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Land Use Planning for Sustainable Development Using Geoinformatics – A Case study in Suryapet Mandal, Nalgonda District

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Abstract

The paper presents an example of the application of the land use planning for sustainable development in Suryapet Mandal, Nalgonda District, Andhra Pradesh (2013). The aim of the research was to propose evaluation methodology applied in GIS environment and based on available digital (or easy for digitalization) spatial data. IRS_LISSIII - 2013 were used for LU/LC. Drainage, TIN, DEM, Slope, Aspect, LU/LC, and Soil data were collected and mapped using GIS software. The ground water potential, Land Productivity and action plan maps were prepared and used for land use planning. The present study helped in the reconnaissance survey of the area as well as integrating the information to look at different scenarios in the landscape and plan for sustainable use of the land. The approach has given good insight into the areas potential for alternate land use. The action plan prepared using this approach shall help the administrators in taking decisions regarding resource use and mobilization of support for a change. The action plan not only serves as a guide but also as a blue print for natural resource management for sustainable development. Compilation and collation of information of the area under study is the preliminary task in planning. The availability of remotely sensed data at high spatial and temporal resolutions has facilitated the planners to access natural resource information at a rate faster than never before.

Key Words:
Spatial Analysis, Sustainable Development, Landscape Functions and Groundwater Potentials, Land-Use Planning, Action Plan, GIS and RS.

1. INTRODUCTION

As population and human aspirations increase, land becomes an increasingly scarce resource, calling for land-use planning. Land-use planning is important to mitigate the negative effects of land use and to enhance the efficient use of resources with minimal impact on future generations. Land-use planning is defined as a systematic assessment of land and water potential, alternatives for land use, and the economic and social conditions. Land-use planning can help coordinate various land uses in a watershed, thereby minimizing conflicts and sustaining water quantity and quality for future generations. This schematic represents typical land uses and conservation strategies that might be found in a coastal mountain watershed required to select and adopt the best land-use options. Various author were execute land use planning across India namely M.K. Jain (1996), A.Sathish et.al (2006) and Sah et.al (1998). The main objective of this planning

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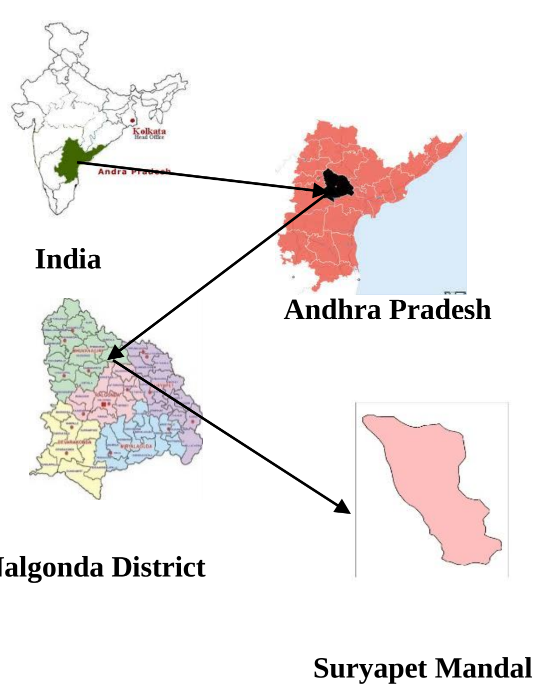
process is to allocate land uses to meet the needs of people while safeguarding future resources. The planning process is iterative (cyclically repetitive) and continuous, and three goals are used to develop a plan: efficiency, equity, and sustainability. Efficiency in land use is achieved by matching different land use with areas that will yield the greatest benefit at the least cost. Equity in land use focuses on reducing inequalities in income, food security, and housing. Sustainable land use meets the needs of the present while conserving resources for future generations. Land-use planning aims at achieving a balance among these goals through the use of information on trade-offs, appropriate technology, and consensus-based decision-making. Effective land-use planning often involves local communities, scientific information on land resources, appropriate technologies, and integrated evaluation of resource use.

2. Study Area

Figure 1: Study Area



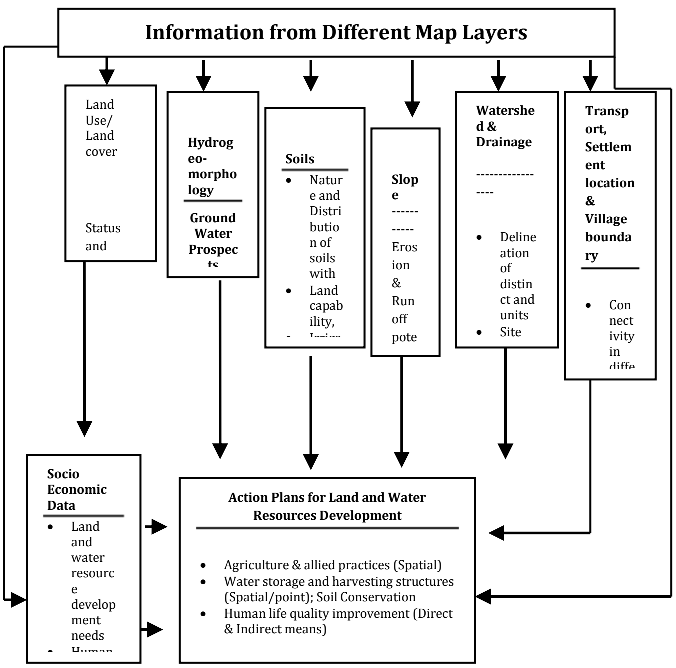
Suryapet is one of the major towns in Nalgonda district in the Indian state of Andhra Pradesh. As per 2013 record the population of the town is about 103,000. Suryapet is spread over an area of 34 km² and divided into 28 municipal wards. There are 44 notified slum areas. Apart from the city population, it has a floating population of approximately 20,000 from the neighboring villages daily. The geo Geographical area of the Mandel is 21,243 hec. Suryapet or Suryapet is located at 17^{0}09’ and 17^{0}15’ of the northern latitude and 79^{0}37’ and 79^{0}61’67” of the eastern longitude. It has an average elevation of 266 meters (875 ft.) foliated whereas the granites are massive. The remaining part of the Mandal is covered by limestone, quartzite, and chists.

3. METHODOLOGY

3.1 Data and Process

The methodology adopted for the study consists of resources inventory, creation of digital data base, identification of critical area, development of action plans for Rational Land use Planning. For generating base line information on various resources of the study area satellite data along with ancillary data was used. Base map and drainage maps were prepared from SOI topographical sheets with important natural and cultural features like streams, road network, settlements etc. The thematic maps viz., geomorphology, soils, land use, drainage have been prepared by visual interpretation of IRS-P6 LISSIII for the study area in association with other ancillary data in the form of published reports and SOI Toposheets Multivariate techniques can help to simplify and organize large data sets and to make useful generalizations that can lead to meaningful insight (Laaksoharju et al 1999). Cluster and factor analyses are efficient ways of displaying complex relationships among many objects (Davis 1986).

Flowchart - showing the methodology for land use/land covers map



In general, the PCA gives large set of principal components to explain the relationship among the chemical variables. The computer package Statistical Packages like for Social Sciences (SPSS) and STATISTICA 6 have been used to carry out the analysis. The data have been standardized by using standard statistical procedures. The interpretation of the principal components can be simplified, using the certain rotational procedures. In the present study, the varimax normalized rotation of Kaiser (1958) was applied to obtain a simple structure with scores. The scores are obtained called factor scores, which show the intensity of chemical process (factor) described by each principal component (Dalton and Upchurch, 1978). Regionally distributed and lithological controlled variables are extracted first from the principal component scores and the more local pathway/origin controlled variables are then identified (Lawrence and Upchurch, 1982). Three sets of plots were made from the PCA results. (1) Scatter plots between the component loadings of the three selected principal component scores of Kaiser Varimax normalized rotation and (iii) sample – wise areal distribution of the principal component scores on the map area.

3.2 Software and Data Process

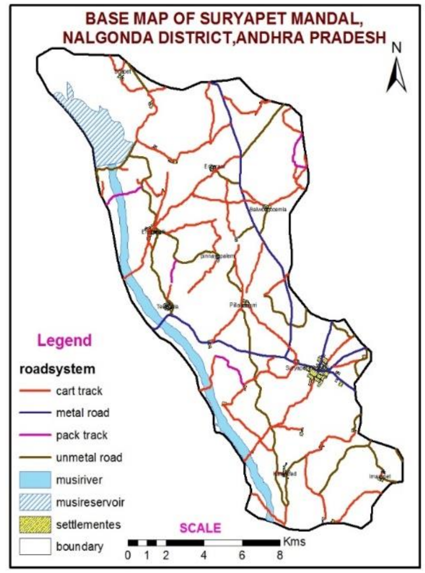
Multi-thematic mapping is done in the study area by using Primary and Secondary data. The visual interpretation of satellite data was carried out based on the image characteristic such as tone, texture, pattern, shape, size, association etc. It was followed by limited field checks. Appropriate legends were adopted for all the thematic maps. Soil maps was prepared using summer season satellite data. To prepare the land use and land cover map kharif, Rabi and summer seasons data were used. Digital data base for all the thematic maps will be generated using Arc GIS package with appropriate attribute data. Integrated analysis will be performed on thematic maps and composite land development units (CLDUs) map was generated through 'union' operation in GIS. Each CLDU reflects the resources potential/limitation helps to arrive at appropriate action item for the development. A scheme for thematic data integration and recommendation for various combinations of land parameters will be evolved by observations in the field. Following the scheme of data integration, action plan maps were generated giving suitable site – specific Topographical sheets (56 O/7, 56 O/11, 56 O/12 are acquired from Survey of India False color composite satellite image, IRS-P6 LISS-III satellite imagery. The ground truth information was taken for verifying the doubtful areas in the satellite image. In this study use Arc GIS software was used for the preparation of layout. ArcGIS includes a suite of integrated applications that allow performing GIS tasks, from simple to advanced, including mapping, geographic analysis, data editing and compilation, data management, visualization and geoprocessing. In this study ArcGIS were used for reclassification, change detection and calculate the area. The 3D Analyst tool and conversion tool were used for create the TIN and DEM creation in watershed. Spatial Analyst tool and surface tool were used for create the slope, Aspect in watershed creation. Hydrology tool were used to create the Flow Direction, Flow Accumulation and Fill. For reclassification the Spatial Analyst tool were used.

4. RESULTS AND DISCUSSION

4.1 Base Map, Contour and Drainage Map

A base map is the frame to which all your ancillary data will be registered. Base map is prepared from Survey of India Topo-sheets on 1: 50,000 scale comprising

Figure 2: Base Map



drainage system, settlements and road network within the boundary. In base map settlements, roads, etc. are identified. Contour is an imaginary line joining the points of equal elevation. Contour map has been prepared with the interval of 20meters. The study area is having an undulating topography and the elevation varies from 160 meters to 440 meters above the Mean sea level.

Figure 3: Contour Map

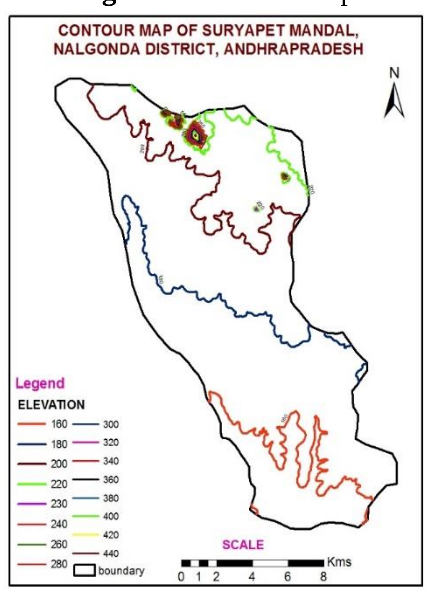


Figure 4: Drainage Map

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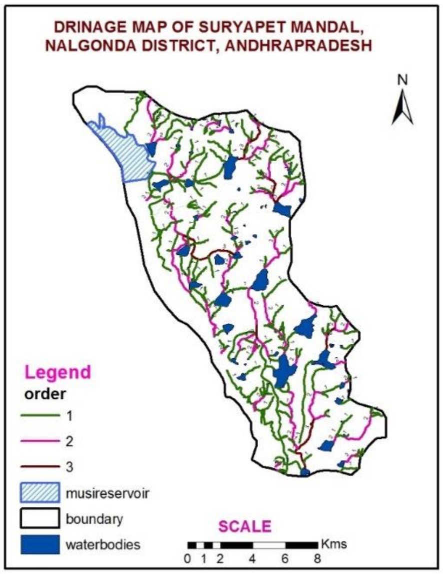
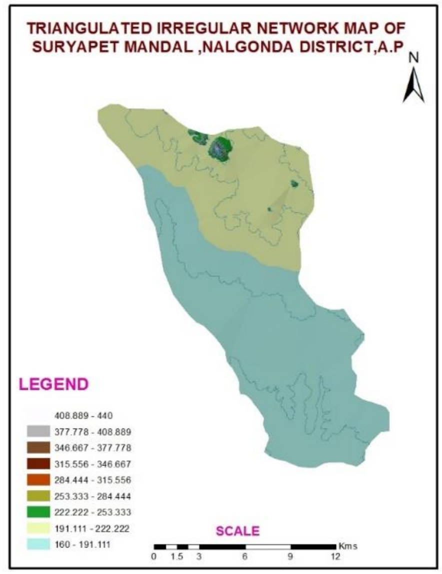


A drainage basin or watershed is a natural unit draining run-off water to a common point. 3rd order is the maximum order in this Drainage map.

4.2 Generation of TIN (Triangulated Irregular Network) & DEM (Digital Elevation Model)

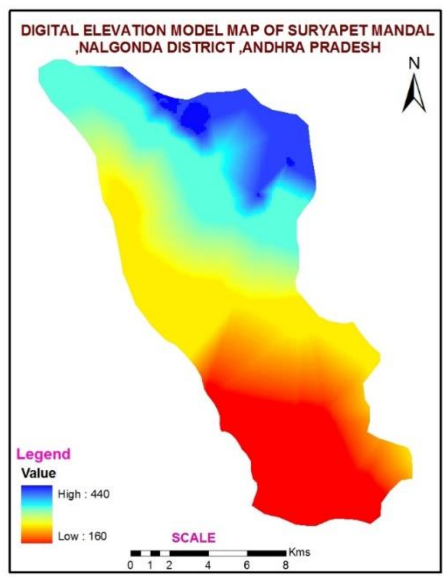
For this contour data thus generated in the vector format has to be used to generate TIN using Arc Map 3D analyst functions. Later this TIN has to be converted to DEM (Elevation raster) raster form by using spatial analyst functions. Slope map can be generated from the elevation raster by surface analysis tools under spatial analyst functions.

Figure 5: TIN



Similarly, aspect map can also be prepared from the slope map in the same method mentioned. A TIN data model is composed of nodes, edges, triangles, hull polygons and topology.

Figure 6: DEM



TIN is surface from features, such as points, line and polygons that contain elevation information. Use points as spot locations of elevation data use lines with height information to enforce natural features such as lakes, streams, ridges and valleys. Polygon to clip the TIN as area of study.

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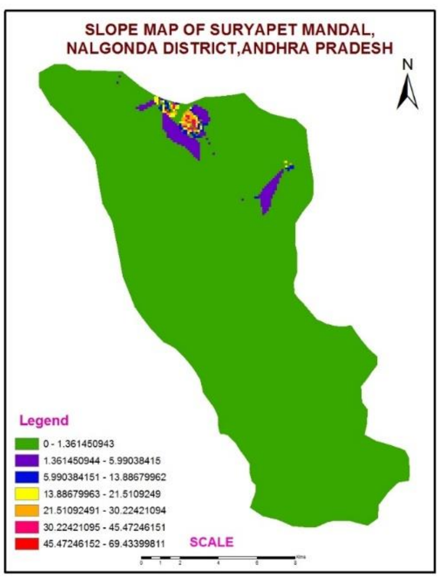
A digital elevation model (DEM) free of sinks—a depression less DEM—is the desired input to the flow direction process. The presence of sinks may result in an erroneous flow–direction raster. In some cases, there may be legitimate sinks in the data. It is important to understand the morphology of the area well enough to know what features may truly be sinks on the surface of the earth and which are merely errors in the data.

4.3 Slope and Aspect

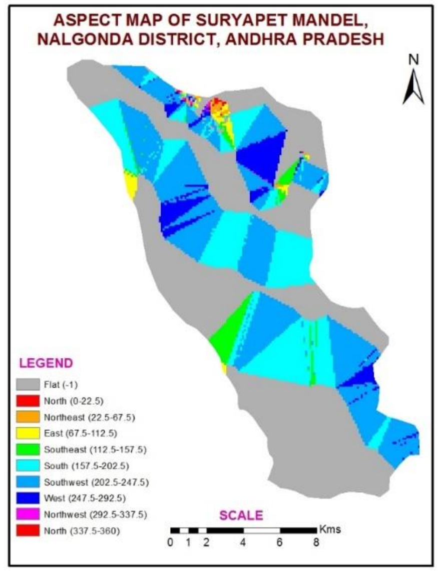
The Slope command takes an input surface raster and calculates an output raster containing the slope at each cell. The lower of the slope value is, the flatter the terrain. The higher of the slope value is, the steeper the terrain. The output slope raster can be calculated as percent slope or degree of slope. Extracts slope information from an input TIN into an output feature class. Produces a polygon feature class is whose polygons are determined by the input TIN's triangle slope values.

Figure 7: Slope



Aspect is the direction that a slope faces. It identifies the steepest down slope direction at a location on a surface. It can be thought of as slope direction or the compass direction a hill faces. Aspect is calculated for each triangle in TINs and for each cell in rasters. Extracts

Figure 8 : Aspect



aspect information is from an input TIN into an output feature class.

4.4 Land Use/ Land Cover

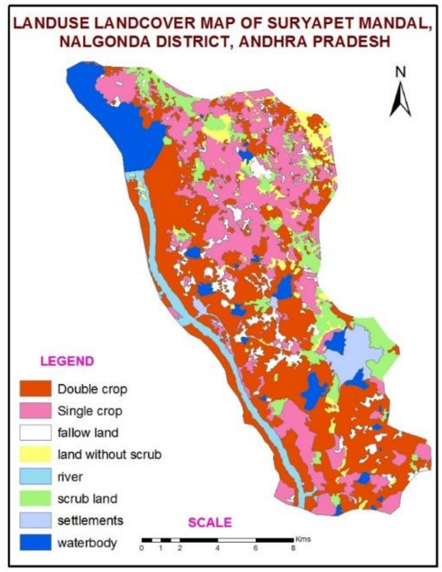
These are the areas of human habitation developed due to intensive non-agricultural use. The major villages in mandel are Endlapally, Suryapet town, Pillalamari, and other villages. The settlements cover an area of 708.2 hec. The use of multi temporal satellite data enabled sub-dividing this category into Kharif and double cropped areas. An estimated 8574.92 hec land is used under Kharif crops. The major crops that are grown during this season are paddy, Groundnuts. Double crops are taken in an area of 5551.92 hec of land. It occupies around 26.1% of the total area of the Mandal. The major crops that are grown during this season are chilies, cotton. Fallow Lands are the agricultural lands temporarily allowed to rest uncropped during the agricultural year. This category could be delineated using temporal satellite data wherein the signature of crops in the cropped areas are conspicuous by their absence as on the data of satellite overpass.

Table.1
Areal Extent of Various Land use/Land cover

Mapping Unit	Land use/ Land cover category	Area in hectares	Area in %
1	Double crop	8574.924	40.3
2	Single crop	5551.920	26.1
3	Fallow land	1221.144	5.74
4	Scrub Land	1740.531	8.19
5	Land without Scrub	773.0477	3.63
6	Settlements	708.2005	3.33
7	Water bodies	1881.136	8.85
8	River	846.519	3.98
Total		21,243.53	100

There may be various reasons that may be attributed for keeping the land fallow – like social, economic and natural factors. This category occurs as small isolated pockets within crop land and cover an area of 1221.14 hec.

Figure 9: LU/LC



It covers around 5.74% area of the total area of the Mandal. The land with scrub are the lands with soils that are too shallow; skeletal or chemically degraded lands with moderate to steep slope and are mostly covered with scrubs of different densities and varying height. Scrub lands taken an area of 1740.53 hec, it covers around 8.19% 0f total area of Mandal. Land without scrub is the counter part of the previous category, but without any vegetation cover on the land. The total area under this category is 773.04 hec .It covers around 3.63% of the total area of the Mandal. The streams/rivers, tanks, jheels and reservoirs are included in this category. The major rivers flowing in the study area are the tributary Musi River. In addition to the reservoir, Musi, there are a good number of tanks of varying sizes spread over throughout the Mandel. These are being used for irrigation and drinking purposes.

Water bodies cover an estimated area of 1881.13 hec. It covers 8.85% of the total area of the Mandal

4.5 Soil

Soil one of the non-renewable natural resources, is very valuable constituent of the ecosystem. Hence for formulation of any action plan for sustainable development and for its subsequent implementation, the information on soils with regarded to their nature, location, extent and physical-chemical characteristics is pre-requisite. Soil surveys provide desired aforesaid information on soils along with their spatial distribution. Until recently, soil surveys have been carried out using topographical sheets and cadastral maps as data base. The development of aerial photo interpretation techniques in late sixties in India substantially augmented the efficacy of soil mapping programme.

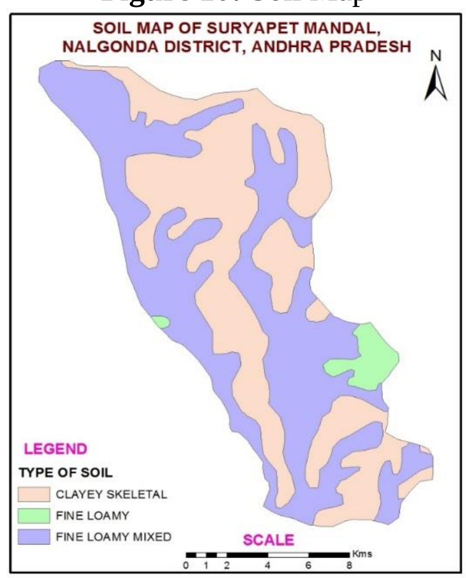
Table: 2

Areal Extent of various Soil Unit

Mapping Unit	Area in hectares	% Area
1	9777.69	46.02
2	678.55	3.19
3	10787.26	50.77
Total	21,243	100

Soil is a natural body differentiated into horizons of mineral and organic constituents usually unconsolidated, of variable depth

Figure 10: Soil Map



which differs from the parent material below, in morphology, physical properties and constitution, chemical properties and composition as well as biological characteristics.

4.6 Ground Water Potential Map

***Zone I*:** It consists of geomorphologic units like Valley fill, Intermountain valley and Structural valley. The material in Valley fill is formed of Gravel, Sand, Silt and Clay of river sediments. It consists of unconsolidated sediments. It has a structure

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with gently dipping beds with faults and fractures. It occurs as narrow valleys surrounded by hills all around. It is highly suitable for shallow and deep aquifers with very good recharge. The area of their Zone is around 110.8636hec. It is around 0.52% of the total area of the Mandal.

Zone II: It consists of geomorphologic units like Shallow Weathered Pedi plain with litho stratigraphic units like Narji limestone and peninsular gneiss and granite. The total area of the Zone is 9606.31 hec. It is around 45.2% of the total area of the Mandal.

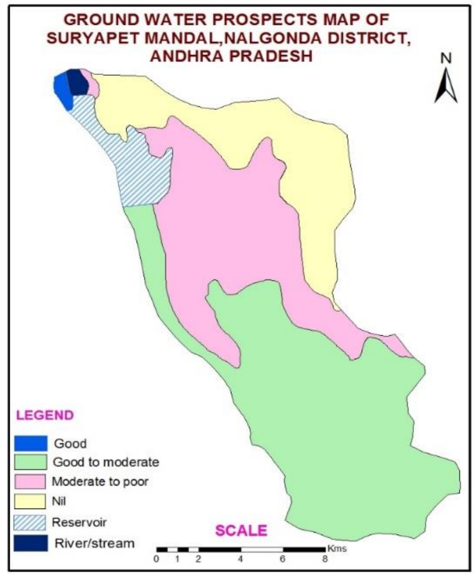
Table: 3
Areal extent of various Ground water potential zones

Zone	Ground water Potential	Area in Hectares	% Area
I	Good	110.83	0.52
II	Good to Moderate	9606.31	45.21
III	Moderate to Poor	6051.72	28.48
IV	Nil	4297.58	20.23
V	Reservoir / Tank	1066.95	5.02
VI	River / Stream	109.86	0.51
Total		21,243	100

Zone III: The weathered zones forms shallow aquifers. The deeper aquifers occur along faults/fracture zones. The total area of the Zone is 6051.72 hec. It is around 28.4% of the total area of the Mandal.

***Zone IV*:** It has geomorphic units like Residual hills, Inselbergs and Pediment Inselberg Complex. The material in the units is made up of peninsular gneiss and granite. It has a structure of foliated gneisses interspersed with massive granite. The total area of the Zone is 4297.58hec. It is around 20.23% of the total area of the Mandal.

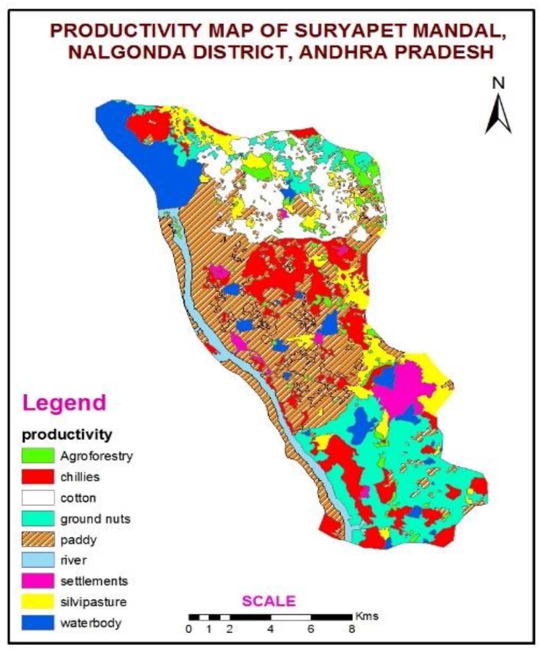
Figure 11: Ground Water Potential Map



4.7 Proposed Productivity

In this suryapet Mandal productivity includes paddy, Ground nut, cotton, chilies etc.

Figure 12: Proposed Productivity



4.8 ACTION PLAN

The strength of GIS is the integration of multi-layered data from different sources and various scales. The integration of different layers of information

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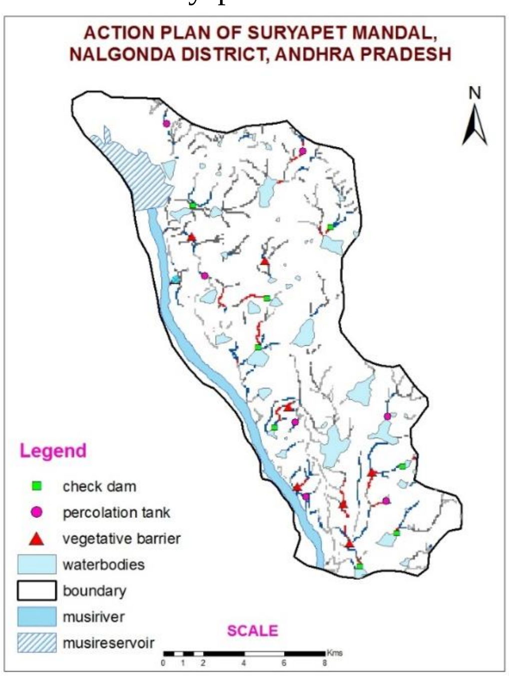
has been a difficult task manually until the maps were drawn on a transparent film. With the availability of GIS, which takes the data into digital space, the ability to see through maps, which are overlaid one over the other digitally and analyze the maps is achieved. Database management systems integrated with graphic interface have a powerful query capability. This will finally give the analytical ability to pose complex query and extract information spatially.

Remote sensing data is the final solution for large area coverage and temporal coverage of land area. It is an important source of input to GIS. Different layers of information generated from remotely sensed data provides an authentic input when used in a GIS. The analysis carried out in the present study uses primarily information generated from remotely sensed data. Layers were generated for land use, soil, ground water potential, slope, along with base map. The soil map is taken as the base.

Figure 13: Action Plan Map of Suryapet Mandal



All the layers were brought to a common coordinate system so that integration is possible and the accuracy of the output is maintained. The preparation of action plan for land resources involves the integration of layers such as land use, ground water potential, soil, and slope. Arc/Info GIS software is used for integration of the layers. The layers were integrated using the UNION command. Once the layers are integrated, a multi-criteria approach has been adopted to obtain information for different combinations of land use, ground water, soil, and slope. Arc view GIS software is used for the multi-criteria query to zone the land into areas of similar criteria. Preparation of action plan involves the suggestion of alteration of present system of land use or alternate system, depending on the local condition of prevalence of practice and socio-economic conditions.

i. Check dam: A check dam has an earthen dam with a masonry spill way. Under permanent check dams concrete or masonry or earth dams to store and slow down water are suggested. The study revealed that check-dams increase ground water level, decelerate soil erosion and help to increase crop yields in the study area.

ii. Vegetative Barriers: Vegetative barriers are closely space gross hedges or plantations – usually a few rows of grasses or shrubs – grown along contours or with little grade for erosion control in agricultural lands. Of late, opinions are gaining ground that vegetative barriers

iii. Land Use Planning: Based on careful integration of information on soil, land use/ land cover, ground water potential and slope, the following action plan have been formulated in development of land, soil and water conservation. Different themes on land resources of the study area were integrated and the management needs of different landscape units were assessed. The scheme of integration is given in Table 4.

Table.4
Scheme of Integration

Soil map ping unit	Ground water potential zone	Land use/ Land cover	slope	Proposed productivity	Proposed conservation measures
1	II,IV,VI	SC,DC,LWWS	3-5%	Paddy+cotton	Gully control measures, vegetative barriers, percolation tank
2	II	SC,DC	0-1%	Ground nuts+chillies	Percolation tanks, vegetative barrier
3	II,IV	SC,DC,FL,LWWS	1-3%	Silvipasture+ Agroforestry	Vegetative barrier

SC- Single Crop, DC- Double Crop, FL- Fallow Land, LWWS- Land with or without Scrub

A resource based action plan package was evolved for the development, conservation and management of the area on a sustainable basis. The different mapping units and the suggested action plan package along with their areal extent are furnished in Table 5 & 6. The action plan will aid planners as well as other executing agencies in implementing various developmental programmes in the Mandal

iv. Agricultural Lands: Most of the area in the Mandal is cultivated either during one or both the cropping seasons (depending up on potential / limitation of soils). These areas provide the maximum scope for development since they are under - utilized at present and are not fully exploited for crop production. With the adoption of few management practices, cropping intensity on these lands can be increased considerably. Consequently, the crops could be raised every year in the same piece of land.

The alternate land use proposed for agricultural productivity is as follows: Chilies is proposed in the soil unit 2, in the combination of ground water prospects and present land use as shown in the Table 5.1. The total area proposed for chilies and cotton crop is 5551.92 hec. Paddy and Groundnut is proposed in the soil units 2, 4, 6 with combinations of ground water prospects, land use, slope as shown in the Table 5.1 the total area proposed is 8574.92 hec.

v. Agro-Forestry

For marginally cropped areas, some permanent vegetative cover in the form of fodder, fuel wood and small timber-yielding tree species has been recommended. This practice, known as 'agro-forestry', not only stabilizes such lands by controlling soil erosion but also improves the fertility of the soil. The tree component under agro-forestry is preferably nitrogen fixing, fast growing, drought-tolerant and multi-purpose in use. The multipurpose tree species recommended are Leucaena Leucocephala, Glyricidia Sepium, Cassia Siamea, Sesbania Sp., Albizia Lebeck. About 773.04 hec of area has been recommended for agro-forestry.

Vi. Silvipasture

This system essentially consists of a top feed tree species and grasses or legumes as understored crop. This system is most suited to marginal drylands and is preferable where fodder shortages are experienced frequently. Also, to increase fodder supply in rural areas and to improve effective interaction between livestock raising/ animal husbandry and crop production, grazing and fodder resources should be created in areas accessible to villages. One effective method will be to introduce silvipasture land use pattern such as growing of:

- Fast growing fodder shrubs and trees in crop lands and pasture lands.
- Pastures in plantations, orchards etc.
- Pastures in forest tree plantations.

About 1740.53 hec of area has been recommended for silvipasture

Table.5
Areal Extent of Proposed Productivity

S.no	Proposed Productivity	Area in hectares	Percentage
1	Paddy+Groundnuts	8574.924	40.3
2	Cotton+Chillies	5551.920	26.1
3	Silvipasture	1740.531	8.19
4	Agro forestry	773.04	3.63
5	Settlement	708.2005	3.33
6	River / Stream	846.519	3.98
7	Reservoir / Tank	1066.95	5.02
	Total	21,243.53	100

Table 6
Areal Extent of Proposed Conservation Measures

Mapping Unit	Control Measures	Area in hectares	%Area
1	Gully control measures, vegetative barriers, percolation tanks.	9777.69	46.02
2	Percolation tanks	678.55	3.19
3	Vegetative barriers.	10787.26	50.77
	Total	21,243	100

vii. Vegetative Barriers: Vegetative barriers are closely space gross hedges or plantations – usually a few rows of grasses or shrubs – grown along contours or with little grade for erosion control in agricultural lands. Of late, opinions are gaining ground that vegetative barriers alone at suitable vertical interval may be sufficient for runoff and erosion control in relatively flat and slightly undulating topography. But it is, safer to have vegetative barriers only as inter-terrace treatments.

viii. Gully Control Measures: Depending on the severity of erosion, different types of mechanical protection measures have been recommended for arresting soil erosion and surface water run-off.

xi. Contour Trenching: The trenches may be staggered or of continues type. Their spacing or vertical interval depends on the slope of the land. Spacing may vary from 30-60 meters. Normally, continuous trenches are with a cross – section not exceeding 60 cmX30cmX60cm. The cross-section is designed to collect and convey the run-off expected from the inter spaces between two successive trenches. Staggered trenches are of shorter length from 4-15 m with a cross section of 30 cm X 30 cm. In the alternative row, the trenches are located directly below one another. On the excavated soil piled on the downhill slope, grass seeds may be sown and saplings may be planted.

x. Check Dams: These structural measures are desirable for medium and large – sized gullies A check dam has an earthen dam with a masonry spill way. Under permanent check dams concrete or masonry or earth dams to store and slow down water are suggested. The study revealed that check-dams increase ground water level, decelerate soil erosion and help to increase crop yields in the study area

xi. Percolation Tanks: The criteria for locating these structures is similar to check dams except that the catchment area is larger and benefit is more in terms of land that can be irrigated either through surface or ground water utilization. These structures are primarily useful for surface water irrigation by gravity and augment the ground water recharge.

5. CONCLUSION

Land and water resources have reached a critical point due to greater pressure with the growing demand for food, fibre and fuel by the burgeoning population in India Land use planning of Suryapet Mandal, is situated in Nalgonda district, Andhra Pradesh. The total geographic area is 21243.53 hectares. in this area constructs by check dams, vegetative barrier, and percolation tanks. In this suryapet

Mandal productivity includes paddy, Ground nut, cotton, chilies etc the alternate land use proposed for agricultural productivity is as follows: Chilies is proposed in the soil unit 2, in the combination of ground water prospects. The total area proposed for chilies and cotton crop is 5551.92 hec. Paddy and Groundnut is proposed in the soil units 2, 4, 6 with combinations of ground water prospects, land use, slope 1 the total area proposed is 8574.92 hec. Earth observation satellites provide the vantage point and coverage necessary for studying our planet as an integrated physical and biological system. Over the past decade India has continuously and successfully shared the platform with the developed countries in the monitoring of the earth with its own series of satellites. The IRS series satellites have not only fulfilled the national mission in integrated development but are also a source of internationally standard data. The present study has utilized the IRS – P6 data set. The data set not only satisfies the needs of the planning at which the study is done but also provides a fastest best solution for a large area comprehensive survey.

The remotely sensed data from the IRS–P6 satellite is the ideal choice for its technical and economic viability. The IRS–P6 LISS III sensor with spatial resolution of 23.5m is used to obtain information on land use over two seasons. Soil mapping also carried out in the summer data set. Landform mapping for water resources targeting is also carried out using the IRS-P6 data. With sufficient ground truthing large areas can be accurately surveyed for a particular purpose. The initial task of survey and appreciation of the landscape is accomplished using the remotely sensed data obtained from the Indian Remote Sensing Satellite. It is axiomatic that in assessing the potential use of land, the existing land use must be taken into account in order that the feasibility of improving production can be assessed.

The present study helped in the reconnaissance survey of the area as well as integrating the information to look at different scenarios in the landscape and plan for sustainable use of the land. The approach has given good insight into the areas potential for alternate land use. The action plan prepared using this approach shall help the administrators in taking decisions regarding resource use and mobilization of support for a change. The action plan not only serves as a guide but also as a blue print for natural resource management for sustainable development. Compilation and collation of information of the area under study is the preliminary task in planning. The availability of remotely sensed data at high spatial and temporal resolutions has facilitated the planners to access natural resource information at a rate faster than never before. Land use map is the first map which any planner would need to look at the extent of use to which the land is put. For purposes of planning at the Mandal level the 1:50,000 maps generated using the IRS-P6 data were found to be suitable. Soil map were the preliminary dataset generated from the satellite data. Information derived by integrating and analyzing the above factors were produced as derivative maps which are the action plan maps. The availability of resource information in the computer for long time makes it easier for planners to access the information in its previous form and also for obtaining outputs at will. GIS has become an invaluable tool in the planning setup. Integration of information being the sole operation involved in this study and an action plan is formulated for development

6. References

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