

A Model of Watershed Management Process-A Case Study of Rarh Region in Gangetic Delta

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Abstract:- Watershed is a region delineated with a well-defined topographic boundary and water outlet. It is a geographic region within which hydrological conditions are such that water becomes concentrated within a particular location, for example, a river or a reservoir, by which the watershed is drained. Within the topographic boundary or a water divide, watershed comprises a complex of soils, landforms, vegetation, and land uses. The terms watershed, catchment, and basins are often used interchangeably. They have long been recognized as desirable units for planning and implementing developmental programmes. A watershed, also called a "drainage basin" in North America, is an area in which all water flowing into it goes to a common outlet, such as the same estuary or reservoir. Watersheds themselves consist of all surface water and include lakes, streams, reservoirs and wetlands, as well as all groundwater and aquifers.

I. SIGNIFICANCE OF THE STUDY

Watershed management encompasses the simultaneous consideration of hydrological, pedological, and biological resources, necessitating the need for making better use of analytical tools and approaches, which address spatial and temporal variability, is critical. The cumulative impacts of human activities, which threaten the ecological, economic, and aesthetic integrity of many drainage systems and the strategies to mitigate these impacts, have explicit spatial dimensions. Watershed approaches in resource planning require timely and accurate data with spatial as well as statistical aspects. In this regard, GIS holds great promise with a provision to handle spatial and temporal data and aid as an integrative planning tool for watershed management.

The All India Soil and Land Use Surveys (AIS&LUS) of the Ministry of Agriculture, Government of India, has developed a system for watershed delineation like water resource region, basin, catchment, sub-catchment, and watershed. The usually accepted five levels of watershed delineation based on geographical area of the watershed are the following;

- 1) Macro watershed (> 50,000 Hect)
- 2) Sub-watershed (10,000 to 50,000 Hect)
- 3) Milli-watershed (1000 to 10000 Hect)
- 4) Micro watershed (100 to 1000 Hect)
- 5) Mini watershed (1-100 Hect)

II. BACKGROUND OF THE STUDY

The Lower Ganga Plain in West Bengal forms a part of the Indo-Gangetic Plains. The plains support one of the most populous areas on Earth, being home to nearly 1 billion people (or around 1/7 of the world's population) on 700,000 km² (270,000 mile²). The Indo-Gangetic plain is bound on the north by the abruptly rising Himalayas, which feed its numerous rivers and are the source of the fertile alluvium deposited across the region by the two river systems. The southern edge of the plain is marked by the Vindhya- and Satpura Range, and the Chota Nagpur Plateau. On the west rises the Iranian Plateau. 14 districts of West Bengal are contained in this physiographic region. This region is further divided into four micro physiographic zones. These are :

Barind tract: This zone comprising Cooch Behar, Malda, North and South Dinajpur districts.

Moribund Delta: This zone comprising of Murshidabad and Nadia districts.

Proper Delta: This zone consisting of the districts of Burdwan, Kolkata, Hoogly, Howrah, South & North 24-Parganas.

Rarh plain: This zone is spread over Purba and Paschim Medinipur districts, Bankura, Birbhum and Purulia.

The overall land use pattern in the Rarh plain depends mostly on the physiographic condition of the area. Total geographical area of the state is divided into two major classes i.e. (a) arable land, that includes net sown area and fallow land (b) non-arable land, which includes

Table-1: Annual Temperature of Rajh Plain in Degree Celsius

DISTRICT	1997		1999		2001		2003		2005		2007		2009	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Purba Medinipur	37	9	40	10	39	9	42	9	42	8	40	12	39	7
Paschim Medinipur	46	9	41	10	43	10	41	8	40	7	44	11	43	7
Bankura	-	-	-	-	-	-	-	-	39	9	44	8	44	6
Purulia	43	8	38	7	46	8	43	9	44	8	45	9	45	-
Birbhum	43	9	43	7	43	7	41	7	40	7	41	9	44	5

Table-2: Annual average Rain fall of Rajh plain in millimeters

District	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
East Midnapur	170	129	145	178	-	150	225	170	217	170		
West Midnapur	153	146	166	166	208	136	166	143	211	189		
Bankura	138	123	132	143	170	121	121	131	180	156		
Purulia	132	103	143	138	159	122	107	127	161	134		
Birbhum	143	201	133	152	151	142	126	160	171	140		

forest, area not available for cultivation and other uncultivable land excluding current fallow. The percentage of non- arable land is about 63.48 % and about 34.36% land is under arable category (Economic Review,GoWB, 2009-10), which includes notified forest area to the tune of 33.38% of total geographical area. Agricultural activities are mostly restricted to the Gangetic plains having fertile cultivable land. Protected forests also cover considerable areas in Purulia, Bankura, Medinipur and Birbhum districts.

III. OBJECTIVES

- 1.Managing the river flow regime to provide overall benefits such as reducing river bank erosion, decreasing sediment transport and accumulation and improving water quality.
2. Maintaining an adequate supply of water to meet demands for irrigation, agriculture, as well as domestic and industrial uses at acceptable levels of assurance.
3. Reducing vulnerability to natural disasters such as floods, droughts and landslides.
4. Utilising natural resources effectively to mitigate adverse effects, prevent environmental degradation, enhance water yield and increase biomass production.
5. Improving the economic and social condition of the disadvantaged and those deficient in resources.
6. Distributing the benefits of land and water resources development more equally amongst the stakeholder.



Fig-1: Model of Objectives for watershed management

IV. METHODOLOGY

Watershed is a natural unit of analysis for addressing the balance of supply and demand for water, and the issues of efficiency, equity and sustainability for the following broad reasons:

water Resource Availability: The aggregate availability of water resources, including sustainable yields is bounded by the hydrological cycle of the watershed.

□ Conjunctive Water Sources: The interaction of different sources: e.g. groundwater and surface water, is confined by the watershed.

Interaction of Demands: The demands for water interact within the watershed and the hydrological impacts of one water user upon another and upon environment; externalities, are defined by the watershed.

An understanding of the hydrological cycle in the watershed area in question is a pre-requisite for the determination of efficient, equitable and sustainable water resource allocation.

The research work prepared in three stages which are as follows -

Pre-field work:

This stage includes - i) collection of districts map ii) collection of secondary information from district handbook, census report, others books and journals etc. iii) preparation of questionnaire statistical schedule for collection of primary data which are closely related with the research work.

Field work:

By questionnaire schedule primary data will be collected from the study area. Observation schedule also help to collect the information.

Post field work:

Collected data will be classified in a master table and various cartographic and statistical techniques will be made in support of the theoretical discussion.

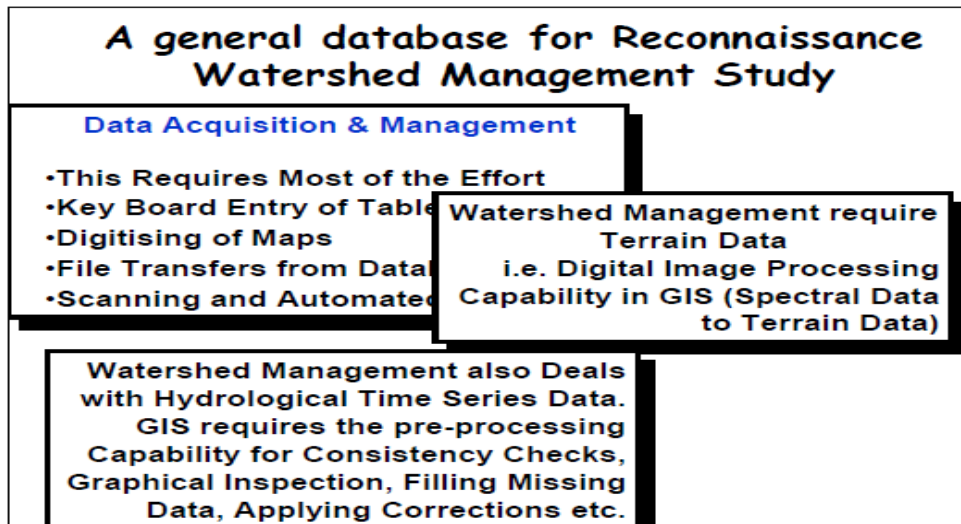


Fig-2: A Model of Research Methodology

V. RESULTS

Water Shed Management Practice:

Watershed management and minor irrigation projects would be most suitable for drought prone, flood prone, tribal and hill areas, which should be allowed and encouraged to be developed by the local communities, with technical and financial help .In the context of physical features and constraints such as steep slopes, rapid run-off, the incidence of soil erosion and the eco-fragility of the area, the benefit-cost ratio of projects in such areas should be acceptable even at a lower rate.

1. In terms of purpose
2. To increase infiltration
3. To increase water holding capacity
4. To prevent soil erosion
5. Method and accomplishment

In brief various control measures are:

Vegetative measures:

1. Strip cropping.
2. Pasture cropping.
3. Grass land farming.
4. Wood lands.

Geo-hydro measures:

1. Rock dam.
2. Construction of silt tanks detention.
3. Interlink with various rivers and water body.
4. Connection of rivers with source.

Engineering measures:

1. Contour bonding.
2. Terracing.
3. Construction of earthen embankment.
4. Gully controlling structure.

Some important controll measures are shown-

a. BROAD BEDS AND FURROWS

To control erosion and to conserve soil moisture in the soil during rainy days. The broad bed and furrow system is laid within the field boundaries. The land levels taken and it is laid using either animal drawn or tractor drawn ridge's



Fig-3: A Image of Broad Beds System

Salient Features:

I.	Conserves soil moisture in dry land.
ii.	Controls soil erosion.
iii.	Acts as a drainage channel during heavy rainy days.

b. CONTOUR BUND

To intercept the run off flowing down the slope by an embankment. It helps to control run off velocity. The embankment may be closed or open, surplus arrangements are provided wherever necessary.

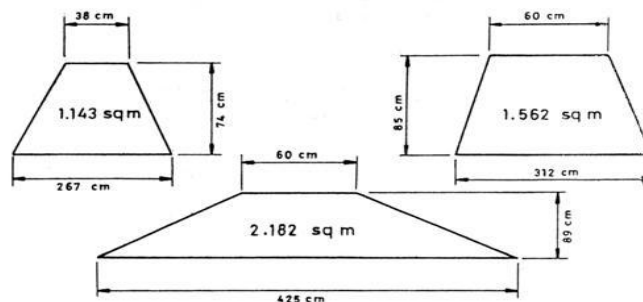


Fig-4: A Model of Contour Bund System

Salient Features:

- i. It can be adopted on all soils.
- ii. It can be laid upto 6% slopes.
- iii. It helps to retain moisture in the field.



Fig-5: A Image of Contour Bund System

c. BENCH TERRACING

It helps to bring sloping land into different level strips to enable cultivation. It consists of construction of step like fields along contours by half cutting and half filling. Original slope is converted into level fields. The vertical & horizontal intervals are decided based on level slope.



Fig-6: A Image of Bench Terracing System

SALIENT FEATURES

- i. Suitable for hilly regions.
- ii. The benches may be inward sloping to drain off excess water.
- iii. The outward sloping benches will help to reduce the existing steep slope to mild one.
- iv. It is adopted in soils with slopes greater than 6%

d. Micro catchments for Sloping Lands:

It is useful for in situ moisture conservation and erosion control for tree crops.

Technique	Storage capacity per unit (m ³)	Annual run-off contribution to soil moisture Additional water stored per ha (m ³)	Estimated surface Run-off control (%)
Triangular catchments (V-Bunds)	13	5200	80
Crescent bunds	10.2	4080	73

Salient Features:

- 1. Slope ranges from 2 –8%.
- 2. Soil type – Light to moderate texture.
- 3. Insitu moisture conservation with staggered planting.
- 4. Suitable for dry land Horticulture & Agroforestry.
- 5. Bund height – 30 to 45 cm.



Fig-7: A Image of Micro catchments for Sloping Lands System

e. CHECK DAM

Salient features:

1. A low weir normally constructed across the gullies.
2. Constructed on small streams and long gullies formed by erosive activity of flood water
3. It cuts the velocity and reduces erosive activity.
4. The stored water improves soil moisture of the adjoining area and allows percolation to recharge the aquifers.
5. Spacing between the check dams water spread of one should be beyond the water spread of the other.
6. Height depends on the bank height, varies from a metre to 3 metre and length varies from less than 3m to 10m.



Fig-8: A Image of Cheek Dam System

f. PERCOLATION POND

Salient features:

1. Shallow depression created at lower portions in a natural or diverted stream course.
2. Preferable under gentle sloping stream where narrow valley exists.
3. Located in soils of permeable nature.
4. Adaptable where 20-30 ground water wells for irrigation exist within the zone of influence about 800 – 900m.
5. Minimum capacity may be around 5000 m³ for the sack of economy.



Fig-9: A Image of Percolation Pond System

VI. CONCLUSION

The people of these areas face a rapid decline in their standard of living as natural resource base become degraded and loses its ability to recover. Increasing number of environmental refugees migrate to other lands, which are then also endangered by over use. The programme should be such that first, they focus on the

positive synergies between poverty reduction, economic efficiency, and environmental protection. Second, the projects are developed with the beneficiaries rather than for them. Third, they are based on an integrated approach to natural resource planning and management in consonance with an Environment Action Plan.

REFERENCES

- [1] Balasubramanian, R and K.N.Selvaraj (2003). Poverty, Private Property and Common Pool.
- [2] Resources Management: The Case of irrigation Tanks in South India, SANDEE Working Paper No.2-03, South Asian Network for development and Environmental Economics.
- [3] Bardhan, Pranab (1993), "Analytics of the Institutions of Informal Co-operation in Rural evelopment," World Development, 21 (4): 633-639.
- [4] Das.B and Bandyopadhyay.A.(2012). 'Causes of Flood by Indian River' A Case Study of Transboundary River Icchamati in Gangetic Delta, International Journal of Advanced Research in Computer Science and Electronics Engineering,Volume 1, Issue 7, September 2012,277-292, ISSN: 2277 – 9043.
- [5] Das.B(2011).Flood Risk Management by Transboundary River of Gangetic Delta ,Lap Lambert Academic Publishing ,Saarbrücken, Germany,65-79.
- [6] Giri.P, Barua.P and Das.B(2012). 'Sundarban Delta: Perspective for the Long Term Future', Lap Lambert Academic Publishing ,Saarbrücken, Germany,84-143.
- [7] Kerr, John, G Pangre, Vasudha LPangre and P I George (2002), "An Evaluation of Dryland Watershed Development Projects in India," EPTD Discussion Paper, No.68, Washington D C: International Food Policy Research Institute.
- [8] Meinzen-Dick, Ruth, K V Raju and A Gulati (2002), "What Affects Organisation and Collective Action for Managing Resources? Evidence from Canal Irrigation Systems in India," World
- [9] Meinzen-Dick, Ruth, Monica Di Gregorio and Nancy McCarthy (2004), "Methods for Studying Collective Action in Rural Development," Agricultural Systems, 82: 197-214.
- [10] Palanisami, K, D Suresh Kumar and B Chandrasekaran (2002), "Watershed Development: Concept and Issues," Watershed Management: Issues and Policies for the 21st Century,