Management of Ground Water Using Geoinformatics in Dwarkeswar Watershed of Puruliya District

Kartic Bera, Jatisankar Bandyopadhyay

Abstract

The present study uses an integrated Geoinformatics based methodology to evaluate the groundwater resources in Kansachara watershed of Purulian district in West Bengal. IRS p6 LISS-III satellite data of 2nd February, 2011 along with other data sets, existing maps and filed observation data have been utilized to extract information on the hydro geomorphic features of the study area. The ground water level is more than 100 meters from sea level and even more than 200 meters also at some places. The ground water potential zones & scarcity zones have been derived for the entire Kansachara watershed management and divided into mainly four categories namely very low, low, medium and high scarcity & recharge potential zone.

Key words: *Ground water, Land use/cover, Weightage, Reclassify, DEM, Scarcity & Potential zone.*

Introduction:

Geoinformatics, combining technologies of RS, GIS and GPS, is an appropriate tool to manage ground water resources. RS data can be used for delineating sub-watershed or micro watersheds and streams. For example, SPOT (PAN)/ CARTOSAT–1&2 (PAN) can be used to plot boundaries, SRTM data for contour line and then Digital Elevation Model (DEM), DEM data can be processed in GIS for delineation of Sub watershed/Micro watershed boundaries, slope and streams. IRS data are used for land use/cover classification. In addition to the high resolution optical, microwave, thermal- infrared and rader are now used in such studies. We can use microwave for studying soil moisture, and the rate of evaporation and evapo-transpiration. Rader is used for weather forecasting, rainfall and snow depth etc. In a river basin there are many applications of GIS for example defining the watershed or a boundary or finding the coincidences of factors, such as erosion prone areas, mapping land use or land cover and population and interactions between basin water supplies, reservoirs, diversions and demands. GPS can be used to increase existing system maps by verifying and correcting locations of system components. Water system or sewer system maps can be generated if they do not exit and attributes can be collected for populating the GIS database.

Geoinformatics technology has been successfully employed for identify scarcity and potential zone and also management. The present study aims at identify scarcity zone respectively and management through surface, groundwater and also water harvesting.

Study area: The Dwarkeswar or Dhalkisor watershed having its' origin from the badlands to the east of Tilaboni hill near Bangalia rail station, in Puruliya district, West Bengal, flows easterly through pediment landscape enters into deselected lateritic terrain in Bankura district and further down stream into the Gangetic alluvial plain debouches in the Rupnarayan river. One of the tributaries on the left bank is Kansachara, having five mini watersheds and twenty six micro watersheds in more than 25 thousand hectares. The sub-watershed geographically located between 23^0 20' N to $23^0$30' N and 86^0 45' E to 86^0 55'E and contains four blocks namely Chhatna, Indpur, Kashipur & Hura (Fig.1).

Physiographic Features

Relief of the study area shows, it is a plateau region. In the north east part of the study area height is very high (>270m), in the south western part relief is low, with a gentle gradient from east to west. The general elevation of the area ranges from 120m to 300m, with a gentle gradient from east to west. In the high relief area ground water availability is shallow & low relief area ground water availability is near the surface then upper part. Mostly the area covered by fallow land and mixed forest.

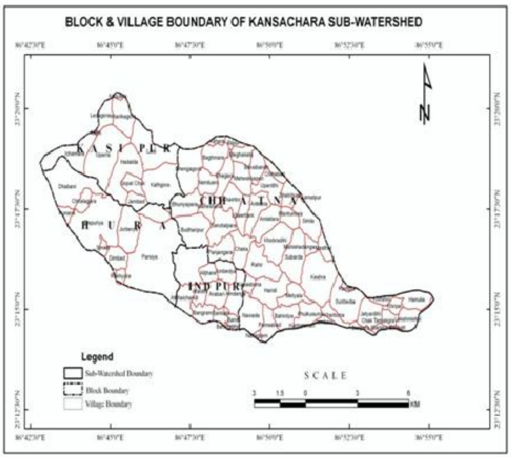


Fig.1

Soil of the study area shows that a major portion of the basin is covered with red and yellow soil; the rest part is composed of red gravel soil on the central part of the basin. Mostly the soil is infertile in type; mostly covering either forest or fallow land .The agriculture is a restricted practice here. The reddish yellow soil is not very fertile.

Geology of the study area comprises Archaean Dharwarian rocks and is an extension of peninsular mass of chhotonagpur plateau:

I. The chotanagpur genesis comp lese (cover most part of the district)
II. Plutonic gabbro and anorthositic rocks
III. Meta sedimentaries and meta basics of Singhbhum groups
IV. Dalma group of basic volcanic rocks
V. Intrusive granites (kuilapal, Manbhum granites
VI. Gondowana groups of sedimentary with coal seam &
VII. Quaternary sediment in order of decreasing antiquity

There are two shear zones:

1. South Puruliya shear zone WNW – ESE trending tectonically distributed shear zone.
2. North Puruliya shear zone ,there are numerous lineaments picked up by remote sensing Apart from the whole districts of my study area chiefly constitute of granite genesis migmatite, and amphibolites & hornblende schist

As the area under study belong to peninsular shield of India, it is constituted of oldest Precambrian or Archean formation from beneath the thin soil cover of recent period appears the granite genesis of the Archean age except where genesis basement is overlain, by the metamorphic rocks of dharwar age and Gondowana deposits of Carboniferous Triassic age. The rocks of Gondowana system consist of glacial materials and fluvial sandstone and shale.

The older schistose rocks include phyllite, quartz schists, quartzites, Granitoferous sillimarite biotica schists. The granitic rocks include grey colored banded biotite granite gneiss or migmatites pink granite, perphynic granite gneiss. All this granite rocks older schist and gneiss basic rocks have been indurated by pegmatite and qurtz rocks the most common archean rocks is gneiss which frequently shows great lack of uniformity in mineral composition but process a constant more or less foliated or banded structure.

The Dharwar consists of quartzite Slates, Mica, and chloride schist. The Gondowana form the main undoubted representative of subsequent sedimentation that continued throughout the Upper Carboniferous and Mesozoic periods, responsible for the structure. The deposition of these glacio-fluvial sediments in the gradually sinking through is responsible for enormous thickness and also for the preservation of there valuable coal saves from enosean and from the effect of crustal movement.

The geology shows that in upper most area granite grano-diorite pegmatite igneous sandstone shale& conglomerate schist are present .The most part of the study area covered

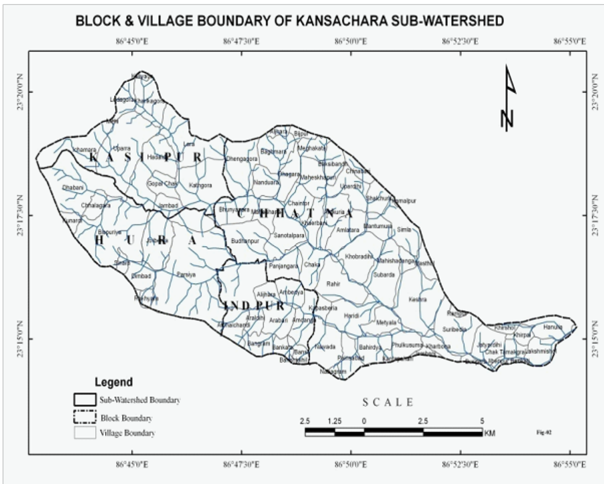


Fig.2

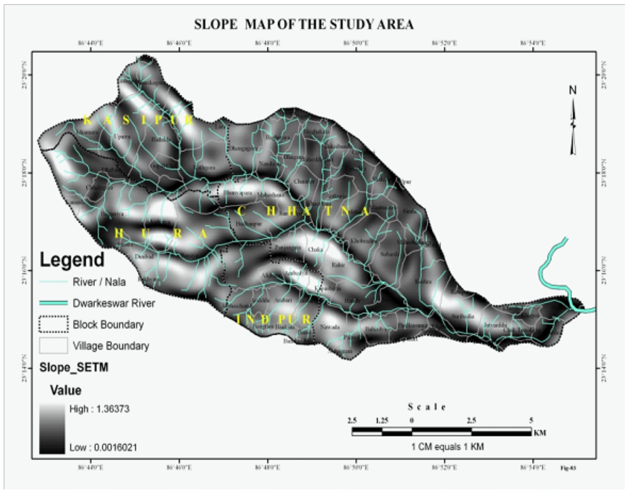


Fig.3

by gneisses rocks. On this region of low permeability through gneissic rocks and reddish soil the intensity of surface cannel is high and thus tendency of branching of streams are also high which facilitates easy drainage of water. Thus availability of water is quite less on the surface as well as at sub subsurface.

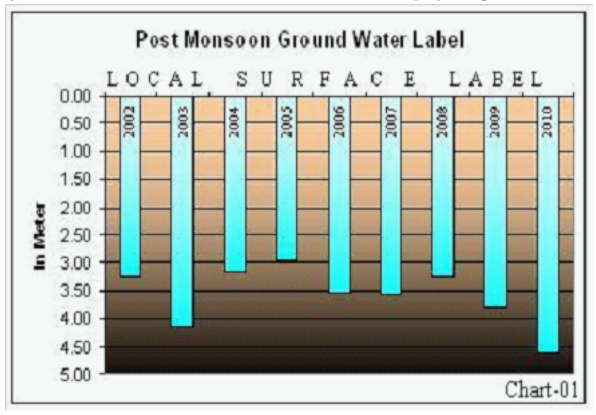
Drainage originates from western upland of chhotonagpur plateau region to and flow almost parallel to each other carrying seasonal flow of water & meets Dwarakeswar. The river Kansachara drains from southwest to northeast of the study area. The study area drainage pattern in dendritic drainage pattern, here sub stream meet with mainstream at right angle .There are five sub watershed in the study area. The total area of watershed 25232.17 hectors and the length of river is around 80.2 km.

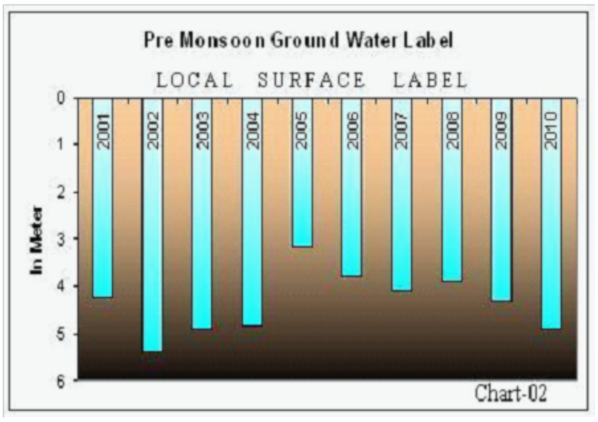
Slope shows that in few part of the study area slope is high, from upper to lower part slope is moderate & other area slope is level slope .In the high slope area runoff is high, so ground water availability is low & low slope area ground water availability is near the surface.

Climate of the district is of tropical dry sub humid with normal annual rainfall ranging from 1100 mm in the western part and 1400mm in the eastern part .The mean daily temperature ranges from 12c (in winter) to the maximum 46c (in summer) The variations in the number of rainy days & soil moisture limitations are common. Severe drought periods lasting for weeks adversely affect the crop growth & yields during main cropping kharif season.

Ground water availability chart shows (see Charts 1 & 2) that in some parts of the district minor irrigation facilities are available and are being developed. Studied on ground water indicate the presence of shallow aquifers in the western part, moderate in the middle part. In maximum part of the study area ground water level is more than 100 meters from sea level and even more than 200 meters also.

Land use/cover- Land use is the use actually made of any parcel of land, house, and apartments, are land use categories, where as the term residential, and agricultural refers to a system of land utilization implying roads,





neighborhood retail and service activities as well as location of agricultural pursuits. In a rural areas tree crop and corn crop would identify the land use, where as orcharding, truck farming and grazing indicate a system of land utilization.

The land use study should be made in close connection with water resource management, flood protection scheme and irrigation utilities such study should include: (i) Survey of soil and land classification, (ii) Investigation of surface and underground water resource for irrigation, and (iii) Re-examination of soil after the beginning of irrigation from to time.

The most part of land use map we see the agricultural fallow land, here one time of year cultivation is occurred. The southwestern western and southeastern part thin forest are present. Here also shows existing agriculture, open fallow land. Here large part of land is prone to gully erosion is present. Southeastern rail way pass through the eastern part.

Materials and Methods

SOI topographical sheets on 1:50,000 scales were used to identify watershed. Satellite image (ETM+ and SRTM) were used for land use/land cover study and delineation of drainage and sub-watershed boundary. Maps of soil were taken from NBSS & LUP, geology from GSI and DPMS from NATMO. Rainfall data were obtained from IMD Kolkata. The ground water level data for 2001 to 2010 were collected from SWID, Kolkata and Well data from the field. Census data and political boundary of blocks & village, collected from District Statistical hand book. All the data set are inter-linkage.

ERDAS IMAGINE-8.5 and ArcGIS-9.2 software were used for digital image processing and generating thematic maps. Boundaries of sub-watershed, blocks, villages & drainage were digitized & attached in the form of the attribute table. This was followed by raster overlay based on weighted value for scarcity and ground water potential zone identification.

Socio-economic data: A standardized questionnaire was prepared to collect socio-economic information for the water-shed management in Kansachara river. Stratified random sampling design was adopted. The list of respondents was prepared by backward class village and villagers of Kansachara Sub-Watershed. The village were selected based on the required information in each village i.e. river distribution and also socio-economic condition session wise (Kharif & Rabi). Every care was taken to give proper representation in the sample by making use of B.D.O office. Finally the collected information was compared with different data set.

Result and discussion

In study area of Kanschara rainy season is maximum four month, therefore needs appropriate planning or management for solving day to day problem. Ground water is the one of the factor. But high slope and other unsuitable factor caused less groundwater available. Annually ground water level ratio 00m (Monsoon) 00m (Permission) all those it varies year to year, due to amount of rainfall and time of rain fall.

Surface water flow/ river flow and ground water are not separate resources- they are parts of the same cycle and interchange many times. For example, infiltrated ground water may be available further down stream of a river as surface flow again surface water flow may in turn infiltrated and join ground water.

This is why it is suitable for surface water management on micro label at mini watershed level. Watershed characterization involves

Table 1

Use Category	Area (in hectares)
Existing agriculture	4400.9
Forest	2699.1
Open fallow	3792.9
Water body	469.6
Agricultural fallow	6784.8
Wet fallow	1578.2
Sand	25.4
River channel	5481.1

Table 2			
Mini watershed Code	Mini watershed Under the Blocks	Number of Village	Number of Micro watershed
2A2C8F7	Chhatna block	51	7
2A2C8F8	Chhatna and Indpur block	19	5
2A2C8F9	Chhatna, Hura and Indpur block	12	4
2A2C8F10	Hura and Kasipur block	11	5
2A2C8F11	Kasipur block	08	3

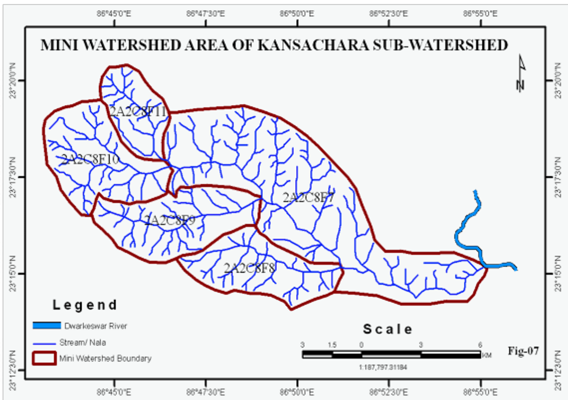


Fig.5

measurement of related parameters (geological, hydrological, Soil, geomorphology & land cover/land use). One the other hand ground water volume related almost same parameters.

In sub-watershed, there are five mini-watershed and 24 Micro watershed (Fig.5). Five mini watersheds clockwise numbering flowing AIS & LUS (All India Soil and Land use Survey) alphanumeric codifications are given in Table 2.

Scarcity zone: The scarcity map prepared primarily from geology, geomorphology, soil, drainage density, slope, rainfall and land use, reclassified by assigning weight value. The scarcity zone are classify in three classes: high, moderate, low. From the output (Fig. 6) it is observed that upper part is a zone of high scarcity. Against this, Kasipur, Hura and also some parts of Indpur and chhatna blocks fall in the low scarcity zone. Chhatna, Indpur, Hura and Kasipur blocks fall in the medium scarcity zone.

Potential zone- Potential zone map of ground water resources was prepared using parameters like geology, lineament, soil, drainage density, slope, rainfall and land use, influencing the ground water potentiality. These factors are good for water potentiality and have higher ground water.

It is observed Chhatna block has good or high potential zone because of low slope, location of lineament, drainage density, infiltrated soil, and porus lithology. On the other hand, high slope, low drainage density, hard lithology and non pours and soil are responsible for low potential zone (Fig. 7).

Conclusion

Water is renewable natural resource. However, its availability is influenced by the physical and anthropological factors. Water resource management/ development require a comprehensive evaluation of both surface water and ground water conditions on watershed basis with regional perspective. On the other hand, water resources development needs a careful analysis of the upper catchments to the lower stretch of a watershed otherwise

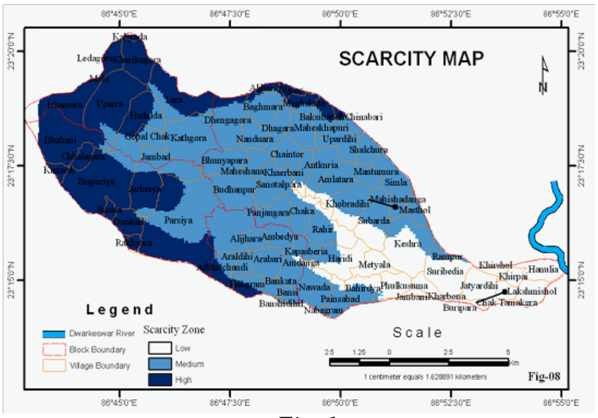


Fig.6

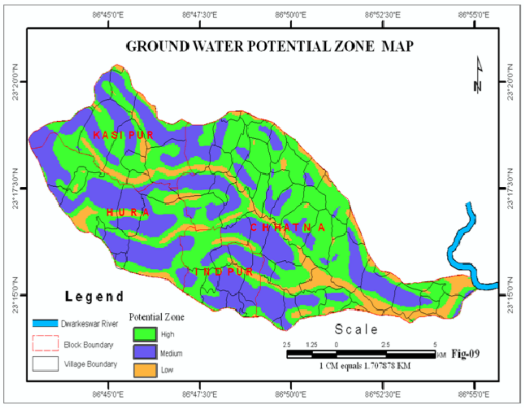


Fig.7

scattered local level surface/ground water management in the upstream affects negatively the recharge in the downstream of a river.

It emerges from the study that the ground water recharge zone is located mainly in the northern portion of the study area. Secondly, rain water is mainly responsible for the ground water recharging for the study area. Thirdly, small size nalas and dams are suggested for temporary storage for live save irrigation.

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(**Mr. Kartic Bera** is a Research Scholar, and **Dr. Jatisankar Bandyapadhyay**, Assistant Professor in the Department of Remote Sensing & GIS, Vidyasagar University Paschim Medinipur, Midnapore (West Bengal) E-Mail : 4kbrsgis@gmail.com)

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