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NATURAL RESOURCES PLANNING FOR REGIONAL DEVELOPMENT USING GEOSPATIAL TECHNOLOGIES

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Abstract: *The present paper is intended to create the spatial information for natural resources in command area and to develop methods for its efficient utilization and sustainable management using remote sensing and GIS techniques. The management of natural resources based on a sustained index without deterioration along with constant increase in productivity is the mainstay of mankind. The natural resources are considered as more efficient and appropriate for studying on assessment of subsequent planning and implementation of various developmental programs. The systematic usage of natural resources is very important in sustainable regional development. Remote sensing plays a key role in identifying natural resources in a particular area. It tells about development of the resources in the area. GIS technology has been proper planning to utilize the particular resources in maximum extent and definite steps can be taken to conserve the resource and the climate of that area. In the study area, total 9 check dams and 2 percolation tanks are suggested using ARC GIS software where is waste land development and shelter belt strip plantation along with the roads are suggested. The present study is aimed to prepare the digital thematic maps of Ongole Mandal from Prakasam District including land use/ land cover, geomorphology, transport, drainage and base map using satellite imageries on Arc GIS 9.2 platform. These constitute the spatial database and generate the action plan for water resource management. For this purpose, IRS LISS IV-MX satellite data used for preparing digital thematic maps.*

Keywords: *GIS, Natural Resources Planning, Regional Development.*

INTRODUCTION

During the last several decades ago, the discussion on sustainability has increasingly shifted from being goal oriented to understanding sustainability as a learning process. Indeed, the notion of sustainability as a social learning process is now pervasive in environmental, economical and natural resource literature.

The impacts of population growth on agricultural productivity and the sustainability of natural resources have been debated, at least since the time of Malthus. In the past few decades, there has been a resurgence of pessimism about the impacts of population growth, particularly in rapidly growing developing countries (Club of Rome, 1972; Brown, 1974; Ehrlich and Ehrlich,

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1990). In the last few decades, ecological system has been destroying by uneven exploitation of natural resources; the aim of this study is to suggest how we can preserve and plan the natural resources efficiently by maintaining sustainable development. Such a development may help to plan the maintenance of productivity of natural resources, especially land and water, while retaining the ecological equilibrium.

Economic, social and environmental processes are inherently spatial (Anji Reddy, 2009). They can be fully understood without taking into account their spatial dimensions. The relationship between man and environment can not be represented without a reference to a special location, because the environment is described by the topological relationship among physical objects and human activities produce impacts on the environment spatially (Campagna, 2005). Planning for sustainable development is a cross-sectorial nature intending to promote economic and social development while ensuring the protection, use and conservation of the natural environment and cultural heritage simultaneously.

Geospatial technology is useful as a planning and decision making tool for resources management (NRSA, 1995). Combination of remote sensing and GIS (Geographic Information System) technologies are very important for assessment and management of natural resources, where integration of data from different sources is essential requirement (Lilleasnd, 1994. G., Bareth, 2009). Remote sensing data can be readily merged with other sources of geo-coded information in a GIS (Aronoff, 1989. Bolstad, 2008). This permit to overlap several layers of information with the remotely sensed data and the application of virtually unlimited forms of data analysis (Anji Reddy, 2004).

STUDY AREA

The study area selected for the project is Ongole Mandal of Prakasam District of Andera Pradesh in India. Prakasam is an administrative district in the state of Andera Pradesh with the district head quarters located at Ongole. Ongole located at 138 km from Vijayawada and 331 km from Hyderabad and 300 km from Chennai (NRSA, 1989). Geographically, the Ongole Mandal lies between Latitude 15° 30' 0" N and longitude 80° 3' 0" E where is covered in the survey of India topo-sheet numbers 57 M/15/NE, 66 A/2/SE, 66 A/2/SW and 66 A/3/NW (IMSD, 1995).

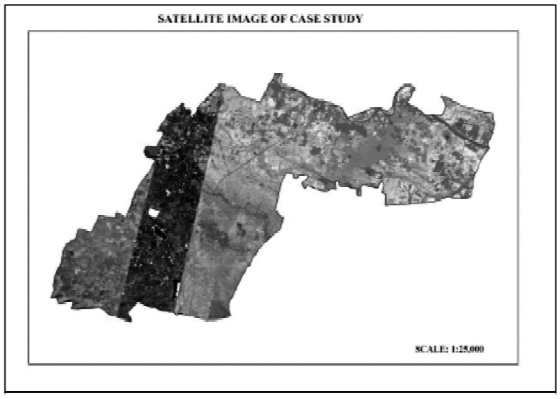


Figure 1: Satellite Image

Ongole is one of the 56 Mandals of Prakasam district, in Andera Pradesh. Area of Ongole mandal is approximately 17.626 Km^2. Ongole Mandal has twenty one Revenue Villages, Boddulurivaripalem, Chejarla, Cheruvukommupalem, Chintayagaripalem, Dasarajupalli, Devarampadu, Devarampadu, Gundayapalem, Karavadi, Koppolu, Mandurivaripalem, Mukthinuthalapadu, Nagraharam, Pathapadu, Pelluru, Sarvereddypalem, Throvagunta, Ulichi, Vengamukkalapalem, Voletivaripalem, Yarajarla (Census of India 2001).

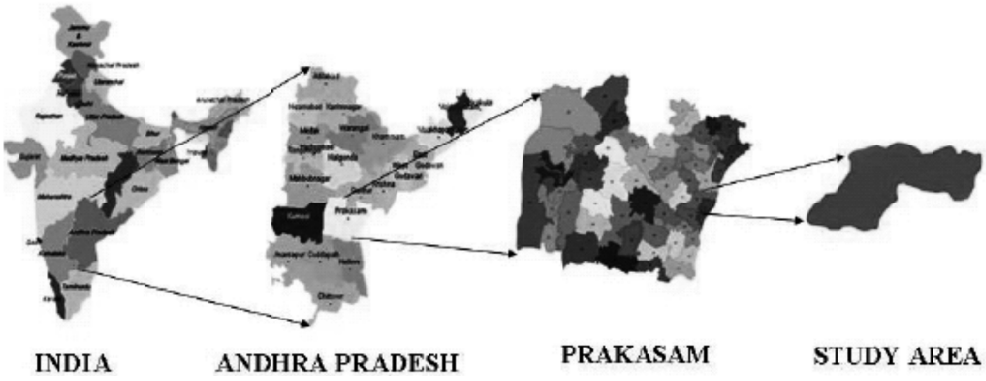


Figure 2: Showing the Location Map of the Study Area

OBJECTIVES

- Preparing the thematic layers such as base map, drainage map, transport map, land use/ land cover map, geomorphology map using SOI (Survey of India) toposheets and satellite data and field studies.
- Generating the action plan for effective management of natural resources and regional development by intergrading the entire thematic maps and the filed data using ARC GIS platform.

METHODOLOGY

The methodology mainly involved the input of spatial data concerning various map layers and associated data. In addition, attributed and spatial data were analyzed to produce thematic maps.

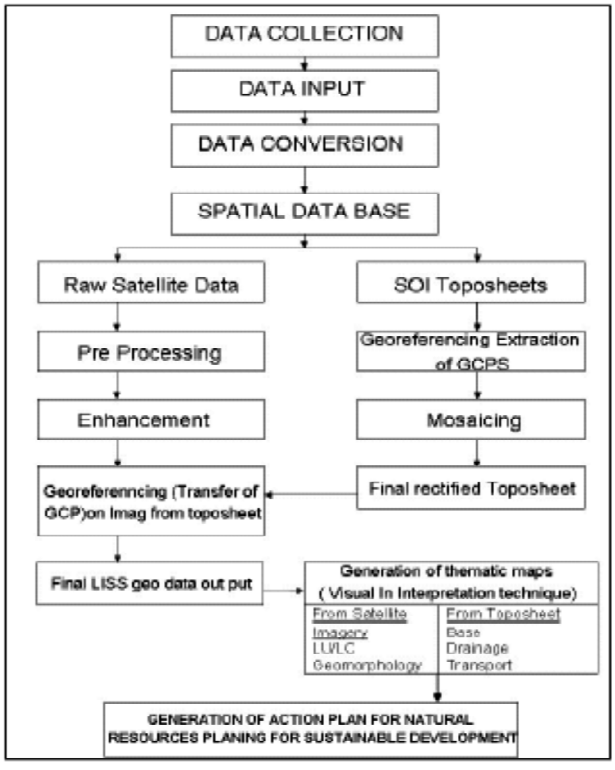
Spatial Database

Creating a GIS spatial database is a complex operation, which involves data capture, verification and structuring processes. Raw geographical data are available in many different analogue and digital forms such as toposheets, aerial photographs, satellite imageries and tables. Out of all these sources, the source of toposheet is much concern to natural resource scientist and an environmentalist (Mohan, 2001). In the present study, the layers were generated from toposheet and satellite data using visual interpretation technique include base map, drainage map and geomorphology map prepared using road network and drainage pattern from SOI toposheet. The procedure consists of a set of image elements, which help in the recognition or interpretation of various land use/ land cover features systematically on the enhanced satellite imagery during

the classification of features (Lillesand, 2000). The thematic maps generation system used in this study is the system, which is pioneered by United State Geological Survey and is modified by National Remote Sensing Agency according to Indian conditions. A preliminary image classification key is prepared for the fused pictorial data and is used during interpretation process. The base map is overlaid on the satellite imagery. Then the different thematic layers features are extracted from the satellite pictorial data.

Attribute Database

The thematic maps are converted to digital mode using scanning and automated digitization process. These maps are prepared to a certain scale and show the attributes of entities by different symbols or coloring. The location of entities on the earth.s surface is then specified by means of an agreed co-ordinate system (Burrough, 1983). It is mandatory that all spatial data in a GIS are located with respect to a frame of reference (Aronoff, 1989). For most GIS, the common frame of reference co-ordinate system is that of plane, Orthogonal Cartesian co-ordinates oriented conventionally North-South and East-West. This entire process is called geo-referencing (Mark, 1994). The same procedure is also applied on remote sensing data before it is used to prepare thematic maps from satellite data. This digitized data is then exported to ARC/Info, ARC View GIS to create digital database for subsequent data analysis (Lang, L, 1998). The overall methodology employed for the present study is represented in flowchart 1.



Flowchart 1: Showing Methodology Flow Chart

The main sources of spatial data were the survey of India (SOI), 1:25,000 scale toposheets, satellite imagery IRS-P6 LISS IV MX (5.8 mt), field data collected during study period and integration of spatial and non spatial data and finally action plan generated for natural resources planning.

RESULT AND DISCUTIONS

Base Map

A topographic map is a representation of the shape, size, position and relation of the physical features of an area**.** Base map is prepared by using survey of India topographic maps on 1:25,000 scale and update with the help of satellite imagery. It consists of various features like the road network, settlements, water bodies, canals, railway track, etc., delineated from the toposheet. Thus the drawn map is scanned and digitized to get a digital output. Figure 2 shows the base map of the study area.

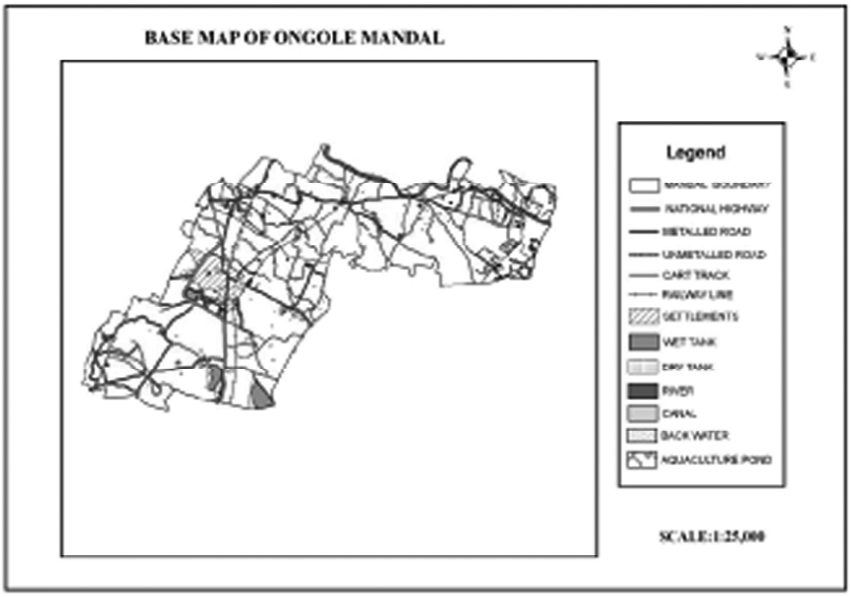


Figure 3: Showing the Base Map of the Study Area

Drainage Map

Drainage map is prepared by using survey of India Topographic maps on 1:25,000 scales. All the water bodies are divided into dry and wet areas. Theses wet (water spread) areas changes from time to time and some new tanks are found in the satellite images. For this reason, the drainage map is updated from the satellite. Buckingham and Jawahar canals are the major canal flowing through the study area. Plenty of the rivers and rivulets in the Ongole Mandal get dry for major part of the year and carry heavy floods during rainy season. Figure 3 shows the drainage map of the study area.

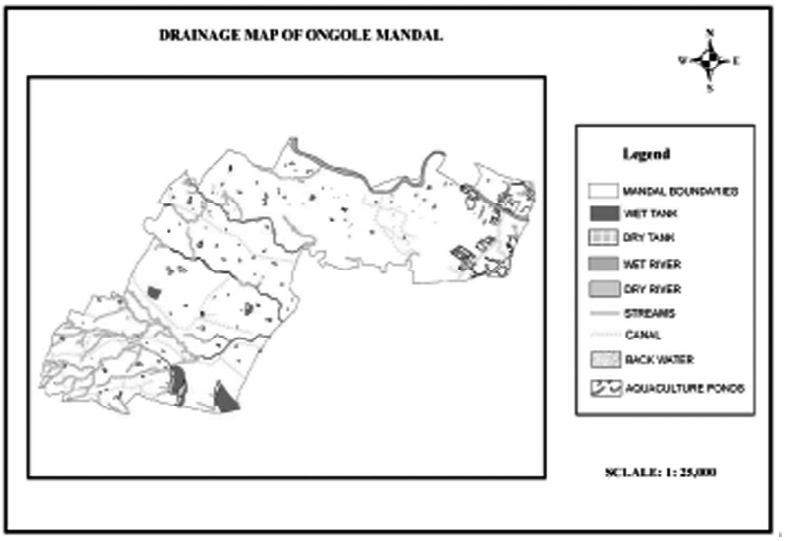


Figure 4: Showing the Drainage Map of the Study Area

Transport Map

The major and minor roads connecting different places of the study area are were delineated from the toposheets and a road network map was prepared. In the study area, all the settlements are connected by Metalled road, Unmetalled road and National Highway etc. Figure 4 shows the transport network map of the Ongole Mandal. Transport network interpreted using IRS-1D PAN. Then data compared with 1: 25,000 scale SOI map delineated about 80% of roads as depicted on the map.

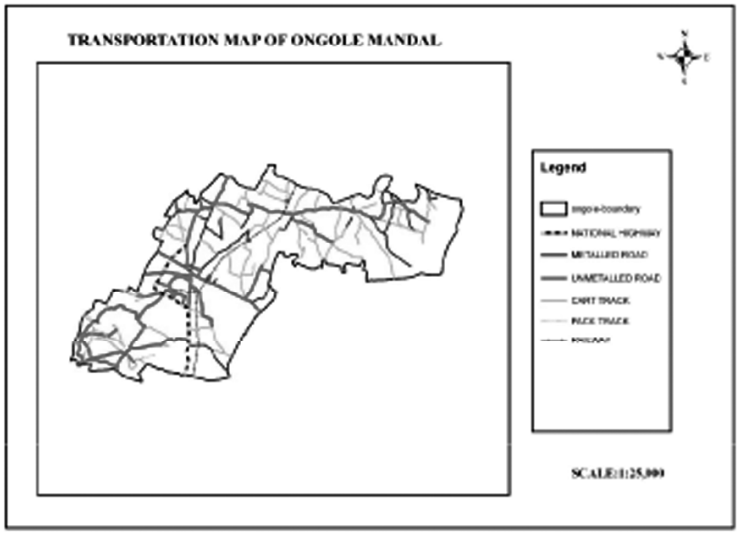


Figure 5: Showing the Transport Map of the Study Area

Land Use/ Land Cover

Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and artificial structures. Land use is a more complicated term. Natural scientists define land use in terms of symptoms of human activities such as agriculture, forestry and building construction that alter land surface processes including biogeochemistry, hydrology and biodiversity (Joshi and Rawat, 2005).

Land Use/ Land Cover map is prepared by visual interpretation of high resolution satellite data with the survey of India topographic maps on 1: 25,000 scales. The Land Use/ Land Cover categories such as built up land, agriculture, and water body, waste lands, canals, rivers, roads and tanks have been identified and mapped from the study area. Major part of the study area (68%) is covered with single crop and double crop. About 1% of the study area is under built up land and industrial area is 0.02 in per cent. From the satellite data the agriculture area (82%) could be clearly delineated as four categories, single crop, double crop, harvested crop and plantations. Though single crop and double crop has been observed at various parts of the study area and plantations are observed at some places of the study area. Figure 5 shows Land Use/Land Cover map of the study area.

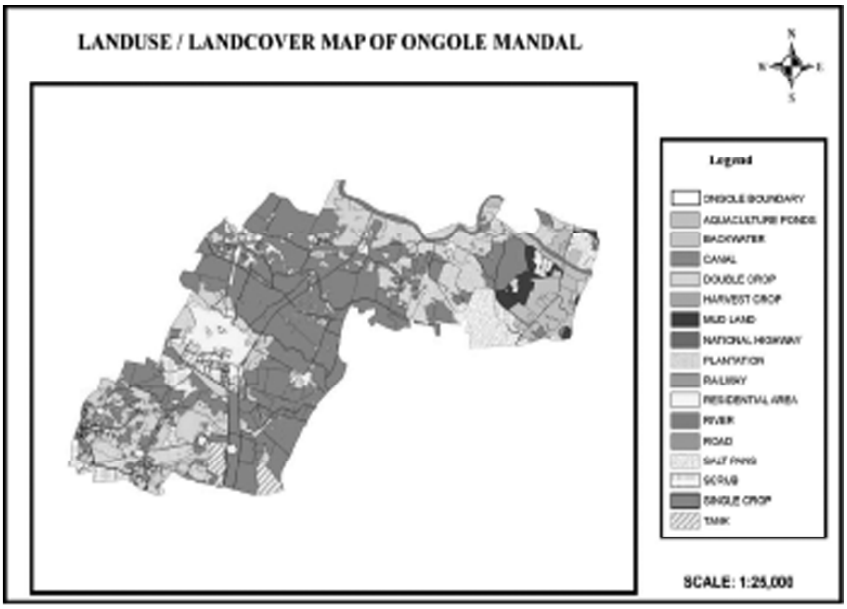


Figure 6: Showing Land Use /Land Cover Map of the Study Area

Geomorphology Map

Geomorphology map is prepared by visual interpretation of high resolution satellite imagery with the help of survey of India Topographic maps and ground truth. Geomorphology map is used for the preparation of ground water prospects map. Figure shows Geomorphology map of the study area.

Table 1
Present Land Use/ Land Cover Finding of the Study Area

Sl. No.	*LU/ LC Category*	*LU/ LC Unit*	*Area (In Ha.)*
1.	Agriculture	Double Crop	210.65
		Single Crop	457.34
		Harvested Crop	23.34
		Plantation	214.56
2.	Built up Land	Residential	126.34
		Industrial	23.54
3.	Waste Land	Scrub	47.65
		Mud Land	123.54
		River	78.34
4.	Water Body	Tank	54.23
		Aquaculture Ponds	120.78
Total			1479.59

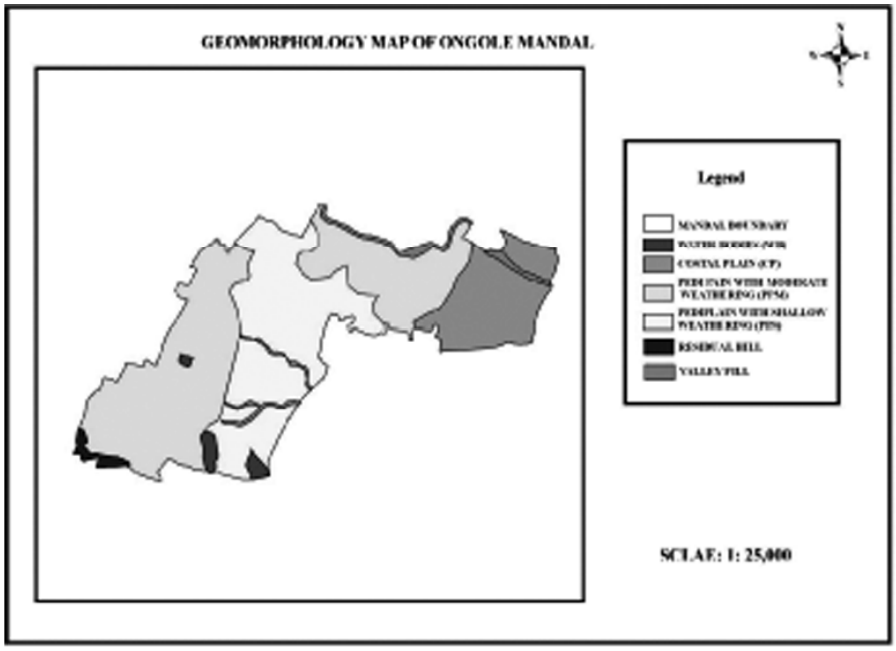


Figure 7: Showing Geomorphology Map of the Study Area

CONCLUSION

Action plan is generated based on the integrated study on spatial data and attributed data with the help of field observations. In the study area, total 9 check dams and 2 percolation tanks are suggested using ARC GIS software where is including waste land development and shelter belt strip plantation along with the roads. The study has successfully demonstrated the utility of remote sensing used in conjunction with the GIS technology for mapping and planning of natural

resources for sustainable development. The same methodology may be applied in analogous area within India or any part of the world with similar environment conditions.

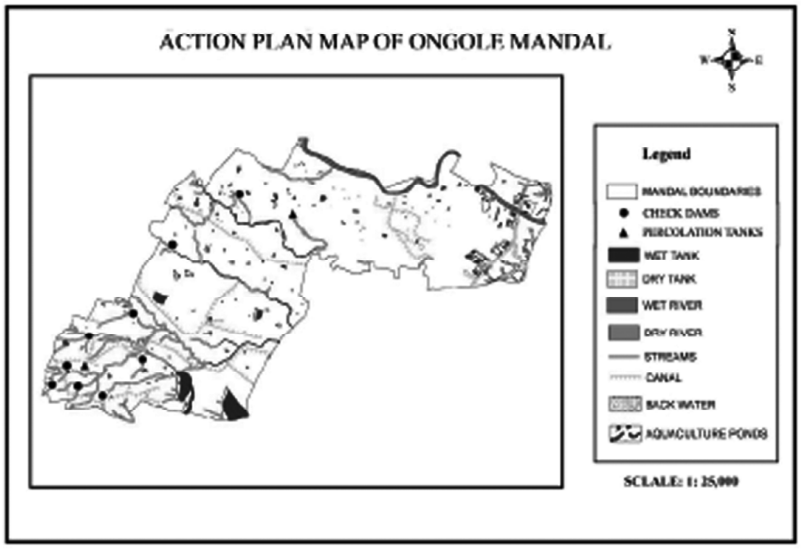


Figure 8: Showing Action plan map of the study area

RECOMMENDATION

Based on the aforementioned results and their analysis, the following recommendations are hereby made in this study:

- Water allocation for agriculture in the study area can be made keeping in mind the irritability of land, food requirement and equity issues in sharing the water and related infrastructure.
- Mechanisms must be evolved and developed in sharing the reservoir and tank waters during deficit rainfall years, normal rainfall years and above normal rainfall years.
- New technological options in recycling of water, water harvesting, soil and water conservation and multiple use of water are to be adapted on a big scale. The technologies including micro filtration at household level to desalination of water for drinking water supplies.
- Rainwater harvesting and storage for further economic use of the study area must be made mandatory of all the households, public and private institutions both in the rural and urban dwellings.
- Restoration of age old tanks and lakes are highly essential by removing silt and maintaining it with fresh water to ensure proper groundwater recharge and ecological development.
- Conjunctive use of different water sources to be made mandatory for all command areas for efficient use of water.

Reference

Anji Reddy, M. (2004), Geoinformatics for Environmental Management, BS Publications, Hyderabad, India.

Anji Reddy, M. (2009), Remote Sensing and Geographical Information Systems, BS Publications, Hyderabad, India.

Aronoff, Stan. (1989), Geographic Information System: A Management Perspective, WdL Publications, Ottawa, Canada.

Bolstad, Paul (2008), GIS Fundamentals: A First Text on Geographic Information Systems, 3rd Edition, Eider Press, White Bear Lake, Minnesota.

Brown, L. R. (1974), In the Human Interest: A Strategy to Stabilize World Population, Norton, New York.

Burrough, Peter and Rachael Mc Donnell (1983), Principles of GIS. Oxford University Press, New York.

Campagna, Michele (2006), GIS for Sustainable Development. CRC Press. United States.

Census of India (2001), Data from the 2001 Census, Including Cities, Villages and Towns (Provisional).

Club of Rome (1972), The Limits to Growth. Universe Books, NewYork.

Ehrlich, P. R., Ehrlich, A. H. (1990), The Population Explosion. Simon and Schuster, New York.

G. Bareth (2009), GIS and Remote Sensing, Based Spatial Decision Support: Structure of a Spatial Environment Information System. *International Journal of Digital Earth,* Volume 2, Issue 2.

Integrated Mission for Sustainable Development (IIMSD) Technical Guidelines (1995), Andhra Pradesh State Remote Sensing Application Center (APSRAC). Government of Andhra Pradesh.

Lang, L. (1998), Managing Natural Resources with GIS. ESRI Press: Redlands, CA.

Lillesand, T.M & Kiefer R. W. (2000), Remote Sensing and Image Interpretation. John Wiley and Sons Inc. New York.

Mark A. Ross (1994), Ground Water Modeling With GIS. Symposium on Ground Water, Edited by Gerard. P. Lennon.

Mohan, Madan (2001), Spatial Data for Environmental Management: A GIS-Based Monitoring of Ecological Restoration for Delhi Ridge, in Muralikrishna, I.V. (ed.) Spatial Information Technology: Remote Sensing and Geographical Information Systems, BS Publications, Hyderabad, Vol. II.

National Remote Sensing Agency (NRSA) (1989), Manual of Nation Wide Land Use/land Cover Mapping Using Satellite Imagery, Part 1.

National Remote Sensing Agency (NRSA) (1995), Technical Guidelines of Integrated Mission for Sustainable Development. Departement of Space, Govt. of India.

PK. Joshi, GS. Rawat (2005), Land Use and Land Cover Identification in Alpine and Arid Region, Using Satellite Remote Sensing. *Journal of Indian Society of Remote Sensing,* 33 (3).

Toposheets prepared by Survey of India. (1993).