IRJIF I.F. : 3.015

North Asian International Research Journal of Social Science & Humanities

ISSN: 2454-9827 Vol. 3, Issue-7 July-2017

DEVELOPMENET OF CADASTRAL LEVEL LAND AND WATER RESOURCE INFORMATION SYSTEM THROUGH REMOTE SENSING & GIS TECHNIQUES IN MOTHKURI WATERSHED, NALGONDA DISTRICT TELANGANA

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ABSTRACT

The modern technologies like remote sensing and GIS are the effective and efficient systems for the assessment and management of land and water resources in the catchment areas of small river basins. These techniques are essential requisites to enhance the agricultural productivity, augmenting income and preventing degradation of soil and water. Mothkuri watershed of Nalgonda district is identified as one of the chronically drought prone areas with low and erratic rainfall coupled with poor groundwater potential. As there are no major irrigation projects, the watershed area is mostly dependent on wells, bore wells and tanks for domestic and agricultural activities. The irrigation wells present in the watershed are deep bore wells with low and medium yields and are getting dried up during most part of the year due to declining groundwater levels. The degradation of forests, grass lands and low production of agricultural yields are mainly due to water scarcity. Hence, the need for assessment and management of water resources is essential from the river basin to watershed delineations for the optimum development. The objective of the present study is to improve the agricultural productivity of different crops cultivated in the villages by implementing the watershed management programmes more effectively and efficiently. The present study has been carried out by collecting both primary and secondary data. The Satellite data of IRS have been acquired and analyzed in the present analysis. The primary and secondary data sources collected from various organizations have been analyzed and presented in the visual form by using Arc GIS 10.2 and ERDAS 9.3 version software's. The secondary data has been collected from Census and Hand-Book of Statistics which has been analyzed and used in the present analysis. Apart from collecting primary and secondary data the researcher made field visits many times to the research area to observe the various aspects of the villages lying in the watershed.

Key words: ***Cadastral, LU/LC, Geomorphology, Geology, GIS, Remote sensing.***

INTRODUCTION

The fundamentals of land ownership and land boundaries date back to the very roots of civilisation and matters relating to possession and control ("ownership") of land are well documented in historical records. Indeed, the territorial control of land has been a fundamental issue in the rise and fall of empires throughout history (e.g. the Roman Empire), and has been the cause of a great number of the world's wars since civilisation began. In the centuries BC, the importance of land ownership was focussed on arable lands used for productive agriculture, and even in those times there were issues associated with occupation and boundaries.

In recent times, the importance of control of land (and a nation's offshore and seabed maritime boundaries) is more likely to be centred on rights of economic development, and control of important resources such as oil and fishing rights.

THE CADASTRE

The concept of "the cadastre" is either unknown or not understood by the population at large – it is, however, a vital tool used by professionals involved in land and land related dealings. In plain English, a cadastre is an official register showing details of ownership, boundaries, and value of real property in a district, made for taxation purposes (Collins English Dictionary 1979).

A cadastral map displays how boundaries subdivide land into units of ownership. The cadastre is used as the foundation for dealings in:

- Land valuation and taxation Land registration and land transfers
- Land use planning
- Sustainable development and environmental protection
- Mapping Management of leases and licences
- Electoral boundary determinations, and Other land based administrative purposes

The International Federation of Surveyors defines that "A Cadastre is normally a parcel based, and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements".

Digital Cadastral Databases (DCDB's) are the modern versions of "the cadastre" and provide spatial views of land parcels. Although they are based on original paper plans, records and maps the database information has been digitised by computer to deliver maps showing digital coordinates of land parcels, as well as a great deal of supplementary information related to the land.

WATERSHED

Every living organism needs water for survival. Without water all life forms will cease to exist. With the ever increasing population, water is becoming a scarce natural resource. A watershed is a drainage basin or catchment area defined as an area in which all water flowing into it goes to a common outlet. Watershed management is an adaptive, comprehensive, integrated multi-resource management planning process that seeks to balance healthy ecological, economic and cultural social conditions within a watershed.

Watershed management serves to integrate planning for land and water, it takes into account both ground and surface water flow, recognizing and planning for the interaction of water, plants, animals and human land use found within the physical boundaries of a watershed. Watershed management assumes an exceedingly important role not only for the production of more food but also for prevention of degradation of land and water in the area. Watershed management is an integrated technological approach within natural boundaries of a drainage area for optimum development of land, water and plant resources to meet the basic needs of the people in sustained manner. Therefore, everyone is charged with the responsibility of taking care of water because the very survival depends on it. The concept of watershed is a small unit that has gained momentum for effective planning for management and optimum development of land and water resources.

CADASTRAL APPLICATIONS

Cadastral maps have been an indispensable tool for the administration in dealing with day to day revenue and development activities in the district. The administrative staffs at field level are more conversant with cadastral maps rather than any other type of maps. Cadastral maps having details of development activities survey number wise will facilitate the district administration to take up implementation of these tasks. Updating the cadastral information is very essential so that transformation/changes of ownership/division of properties etc can be recorded in an orderly manner for documentation and further use. With the advent of remote sensing technology, these records in the form of maps can be updated as satellite remote sensing provides details of the study area approximately once in two weeks with higher spatial resolutions.

Satellite imagery, which forms the base for the generation of action plan maps, if overlaid on cadastral maps can improve the details of the thematic maps as well as action plans maps. It also helps in the monitoring of changes that can be measured at Plot/Survey Number levels.

Developmental planning with integrated approach has been accepted world over for optimal management and better utilization of natural resources towards improving living conditions of the people and to meet the growing demands of an increasing population. Timely inflow of information (both the spatial and non-spatial) and its reliability is a pre-requisite for integrated developmental planning.

Satellite remote sensing is an ideal tool for generating such spatial information base. The Indian Remote Sensing Satellites are providing timely information from regional to farm level studies through a variety of sensors. Integrated development is aimed at optimal realization of resource potential in the light of physical, economical, social and other developmental goals. In such planning process, in order to derive maximum benefit out of land, water, vegetation and other resources, in a sustainable way, it is preferable to treat that watershed as a single unit.

The practical approach in planning for preservation, conservation, development, management and exploitation of natural resources of the watershed has to be operated within the framework of physical and biological attributes, socio-economic conditions and institutional constraints. The system as a whole operates upon to develop appropriate alternative plans of conservation-production programme commensurate with production potential.

To meet the people requirement and imbibe local wisdom in the action plans, the ownership of the land under study is a pre-requisite. A unique approach has been developed to geo-reference Cadastral maps using high resolution satellite data, and thereby providing seamless access to the databases and resultant action plans, from district to village level.

This has also facilitated in translating the action plans with alternatives of land and water use derived based on the inherent resource potential, considering the social and economic priorities as per the existing development schemes and Government policies. This approach has further enhanced the scope for monitoring beneficiary wise impact assessment of various developmental programmes using remote sensing data periodically.

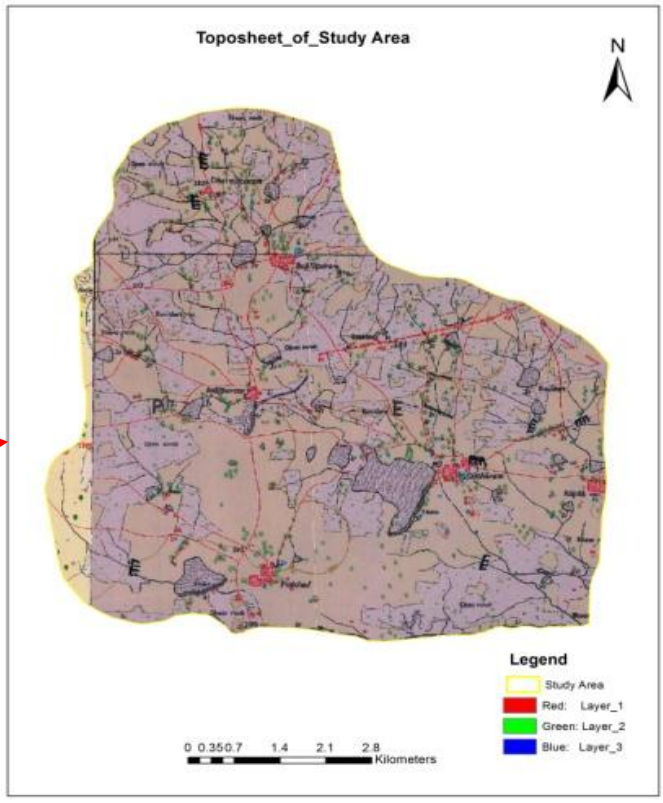
STUDY AREA

Mothkuri is located in Nalagonda District of Telanagana. The Mothkuri watershed is situated It lies between 17°28'51.14° and 17°25'58.53°N latitude and 79°17'3.63° and 79°14'2.69°E longitude and the total area is 5541.82 ha. It is located on the banks of Bikkeru a tributary of Musi River which itself is a tributary of river Krishna (Map1).

The population of Mothkuri Mandal as per 2001 census is 55638 and 2011 census is 55699 with a very less growth of 0.11%. Tobaccos, Paddy, Sugarcane, and Groundnut are the major crops that are cultivated mostly in the area.

Map 1
Map of the Study Area

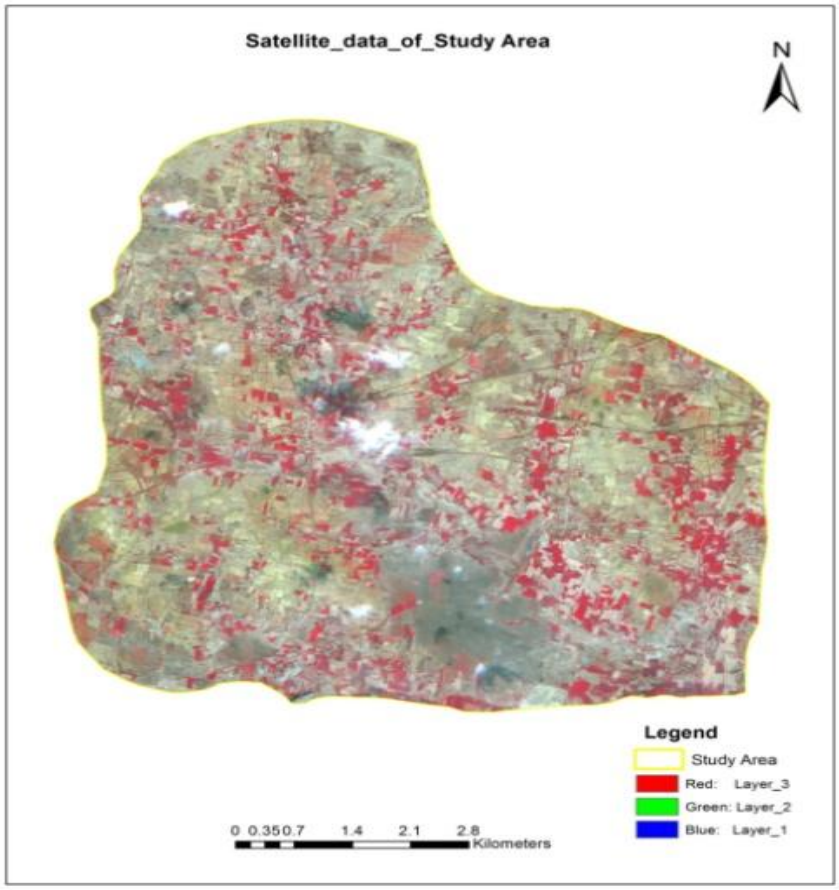
India & Telangana



Mothkuri Study Area

The satellite data map of the study area is shown below.

Map-2
Satellite Data Map of the Study Area



DATA USED AND METHODOLOGY

The study involves preparation of various thematic layers on 1:50,000 scale using SOI toposheets, IRS P6 LISS IV / CARTOSAT data, for the year 2011-12. The base map is prepared from SOI toposheets and updated on Satellite Image. ERDAS Imagine processing software has been used for image rectification, enhancement and classification operations. On Screen interpretation would be used to extract thematic layers. Interpretation would be made in conjunction with the topographical map and also supported by adequate ground truth data for accurate output. Field work would be carried out with the help of GPS to identify the training sets.

Required thematic layers - Geology, Geomorphology, Hydrology (drainage), Soils, Slope, Land use / Land cover will be derived from the image. The Cadastral boundary will be overlaid on the action plan.

Methodology developed by NRSC would be applied to classify the land use categories and suggest appropriate recommendations.

Preliminary information about the geology of this area was collected, through literature review which served the basis for carrying out this study area. The satellite data was visually interpreted using the elements like shape, size, pattern, tone/colour, texture, association, etc., and terrain elements like topography, drainage, vegetation and land use pattern etc.

The various GIS software is used such as ERDAS 9.2, ARC GIS 10.2 in the preparation of digital layers of various thematic maps. The location map of the study area & surface water bodies are prepared by using GIS systems. The morphometric parameters of mothkuri watershed such as linear, relief and areal aspects have been analyzed using GIS technique.

The study was carried out specifically for the years, 2011-12 for analyzing the following parameters:

- Base maps including road, railway, settlement, village location and watershed boundary extracted from the topographic sheets and converted into GIS database.
- The modifications in the LULC map updated with Remote Sensing Imageries.
- Geology, Geomorphology, Hydrology (drainage), Soils, Slope, Land use / Land cover will be derived from the image. The Cadastral boundary will be overlaid on the action plan.

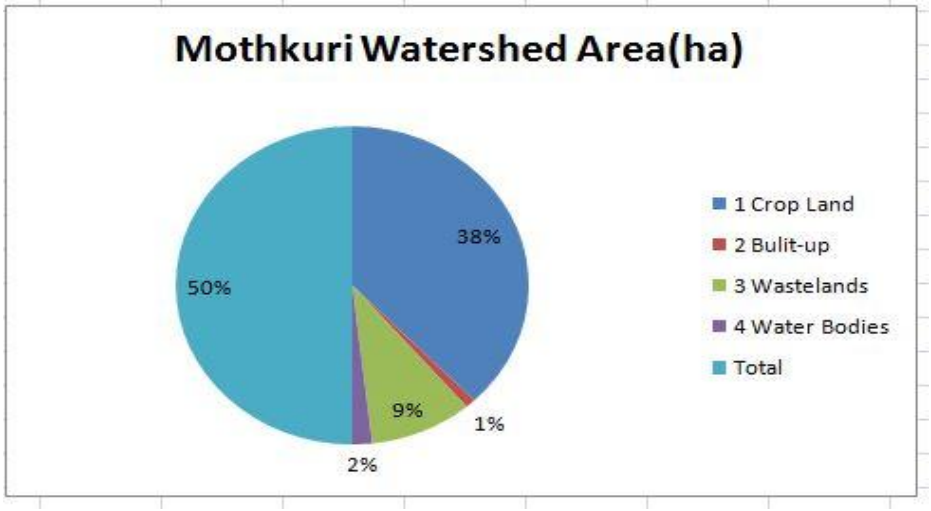
The Land use/ Land cover of the study area-2011-12 and its area extent are shown in Table 1.

Table 1
Land use/ Land Cover of the Study Area (2011-12)

Mothkuri Watershed			
S.no	Description	Area(ha)	Area(%)
1	Crop Land	4198.53	75.761
2	Bulit-up	106.053	1.914
3	Wastelands	1037.93	18.729
4	Water Bodies	199.3	3.596
Total		5541.813	100

The Land use/ Land cover of the study area-2011-12 and its area extent are shown in figure 1.

Figure 1
Area of Mothkuri Watershed in Hectares

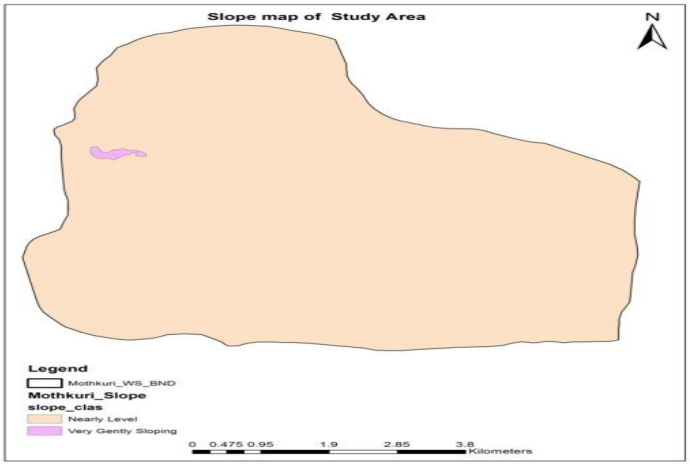


Slope

The slope is an important aspect of the present study. The slope of the Mothkuri watershed gives an idea about the runoff in the streams and erosion aspects in the high intensity of rainfall. The SRTM data has been used to find out the slope in Degrees. The slope map of the mothkuri watershed has been prepared by using the Arc GIS and ERDAS software's.

The Slope maps of an area provide information regarding the distribution of various slope elements. The slope elements in turn are controlled by the climate-morphogenic processes in the area underline by rocks of varying resistance. An understanding of the slope distribution is essential since slope maps provide data for planning of settlement, mechanization of agriculture, afforestation, deforestation, it is not only the slope angle which is important but equally important are the shape of the slope namely whether they are convex or concave. (See map.3)

Map 3
Slope Map of Study Area



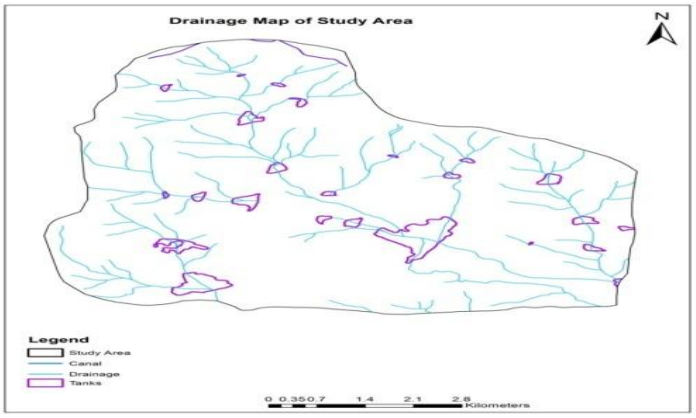
Slope

1. 0 – 3%
2. 3 – 5%
3. 5 – 15%
4. > 15%

Drainage Map/Water Bodies/Catchment Area:

Drainage map of the study area has been prepared from the SOI topographic maps. Drainage pattern of the study area indicates that the drainage pattern is dendritic in nature with the stream order ranging from 1st to 5th order (Map4) .The updated water bodies from the satellite imagery are included in the drainage map.

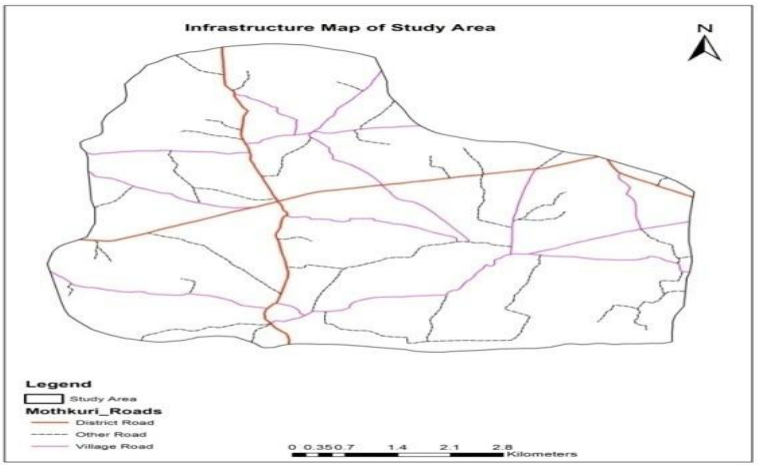
Map 4
Drainage Map of Study Area



Infrastructure Facilities in Study Area

The study area is connected with district road, mandal roads, village road and other roads.

Map 5
Infrastructure Map of Study Area

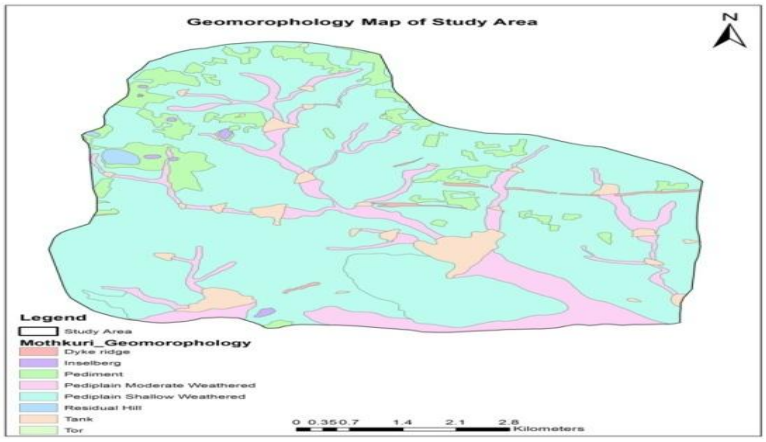


Hydro-geomorphology of Study Area

The procedure adopted to prepare the hydro geomorphology map of the study area is given .It consists of basically four distinct parts. They are;

1) Acquisition of satellite and collateral data
2) Preparation of pre-field interpretation maps
3) Limited field checks in the doubtful areas and
4) Preparation of hydro-geomorphologic map

Map 6
Geomorphology Map of Study Area



The analysis of geomorphology brings forth the following important special features of the study area. They are;

1. Moderately Weathered Pediplain (PPM - Gr)

It is a gently sloping smooth surface of granite gneiss with more than 5m depth of weathered material, generally covered with red soil. In general, the ground water prospects are moderate to good. Good yields can be expected along fractures / lineaments with yields ranging from 2 to 51ps.

These landforms are observed only in the granites and gneisses and they occupied major part of the area, and mainly, confined to the major rivers, streams and narrow valley zones.

Ground water development is extensive in these areas due to the availability of good ground water potential. These landforms are developed throughout catchment area.

2. Shallow Weathered Pediplain (PPS -Gr)

It is a gently sloping smooth surface of granite gneiss with less than 5m depth of weathered material, generally covered with red soil. The ground water prospects are poor to moderate. Moderate yields are expected along fractures/lineaments with yields ranging from 1 to 31ps. These land forms developed in the middle and north-western part of the catchment area.

3. Isenberg

This means small light hilly. These landforms are located in the Northeast corner part of the catchment area. Gently sloping rock-cut surface of granites and gneisses with thin veneer of detritus.

In general, the ground water prospects in a pediment area poor. These landforms are developed in the north-eastern part of the catchment area.

4. Tor/Tor Complex (T/TC-Gr)

These are a group of sporadically weathered boulders with isolated rock outcrops. In general, the ground water prospects are poor.

These landforms are observed. In middle and south-western parts of catchment area.

5. Residual Hill (RH-Gr)

It is an isolated low relief relict hill occupying considerably small area. The ground water prospects are poor.

These landforms are seen in the granite terrain of the area. These landforms are located in the North part of catchment area.

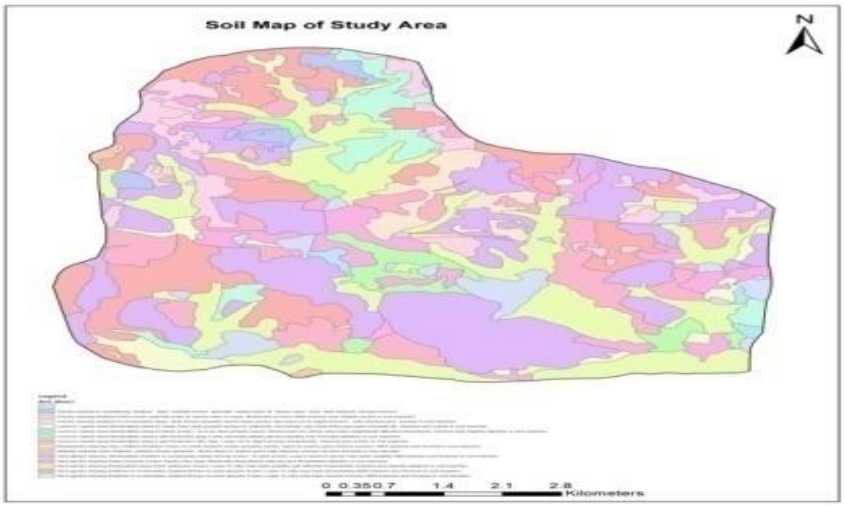
6. Pediment (P-Gr)

It is a gently sloping rock-cut surface of granites and gneisses with thin veneer of detritus. In general, the ground water prospects in pediment area poor. These landforms are developed in the north-eastern part of the catchment area.

Soil Classification

The soil map and data furnished in this study in alliance with topographic, geomorphic and hydrologic data which helped to prepare an integrated land resource development plans.

Map 7
Types of Soils in the Study Area



Keeping in view the afforestated objectives and the discussions with the TRAC scientists, the soil resource map of Mothkuri catchment area and this has been designed and completed as per terms of reference.

Land use/Land cover classes

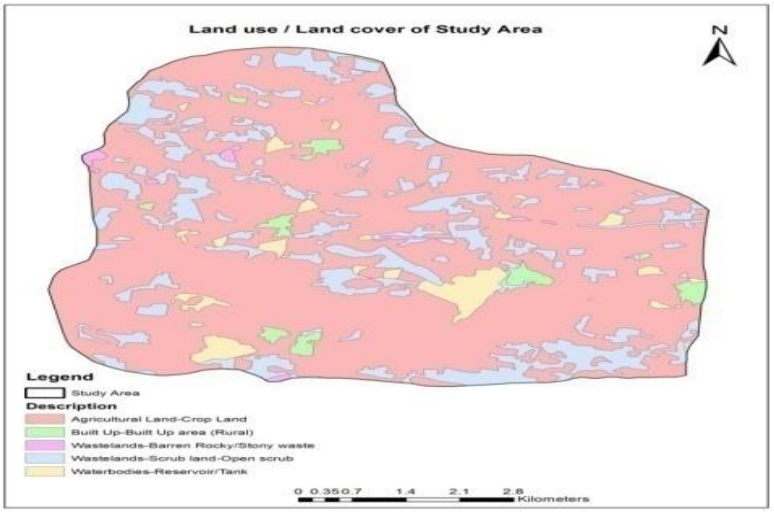
Land use refers to "man's activities and the various uses which are carried out on the land". Land cover refers to "natural vegetation, water bodies, rock/soil and other natural covers".

Land is the basic and most important natural resources for all human activities and efforts for development. The information on land use/land cover in the form of maps and statistical data very important for spatial planning and management of land resources.

Further, an understanding of the dynamics of land utilization aspects, such as pattern, fallow lands, forest and grazing land, wasteland, surface water bodies etc., help to plan for optimum land use for sustainable development.

Today, the availability of information on land use/land cover in the form of records and statistical figure is inadequate and does not provide an up-to- date information on the changing land use patterns and processes. In most of the cases, as the time gap between collections, reporting and availability of data increases the data often become out-dated.

Map 8
Land Use/Land Cover in the Study Area



Basic Integrated Land Water Resources Unit (BILWRU)

Land and water are the basic life supporting systems, which ultimately determine the productivity and prosperity of a country. Widespread occurrence of dry spells has been a common feature in our country. To mitigate this environmental aberration, remote sensing technology is an important key to tackle and manage

drought related problems. In this direction attempts have been made regarding the assessment and management of natural resources using an integrated approach to bring sustainability.

The data derived from remote sensing to generate spatial information showing hydro geomorphology, soils; land use/land cover and slopes have been integrated digitally using GIS packages. Thus basic integrated land and water resources units (BILWRU) have been derived, which are unique in combination and recommended optimal land utilization and farming systems (ROLUFS) are suggested accordingly.

Integration of Land and Water Resources Unit

Integration of land and water resources unit has been carried out digitally by using GIS software packages. The GIS technique which helps to visualize, organize, combine, analyze, predict and query the spatial data along with non spatial data.

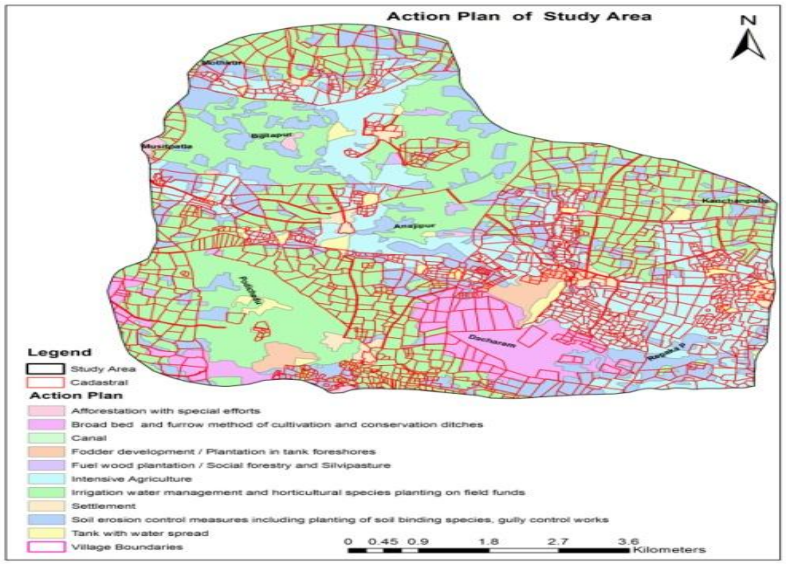
GIS is useful for combination of all the available resources together with a set of operational procedures to produce information for taking administrative and economic decisions as an aid to planning and development process related to geographical unit to meet the set objectives. GIS plays a key role in achieving an integrated model of any parcel of land in the area of interest.

The thematic maps of hydro geomorphology, slope, soil, and land use/land cover maps are digitized and integrated in Arc Info GIS package and basic integrated land and water resources units are derived. In order to keep manageable of integrated units some of the thematic classes have been merged as shown below.

Preparation of Action plan

By integrating the data such as Infrastructure map, slope map, land use and land cover map, soil map, hydro-geomorphology map, drainage map, cadastral map an action plan for watershed was prepared.

Map 9
Action Plan of the Study Area



The following conclusions can be drawn from the action plan of the sample watershed. They are;

1. Soil and Water Conservation

A good understanding of soil and water conservation with reference to their nature and distribution is essential to formulate any land based production system.

The watershed as a planning unit for development of land and water resources has gained importance since the Ministry of Agriculture, Government of India, initiated various developmental programmers on watershed basis.

According to the guide lines given by the department of Agriculture the soil and water conservation measures have been recommended for the 'Mothkuri' watershed depending upon the land attributes.

Dursh wood and random rubble (Loose Boulder) dams, contour bunds, vegetative barriers are suggested in uplands and foot hill regions, Check dams are proposed on lower order streams to control water velocity and to store the water. Construction of percolation tanks at suitable distances are suggested for supplemental irrigation.

2. Action Plan for Soil and Water Conservation Measures

Terracing and bonding and construction of brushwood dams and random rubble dams are recommended after considering the climate, groundwater potential, surface water availability, and morphology of the area, soil characteristics, current land use practice and slope of the area.

The socio-economic conditions of the particular watershed were also taken into consideration to suggest optimum utilization of land and water resources. Te details of action plan suggestions are described below.

3. Soil Erosion Control Measures including planting of soil binding species, gully control works etc;

These soil conservation measures are suggested in relatively flat cultivated areas. Vegetative barriers can be easily established across a wide spectrum of soil and climatic conditions except in arid conditions. These are usually a few rows of grasses and shrubs along the contours for erosion control. Water harvesting structures may be constructed across the slopes to store as much water as possible for use in lower slope areas

4. Ground Water Development with Conservation Measures and Horticulture/Nurseries Development

To increase crop lands, horticulture and nurseries groundwater exploration is suggested which is not earlier exploited in moderate range. The groundwater is a major source for irrigation in Mothkuri district. Horticulture plantations with interspaced cultivation can bring better returns than the field crops. Interspaces in horticulture plantations may be grown with vegetables in both seasons. Different tree species are recommended for forest nurseries.

5. Fodder/Fuel Wood Plantation

These are suggested in the marginal lands with poor groundwater potential areas and not able to sustain crops. The open forest areas may be converted into grazing lands by over seeding grasses and fuel wood species are recommended to meet the demand of local people requirement.

6. Afforestation

Afforestation is proposed in the forest blanks/open forest areas to increase the density of vegetation. These gaps may have been caused due to several reasons which include grazing in the initial stage and unauthorized tree felling. The economic forest plantations are suggested for compensating forest degradation.

7. Recommended Optimal Land Utilization and Farming System (ROLUFS)

Various soil and water conservation measures, cropping patterns, alternate land use systems are proposed based on the climate, current land use pattern, soil characteristics, water potential, slip, morphology etc.,for the development of the watershed area.

These recommendations give better benefits for the optimal land utilization with our hampering the productivity and quality of environment of the natural resources/ecological setup.

8. Recommended Cropping Systems for Watershed

The watershed area is divided into wastelands, non-agricultural areas and agricultural areas. Accordingly different recommendations are given and described as below.

9. Wastelands

The barren and stony areas, dykes & land with or without scrub come under this category. Quarrying, over seeding of grasses, silvipasture are recommended in these areas. No specific recommendations are given on dykes, since dykes cannot be retrieved. In stony areas quarrying may be taken up. Overseeing on grasses, silvipastures, agro-forestry plantation are commended on upland with or without scrub. Water harvesting structures in middle slopes ranging from 5-10% will help in raising soil moisture, in slopes at higher reaches brushwood dams and rubble dams will arrest soil erosion. Water-harvesting will improve subsoil moisture helpful for crop growth and change in land use. In uplands higher slopes should be covered with Agro-forestry or silvipastures.

CONCLUSION

The results have shown that in the total study area of 6133.35 Ha, consideration of the existing socio-economic scenario is necessary before implementing any sort of land use practices in the study area in future. It is expected that the findings of the investigation will undoubtedly be of use to planners and local bodies to implement suitable land use plans in the watershed, thereby achieving eco-preservation and enabling the restoration tanks under various watershed programmes.

REFERENCES

1. T. Subramani and V. Vishnumanoj (2014),"Land Use & Land Cover Change Detection and Urban Sprawl Analysis of Panamarathupatti Lake, Salem", International Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 6(Version 2),pp.217-127.
2. S.Tamilenthi1 et al,(2011), "Dynamics of urban sprawl, changing direction and mapping: A case study of Salem city, Tamil Nadu, India", Achieves of Applied Science Research, 3,277-286 3. P. P. Nikhil Raj, P. A. Azeez (2010) " Land Use and Land Cover Changes in a Tropical River Basin: A Case from Bharathapuzha River Basin, Southern India", Journal of Geographic Information System, Published Online October 2010 (http://www.SciRP.org/journal/jgis).
3. M.Girish Kumar, Rameshwar Bali & A. K. Agarwal, October (2009) "Integration of remote sensing and electrical sounding data for hydro geological exploration— a case study of Bakhar watershed, India" Hydrological Sciences–Journal–des Sciences Hydrologiques. 388 Jiya George et al. International Journal of Science, Engineering and Technology, 2016, Volume 4 Issue 2 ISSN (Online): 2348-4098 , ISSN (Print): 2395-4752 5. J.Li and H.M.Zhao, (2003), "Detecting Urban Land Use and Land Cover Changes in Mississauga using Land sat TM images.
4. Adeniyi P.O and Omojola A. (1999) Land use Land cover change evaluation in Sokoto – Rima Basin of North Western Nigeria based on Archival of the Environment (AARSE) on Geo-information Technology Applications for Resource and Environmental Management in Africa. Pp 143-172.
5. Arvind C. Pandy and M. S. Nathawat 2006. Land Use Land Cover Mapping Through Digital Image Processing of Satellite Data – A case study from Panchkula, Ambala and Yamuna nagar Districts, Haryana State, India. Anderson, et al. 1976. A Land Use and Land Cover Classification System for Use with Remote Sensor Data. Geological Survey Professional Paper No. 964, U.S. Government Printing Office, Washington, D.C. p. 28.
6. Christaller (1933), Central Place Theory – Wikipedia Free Encyclopaedia Coppin, P. & Bauer, M. 1996. Digital Change Detection in Forest Ecosystems with Remote Sensing Imagery. Remote Sensing Reviews. Vol. 13. p. 207-234.
7. Daniel, et al, 2002 A comparison of Land use and Land cover Change Detection Methods. ASPRS-ACSM Annual Conference and FIG XXII Congress pg.2. Dimyati, et al.(1995).
8. An Analysis of Land Use/Land Cover Change Using the Combination of MSS Land sat and Land Use Map- A case study of Yogyakarta, Indonesia, International Journal of Remote Sensing 17(5): 931-944.ERDAS, Inc. 1992. ERDAS Production Services Map State for Georgia DNR in the Monitor, Vol. 4, No 1, ERDAS, Inc, Atlanta, GA.

9. Shoshany, M, et al (1994). Monitoring Temporal Vegetation Cover Changes in Mediterranean and Arid Ecosystems Using a Remote Sensing Technique: case study of the Judean Mountain and the Judean Desert.
10. Journal of Arid Environments, 33: 9 – 21.Singh, A. 1989. Digital Change Detection Techniques Using Remotely Sensed Data. International Journal of Remote Sensing. Vol. 10, No. 6, p. 989-1003.U.S. Geological Survey, 1999. The Land sat Satellite System Link, USGS on the World Wide Web. URL: http://landsat7. usgs.gov/ landsat_sat.html.11/10/99.
11. http://www.icsm.gov.au/cadastral/Fundamentals_of_Land_Ownership_Land_Boundaries_and_Surveying.pdf retrieved on 4-5-2017.