Integrated Water Resource Development Plan for Suistainable Management of Gurramkonda Watershed

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Abstract : Integrated watershed management requires a host of inter-related information to be generated and studied in relation to each other. Remote sensing techniques provide valuable and up-to-date information on natural resources. Geographical information system (GIS) with its capability of integration , multi layer information obtained both from remote sensing and other conventional sources has proved to be an effective tool in planning for watershed development .

In this study area and locale specific watershed development plans were generated for Gurramkonda watershed, Chittoor district A.P. adopting IMSD guidelines, suitable sites for artificial recharge structures were suggested using lithology, geomorphology, ground water potential, structural maps.

Keywords: Remote sensing, GIS, Watershed Management, Integrated water resource development plan

INTRODUCTION

Watershed is a natural Hydrologic entity that covers a specific aerial expanse of land surface from which the rainfall run-off flows to a defined drain ,channel, stream or river at any particular point. the watershed delineation has been carried out as per the guide lines of national watershed at has prepared by All India SOIL AND LANDUSE SURVEY (ALSLVS). Integrated watershed management requires a host of inter-related information to be generated and studied in relation to each other. Remote sensing techniques provide valuable and up-to-date information on natural resources . Geographical information system (GIS) with its capability of integration , multi layer information obtained both from remote sensing and other conventional sources has proved to be an effective tool in planning for watershed development .

OBJECTIVES

The objective of the paper is to prepare the ground water prospects maps corresponding to Survey of India toposheet on 1:50,000 scale, covering all the habitations.

- Prospective ground water zones.
- Studies involved in selection of sites for implementation of artificial recharge schemes
- Help in planning for recharge structure (Prioritizing the areas for water harvesting through different types of recharge structures).

STUDY AREA

The study area falls between North Latitude 13^0 $46'$ to 13^0 $51'$ and East longitude 78^0 $35'$ to 78^0 $41'$ covering the form part of Survey of India toposheets 57K/9.

DATA USED

- Satellite imagery (23.5 m. resolution data) of 2006 supplied by National Remote Sensing Centre is used for 1:50,000 scale base line feature data capture covering the proposed study area.
- Ground truth data (photographs, etc.) and GPS control points, collected during field survey in the study area is incorporated into the geodatabase.

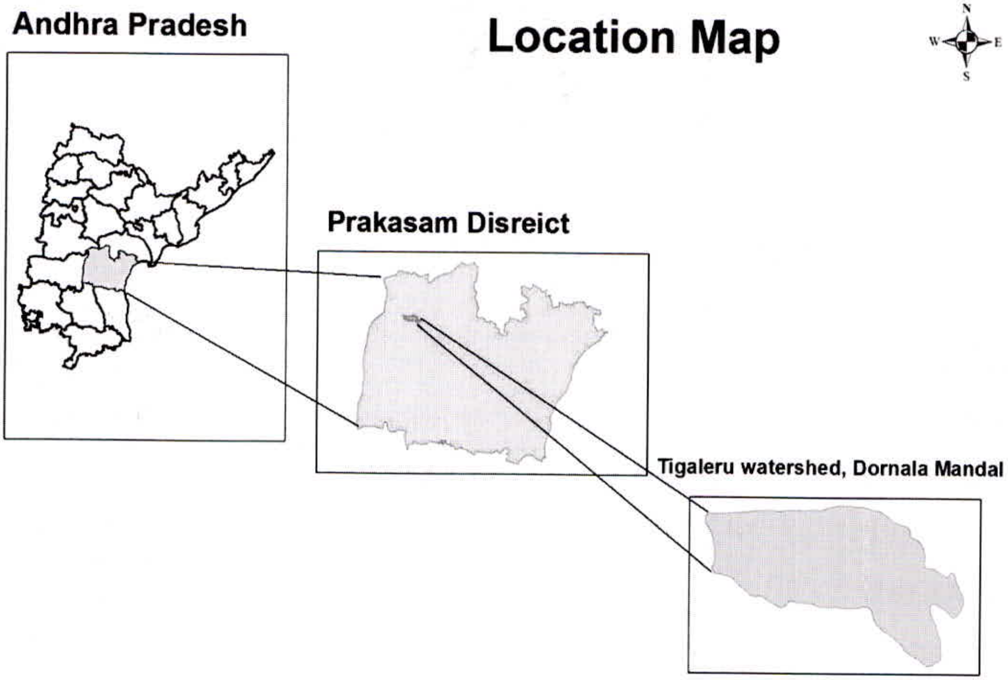

Fig.1. Location Map

- The map is generated in LCC projection with WGS84 datum.
- 1:50,000 scale grid is generated for the 2D mapping of study area.

METHODOLOGY

The methodology is basically a systematic procedure evolved to prepare a ground water prospects map using satellite data and GIS techniques in conjunction with limited field work. Various steps involved in the preparation of ground water prospects maps are furnished as a flow chart in (Fig.2).

GIS technique is useful to derive and integrate geology, structural and geomorphological details. The various layers generated using remote sensing data like lithology/ structure, geomorphology, lineaments etc. are integrated with already available information on slope, drainage density and other collateral data in a Geographic Information System (GIS) framework and analyzed with reference to the groundwater zones as well as artificial recharge sites.

The total methodology can be divided into two main parts. the first part deals with the delineation of hydrogeomorphic units considering parameters influencing the hydro geological properties. It consists of a) preparation of individual thematic maps i.e. lithology, geomorphology, structures, hydrology and base map details based on the visual interpretation of standard false colour combination (FCC) of satellite data in conjunction with limited field/existing data, and b) Derivation of hydrogeomorphic units by integrating the thematic data. The second part deals with the

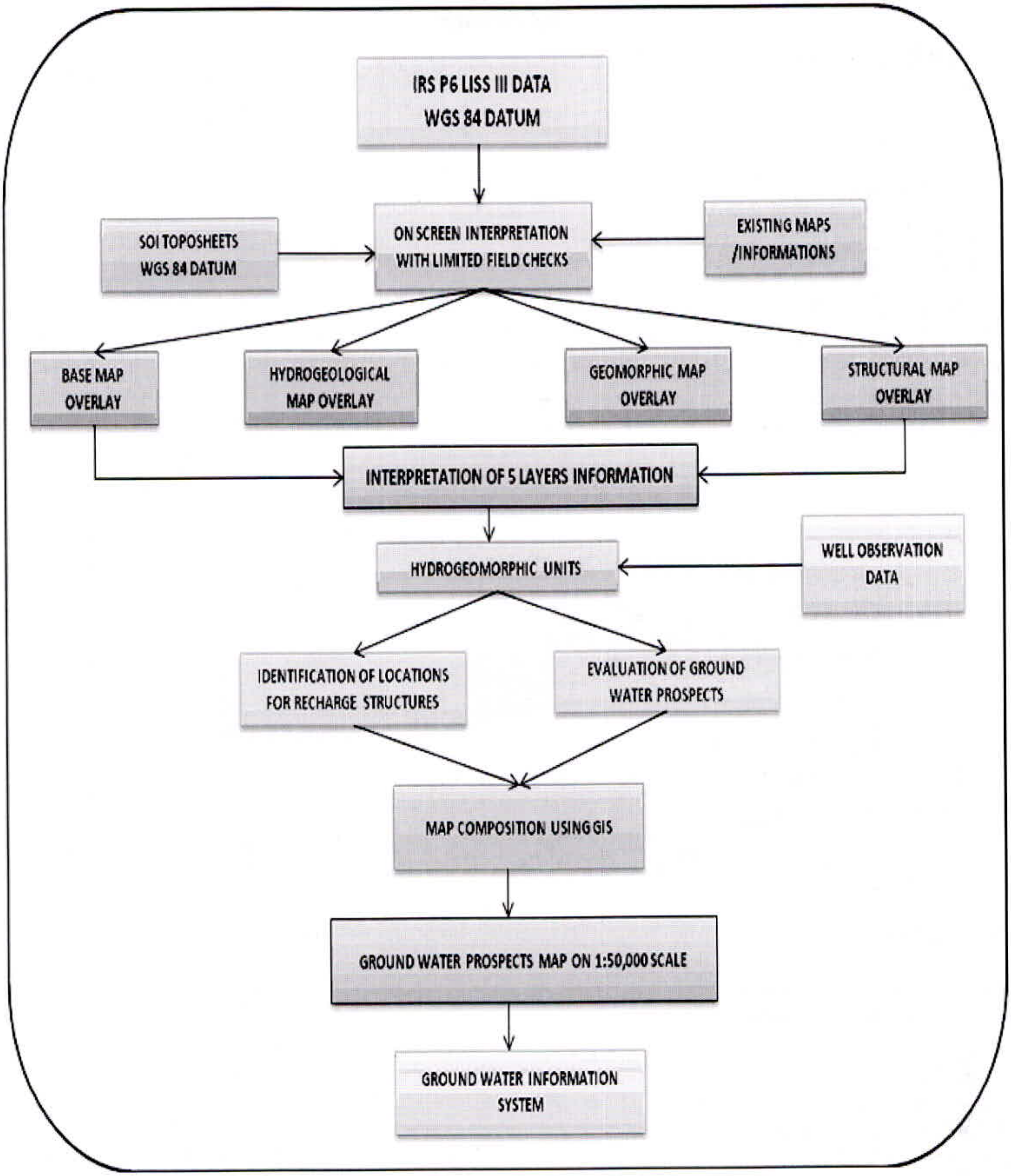

Fig.2. Flow chart showing the salient features of the methodology

evaluation of ground water condition in each hydrogeomorphic unit. It consists of a) evaluation of ground water prospects based on hydrogeological characteristics of each and every parameter, and b) Semi-quantification of ground water availability by taking into account the well observatory data, and c) Selection of tentative locations for taking up artificial recharge structures.

The map depicts major roads, minor roads, major and minor settlements, tanks, etc. The data is collected from Survey of India toposheets and updation is done using satellite data, integration and correlation of the field observations (Fig. 3).

GEOLOGY

The PGC comprises a complex assemblage of gneissic variants and granitic rocks, which occupy almost major part of the district. PGC in the area is represented mostly by biottte-homblende gneiss, biotite granite and migmatite.

The Dharwar Supergroup of rocks represented by quartz-mica schist, amphibolite schist, quartzo-flespathic mica schist (Champion gneiss, metabasalt, matadacite and banded ferruginous quartzite, belonging to various schist belts and occur as long linear N-S trending belts and overlie PGC non-conformably.

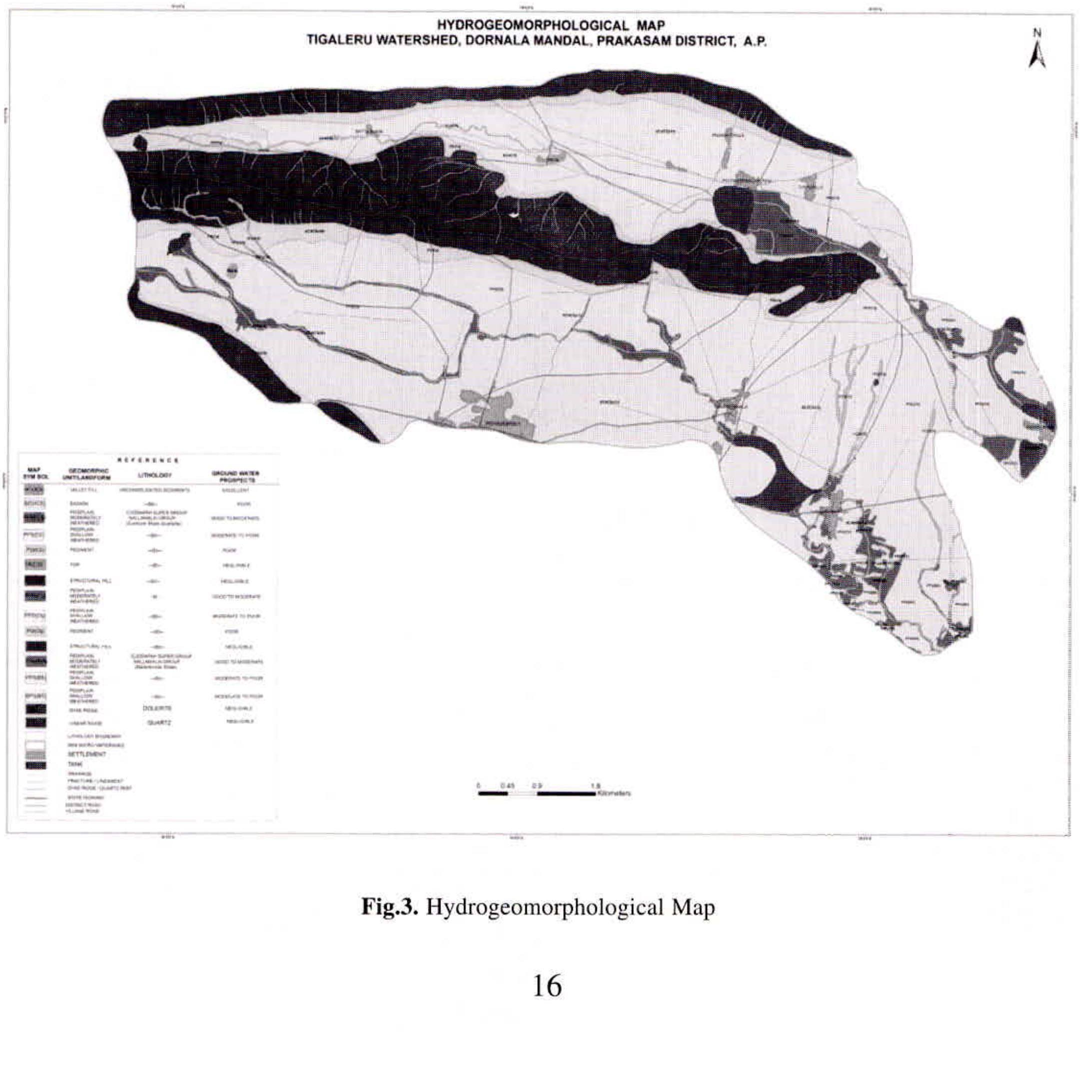

Fig.3. Hydrogeomorphological Map

HYDROGEOMORPHOLOGY

Geomorphologically the valley fill area occurs along rivers, streams these isolated narrow patches comprises of river born alluvium and shallow with colluviuel fill .Ground water yields range from 100 to 200 lpm. The Residual hills represented the presence of an earlier extensive denudation hills .These hills comprises of granitic gneiss characterised by horizontal curvilinear, and vertical joints which unable the process of weathering and give rise to the typical semi-arid type of weathering, resulting in geomorphic forms such as exfoliation, domed inselbergs and tors with steep slops and narrow valleys. As for as ground water potential is concerned only the fracture zones give negligible yield ranging from 10-25 lpm. Pedimental land forms is an upland area of undulating topography with or without a thin layer of detritus. Generally these areas represent barren rock. exposure crisscrossed with fractures,it has poor potential. It is formed on granitic gneisses. Ground water yield ranges from 25-50 lpm.

The inselberg land form is the ultimate product of denudation process and it remains as remanence of residual hills. It is isolated hill surrounded by shallow weathered pediplain .They act as runoff zones. These land forms are formed on granitites granitic gneisses. The denudational hills land form is represented with massive hill ranges crisscrossed with fractures and lineaments. They act as run off zone and valley portions are crisscrossed with fractures which act as potential zones. This land forms are formed on granites yield ranges from 10-25 lpm.

GROUND WATER OCCURRENCE

The occurrence and movement of ground water is a consequence of a finite combination of topographical, climatological, hydrological, geological, structural and pedological factors which together from integrated dynamic system. All these factors are interrelated and interdependable, each providing and insight into the total functioning of this dynamic system, About 90% of the study area is underlain by hard rocks and the remaining area by the alluvium. The nature of occurrence and behaviour of ground water in these formations is presented in the following paragraphs.

GROUND WATER IN ARCHAEAN CRYSTALLINES

The granites and gneisses are basically devoid of primary intergranular porosity. However they develop secondary porosity through, joints fissures, shear zones, faulty crevices etc., during the tectonic disturbances and subsequent weathering over ages enables the otherwise massive granites to hold the ground water at suitable locations. Consequently the occurrence and movement of ground water is controlled by these secondary pores and voids. The depth and degree of weathering varies from place to place. Quantitatively also the occurrence of ground water is controlled by the depth and intensity of weathering and grain size, intensity and persistence of joints fissures etcthe process of weathering has a dominant role in the determination of ground water potentiality of given area. The aquifer system in the hard rocks is heterogeneous and anisotropic and water bearing characteristics vary very widely both laterally and vertically. Ground water occurs under phreatic conditions in the shallow weathered zone of rocks and under semi confined conditions in the fissured and fractured zone within the hard rock.

LINEAMENTS/STRUCTURES

The study area is criss crossed by number of lineaments depending upon the lithology three set of fracture patterns are observed in the study area they are follows E-W, NW-SE, and NE-SW.

ARTIFICIAL RECHARGE OF GROUNDWATER

The term artificial recharge has different connotations for various practitioners. Artificial recharge to ground water is defined as the recharge that occurs when the natural pattern of recharge is deliberately modified to increase recharge (ASCE 2001).

The term artificial recharge refers to transfer of surface water to the aquifer by human interference. The natural process of recharging the aquifers is accelerated through percolation of stored or flowing surface water, which otherwise does not percolate into the aquifers. Artificial recharge is also defined as the process by which groundwater is augmented at a rate exceeding that under natural condition of replenishment. Therefore, any man-made facility that adds water to an aquifer may be considered as artificial recharge (CGWB 1994). Artificial recharge aims at augmenting the natural replenishment of ground water storage by some method of construction, spreading of water, or by artificially changing natural conditions. It is useful for reducing overdraft, conserving surface run-off, and increasing available ground water supplies. Artificial recharge can also be defined as a process of induced replenishment of the ground water reservoir by human activities. The process of supplementing may be either planned such as storing water in pits, tanks etc. for feeding the aquifer or unplanned and incidental to human activities like applied irrigation, leakages from pipes etc.

RESULTS AND DISCUSSION

Artificial recharge structures

The increase in population has necessitated over utilisation of groundwater, while concretisation of roads have resulted in the reduction of recharge areas, scanty distribution of rain fall and coupled with over exploitation have further aggravated the problem. The appreciable drop in the water table and ever increased demanding for the groundwater especially during summer has warranted initiation of artificial recharge structures on a large scale. The site specific structures suitability has been evaluated based on the criteria followed in Rajiv Gandhi National Drinking Water Mission. The type of structures proposed area

- Check dams
- Mini percolation tanks
- Desiltation of tanks

While suggesting the above structures the rock type geological structures, drainage, soil type, slope, characteristics have been considered.

Check dams

The check dam locations are given on first order and second order streams with medium slopes. They are proposed where water table fluctuations on the stream is influent or intermittently effluent. The parameters to be considered are slope, soil cover and its thickness and hydrogeologocal conditions such as rock type, thickness of weathered strata, fracture, depth to bed rock etc. There should be some irrigation wells downstream of the proposed structures. These structures will serve for dual purpose. Firstly it reduce runoff velocity thereby minimising erosion and secondly allows the retained water to percolate and thus results in increased recharge in the wells located downstream of the structures. These locations are to be verified in field before taking up the check dams (Fig.4).

Desiltation of tanks

The tanks which were identified as silted can be recommended for desiltation activity.

Mini percolation tanks

They are normally recommended on 2nd , 3rd or higher order streams. Mini percolation tanks are structures constructed across nalas / streams for checking velocity of runoff, increasing water percolation and improving soil moisture regime. The main objective is to impound surface run off coming from catchment and to facilitate percolation of stored water in to the soil sub strata with a view to rise groundwater level in the zone of influence of the percolation tank and also to hold the silt flow which would otherwise reach multipurpose reservoirs and reduce their useful life. These

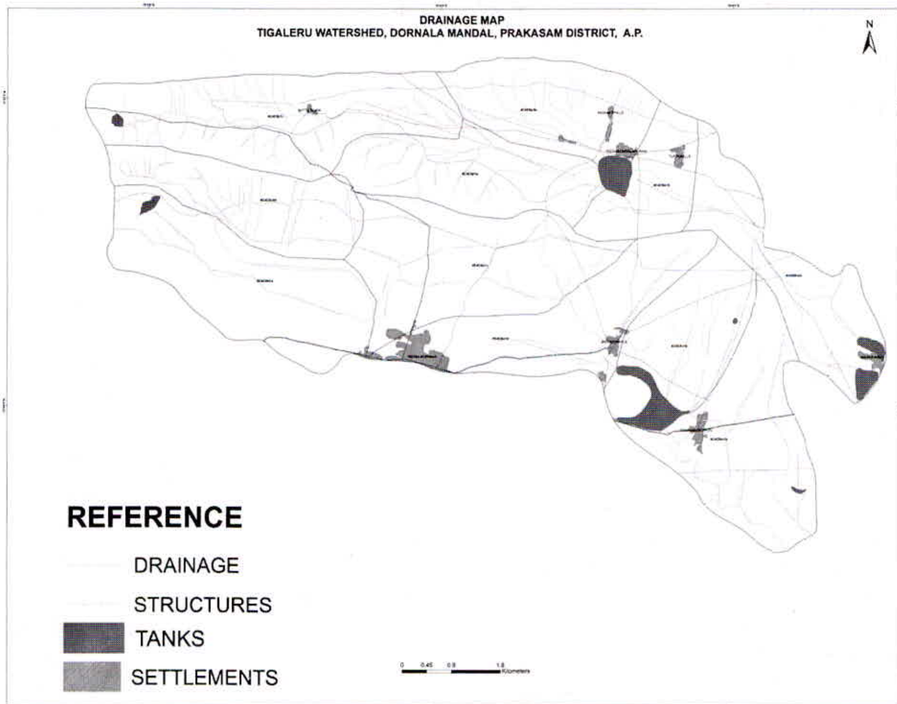

Fig.4. Action Plan Map

structures are different from check dams by the way of having an emergency spill way in the case of heavy runoff. The location is indicative and actual location may be decided based on field conditions. The size of the structures may be limited to or less than 1mcft capacity.

ADVANTAGES OF ARTIFICIAL RECHARGE

Artificial recharge is becoming increasingly necessary to ensure sustainable ground water supplies to satisfy the needs of a growing population. The benefits of artificial recharge can be both tangible and intangible. The important advantages of artificial recharge are

- Subsurface storage space is available free of cost and inundation is avoided.
- Evaporation losses are negligible, quality improvement by infiltration through the permeable media.
- It has no adverse social impacts such as displacement of population, loss of scarce agricultural land etc.
- Temperature variations are minimum.
- It is environment friendly, controls soil erosion and flood and provides sufficient soil moisture even during summer months.
- Water stored underground is relatively immune to natural and man-made catastrophes
- It provides a natural distribution system between recharge and discharge points.

- Results in energy saving due to reduction in suction and delivery head as a result of rise in water levels.

CONCLUSIONS

Successful implementation of artificial recharge schemes will essentially involve the following major components

- Assessment of source water
- Planning of recharge structures
- Finalisation of specific techniques and designs
- Monitoring and impact assessment

Groundwater occurs under phreatic to semi-confined conditions in the weathered granite mantle and under semi-confined conditions in the fractured zones located at moderately deeper depths.

People may be educated by providing the above tips for maintenance of the system through pictures, handouts and wall posters. The implementing agency should visit the structures as follow-up to monitor and motivate the users in proper maintenance of the systems. There could be informal group discussions among the users on the maintenance aspects of the Roof Top Rainwater Harvesting Systems.

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