CONFERENCE

ON

"SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF GROUND WATER RESOURCES, ITS REMEDIAL MEASURES FOR EMERGING CRISIS AND CLIMATE CHANGE IN WEST BENGAL"

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Watershed prioritization using Geomatics Technology for development and Management of Groundwater Resources, West Bengal

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Abstract: Management of watershed resources is related to various activities from watershed delineation to monitoring. The suitability of land for development is not only based on a set of physical parameters (geography/terrain, soils, slopes, forest, geology etc.) of the land but also very much on the economic factors. The cumulative effect of these factors determine the degree of suitability and also helps in further categorization of land into different priority orders for development. The study area is totally rainfed and availability of water for drinking and domestic use is a day by day acute problem in climate change scenario. The natural recharge process in the area is very poor due to hard compact granite terrain. The response of a watershed to different hydrological processes and its behavior depends upon various physiographic, hydro geological and geomorphological parameters. The characterization of a watershed provides an idea about its behavior.

Introduction: A watershed is an area from which runoff resulting from precipitation flows past a single point into large streams, rivers, lakes or oceans. Thus, a watershed is the surface area drained by a part or the totality of one or several given water courses and can be taken as a naturally occurring hydrologic unit characterized by a set of similar topographic, climatic and physical conditions. Various terms have been used in order of their rank/hierarchy, i.e., sub-watershed, watershed, sub-basin and basin. The Watershed Atlas prepared by SLUSI (1990), describes the mean area of watershed as being less than 500km^2 (Nag SK 1998) . The National Remote Sensing Agency (1995) has further classified the watershed into sub-watershed (30-50km^2).

Watershed prioritization is an holistic approach many authors/ researcher had prioritized in different way. Morphometric parameter based sub-watersheds prioritizatied basins using remote sensing & GIS techniques, was attempted by Bera and Bandyopadhyay (2013). K. Nookaratnam et al., (2005) carried out check dam positioning by prioritization of microw-watersheds using Silt Yield Index(SYI) model and morphometric analysis using remote sensing and GIS in Midnapore district of West Bengal. Arun et al (2005) attempted a rule based physiographic characterization of a drought-prone watershed applying remote sensing and GIS techniques in Gandeshwari watershed in Bankura district of West Bengal. In the present study, surface water and groundwater potential zone analysis has been carried out in Silabati watershed to prioritizes sub watershed of Paschim Midnapur, Bankura and Purulia district, West Bengal using remote sensing and GIS techniques.

Location: Silabati watershed is located in 23^0 14' 23.45''N to 22^0 28' 21.25''N and 86^0 42' 13.75''E to 87^0 46' 43.35''E. The political boundary of the study area is some portion of Purulia & Bankura district (upper cathment) and some portion of West Midnapur district (lower cathment) of West Bengal. The Silabati watershed cover Puncha block of Purulia district, Taldangra, Chatana, Onda, Bankura-I block of Bankura district and Chandrakona-I & II, Keshpur, Garbeta-I,II & III, Ghatal, Daspur block of Paschim Midinipur district (Figure 1).

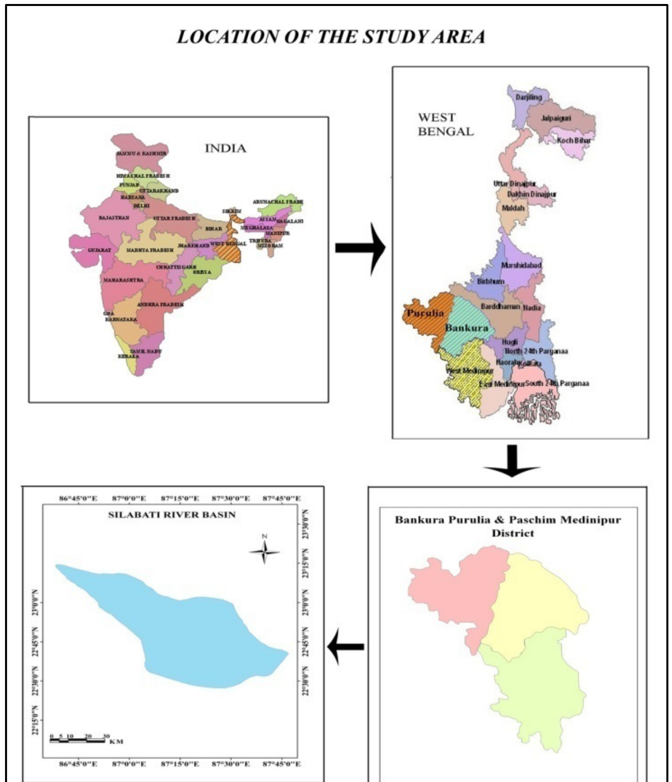


Figure 1

About the Study Area: The Silabati river is originated from Chotanagpur plateau region of Purulia district of West Bengal and near Ghatal of Pashim Midnapore, it join with Rupnarayan river. In the runway of Silai many tributary and sub-tributaries are joined with the river.

Climate: The study area has a tropical monsoon climate, hot summer and well distributed normal rainfall. The year divided into four seasons. The cold season starts about middle of December and continuous till the mid of February and summer which extended up-to May. The south-west monsoon season continuous up-to the end of September. October & the first half of November is the post monsoon season. The upper catchment region of Silai river watershed is extensive hot and dry region than the lower part or catchment of the watershed.

Temperatures: Temperature rapidly rises about from early March. May is the hottest month with a mean daily temperature 31.7˚**C**. The mean annual temperature is about 28.92˚**C**. The temperature rapidly decreases appreciably in November; the mean temperature is about 19.7˚**C**. The coldest month of the year is mid of December to mid of January.

Rainfall: The average annual rainfall between upper & the lower catchment of the study area have great variation. In the upper catchment, mainly the Purulia & Bankura district, where the average annual rainfall is very low (about 90.6mm to 115.2mm). In the lower catchment the average annual rainfall is about 150 mm to 225mm. Rainfall decreases in hot & cold weather. A considerable amount of monsoon rainfall occurs in association with the movement of cyclonic depression from the Bay of Bengal. It rains heavily from June to September.

Humidity: In the rainy months of the south-west monsoon season, the air is generally very damp and the relative humidity ranges between 80 and 90% over a greater part of the State.

Soil: Silabati river basin has varied unit, like the climatic variation, variation of soil characteristics is also noticed. In the extreme north west and western section mainly the red & yellow soil are found. Some parts are cover red gravelly soil & halpustals soil. Middle part of the Silai watershed are mainly cover the lateritic soil & river beds area are found older alluvial soil. Lower catchment of the river is covered with younger alluvial soil (Figure 2).

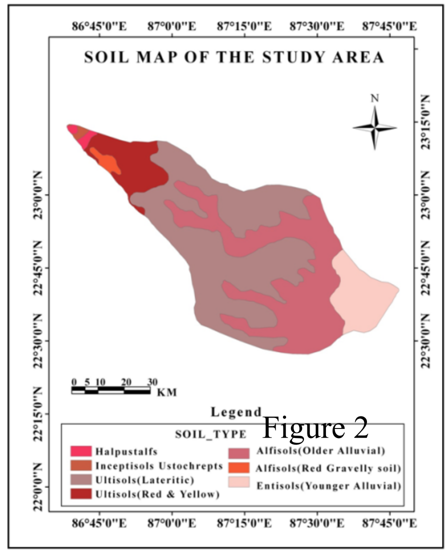


Figure 2

Geology: In the present study area there are many geological types or variation are observed. Upper part of the study area are mainly found Granite gneiss (about 13%), Pink granite (about 63%) & Mica schist (about 24%). Middle part of the study area are mainly found sand, silt, clay & Quartz, Granite, Gravel, Laterite & some parts are found Clay & Grit and Lateritic soil. Lower part of the study area cover mainly with Sand, Silt, Clay & Greenish grey clay. The starting part of Silai river consist of the geological unit of Chotonagpur gneissic complex, the next part of the watershed is unclassified quaternary. The lower catchment of Silai is formed with Lalgarh formation, Laterite and Sijua formation (Figure 3).

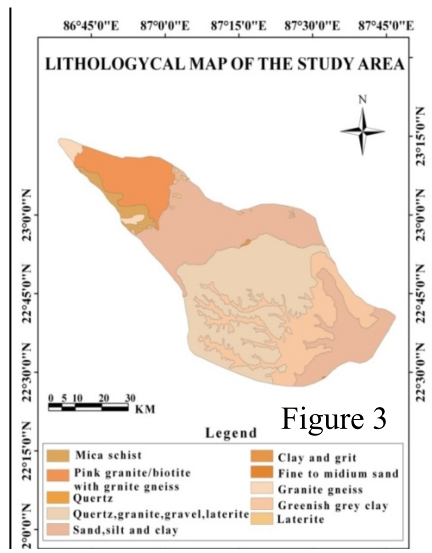


Figure 3

Relief and Slope: In geographical position, the Silabati river catchment is the most varied unit in west Bengal. The North & North West embrace a portion of the eastern fringe of the Chotanagpur plateau & consist of the hard lateritic formation. The height of this tract from base level is varied from above 200m to 100m tract, and the trend of the tract from North-West to South-East (Figure 4). Gentle undulations appear width lower ridges of the Chotanagpur hills covered by the thick growth of dwarf Sal trees & other scrub jungle. The horizontal hills line is terminated by long rolling waves of laterite rock.

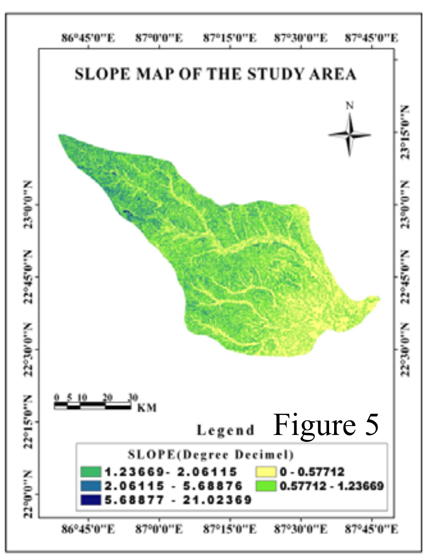


Figure 5

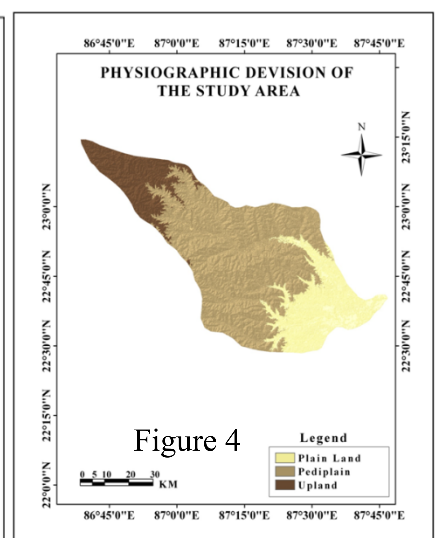


Figure 4

Micaceous schists crop up from beneath the lateritic flats. Irregular shaped hills have composed of gray and bluish- gray micaceous schists, greyish – white, Gritty quartzites, quartzose grits. The ridges have broken and picturesque in isolated masses separated by valleys and lower grounds which are formed by blue slates. All over this hills are scattered masses of iron- slag coarse gritty sandstone of red colour, often the rocks become conglomeratic, pebbles of quartz, and rounded fragments of other rocks, detrital or nodular laterite, gravelly laterite(used for road construction) being embeded in it. But the eastern portion (mainly the flood prone area) has been formed out of alluvial deposits borne down by the Silabati river and its tributaries. The general appearance of this unit is that of a large, open & rough triangulated, cultivated plain. The height of the alluvial portion is varied from 100m to10m contour height (Figure 5).

Drainage System: The Silai river originated from Chotonagpur plateau of Purulia district. First the river flow in the south eastern direction and enters the Bankura district. Then it flows eastern & south-eastern direction and enters Paschim Medinipur district and lastly it ends with Rupnarayana river at Bandar four miles below Ghatal town (Figure 6). In the present study we divide the total watershed into eight micro watersheds for better analysis. The drainage map of the study area is shown in below(Figure-6). Here the main river is Silabati , in the runway of the river many tributary and sub-tributary are joined to Silai. The left hand tributary of Silabati are Betal, Parang, Kubai, Sundra, & Tamal and also there are sub-tributaries, on the other side Jalpanda & Purundar sub-tributary are joined to the Silai.

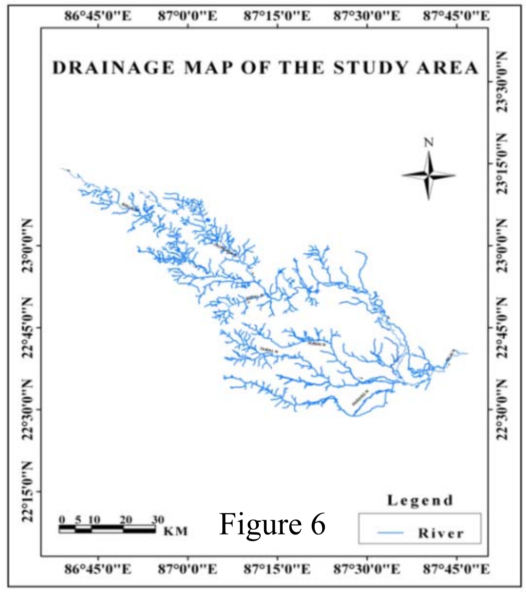


Figure 6

Land Use/Land Cover: The land use and land cover map is prepared using LANDSAT TM satellite data of the year 2014 by using supervised classification and recode techniques. Under the classification Settlement, Water body, Deep vegetation, Light vegetation, Fallow land/ Agricultural fallow, Lateritic exposure & agricultural land are found (Figure 7). Maximum portion of the study area is covered with fallow land/ agricultural fallow (about 61.12%). In the watershed settlement (4.29%), deep vegetation (5.88%), light vegetation (5.88%), lateritic exposure (13.40%), water bodies (1.33%) & agricultural land (8.02%) has been covered.

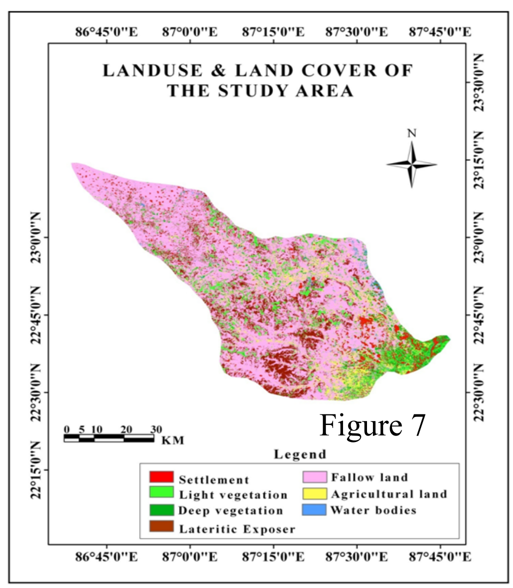


Figure 7

Aim: Sub-watershed prioritization for development and Management of Groundwater Resources.

Objectives:

I. To get better knowledge of the study area.
II. To identify surface and Ground water potential zone of the study area.
III. To prioritizes sub watershed.
IV. Sustainable development of the study area.

Data Used:

Table 1 Data Base		
DATA	**SOURCE**	**YEAR**
SOI TOPOSHEET (1:50000)	Survey of India, Kolkata	1975
THEMATIC MAP & DPMS	NATMO, Kolkata (Purulia, Bankura & Pashim Midnapore)	2001
CIMATE DATA	Metrological Department, Kolkata and Irrigation department of Paschim Medinipur.	2010
LANDSAT TM	USGS website	18th April, 2014
SRTM DEM	USGS website	2008

Analysis and Results:

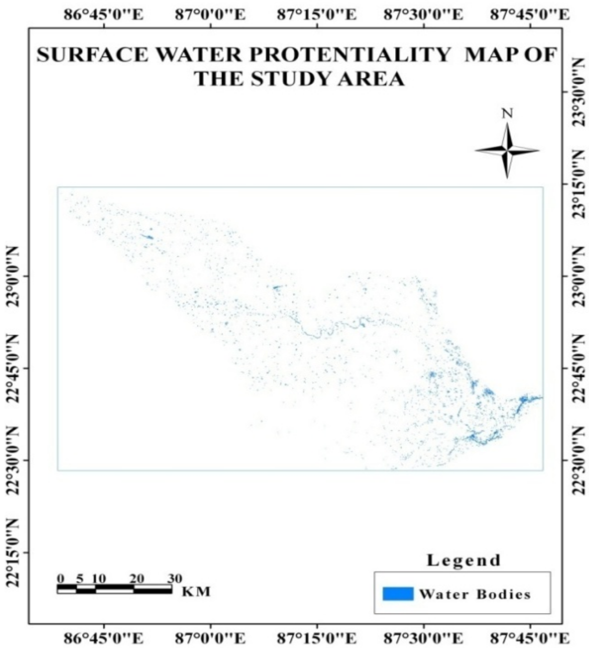
Surface Water Potentiality: A Surface Water Management Plan (SWMP) which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall (Omotayo Olarewaju 2008).

In the whole, surface water are developed in a scatter manner in the watershed. In all of these watersheds water bodies are present more or less (Figure 8). The highest surface water potential zone is micro watershed-8 (Table 2).

Table: 2, Rank of Surface Potentiality		
Micro watershed	**Surface water area (%)**	**Rank**
SW1	1.29	4
SW2	1.51	2
SW 3	0.49	7
SW 4	0.34	8
SW 5	0.82	5
SW 6	0.81	6
SW 7	1.30	3
SW 8	2.63	1

Groundwater Potential Zone Estimation:

The rapid expansion in development of ground water resources for varied usage has contributed in expansion of irrigated agriculture, overall economic development and in improving the quality of life in India. Last three decades have seen an exponential growth in number of ground water structures and more than 17 million wells all over the country are providing irrigation water to more than 50% of irrigated area. The substantial proportion of agricultural output is from ground water irrigation due to higher yields in ground water irrigated areas (Dasgupta et.al



1992). This resource has become an important source of drinking water and food security for teeming millions of the country. It provides 80 percent of water for domestic use in rural areas and about 50 percent of water for urban and industrial areas. The significant contribution made for Green Revolution and also as primary reliable source of irrigation during drought years has further strengthened the people's faith in utilization of ground water as dependable source.

A probability analysis was done in ARC INFO in GIS environment. The overlay analysis allows a linear combination of weights of each thematic map with the individual capability value with respect to Ground water potential. Various terrain parameters like Slope, Drainage density, Soil characteristics, and Land use are prime control on movement of surface and sub- surface water and occurrence of perspective ground water reserves in the region (Bera and Bandyapadhyay 2011).

Different parameter for ground water prospect and there themes and class weight value:

Soil (theme weight-15)		**Land use/land cover(theme weight-20)**	
Category	Class weight	**Category**	**Class weight**
Inceptisols ustochrepts	1	Settlement	1
Halpustolfs	2	Lateritic exposure	2
Ultisols(red & yellow)	3	Fallow land	3
Alfisols (red gravelly)	4	Agricultural land	4
Ultisols(lateritic)	5	Light vegetation	5
Alfisols (older alluvium)	6	Deep vegetation	6
Entisols(younger alluvium)	7	Water body	7
Slope (theme weight-5)		**Geology (theme weight-20)**	
Steep	1	Sand, silt, clay	1
Moderate	2	Quartz	2
Moderately low	3	Green grey clay	3
Gentle	4	Clay & grit	4
Drainage density (theme weight-10)		Mica schist	5
High	1	Laterite	6
Medium	2	Quartz, granite, gravel, laterite	7
Low	3	Pink granite	8
Very low	4	Fine to medium sand	9
Lineament (theme weight 30)		Granite gneiss	10

In this way every parameter has its own weighted value. This weighted value define by reclassify all the parameter and there categories in GIS environment. After reclassifying all parameter, weighted overly operation/function has been made to calculate ground water potentiality zone (Figure 9).

In the watershed high ground water potentiality zone are located at micro watershed-1 & 2 because in this area there have some lineament and it has a great influence in ground water targeting. And some portion of SW 7, 6, 5, 4 & 8 the high potential zone is located in edge of upland.

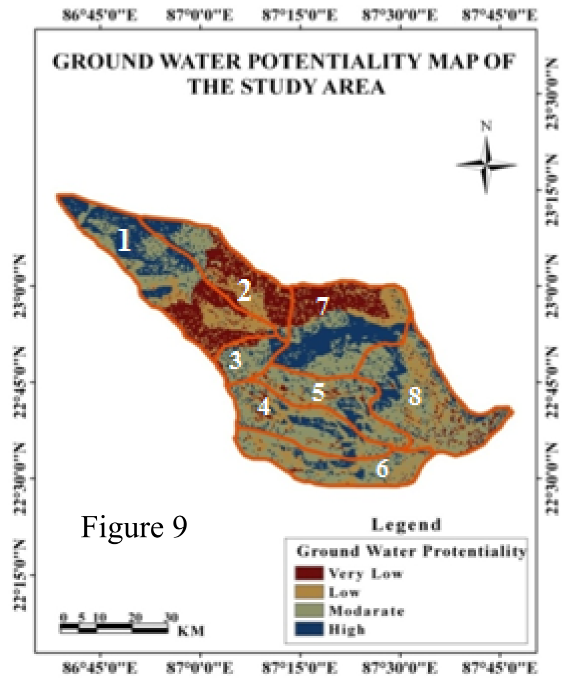


Figure 9

Prioritization of Watersheds:

Based on Surface water potentiality: High surface water storage indicates a positive view to prioritization of a micro watershed in a watershed. In present study of Silabati river basin there is high surface potentiality located in Sub-watershed 8 about 2.63% of total land use & land cover, so it ranked as 1, and lowest surface water storage SW4 about 0.34% ranked as 8. The SW 4, 2, 7, 8, 5, 6, 3 and 1 is surface water potential respectively.

Based on Ground water potentiality: Ground water is an important parameter for human lives and it is also important for a better development planning. In present study area high ground water potentiality zone belong to micro watershed-1 (about 35%). In the basis of ground water potentiality we ranked micro watersheds SW1, SW2, SW3, SW4, SW5, SW6, SW7 and SW8 as 1, 7, 8, 4, 3, 6, 2 and 5 respectively.

Conclusion:

The present study demonstrates the utility of remote sensing and GIS techniques in prioritizing watersheds based on surface water potential and ground water potentiality analysis. The study concludes that SW 1 (Sub Watershed 1) is low potential based on surface water potential; on the other hand groundwater potential based study confirms 1st position of the SW1. Hence, these may be taken for conservation measures by planners and decision makers for local-specific planning and development of the area.

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