Application of Remote Sensing & GIS in Land use Land cover Mapping of Mangaluru city, Karnataka

A case study in and around Mangaluru City

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Abstract— Remotely sensed data is one of the most important data source for land use land cover change trajectories over the past 30-40 years. These data's are recently playing an important role in the study and assess of the resources in any part of the world. The anthropogenic changes in land use and land cover often assumed to be identical but they are rather quite different. Land cover may be defined as the biophysical earth surface which is natural, while land use is often shaped by human, socio-economic and political influence on the land hence it is artificial. Remote sensing (RS), integrated with Geographical Information System (GIS), delivers an effective too for analysis of land use land cover changes at regional level. The RS and GIS holds the potentials for time and cost effective assessment of land use and land cover since it is an geospatial technology. This technique has been widely used for generating valuable information on vegetation type, vegetation cover, water bodies and land use changes. Hence in this study RS and GIS was opted to study land use land cover of Mangaluru city, Dakshina Kannada District, Karnataka, India. This study covers an area of 160km2 that falls between 12°50'N – 12°57'N lat. and 74°48'E – 75°00'E long. By the results it was clearly seen that city was expanding at a rapid rate. The built up area covered approximately half the study area i.e., 68 km^2 and other classifications like water bodies, dense forest, mixed forest and barren land covered 8 km^2, 10 km^2. 26 km^2 and 7 km^2 respectively. It could be understood that the area covered by mixed/dense forest area, water bodies was less and compared to built-up area.

Index Terms—Land use, Land cover, Mangaluru, Remote Sensing and GIS.

1 Introduction Study Area

When the earth is viewed from space we can understand the influence of man's activities on his natural resources over several years. In situation of rapid and often unrecorded land use change, observations of the earth from space provide objective information of human utilization of the region. The natural, social – economic factors and land utilization by man decides the land use/land cover pattern of the region. Due to the increase in population, agriculture and demographical pressure land is becoming a scarce resource to us [1]. Land use/land cover mapping and identifying the changes has become an important sector in current strategies for managing natural resources and monitoring environmental changes. Hence there is a need of regular study on land use/land cover its factors and effects on environment.

The expansion of residential and industrial area to rural area at periphery of urban areas is has been considered as a sign of regional economic vitality. Because of these changes there is degradation of air and water quality and loss of vegetation and forest land. The urban growth also have socioeconomic effects like economic disparities, social fragmentation and infrastructure costs. Due to these activities there have been imbalance in various ecosystem processes ad functions. Climate change is one of the serious issues which are caused due to increase in greenhouse gases and surface albedo effects [2-3].

Proper scientific planning has to be adopted for sustainable development. The multidisciplinary scientific surveying techniques are carried out nowadays to quantify the resources and the area availability to study the status of exploitation of resources. The investigation method is decided by various parameters starting from the funds availability to the environmental suitability [4]. Keeping this in context the thematic maps prepared on resources will enable the planners to formulate programs and decide the method for respective program based on the data available through it. It can also be used to initiate measures to correct imbalances due to unscientific management and planning.

The study was conducted on Land use and Land cover since it is one of the main driving forces of global environmental changes. Current technologies such as remote sensing and GIS provide a cost effective ad accurate alternative to understand landscapes dynamics. With the invent of this techniques, land use/cover mapping has given a useful, economical and detailed way to improve the selection of areas designed to agricultural, urban and/or industrial areas of a region [5]. Digital change detection techniques based on multi temporal and multi – spectral have a great potential in understanding land use/land cover mapping and monitoring differences over time irrespective of casual factors [6].

2 STUDY AREA

The study area Mangalore region is located at Dakshina Kannada District of the Karnataka state, India and lies in between Arabian Sea towards west and Western Ghats

mountain range towards east side. The study area has river as boundary in three sides. It extends between 12○50' N – 12○57' N latitude and 74○48' E – 75○00' E longitude and covers an area of 160 km2. The study area has humid hot temperature with annual mean maximum, minimum and average temperature at 36.6, 20.1 and 28.3°C. The average rainfall in this region is about 4030mm per year. The region has a total population of 9,95,623 as per 2011 census.

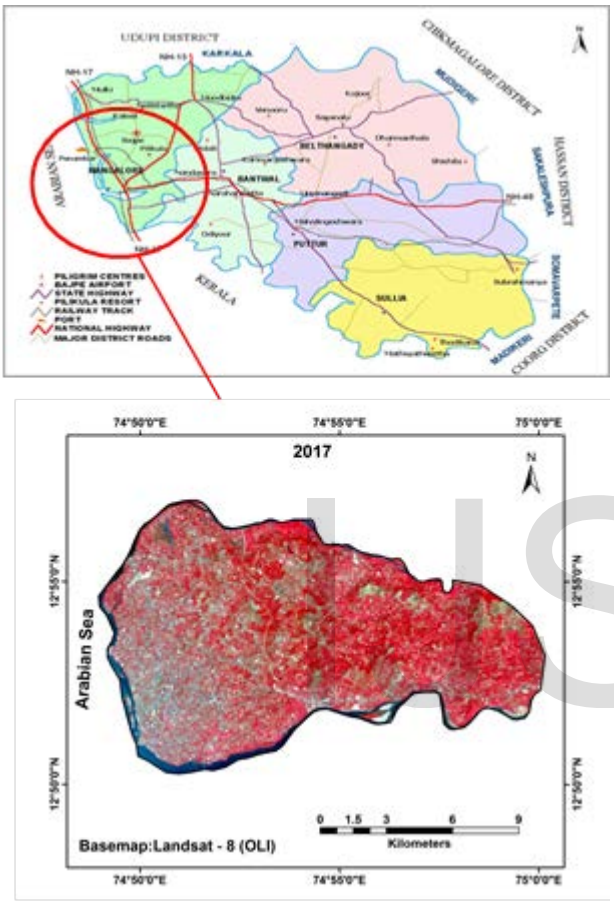

Fig. 1: Study Area Mangalore, Dakshina Kannada District.

3 MATERIAL AND METHODOLOGY

Various primary and secondary data's were used in this study. It includes Survey of India (SOI) topographic sheets of 1:50,000 scale and Landsat Thematic Mapper at a resolution of 30m for the year 2017 was used for land use/land cover classification. The study area is covered by Landsat-8 scene 146/51 (path/row) for January 2017. The image was downloaded from Earth Explorer USGS image database (Landsat Imagery Archive). The solar elevation angle was 63.13 degree and cloud cover less than 10%. ArcGIS software was used for processing, analysis and integration of spatial data to reach the objective of the study. Along with these data adequate field checks were made before finalizing the thematic maps.

The supervised classification is the most common method in obtaining land use/land cover information. The satellite image of the study area was classified using ERDAS Imagine. The existing analogue boundary was converted into digital format through digitizing using ArcGIS 9.2 application software. The types of land use/land cover categorization developed in this study can be related to system for classifying land capability, vulnerability to certain management practices, and potential for any particular activity or land value, either intrinsic or speculative.

The step by step approach (methodology) taken to achieve the objective of this study are as shown in figure – 2.

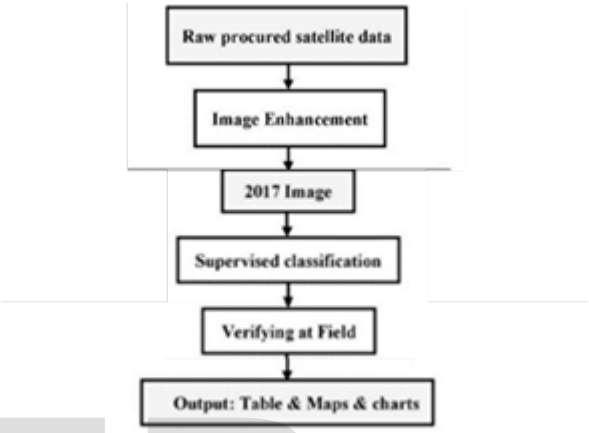

Fig. 2: Methodology Flowchart

4 RESULTS AND DISCUSSION

Detailed account of the land use/land cover of study area are described as follows:

Table I: Classification scheme used for preparing the decadal land use and land cover datasets

Level - 1	Level - 2	Description
Built-up	Built-up(both urban & rural) BU	Urban, rural, residential, and industrial areas.
Agriculture	Crop Land	These include agriculture area delineable on satellite images in different seasons and the areas which are primarily agriculture but may be fallow.
Mixed Forest	Shrub land (SL)	Stunted height degraded forest.
	Grass Land (GL)	Land covered with grasses, notified or otherwise.
	Permanent wetland (PW)	Water saturated area having land-water interface.
Dense Forest	Forest (FO)	Included evergreen broad leaf forest (EBF), Deciduous Broad leaf forest (DBF), mangrove forest (MF).
	Plantation (PL)	

		Primarily commercial plantation outside forest, protected areas and wild-life sanctuaries.
Barren Land	Barren Land (BL)	Rocky or exposed rocky areas, Soil filled surfaces.
	Mining (MN)	Mining areas
Water bodies	Water bodies (WB)	Surface water delineable on satellite data in the form of river, lakes, pond, reservoirs/dams, canals.

Based mainly on International Geosphere Biosphere Program (IGBP)

1. Built-up Area: Due to an exponential increase in population over the years, there has been a significant need for construction of buildings and land cover. Frequent observations on the built-up land indicates that there have been a lot of change as compared to the data taken prior the current interval [7]. Current data show us the increase in urban growth and development, especially rural places being urbanized residentially and commercially which also indicates vitality of the regional economy under observation. This rapid increase in population has resulted in changes that are not required in the landscape and may pose risk to the environment under observation. This results in significant depletion in the green cover which includes forestlands, cropland including water resources. Urbanization and development rate is dependent on the consumption of natural resources and land in the area under observation. It also is dependent of the scrublands and other areas of active agricultural practises [8]. Using Remote Sensing and GIS, planning and determination of results can be done and rather than tackling the issues placing urban life, presumptuous approaches should be implemented.

2. Agricultural Land: One of the most vital and indispensable source for all countries, developed or undeveloped, economic development and food securities are directly dependent. Data from satellite feed is very helpful to analyse crop plantation yield and agricultural strategies. Land cover data is very helpful to monitor increasing cropland growth and comparison between hyper spectral and multispectral image processing methods give faster results of optimized crop recognition and categorization. In Mangalore, random scattered growth in the population number along with unpredictable development has resulted in a disproportionation of urban land and agricultural land, the latter being steadily on the decline.

3. Forest: One of the most vital players in preserving environmental instrumentation, Forests maintains the nutrient cycle and also maintains the concentration of carbon through modulation of gasses in the atmosphere. Forests also are a part of economy through the various products such as wood, fibres, food and other raw materials. It supports many major and minor Ecosystems within and has always helped positively in the growth of human society. Exercising non sustainability and irresponsibility in consumption of forest resources has led to degradation of environment. Detection of such activities using vegetation maps give helpful data for biodiversity conservation planning and which on analysis can help flora and fauna from dangers of over-exploitations. Vegetation mapping is also applicable for region where no sustainable shifting cultivation is present.

5. Water Bodies: Studying the arrangement of the streams, rivers and drainage patterns formed, we can get useful inferences on the regulation of rocks and its structures. Water and land resource management employ sustainable land and water resources with minimal effect on the environment. Coastal areas are generally more active and changing as compared to other areas. Since it is finite, implementation of sustainable practices are necessary as they bear high importance due to concentrated population, resource degradation and ecosystem productivity [9]. Stable production and growth should be assumed for protection of coastal areas and since they are a non-renewable resource, rules should be developed for its protection. They are also damaged by various natural disasters like tidal storm formations, cyclones resulting in loss of human and economy.

6. Barren Land: They are one of the natural resources whose data and information can be used for various recovery measures and implementation of social activities like agroforestry, social forestry and afforestation. Diplomatic procedures are followed\d for data collection of barren lands since there are no limiting boundaries and structures defined for barren lands and areas. In such areas, illegal loggings, extended colonization, subsistence farming are some of the major factors behind the land cover modifications in the area under observation over the years. This fact highlights the requirement for assessment and regulation of human activities and adoption of sustainable methods of forest management activities by analysing the data and taking proper measures. It will also be immensely valuable if government that possess such data share with academic, research and non-profit institutions for further analysis and use.

After the image classification it could be clearly describe the area coverage of various classification parameters. To begin with built up area that cover approximately half the total area was 68 km^2 (43%). It was clear indication for the increase in residential and industrial area in the study area. Dense forest, Mixed forest and cultivation land was 10km^2 (6%) 26 km^2 (16%) and 39 km^2 (25%) respectively. Water bodies might have reduced from past decades due to over demand of resource it covered around 8.02 km^2 (5%) of the total area. Due to rapid growth of construction work or vacant spaces the barren area was 7.7 km^2 (5%) of total area. This statistic is represented by a pie chart shown in figure – 3.

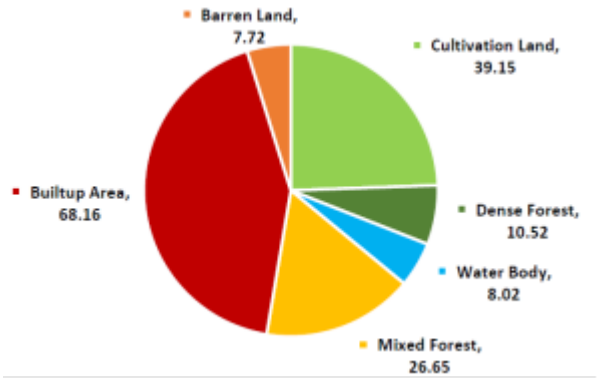

Fig 3: Pie chart of Area coverage of various classifications.

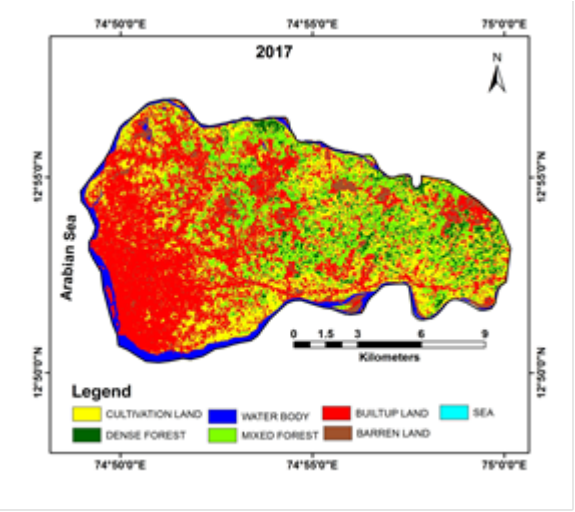

Fig 4: Classified image of study area.

The area coverage of the various classification with percentage of area is represented in table 2. It clearly indicates the built up area is more than any other classification. Water bodies and barren land are the least area covered in the study area. Some area there still prevails agricultural practices so it covered around 39.15km² of the area.

These results obtained were the clear indicator of rapid urban growth in Mangaluru City. As there is growth in built up area i.e., urban growth there will be gradual decrease in agricultural area and vegetation area which will lead to imbalance in ecosystem. It may also cause severe problems for the environment like climate change, urban heat island, quality of air and water may also reduce due to various other connecting factors. Appropriate sustainable urban planning has be adopted by looking into the results obtained by such studies.

Table – II: 2017 Area coverage (km²)

Classification	Area (%)	Percentage (%)
Cultivation Land	39.157	24.44
Dense Forest	10.521	6.57
Water Body	8.028	5.01
Mixed Forest	26.656	16.63
Builtup Area	68.166	42.54
Barren Land	7.729	4.82

The figure – 4 shows us the classified image of study area for seven various classification parameters. Different colours were used to represent the classifications.

5 CONCLUSION

The classification procedure followed in the study was as per major land use/land cover types. The Indian Remote Sensing Satellite (IRSS) data, image processing and Geographical Information System techniques were used to identify the land use land cover categories such as built-up area, dense forest, mixed forest, water bodies, cultivation land and barren lands. The satellite image in combination with topographic sheet of Survey of India were used for analysing land use and land cover detection. This will help in micro and macro level planning. Urban development resulted in environmental deterioration; consequently it reduces the space occupied by the vegetation, water bodies and cultivation. Settlement expansion, subsistence farming and illegal logging are the major factors behind the land use/land cover changes observed in the study area. This findings highlights the need for comprehensive assessment of human activities and adaptation of sustainable city planning practices.

6 RECOMMENDATION

High resolution (<5m) satellite data like Quickbird, Worldview, Cartosat and Resourcesat can be used for detailed level-2 or level-3 classification. Also, time series data provide temporal mapping for natural resource management and urban expansion/ encroachment detection. Remote Sensing and GIS technology can be used for the assessment of urban sprawl and urban heat island.

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