Bhaskar Das, Reshma.Chakraborty / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 1, January -February 2013, pp.1104-1112

Integrated Land and Watershed Development of Dhobai Watershed in Dumka District, Jharkhand-a GIS-Geonomic analysis

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ABSTRACT

Land and Water Resources Management imply rational utilisation of land and water resources for optimal and sustained production with the minimum hazard to natural resources and environment. An integrated and reliable GIS-geonomic database has been designed and generated for optimal planning, proper development and management of Dhobai watersheds (23°45' N to 24 ° 45' N; 86 ° 15' E to 87° 45' E) ,a part of Mayurakshi river basin in Dumka district, Jharkhand. Knowledge of drainage system, land use/Land cover and hydro-geomorphology and other terrain attributes under this watershed are very much important for planning and management activities.

Key words: Watershed management, Geonomy, GIS, TIN

1.0 Introduction

Land and water are essential resources for day to day activities. Knowledge of drainage, land use/land cover and hydro-geomorphology and other terrain attributes are important for planning and management activities. Remote Sensing and GIS both from the conventional sources has proved to be an effective tool in planning for Land and Water Resources management.

Land and Water Resources Management imply utilisation of land and water resources for optimal and sustained production with the minimum hazard to natural resources and environment.

2.0 Aims and Objectives

The ultimate aim of the project is to study different elements of land and water resources for their management towards development and planning purposes of the study area.

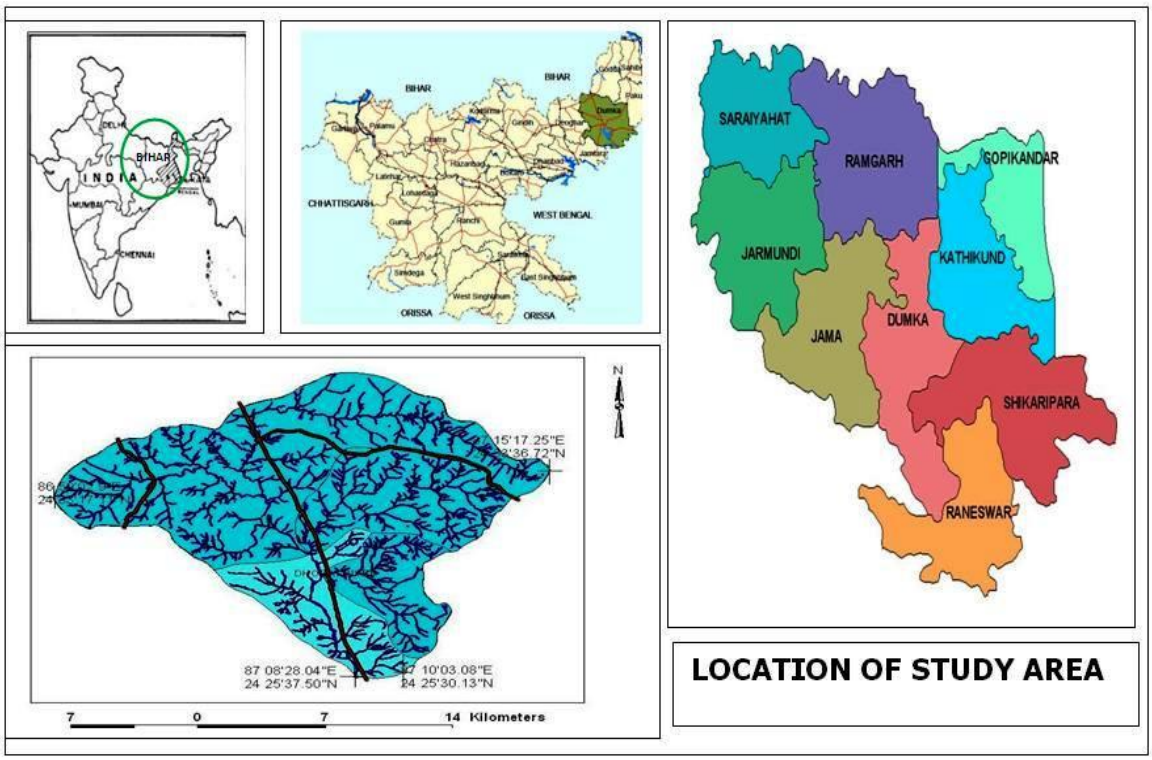
The main objective of the programme is to generate up to date thematic information on basic natural resource potential on watershed basis, for facilitating land and water resources management designing towards sustainable development planning.

3.0 Study Area

Dumka district (23°45' N to 24 ° 45' N; 86 ° 15' E to 87° 45' E) is one of the four districts of Jharkhand which have been curved out of erstwhile Santhal Pargana.

The present study area, Dhobai Watershed forms a part of Mayurakshi river basin in the State of Jharkhand. Politically, the study area is located covering parts of the Saryeahat and Ramgarh Blocks of District Dumka, Jharkhand.

The study area lies between the 86 degree59' 02.9"E to 87 degree 15' 17.25" E and 87degree 08'28.04"E to 87degree 10'0.308"E Longitude and 24degree 25'37.50"N to 24degree 25'30.13"N and 24degree 33'17.11"N to 24 degree 33'3.77"N.The study area is about 306.87 sq.km.



4.0 Methodology

The micro level interpretation through integration and analysis of the various thematic information provided by the IRS 1D satellite data, IRS P6, LISS-III satellite image (precision geocoded images) has been used as the input for preparation of thematic maps or layer. In order to prepare the maps with attributes as stated in methodology, will be three phases for carrying out the whole work – i) Pre-field, ii) Post-field, iii) after Digitisation.

A systematic methodological principle was followed in this project work. This can be explaining as follows:

i) ***Pre-field study***: this study area as selected earlier, was identified from corresponding Toposheet No-(72P02,72P03,72L14-on scale 1:50000) and the spatial information have been collected from different Govt. office like- Deptt.of Science and Technology- Kolkat,etc.

ii) ***Field study***: Primary data were generated by interviewing people upon property desire questionnaires through intensive field survey. The study of imperial observation can has been done very carefully through spatial data collection in this watershed area.

iii) ***Post-field study***: in corresponding the various thematic maps (scale 1:50000) has been prepared from corresponding Toposheet No-(72P02,72P03,72L14-on scale 1:50000) and up-to-date multiseasonal IRS-P6 LISS-III imageries (Hardcopy) as well as digital data with subsequent ground checks and existing collateral data appropriately to find out the actual scenario.

4.1 Flow Chart of Methodology

In the present study two basic methods which has been applied-

A. Visual Image Interpretation and

B. Digital Image Interpretation.

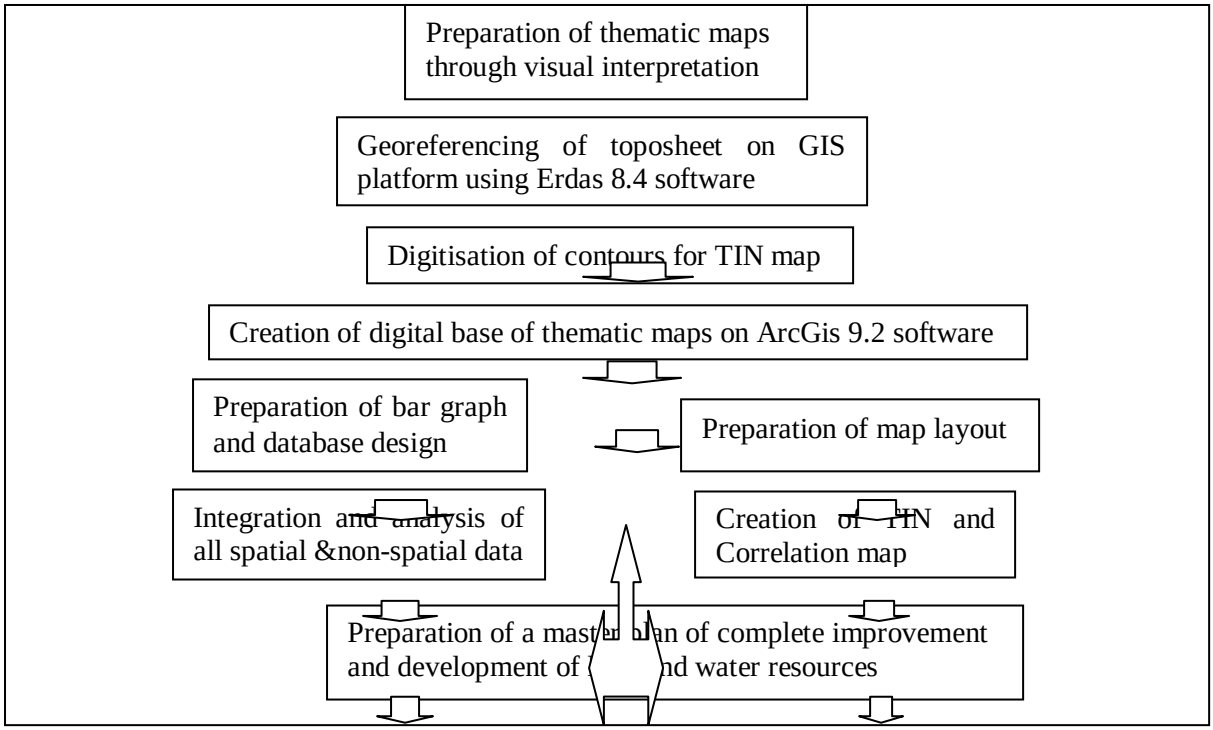


Fig-1**:** Flow chart showing methodology of land and water resources plan

5.0 **Database**

- The present study is based on Survey of India Toposheet No- 72P02,72P03,72L14 (1:50,000), up-to-date multiseasonal IRS P6 LISS III 15th March 2005 and 10th November 2005 satellite imageries (hardcopy), field verification and other collateral data
- Category wise area for Land use / Land cover and Geomorphologic maps has been prepared with the help of ArcGIS 9.2 software.
- The calculated data are used as input data to prepare bar graphs for quick evaluation of area occupied by each unit in individual theme maps of the study area.
- The Data's that are being used are:
- Survey Of India Topographical Sheets (72P02,72P03,72L14)
- Satellite Imageries IRS P6 LISS-III, (November and March 2005).
- Other collateral data.

6.0 Regional Physiographic Backdrop

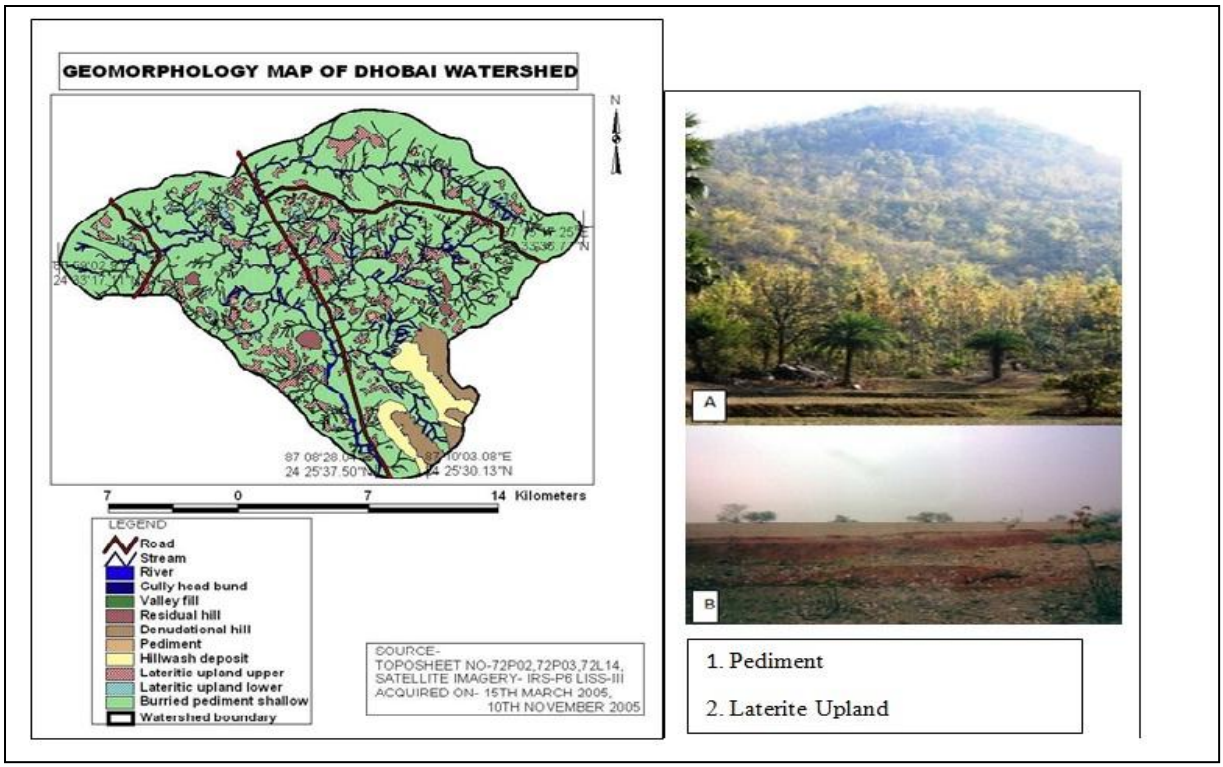
6.1 Geomorphology: This map classifies the terrain into various homogeneous units which are termed as terrain units/geomorphic units. These terrain units are very much useful for the optimal and scientific utilisation of natural resources and environmental management.

The geomorphologic units that are identified from the concerned study area are-

1. Valley Fill
2. Denudational Hill
3. Residual Hill
4. Pediment
5. Lateritic Upland Upper
6. Lateritic Upland Lower
7. Burried pediment shallow

Table 1; Geomorphological details

Geomorphology Categories	Area (sq.km)	Percentage
River	2.831	0.922
Gully Head Bund	0.396	0.13
Valley Fill	14.684	4.78
Residual Hill	3.181	1.04
Denudational Hill	10.711	3.49
Pediment	3.017	0.98
Hill wash Deposit	10.519	3.43
Lateritic Upland Upper	27.585	8.99
Lateritic Upland Lower	5.809	1.9
Burried Pediment Shallow	136.7	44.55
Total Area	306.872	100



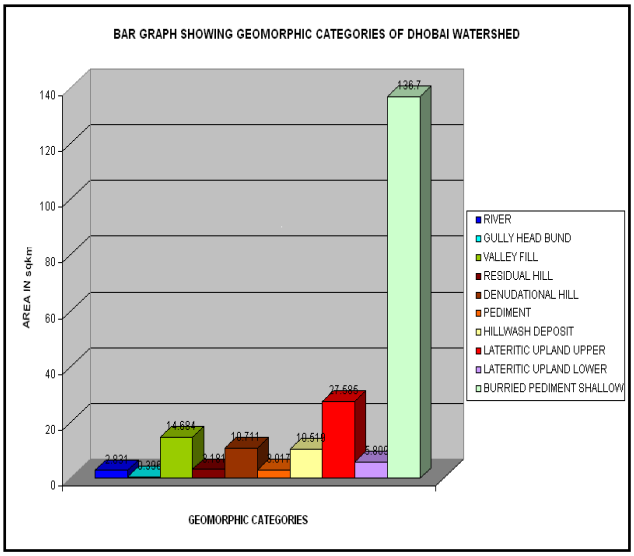


Fig.2-Geomorphology map and field photo

6.2 **Drainage Map**

The master stream, Dhobai river has its source near Chihutiya village in the north western part of the study area. It flows in a general SE direction, broadly parallel to the general strike trends of the prevalent rock formations, but locally guided by major joints and faults. The Hardia Nala originates near Kanjo village and Murko Nala originates near Madhuban, both these Nalas joins the master stream as left-hand tributaries. This combined flow is known as Dhobai Nadi and it ultimately joins Matihara Nadi near Jhilua village, a tributary to the Mayurakshi River. Two important drainage patterns have been identified in the study area are Dendritic Pattern and Radial Pattern. So the effect and impact of socio – cultural and economical life is fully determined by the Dhobai river and little effect by Hardia Nala.

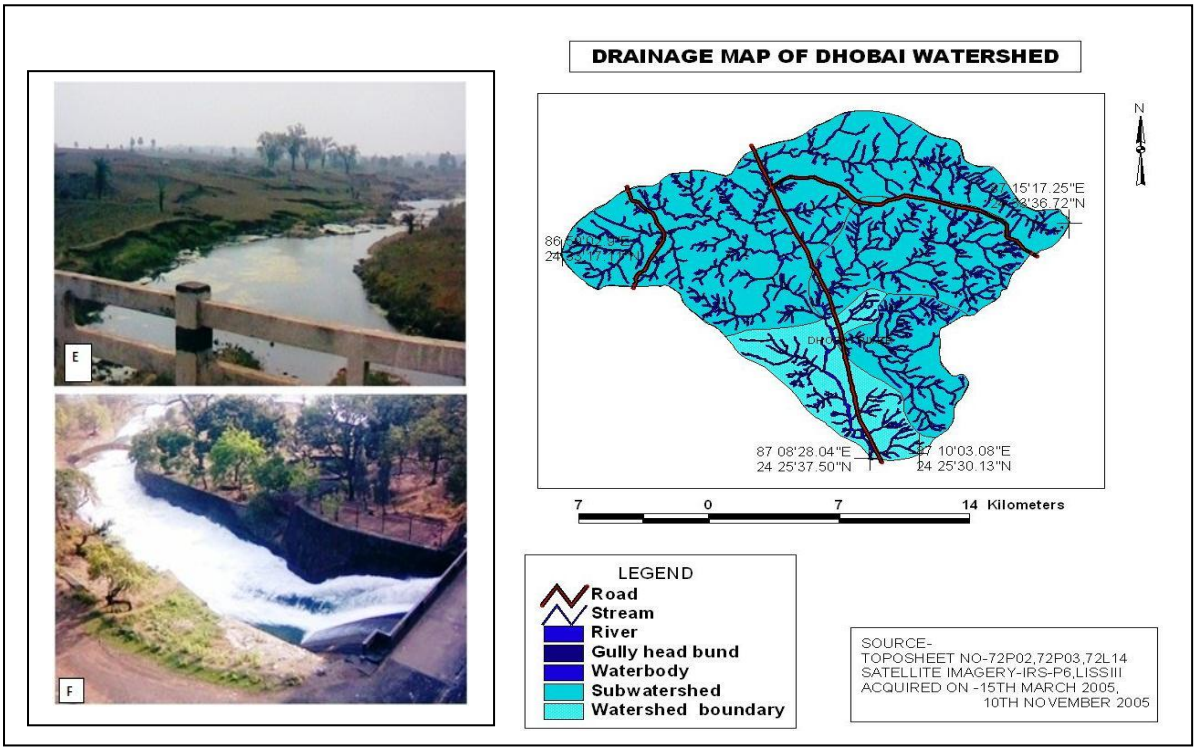


Fig.3-Drainage map and field photo

6.2 **Climate**

The climate of the region is characterised by a hot summer and well distributed seasonal rainfall. The district receives an annual rainfall of 1500 mm.. South-western monsoon is responsible for the occurrence of rainfall. During June to September near about 80% annual rainfall occurs. The month of August witnesses highest rainfall. May is the hottest month with During winter season the temperature varies between 16° to 21° C and during summer season it varies between 22 to 32 0C. January is the coldest month of the region. Annual and diurnal range of temperature is quite high in this district.

6.3 **Soil**

The soils occurring in different landforms have been characterised during soil resource mapping of the state on 1:250,000 scale (Haldar et al. 1996) and three soil orders namely Entisols, Inceptisols and Alfisols were observed in Dumka district (Fig.1 and table 1). Alfisols were the dominant soils covering 43.9 percent of TGA followed by Inceptisols (43.8 %) and Entisols (10.0 %).

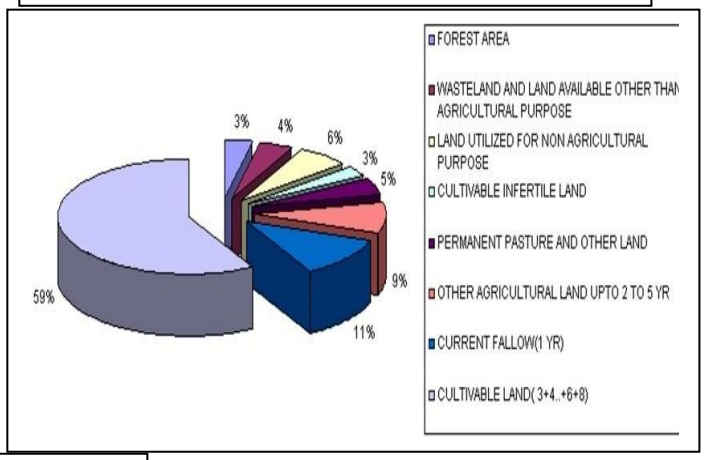
6.4 **Land use**:

Total geographical area of the district is 5.58 lakh **hectares** out of which nearly 40% area comes under net cultivated area, 11% covered forests and the rest 49% area falls under barren, cultivable waste, pasture and other agricultural use. The details of land use pattern in the district are presented in table 2.1. 0ut of 2.18 lakh hectare net cultivable land, about 50% is under upland situation, 30% under medium land and 20% under low land situation.

Table 2: Land use/Land cover On Sample Two Block (i.e. **Sareayahat Block** And **Ramgarh Block**)

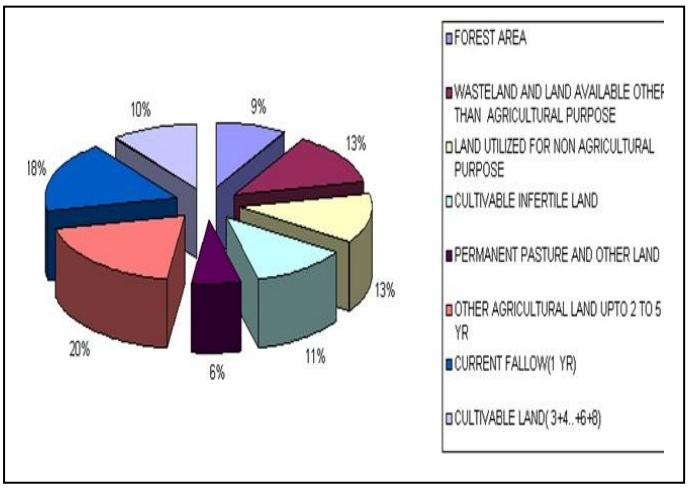
Land use/Land Cover Categories	*Area In sq.km*	*Percentage*
River	2.831	0.922
Waterbodies	0.772	0.251
Settlement	25.456	8.295
Single Crop/Kharif	202.332	65.93
Open Forest	11.508	3.75
Scrub Forest	1.099	0.358
Land With Scrub	44.81	14.6022
Land Without Scrub	17.43	5.679
Stony Waste	0.637	0.2075
TOTAL AREA	306.872	100

LANDUSE/LANDCOVER ON **SAREAYAHAT BLOCK**



LANDUSE/LANDCOVER ON **RAMGARH BLOCK**

Data Of Sareayahat Block	*Area*
Forest area	1258.95
Wasteland and land available other than agricultural purpose	1645.32
Land utilized for non agricultural purpose	2527.68
Cultivable infertile land	1179.44
Permanent pasture and other land	1897.2
Other agricultural land upto 2 to 5 yr	3489.82
Current fallow(1 yr)	4356.59
Cultivable land ((3+4..+6+8)	22756.23



7.0 Co-Relation Regarding Process of Land and Watershed Management

7.1 *Watershed Concept*

Watershed is a technical term used by the British to denote a common drainage point. It is a hydro geological unit. In American terminology, it is referred to as Catchment Area. Watershed is the line separating neighboring drainage basins (catchments). In hilly country, the divide lies along topographical peaks and ridges, but in flat country (especially where the ground is marshy) the divide may be invisible – just a more or less notional line on the ground on either side of which falling raindrops will start a journey to different rivers, and even to different sides of a region or continent. Drainage divides are important geographical and often also political boundaries. Roads (such as ridge ways) and rail tracks often follow divides to minimize grades (gradients), and to avoid marshes and rivers.

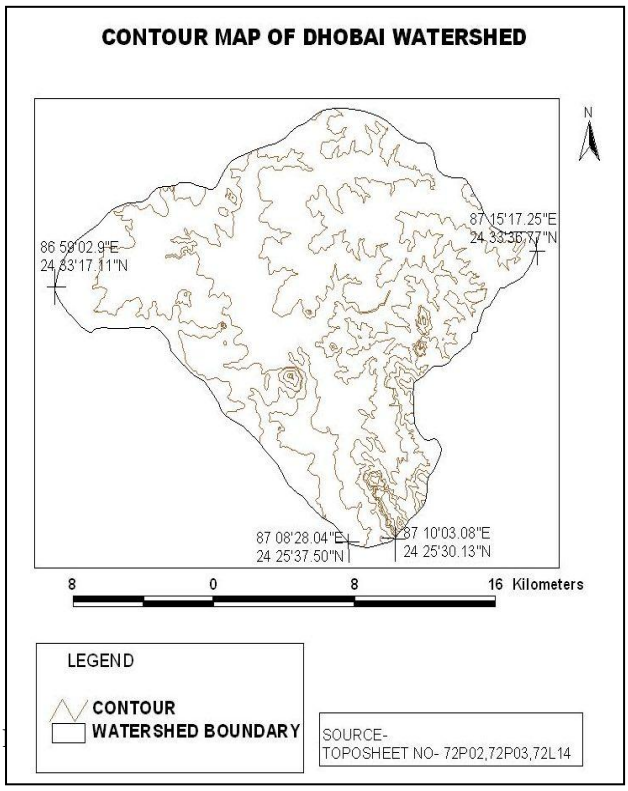
Table 3:Co-relation between sub-surface water and irrigation

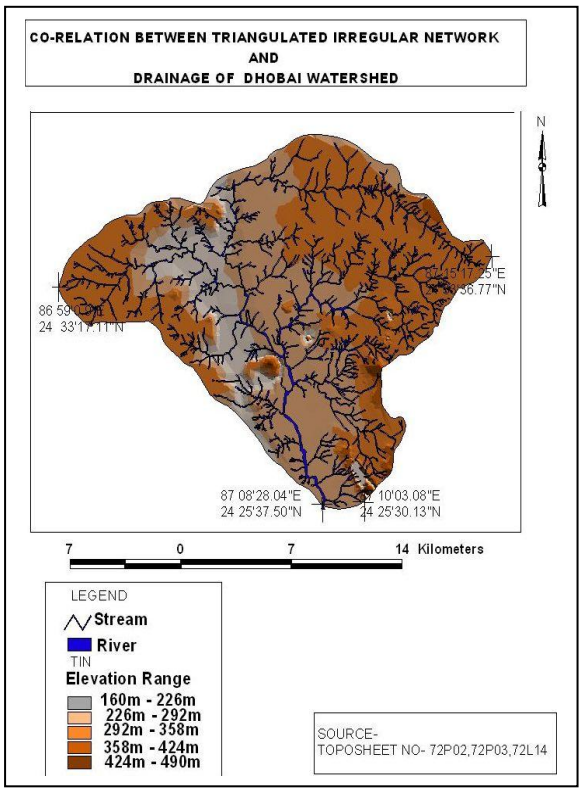
Block	*Utilisable ground water resources (Ha.M)*	*Net irrigation requirement (m.)*	*Net draft (Ha.M)*	*Irrigation potential created (Hact.) (4/3)*	*Ultimate irrigation potential to be created (Hact.) (2/3)*	*Ground water balance (Hact.) (6-5)*
1	**2**	**3**	**4**	**5**	**6**	**7**
Sareayahat	1,731	0.4	66	165	4328	4163
Ramgarh	2586	0.4	25.2	63	6465	6402

The other maps that have been prepared for co-relation between physiographic feature and land use/land cover are

Contour Map has been prepared by taking contour information by Survey of India Toposheet No: 72P02, 72P03 and it has been digitized using Arcview 3.2a software, in GIS Platform.

Triangulated Irregular Network (TIN) Map has been prepared with the help of contour information.





7.2 Co-relation

(i) Co-relation between Triangulated Irregular Network and Drainage of Dhobai Watershed region depicts that the Radial drainage pattern is observed around the Residual and Denudational Hills of this watershed.
(ii) The Dendritic drainage pattern is also observed throughout the study area.
(iii) The elevated region Radial pattern of drainage comes down and unites with dendritic pattern of drainage.
(iv) Major portion (65.9 %) of the area (Single crop/Kharif) of Land use/Land cover category which are mainly occupied by Burried Pediment Shallow (44.55%) of geomorphic unit.
(v) Area acquired by Land with Scrub (14.60%) of Land use/Land cover category is almost occupied by Lateritic Upland Upper (8.99%) of geomorphic unit.
(vi) The Open Forest (3.75%) of Land use category is present over the Residual hill (1.04%) and Denudational hill (3.49%) of the geomorphic unit.

7.3 Water Related Environmental Issues at Dhobai Watershed

(i) Changes in flow: Excessive abstractions of water from rivers and lakes for irrigation, urban supply, inter-basin transfers, or other consumptive purposes can significantly decrease downstream flow rates and diminish aquifer recharge in Dhobai watershed region.
(ii) Watershed degradation. Changes in land use in watersheds can release large loads of sediments and attached contaminants into waterways and as a result of this degradation, downstream areas can become blanketed in sediment.
(iii) Water quality: Diffuse (or non-point) source pollution is also a major cause of contamination in many areas, especially where there is little enforcement over the use of agro-chemicals sources are a threat to human health and environmental health.
(iv) Riverine and estuarine system health: Healthy riverine and estuarine systems require functioning wetlands, floodplains, lakes and riparian areas which mediate important services such as pollutant removal, amelioration of floods, and provide habitat for economically important fauna and flora corresponding through unscientific agricultural and grazing activities and land use conversion.

(v) Land Use: Uncontrolled, unplanned, unscientific land use and interventions lead to deterioration of the watershed area. Some of the activities detrimental to watershed.

(vi) Cultivation: On sloping of land without adequate precautions, cultivation without agronomic measures to conserve soil and water, cultivation along susceptible nalla banks, cultivation of erosion-permitting crops, over-cropping without soil fertility replenishment, faulty agricultural techniques etc.

(vii) Grass land: Excessive and uncontrolled grazing, growth of weeds, development of cattle tracks causing damage and compaction of soil resulting in lower infiltration rates, fires, theft etc.
(viii) Forest: Excessive and uncontrolled grazing which inhibits regeneration from seed or stock, clear felling on steep slopes, destruction of forest land by fires and thefts, biotic pressure for fuel, fodder, NTFP and small timber, drastic thinning of plantation along slopes etc.

(ix) Shifting cultivation: Shifting cultivation or Jhum kheti practiced in certain areas of counties (like North East India etc.) has proved to be very damaging to protective and productive vegetation. This practice results in damage to the topsoil and inhibits the growth of grasses, shrubs and trees.

(x) Non-cooperation of the community: Non-Cooperation of the community in conserving, protecting and enriching then ecosystem and CPR has also resulted in most of the ills.

Watershed management is required for the following reasons for this two sample blocks are:

1. To control damaging runoff.
2. To manage and utilize runoff for useful purposes.
3. To control erosion affecting reduction of sediment production.
4. To moderate floods in the downstream area.
5. To enhance groundwater storage wherever applicable, and
6. To appropriately use land resources in the watershed for other resources.

8.0 Formulation of Master Plan

1. Establishment of long-term objectives and developmental targets/criteria-
a. Explain the socio-economic scenarios and constraints of development
b. Discuss the planning objectives with respect to food production, industrial growth, public health improvement.
c. Relate basin planning objectives to the national planning objectives.
d. Establish water use as well as land use/land cover priorities in various sectors.

2. Preparation of Master Plan-
a. Discuss availability of surface and ground water and their quality as appraisal
b. Discuss present and future demand for water as brought out.

c. Carry out water balance for present as well as future conditions at sub-basin and basin levels and at critical points.

3. Alternate developmental scenarios and Evaluation –
a. Various measures for water conservation and distribution
b. Possibility of integrating various uses of water
c. Possibility of integrating various reservoir systems & Conjunctive use of surface and ground water
d. Integration of environmental/ecological consideration
e. Possibility/need of inter-basin transfer of water, recycling, recharging for augmenting

4. Selection of most promising alternative-
a. Impact of alternatives on plan objectives
b. Decisions analysis & Recommended plan of action

9.0 Conclusion:

Development of water resources without any scientific planning leads to sharp depletion of the resources and also degradation of quality. Therefore a comprehensive and reliable scientific data base management is a pre-requisite for proper management and planning of Dhobai watershed. Ultimately the proposed work will provide guidelines to conserve develop and harness these natural resources to minimise the adverse effect of both natural hazard and anthropogenic interventions for restoration of ecological balance of the fragile environment under physical-social-economical-cultural context.

The issues noted above clearly need to be addressed in a comprehensive manner as in a national water resources management plan. Timing is critical as the various groups are performing their studies independently without much effort to coordinate. If left unchecked, this process would not take advantage of the synergy that could be developed if the projects were developed with a common goal that would be identified in the management plan under this region watershed.

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