International Journal of Engineering, Science and Mathematics
Vol. 7Issue 3, March 2018, (Special Issue)
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Land Use/Cover Mapping for Janjhavathi river basin of Odisha and Andhra Pradesh using Geo-Spatial techniques

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Abstract :

Geospatial technologies offer an efficient and timely approach for mapping because of their wide area coverage, giving information about inaccessible area and timely repetitive coverage of the same area. In this study, on- screen visual interpretation was made to classify the land use/land cover particularly for the Janjhavathi river basin which lies in between the latitudes of $18^0$45" to $18^0$61" 30' North and the longitudes of 83^0 to $83^0$29" East. The identified land use / land cover features are agriculture, barren land, built-up area, dense forest, open forest, scrub forest, scrub land, gullied land, waste land, wet land and water bodies. Maximum area (37% of the total geographical area of the river watershed) is covered by open forest followed by gullied land and agricultural crop land (16%), deciduous forest (11 %), scrub forest (5%), agriculture fallow land (4%) and vegetation land (2%) while water bodies cover only 1 % of the Total Geographical Area (TGA). Further, an attempt has been made to analyze land use / land cover of Janjhavathi river basin keeping in mind the objective of developing the infrastructure with the available resources for the upliftment of the socio-economic conditions of the areas.

Keywords:

Geo-spatial technology;

Visual interpretation;

Land use/Land cover;
Total geographic area;
Socio-economic;

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1. Introduction:

Man's restless pursuit of progress, comport and security has resulted in an increased stress on the land, because it provides all sorts of food to man as well as it provides the basis of life to terrestrial and aquatic flora and fauna in one or the other [2]. Inventory and monitoring of change in land resources are an essential aspect for accepting of change mechanism and modeling the impact of change on the environment and associated ecosystems at different scales [11]. Information on exiting land use / land cover and its spatial distribution is essential prerequisites for planning of land to maximize the productivity without causing environmental degradation [4].Land use is man's activities and the various uses, which are carried on land; land cover refers to natural vegetation, water bodies, rock/soil etc. Both the terms are related,

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interchangeable, dynamic in nature, provides a comprehensive understanding of the interaction and relationship of anthropogenic activities with the environment [12]. Now a days, advanced geospatial technologies like Remote Sensing, Geographic Information System and Global Positional System are the excellent tools for mapping the land use/cover and provide accurate information to understand the dynamics of land use due to human activities, particularly in inaccessible areas like hilly terrain [3]. Many researchers have carried out the land use / land cover analysis through visual or digital interpretation of satellite data.
LandsatMSS, Landsat-TM and IRS-P6-LISS III satellite imageries are taken to assess the land use and land cover changes through visual interpretation techniques and the detailed analysis was carried for the past 36 years in the Nilgiris district of Tamilnadu State during the periods 1973-2009[5]. Land use/cover using LISSIII sensor data of IRS P6 satellite through visual interpretation and linked to socioeconomic data of submergence area of Polavaram in the state of Andhra Pradesh, India [8]. Critically evaluate the different land use/land cover types spread on different landforms and to study the influence of the physical factors on the type of land use using IRS LISS III of the Chintapalli, Visakhapatnam District, Andhra Pradesh, India [7]. The different types of land use/ land cover categories i.e crop land, dense forest, fallow land, barren rocky land with or without scrub, plantations and water bodies of Madurai district inTamilnadu [1]. The detailed information about the extent and spatial information of various land uses can be useful for effective planning for future by considering the present pattern of land use and factors responsible for its change [9]. Hence, information on land use / land cover is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs, welfare of the people and they can inform decision makers in a timely fashion on land resources utilization.

1.1 Study Area:

Janjhavathi River is a tributary of Nagavali River having a catchment area of 813.91 sq.km and is an interstate river taking its origin from the hilly regions of Narayanpatna tehsil Orissa State, and enters in Andhra Pradesh near Banjakuppa village of Komarada mandal and joins Nagavali River10.00 km upstream of Thotapalli regulator near Gumpa village of Komarada mandal in Vizianagaram district. Most of its catchment laying is in the Odisha state.
The study area falls in the Narayanpatna, Bandhugam, Laxmipur , Rayagada tehsils of Orissa and Komarada mandal of Vizianagaram district in Andhrapradesh. Most of the river basin is covered in the Orissa state. The study area lies between 83^0 to 83^0 29" E longitudes and $18^0$45" to 18^0 61" 30' North Latitudes (shown in Figure 1). The area is covered in the Survey of India toposheets 65M/4, 65M/8, 65N/1 and 65N/5 of 1:50000 scale and are used for delineation and digitization of the drainage basin boundary. Only small part comes on the 65M/4 area topomap and 20% comes on the 65M/8 topomap and the remaining area in the two topomaps of 65N/1 and 65N/5. The Jhanjavati is a small river. It originates from the hilly regions of Narayanpatana tehsil. Covering a winding path of nearly 60 kms within the koraput district of Odisha state, it meets the need of water in that region. A small river, the Jhanjavati and other numerous streams enrich the valleys and land of the districts with green vegetation.

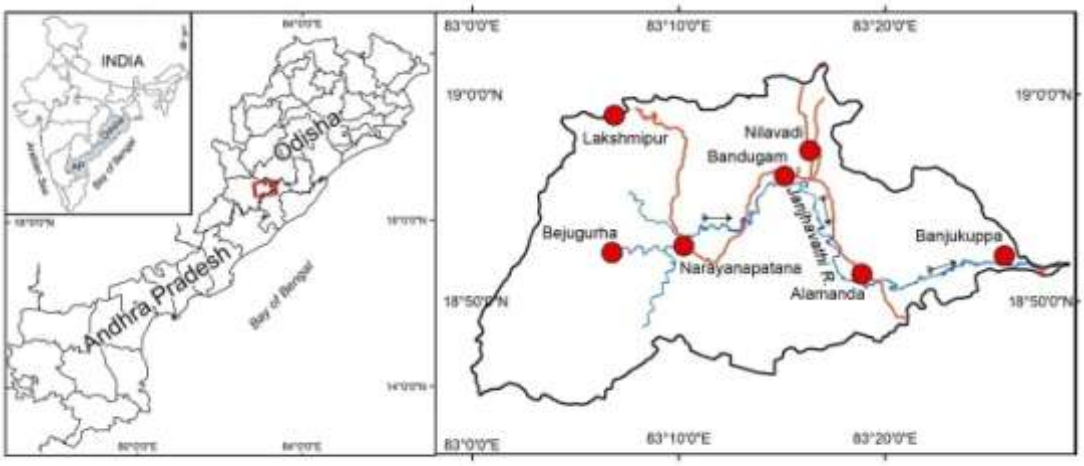

Figure1. Location Map of the Study area

2. Research Method:

The study area covers 4 numbers (65M/4, 65M/8, 65N/1 and 65N/5) of Survey of India (SOI) toposheets on 1: 50000 scale. These toposheets are geo-rectified and projected to polyconic projection (the Metric system units – meters are used as in the present study). The Janjhavathi river watershed boundary map has been scanned and saved in .jpg format and then it is imported into .img format and referenced to polyconic projection using ERDAS IMAGINE software. The study area boundary is digitized and overlaid on mosaic toposheet and demarked the study area boundary on 1:50000 toposheet and verified by ground truthing; necessary corrections were made and checked in the field with the help of GPS. Image processing was carried out for Landsat 5 data of 2012-13 (Subset of the study area shown in Figure 2). After applying necessary image enhancement techniques (Contrast stretching is applied to increase the brightness of the original input image; bringing the features into sharp focus by Histogram equalization; Filter Sharpening which nullifies the effect of high frequency noise present in the input image and produces a smooth image ; LUT (Look up Table) stretch is applied to the image so that even small features like settlements are also seen very clearly) to improve the distinction between the features in the imagery. The land use / land cover features have been precisely captured through onscreen visual interpretation based on basic image characteristics such as size, shape, shadow, location, association, texture, tone/color, pattern and various related features were considered.

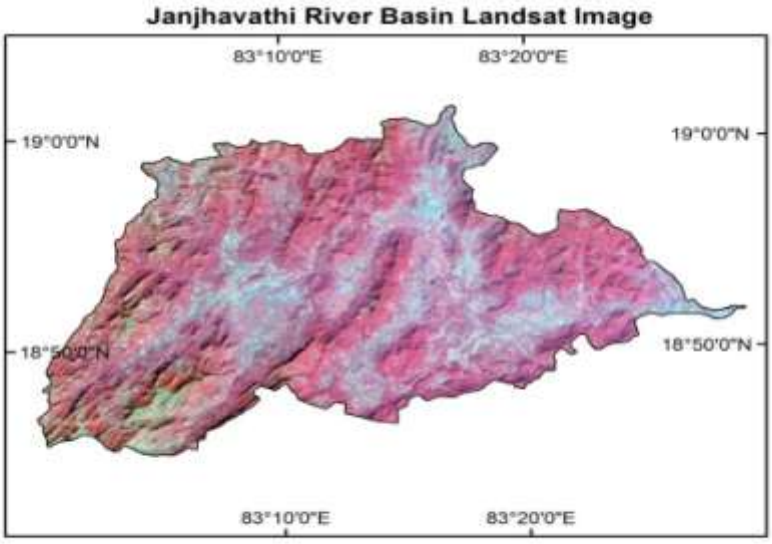

Figure2. Satellite imagery of the study area

3. Results and Analysis:

Distribution of various categories of the land use/land cover derived from the Landsat 5 data of 2012-13 has been identified as agricultural land, barren land, built up land, forest, grass, gullied land, river, scrub land, waste land, wet land and water bodies in the study area (Figure3) and the areal extent of the each category is presented in Table 1.

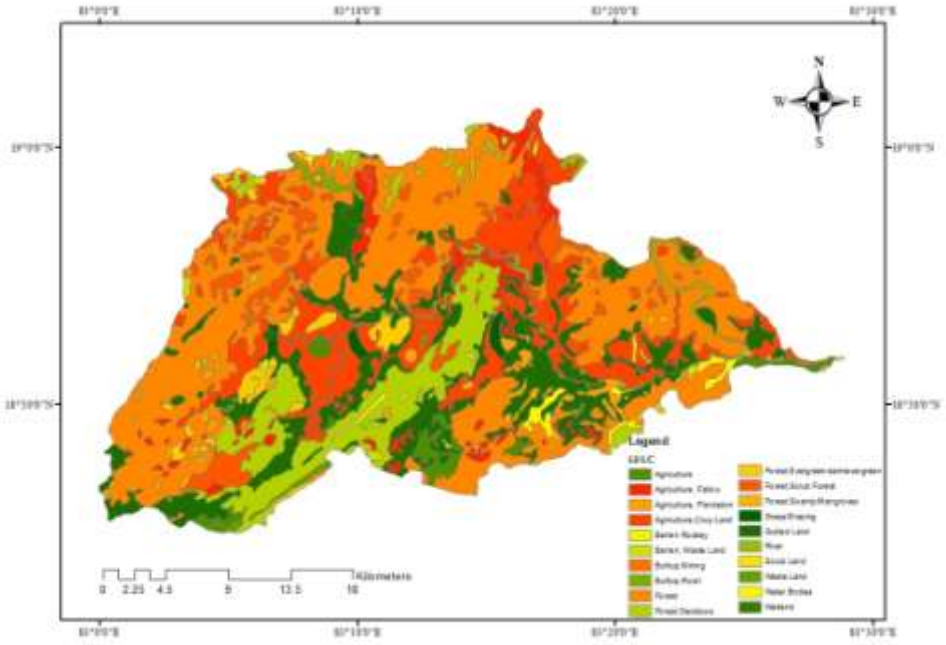

Figure 3: Land use/cover categories from Landsat 5 data, 2011-12 of Janjhavathi river basin

Built-up land

It is an area of human habitation developed due to nonagricultural use and that has as cover of buildings, transport and communication, utilities in association with water vegetation and vacant lands. The study area consists of built-up mining (1.320km^2) and builtup rural (3.83km^2) covering an area 5.15km^2 of the total geographical area of the study.

Forest land

These are the areas bearing an association predominantly of trees and other vegetation types (within notified forest boundaries) capable of producing timber and other forest produce. The deciduous forests include bamboos, palms, tree ferns etc. The forest plantation species mainly include teak, Sal, eucalyptus, casuarina, bamboo etc.This cover includes open forest (303.57 km^2), deciduous forest (88.8564km^2), evergreen/semi evergreen forest (20.765km^2), scrub forest (43.14km^2) and swamp mangroves (0.56km^2). These covered an overall area 456.8914km^2 of the total geographical area of the study.

Scrub land

These lands covered 0.9418 km^2 under scrublands area in the study area. This is a land, which is generally prone to deterioration due to erosion. Such lands generally occupy topographically high locations, excluding hilly/mountain terrain. They appear in light yellow to brown to greenish blue depending on the surface moisture cover and vary in size from small to large having either contiguous or dispersed pattern. Scrublands

are associated with moderate slopes in plains and foot hills and are generally surrounded by agricultural lands.

Agricultural land

These are the lands primarily used for farming and for food production, fiber and other commercial and also horticultural crops. It includes agricultural plantation (like tea, coffee, rubber etc.), horticultural plantation (like coconut, arecanut, citrus fruits, orchards, fruits, ornamental shrubs and trees, veg etable gardens etc) and agro-horticultural plantation. The total area covered under agriculture is classified into agriculture land (13.78 km^2), agriculture fallow land(32.19km^2), agriculture plantation land(12.39 km^2) and agriculture crop land(130.7km^2) which makes about 189.06 km^2 of the study area.

Water bodies

This category comprises areas with surface water, either bounded in the forms of ponds, lakes and reservoirs or flowing as streams, rivers and canals. These are seen clearly on the satellite image in blue to dark blue or cyan color depending on the depth of the water. River covers about 7.3045 km^2 and water bodies cover 11.73210km^2 of the total geographical area.

Barren land

Barren land describes an area of land where the plant growth may be sparse, stunted, and/or contain limited biodiversity. Environmental conditions such as toxic or infertile soil, high winds, coastal salt-spray and climatic conditions are often key factors in poor plant growth and development. Barren land can be categorized depending on the climate, geology and the geographic location of a specific area. The study area is under barren rocky (0.04 km^2) and barren waste land (3.777 km^2) covering 3.817km^2 of the total geographical area of the study.

Grass land

Grass lands are the areas of natural grass along with other vegetation, predominantly grass-like plants (Monocots) and non-grass-like herbs (except Lantana species which are to be classified as scrub). It includes natural/semi-natural grass/ grazing lands of Alpine/Sub-Alpine or temperate or subtropical or tropical zones, desertic areas and ma nmade grasslands. The study area covers about 5.8651km^2 of the total geographic area of study.

Gullied / Ravinous Land

They are the resultant of terrain deformation due to water erosion which occurs widely in all agro-climatic zo nes. Gullies are formed as a result of localized surface run-off affecting the unconsolidated material resulting in the formation of perceptible channels causing undulating terrain. They are mostly associated with stream courses, sloping grounds with good rainfall regions and foothill regions. These are the first stage of excessive land dissection followed by their networking which leads to the development of ravinous land. The study area under gullied land is about 128.9712 km^2 of the total geographic area of study.

Waste land

Waste land is a land that is uncultivated, barren or without vegetation. It is described as degraded lands which can be brought under vegetative cover with reasonable effort and which is currently underutilized and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes. The study area under waste land is about 3.6958 km^2 of the total geographic area of study.

Wet land

All submerged or water-saturated lands, natural or man-made, inland or coastal, permanent or temporary, static or dynamic, vegetated or non-vegetated, which necessarily have a land-water interface are defined as wetlands. The main wetland types include swamps, marches, bogs and fens. Mangrooves are an important sub type of wetlands. The study area under wet land is about 0.30 km^2 of the total geographic area of study.

Table1. Areal distribution of Land Use/Cover from Landsat 5 data of 2012-13

S.No	Land use/cover categories	Area(km^2)
1	Agriculture	13.78
2	Agriculture, Fallow	32.19
3	Agriculture, Plantation	12.39
4	Agriculture,Crop Land	130.7
5	Barren Rockey	0.04
6	Barren, Waste Land	3.777
7	Builtup,Mining	1.320
8	Builtup,Rural	3.83
9	Forest	303.57
10	Forest Deciduos	88.8564
11	Forest,Evergreen/semievergreen	20.765
12	Forest,Scrub Forest	43.14
13	Forest,Swamp/Mangroves	0.56
14	Grass/Grazing	5.8651
15	Gullied Land	128.9712
16	River	7.3045
17	Scrub Land	0.9418
18	Waste Land	3.6958
19	Water Bodies	11.73210
20	Wetland	0.30112234754
Total		813.7300223

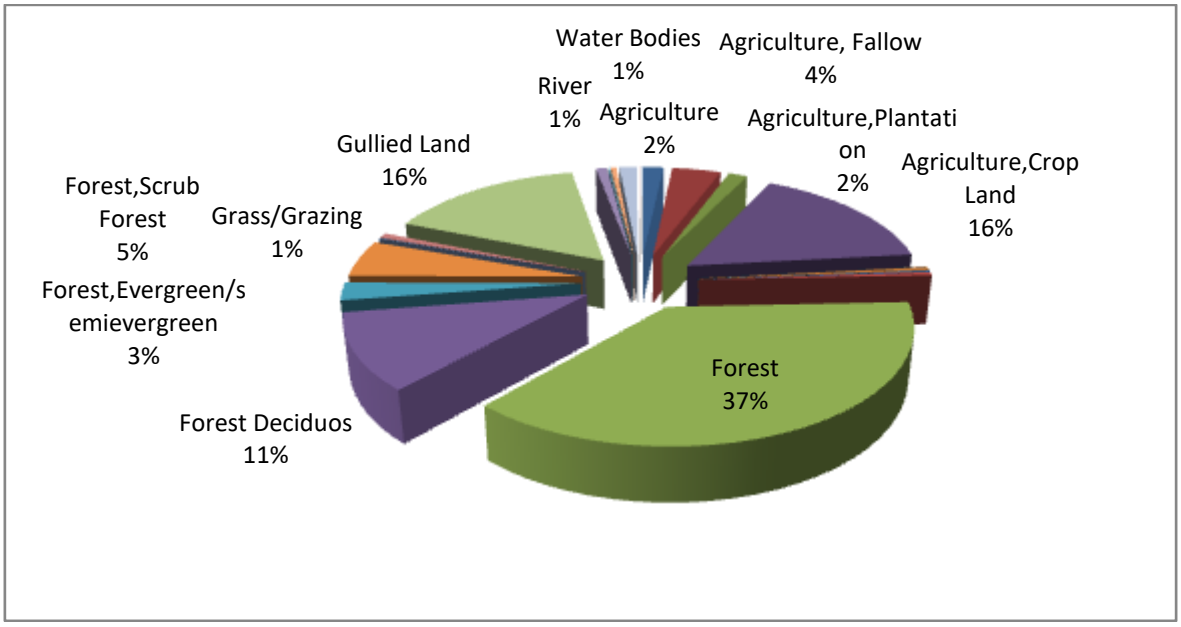

Figure 4: Areal percentage distribution of Land Use/ Cover of Janjhavathi river basin

4. Conclusion:

Land use/ cover mapping provides the baseline for proper understanding of existing land resources for sustainable development to conserve natural resources .It has great significance in scientific research, planning and management . This paper focuses on mapping of existing land use/cover in Janjhavathi river watershed area using remote sensing data and GIS technology. The study reveals that the major land use in the Janjhavathi watershed is forest area (456.8914 km^2) followed by agricultural land (189.06 km^2), gullied land (128.9712 km^2), water bodies (11.73210 km^2), grass land (5.8651 km^2), built-up land (5.15 km^2), barren land (3.817 km^2), waste land(3.6958 km^2) while rest of other cover less than 1 km^2. The results show that the Janjhavathi river basin has an average agricultural potential (24% of TGA) and area covered under scrub land and waste land is 4.6376 km^2 i.e only about 0.006 % (< 1%)of the total geographical area indicating the study area as highly fertile land fit for growing crops like food, fiber, and other commercial and horticultural crops. Further, the study is useful for making preparation of developmental plans, Identification of encroachments in forest land, micro-level planning and implementation of developmental activities with people's participation for socio-economic improvement of these areas.

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