Application of Geoinformatics in Groundwater Resource Management at Micro Level – A Case study

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Abstract: *Rapid innovation in Information Technology has enabled spectacular breakthrough in every field of science. High processing speed, large storage capacity, easy network / wireless connectivity, mobile computing devices and ever growing Internet have ensured that it is possible to remain connected practically from anywhere, anytime, using anything. In recent years, the Internet, which revolutionized the way we communicate and distribute information, is slowly evolving into a Cyber-Infrastructure or the GRID i.e. the technological solution to the problem of efficiently connecting data, computers and people with the goal of enabling derivation of novel scientific theories and knowledge.*

The pressures on the natural resources have tremendously increased over years by man's greed for commercialization and livelihood of local people. Therefore it is imperative to understand the consequences of manmade initiatives and to devise proper strategies to counteract these detrimental effects to keep a balance of the environment, ecology, green cover and human livelihood. Geoinformatics has proven as a powerful tool for studying the natural resources and help in locational features, extent of coverage, monitoring the resources and in generating models for probable scenarios, which assists in optimizing resource utilization.

The Geoinformatics applications in groundwater resource management at micro level is demonstrated through a Case Study in GP_10 watershed of Aurangabad District of Maharashtra, India. Various layers like Drainage, Contour, Geology, DEM, Geomorphology, Slope etc have been generated along by integrating both satellite imagery and ground data, which was analysed to generate an action plan for groundwater development.

Keywords *: Geoinformatics, GRID, Information technology, natural resources, watershed.*

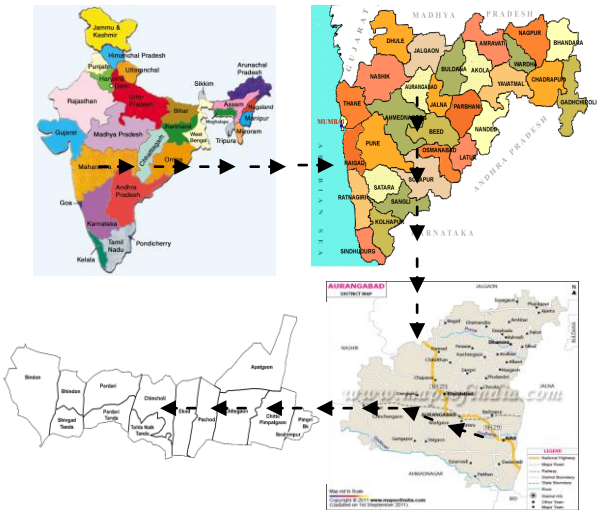
Introduction:

The pressures on the natural resources have tremendously increased over years by man's greed for commercialization and livelihood of local people. Devoid of regeneration, population pressure and wide scale tree felling depleted the natural resources to a level, which posed a problem for the very sustenance of man. Therefore it is imperative to understand the consequences of manmade initiatives and to devise proper strategies to counteract these detrimental effects to keep a balance of the environment, ecology, green cover and human livelihood.

The state of Maharashtra now again reels under the scarcity of water. Geologically major part of state is covered by Deccan basaltic flow. Low rainfall & deep water table are crying evils of study area. Water, soil & climate are the basic things for the development of agriculture, industries & drinking water. Water table is decrease day by day due to increase in population, industries, irrigation, crop pattern, over exploitation & low recharge conditions. Scarcity of water in study area is due to hard rock & their heterogeneous hydrological characters.

Location:

The study area named Chincholi in the Aurangabad dist. The study area having geographic location 19°47’16 N & 75 °25’759 E. The total area of village is 6427.30 ha. The area is located on South-East side of Aurangabad city at a distance of 17 km.



Topography:

The area appears to be "U" shaped in cross sectional view. Hill ranges in East & West direction surround it. Having maximum elevation is of 638m & minimum elevation is of 560m from sea level. The elevation difference is 78m. The sources of chitti river which is subtributary of Godavari which originate from hill ranges. The river is running towards E- direction & this chitti river meets the Sukhna River further towards east.

Climate & Rainfall:

In the area temperature ranges from 25^{o}c to 42^{o}c .The project area receives its annual precipitation from south west monsoon. The average annual rainfall is 650mm.

Geoinformatics Application:

The approach takes into consideration various elements of natural resources, viz., all base layers, Geology map, Contour map, hydrogeomorphology, terrain slope, drainage, watershed maps and local peoples aspirations with respect of socio economic considerations to suggest a suitable action plan for sustainable development of groundwater after scientific analysis of the spatial and non-spatial data. Locale-specific action plans for sustainable development of groundwater resources can be generated on watershed basis, integrating thematic information generated using satellite data with collateral/conventional information and socioeconomic inputs.

The action plans are basically for watershed development program to increase groundwater potential for ensuring enhanced productivity, while maintaining ecological/ environmental integrity of the area. The action plan, to identification of sites/areas for surface water harvesting, groundwater recharge, soil conservation measures through check dams, vegetation bunding, sites/recommendations for improved/diversified farming systems. These action plans can then be presented to the people for sensitizing them to get involved and to integrate their planning with reflections of their aspirations and with a convergence approach for Panchayats and Local Bodies to take decisions. The support organizations for such an efforts can be the Government Departments, State Remote Sensing Centre, universities, private entrepreneurs and NGOs.

Methodology:

- The methodology used in this study follows the standard sequence of drainage, lithology, contour & the integration of their results for geological & hydrological assessment.
- All data were in digital format and stored in a geo-database as GIS layers .
- All analyses and interpretations were performed from the computer screen and followed by ground truth field checks, a comprehensive geo-database was created including all GIS layers which were considered .
- For this GIS software's were use like Global mapper, MapInfo, IGIS, Arc GIS etc.
- Also for spatial data handling Google Earth image is taken in account.

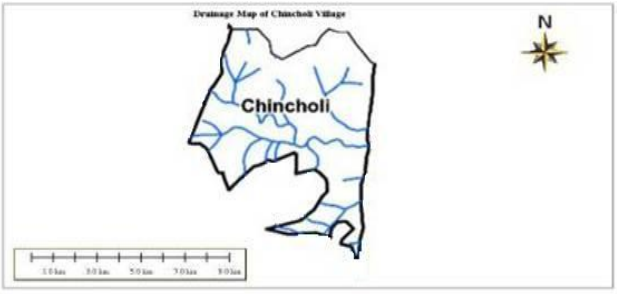
The creation of a GIS database, including the data format and entry, is a time-consuming and laborious exercise, as high accuracy is definitely mandatory.

Study area

The study area is having geographic location $19^{o}47'16$ N & 75 $^{o}25'759$ E. The annual precipitation in this region is about 650mm and the post-monsoon availability of water is plentiful. The top soil cover together with the underlying weathered rock forms the upper unconfined aquifer in the area. The rain water accumulates in the unconfined aquifers with gentle to moderately sloping grounds, then it flows downstream. The available water is sufficient during the early part of the winter season (till December); later, the water table declines , and by March, many of the shallow wells tapping the upper unconfined aquifers either become dry or do not adequately meet the requirement. Thus, although there is an average rainfall having acute shortage of water in summer. Hence, there is a need to identify regions where site-specific artificial-recharge methods can be adopted to augment water supply.

To demonstrate the application of geoinformatics in natural resources study, a Study was taken up in the watershed GP_10 of Aurangabad District of Maharashtra and resource analysis was made for one selected village with base information and through satellite imageries, the various analysis of which are presented below-

Drainage map:



In the study area stream orders are found upto third order in which the smallest fingertip order two & three are form. Where two of order 2 join order 3 is form as shown in drainage map.

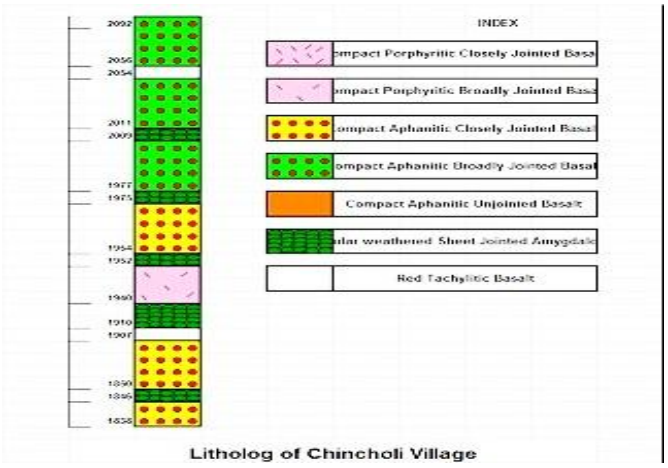
Geology of Area:

The study area comprises of volcanic rock with alternating layers of compact basalts and amygdaloidal basalts. Low lying region is covered with soil with an average thickness of 0.3m to 1m. Rock exposures are found and these are predominantly at road cuttings, hill slopes and along river banks. The typical soil type observed is the medium-black-cotton variety.

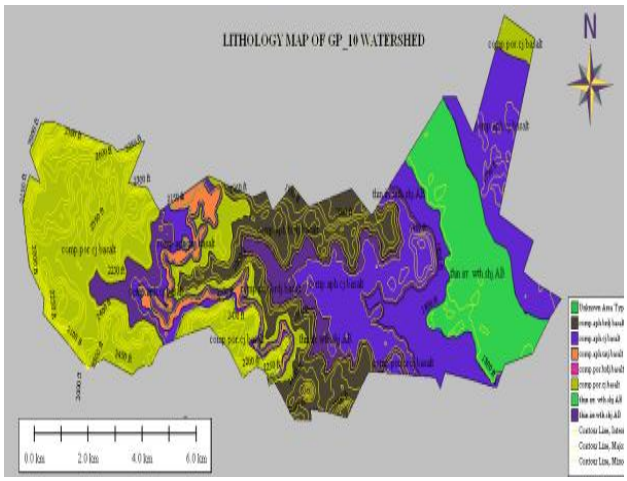
Following types of flows constitute in study area Viz.

- Compact Basalt(closely to broadly jointed aphanitic compact basalt)
- porphyritic compact basalt
- Techlytic Basalt (Red bole)

From the top of the hills to the low lying area of Chincholi village, well inventory survey is done of 10 dug wells from north to south direction & transverse were taken from vertical road cut of the hills. Fresh rock exposures are available for observation at road cuts.

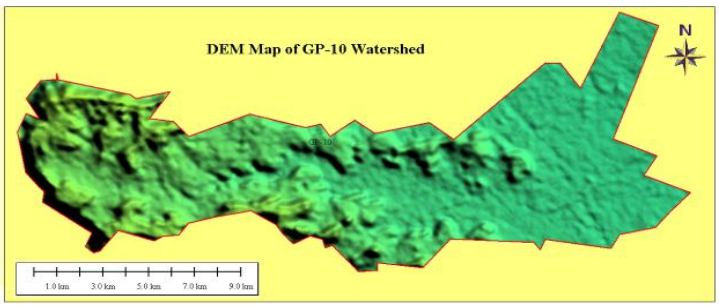


Litholog of Chincholi Village



DEM Map:

Digital Elevetion Model map has been prepared with the help of Globalmapper software. Which shows the elevation of study area having max. height of 638m in study area and lowest height having 560m .



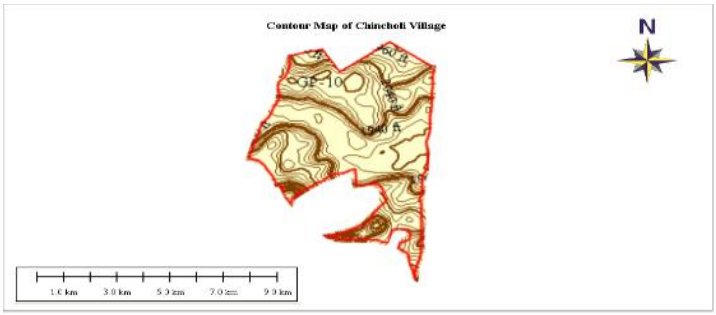
Litholog of study Area:

The entire village comprises 12 flows out of which 7 flows are thick & closely to broadly jointed aphanitic compact basalt & one flow is thick broadly jointed porphyritic compact basalt & three flows are of thin band of Red tychyletic Basalt.

(Height of flows shown in feet from SWL)

Contour Map:

Contour map shows same elevation lines in study area having elevation difference of 78m from lowest to highest.



Results & Discussion:

Recommendations for optimising the resource use

1. As the fracture zones form the important and promising horizons for potential ground water of the study area, proper identification of the weak zones using remote sensing techniques (aerial & satellite images) followed by ground checks would go a long way while selecting sites/areas for assured ground water development.

2. As the well irrigation is the main key in the study area, as the rainfall in the district is medium and irregular and the average annual rainfall is low. There is every need to utilise as much of rain water as possible by improving the recharge condition in the study area. This is possible by constructing the low - cost rainwater harvesting structures such as percolation tanks, check dams, farm ponds and recharge shafts & trenches, etc.

3. It is suggested to go for trenching and spoil banks to conserve moisture, plantation of arid horticulture species, soil and water conservation on village basis, mixed cropping, moderate or mixed and multiple cropping, drip & sprinkler irrigation, etc can be recommend for drought mitigation.

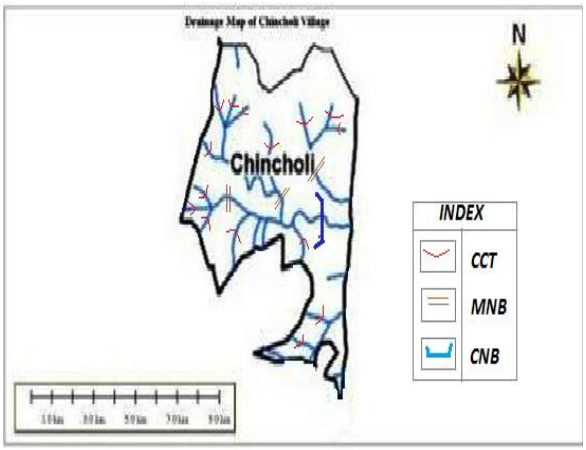
Action Plan for Resource Management

Keeping in view the need for rainwater harvesting structures, soil and moisture conservation for groundwater development the following Action Plan is recommended for implementation in GP-10 watershed for optimizing the groundwater resource management:

a) Rain water Harvesting Structures & Artificial recharge

The areas of fractures, joints, out crops, flow contacts, thick soil areas, etc can be promising for artificial recharge and roof top rainwater harvesting structures can also be construct. In view of the poor permeability areas we can construct some surface water structures in barren rock areas. These recommended structures may promoting for groundwater increase in the region.

Map showing recommended recharge structures in study area.



b) Soil and Moisture Conservation

Soil and water are the basic natural resources whose conservation is of paramount importance, particularly in a semiarid region. The conservation of these resources will not only increase the production of food, fodder, and fiber but also check the on sight of drought. These are to be taken up in the areas where rainwater harvesting structures are not possible.

c) Vegetative and Contour Bunding

Vegetative barriers like closely spaced plants usually a few rows of grasses of shrubs grown along the contours for erosion control in agricultural lands for preventing soil erosion and silting of percolation tanks, check dams and minor irrigation tanks. Contour bunds are essential for delaying the surface run-off and to increase the time of concentration and there by allowing more opportunity for rain water to be absorbed in the soil profile.

d) Irrigation Water Management

Efficient method of water application such as drip and sprinkler irrigation along with improved agronomic practices helps to economize water and increase water use efficiency. Along with the conservation measures, introduction of optimal farming systems, alternate land use and adoption of crops requiring less water , will improve productivity which in turn will lead to better economic development of the study area.

Conclusion:

Geologically it is observed that the groundwater is mainly confined to secondary porosity i.e. fractured zone, joint and weathered column. It is observed from field survey and also from wells inventory survey in the study area. To emphasis the groundwater potential & mitigate scarcity problems effective site selection for artificial recharge and other measures these new tools, techniques and technology for proper use and conservation practices for groundwater resource is very helpful. Geoinformatics have evolved as a proven tool for resource planning. The high resolution satellite data and the GPS use made it possible to plan at land parcel level. Precise groundwater recharge models and judicious use and regeneration of resources can be ensured at local level, at almost real time basis. Thus geoinformatics hold a great promise for resource planning in India in future**.**

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