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Evaluation of the Hydraulic Criteria of Environmental Flow

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Abstract: *Environmental Flows (EF) are the flows of water in rivers that are necessary to maintain aquatic ecosystems. In other words, a flow regime in the river, capable of sustaining a complex set of aquatic habitats and ecosystem processes are referred to as environmental flow. Hydraulic Parameter such as depth, width, area, velocity and discharge were calculated for the selected nine locations of downstream side to know Depth - Area - Discharge relationship. The discharges of the selected downstream nine stations (Baragaon Nandur, Rahuri Budruk, Rahuri Khurd, Deswandi, Aradgaon, Valan, Manori, Manjari and Panegaon) are 483.54, 223.02, 177.13, 60.08, 323.2, 110.48, 102.24, 10.89, 10.09 m*^{3}*/s, respectively.*

INTRODUCTION

The flow of water in a river channel and the physical structure of the channel are intimately related in a cycle of cause and effect in space and time. Local hydraulics and channel morphology are the primary determinants of the availability of physical habitat which, in turn, is a major determinant of ecosystem functioning. A quantitative understanding of a river's flow regime, its physical structure, and its depth/velocity regime, derived jointly and severally from hydrological, geomorphological and hydraulic analyses, is therefore a prerequisite for deriving quantitative information about its ecological functioning. The EFRs for rivers tend to quantify water needs of various biotic components in terms of parameters such as water depth, flow velocity, area and water surface width. It is important that in the study on the hydraulic characterization of low flows, because these are the flows that are experienced by the biota for majority of the time. It is also necessary to understand how the riverine ecosystem is likely to change as discharge are reduced as a result, for instance of increasing abstractions.

MATERIALS AND METHODS

The flow of water in a river channel and the physical structure of the channel are intimately related in a cycle of cause and effect in space and time. Depending on the susceptibility of the channel to flow-related change, its morphology is determined by local geology as well as by the sediment and flow regimes, whilst local hydraulic conditions are determined by the geometry and flow resistance of the channel.

Hydraulic studies in the Building Block Methodology

EFRs for rivers tend to quantify the water needs of the various biotic components in terms of parameters such as depth, flow velocity, and water surface width. Time is added as a parameter, by referring to the frequency of occurrence of a

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particular discharge, or the duration of inundation resulting from a particular flooding event. Duration, depth and lateral extent of inundation are especially relevant when considering the water requirement of riparian biotas.

It is important to note that there is great emphasis in the BBM on the hydraulic characterization of low flows, because these are the flows that are experienced by the biota for the majority of the time. It is also necessary to understand how the riverine ecosystem is likely to change as discharges are reduced as a result, for instance, of increasing abstractions.

Estimating the Flow of Streams

The Float Method

This method can use in canals or channels and also used in rivers and streams although with less accuracy. The two steps of information are needed to calculate the flow. The first is the cross-sectional area of the water flowing in the stream. The second is the speed that the water is flowing. This is measured using a float and timing of its travel between two points a known distance apart.

STEP 1 Finding of cross-sectional area.

To estimate the area at a particular point, measure the width and then take depth measurements at regular interval across the flow. Plot the depth measurements on squared paper. Join them up with straight lines to the width that is marked along one axis to create an enclosed area. The area can be estimated by counting the number of squares that are enclosed. Multiply the number of squares by the area which one square represents in m^2. Repeat these measurements in the middle and at the other end of the length over which the float is being timed. Three values of the cross-sectional area will allow an average to be calculated.

STEP 2 Measurement of surface velocity of the flow

Put the float in water several metres upstream of the first marking point. Begin to time the float when it passes the first marker and stop as soon as it passes the second. The mean velocity of flow in a channel, when necessary, by timing the movement of a float along a measured channel reach by the following formula.

$$v = \frac{L}{T} \tag{1}$$

Where L is the distance traveled in metres, and T is the time of travel in seconds. This method was used in a straight reach of channel on a windless day so that the float can be maintained in the centre of the channel. Because velocity varies across the width and depth of flow in stream, coefficients must be applied to convert surface-float velocity to mean channel velocity. Velocity Correction factor 0.85 was used.

STEP 3 Calculation of the flow in cubic metres per second

The flow is the product of the average stream area and the average velocity of the flow. The difference between the surface velocity and the average stream velocity depends on the type of stream. The accuracy of the float method is limited because of the requirement for correction factors and the difficulty of measuring the cross-sectional area of many streams. The equation to calculate the flow is

$$Q = A_{ave} \times V_{surface} \times \text{Velocity Correction factor} \tag{2}$$

Where, Q = Flow rate (m^3/s), A_{ave} = Average cross-sectional area (m^2), $V_{surface}$ = Surface velocity (m/s)

RESULTS AND DISCUSSION

The product of the hydraulic components of the BBM comprises a series of relationship between discharge and, among other parameters, water depth, flow velocity, and water surface width. River profile cross-section data that was measured along the nine selected stations at downstream of Mula dam are shown in the Appendix C from which discharge for the particular stations are find out. The discharges of the selected downstream nine stations(BaragaonNandur, Rahuri Budruk, Rahuri Khurd, Deswandi, Aradgaon, Valan, Manori, Manjari and Panegaon) are 483.54, 223.02, 177.13, 60.08, 323.2, 110.48, 102.24, 10.89, 10.09 m^3/s, respectively. These shows unsteady flow in the downstream of Mula River. The hydraulics are the primary determinants of the availability of physical habitat which, in turn, is a major determinant of ecosystem functioning. Stage-discharge relationship developed for each cross-section. Graphical presentation of depth - area - discharge relation are shown in Figure 1, 2, 3, 4, 5, 6, 7, 8, and 9.

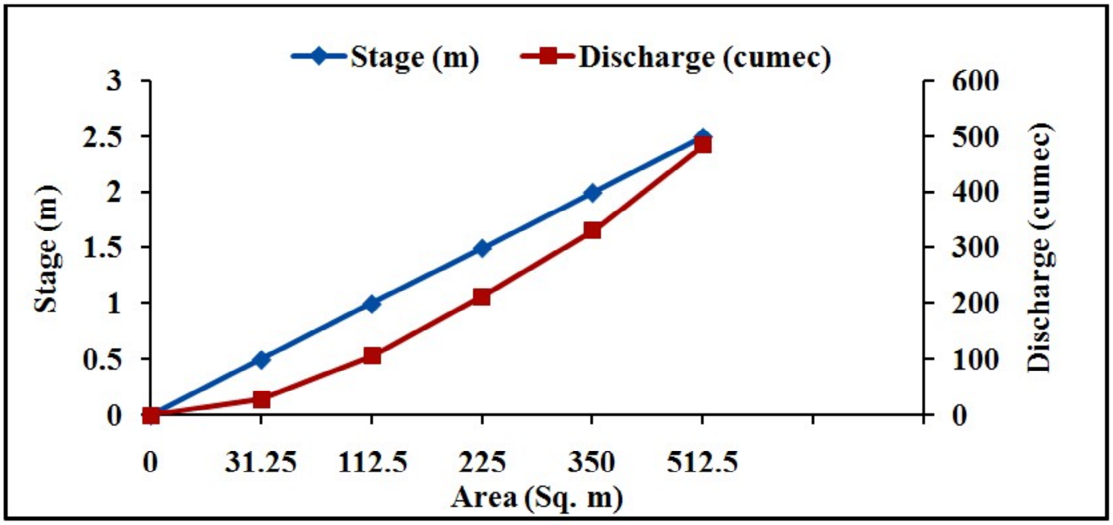

Figure 1: Graphical presentation of depth – area - discharge relation at Baragaon Nandur

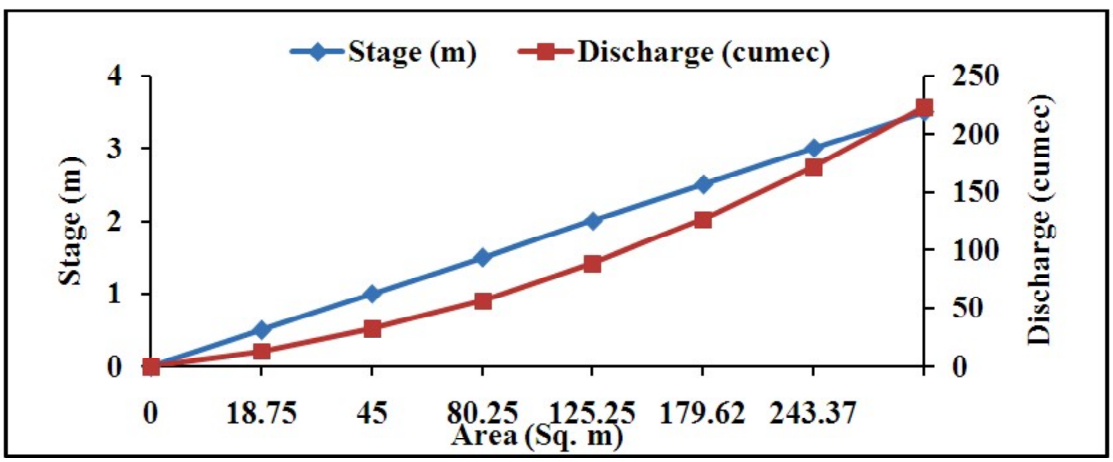

Figure 2: Graphical presentation of depth – area - discharge relation at Rahuri Budruk

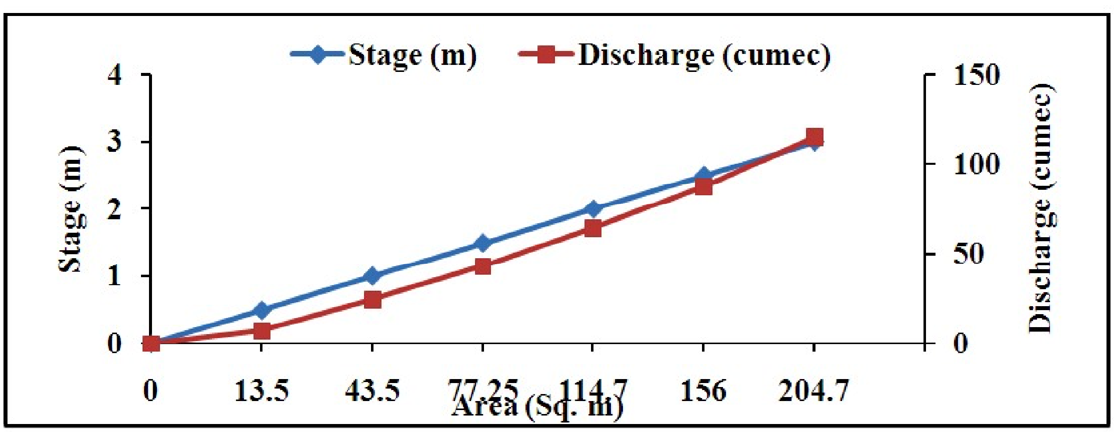

Figure 3: Graphical presentation of depth – area - discharge relation at Rahuri Khurd

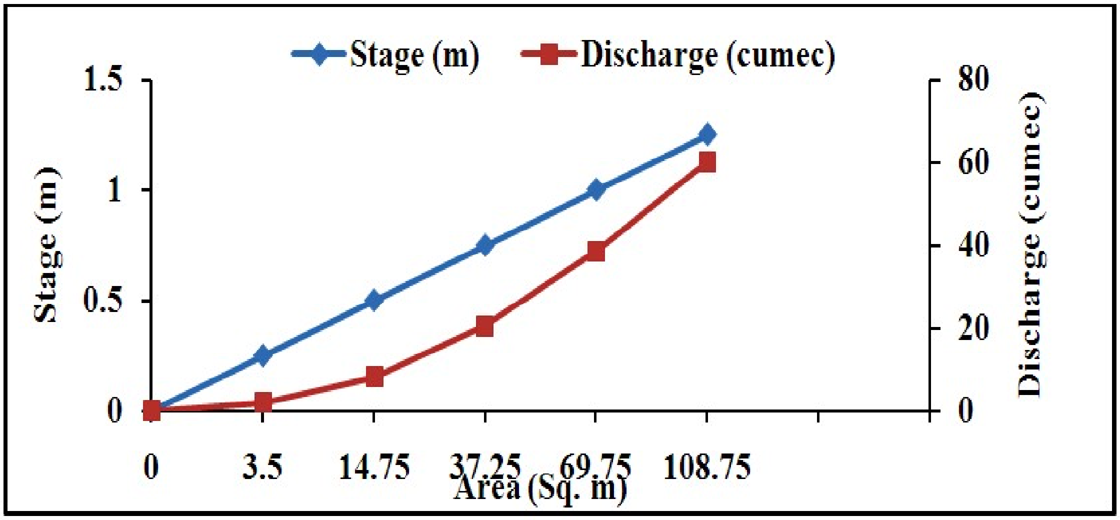

Figure 4: Graphical presentation of depth – area - discharge relation at Deswandi

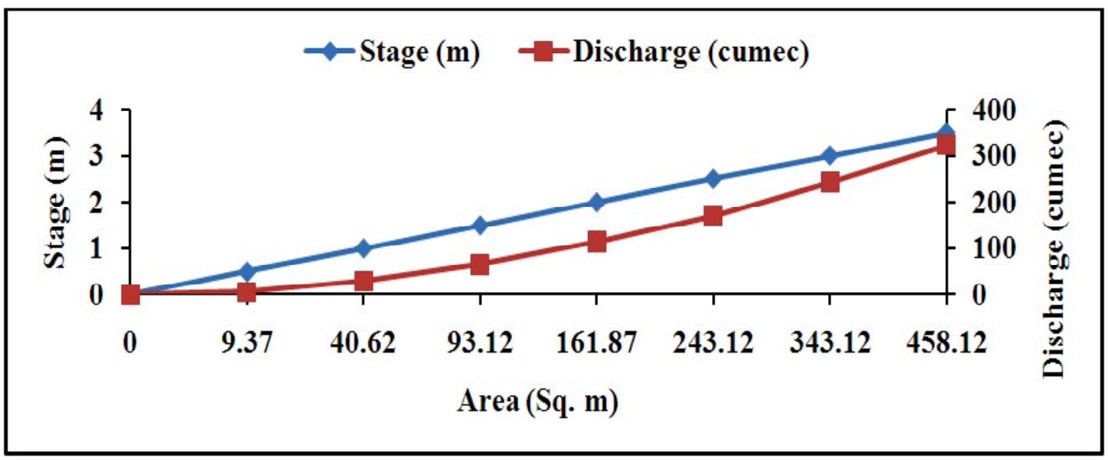

Figure 5: Graphical presentation of depth – area - discharge relation at Aradgaon

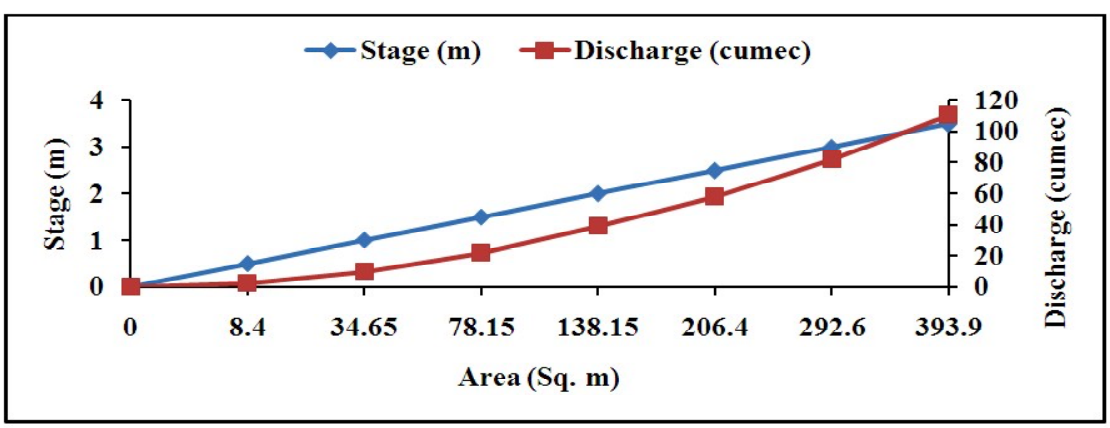

Figure 6: Graphical presentation of depth – area - discharge relation at Valan

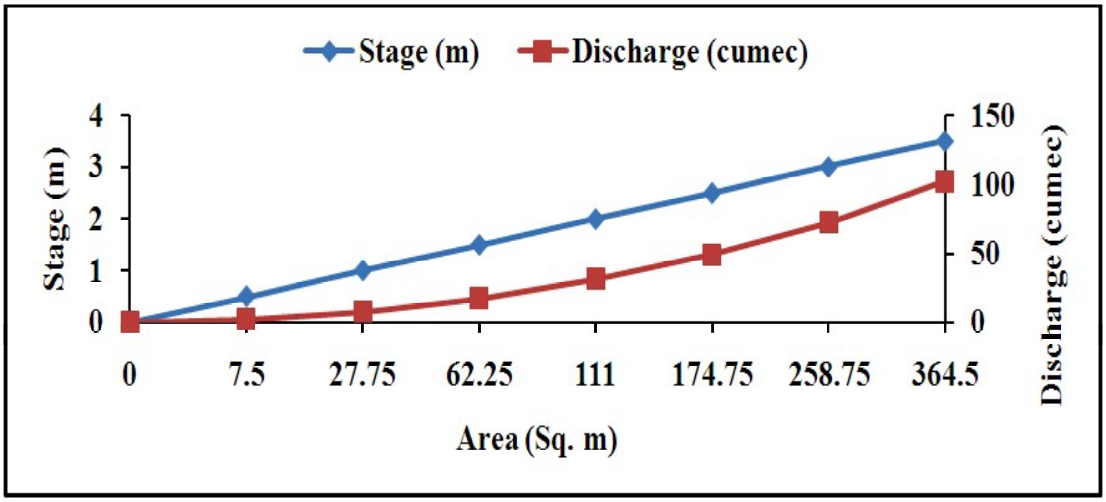

Figure 7: Graphical presentation of depth – area - discharge relation at Manori

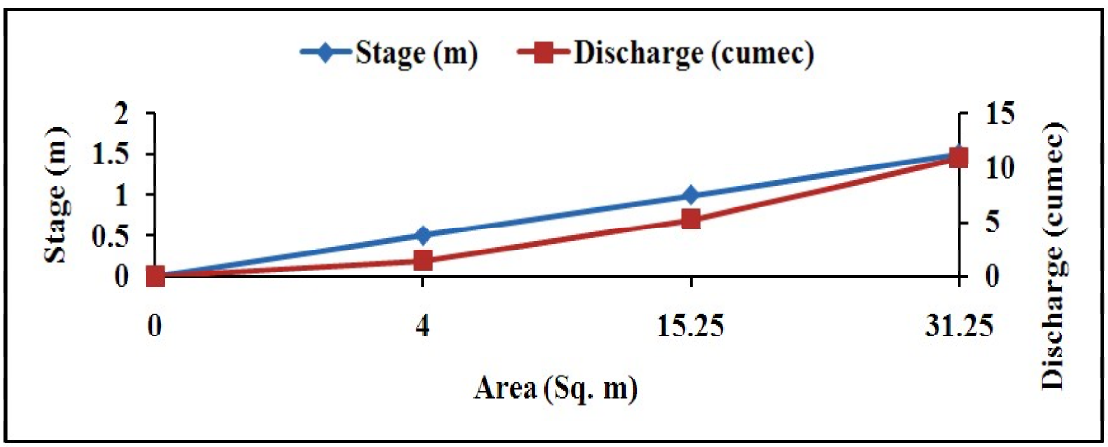

Figure 8: Graphical presentation of depth – area - discharge relation at Manjari

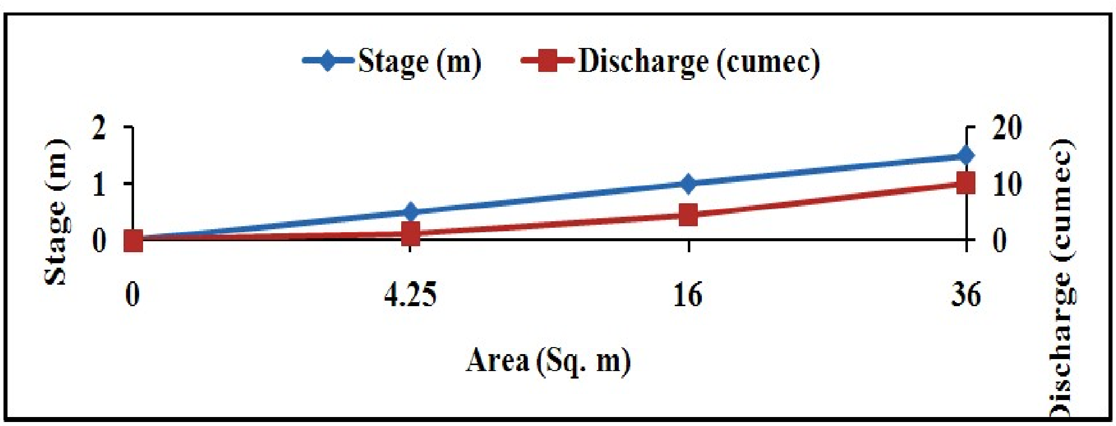

Figure 9: Graphical presentation of depth – area - discharge relation at Panegaon

SUMMARY AND CONCLUSION

In hydraulic criteria, the discharges of the selected downstream nine stations (Baragaon Nandur, Rahuri Budruk, Rahuri Khurd, Deswandi, Aradgaon, Valan, Manori, Manjari and Panegaon) are 483.54, 223.02, 177.13, 60.08, 323.2, 110.48, 102.24, 10.89, 10.09 m^3/s respectively. The trend of discharge from downstream stations at nine selected locations shows the unsteady flow along the Mula River.

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