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Engineering

APPLICATION OF GIS AND REMOTE SENSING FOR PROMOTING IRRIGATION PROSPECTS IN UTNOOR AND INDRAVELLY MANDALS OF ADILABAD DISTRICT

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ABSTRACT : Adilabad is northern most district of Telangana state. having largest forest cover area and maximum rainfall in Telangana. The study area comprises of Utnoor and Indravelly mandals of Adilabad district. According to 2011 census Adilabad district has a population of 2,737,738. Utnoor mandal is having a population of 63,465 and Indravelly has 47,506.Utnoor has a tribal population of 51.97 percent and Indravelly has 57.24 percent of total population. There are total 37 and 34 villages respectively in Utnoor and Indravelly mandals. The area of Utnoor and Indravelly mandals are respectively 312.64 and 306.5 square kilometre. The main occupation of the people in the study area is agriculture. For the irrigation purpose farmers mainly depend on tanks and ground water. It is found that Utnoor is having relatively more no of surface water and ground water recourses, Even though there is adequate rainfall, there is no ground water storage capacities. Southern parts of Utnoor and Indravelly mandals have more forest cover area and a small part of north area of Indravelly is also have forest cover area. The soil in the study area is mainly black soil. since the water availability is low commercial crops like cotton are cultivated in the area. The main objective of the project is to suggest methods for promoting irrigation prospects using the GIS and Remote sensing techniques. The methods used are Digital Elevation Model (DEM), Rain Water Harvesting and Storage (RWHS). Rain fall data, crop calendar data will be used in the preparation of RWHS. RWHS depend upon soil type, geology, geomorphology of the study area. Slope map, contour map are used for the preparation of DEM. The expected outcome of the project is increasing the agriculture productivity by improving the irrigation prospects and infrastructure facility in Utnoor and Indravelly mandals .

KEYWORDS : Remote sensing, Irrigation, Prospects, Water Harvesting.

1. STUDY AREA

1.1 Introduction:

Adilabad district is bounded by Maharashtra state on northern, eastern and western sides and Nizamabad and Karimnagar districts on southern side, with a geographical area of 16,200 Square Kilometre and lies in between 77046'00" to 80000'00" Eastern Longitudes and 18040'00" to 19056'00"Northern Latitudes. Forests occupy 42.6% of the total area.

Utnoor is having maximum forest extent as compare to Indravelly mandal. The Southern parts of Utnoor and Indravelly mandals have more forest cover area and a small part of north area of Indravelly is also have forest cover area. Some of the villages are inside the forest isolated from other villages. Six villages of Indravelly and eleven villages of Utnoor have boundary with the forest.

1.2 Location & Extent:

The study area Utnoor and Indravelly mandals are located in the Adilabad district. It is situated between North Latitudes 19°54'42.806' and 19°31'16.121' and East Longitudes 78°19'1.237" and 78°33'52.224" and is covered in the Survey of India Topographical map numbers 56I/11 and 56I/15. This catchment area includes several minor and major tanks.

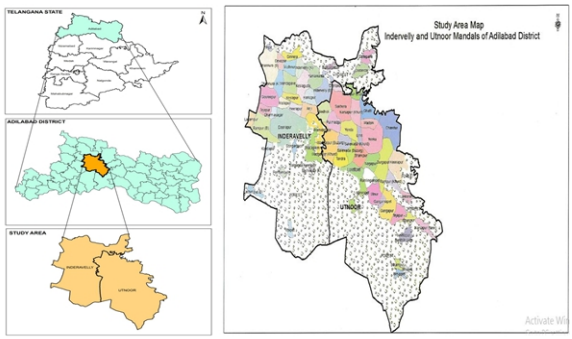


Fig 1: Location Map of Study Area

1.3 Climate / Rainfall and Temperature:

The North West monsoon commences by middle of June and extends up to end of September. The average rainfall recorded in this region is 1051 mm. of the total rainfall is received during the period from June to September. The mean annual temperature is 26.7ºC. From the month of February the temperature rise rapidly till May, this is the hottest month. The hot weather continues till the onset of monsoon.

1.4 Principle Crops:

Cotton, Soya bean and Groundnut are represents two seasons, they are Kharif and Rabi. In these mandals, Cultivation is based on rainfall and tanks.

Major Source of Irrigation: Tanks, Wells, Bore Wells.

Many villages of these Mandals having fertile lands which are good source for growing paddy, Jowar, Redgram, Cotton, black grams. Moreover, heavy annual rainfall of these mandals which recorded as 1105.5 mm. gives stimulus to the tiller to extend the cultivable areas to raise many crops.

The main objective of study is to prepare Hydro-geomorphological, Land use/Land cover, Soil, Crop production and slope maps of the mandals on 1:10000 scale using satellite remote sensing techniques. The study also includes the preparation of the themes of metrological data analysis, surface and ground water analysis including quality of ground water and land use/land cover pattern. This project, aimed at (1) conserve natural resources (2) increase the crop production through efficient use of available surface and groundwater resources.

2. METHODOLOGY

2.1. Data Used:

IRS – 1C PAN and LISS IV merged data was used in the study. Survey of India toposheets on 1:25,000 scale were used to collect topographic information, preparation of base maps, location of sample areas / ground truth sites and planning for traverse routes in the field. The other relevant information indicating geology and geomorphology of these mandals area was used from existing maps and reports.

Survey of India (SOI) topographical sheets and normal false colour composites (FCC) of IRS-1C Pan and LISS-IV merged data were used

for the study. 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 in GIS environment. (Sabins, F. F., (1997). The field observations have been incorporated in to pre-field interpreted maps and final maps have been prepared.

Subsequently the litho logical, structural and geo-morphological maps have been combined to prepare Hydro-geomorphological Map, Land use/ Land cover map, Drainage and Surface Water bodies, Slope Map and Soil Map on 1:25,000 Scales.

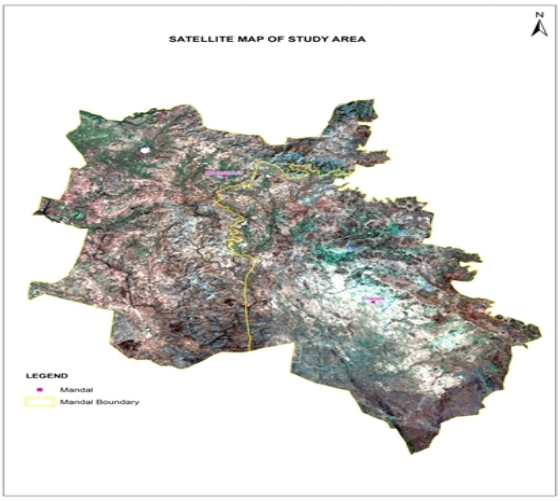


Fig 2: Satellite Map of Study Area

2.2. Drainage map/water bodies: 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 .the updated water bodies from the satellite imagery are included in the drainage map.

2.3. Slope mapping: Slope, aspect and altitude are important terrain parameters from land utilization point of view. Among the three, slope is very vital one for land irritability and land capability assessment.

Classification: The slope map showing following slope categories has been prepared on 1:25,000 scale. Steeper slopes of more than 35% can be further sub-divided as per local need especially in hilly areas. The aspect indicating following directions should be depicted on slope map for the last two categories of slope (having more than 15% of slope).

i) Slopes facing north including north east and north west
ii) Slopes facing south including south east and south west
iii) Slopes facing east and west.

Survey of India topo maps on 1:25,000 scale are to be used for deriving the information on slopes. A land with five meters of vertical drop over a horizontal distance of 100 meters has 5% slope. Accordingly, 10m or 20m vertical drop for every 100 meters of horizontal distance is 10% or 20% slope respectively. Topographical maps on 1:25,000 scales give contours with 10 meter interval or it's multiple i.e. Close spaced contours on the map have higher percentage slope as compared to sparse contours in the same space. Thus density of contours on the map can be used for preparing the slope map that gives various groups / categories of slopes.

2.4. Geology & Structure: These mandals are underlain by Archaean consisting of gneissic and granitic rocks. In the study area structures like joints, faults fractures and lineaments etc. have a bearing on the capacity of the rocks to hold and transmit groundwater. The area is marked by numerous fractures and the drainage is mainly controlled by these fractures/lineaments.

2.5. Soil : The soils of Indravelly, Utnoor mandals are derived geological formations, viz, granite and Basalt formation of Deccan traps. so the soil ranges of this area from red to mixed red and black soil. The red soils are originated from the granites and granite gneiss. The coarse loamy skeletal soils occupy hills. The mixed loamy red soils are occupied pediplain and shallow weathered pediplain. The fine loamy red soils occupied moderately weathered pediplains and valley fills occupied Alkali soils. block clayey soil are occupied those mandals in northern part. this soils suitable for cotton, chilli. It is observed that the fine soils are located in valleys and in tank commands, which are mostly under irrigated agriculture.(NBSS.1987).

2.6 Land Use / Land Cover: Land Use/land cover mapping for these mandals was carried out by standard visual interpretation techniques using IRS-1C PAN and LISS-IV merged false composite (FCC) Data Generated on 1:10,000 Scale. Identification of Different Land Use/land cover classes were made based on the image characteristics like tone, size , shape, pattern, texture, geographic location and association etc (NRSA1989).

Land use/land covers classes:

1. Built-Up Land: It is defined as an area of human habitation developed due to non-agriculture activities that include buildings, transport, communications, utilities in association with water and vegetation.

2. Agricultural Land: It is defined as the land primarily used for farming and production of food, fiber, and other commercial and horticultural crops. It includes land under crops (irrigated and un irrigated, fallow, plantations, etc). The principal crops in the catchment area are mainly Jower, Groundnut, Cotton, Red gram, Horse gram.

The chief irrigated Kharif crops in these areas are paddy, groundnut, and cotton. The major Rabi irrigated crops in the area are paddy, groundnut, sunflower and cotton. Few patches of citrus and papaya plantations are identified in the agricultural land.

3.Forest: mainly study area is scrub and deciduous forest. some parts are occupy forest plantations.

4. Wastelands: It is described as degraded lad which can be brought under vegetative cover with reasonable effort, and which is currently under utilized and land which is deteriorating due to lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed constraints such as, by location, environment, chemical and physical properties of the soil or financial or management constraints. The waste lands identified in the district are described below:

a) Salt-affected land, b) Gullied / Ravenous Land ,
c) Land with or without scrub,
d) Barren rocky/Stony waste/Sheet rock area .

Land use/Land Cover Class	Area	Percentage
Agricultural Land	328.43	44.06
Built Up Land	5.40	0.72
Forest Land	385.75	51.75
Wasteland	9.00	1.2
Water bodies	16.79	2.25
Grand Total	745.33	100

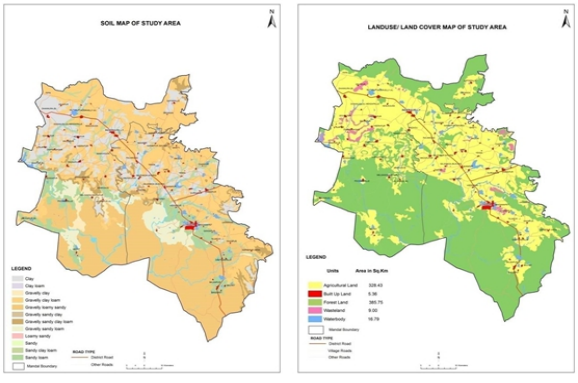


Fig 3: Soil and land use map of Study Area

2.7. Hydro-geomorphology:

The geomorphological map is to be prepared by demarcating the geomorphic units and forms. All the listed geomorphic units and landform details have to be grouped / classified as per the origin like fluvial, Aeolian, structural etc.

The geological details like Lithology / rock types and structural details are also to be delineated using available geological / geomorphological maps of the area. Then such geological details are incorporated on geomorphological map since this information is necessary in identifying the groundwater potential associated with each geomorphic unit. For instance pediment / pediplain without fractures / joints and lineaments normally has moderate to poor groundwater prospect whereas the same geomorphic unit with a network of fractures / joints indicates good groundwater prospects. Similarly a pediplain area of crystalline / metamorphic rock is generally marked by poor to moderate groundwater prospect wherein the same unit in sandstone or limestone / sedimentary rock can have a good to moderate prospect.

The legend should be classified and incorporated on the map based on the origin and chronology. All the details like geomorphic unit, structure, litho logy and prospect of groundwater have to be described.

hydro-geomorphic units:

Plateaus: Elevated flat uplands occupying large area(> 5 km x 5 km) and bound by escarpments/ steep slopes on all sides. Based on the geomorphic position ,they are classified into 3 categories-1)Upper,2)Middle and 3)Lower. Further, based on dissection, these Upper, Middle and Lower Plateaus have been further classified into undissected, moderately dissected and highly dissected categories.

Influence on the ground water regime: Ground water regime on the plateaus depends on their geomorphic position, areal extent, dissection pattern and recharge conditions, besides underlying Lithology, fractures and depth of weathering.

Mesa(M) & Butte (B) : Flat-topped hills having width 2 km to 250 m. It forms run off zones without any significant recharge potential and prospects. Butte is Flat-topped hills having width < 250 m.

Influence on the ground water regime: Shallow aquifers partially drain out into the deep valleys formed by dissection.

Moderately Weathered Pediplain (PPM - Gr): It is a gently sloping smooth surface of granite gneiss with more than 5m depth of weathered material, 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. Ground water development is extensive in these areas due to the availability of good ground water potential.

Shallow Weathered Pedi plain (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.

Influence on the ground water regime: Pediplain occupied by semi-consolidated sediments form good aquifers depending on their composition. In hard rocks, they form very good recharge and storage zones depending upon the thickness of weathering/accumulated materials, its composition and recharge conditions. Faults/fracture zones passing through Pediplain act as conduits for movement and occurrence of ground water.

Pediment: It is a very gently Sloping(5-7 degree)inclined bedrock surface. It typically Slopes down from base of a steeper slopes, retreating desert cliff or escarpment, but may continue to exist after the mountain has eroded away. It is caused by erosion.

Tor/ Inselberg: A tor is a large free standing rock out crop that rises abruptly from surrounding smooth and pentile slopes of a rounded hill summit or ridge crest. Inselberg is a isolated hillock.

Residual hill: The hard rock's left behind after erosion are called residual hill.

2.8. Ground water prospects:

The major landforms of the area include shallow weathered Pediplain, moderately weathered pediplain, residual hills, Inselberg, pediment and Dykes. The ground water prospects in shallow weathered pediplain are moderate to poor and while in moderately weathered pediplain the prospects are good to moderate. In pediments, the ground water prospects are negligible to poor while in hilly areas it is negligible. Excellent ground water prospects maybe expected in the fracture valley depending upon the thickness for the weathered material. The hydro geomorphology units obtained are moderately weathered pediplain, Shallow weathered Pediplain, and Pediment.

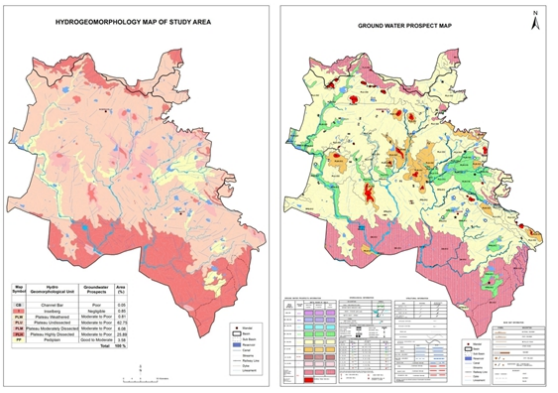


Fig 4.3: Hydro-geomorphology and Ground Water Prospects Map

3.0 Conclusions And Recommendations:

The observations are as follows:

1. The average rainfall of the area is 1054 mm. 77% of the annual rainfall is received during North West monsoon season.

2. With the help of satellite data, hydro-geomorphological map was prepared, land use/land cover, soil map, drainage map are delineated.

3. Most of the area is rain fed agriculture with cotton as a major crop and other crops are rice, groundnut, Jowar, soya bean etc.

4. Seven mapping units and soil series were identified in these mandals. Based on the different soils, Black Cotton Soil is covered more percentages of area than other type of soils.

5. Based on the land use/land cover map prepared by satellite data, Agricultural land covers 328.43 Sq.kms, Built up land covers 5.40 Sq.kms ,waste land covers 9.00 Sq.kms, Forest covers 385.75 Sq.kms, Water bodies covers 16.79 Sq.kms.

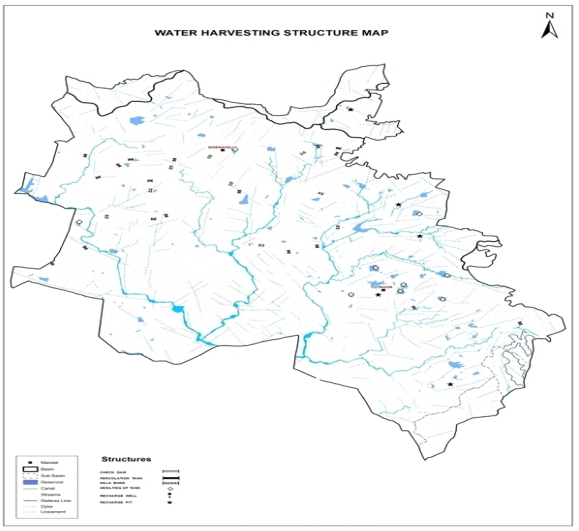
6. Based on the technical guidelines given by the department of agriculture, Crop pattern in different seasons is observed.

7. Based on the technical guidelines given by the department of Irrigation and CAD, there are more tanks when compared to bore wells, dig wells is observed.

8. Based on the hydro-geomorphological map, Ground water level is less compared to other mandals, hence water harvesting structures have been suggested.

The RWHS structures will be proposed on GIS platform by using Remote Sensing & GIS techniques by considering the district wise drainage layer as the main input to generate drainage nodes on 1st, 2nd and 3rd order streams, intersection of drainage nodes, slope categories (0-5% slopes), Geomorphology (shallow and moderately weathered pediplain zones), Land use / Land cover (by eliminating the command areas, double crop areas, barren rocky / stony waste, build up, and mining areas), and soil (red soil are considered and leaving the black soil areas) for identifying the new locations for RWHS. The proposed RWHS locations may be finalized on field verification by the officers concerned. (Krishnamurthy, J.& all 1990).

Fig 3: Proposed water harvesting structures these mandals Identification of Suitable Sites for Rainwater Harvesting Structures (RWHS):



Criteria to be adopted for taking up RWHS:
The following aspects are to be taken in to account while identifying the locations of the recharge structures.

- Location of the habitation
- Adequacy of recharge water
- Hydro-geological properties of aquifer material
- Slope / terrain condition
- The spacing between 2 check dams shall be not < 500 meters.
- Check Dams shall be taken up only in permeable soils, shall not taken up in BC / Alkaline soils.
- The approximate catchment area should be 50 Hectares.
- Reserve Forest area shall also be taken to consideration to arrive with the catchment areas.
- Rock Fill Dam (RFD)/Gabions/Gully Control works shall be taken up across 1st order streams.
- The existing functional structures shall be taken into consideration to take up new structure.

The locations of recharge structures which are to be constructed for harvesting the overland flow are identified about 200-300 m (approximately) upstream of the benefitted areas. Whereas the location of recharge structures which is to be constructed for harvesting the base flow is identified about 200- 300 m (approximately) downstream of the benefitted area. The recharge structures which are dependent on stream water are located mainly on 1st to 3rd order streams and at the most up to the initial stages of 4th order stream. No recharge structure is located on major streams / rivers occupying large area. (Arwal, C.S and Garg, P.K. (2000).

The criteria for selection of locations for various types of recharge structures are given below:

Check Dam: On the 1st and 2nd order streams along the foot hill zones and the areas with 0-5% slope Percolation Tank: On the 1st to 3rd order streams located in the plains and valleys having sufficient weathered zone / loose material / fractures.

Nala Bund: On the 1st to 4th order streams flowing through the plains and valleys where acquisition of land for inundation of large areas is not possible. Limited water will be stored in river bed for some time which increases recharge Invert Well / recharge Well: In areas where transmissivity of the upper strata is poor, for example in shales underlain by sandstones, in buried pediplains with top soil having low permeability, in Deccan Traps where vesicular basalt is overlain by massive basalt or thick black cotton soil or impervious zone.

De-silting of Tanks: The de-silting is to be done in small tanks which are partially silted up (Siltation in the tanks is found by study of the image and ground truth).

Sub-surface Dyke: On the stream courses flowing in unsaturated zones, for example vesicular / weathered / fractured basalt, lateritic terrain, etc., where the ground water seepage as base flow is significant. On the upstream side the subsurface storage improves.

Ground water recharge methods are environmental friendly, recharge can significantly increase the sustainable yield of an aquifer, increase the vegetation cover due to increase in soil moistures. It is the perfect solution to meet water requirements especially in the areas which do not have sufficient water resources. It helps in improving the quality of the ground water and increasing the level of the ground water level.

REFERENCES:

1. NRSA (1991). Technical guidelines: Integrated study to Combat Drought for Sustain able Development. Department of Space, Hyderabad.
2. Department of Space/ ISRO (1988). Manual for Hydro-geomorphological mapping for drinking water mission.
3. Arwal, C.S and Garg, P.K. (2000), Textbook on Remote Sensing In Natural Resources Monitoring and Management. Wheeler Publishing. Pp. 213.
4. Central Research Institute for Dry land Agriculture, (1990). Field Manual on Watershed management, CRIDA, Hyderabad.
5. All India Soil and Land Use Survey (1990). Watershed Atlas of India. Department of Agriculture and Co-operation. IARI Campus, New Delhi.
6. Krishnamurthy, J., Arul Mani, Jayaraman, V., and Manivel, M. (2000), Groundwater resources development in hard rock terrain – an approach using remote sensing and GIS techniques, International journal of applied geology, 2(¾), pp 204-215.
7. Sabins, F. F., (1997), Remote Sensing Principles and Interpretation, W. H. Freeman & Company., Newyork.
8. Handbook of statistics of Adilabad District 2010-2011 compiled by Chief planning Officer, Adilabad.
9. Bhagavan, S.V.B.K and V. Raghu, "Integrated Remote Sensing based Study of National Watershed Development Project for Rained Area In A.P". Abstract Volume of National Symposium on Remote Sensing for Natural Resources with Special Emphasis on Watershed Management held during 21st March to 24th March 2000 at Bhubaneswar, pp.15.
10. Fetter, c.w, (1990). Applied Hydrogeology. CBS Publishers, Delhi.
11. National Bureau of SOIL Survey and Land Use Planning, 1987.
12. NRSA (1989). Manual of Nationwide Land Use/ Land Cover Mapping using Satellite Imagery, Department of Space, Hyderabad.

WEB-SITES:

1. www.worldgis.com
2. www.nrsa.com
3. www.mapobjects.com
4. www.gishelpers.com
5. www.mapsofindia.com
6. www.esri.com
7. www.gisdevelopment.com
8. www.geocommunity.com