Geo-hydrological Study for Agriculture Development of Dungra Sub-watershed through Geoinformatic Platform, Bankura and Puruliya district, West Bengal

Kartic Bera* and Jatisankar Bandyopadhyay

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

**E-mail: kbrsgis@gmail.com*

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Abstract: Watershed is the natural boundary of a particular drainage area. It's appropriate management invites close participation of the Panchayaty Raj Institution at local government level. The present study was conducted on Dungra watershed situated in part of Bankura and Puruliya district of West Bengal. The techniques of Geoinformatics have been proved to be efficient in identification of geo-hydrological aspects for watershed management. IRS LISS-III of 2009 and 2011 multi-temporal data was used for land use / land cover change analysis. Besides the important environmental parameters, critically sensitive socio-economic conditions of the said watershed were taken into considerations for an all-round sustainable development. The study synthesizes the interdependent physico-scio-economic parameters and works out a detailed land capability analysis for the various sectors within the watershed to suggest a viable alternative land use plan. This proposition would not have been feasible unless the instant run-off and the resultant seepage get arrested by practicing contour bunds (aals) and constructing nala bunds across minor and major streams to cater local irrigation needs.

Introduction

Agriculture resources considered being one of the most important renewable and dynamic natural resource. The ability of the world's natural resource to provide the needs of its growing population is a fundamental issue for the international community (Rasheed and Venugopal, 2009). Soil resource are very much essential for India, where agriculture is the mainstay one our national economy in coming decades; the world community will face an enormous challenge concerning food security, food supply and sustainability in agricultural development environmental conservation, and preservation. But the population growing process with an increasing Variety of demand being made on land resources have creates enormous pressure on the available resource of the country. Such issues as food security can only be address through the capability to define changes in agriculture production. Local land-use and land-cover change can influence environmental and ecological changes and further more contribute to global change. All of these changes, especially the loss of agricultural land, have the potential to undermine the long-term harmony of humans and their environment and threaten the food security. Obviously urbanization produces a permanent loss of productive land. A secondary but important question relates to the quality of the lost. Given that agricultural land is affixed quantity and that not all land is equal in its productive capacity, the ability to relate land use changes to the soil on which they occur is an important capability.

The use of sophisticated Information technologies such as Geographic Information Systems (GIS), Remote Sensing (RS) and Global Positioning Systems (GPS) offers many advantages. In this study productivity of soil, Land use / Land cover map, Relief, Drainage Density, Ground water, Slope help to delineate crop suitable zone.

Location of the study area: - The Darakaswar watershed at Tilabonihill in Purulia district, West Bengal, flow easterly through the padimental landscape that enters into the deselected lateritic terrain in Bankura district and further

down stream into the Gangatic alluvial plain debouches in the Rupnarayan River it is the part of chotonagpur plateau. This area consists by four blocks under Bnkura & Purulia district, namely Chatna, Kasipur, Raghunathpur-I and Snturi, The total area is under study 210^2 km. This sub-watershed geographicly located between 23°20´N to 23°30´N and 86°45´E to 86°55´E (Fig:1).

Location Map of Study area

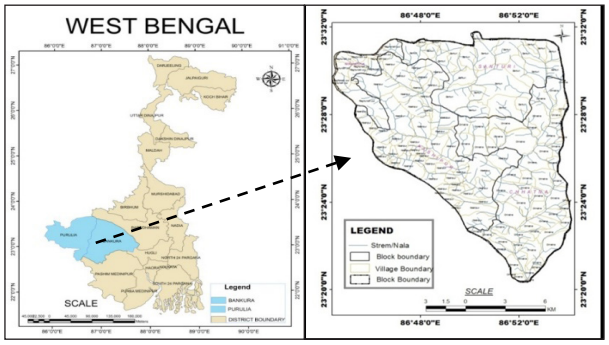


Figure 1.

Physical background

1.1 Relief: - Relief of the study area shows as a plateau region. In the north part of the study area is very high (>200m) and the south part of the relief is low with a gentle gradient form north to south. The gentle gradient form 90 to 250 meter. (Fig. 2) with argental gradient form upper to lower part. Mostly the area covered by scrub land and also some part protected forest.

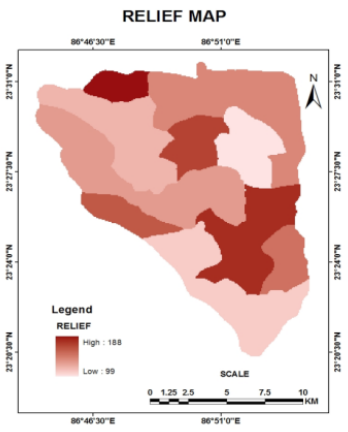


Fig. 2

1.2 Soil:-The soil map of the study area is mainly divisible in two groups-

a) Reddish yellow soil,

b) Young alluvial soil.

The major part of the basin area is cover with red and yellow soil and the western part of the Dungra watershed is covered with yellow soil. Mostly the soil is infertile of scrub land. The radish yellow soil is not very fertile and due to minor availability of water productivity is less. Maximum season fallow land is shows in respect of land use. The agriculture is restricted practice (Bera and Bandhopadhyay, 2011).

1.3 Slope: - Slope of the study area plays important role for agriculture activities in general and specially crop suitability study for agriculture. The maximum part of the study area slope is moderate. The slope of study area was derived from DEM which was obtained from the SRTM data. The dark black indicates the low elevation and gray to white color represent high elevation. Slope value ranges from 0.00111207 (Low) to 1.28274 based on the SRTM data information.

1.4 Climate: - Climate of study area is tropical dry humidity. The annual rain fall is 1100 mm to 1400 mm/year. The temperature is range from 12°C (in winter) and maximum 46°C (in summer). The variation in the no. of rainy season and soil moisture limitation are common. Severe drought period lasting for week adversely affects the crop growth & yields during main cropping, kharip season.

1.5 Drainage: - Drainage is most important factor of agriculture. In this study area Main River is Dwarkeswar which originate from western up land of Chhotonagpur plateau region & meet Damodar River. The Dwarkeswar River flows from north-west to south-east of

Table 1: Data source

TYPE OF DATA	YEAR OF PUBLISED	SOURCE
IRS LISS-III	February and September, 2011	NRSC
SRTM DATA	2000 (90mtr Resolution, path/ row-54/08).	SRTM Website (Bhuvan)
Top sheet	1972 (First edition)	Survey of India (Kolkata)
Block map & Village map	1981(Census hand book)	District Statistical Hand book (Kashipur block)
Socio economic data	2013	Census office, field survey.
Soil characteristics	2013	Collect sample by lab test

the study area. The flowing system is seasonal mainly monsoon period. In this flow one of the left bank tributary Dungra, meet Dwarkeswar near Malpara village.

1.6 Geology: - The study area is under Chhotonagpur granitic gnesses complex, which is mainly consist of –

a) Granite gnesses (cover most part of the study area).

b) Plutonic gabbro and anorthositic rock.

c) Pegmatite vein, quartz vein & d) Laterite.

The geology of upper most area granite grano-diorite pegmatite igneous sand stone shale and conglomerate schist is present. The most part of the study area cover by gneiss rock.

1.7 Ground water: - Ground water is most important factor of the rabi crop. The ground water is deferent layer of the study area, like 60 to160 feet. Irrigation is depending on ground water table. District minor irrigation facilities are available in some part of study area. The ground water table is high in lower part (south) moderate in middle part, low is upper part (north) (Fig-3).

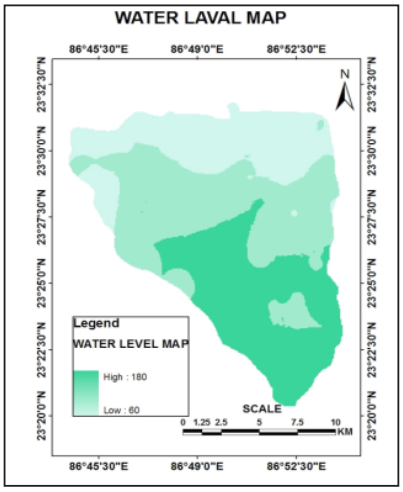


Fig. 3

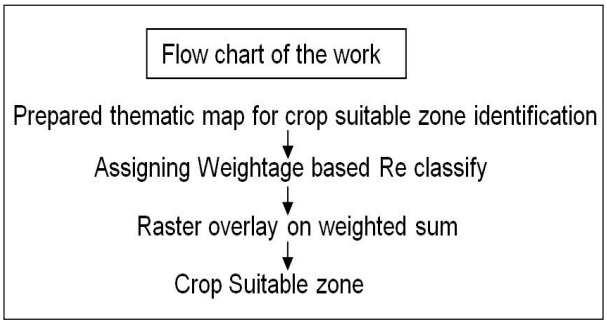
Aims and Objectives

1. Present land use land cover Condition.
2. Soil properties (Productivity)
3. Crop calendar (Kharif & Rabi)
4. Alternative land use practices by crop suitable zone.

Data & Methodology

Table 2: Software used

Image Processing Software	ERDAS IMAGING 9.0;
GIS Software	ARC-MAP 9.3
Documentation, calculation and presentation	Microsoft office -2007



Result and Discussion

1). Soil Productivity: - Soil is important factor for land suitability evaluation of agricultural crop. For the study, the soil mapping unit of this area is used for analysis. The physical and chemical properties of soil get from lab test which are collect from field survey and assigning productivity weaightage value (Table 3) and then prepared a map of soil (Fig. 4).

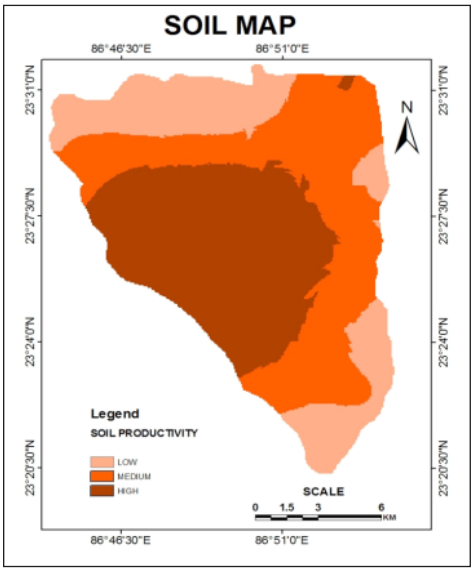


Fig. 4

Table 3: Soil productivity Weightage (37)

Category	Weight -age
High productivity	15
Medium productivity	12
Low productivity	10

2). Land Use / Land Cover:- The land use / land cover of the study area has been obtained by performing supervised classification on the LISS-III satellite imagery based on field observation. Accordingly training points identified to represent the various land use classes were marked using GPS during field visits. These GCP point were used to sample representative signatures for different land used class. The categories including single crop area, double crop area, deep forest, open forest, water body, plantation, scrub land, settlement. These land use land cover map were reclassified to make it compatible with other parameters use for the analysis (Fig. 5). The weightage of land used/land cover category are given in Table 4.

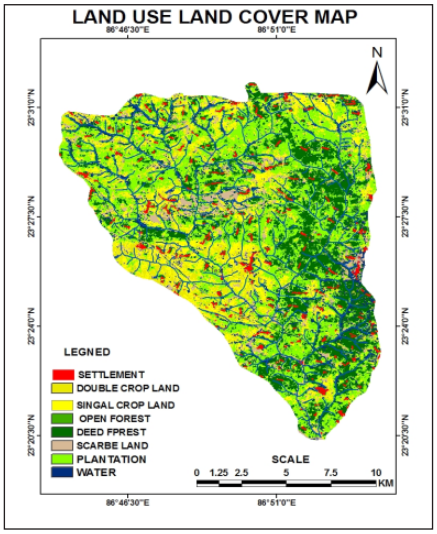


Fig. 5

Table 4: Land use land cover (23)

Land use Class	Class Weight
Double crop	5
Single crop	4
plantation	3
Open forest	2
Dense forest	1
Water body	6
Scarab land	1
Settlement	1

Table 5: Relief weightage (14)

Category	Class weight
High	2
Medium	5
Low	7

3). Relief: - Relief is an important determining factor for land suitability evaluation of agricultural crops. For study, the relief mapping unit of this area is used for reclassify crop suitability zone. The relief category is high, medium, low. The High class weightage are 2, Medium-5, Low class weightage-5 (Fig. 6)

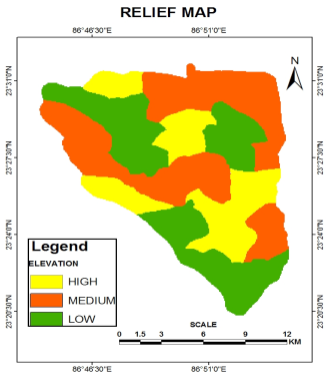


Fig. 6

4) Drainage Density: - Drainage condition is important as it controls the soil-cum-water relationship and the supply of nutrients to plant. The drainage density is high, moderate, and low of the study area. Where drainage densities are high, there are most suitable soil for the agricultural crops (class weights-5), moderate drainage density class weights 3 and low drainage density class 2 (Fig-7).

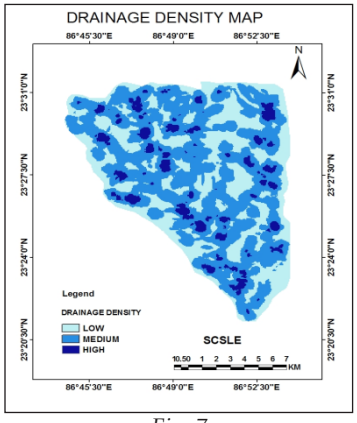


Fig. 7

Table 6: Drainage Density weightage (10)

Category	Class weighted
High	5
Medium	3
Low	2

5). Water Availability: - As it is a plateau region, therefore water availability is so much low. The average lope of the study area is 4-6%

ad at river side some time it 10%. The ground is being recharge directly by infiltration of rainy water. Surface water bodies, river, channels, etc. Since the terrain is rocky in nature, rock fracture and weathered rock act, as place of accumulation of underground water. Due to the existence of high slope, surface run off is much higher than the rate of ground water recharge. Though, the quantum of annual rain fall is considerably high. But it has not been distributed over a period of time. Rather it occurs intensely on a few days during rainy season (Fig. 8).

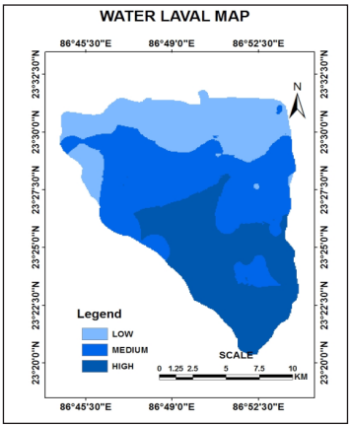


Fig. 8

1. River: Here rivers are non perennial. So water availability is only in rainy season. Other time rivers are dry.
2. Pond: Here pond condition is very poor. Whole year water is not available in all the ponds. Few ponds have water availability on all month. Their location is given in the map.
3. Well: Here well condition is also very poor. All year have water availability. But this water is not used for drinking purpose. Well depth is 30-40 ft.
4. Tube well: Here tube well condition is medium. Tube well is used for drinking purpose. Water availability is round the year. The depth of ground water is 60 ft to 180 ft.

Table 7. Water availability weightage (9)

Category	Class weighted
High	5
Medium	3
Low	1

6). Slope: - Slope of a given area plays an important role for agriculture activities. Slope defines if an area is workable at all or not, its erosion hazard too. Thus the study area of slope is an important factor for the land suitability study for agriculture crops. The slope of study area is 4% - 10% (Fig. 9). Slope of the study area was dived from DEM which was obtained from SRTM data Low slope area is better than the high slope area for agricultural activities. The slope category class weight are low-5 middle-3, high-2.

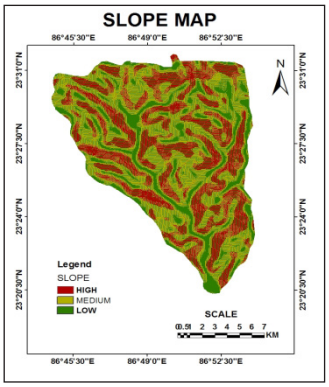


Fig. 9

Table 8: Slope weighted (7)

Category	Class weight
High slope	1
Medium slope	2
Low slope	4

Crop Suitability Zone: - Different parameter of soil properties, land use/land cover, relief, drainage density, and slope are the most important category of crop suitable zone mapping. This category sum weightage overlay creates the suitable cropping zone. This map is representing the six classes of crop suitable

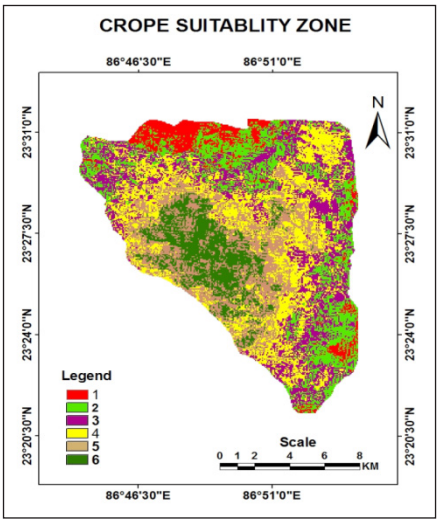


Fig. 10

zone. Among the classes 5 & 6 classes are high suitable zone. 3 and 4 classes are medium; 1and 2 classes are low suitable zone. Kasipur and meddle part of Chatna is high suitability zone. North – western part of the study area (Santuri and Raghunath pur) and south eastern part is under low suitability. All others part is under medium suitability (Fig-10).

Conclusion

The overlay analysis method is applied for specialist's alternative and reliable approach to demarked suitable area for crop through a GIS context. Weighting factor is used to define important factor, which could be use full for crop suitable zone. Study area Kasipur and middle part of Chatna is high suitability zone. North – western part of the study area (Santuri and Raghunath pur) and south eastern part is under low suitability. All others part is under medium suitability. But this medium suitable zone could not cultivation due to lack of irrigation water. For development of agriculture, necessary to increase water availability/ develop irrigation system at list side select for reservoir or nala bund for live saving agriculture purpose. This approach can be further enriched by incorporating other socio-economic and environmental variable to obtain the optimum result.

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