

Environmental Flows and its assessment for upper stretch of River Ganga: *A WWF initiative*



Environmental Flow

“The **flows pattern required** for the maintenance of the ecological integrity of rivers, their associated ecosystems and the goods & services provided by them”

Environmental Flows are increasingly recognised as a vital mean to ensuring the continuing provision of environmental goods and services upon which peoples’ **lives and livelihoods depend.**



Significance

E-Flows are required for –

1. maintaining river regimes
2. maintaining aquatic biodiversity
3. recharging groundwater
4. supporting livelihoods
5. preventing salinity
6. allowing the river to play its role in the cultural and spiritual lives of people



Environmental Flows Assessment

- Over 200 methodologies
- One of the most comprehensive and suitable methodology is the Building Block Methodology, because:
 - Bottom up approach
 - Much detailed and can be tailored to suit local conditions
 - Most frequently used holistic methodology
 - Rigorous and well documented



**Initial Training Workshop
Delhi, November 2008**

Work in Progress

**Appointment
of specialists**

**Objective Setting and Methodology
Development Workshops
December 2008 and February 2009**

**Information
Review**

**International Conference on
“Environmental Flow Requirements of Himalayan Rivers”
Organised by SWaRA, GoUP and WWF-India
Lucknow, July 2009**

Fieldwork

**EFA Progress Workshop
Delhi, November 2009**

**Specialist
Reports**

**EF Setting Workshop
Rishikesh, May 2010**



Environmental Flows Assessment – Partners

Fluvial Geomorphology: Prof. Rajiv Sinha, IIT Kanpur and Dr. Vikrant Jain

Water Quality: Prof. Vinod Tare, IIT Kanpur

Hydraulics: Prof. A K Gosain, IIT Delhi & Dr. S. Rao, **INRM**

Hydrology: Dr. Vladimir Smakhtin and Dr. Luna Bharati, **IWMI**

Facilitation: Prof. Jay O’Keeffe, UNESCO-IHE, Netherlands

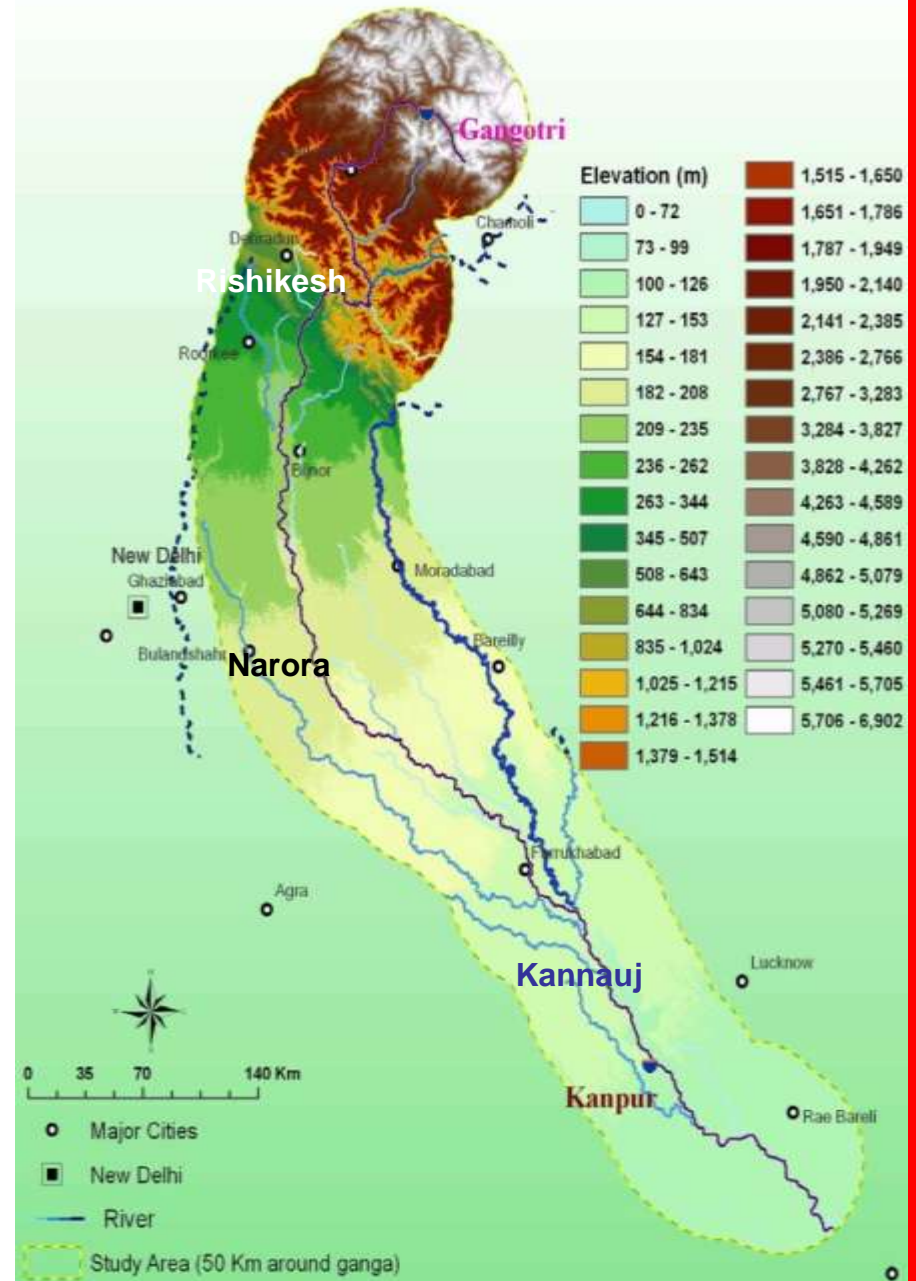
Biodiversity Prof. Prakash Nautiyal, Srinagar Garhwal University

Cultural-Spiritual: Dr. Ravi Chopra, People’s Science Institute, Dehradun

Livelihoods: Dr. Murali Prasad, IIT Kanpur

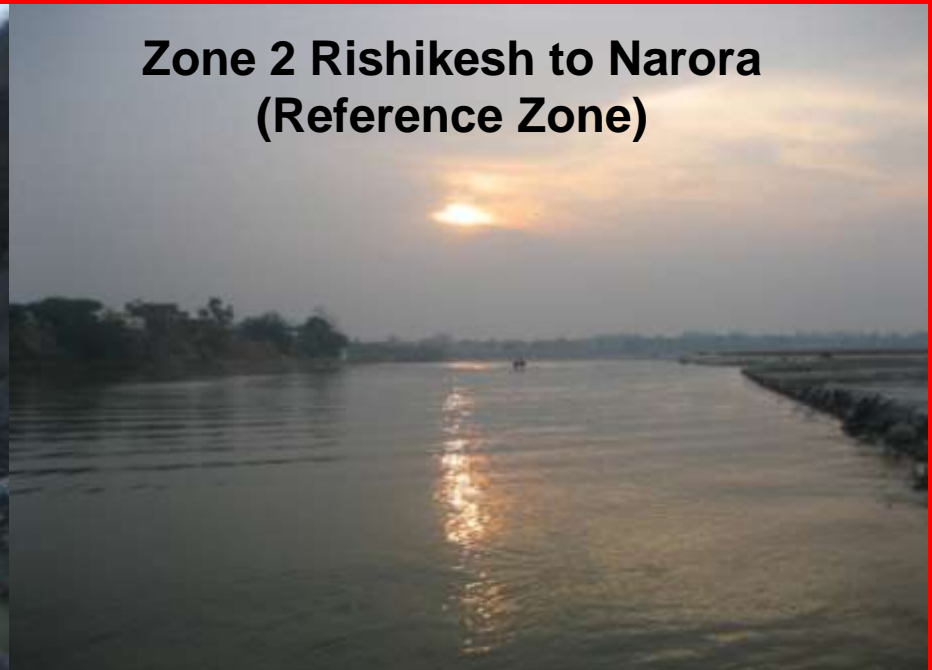


- **Zone I: Upper Reach (Gangotri to Rishikesh)**
- **Zone II: Reference zone (Rishikesh to Narora)**
- **Zone III: Middle Reach (Narora to Farrukhabad)**
- **Zone IV: Lower Reach (Kannauj to Kanpur)**





**Zone 1
Gangotri to
Rishikesh**



**Zone 2 Rishikesh to Narora
(Reference Zone)**



**Zone 3
Narora to
Farrukhabad**



**Zone 4
Kannauj to
Kanpur**

Objectives:

Overall: to promote the sustainable use of water resources in the Ganga

- Maintain sacred values
- Ecological integrity
- Provide livelihoods



Flow Indicators:

Fish, Dolphins,
Invertebrates, Algae,
Religious aspirations,
Livelihoods,
Channel processes



Habitats
Activities
Processes

Required



Hydraulics:

Depth
Velocity
Width
Substrate

Hydrology:
Cubic metres
per second of
water
required



Key components of the study

- Hydrology and hydraulics
- Fluvial geomorphology
- Biodiversity
- Livelihoods
- Cultural and spiritual
- Water quality



Process to arrive at recommendations

5-day Flows Setting Workshop

- The workshop began with a field visit to one of the site. Where,
 - the **Hydrology Group** provided a summary of flow characteristics and how they have changed over time.
 - **Hydraulics Group** pointed out the positions of cross-sections and described the hydraulic characteristics.
 - The **water quality, fluvial-geomorphology, biodiversity, livelihood & cultural expert groups** provided an overview of the aspects of interest at the site-Indicators, habitats, uses, seasonal changes, major issues, reference conditions, present conditions, objectives.



- After detailed discussion, 'January' as driest month and 'August' as wettest month.
- The **Cross-sections** of each of the sites were explained by the Hydraulics Group, so that other experts can work on and derive the figures related to Flows, Average Velocity and Depth etc.
- **Flow Motivations Forms** were filled by each of the Expert for each of the identified site i.e. **Kaudiyala, Kachla and Bithoor**.
- The baseline data collected by each of the Expert Group was used to come out with specific motivations while recommending figures related to **Flows, Average Velocity and Depth etc.**



Filling of FLOW MOTIVATION FORMS

Each recommended flow motivated in terms of:

- Fluvial Geomorphology
- Biodiversity
- Livelihoods
- Culture/Spiritual
- Water Quality

FLOW MOTIVATION FORMS

River: Ganga **Date:** 11-05-10 **Site:** Kaudiyala **Specialist:** Geomorphology

Month: Aug **Low flow or flood?** Wet season (Normal Year)

Discharge: 1494 cumec **Depth:** 16.37 m **Average velocity:** 0.91 m/s

Reasons for recommending this flow:

Lateral connectivity should be established at least once in a year, hence the lateral bars should be submerged. Also, the water should touch the banks so that the riparian zones including the riparian vegetation get inundated.

However, much high flows are not desirable as it may erode the bars which will modify the channel morphology.

Compared to low flow, the recommended flow represents an increase of 3.7 times increase in discharge, 2 times increase in width and 1.5 times increase in hydraulic radius. This approximately increases the unit stream power by an amount of 2.5 times. Such variability is acceptable for the functioning of the river ecosystem.

Consequences of not providing this flow:

Absence of lateral connectivity will affect the biodiversity. Further, much higher flow may destroy the bars and permanently change the channel morphology. In addition, high values will increase the total amount of variability into the system in terms of hydrology and would be manifested in morphological changes. The observations are validated by large platform changes in the river system around Kaudiyala over 10 period of study (Please refer to the Starter Document)



Maintenance Flows

The **Maintenance Flows** are for "normal" years, not very wet or not very dry, here one would expect all the **ecological functions and processes**:

- ✓ fish breeding
- ✓ inverts emerging
- ✓ floodplain wetlands full
- ✓ sediment transport etc.

Maintenance Flows would be equaled or exceeded during 70 years out of 100; however flows would be lower for 30 years out of 100 or in other words, 70% probability on the flow duration curve.

So, for a **long-term E-Flow**, the water volume required would be at maintenance recommendations or higher for 70% of the time, and between drought and maintenance for 30% of the time.

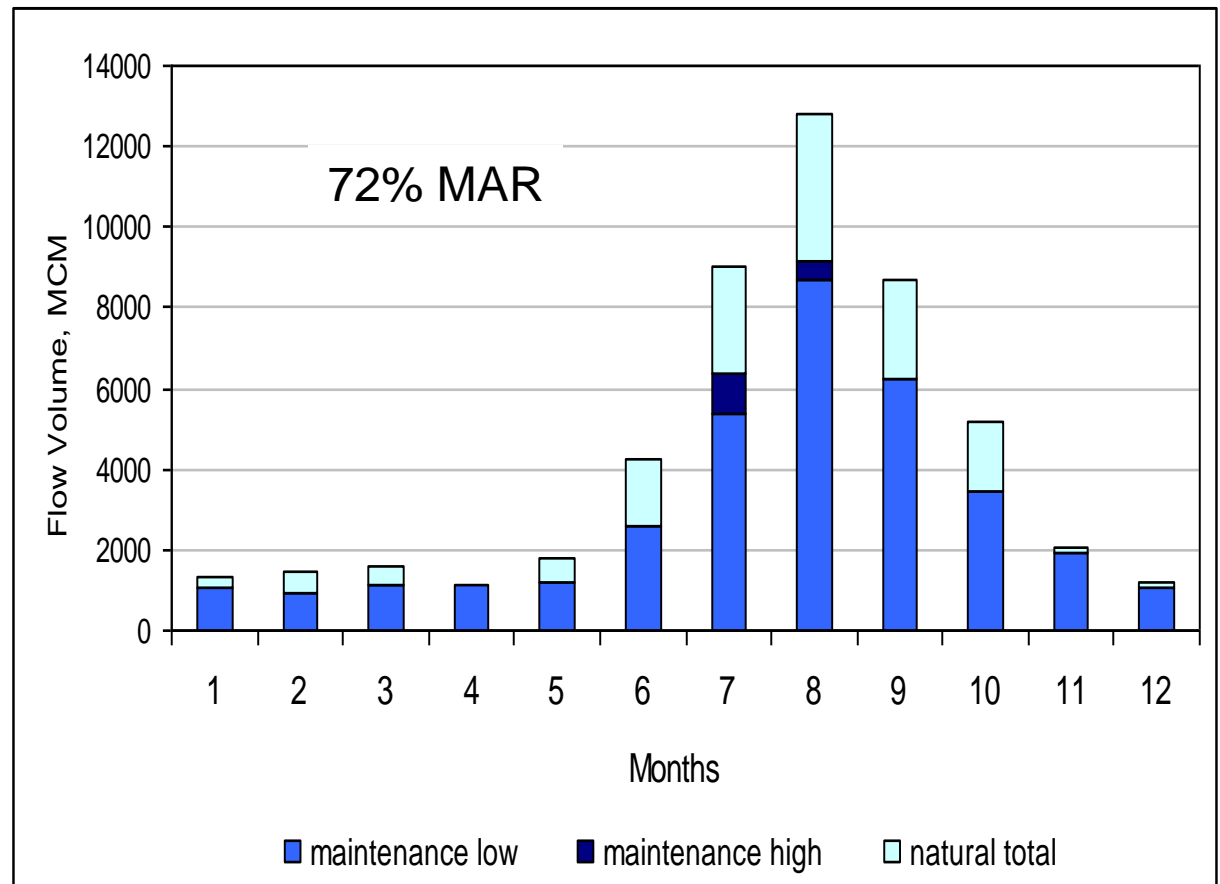


Results: Zone 1, Maintenance Flows

Site EF1 -Kaudiala

The E-Flows requirements were calculated as **72% of Mean Annual Runoff (MAR)**.

While estimating the flow requirements for this zone, the present day flows were not calculated, as flow release data from the Tehri Dam was not available.

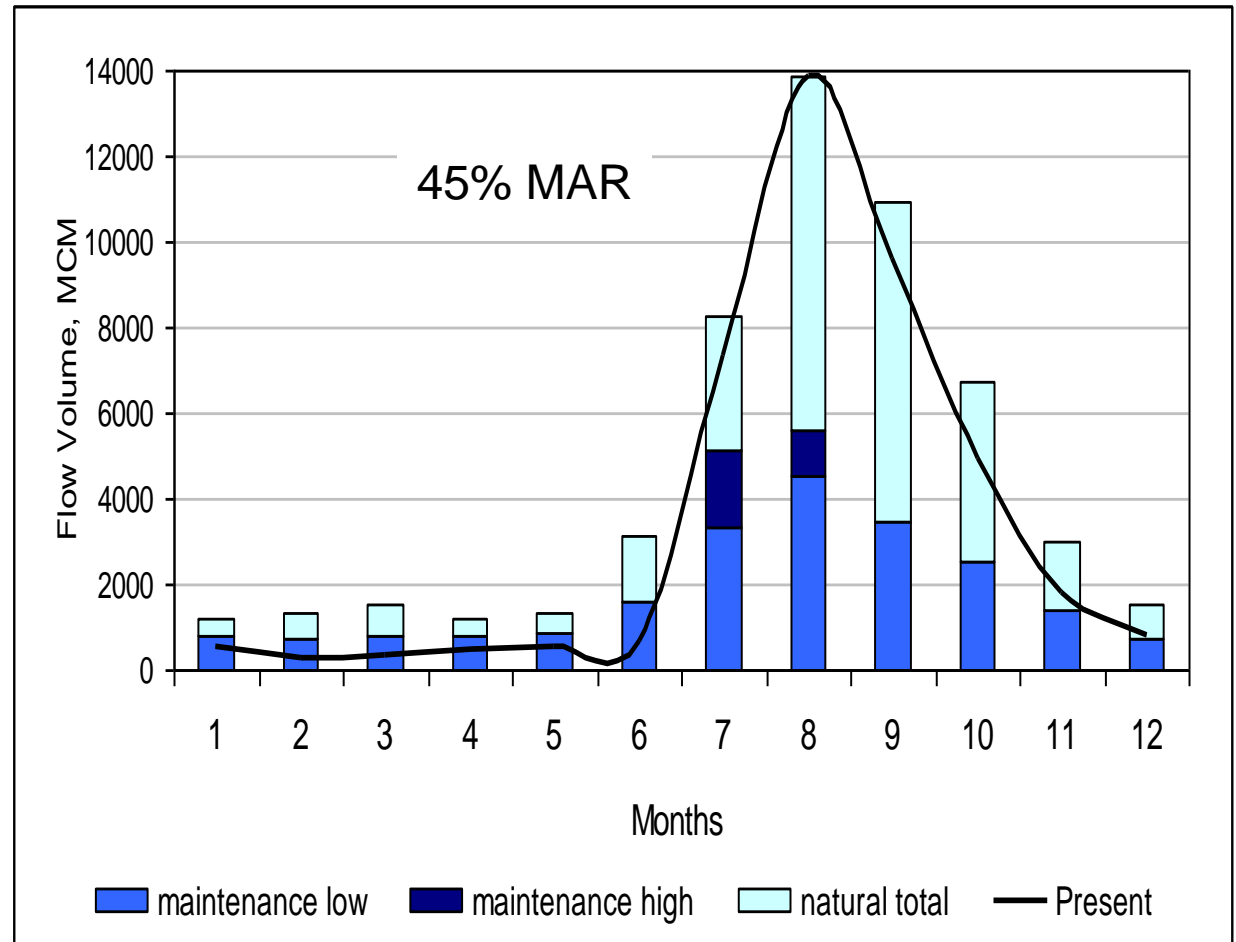


Results-Zone 3: Narora–Farrukhabad Maintenance Flows

Site EF3 –Kachla Bridge

The E-Flows requirements were calculated as **45% of MAR**. The figure also presents the Naturalized Flows as well as simulated present day flows.

The present day flows fulfill E-Flows requirements for August but are lower in all the other months and are critical especially in the summer months (Feb-May).

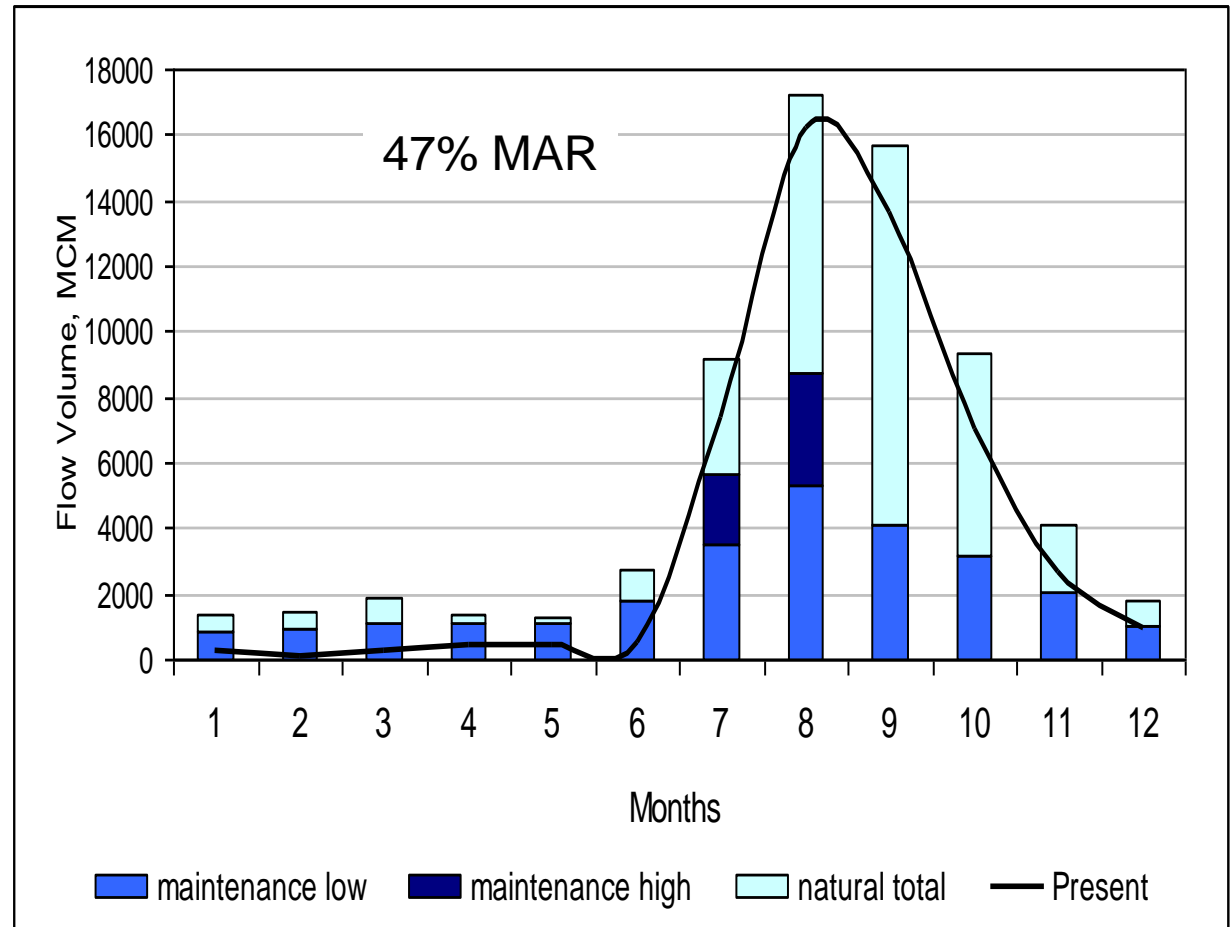


Results - Zone 4: Kanauj- Kanpur Maintenance Flows

Site EF4 – Bithur

The E-Flows requirements were calculated as **47% of MAR**. The figure also presents the Naturalized Flows as well as simulated present day flows.

The present day flows are lower than the E-Flows requirements for all twelve months.



Further Information Requirements

- One of the products of a preliminary assessment such as this is to **identify areas** where further information is required to increase the confidence of the flow recommendations
- This is an **adaptive process**, in which the management of the river can be constantly improved by monitoring and refinement of the initial flow assessment



Further Information Requirements

- Access to the extensive long-term observed hydrological data would considerably **increase the confidence** in the environmental flow assessment. **Without access to observed data, there is no reliable way** of assessing flows
- **Further calibration and verification** of the existing rated cross-sections, and the establishment of additional cross-sections, would also **increase confidence** in the flow **recommendations**
- Relationships between **indicator fish, invertebrates** etc. and flow would allow more precise flow recommendations





Thank You



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Sub-Components of the study

1. Hydrology

- Identify and review previous hydrological modeling studies and assessment of their usability
- To set up model and calibrate under existing conditions of land and water use
- Examine the feasibility of different ways of modeling the past 'natural' and present-day flows, using observed flow data



2. Fluvial Geomorphology and hydraulic modeling

- Analysis of sediments in the river, and the assessment of the effects that will result from different flow regimes
- Analyse the channel and floodplain morphology in terms of the geomorphic features, and their stability
- Generate the cross section and longitudinal profile for hydraulic modeling

3. Establishing the habitat preferences of selected Aquatic species

- Assess present condition in terms of the difference between the reference condition and survey results
- Describe measured depths, average velocities and substratum types most commonly associated with sensitive species and families, and/or with maximum biodiversity



4. Economic and Livelihood objectives and Assessment of Cultural & Spiritual in stream flow required

- Evaluate livelihood activities and its implications on environmental flows of the river
- Representation of the river in mythology, folklore, folk art and popular literature and art
- Historical evidence of civilizations along the river, and its influence on society
- Cultural, Religious, spiritual importance of the Ganga, with special focus on rituals and festivals that are linked to the river

5. Collation of Water Quality and Pollution Data

- Generation of data on certain water quality parameters that is not likely to be available from any sources and considered essential by the water quality group. This was done by collecting samples in all three seasons at thirty locations
- assessment of various types of pollution loads in different stretches/sub-stretches

