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Remote Sensing and GIS Based Comparative study of watershed of different Physiographic Conditions, Wainganga Sub Basin, Maharashtra

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ABSTRACT

The present study carried by a Wainganga river basin is of critical importance for Maharashtra to preserve its watershed, drainage, relief, soil, forests, wildlife, and tribal population dependent on it. Protecting the basin however does not seem to be priority for the state. The very lifeline of the Wainganga River is being subjected to growing pressure. Its flow has already been obstructed at several places with dams and barrages. By 2012 there were as many as 149 dams built in Wainganga basin. The river in its initial reaches flow westwards and thereafter southwards in M.P. State and continues to flow Southwards in Maharashtra State. Several studies related to different aspects of channel cross section and longitudinal profile river have been carried out from different parts of the country and abroad. Recent emphasis is placed on quantitative geomorphology of drainage basin by various methods and measures to establish the interrelationship of cross section and longitudinal profile river and to impact on river morphology. Water is not only for sustains of life but also determines the quality of life. Assessing water quality is important as quantity in water resources planning and management. It may be observed that the existence of human being a lot of serious problem to disturbance of quality and quantity of water. There are several reasons for scarcity of water and most important things to the increasing population and changing environment condition in the local as well as world level. For sustainable development requirement to that fresh water is indispensable for human survival. Water is being transferred to irrigation and urban industrial uses, putting additional stress on the performance of the irrigation sector. Keeping in mind the scarcity of water resources to cater to the multi various needs of the growing population along the Wainganga River with the vagaries of monsoon precipitation and dearth for quality of water. The purpose of the present research work is to describe the physical condition in Wainganga drainage basin as a system unit resulting from the interaction between landuse & landcover and topography, which is an impact of socio economic condition and surrounding area or region.

Keywords – Wainganga River, GIS, RS, Physiographic Condition

I. INTRODUCTION

Various relief, climatic, watershed and hydrological phenomena is correlated with the physiographic characteristics of a drainage basin such as size, shape, slope of the drainage area, drainage density, size and length of the contributories, etc. Application of remote sensing provides a reliable source for the preparation of various thematic layers for morphometric analysis (1, 17, 21, 2, 22, 32). The digital elevation data is used for generating the elevation model of a landscape to any extent. The resolution of the image may vary with respect to the satellite sensors. The processed DEM is used for generating the stream network and other supporting layers (18, 3, 4, 5, 20, 23, 24, 33).

Geographical information systems (GIS) have been used for assessing various basin parameters, providing flexible environment and powerful tool for determination, interpretation and analysis of spatial information related to river basins. Geology, relief and climate are the primary determinants of a running water ecosystem functioning at the basin scale (6, 7, 19, 21, 34).

II. STUDY AREA

The Wainganga River rises at El 640.0 m in the Seoni District of Madhya Pradesh from the Western slopes of Maikala Ranges which is continuation of the Satpura Ranges in Central India. The Wainganga River receives numerous tributaries on either 8 bank and drains the western, central and eastern regions of the Chandrapur, Gadchiroli, Bhandara, Gondia and Nagpur districts of Maharashtra (Fig. 1).

Total river basin area- 26347.47 Sq. Km.
Latitude extension- 19030'N to 22030 N'
Longitude extension- 79000'E to 80030 E'

The river in its initial reaches flow westwards and thereafter southwards in M.P. State and continues to flow Southwards in Maharashtra State. It is joined by the Wardha River at a place called Gundapet flowing from the west, draining the major portion of the Maharashtra Plateau (35, 36). Thereafter the river is known as Pranhita River (Fig. 2). The climate of the sub-basin is characterized by hot summer from March to May with rainy season from June to September although the area has some rains in post monsoon season also. The upper catchment area lies in the high rainfall range of 2000-4000 mm. The Pranhita River joins the Godavari River on the left bank which drains the Eastern Coast in Andhra Pradesh and flows out to the Bay of Bengal (22, 23).

III.RESEARCH METHODOLOGY

The data required for the present study comprises of topographical maps, satellite images, and utility services data details. For the present studies of drainage map and physiographical region data have obtained from one inch topographic map of Survey of India (1:63,360 or 1:2, 50,000). They are toposheet No. 55K, 55O, 55P, 56M, 64C, 64D, 65A.Includes sorting of data, digitization of various layers, preparation of maps, statistical analysis and other GIS/RS techniques, like Georeferencing, Data attachment. The various maps were formed using ArcGIS and ERDAS imagine software.

IV. ANALYSIS AND INTERPRETATION

Wainganga basin is enclosed by higher lands from the three sides which carve out a distinct regional entity separated from the hilly Satpura on the north, the Maharashtra Plateau on the west and Chhattisgarh plain on the east. Wainganga river basin forms a part of Wardha-Wainganga basin which further constitutes the Satpura ranges and Vidarbha Plain.

The main stream of the Wainhanga originates at Mundara, Seoni District, on the southern slopes of the Satpura Range of Madhya Pradesh.

The river has developed extensive floodplains characterized by sweeping graceful meanders, low alluvial flats, and slip-off slopes. The river has high banks, which measure from 10 m (33 ft) to 15 m (49 ft) on either side. The northern part is surrounded by the Mahadeo hills and Satpura Range, with an average elevation of 625 m (2,051 ft) above sea level. The valley of the Wainganga River is forested and sparsely populated. Balaghat and Bhandara are the major cities located on the bank of the Wainganga River, while Pauni and Desaiganj are smaller urban centers on the smallest of the river banks. The Wainganga River is the water lifeline of these cities and their primary source of water. The Government of Maharashtra is developing a protection wall for Bhandara to protect it from heavy flooding. This flood protection wall encircles Bhandara from east to south (8, 9, 10, 24, 25).

Watershed Area:

The Wainganga river receives numerous tributaries on both sides and drains the western, central, and eastern regions of the Balaghat district of Madhya Pradesh, Chandrapur, Gadchiroli, Bhandara, Gondia, and Nagpur Districts of Maharashtra. The main tributaries of the Wainganga River are the Thel, Thanwar, Bagh, Chulband, Garhavi, Khobragadi, and Kathani, which meet on the left bank; and the Hirri, Chandan, Bawanthari, Kanhan, and Mul joining on the right bank.The Thanwar River joins the Wainganga at the Nainpur Forest Range, at the border of the Seoni District and Mandla District, before the Dhuty Dam on the Wainganga. It originates from the forest of Chiraidongri in the Mandla District. There is a medium-sized dam at the village of Bejegaon on the bank of this river, which opened in 1980. River water stored in the dam is used to irrigate the farmland of 50 villages. The Halon River. and the Chakor River (catchment from Nainpur Forest Range) are some of the well-known tributaries to this small, fully utilized river. Geographically, this river misses a few miles due to a Satpura foothill to become the Narmada's first major tributary (37, 38). The main towns on this tributary are Nainpur and Pindrai. The river has been in recreational use since ancient times, as it was on the route of pilgrimage from South to North India (11, 12, 13). The village Jhulpur, on the bank of this river, was a stoppage and temple town. The major bridge over the river is at the town Pindrai by Indian Railway (Jabalpur-Gondia rail track). The Wainganga river basin total calculated Plain region is in 42.62% and expanded in 11,229.92 area sq.km. The southern lowlands, a slightly undulating plain, comparatively well cultivated and drained by the Wainganga River and its tributaries. A number of Sub Rivers and tributaries in piedmont plateau region developed narrow cultivated land. Central and southern part of the study region is a very large and important in the Wainganga river basin. Here soil depth is very deep and this soil region is fertile (14, 15, 16, 26, 27). Bhandara, Chandrapur, Gondia districts are located in this area. In north direction the natural boundary is formed by Kanhan river basin. The Kanhan narrow basin is irrigated area having high productivity. In this valley Nagpur district is located (Fig. 3).

Drainage

The Wainganga River originates at Partappur (21056'32.05"N, 79033'29.18"E) in Seoni District of Madhya Pradesh from the foot of Ambagad range, an outlier of the Satpura Mountains, at an altitude of

1350 m above MSL. It meanders northwards, then northwest and turns southward after the Sanjay Sarovar Dam (80 km from origin) at Bhimgarh (22.37 N 79.66 E) and then rushes through Seoni and Balaghat regions and enters the State of Maharashtra. In the upstream regions, the river sometimes becomes wide and shallow at places, while at some it becomes narrow and deep. After it enters the comparatively plain and slightly undulating lands of Maharashtra, and flows through Gondia, Bhandara, Nagpur, Chandrapur and Gadchiroli. It meanders, splits and reunites at several places creating an almost braided structure. The width of the Wainganga River varies from 100 m to almost 1.5 km near. Its confluence with Wardha near Chaprala elevates 140 m above MSL in Gadchiroli district (Fig. 4).

The total length of the Wainganga River is 638.91 km, of which 270.2 km lie in Madhya Pradesh. It then travels 32 km along the border between Madhya Pradesh and Maharashtra and the rest of 368.7 km lie in Maharashtra. The Wainganga has 24 tributaries. Twelve of them lie on its left bank, and other 12 are on the right bank. Of these rivers such as Halon, Sagar, Hiri and Nahar join the Wainganga in Madhya Pradesh across Seoni and Balaghat districts. However Bagh (at Birsola, 283m above MSL), Chandan and Bawanthadi (at Bapera, 275 m above MSL) join the Wainganga on the borders of Madhya Pradesh and Maharashtra. And finally 17 rivers, namely, Sur, Gaimukh (Nala), Ambagad (Nala), Bodalkasa, Chulband, Maru, Pohar (Nala), Kanhan, Gadhvi, Khobragadi, Andhari, Kathani, Mandoli (Nala), Satti/Wainlochana (Nala), Dina, Ambi, and Mul join the Wainganga River in Maharashtra.

The rivers on the left bank of the Wainganga lie in the high rainfall zone within the basin and are major contributors to the yield of the Wainganga Rive. Chulband, the longest tributary of Wainganga traversing 109.15 km, flows through Gondia and Bhandara districts (28, 29). The rivers Gadhvi (69.18 km) and Khobragadi (76.94 km) flow through the Gadchiroli district, and traverse

The channel gradient or longitudinal profile represents fall in bed elevation with distance down channel. The overall cannel gradient declines in the downstream direction, and tends to attain a concave-to-the-sky form. The longitudinal profile of a river is a property of river geometry that can provide clues to underlying materials as well as insights into geologic processes and geomorphic history of an area. The longitudinal profile of a river channel may be shown graphically by a plot of altitude (ordinate) as function of horizontal distance. The long profile shows how a river's gradient changes as it flow from its source to its mouth. The long profile shows how, in the upper stage of a rivers course, the rivers gradient is steep but it gradually flattens out as the river erodes towards its base level. The construction of longitudinal profile provides an interpretation of the surface history and the river course flows from the source to mouth at any stage of evolution (30, 31).

The longitudinal profile is drawn for the three course of the river as is covered by survey of India toposheet number 55K, 55O, 55P, 56M, 64C, 64D, 65A. (Map No. 4.10). In the profile shown in the flow calculation result, there are trends of rising in the longitudinal profile that is inconsistent with the real tendency of a river channel. These errors are associated with the scale of representation of the DEM.

This is because the geometric complexity of the Wainganga River is not reflected in the low-resolution digital maps, so that the flow calculation algorithm has to do local ascents to find the general trend of maximum slope from the starting point. In the case of 640-meter DEM resolution this error is very remarkable, as can be seen in the calculated profile. This new representation shows how local promotions have been virtually eliminated, showing a continuous trend of decrease in altitude consistent with the actual longitudinal profile of a river. The

longitudinal profile is taken from second stage of the river is mature. In this profile both bank are shown as a vertical wall and steep slope. The channel has a steep slope is found in starting point. So the channel consists of boulders and smooth meandering and erosion can be seen along the main channel. Also the boulder size is small on the left bank. The area around Nagpur and Bhandara districts falls within the extensive flooding almost every year. The patches of channel sand are extensive overbank spilling in the area. Presently, the right side of the channel lies abandoned due to silting in the upstream region but is activetd during only monsoon period that the floodplain slope is towards South west, which is the flooding effect in the around area.

Biodiversity of Wainganga

Wainganga River Basin or Wainganga Valley as nature lovers call it is home to two tiger reserves viz. Tadoba Andhari National Park in Maharashtra and Pench National Park in Madhya Pradesh. which harbor presence of flagship species such as Royal Bengal Tiger & elephant, along with several other wildlife parks with various species of endangered fauna. The valley is virtually a nexus for critically important tiger corridors of Kanha, Pench, Satpuda, Melghat, Navegaon-Nagzira, Bor and Tadoba tiger reserves. It provides for 16,000 sq km of undisturbed landscape connecting Kanha and Pench tiger reserves which according to National Tiger Conservation Authority (NTCA) and Wildlife Institute of India (WII) is one of the four most viable tiger habitats in the country. This rich forest ecosystem of the valley has also stood a witness for life of some of the most primitive tribes of the country like Baiga, Bharia, Kolam, Maria Gond etc. which have been categorized as Particularly Vulnerable Tribal Groups (PTGs) by Government of India (GoI). Recognizing the importance of Wainganga Valley in terms of its bio diversity & dependence of the tribal on the forests the Working Group of Planning Commission on Ecosystem Resilience, Biodiversity and Sustainable Livelihoods for the XII Five-Year Plan recommended for conducting pilot study of Wainganga basin to develop River Ecosystem model for Biodiversity Conservation.

Plan to divert Wainganga Waters

Brushing aside the fact that the dams built on Wainganga failed to yield promised benefits and more importantly that they have come up at the huge costs of forest and wildlife besides social and financial costs, Maharashtra Government continues with the reckless planning in the basin. Oblivious of its future environmental and ecological implications Maharashtra Government is now pushing for further diverting water of Wainganga River through 'intra-state river linking projects'. Pre-feasibility report (PFR) of linking Wainganga (Gosikhurd) and Nalganga (Purna Tapi) has been completed by NWDA. This proposed project envisages diversion of 2721 Mm3 of water to the Western Vidarbha from the Gosikhurd project, which has failed to provide any irrigation. One of the priorities is to cater to the future municipal and industrial water requirements in the command area and the city of Nagpur. Out of 2721 Mm3 quantum of 2207 Mm3 is earmarked for irrigation, 253 Mm3 is planned to be utilized for municipal & industrial purposes in the command areas and the remaining 261 Mm3 will be transmission losses.

Flood as a disaster in the Wainganga sub-basin

The Wainganga sub-basin is naturally prone to flooding, with floods being recorded every 5-7 years. Recently the Wainganga basin has experienced floods in 2001, 2004 and 2007. In many cases the floods have been a result of continuous heavy rainfall in upstream areas or throughout the basin. Further, due to the relatively gradual slope and topography of the basin, the flood waters have a tendency to spread and accumulate over large areas. The river also has a peculiar morphology which leads to several spin-off problems, e.g. in the Balaghat district the river has a

narrow channel and the flow rates increase enormously, whereas in the Bhandara district the river pulses lead to backflow in its tributaries like Chulband, Bodalkasa etc.

Several fishing villages lie in the flood prone areas. Usually these villages represent economically under privileged communities or subsistence agriculturists, which make them further prone to long term impacts of flooding disasters. The Wainganga is also known to erode its bank and carry huge amounts of silt along with its floods. A few villages like Rengepar Kotha (Tumsar Taluka) in the Bhandara district are severally affected by the continuous erosion of the bank by the Wainganga River. Thus, flood related disaster in the Wainganga basin is a complex of natural causes and human induced problems.

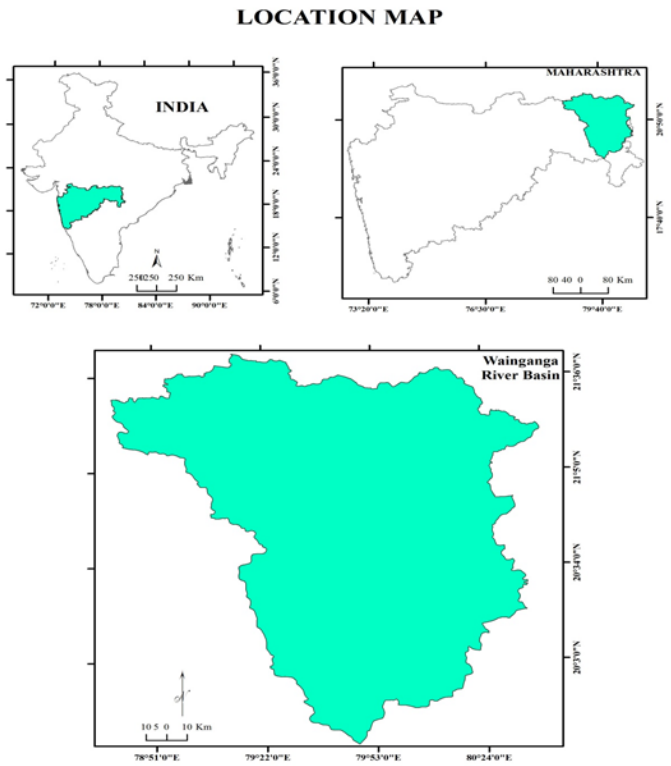
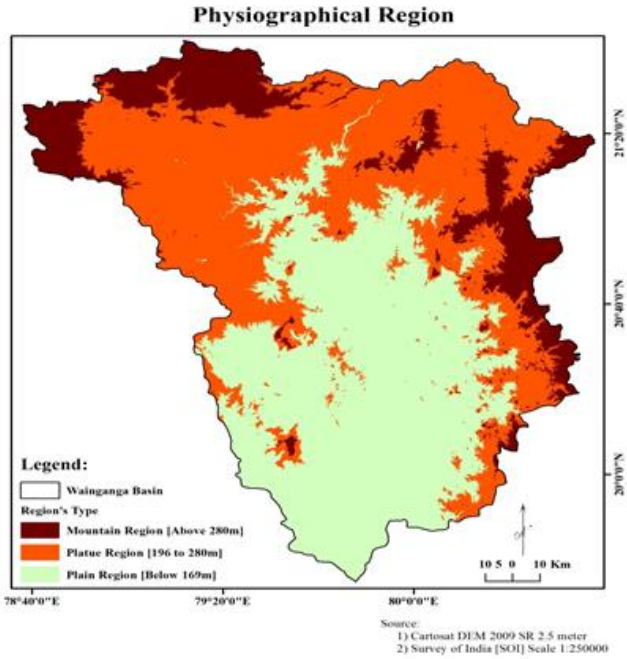


Fig. 1. Study Area



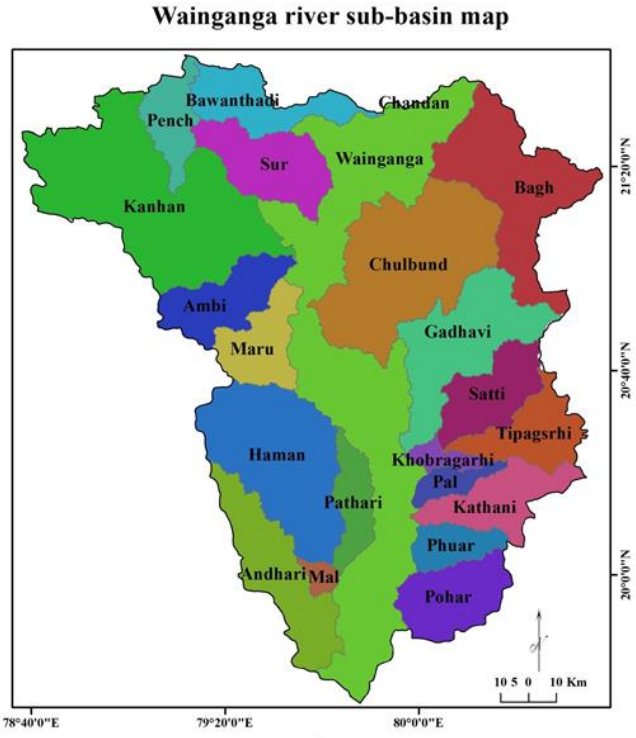


Fig. 3. Wainganga Sub-basin Area

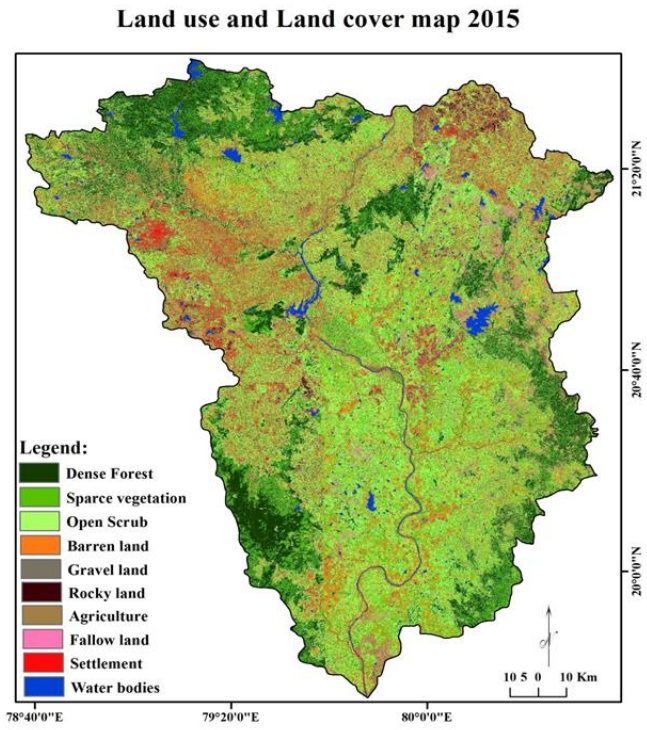


Fig. 4. Land use Map

V. CONCLUSION

The Wainganga river basin total calculated Plain region is in 42.62% and it is expanded in 11,229.92 area sq.km. The southern lowlands, a slightly undulating plain, comparatively well cultivated and drained by the Wainganga River and its tributaries. A number of Sub River and Tributary in piedmont plateau region developed Narrow cultivated land. The main rivers along with their tributaries drain the area and are seasonal rivers. While passing through the plains they flow in meanders and at times form ox-bow lakes. Having complete disregard for the rich ecosystem of the region Vidarbha Irrigation Development Corporation (VIDC) which was established by state's Water Resources Department (WRD) has been pushing unfeasible dam projects without assessing options for small scale water conservation which will cause lesser damage to the environment. A whopping 257 number of projects taken up by VIDC were ongoing in Vidarbha (Wainganga and Wardha sub basins of Godavari) as on March 2011.

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