Impact of Dam and Weirs on Cross-Sectional Characteristics of Urmodi Channel, Maharashtra: An Approach to Geoinformatics

Sarika B. Suryawanshi, Jagdish B. Sapkale, Vidya A. Chougule

***Abstract*— Dams and reservoirs play their significant role by providing the numerous facilities for social and economic development. However many studies around the world documented the impact of dam on the socio-economic aspects of the people and also give the side effects on the environment. Some environmental problems occurs due to dam may be directly or indirectly. Destruction of vegetation in the upstream of dam, variation in river channel morphology in the downstream of dam, salinization and water logging problem due to over exploitation of water through irrigation are the negative impacts of dam. In the present study, authors have discussed the impact of dam and weirs on the morphological characteristics of Urmodi river channel.**

***Index Terms*— Dams, River Cross sectional change, River Bar, River Bed Configuration, Pebbles, Cobbles.**

I. INTRODUCTION

The Urmodi Dam is located at village Parali on the Urmodi river of Maharashtra. The impounded water is being used for irrigation purpose in the basin area. Dam's impact may be positive and negative also. In view of this, aggradational and degradational impact in channel has been studied because the channels are logical and efficient place to investigate the geomorphic effects of force, resistance, erosion, transportation and deposition. In Urmodi channel the flow of river water and the distribution of bed material have been regulated by Urmodi dam.

An intervention by man has serious effects on natural processes. The degree of intervention is the outcome of technological advancements, which exert pressure on the natural resources. The increase in Population leads to increasing demand on houses, food crops and basic needs [1]. One more important mechanism has observed during the studies that providing over- irrigation to the agricultural fields, the soil material getting loose that helps in heavy erosion during the monsoon. The detached loose material washed out from the fields and added with the rills and gullies of the tributaries, moreover moving as a bed load in the river channel. Uneven and low discharges after monsoon in the river channel due to controlling measures like dams and K.T. Weirs (Kolhapur type weirs) tends to slow down the river velocities and carrying capacity, resulting for silting up of channel [2]. According to Petts and Lewin in 1979, the dam influences on downstream river channel morphology and decreases magnitude and flood frequency; also reduces the quantity of sediment load [3], [4], [5].

Gaeuman has studied the channel responses to changes in stream flow and sediment supply in the lower reaches of Duchesne River. Gravel-bed and sand-bed reaches of the lower Duchesne River showed particular adjustments to the discharge and sediment supply. "Sand-bed reaches tended to adjust to all perturbations with rapid bed-level changes, whereas the gravel-bed reaches adjusted primarily through width changes. The gravel bed reaches aggraded only when gravel was supplied to the channel through local bank erosion and degraded only during large floods" [6].

Osterkamp also observes that stress imposed by human activities on global systems has drawn attention of planners, earth scientists, environmental managers and citizens that changes have occurred since historic time but major transformations of landscapes including fluvial and coastal systems continue to occur in areas of human settlements and mineral extraction. The environmental effects of Urbanization and related activities of mining, quarrying and infrastructure development are principal factors promoting anthropogenic changes in the nature and processes of the earth's surface [7], [8].

Human intervention in terms of excavation activities along the bank and other human related activities like dam construction in river catchments probably modify the channel geometry, and distribution of sediments and water to rivers [1], [8], [9], [10]. Therefore, study regarding channel morphology, changes in bed configuration and changes in river behavior with response to dam and weirs in the study area has attempted.

II. MATERIALS AND METHODS

The study requires contouring of some depositional sites of river bars and to generate some profiles/cross sections. Intensive field work and field surveying was the base for research work. Surveying was carried out using Transit Theodolite and GPS. On the basis of surveying data contour map and profiles were prepared for the present study.

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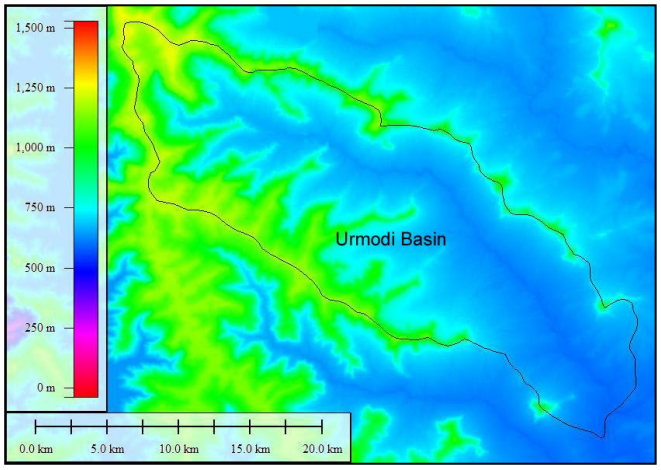

Figure 1: Relief Map of Urmodi Basin

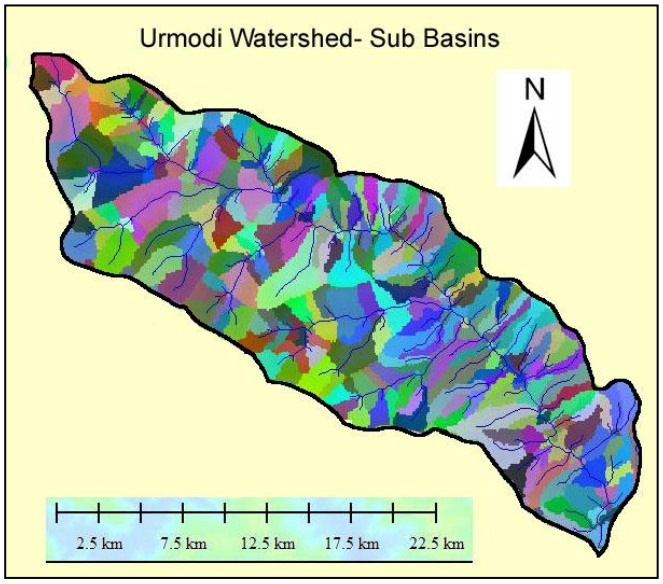

Figure 2: Sub-Watershed of Urmodi Basin

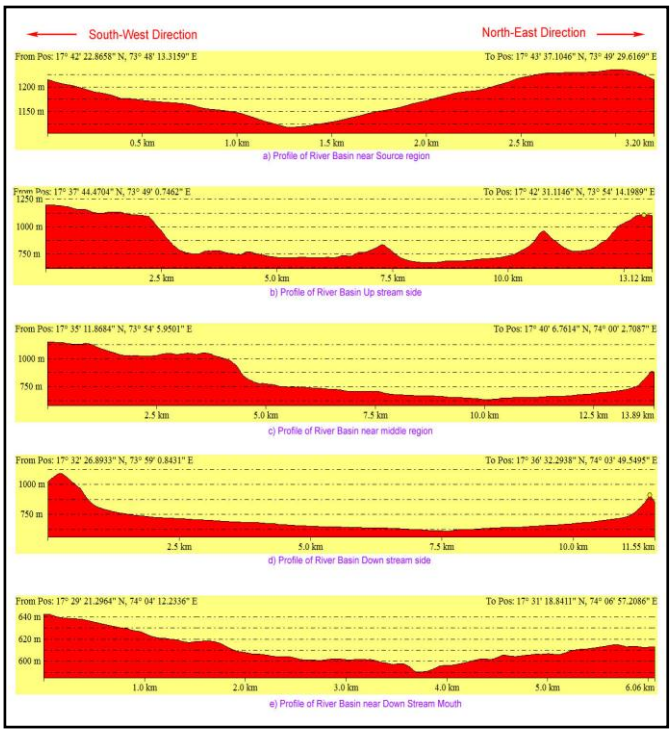

Figure 3: Profiles of Urmodi River Basin
Source: S.R.T.M. Data

The cross section were surveyed during May 2012 and march 2013. During the field surveys eight cross sections were measured to understand the cross sectional properties of the channel and variations in them. The topographical maps and images from Google earth have been used for identification of river landforms. Change detection in bar formation and changes in river morphology for past years have analyzed by using Remote Sensing data and Google earth images. Profiles, DEM, watershed and sub basin map of Urmodi Basin were also prepared by using SRTM data and global mapper software (fig. 1, 2 and 3).

III. Discussions

In view of the above, the study area has been considered the Urmodi basin of Maharashtra. The catchment area of the Urmodi basin is 408sq.km. The entire basin is covered by Deccan Trap. Most of the basin is contributed by hills and slopes extending for 1000 m to 700 m in heights (fig 3). The upstream catchment area is partly hilly and the average annual rainfall ranges are from 500 cm to 180 cm. The Urmodi Project has constructed at village Parali on river Urmodi, which originates from Kas village. The dam is constructed far 17 km away from river origin and located near Parali village in Satara district. The undulating topography in the upper basin region is responsible for the diversified effects on the agricultural practices that to effects on the variation in the channel bed material. The variation in river characteristics also takes place due to the changing cropping patterns in the command areas of the river basins/ sub basin. Considering Urmodi basin, left side of the river side is gentler than the right side. Highly elevated and undulating topography comes in the right side of the river. The larger tributaries coming from the sub-basins eroded the bank and bed and pour the large sized bed material into the main channel (fig 2).

IV. River Cross-Sections

Channel change and variation in channel cross sections were measured at four sites downstream to the Urmodi dam. Cross section (CS) 01 and 02 are the cross profiles of Shahapur site. CS 01 measured at the upstream side of K.T. weir and CS 02 at the downstream side of the weir. At the upstream side of the K.T weir, slight depositions have observed during the year 2013 as compare to measurements of 2012. Left bank erosion have seen here at this site. Down stream to the weir the thalweg height has increased by 70 cm during the year 2013.

Cross section 03 and 04 have been measured at Shendre-Vechale K.T.weir . Cross section 03 has located on the upstream side of the K.T.weir (fig 4) and cross section 04, on the down-stream side of the weir. At cross section 03 and 4 the left and right bank slope is moderate. 20-30 cm of average deposition has observed at these cross sections. Average width of the channel as shown in cross section 03 is 97m; and the average width of the channel at cross section 04 has decreased to 91 m. No periodic change has found for cross section no. 5 and 6.

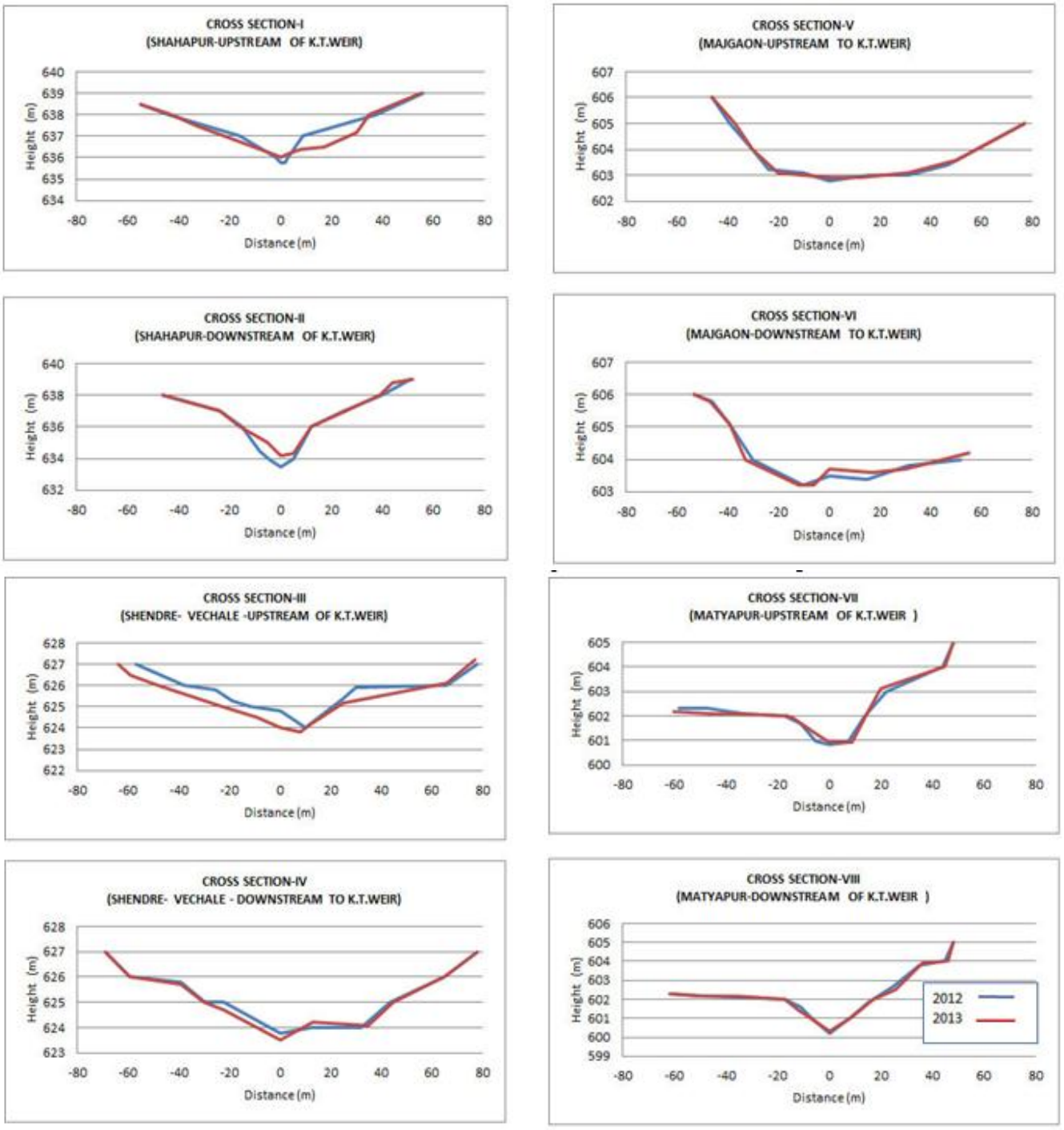

Figure 4 : Channel Cross section No. 01 to 08

Fig 4- of CS 5-6 shows that, left bank is steeper than the right bank. At cross section 05 the thalweg height is 603.9 m (above sea level) which is 603.2 m at cross section no. 06. This condition gives rise to refilling and scouring of the channel. Here, K.T.weir traps most of the bed load sediments in the upstream side, resulting for the aggradations in channel, but contiguous part i.e. down stream of weir shows scouring of the channel bed. River bank at this Site has dense vegetation with mixed species, resulting to reduce the erosion. Very few changes have occurred at this cross sectional site. Regulated water has very little effect on the river morphology at this site. Drop of bank height at left side of the bank is 3 m. Upstream to the K.T. weir pools and slack water have seen where velocity of river water decreases, supports to transport silt and fine clay.

Cross section 7 and 8 were measured at Matyapur location, upstream and downstream of K.T. weir respectively. Comparatively, to the previous cross sections the right bank of these cross sections are near vertical than the left bank. Right bank height is of 5 m; average width of the river bank is 105 m at C.S. 8.

V. RIVER BED CONFIGURATION

Figure 5-1 shows the site of Ambavade Bk. A very sharp turn has observed, developing a river bar deposited at the concave side of the bend. Here the river bar of Ambavade shows maximum amount of pebbles and coarse sand, ranges from 0.1mm to 2 cm that is moving downstream in the form of

saltation and traction. In the main river flow, grasses and scanty vegetation are stable and leads to bifurcated the channel into many flow lines. Mostly the deposited material at this bar is poured by two main tributaries joined from the left side of the Urmodi River. A large sized point bar has developed at Raghobawadi site (fig 5- 2). This figure reveals that most of the bar is covered by various sized pebbles and cobbles. The average size of the pebble is of 6cm diameter. The presence of this large sized bed material increases the channel roughness. Such condition is responsible to minimize the river velocity due to increase in the channel bed friction. Most of the bar sites reflect such conditions tends to reduce the velocity, caused within channel siltation. Opposite side tributaries of the river are resulting for the formation of central bar at Shahapur-Upali. River bar is covered by uneven size of pebbles and cobbles; bar height is of 1 m.

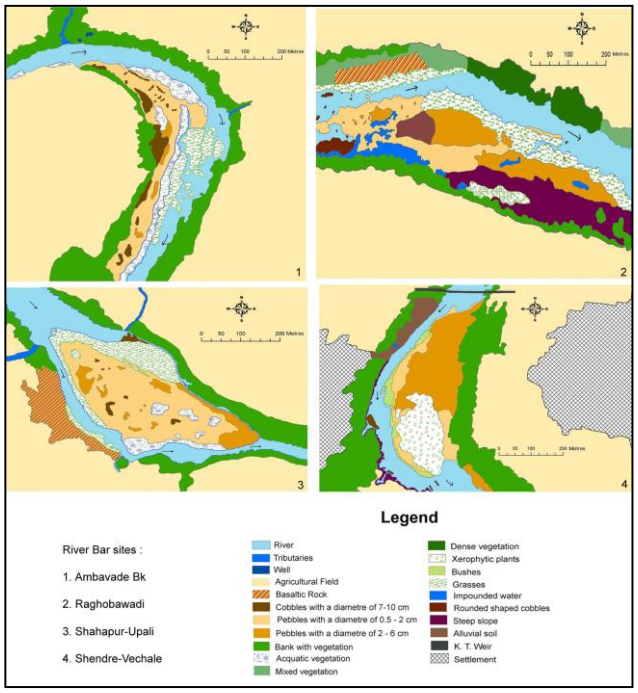

Figure 5 : River Bed Configuration and Bar

K.T.Weir of Shendre-Vechale is located in the zone of middle basin area over the Urmodi River. In this stretch the river pattern is sinuous to the upstream and downstream of the K.T.Weir. Keen observation indicates that upstream to K.T.Weir river water is impounded and pool is formed there for a distance of 100-150m. The average thalweg depth in the upstream of K.T.Weir near the pillar is 624m and downstream to the K.T.Weir the average depth is reduced by half metre and measured 623.5m. There is a deposition of bed load material due to the changing characteristics of velocities and river discharge. The river discharge increases, while moving towards the downstream side because number of tributaries joins the main river and add their extra discharge and load. A large size bar is formed for a distance 350 metre having a width of 127m. The formation of this bar at left side of the main flow line is resulting of inconsistency of river energy to transport bed material (fig 5-4). The bed material is indirectly affected by the dam and K.T.Weir that is constructed in the upstream direction of this bar. The large sized cobbles and stones have been transported from the upper course of the river i.e. from upstream basin area.

It has noticed that, most of the suspended sediments from upstream basin have collected in the Urmodi dam. It reduces the amount of silt and suspended material. That would be accumulated in the downstream part of the basin; therefore meager amount of fine and suspended sediment is being transported in the downstream channel. But, the channel siltation with large size material occurred in the downstream of dam. Such siltation is the indirect effects of dam, the perennial water reduces due to dam reservoir, and there is a control over regular flow of water. Consequently, the river energy to transport the bed load, is reduces. Numbers of tributaries have joined to the left and right bank of Urmodi River (fig 2 and 5). These tributaries are responsible for the variations in channel morphology. The uneven size of pebbles and cobbles coming from the catchments of various tributaries have directly deposited in the Urmodi channel. The large sized deposited material unable to move in downstream direction due to lower flows and gets stable to form river bars (fig 5). On the Shendre Vechale bar, uneven sizes of bushes have colonized, supporting to stable the bar.

The study also reveals that the specific increase in discharge and bed load at the confluence occurs, when the tributaries joins the main river. The volume of river discharge and bed load depends on the size and length of the tributary; if the tributary drains its water from small water shed that means a small first order stream that will add a lower discharge than a much larger tributary which comes from larger sub watershed. Here it has seen that, tributaries joins at right bank from south-west direction is having larger size bed material. It also depicted that, the stream shows uneven pattern i.e. the channel in section and channel in plan. The right side of the bank is of basalt. Overburden material has deposited which has increased the height of the channel bed.

VI. CONCLUSIONS

Keen observation of the Urmodi basin reveals that half of the right upstream side of the basin is mostly covered by vegetation and forest. Such vegetated part acts as an obstacle for the surface runoff, more and more water gets penetrate into the soil. Therefore, discharge that enters into the channel gets reduced and decreases. Consequently, the left part of the Urmodi is having more gentle slopes and unvegetated, therefore surface runoff, which is more, adds higher discharges. Such natural process and human activities simultaneously responsible for the runoffs, river flow and movement of sediments in river channel. Overall, the river characteristics in its plan and section are highly influenced by dam. Study also reveals that at upstream of K. T. Weirs the channel has aggraded and downstream to the K. T. Weir there is a degradation of channel bed.

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