GEOINFORMATICS IN WATER SCARCITY MANAGEMENT BY SUGGEST NALA BAND & RESERVOIR: PART OF DWARKESWAR WATERSHED, WEST BENGAL, INDIA

Kartic Bera*

Abstract

Water is the greatest gift of nature. But, unfortunately the humans are using that gift wastefully. The villages of the study area are fast heading towards a water crisis. The most part of the area have traditionally relied on local rainfall for meeting the water requirements for drinking, washing and other purposes and for agriculture. Its' shortage is likely to be so acute that the future may fought on sharing of water resources among various villages. Geoinformatics use in Micro Watershed Management can provide the appropriate platform for convergence of multidisciplinary data from various sources for appropriate planning. Remotely sensed data provides valuable and up-to-date spatial information on natural resources and physical terrain parameters. Geographical Information System (GIS) with its capability of integration and analysis of spatial, aspatial, multi-layered information obtained in a wide variety of formats both from remote sensing and other conventional sources has proved to be an effective tool in planning for micro-watershed development. In this study remote sensing and GIS has been applied to identify the natural resources management problems and to generate locale specific micro-watershed development plans. Micro watershed management through the remote Sensing and GIS based methodology is developed and tested for the evaluation of the water resources of Dungra watershed part of the Dwarkeswar river. The present study reveals the availability of water is quite less on the surface as well as at sub surface. The ground water level is more than 100 meters

* Department of Remote Sensing & GIS, Vidyasagar University, Paschim Medinipur, Midnapore-721102, West Bengal, India.

from sea level and even more than 200 meters also at some places. The rainfall is varying between 105 to 115 cm per year and maximum of which are drained down slope just immediately after the rain, and so availability of surface water is quite less. The reddish yellow soil is not very fertile and due to less availability of water productivity is less and land use shows a maximum part of the study area is fallow land. To ensure availability of surface water and to facilitate recharge of ground water construction of check dam seems to be essential.

Key words: Wastefully, Platform, Multi-layered, Pragmatic dataset, Scrub Land, Scarcity, Planning & Management.

1.0 Introduction

Micro watershed management involves of land, eater, energy and greenery integrating all the relerent scientific approaches appropriate to socio economical background for a pragmatic development of a watershed. in practice, it means allowing load free rainfall runoff from the water shed clean outflows imply management of effective soil and water conservation and generating a lush green carpet in whole resources (Murty.J.V.S -1996).

Geoinformatics application in watershed management is an appropriate tool. Geoinformatics operational combination of Remote Sensing (RS), Geographic Information System (GIS) and Global Positioning System (GPS). RS data can be used for delineating sub watershed or micro watersheds and streams. As for example, SPOT (PAN) / CARTOSAT – 1&2 (PAN) uses for plot boundaries, SRTM data can provides contour line, from contour line we can create 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 use for land use/ land cover classification. Now a day, in addition to the high resolution optical, Microwave, Thermal- infrared and Rader. From Microwave, soil moisture & rate of evaporation and evaporatranspiration. Rader for weather forecasting, rainfall and snow depth etc. in a river basin there are many applications of GIS (Christopher et.al 2010) 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 demographics and schedule the interactions between basin water supplies, reservoirs, diversions and demands. GPS can be used to increase the of existing system maps by verifying and correcting locations of the system components. Now water system or sewer system maps can be created if they do not exit and attributes can be collected for populating the GIS database.

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

1.1 Study area The Dwarkeswar or Dhalkisor watershed after having its' origin from the badlands to the east of Tilaboni hill near Bangalia rail station, in Puruliya district, West Bengal, flows easterly through pedimental landscape enters into deselected lateritic terrain in Bankura district and further down stream into the Gangetic alluvial plain debouches in the Rupnarayan river. In this flow several tributaries one of the left bank tributaries is Dungra. Dungra has six mini watersheds and twenty eight micro watersheds in **210.17^2 KM**. The sub watershed geographically located between latitude **23^0 20' N to 23^{0}32' N** and longitude extension is **86^0 45' E to 86^0 55'E** and contains four blocks under Bankura and Puruliya district namely Chhatna, Kashipur, Raghunathpur & Santuri. (Fig-01 Location map).

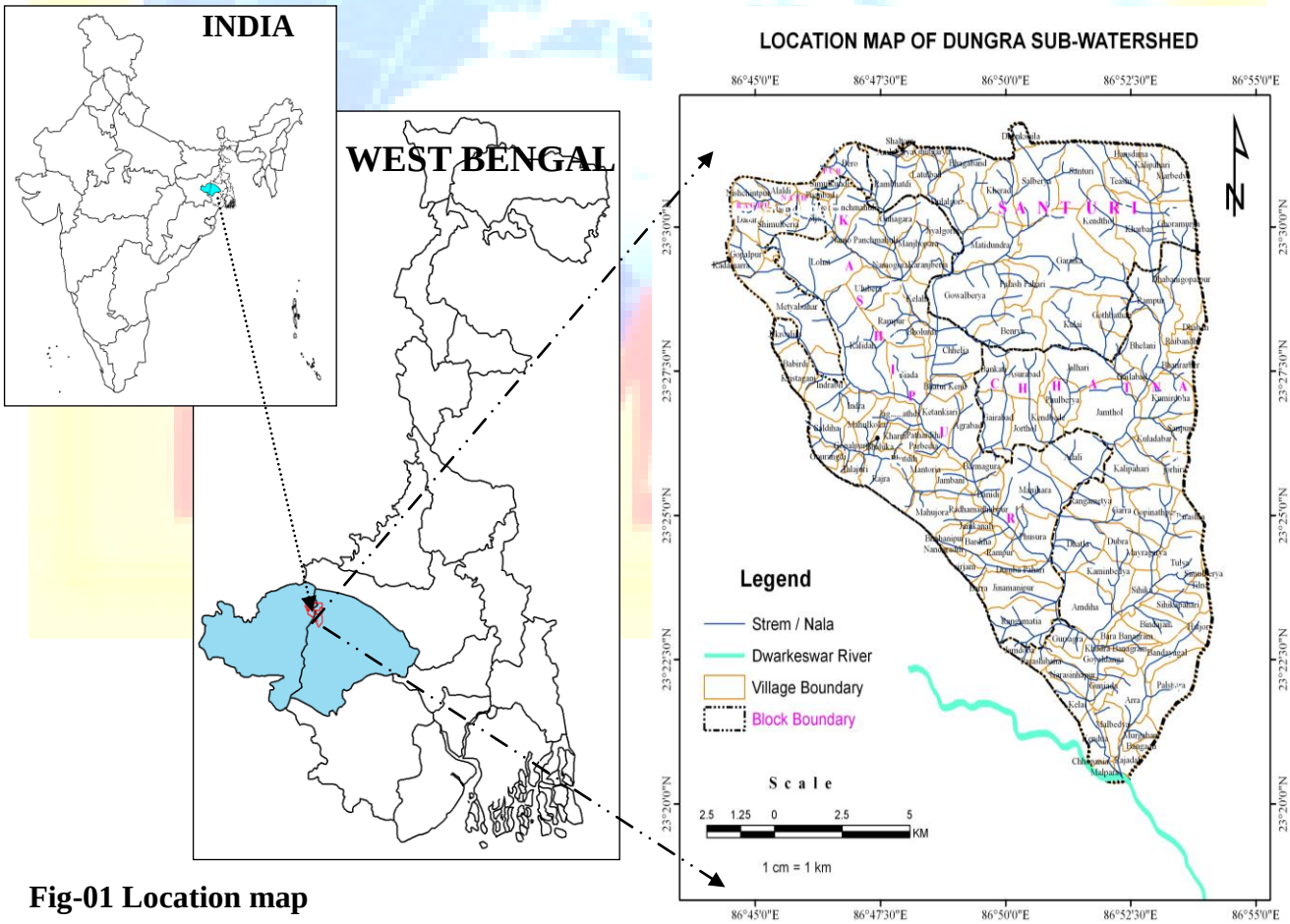


Fig-01 Location map

2. Physiographic elements

Fig: 02

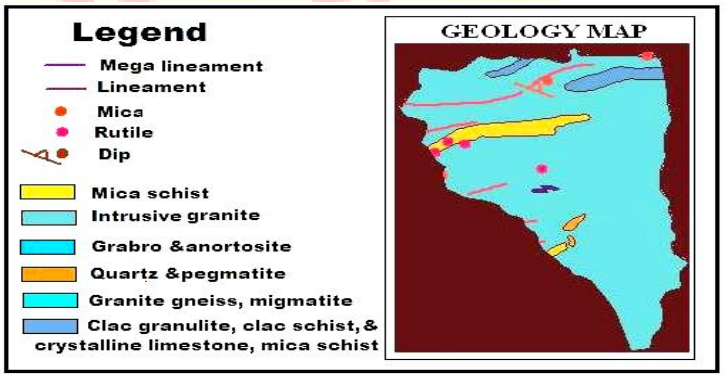
2.1 Relief: The relief map (Fig-02) of the study area shows that it is a pleatu region .In the upper part of the study area height is very high (>200m), in the lower part relief is low, with a gentle gradient from upper to lower. The general elevation of the area ranges from 90m to 250m, with a gentle gradient from upper to lower. 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 scrub land and also some part Protected Forest (P.F).

Fig: 03

2.2 Soil: The soil map (Fig- 03) of the study area shows that a major portion of the basin is covered with red and yellow soil. The young alluvial soil is present at the western part. Mostly the soil is infertile in type; mostly covering either forest or scrub land .The agriculture is of a restricted practice here. The reddish yellow soil is not very fertile and due to less availability of water productivity is less and land use shows a maximum part of seasonal fallow land.

2.3 Geology: The dominant geological formation of the study area comprises Archaean Dharwarian rocks and is an extension of peninsular mass of chhotonagpur plateau. From the figure-04 shows that-

I. The chotonagpur genesis comp lese (cover most part of the area).
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. Qurternary sediment in order of decreasing antiquity



There are numerous lineaments picked up by remote sensing Apart from the whole districts our study area chiefly constitute of

- Granite genesis migmatite
- Mica schist
- Amphibolites & hornblende schist
- Intrusive granites (Kuilapal, Manbhum and other granites)

As the area under study belong to peninsular shield of India it is constituted by 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.

Archean the oldest and most extensive rock formation comprise granite rocks, Meta sedimenteries, calo granites and Meta basic traverse by quartzite and pegmatite veins. 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.

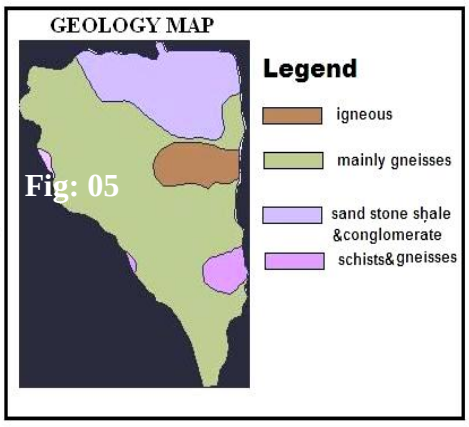


Fig: 05

The geology map (Fig-05) 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 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 the availability of water is quite less on the surface as well as at sub subsurface.

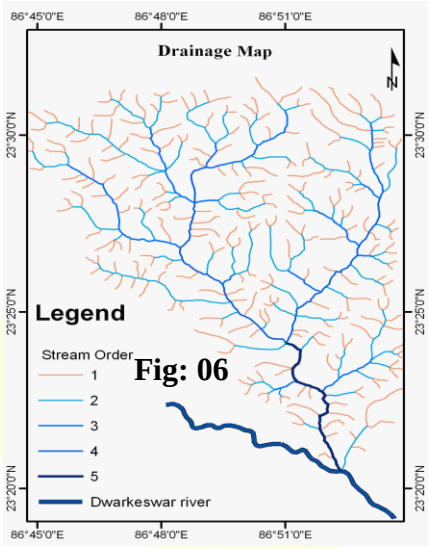


Fig: 06

2.4 Drainage: The main river (Dwarkeswar) originates from western upland of chhotonagpur plateau region to and flow almost parallel to each other carrying seasonal flow of water & meets Damodar river. The river Dwarakeswar drains from northwest to southeast of the study area. Here sub stream meet with mainstream at right angle. In this flow several tributaries one of the left bank tributaries is Dungra (Fig-06), meet Dwarkeswar at near Malpara village with combined flow of Adli nadi. The drainage pattern of Dungra in dendrite drainage pattern. The sub watershed further divide in to six mini watershed and twenty eighty micro watershed.

2.5 Climate: The climate of the area (Chart-01) is of tropical dry sub-humid with normal annual rainfall ranging from 1100 mm to 1400mm.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.

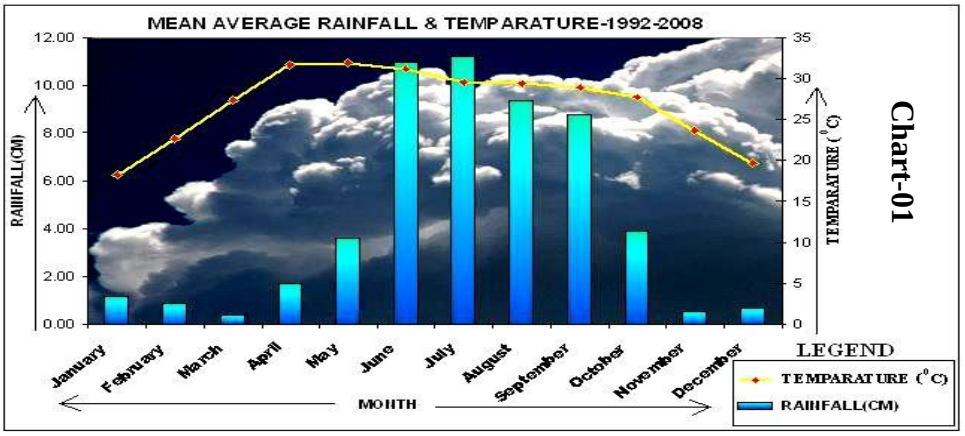


Chart-01

2.6 Slope: The slope map (Fig-07) shows that in the maximum part of the study area slope is moderate, from upper to lower part along the channel slope is level slope & some part of the area slope is high with dip Brown color on the map. In the high slope area runoff is high, so ground water availability is low even low slope area ground water availability is low due to geomorphic condition.

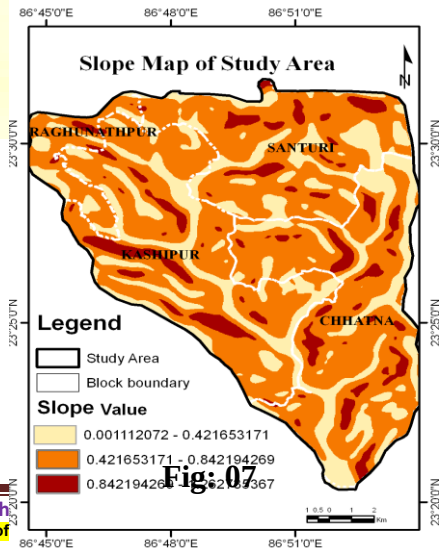


Fig: 07

2.7 Ground Water availability: The study area known as drought prone area. Ground water availability chart-02 shows Pre (Chart-02-A) and Post Monsoon (Chart-02-B) ground water label, 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.

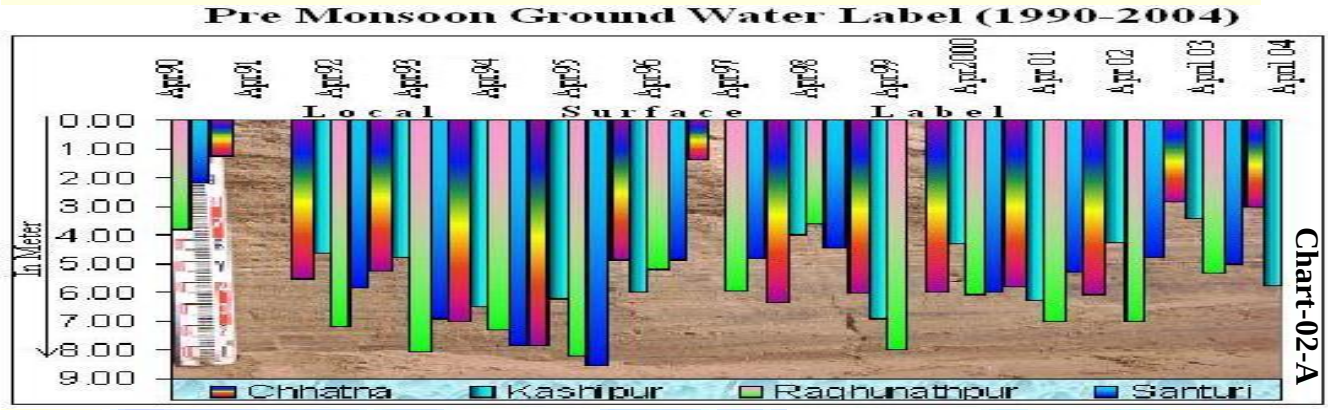


Chart-02-A

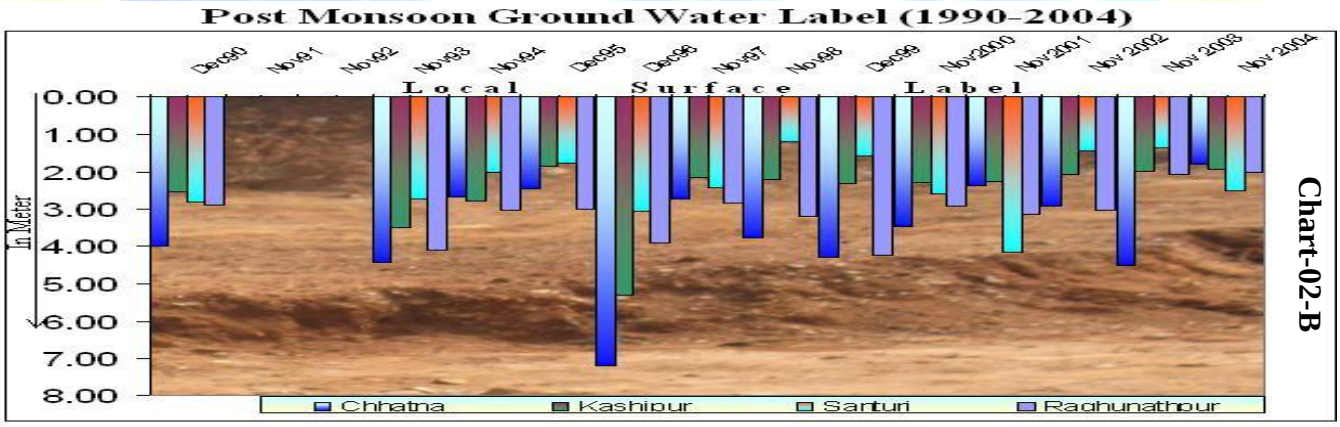


Chart-02-B

2.8 Land use/ Land cover: Land use/ Land cover is the surface utilization of all the development and vacant land on a specific area, at a given time and space. This leads on back to the plot / JL no. from and the farmer to the field gardens, pastures, fallow and forest and to the isolated farmstead. The difference between the land uses and the land utilization is important. Land use is the use actually made of any parcel of land, house, and apartments. And industrial locations 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 industry and carring of agricultural pursuits. In a rural areas tree crop and corn crop would identify the land use.

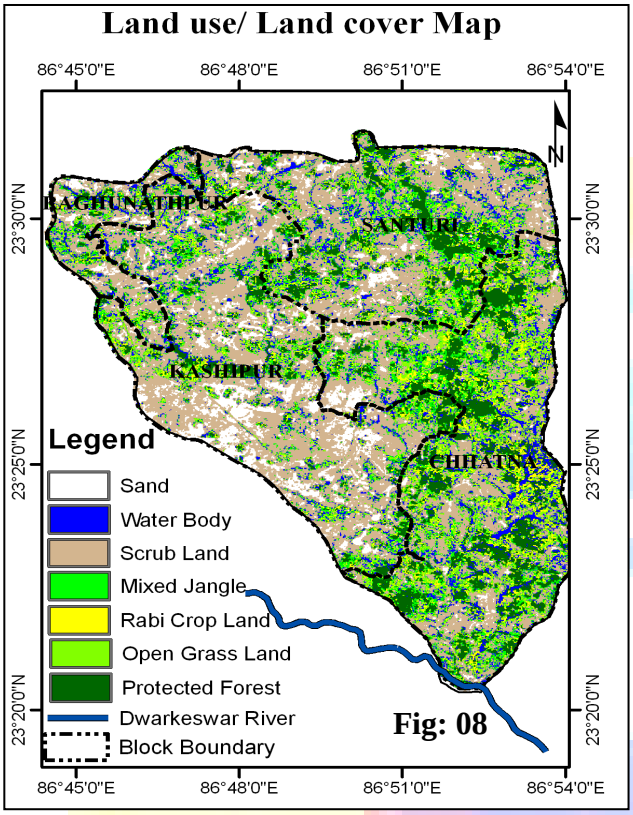


Table No- 01

Class name	Area in hectors
Water Body	2426.56
Rabi Crop Land	1271.89
Open Grass Land	2744.56
Mixed Jangle	2081.08
Protected Forest(P.F)	2779.48
Scrub Land	8071.5145
Sand	1641.65
Land cove	0.00
Total Land use Area	**21016.7345**

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.

III. Re-examination of soil after the beginning of irrigation from to time.

The most part of land use/ Land cover map (Fig-08) we see the Scrub land, here double time crop of year cultivation is occurred eastern part of the study area, under Chhatna block. The thin protected forests (PF) are present under Chhatna & Santuri block. Here also shows Mixed Jangle,

Open/ Grass Land. And also sand few portion of the study area. Here huge amount gully erosion is present.

3.0 Materials and Methods

3.1 Materials: Survey of India (SOI) toposheets on 1:50,000 scales Satellite image (ETM+, IRS LISS-III and SRTM) From Depatment of Remote Sensing & GIS Vidyasagar University. Soil information and map from NBSS & LUP, Geological map: Geographycal Survey of India (GSI) & DPMS map from NATMO Kolkata. Historical rainfall data was obtained from Indian Meteorological Department (IMD) Kolkata. The ground water level (Well) data from State Water Irrigation Department (SWID) Kolkata and Well data collect from field. Census data and political boundary of blocks & village, collected from District Statistical hand book. Also questionnaire survey and other information were also collected from the published literature.

3.2 Methodology: Image processing (ERDAS IMAGINE - 8.5) & GIS (Arc GIS-9.2) software used for digital image processing, generate thematic map and boundary map of sub-watershed, blocks, villages & drainage was digitized & attached in the form of the attribute table then raster overlay based on assigning weightage value for scarcity and ground water potential zone identification (fig-).

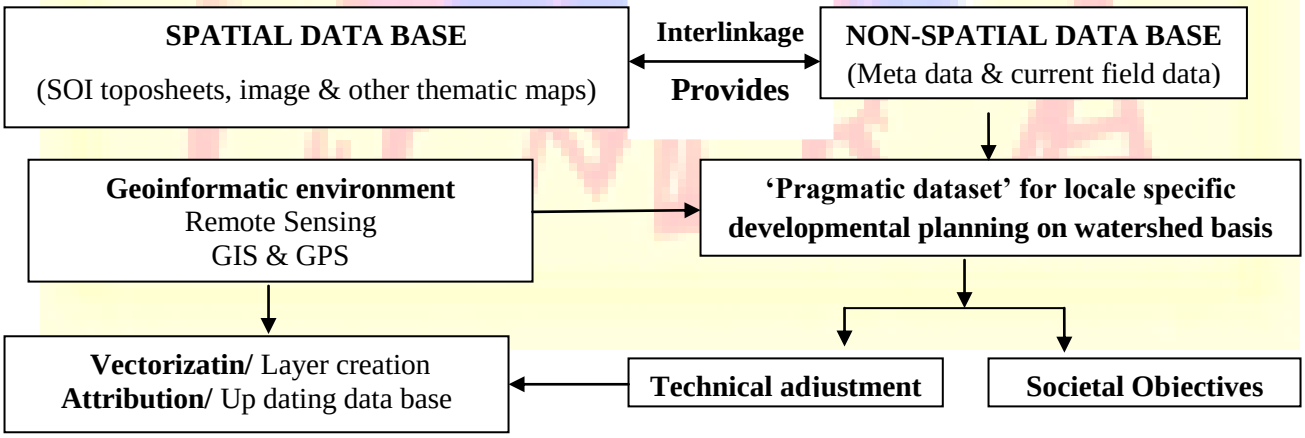


Fig: 09 Flow char of data inter linkage work

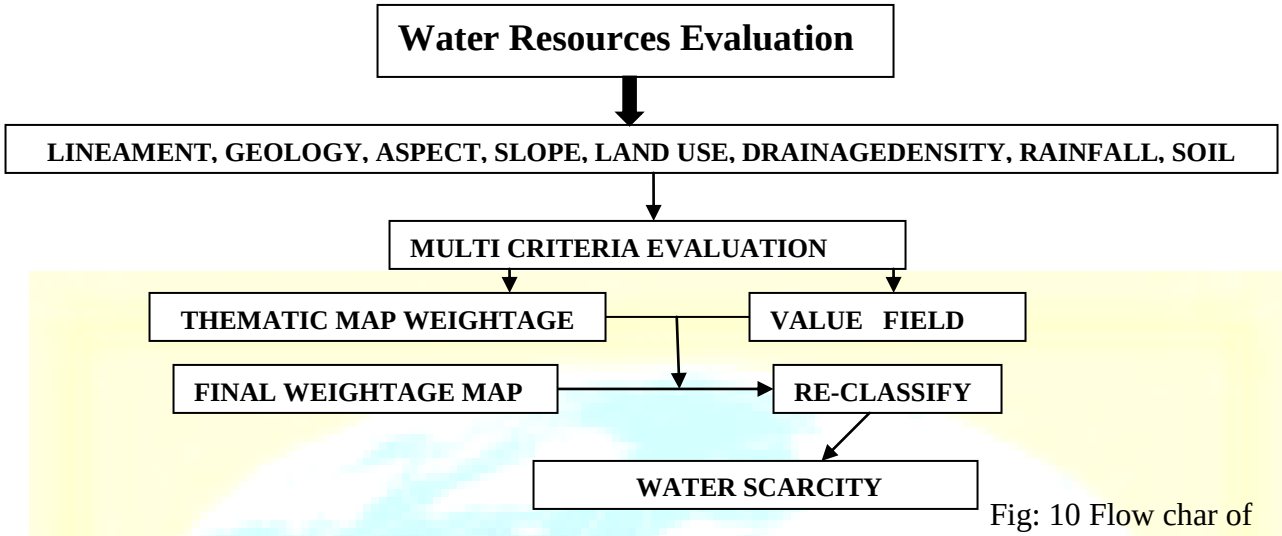


Fig: 10 Flow char of the work

3.3 Socio-economic study: The standard qustionnaraires was prepared and used to collect socio-economic information for the water-shed management in Dungra nala. Random sampling design was adopted. The list of respondents was prepared by backward class village and villagers of Dungra catchments. The villages were selected based on the required information in each village i.e river distribution and also socio-economic condition Kharif & Rabi session wise (Fig-11). 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.

4.0 Result and Discussion

The area under Sámi aride region belongs from Physiographic elements (Relief, Soil, Geology, Drainage, Slope, Climate, Land use/ Land cover, rainy season and Ground Water availability).In the present study, an attempted has been made to estimate the scarcity zone due to physiographic and anthropogenic condition in sub watershed area. It is mention that relief and water availability are closely related which is again very much influenced by the land use practices. i.e. anthropogenic activities. Therefore, in water resources management is the appropriate approach is to identify hydrological

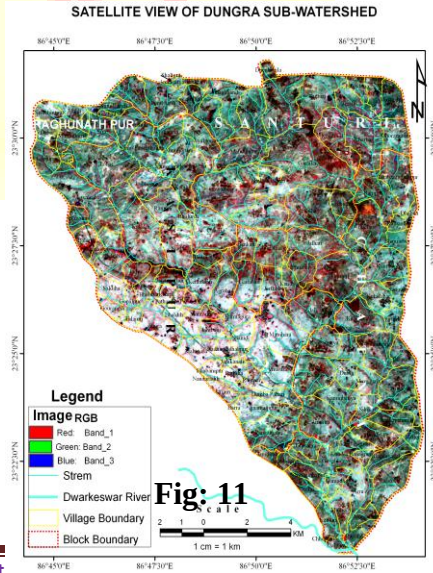


Fig: 11

unit. This approach has also been accepted in the National Water Policy (NWP). How ever, in this respect the conflicts generally faced are-

- When we identify a watershed/ Mini/ Micro watershed boundary, we faced watershed boundary versus administrative boundary (Fig-11). So, a comprehensive plan discussed earlier.
- Micro watershed concept in relation to physiographic provinces. For example whether tributaries (Pedimental landscape), or distributaries (Alluvial plains/ fan).
- Micro-watershed delineation varies in the terrain condition e.g Dungra nala origination from near Tilaboni hill complex area in Puruliya dist, flow south direction enters into lateritic terrain in Bankura district.
- Existing land use versus alternative land use practice considering the risk factor over amount of production parlay income.

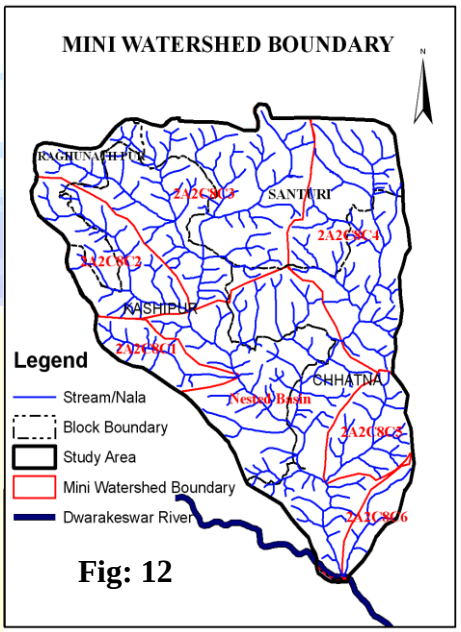


Fig: 12

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.

In study area there is only source of water is rain, this is why it is suitable for surface water management on micro label at list mini watershed wise. Watershed characterization involves measurement of related parameters, such as geological, hydrological, hydrogeological, geomorphological, soil, & land use / land cover. One the other hand ground water volume related almost same parameters.

Dungra sub-watershed 6 Mini watershed (Fig-12) and 28 Micro watersheds. 6 mini watersheds clockwise numbering flowing AIS & LUS (All India Soil and Land use Survey) alphanumeric codification is details given in table No- 02.

Table No- 02				
Code of Mini Watershed	**Mini watershed Under the Blocks**	**Area in Hectors**	**Number of Village**	**Number of Micro watershed**
2A2C8F1	Kashipur block	937.219	14	1
2A2C8F2	Kashipur & Raghunathpur block	2203.667	11	4
2A2C8F3	Kashipur,Raghunathpur & Santuri block	6051.231	38	9
2A2C8F4	Santuri & Chhatna block	4079.548	25	9
2A2C8F5	Chhatna block	1311.376	12	4
2A2C8F6	Chhatna block	607.401	07	1
Nested Basin	Chhatna & Kashipur block	6155.647	41	-

Scarcity Zone: The settlement location map prepared form Survey of India (SOI) Toposheet on 1:50,000 scale of 1977 Fast publication. From the figure (Fig-13) it is observed that the maximum settlement located besides the water body/ reservoir. On the hand the high scarcity of water is identify where no channel or nala are not available accordingly we see that settlement are present where the water available. Scarcity Map prepares primarily from (geology, geomorphology, soil, drainage density, slope, rainfall and land use) all reclassify thematic map by assigning wetage

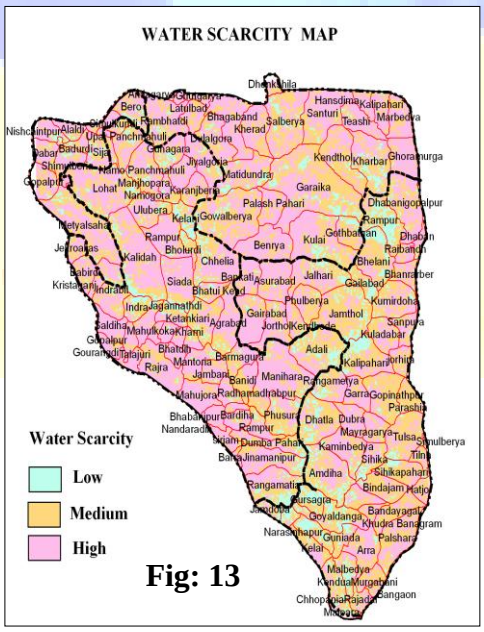


Fig: 13

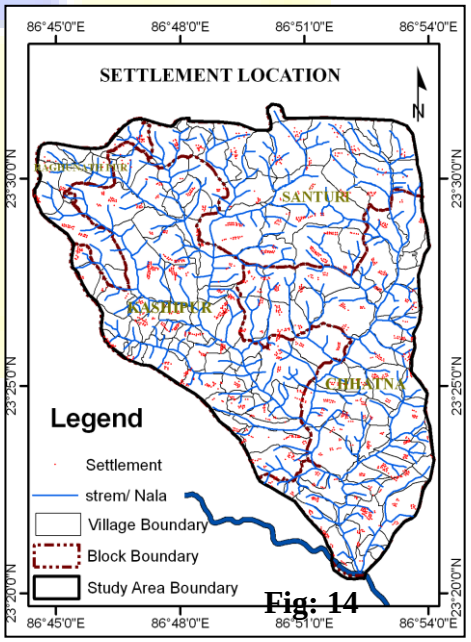


Fig: 14

value. The scarcity zone are classify in three classes this are high, moderate, low (Fig-14). The maximum area under high scarcity zone, low scarcity zone flow along river channels also medium scarcity zone. But there is an interesting matter that the settlements are not present in low scarcity zone, the main reason behind it channels are not permanent flow.

Watershed is a natural hydrologic unit, considered as the most appropriate basis for sustainable integrated management of the land and water resources. Judicious management and conservation of soil and water resources on watershed basis is perquisite for sustaining the productivity. One of the management process is constructed a reservoirs or dam, but whereas no big/ large check dam/ reservoirs suggested on that area. The main reason behind the suggestion is not to hinder the normal flow of the tributary of the Dwarkeswar river as it is the source of water supply of Bankura town.

So, Small size nala bandh and reservoir are suggested for temporary storage for life saving irrigation based on the physical parameters and morphometric analysis also maintain the length of nala band area of area of reservoir (Fig-15).

Mainly two Nala band and one reservoir are suggested. 1st Nala band is located at Siada village. 2nd Nala band is at border of Phusura and Dumba Pahari village length of band respectively 8612 & 1471meters. One reservoir is locked at Rajadal and Malpara village under 1184 feet^2 near meet point of Dwarkeswar river.

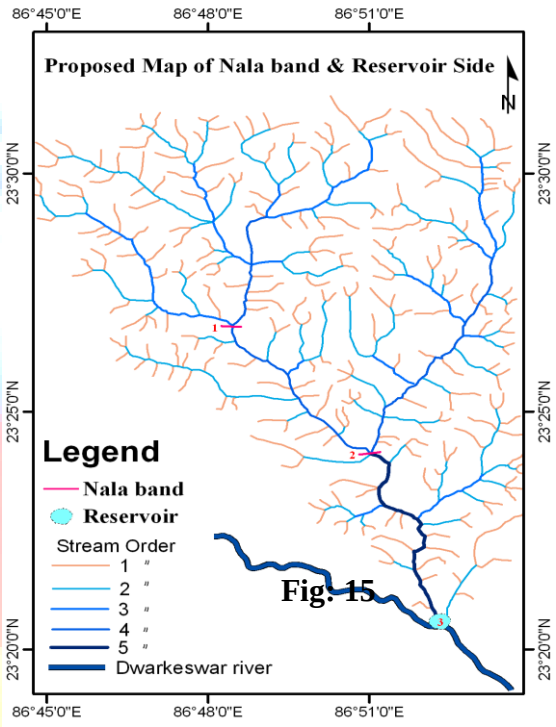


Fig- 15

Table No- 03

SL No of Nala band/ Reservoir	Geology	Length Area of Nala band (m/ m^2)	Total area where water drain in that area (sq km)	Soil	Ground Water from surface (In meters)	Altitude (meter)	Stream Order (Strahlers)
1 Nala band	Gneisses and Schist's	8612	130069.760	Red & yellow soil	>200	170	4^{th}
2 Nala band	Gneisses	1471	49869.984	Red & yellow	100-200	160	4th
3 Reservoir	Gneisses	110	155154.96	Red and yellow & Young alluvial soil	100-200	120	5^{th}

5.0 Conclusion: Water is renewable natural resources, however availability is influenced by the physical and anthrop factors. Water resources management / development require a comprehensive evaluation of both surface water and ground water conditions of an area on watershed basis with regional perspective. On the other hand water resources development needs very careful analysis of the upper catchments to the lower streatch of a watershed otherwise scattered local level surface / Micro watershed management in the upstream is likely to affect negatively the recharge in the downstream of a river.

- ✓ It is observed form the study the scarcity zone is located all over the study area.
- ✓ In Dungra sub-watershed where as no rooftop harvesting are suggested, due to short period of rainy secession.
- ✓ Rain water is mainly responsible for the ground water recharging for the study area.
- ✓ Existing land use pattern in response to the present day societal aspects versus acceptance of alternative land use practices e.g. marginal farmers are scared to accept alternative practices considering the risk factor over their assured production /income.

- ✓ Where as no big/ large chak dam/ reservoirs suggested on that area. The main reason behind the latter is not to hinder the normal flow of the tributary of the Dwaarkeswar river as the bore wells for the water supply of Bankura town.
- ✓ Small size nala bandth and dam are suggested for temporary storage for life save irrigation.

Acknowledgements

A number of people have assisted us, directly or indirectly, in the preparation of research. Namely Dr. Jatisankar Bandyopadhyay**, (**Assistant Professor , Department of Remote Sensing & GIS, Vidyasagar University**),** Dr. Parthasarathi Chakrabarti (Former Chief Scantest-DST Kolkata Govt. of West Bengal) and also thankful Prof Susanta Kr. Chakraborty (Ex-Dean, Faculty of Science, Vidyasagar University). I offer apologies & request that all of you provide corrections to me by email at 1kbrsgis@gmail.com.

Reference:

Chakrabarti.P, & Nat, S. (2002): Geoinformatics: Spatio-themtic information for natural hazards/ disaster management. Int. Symp. ISPRS, Vol.34.Pt.-7 'Resource and Environmental monitoring', NRSA, Hyderabad pp.1198-1201

Christopher et.al (2010),"Hydrological Analysis of Onitsha North East Drainage Basin Using Geoinformatic Techniques" World Applied Sciences Journal 11 (10) p. 1297-1302.

Johnson, E, Lynn: (2008) "Geographic Information Systems in Water Resources Engineering" Book on 1st publication,

Murty, J.V.S. (1996): "Watershed Management" Book on - 2nd Publication, P.24)

Rao VV & Raju PV (2010): "Water Resources Management" Part of the book Remote Sensing Application NRSC 2010 on 2nd Publication, P.133-164.