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Rivulet Restoration with Integrated Natural Resource Management through Application of RS and GIS

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ABSTRACT: Rivers are the backbone of any economy, and also essential for the existence of lives on the planet. Rivers are the sources of fresh water required for most of the living creatures on this earth. Rivers are also the sources for inland navigation, irrigation for agriculture, industrial use, domestic uses and many other purposes. Some rivers are annual and some are seasonal, based on their duration of flows over a year.

India has been blessed with the network of river systems, which are abundant in almost all states. Chhattisgarh is no way behind in blessings from rivers and rivulets. The rich forest ecology and physical features bestow the state with sufficient amount of small, medium, big, seasonal and annual rivers and nalas, which are essential for the existence of the state. The different drainage systems in the state supply irrigation and industrial water from northern to southern part. Most of the rivulets originate from the forest areas, and flow towards the villages, becoming tributaries of higher order streams and finally contributing to the bigger catchment.

The climate change, global warming and over exploitation of water through all sources have led to the decline of fresh water sources. Rivers are also one of the victims of such happenings. The natural phenomenon is that the good amount of groundwater serves as the base flow of river which is responsible for making it run for a longer duration. Unfortunately, due to declining groundwater due to various climatic reasons and exploitative uses, the process has become the reverse, i.e., rivers feed the groundwater and hence become dry soon after the monsoon. There have been various programmes since independence towards soil conservation, river rejuvenation, groundwater development and exploration for sustainable development. The use of technology in mapping the resources and planning the best suitable activities to make bigger impacts is one of the key solutions required today.

This study aims at use of modern technology like GIS (use of softwares and data interpretation), for assessment and locating of water resources, assessing physical features of the study area and concluding at proposed activities which are essential for the revival of rivers. The technology will guide upon the study of the various features like lineaments, faults, geomorphology, groundwater prospects and other data required to assess the need of actions and activities to restore the targeted study area. Available information from open source portals like Bhuvan (ISRO), help in decision making and softwares like QGIS, Google Earth Pro etc provide the platform to map the available resources and planned activities and also to estimate the impacts over the selected area.

KEYWORDS: Remote Sensing, GIS, Thematic maps, GIS Based Planning Rivulet Restoration, INRM, Watershed approaches, Area Treatment, Stream line treatment.

I. INTRODUCTION

1.1 Concept Of Rivulet Restoration

A watershed can be defined as a specific stream or river's drainage basin or catchment area. Simply put, it refers to the area from which the water comes from to a specific drainage system, such as a river or stream. People and their atmosphere are interdependent. The individuals living therein are directly impacted by any change in the surrounding climate. A deteriorated world results in people's quality of life being degraded. Thus, efforts to alleviate poverty and raise people's living conditions must be directed at improving the world in which they work. Watershed development: watershed development refers to the conservation, restoration and judicious use of all resources within a given watershed - natural (land, water, plants and animals) and human. Two methods may treat the watershed.

- (i) Area treatment
- (ii) Stream Line treatment

1.2 Integrated Natural Resource Management (INRM)

Management of natural resources refers to the management of land, water, soil, plants and animals, with a special emphasis on present and future generations' quality of life. NRM deals with the control of the way people and local services connect. It assists in planning for land use, water management, protection of biodiversity, agriculture, and related sectors. Specifically, this approach focuses on a scientific and technological understanding of the resources, the environment and the life-supporting potential of those resources. INRM is a comprehensive natural resource management method that involves multiple aspects of the use of natural resources (biophysical, social and economic) to achieve production objectives (e.g., food protection, profitability, risk aversion) as well as objectives of the broader community (e.g., poverty alleviation, welfare of future generations, environmental conservation).

1.3 RS & GIS

Remote sensing, in contrast to on-site observation, is the collection of information about an object or phenomenon without having direct contact with the object. In particular, the term refers to the acquisition of knowledge about the Planet. Remote sensing is the art and science of using sensors on airplanes or satellites to make earth measurements. A geographic information system (GIS) is a conceptualized structure that enables spatial and geographic data to be collected and analysed. GIS applications (or GIS applications) are computer-based tools that allow users to generate interactive queries (searches generated by users), store and edit spatial and non-spatial information, analyse the performance of spatial information, by showing them as diagrams, and visually sharing the outcomes of these operations.

II. RELATED WORK

2.1 Details of the Study Area

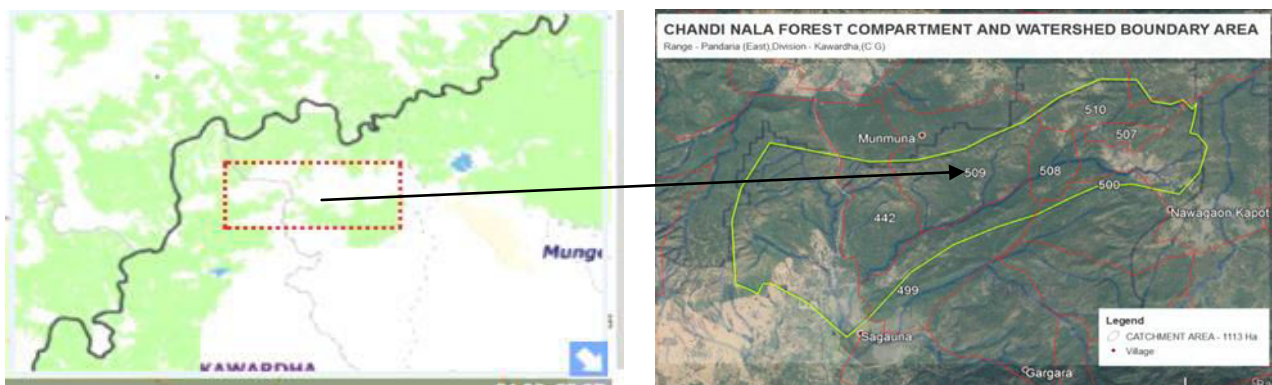


Figure 1-Location of Chandi Rivulet

The study focuses on the Chandi Rivulet, which is Mahanadi Basin's non-perennial drainage, and drains at Kranti dam. The rivulet flows for four to five months a year, i.e., between June and September. Though the rainfall in the region is around 1100 – 1200 mm annually, but it does not impact the flow of the rivulet. The strong need arises to rejuvenate the base flow of the river so that, the duration of flow could be increased.

2.2 Using GIS based Planning

The preparation of an Action Plan for the Rivulet Restoration is a very technical process that needs a lot of data to be used to carry out the study. Recommendations on treatment interventions should be focused on judicious decisions; otherwise, there would be little result from the effect of the intervention after implementation in the region. The choice of treatment and proper site selection is the crux of the management of the Rivulet Restoration, and a micro-level Watershed GIS will easily accomplish this. On the contrary, the watershed GIS or GIS-based watershed action plans ensure that all information is referenced and well presented on Compartment map [cadastral maps] where detailed

action plans can be made from FMIS. It is very important to understand that it is only the GIS-based Watershed Maps that correctly present the image of the present situation and the region's requirements.

III. METHODOLOGY

Study of Rivulet Restoration GIS Assisted Tools have been used to plan the content. With the aid of this Catchment Area Review, we prepare the Area Based Treatment Plan and the Drainage Line Treatment Plan with Holistic Integrated Natural Resource Management Approaches. In this analysis, thematic layers such as satellite map, slope, drainage line, contour, erosion, land use/land cover, lineament, CLART, ground water prospect, lithology, forest cover, soil texture, grid point, forest compartment and geomorphological are obtained with the aid of GIS-assisted tools. The methodology used in the analysis is essentially 2-3 thematic maps superimposed and based on the maps providing Inferences for the selection and placement of the framework for the Chandi rivulet restoration project.

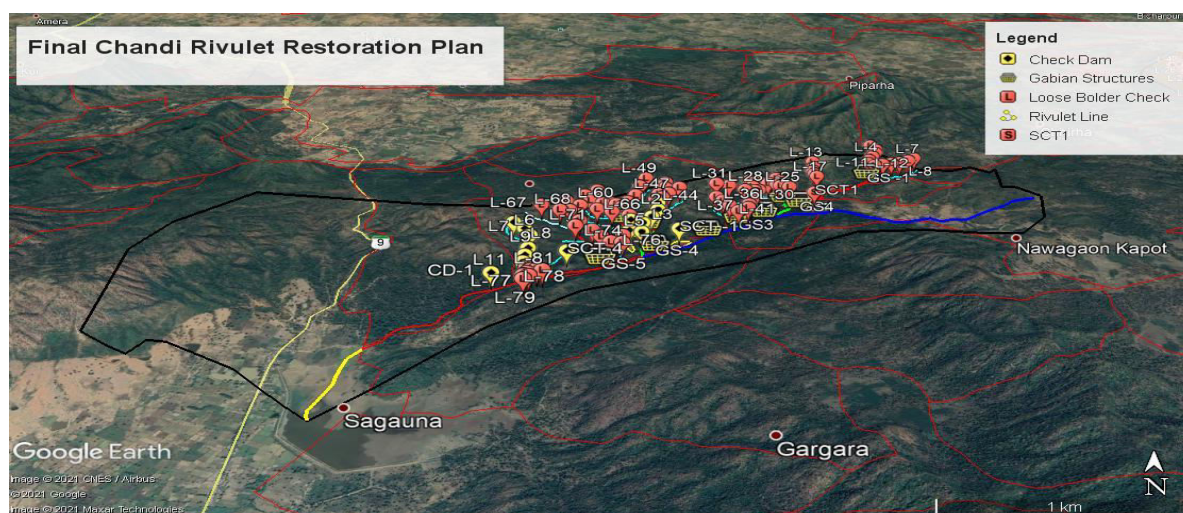


Figure 2-Proposed Chandi Rivulet Restoration Plan

Based on the GIS based information Natural resource management works has been Proposed. This is done to ensure that the interpreted elements of the satellite data conform to the ground characteristics. The data that is collected on the ground is geo-referenced with the help of a GPS to ensure that its corresponding location can be accurately identified in the images that were collected earlier. Additionally, field points identified in the images are visited to verify information regarding the state of the vegetation, geomorphology, topography, soils, and so on. With the use of the pre-field map that was generated and as per site condition of field technical design of Chandi rivulet restoration plan to be prepared.

IV. EXPERIMENTAL RESULTS

The outcomes of the works it will Increase in the net irrigated area will be around 3.5 ha through check dams. Water Harvesting Potential (27000 m³) will Increase through check dams and Pond Volume of water will be percolated through 58000 Staggered Contour trench in the lineament zone of the catchment. Soil water conservation will be done by the different structures like gully plug, Gabion and brushwood and it is estimated around 827 ha will be treated. 6000 Seed (Bamboo, Acacia, eucalyptus) will be Showing in the Rivulrt stream bank and bund of trenches for checking erosion and side bank protection and stabilization. The plantation will also give additional livelihood generation option for the nearby farmers in future (3-4 years).

Table 5.Outcomes of Rivulet Restoration Plan

S No.	Nature of Treatment	Name of Work	Number of Structures	Land Erosion Control/ Area treated (Ha)	Increase in Irrigated Area (Ha)	Plantation Area (Ha)	Water Harvesting Potential (m3)
1	Stream line Treatment work	Loose Bolder Check Dam	96	150			
2		Gabian Structures	10	630			
3		Check Dam	1	1	3.5		9000
4	Area Treatment works	Staggered Contour trench	10	32		4000	
5		30-40 Model	2	15		2000	
6		Percolation Tank	1				4000
7		Pond	2				18000
		Total	122	827	3.5	6000	31000

V. CONCLUSION

The primary goal of this study is to determine proper NRM works for Rivulet restoration named as Chandi rivulet situated in range Pandariya East, Pandariya Sub division, Division Kabirdham, C.G., with the help of GIS and GPS and based on area and stream line treatment approaches, The following findings have been taken from the experimental outcome report in the project work,

1. GIS, QGIS, and Global mappers were used to extract 17 different types of thematic layers that define the characteristics of land and rivulets. We can see Rivulet restoration management in the Pandariya area through the GIS application, which provides information on all the physical features needed. The study's aim was to develop a strategy for creating regeneration in this region by superimposing various thematic maps,
2. Field verification of proposed works is essential because it provides detailed details about NRM works and ground reality,
 - For the treatment of stream lines 10 gabion, 85 LBCD, and Line Plantation are proposed to prevent soil erosion and water conservation and harvesting, as well as a check dam for agricultural and wildlife purposes,
 - For Area treatment Pond, Percolation tank 58000 unit of Trenches proposed in area for protection and regeneration.
 - The potential for water harvesting (27000 m3) would be increased by check dams and ponds. Water will be percolated into a 58000 Staggered Contour trench in the catchment's upper ridge section. Soil water management can be accomplished by the use of various structures such as gully plugs, gabions, and brushwood, with an estimated 827 ha being managed. 6000 seedlings (Bamboo, Acacia, and Eucalyptus) will be planted in the Rivulet stream bank and trench bunds to prevent erosion and side bank defense and stabilization.

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