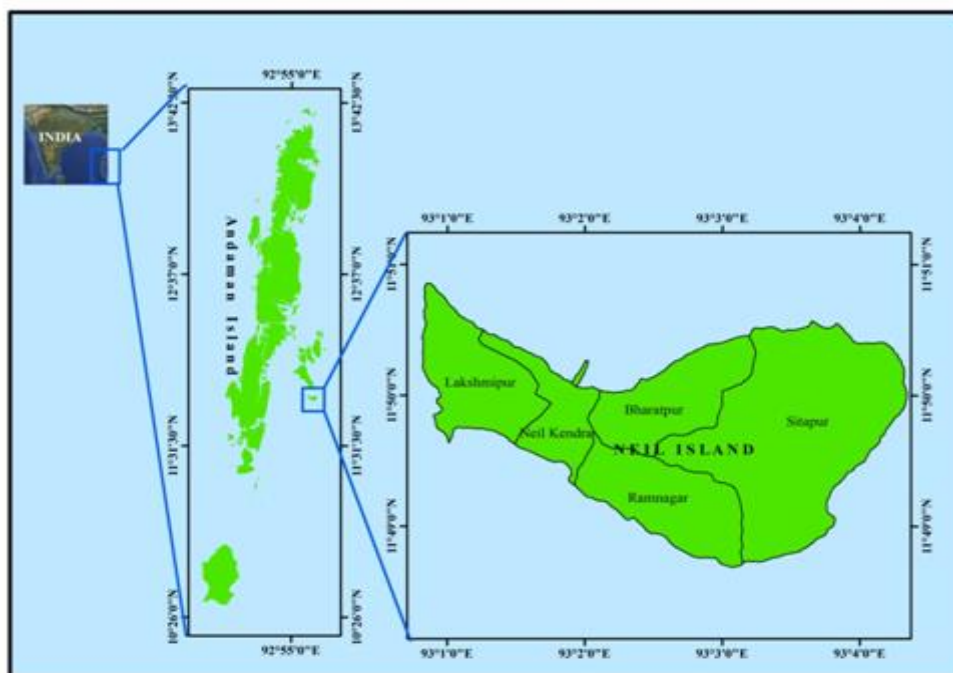
different epochs in order to detect the changes that have taken place particularly in the built-up land and subsequently predict likely changes that might take place in the same over a given period.

## 2. Literature review

Knowledge of the nature of LULC change and their configuration across spatial and temporal scales is consequently indispensable for sustainable environmental management and development (Turner et al 1994). Remote sensing technology is principally appropriate for mapping environmental phenomena such as land use and land cover as field-based mapping is practically difficult, remote sensing observations provide continuous monitoring across varied spatial and temporal scales (Gibson and Power, 2000). Application of remotely sensed data made possible to study the change in land cover in less time, at low cost and with better accuracy (Kachhwala, 1985) in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval (Star et al. 1997; Chilar, 2000). Blaschke et al., (2001) has emphasized the need to measure landscape dynamics quantitatively by incorporating landscape pattern and change from satellite image analysis. National spatial databases enable the monitoring of temporal dynamics of LULC these kinds of databases primarily important for accounting of natural resource planning (NRSA 2005). Monitoring the dynamics of landuse results both were changing demand of increasing population and forces of nature acting to shape the landscape ( Zubair 2006).

## Study area

Neil Island covers a total area of 18.90 sq. km. and a shore length of 18.6 km. and it was extending between 11°48' 27" N and 11°51' 03" N latitudes and between 93°00'43" and 93°04'29" E longitudes. The island is located 40 kilometers north-east of Port Blair, the capital of Andaman and Nicobar Islands.

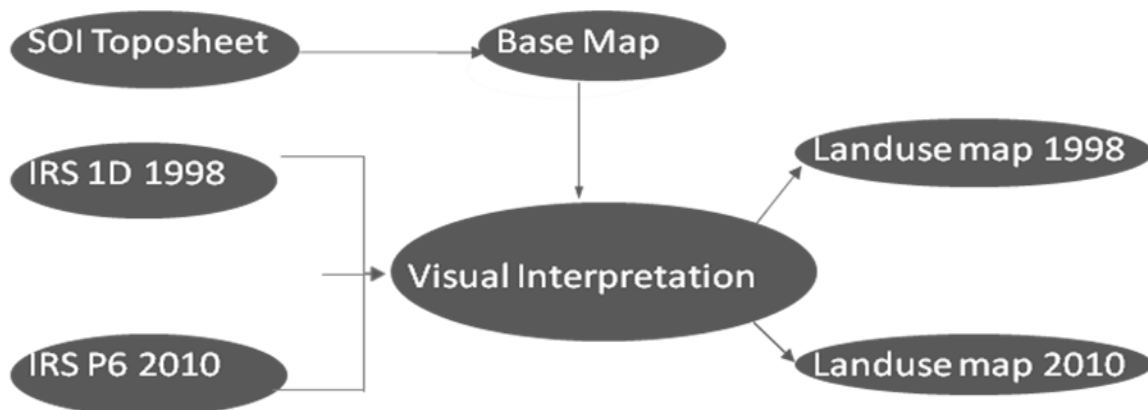


**Figure 1:** Study area

Agriculture is the primary occupation of the villagers, and the island supplies vegetables to the rest of Andaman. It possesses various coastal resources such as forests, corals, mangroves, creeks, sandy beaches and mudflats. This Island has the beautiful beaches at Lakshmanpur, Bharatpur, Sitapur and the natural bridge formations on the seashore are the main tourist attractions in Neil Island. Neil Island is flatter with less forest cover. Increasing agriculture activity and tourism causes changes in landuse landcover pattern of this Island.

### 3. Methodology

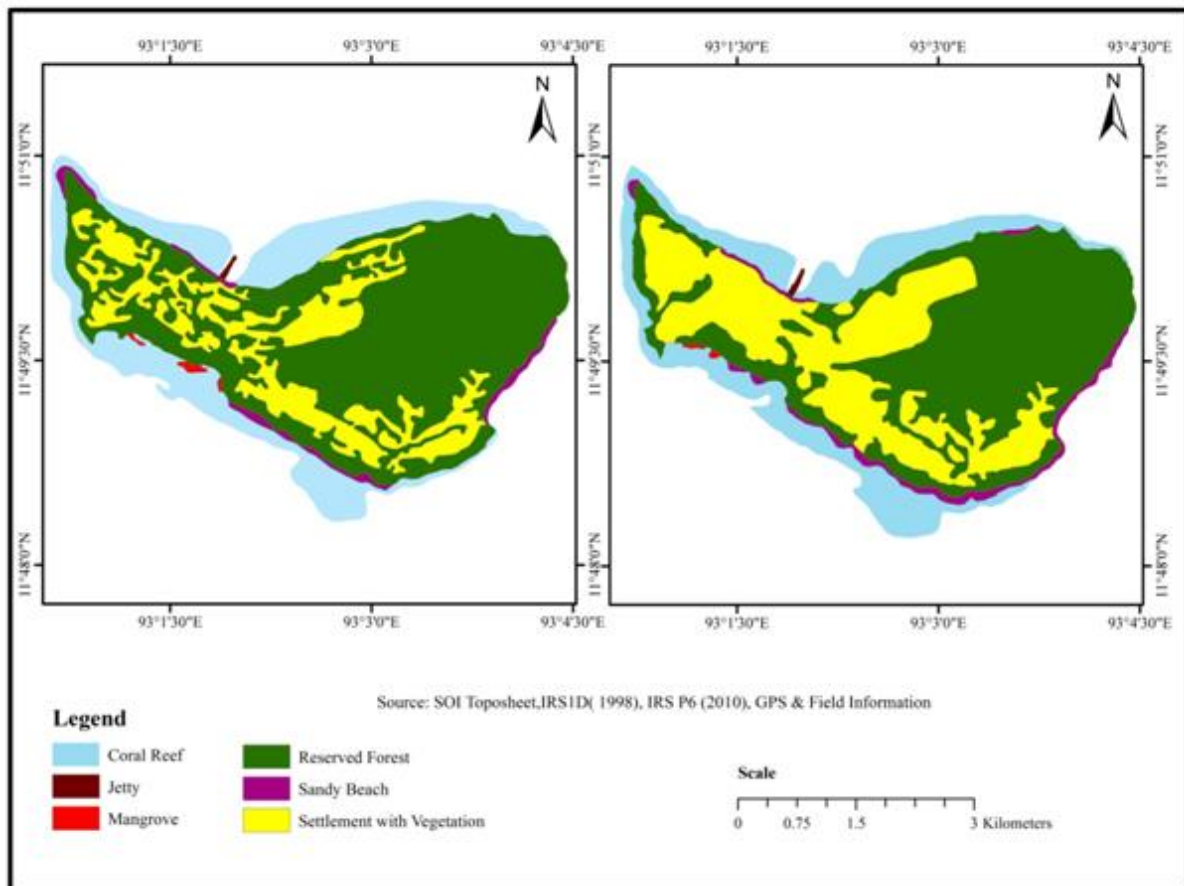
Satellite data processing, information extraction and Geo-registration with toposheet were done by ERDAS IMAGINE 9.1. Base maps were created from SOI toposheet and they were used for co-registering the satellite data. The satellite data were interpreted based on the visual interpretation keys like tone, texture, size, shape, pattern, association etc. as per the classification system given by Space Application Centre (SAC 1992). Visual interpretation is still one of the most widely used methods for detecting or identifying the spatial features on an image (Lillesand and Kiefer, 1994). Landuse/ landcover map was generated for multi date satellite images. Change detection analysis for landuse was carried out using Arc GIS 10 software. Ground truthing were conducted through GPS to access the accuracy of visual interpretation.



**Figure 2:** Methodology

### 4. Results and discussion

The beautiful Neil Island is a vegetable bowl of Andaman. It is inferred from satellite image this Island covers total area about 18.90sq.km and it possessing various natural environmental features such as forest, coral reef, sandy beach and mangroves. The landuse/ landcover change map from the year in between 1998 to 2010 were prepared from the two period satellite images (fig. 2). It is inferred from landuse map that the western part of this island is prominent in settlement cover. The human intrusion is more due the agriculture activity. The coast zone of this island has shallow feature. This is favor for the distribution of coral reef around this Island.



**Figure 2:** Statures of Landuse/ landcover

#### 4.1 Statures of Landuse/ landcover

##### 4.1.1 Mangroves

Mangroves in Neil Island are the most sensitive and fragile ecosystem may be affected by coastal environmental change including sea level rise and hydrological variations. Mangroves are diverse groups of plants which are adapted to wet saline habitat and evergreen trees and shrubs. (Tomlinson 1986). Mangroves are multi use ecosystem which act as a bio-shield to many coastal communities from natural calamities such as coastal erosion, cyclone and storm surges etc. and provides nursery ground for fish prawn and crabs (Twilley 1985, Moran et al. 1991, Kathiresan 2000). The mangroves were identified by its bright red tone and its irregular shape from the satellite image. Interpretation of satellite data shows that 7.91 ha. mangroves in 1998 were decreased to 5.27 ha. in 2010 (table 1). Which shows very insignificant change (- 2.64 ha.) mangroves were degraded due to coastal activities such as tourism development, timber cutting from mangroves and tidal fluctuation in Neil Island.

##### 4.1.2 Coral reef

The coral reefs are plays a vital role in a ecosystem because they protect the shore and also provide a breeding ground for diverse group of marine organism. It is well known fact that the coral reefs are economically important and providing up to 25% of total catch of fish. Coral reefs found around the coast are fringing type and are attracting tourist towards this Island. There are patches of fringing reef found along the western and southern coast of the

Island. The coral reef was colonized about 419.03 ha. in the year of 1998 and it was decreased to 402.03ha. in the year 2010. The corals were mainly affected by agriculture runoff and sedimentation. The siltation decreases the health of the coral reef. Destructive fishing and the runoff coming from agriculture land in the Island are led to destruction of coral reef. (Sarang Kulkarni et al. 2001)

#### 4.1.3 Reserved forest

Forests play an important role in protecting hill environment and preserving the natural resources. Overwhelming population pressures, practicing of unscientific agriculture methods are the prime cause for deforestation. Forest Land generally can be identified rather easily on high-altitude imagery and it was identified by its red tone, irregular shape and smooth texture. The reserved forest was decreased to -31.06 ha. It was 990.09 ha. in the year of 1998 and 959.03ha. in 2010. The extraction activities of timber coupled with increasing population has led to deforestation and converted into agriculture lands.

#### 4.1.4 Sandy beach

Sandy beaches are the product of waves interacting with the shoreline. Beaches are located between the lowest low tide level and a landward limit. Beaches consist of accumulated, unconsolidated sediments transported to shore and molded into characteristic forms by wave generated water motion. The sandy beaches are extensively developed along north and southern part of study area except at some places. Lakshmanpur, Bharatpur, Sitapur were the beaches well developed which attracts many tourist. Sandy beach is found as thick white patch and smooth texture in the satellite imagery. The sandy beach was increased to 21.60 ha. in 2010 from 11.47 ha. in 1998 it shows 88.20 % (fig.2) rate of increase in between the ten years.

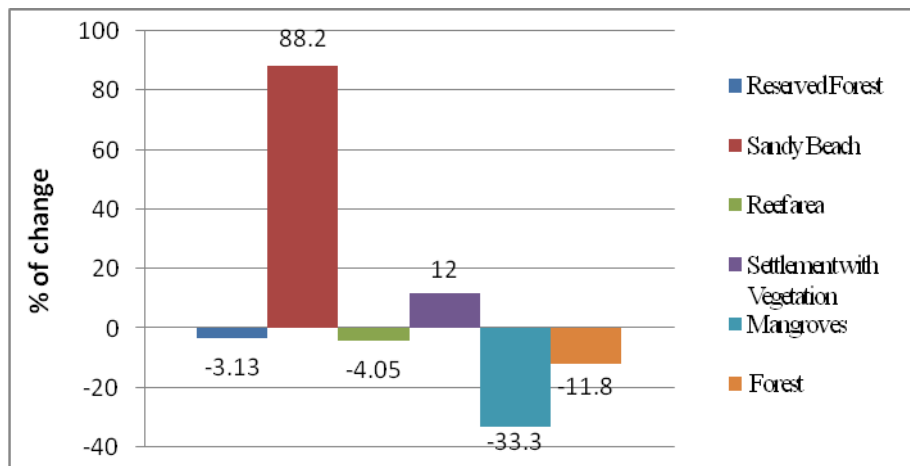
#### 4.2 Settlement with agriculture land

The total population of Neil Island was 2463 according to 1991 census and in 2001 census it was increased to 2800. Neil Island has a population density of 130 p/sq.km. The highest population recorded in the village is Neil Kendra. Agriculture occupies sizeable area; vegetable are the major agriculture crops. The settlement with agriculture land was identified with its light yellow tone and irregular shape in satellite data. Settlement with agriculture land was 313.32 ha. in the year of 1998 and it was increased to 350.98 ha. in 2010. The increasing population has gradually encroached upon reserved forests especially on the western part of Neil Island. The main economic activity of the people in Neil Island is agriculture. Therefore an increase in population automatically witnessed an increase of 37.66 ha. in the agricultural area in the year 2003.

**Table 1:** Coastal Land use/Land cover changes

| Class                       | Area in ha (1998) | Area in ha (2010) | Change in area(ha) | % Change |
|-----------------------------|-------------------|-------------------|--------------------|----------|
| Reserved Forest             | 990.09            | 959.03            | -31.06             | -3.13    |
| Sandy Beach                 | 11.47             | 21.60             | +10.12             | +88.20   |
| Reef area                   | 419.03            | 402.03            | -17.00             | -4.05    |
| Settlement with Agriculture | 313.32            | 350.98            | +37.66             | +12.00   |

|           |      |      |       |        |
|-----------|------|------|-------|--------|
| Mangroves | 7.91 | 5.27 | -2.64 | -33.30 |
| Forest    | 3.85 | 3.39 | -0.46 | -11.80 |



**Figure 3:** Graph showing % of change in resources in 2010

## 5. Conclusion

Landuse change pattern analysis provides insight into the ecosystem functioning and its impacts. Remote Sensing and GIS technology is vital tool for continuous observation and quantification of environmental phenomena. The present study is based on analyzing landuse pattern change using onscreen visual interpretation with the help of multi dated satellite data IRS 1D LISS III (1998) and IRS – P6 LISS III (2010). Neil Island has undergone outstanding changes in various landuse categories; it provided useful analysis for the landuse/ landcover change from 1998 to 2010 for a span of twelve years. It was observed that as a result of rapid settlement development and expansion of agriculture land led to reduce the percentage of reserved forest. Forest and Mangroves were decreased for about 11.8% & 33.3% respectively. There is a significant change observed in sandy beach it was increased to 88.2% in the period of twelve years it was observed 11.47 ha. in 1998 and increased to 21.60 ha. in the year of 2010. The observation in the reef area also shows decreased about -4.05%, the fishing activity in the reef area and the runoff coming from the agriculture land led to the destruction of the coral reefs. The changes quantified using remote sensing and GIS technologies shows critical adverse and undesirable environmental impacts. Therefore an effective sustainable land management policies and practices are needed to avoid the endangering of the environment and sustainable development.

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