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ENVIRONMENTAL FLOW ASSESSMENT FOR RIVER VALLEY PROJECTS

By

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Environmental Flow

- **(IUCN-2003) defines "E-Flows as the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated"**

- **Brisbane Declaration (2007) defines "E-Flows as the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems".**

- **Policy Paper for Implementation of E-flow (2017) defines "environmental flows are the acceptable flow regime required to maintain the river in desired environmental condition or predetermined state where there are competing water uses"**

Importance of Hydrological Regime

- All components of the hydrological regime have certain ecological significance
- High flows of different frequency are important for channel maintenance, bird breeding, wetland flooding and maintenance of riparian vegetation
- Moderate flows are critical for cycling of organic matter from river banks and for fish migration
- Low flows of different magnitudes are important for algae control, water quality maintenance and the use of the river by local people.

The National Water Policy (2012)

- **The National Water Policy (2012) recognized the ecological needs of riverine ecosystems. In the Preamble of the policy, it is stated that *"water is essential for sustenance of eco-system, and therefore, minimum ecological needs should be given due consideration"*.**

- **Clause 3.3 specifies that *"a portion of river flows should be kept aside to meet ecological needs ensuring that the low and high releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water uses*".**

Importance of E-flows

- **Expert Appraisal Committee (EAC) for River Valley and Hydroelectric Projects (MoEF&CC), examines the project (planning) reports and recommends the required E-Flows in the affected river reach**

- **The National Green Tribunal (NGT) order of August 2017 specified that for all rivers in the country a minimum 15 % to 20% of the average lean season flow of that river shall be maintained**

- **The Ganga E-Flows Notification of 2018 (amended in Sept 2019) is so far the strongest E-Flows implementation action, demanding and specifying the continuous release and monitoring of E-Flows from the Upper Ganga until the middle/lower reaches at Unnao, Uttar Pradesh**

Environmental Flow Assessment Methods

Hydrological Methods

- Tenant and Modified Tenant method
- Flow Duration Curve (FDC) Method
- Shifting FDC based on EMC Class

Hydraulic Methods

- Hydraulic rating Method
- Habitat Simulation Method

Holistic Methodologies

- Building Block Methodology (BBM)
- Downstream Response to Imposed Flow Transformation (DRIFT)

Hydraulic Methods

- Hydraulic rating cum Habitat simulation methods use the hydraulic conditions, which meet specific habitat requirements for biota, to determine flow requirements
- Hydraulic variables such as depth, velocity wetted area, top flow width are estimated using hydro-dynamic modelling for a representative river reach
- The representative river reach is represented by the surveyed cross sections taking at an interval of about 200 m
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- Hydraulic variable are correlated with the habitat parameters to quantify the E-flow

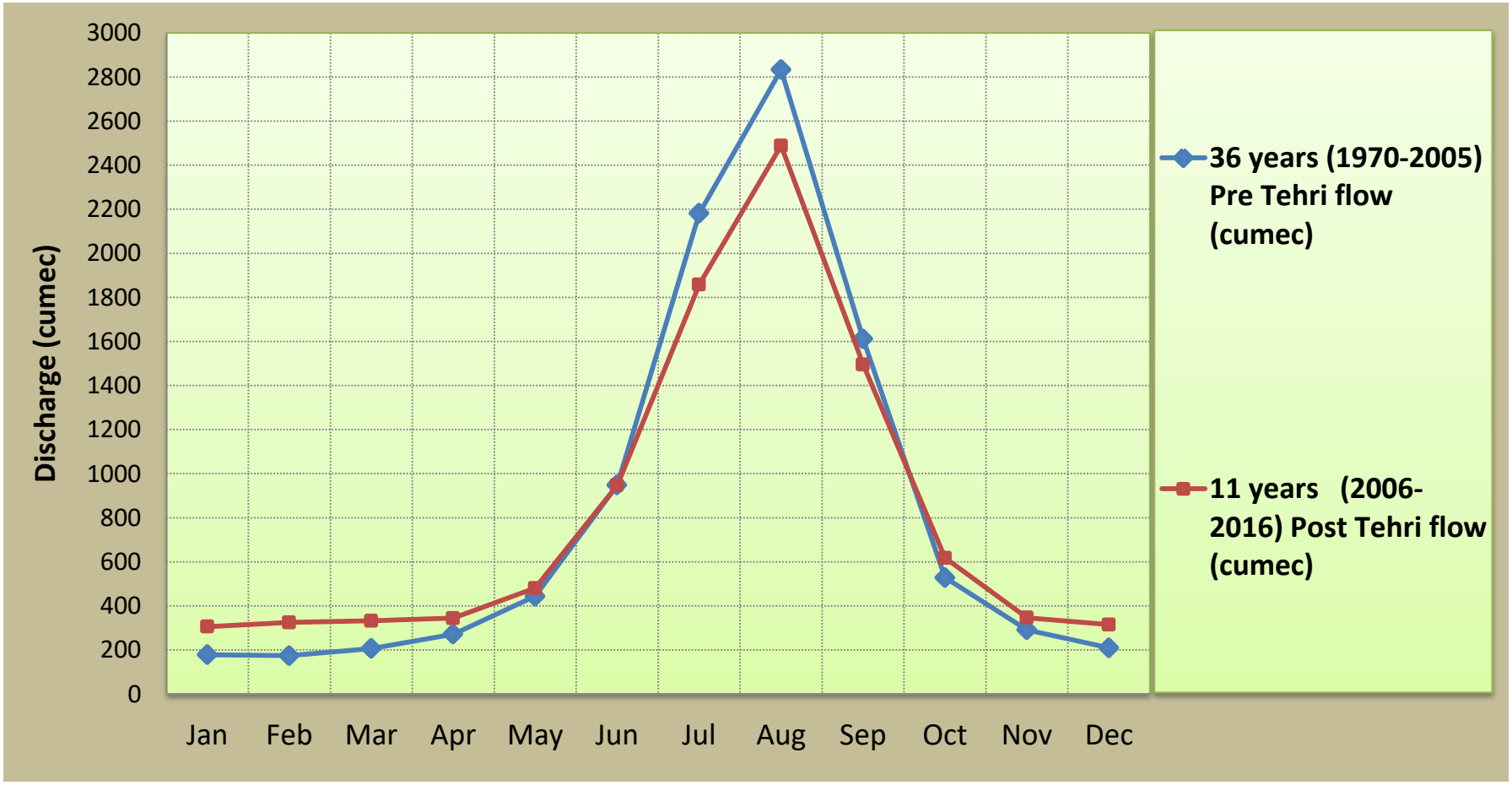
Environmental flow assessment for reach of river Ganga between Haridwar and Unnao

- Combination of hydraulic rating methodologies and habitat simulations has been used

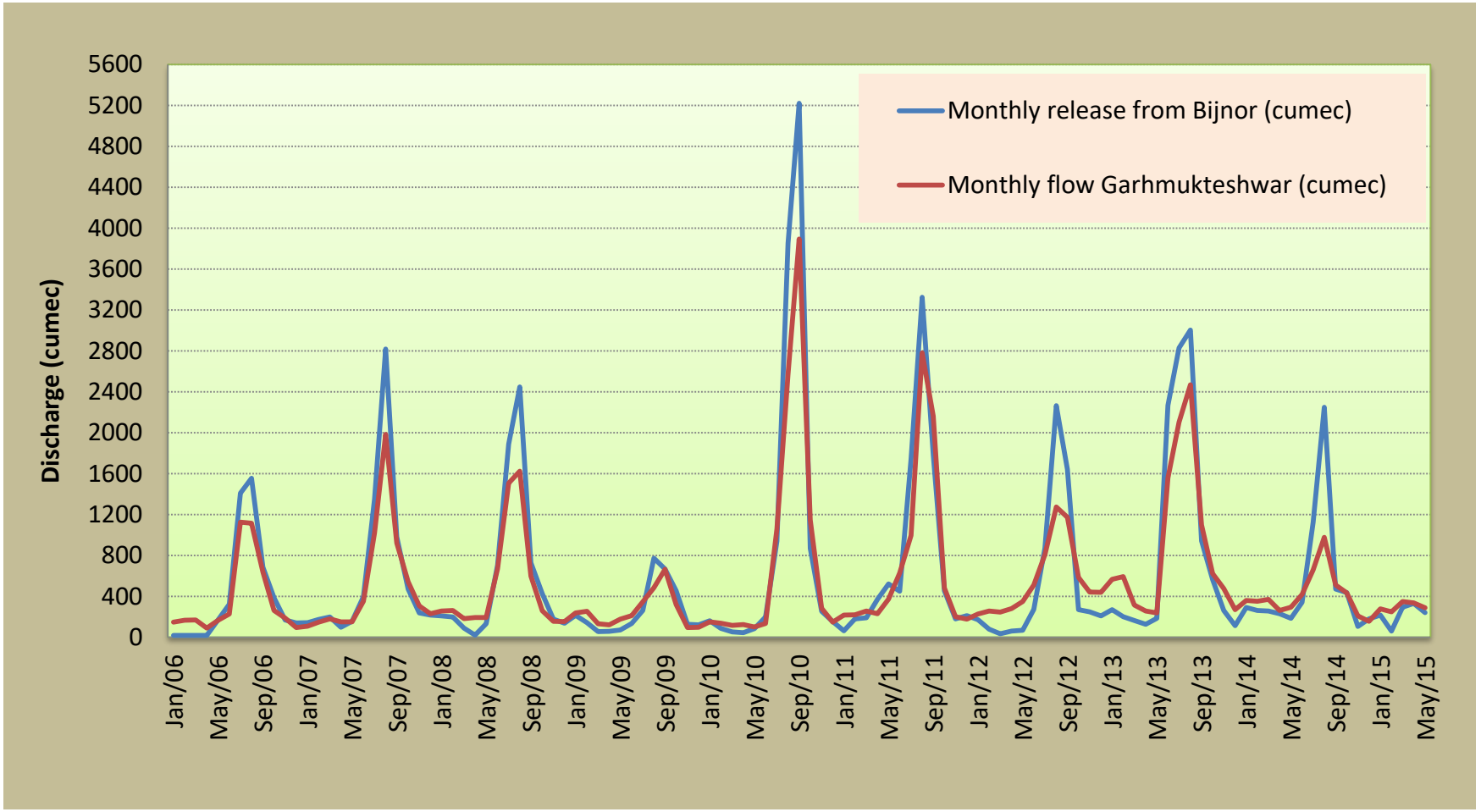
Data used

- 10 daily discharge data of river Ganga at Garhmukteshwar and Kachhlabridge G&D sites
- Inflow, diversion and release data at Bhimgoda, Bijnor and Narora barrages
- Command area of Upper, Middle and Lower Ganga Canals
- 4 to 5 cross sections of river Ganga at Garhmukteshwar, Kachhlabridge and Kanpur to represent a river reach of about 1 km at each location.

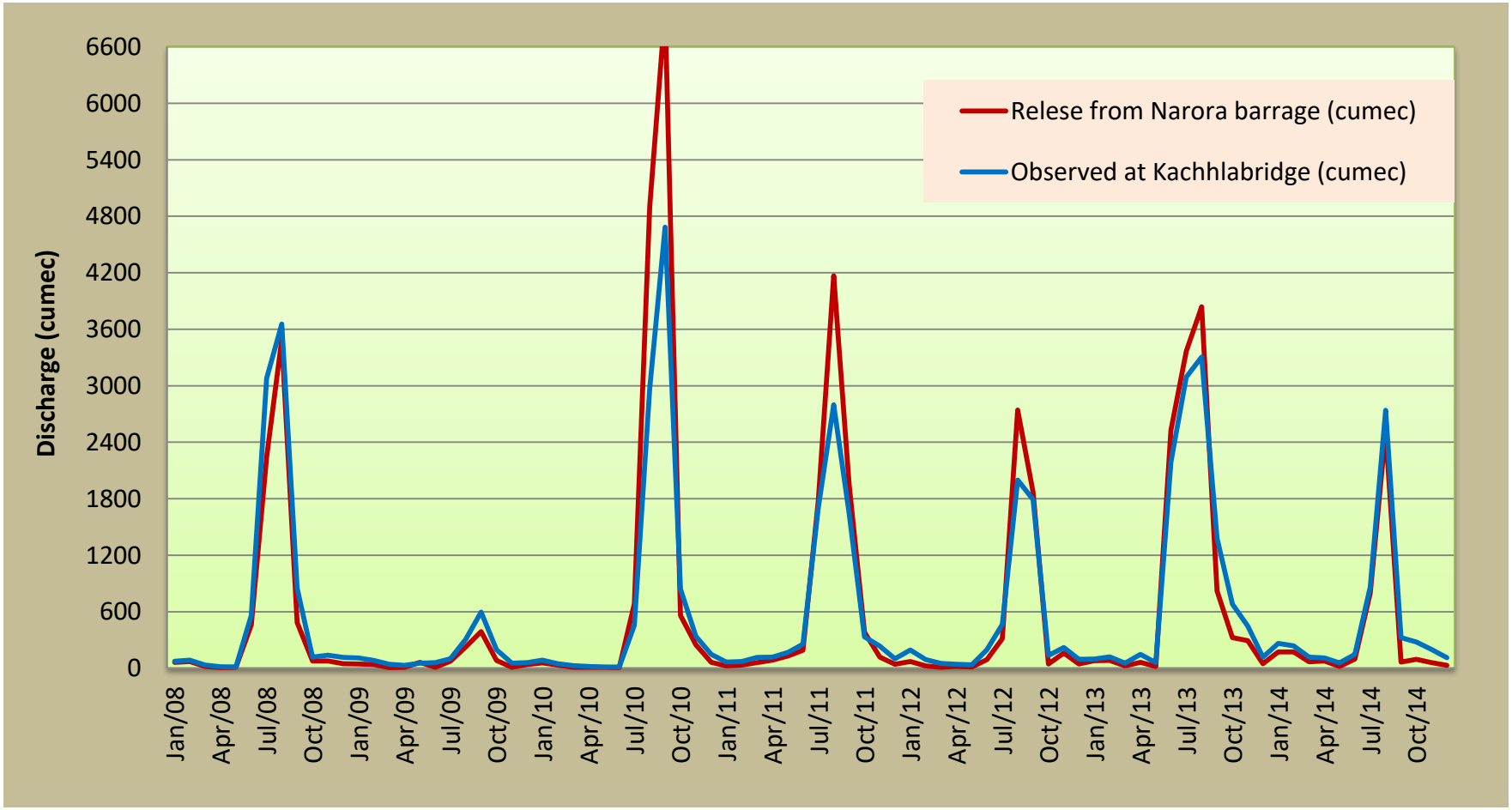
Flow pattern analysis at Haridwar – Pre and post Tehri scenario



Flow pattern analysis - Bijnor and Garhmukteshwar



Flow pattern analysis - Narora and Kachhlabridge



Findings of flow pattern analysis

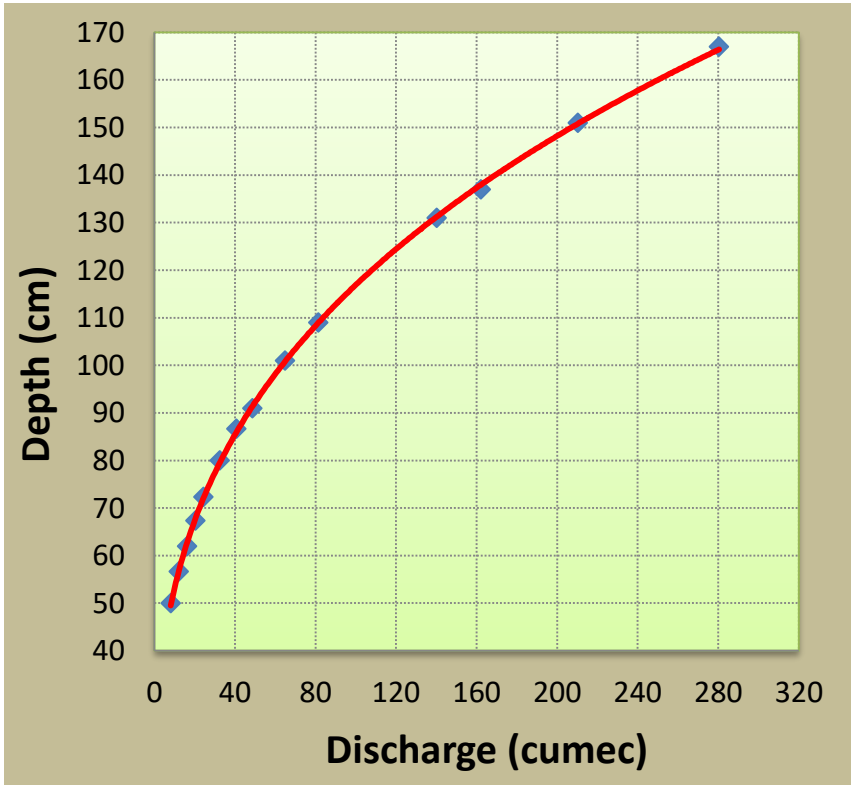
- From flow pattern analysis it was found that in general the reach of river Ganga between Haridwar and Kanpur is of effluent nature.
- In this reach of the river contribution to base flow during the lean months and return flow from the command are able to augment the lean season discharge in the river up to some extent

Habitat data provided by CIFRI

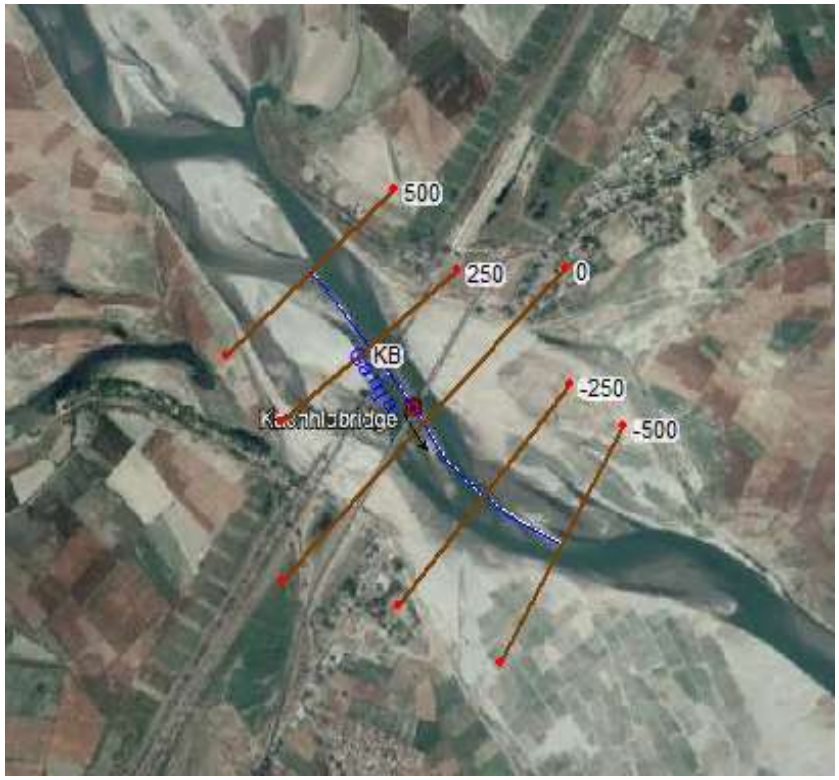
- **E-Flows assessments have been made for a depth requirement of 0.70 m during the non-monsoon months (Oct to May) and 0.90 m during the monsoon months (Jun to Sep)**
- **Flow parameters have been studied taking the representative river reach of 1 km at a few locations**

Species	Weight range	Depth (Lean period)	Velocity
Labeodyocheilus	30-800g	60-80 cm	0.8-1.5m/s
Labeodero	94-563g		
Cyprinuscarpio	120-563g		
Schizothoraxrichar-dsonii	80-500g		
Crossocheiluslatius			
Botialohachata	10-175g		
Bariliusbendelisis			
Tor putitora	30-800g		

Assessment of hydraulic parameters for different flow conditions



Discharge vs depth at Kachhlabridge



HEC-RAS model set up at Kachhlabridge

Simulated hydraulic parameter from model at KB

River Sta	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)
0	8.14	158.25	158.7	0.56	14.46	98.48
0	12.21	158.25	158.75	0.62	19.69	102.29
0	16.27	158.25	158.8	0.66	24.73	104.17
0	20.34	158.25	158.84	0.71	28.83	105.67
0	24.41	158.25	158.88	0.74	32.81	107.11
0	32.55	158.25	158.94	0.83	39.39	109.45
0	40.68	158.25	158.99	0.9	45.06	111.42
0	81.37	158.25	159.2	1.17	69.76	119.65
0	140.21	158.25	159.39	1.5	93.29	126.99
0	210.31	158.25	159.55	1.86	113.35	132.93
0	280.41	158.25	159.68	2.13	131.69	138.13
0	350.52	158.25	159.81	2.35	149.06	142.89
0	420.62	158.25	159.92	2.54	165.86	147.34
0	560.82	158.25	160.24	2.58	217.02	185.63
0	701.03	158.25	160.47	2.59	270.48	245.89
0	841.24	158.25	160.65	2.67	314.81	249.8

Estimated environmental flow

Barrage	E-Flow releases during non-monsoon (Oct-May)	E-Flow releases during monsoon (Jun-Sep)
	(cumec)	(cumec)
Bhimgoda	36	57
Bijnor	24	48
Narora	24	48
Kanpur	24	48

Conclusions

- There are several methods for environmental flow assessment.
- Hydraulic rating cum Habitat simulation methods use the hydraulic conditions, which meet specific habitat requirements for biota, to determine flow requirements. This method suits for hydrological regimes of Indian rivers.
- It is one of the scientific method which can be used for assessment of environmental flow releases from River Valley Projects.

Thank You