International Journal of Applied Engineering and Technology ISSN: 2277-212X (Online)
An Online International Journal Available at http://www.cibtech.org/jet.htm
2011 Vol. 1 (1) October-December, pp.32-40/Asadi et al.
Research Article

PREPARATION OF AGRICULTURAL CAPABILITY MAP FOR PROPER MANAGEMENT OF LAND RESOURCES USING REMOTESENSING AND GEOGRAPHICAL INFORMATION SYSTEM: A MODEL STUDY

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ABSTRACT
The present study has been carried out Agricultural Capability map for proper management of land resources in nine mandals namely Nakkapalli, Elamanchilli,S. Rayavaram, Achchutapuram, Rambilli, Anakapalle, Munagapaka, Kasimkota, Paravada of Visakhapatnam District, covering an area of 1355 Sq.km. The study area is located between north latitudes 17° 19' and 17° 46'"and east longitudes 82°35' and 83°10' and is covered in the survey of India topographical map numbers 56H65 K/10,11,13,14,15M 65 O/1, 65O/2. The IRS-P6, LISS-IV geo coded Remote sensing Satellite data and the above top sheets from Survey of India (SOI) are acquired for primary analysis. Using Visual Interpretation technique different thematic maps are prepared like base map, drainage map, village Reference map, Physiography map, watershed map, Land use/Land cover map. To prepare these maps field work has been conducted to collect the information from various departments like Agricultural, Irrigation, Ground water board, Bauer of statistics and study of land use patterns ,cropping patterns, soil type information based on the all the above information final thematic maps has been generated. These thematic maps were scanned and digitized using AutoCAD and converted into GIS. Based on the above data Topology is created by linking the spatial data file and attribute data file. GIS overlay analysis derived map of Agricultural use and Capability map has been developed. This kind of studies is very useful for preparation of Land resources Action plan and also useful for the planners decision makers for management and monitoring of Land resources .

Key Words*: Agricultural use and Capability map, Land resources Action plan, Remote sensing, GIS*

INTRODUCTION
The high density of population and industries in the cities lead to allied vehicular, industrial and domestic emissions affecting, adversely the health and property of inhabiting citizens. Keeping the air quality acceptable has become an important task for decision makers as well as for non-governmental organizations. Particulate matter and gaseous emissions of pollutant emission from industries and auto exhausts are responsible for rising discomfort, increasing airway diseases and deterioration of artistic and cultural patrimony in urban centers (Anjaneyulu Y 2001). Emergence of remote sensing as a powerful technology for Mapping and modeling of pollution studies, proper planning, management and monitoring of the pollution status depend on the availability of accurate information. The integration of data generated in the areas of etc. can lead to identification of pollution stress zones having unique combination of characteristics and hence specific suitability in terms of scientific methods to decrease the pollution load without compromising long term action plans for the environmental quality in order to achieve the above-mentioned goal, a baseline environmental study has been conducted within the study area and interpreted with the help of GIS tools (Barrow, Chris). GIS is best utilized for integration of various data sets to obtain a homogeneous composite land development units which helps in identifying the problem areas and suggest conservation measures. This study will set a new trend in the industrial sector with concern for sustainable development and clean environment.

Study Area

The study area is the part of the Visakhapatnam district, one of the nine coastal districts of Andhra Pradesh, is located in the north-eastern part of the State situated adjacent to the coast and where rapid development will take place in terms of industrialization. The study area is located between north latitudes 17° 19' and 17° 46'"and east longitudes 82°35' and 83°10' and is covered in the survey of India topographical map numbers 56H65 K/10,11,13,14,15M 65 O/1 and O/2. The area is under influence for fast development of urban agglomeration and industrial growth with mega industries for petroleum, Pharma parks . The study area is covered in Narsipatnam and Visakhapatnam revenue divisions. The study area is situated along the coastline from Nakkapalli mandal to Paravada mandal where the future development for industrialization will take place. It also includes the Anakapalli, Kasimkota, Munagapaka, Achchutapuram, Rambilli, Elamanchili and S.Rayavaram Mandals. Out of 246 revenue villages, Anakapalle (Class-II) and Elamanchilli (Class-III) are the major towns in the study area. The study area is covered an area of 1314 Sq.Km.

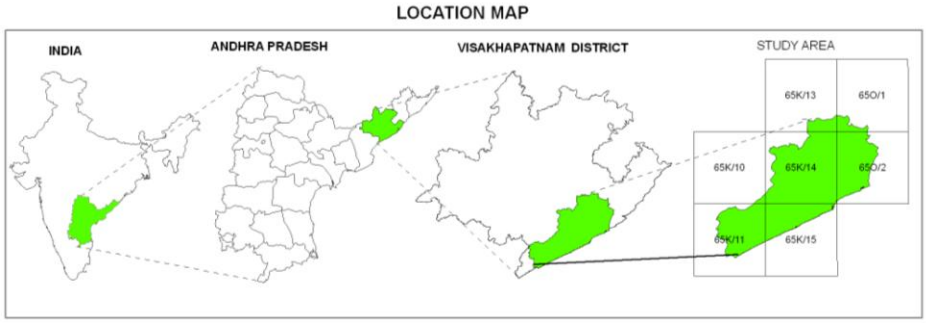

Figure 1. Location map

Study Objectives

1. Preparation of thematic maps using survey of India toposheet and satellite imagery using visual interpretation Technique.
2. Collection of collateral data from different departments and creation of attribute data of thematic maps using GIS tools.
3. Preparation of Agricultural Capacity map.

MATERIALS AND METHODS

Data Used

Different data products required for the study include the65 K/10,11,13,14,15, 65 O/1 and O/2 toposheets which are obtained from Survey of India (1:50,000) and fused data of IRS – 1D PAN and LISS-III satellite imagery from National Remote Sensing Centre (NRSC), Hyderabad.

Database Creation

IRS-ID PAN and LISS-III satellite imageries are georeferenced using the ground control points with SOI toposheets as a reference and further merged to obtain a fused, high resolution (5.8m of PAN) and colored (R,G,B bands of LISS-III) output in EASI/PACE v6.3 Image processing software. The study area is then delineated from the fused data based on the latitude and longitude values and a final hard copy output prepared which is further interpreted visually for the generation of thematic maps. These thematic maps (Raster data) are converted to vector format by scanning using an A0-Flatbed Deskjet scanner and digitized in AUTOCAD 2000. The map is further edited in ARC/INFO and final hardcopy output is prepared using ARC/VIEW GIS software. The methodology adopted for creation of database is given in Fig. 2.

Spatial database

Thematic maps like base map and drainage network maps are prepared from the SOI toposheets on 1:50,000 scale using AutoCAD and Arc/Info GIS software to obtain a baseline data. All the maps are scanned and digitized to generate a digital output was prepared using visual interpretation technique from the fused satellite imagery (IRS-ID PAN + LISS-III) and SOI toposheets along with ground truth analysis.

Attribute database

Fieldwork was conducted and crop, soils information were collected from predetermined locations based on the Landuse/Land cover map of the study area and related Government offices.

Integration of Spatial and Attribute Database

The spatial and the attribute database generated are integrated for the generation of Agricultural Capacity map.The Agricultural Capacity map is determined based on the influencing factors of The procedure involved is preparation of base map, drainage map, village Reference map, Physiography map, watershed map, Land use/Land cover map. The Agricultural Capacity map depicts the areas of High Agriculture use, Medium Agriculture use and Non Agriculture use (CPCB, 1996). The procedure followed for integration of the theme maps to final Agricultural Capacity map is given in the following flow chart.

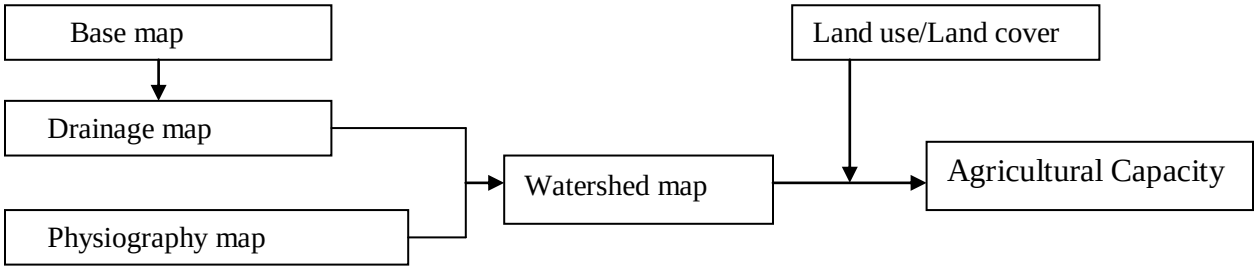

Figure 2: Methodology Flow chart

RESULTS AND DISCUSSION

Base map

A topographic map is a representation of the shape, size, position and relation of the physical features of an area (IMSD Technical Guidelines 1995). The base map is prepared using SOI toposheet on 1:50,000 scale and updated with the help of satellite imagery. It consists of various features like the road network, settlements, water bodies, canals, railway track, vegetation etc. delineated from the toposheet. The map thus drawn is scanned and digitized to get a digital output. The information content of this map is used as a baseline data to finalize the physical features of other thematic maps. Since the topo sheets are very old all the features like roads, railways, settlements etc are updated with the help of rectified and scaled satellite imageries of the area. The major settlements in the present study area are Nakkapalli, Elamanchilli, S. Rayavaram, Achchutapuram, Rambilli, Anakapalle, Munagapaka, Kasimkota, Paravada etc.

Drainage Network map

The drainage pattern in the study area is mostly dendritic to sub-dendritic patterns controlled by fracture (Reddy, P.R., Balu Rao, P. & Prakash Gound, P.V, 1988). The drainage map network of the study area is taken from SOI topo sheets. All the rivers, tributaries and water bodies shown on the toposheet are considered for preparation of the drainage map. Further these water bodies are updated from the latest satellite imageries for delineating the water spread in the tanks, reservoirs and rivers.

Physiography Map

The Physiographic map has been prepared from survey of India toposheets based on countour data. The area is divided into five slope categories.

Very high - hills and hill ranges with very steep slope

High - hills and hill ranges with moderate to steep slope
Medium - undulating land with 3-10% slope
Low - plains with very gentle slope of 1-3%
Very low - plains with 0-1% slope.

In order to prepare the final physiography map these five classes grouped into three classes as Slope correspondingly represent nearly level ground(<1%) very gently slope(1-3%) are categorized as Low physiographic areas, gently to moderate slope (3-10%) area categorized as Medium physiographic area and moderate to sleep slope (10-35%) and very steep slope (above 35%) are grouped in to High physiographic areas. No development is possible in areas of high (10-35%) and very high (>35%) slope categories (Srivastava, V.K. and Mitra, D.1995). due to physical constraints. The Physiography map shows the spatial distribution of hills, hill ranges and plain area of the study area. The study area is occupied an area of 217.1 Sq.km with hills and the undulating land occupied an area of 5.06 Sq.km and the rest of the area is the plain area.

Watershed Map

This map is prepared by dividing the drainage into different watersheds so that the discharge pattern of effluents at a particular site is known. The watersheds represent catchment area of a particular stretch of a stream or river. The map prepared based on identification of the drainage flowing into each of these rivers and divided the map into Regions, River basins, catchments, sub catchments, watershed areas for each of these rivers as per the AISLUS (All India Soil and Land use Survey) Atlas. These watersheds are further sub divided into sub-watershed, mini-watershed and micro-watershed based on streams and tributaries. The entire study area lies in the basin between Godavari and Mahanadi. The study area drainage networks is divided into five major watersheds viz. drainage flows into Kaniti reservoir and Mehadri gedda (4F1C1), Sarada river basin (4F1B4), Varaha river basin (4F1B3) and Tandava river basin (4F1B1). Out of these, Sarada and varaha rives are the principle rivers that flows in through the study area. The water divides between the catchments of Sarada River and Mehadri gedda runs thoroughly west north-west to east –south east.The micro-watersheds of the study area is shown in the watershed map**.**

Table 1: Details of Watershed

No.	Description	Quantity
1	Region	Bay of Bengal (1No.)
2	Basin	Between Godavari and Mahanadi (1No.)
3	Catchments	From Krishna to Vamsadhara (1No.)
4	Sub-catchments	Tandava to Sarada (4F1B) & Sarada to Suvarnamukhi (4F1C) - (2 Nos.)
5	Watersheds	Mehadri gedda (4F1C1), Sarada river basin (4F1B4), Varaha river basin (4F1B3) and Tandava river basin (4F1B1)
6	Sub-watersheds	8 Nos.
7	Mini-watersheds	23 Nos.
8	Micro-watersheds	122 Nos.

Land use / Land cover

The land use Map depicts the utilization status of land and is an important input for the preparation of other theme Maps (Clarke, J.I,1966). The Map has been prepared based on Survey of India toposheets and visual interpretation of satellite imagery and field checks .Visual interpretation uses various scene elements like tone, texture, shape, size and association in general to identify and delineate objects(NRSA,1995) . While preparing the Map, care has been taken to correctly demarcate environmentally sensitive zones such as forests. Reserved, protected, degraded and other forests and scrubs are delineated.

Land use / land cover classes

Built-up land

The Built up land in the study area includes Anakapalli, Paravada, Munagapaka, Kasimkota, Yelamanchili, Achchutapuram, Rambilli and Nakkapalli are the mandal head quarters and Steel Plant township, Wada Cheepurupalle, Tummapala, Dimili, Kottubolu, Pedda Uppalam, Korroprolu, Kondakarala, Seetanagaram, Aganampudi, Regupalem, Bayyavaram, Chedika, Rebaka are the other important villages. The total villages and towns covered an area of 20Sq.km.This class also covered NTPC Simhadri Thermal Power Station occupies an 11.3 Sq.km

Crop land

It includes those lands with standing crop (per-se) as on the date of the satellite imagery. The crops may be of either Kharif or Rabi or Kharif + Rabi seasons and covering an area of 5160.34 ha .

Degraded forest or scrub Forest

It is described as a forest where the vegetative (crown) density is less than 20% of the canopy cover. It is the result of both biotic and abiotic influences. Scrub is a stunted tree or bush/shrub and occupying an area of 1005.18 ha.

Land with scrub and without scrub

These are the lands devoid of any good vegetative cover, generally prone to deterioration due to soil erosion and may or may not have scrub cover. In the study area large extent of land covered mostly with Prosophis Juliflora are seen scattered in the entire study area. The land with scrub is occupied an area of 350.28 Sq.km and the land without scrub is occupied an area of 16.49 Sq.km

Barren rocky / stony waste/sheet rock area

It is defined as the rock exposures of varying lithology often barren and devoid of soil cover and vegetation. They occur amidst hill forests as openings or scattered as isolated exposures or loose fragments of boulders or as sheet rocks covering an area of 0.49 Sq.km

Gullied or Ravenous Land

The gullied land is formed as a result of localisd surface runoff affecting the unconsolidated material resulting in the formation of deep channels causing undulated terrain and no suitable for cultivation. The total area occupied by gullied land 11.74 Sq.km

River / Stream

It is a natural course of flowing water on the land along definite channels. It includes from a small stream to a big river and its branches. It may be perennial or non-perennial. and occupies an area of 41.60 Sq.km

Marshy / Swampy area and Mud flat

It is an area association with water bodies and the land along the channels is wet during all the seasons. The marshy land occupies an area of 18.01Sq.km and the mud flat is occupies an area of 11.04 Sq.km

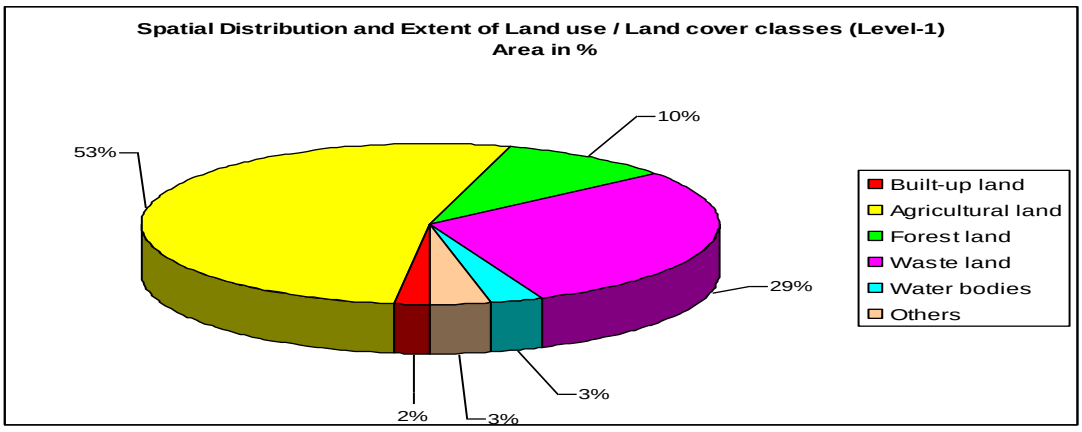

Figure-3 Spatial Distribution of Landuse/Land cover

Salt Pans

These are the area where the lands are used to produce the salt. These are generally associated with sea coast. This type of land use occupies an area of 14 Sq.km

Aquaculture

These are the areas where fish are bred and reared for commercial purpose. This type of class is occupied an area of 0.27 Sq.km

Table - 2 Land Use/ Land Cover Area Statistics

Land use/ Land cover Class	**Area in Sq.Km**
BUILT-UPLAND	
Village / Town	17.00
Industry	10.69
AGRICULTURE LAND	
Single Crop	397.70
Double Crop	156.13
Agriculture Plantation	157.27
FOREST	
Scrub Forest	117.56
Deciduous Forest	14.30
WASTELAND	
Barren Rocky/Stony Waste/Sheet Rock Area	0.49
Land With Scrub	350.28
Land without Scrub	16.49
Gullied / Ravenous land	11.74
Sandy area (Coastal)	18.51
WATER BODIES	
River / Tank	41.60
OTHERS	
Marshy/Swampy Land	18.01
Mudflat	11.04
Salt Pans	14.00
Waterlogged Land	1.94
Aquaculture	0.27
Total	**1355**

Agricultural Capability Map

This map is prepared from Land use / Land cover map and data collected from agriculture and irrigation departments. Three categories viz. High, Medium and Low agricultural use and capability areas are delineated in the map is as follows.

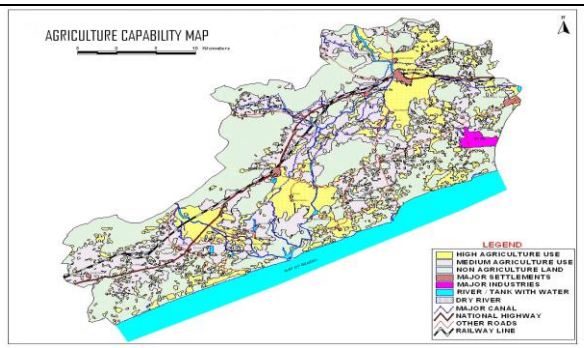

Figure 5: Agriculture Capability Map

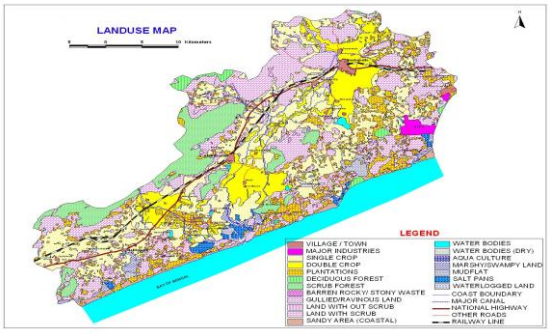

Figure 6: Land use Map

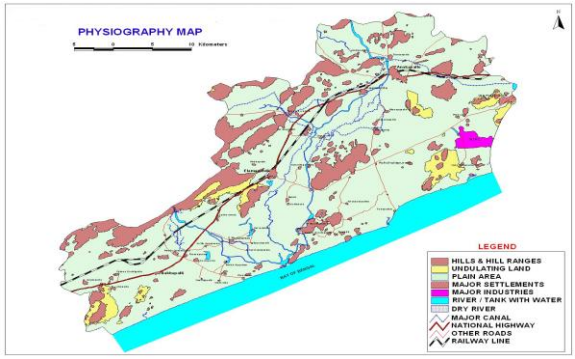

Figure 7: Physiography Map

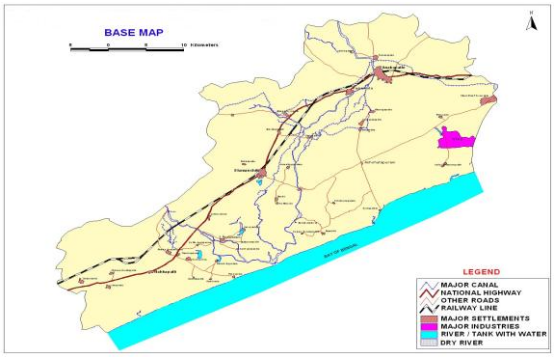

Figure 8: Base Map

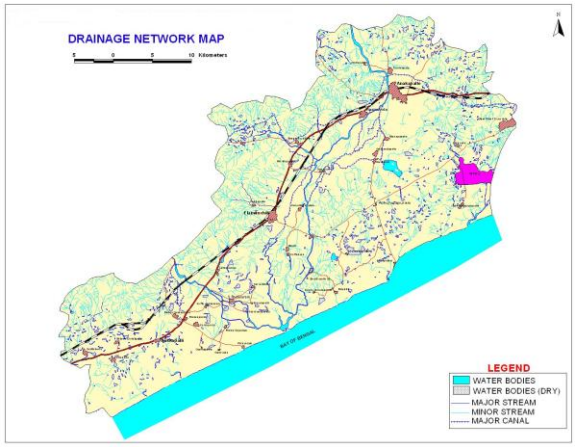

Figure 9: Drainage Network Map

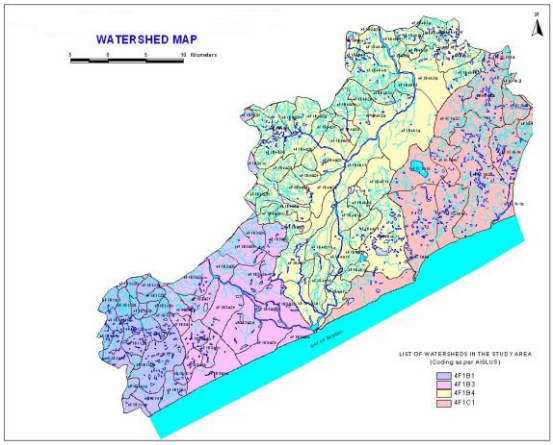

Figure 10: Watershed Map

High – All double crop areas, plantations areas and command areas of irrigated land
Medium – All single cropped areas
Low – All fallow lands
Others – All non-agriculture lands
As per the above mentioned categorization(NRSA,2000), there is no fallow land in the study area hence only high, medium and other land use categories are delineated. The category others includes all built-up land, wastelands, forest lands and other land use classes such as saltpans, aquaculture, water logged area, marshy area etc. The area statistics for high, medium and others are as follows.

Table 3: Agricultural Capability Area Statistics

S. No.	Description	Area in Sq.Km
1	High	311.82
2	Medium	397.70
3	Others	645.48

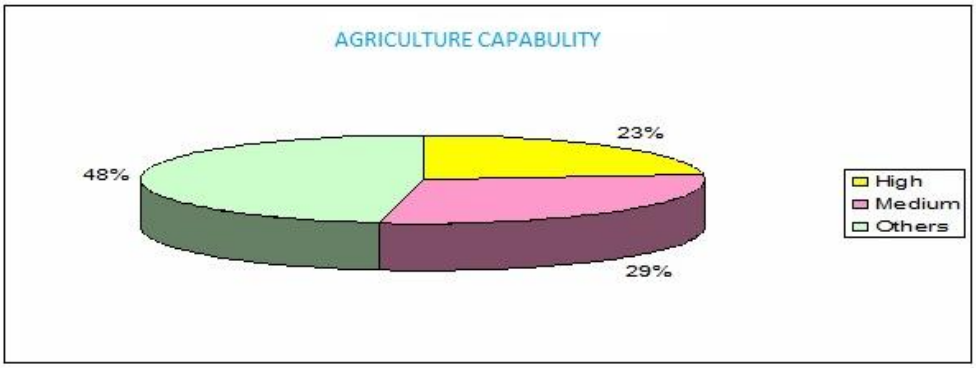

Figure 4: Spatial Distribution of Agricultural Capability

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