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

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Presentation covers

- **Introduction about WWF-India**
- **Initiative under the Living Ganga Programme**
- **Environmental Flows and its Assessment**
- **Future activities and trajectory**
- **Environmental Flows and its status in Indian context**

Overview of WWF India

WWF India is largest nature conservation organization in India

Focus on -

- Freshwater and Wetlands
- Sustainable Livelihoods
- Species
- Forests
- Climate change and energy

Supported by-

- Centre for Environmental Law
- Centre for GIS & IT
- Environmental Education

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HSBC – WWF India Programme

VISION

Sustainable energy and water resources management within the Ganga Basin in the face of climate change.

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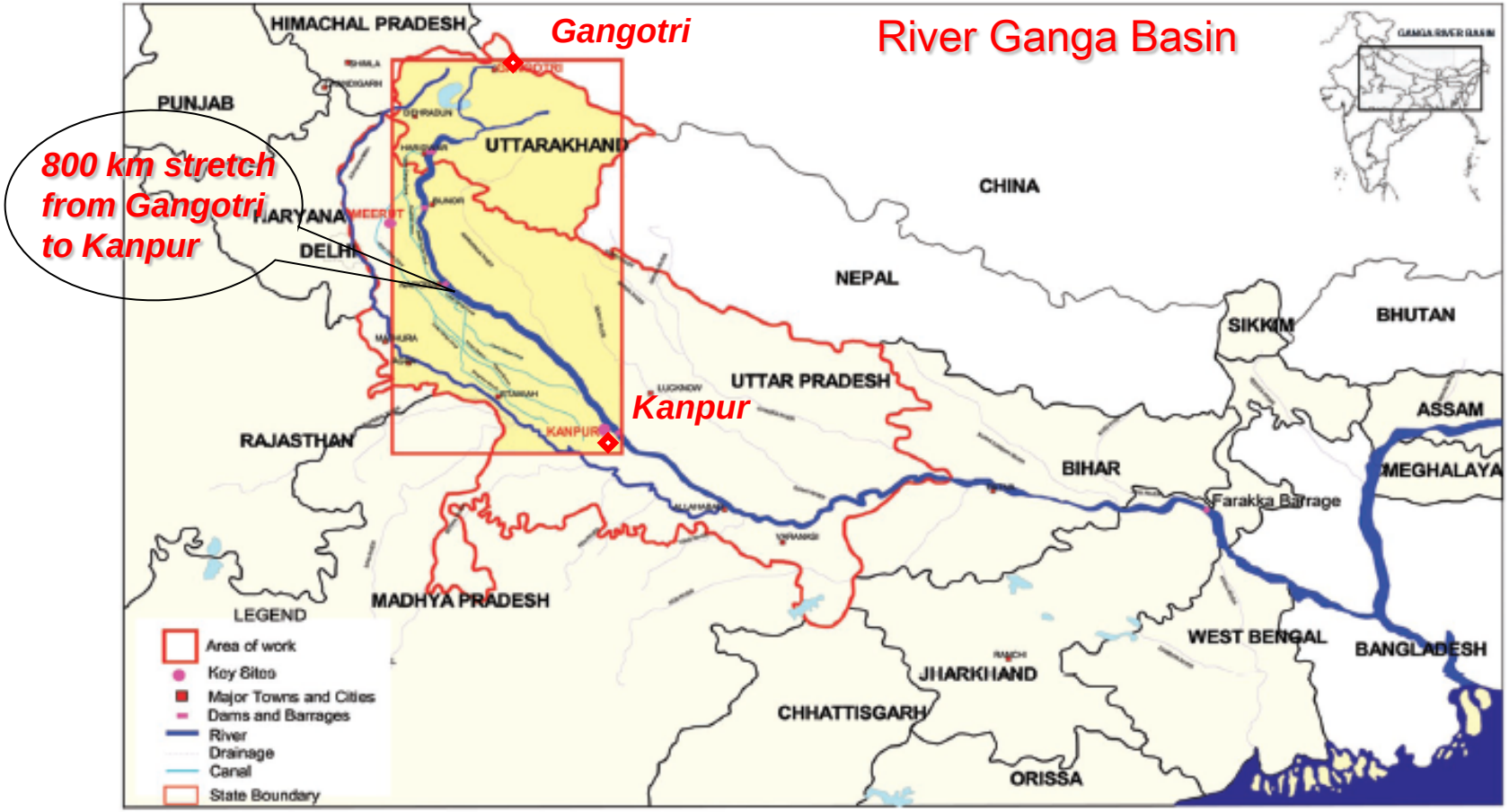
Living Ganga Programme : Scope & Focus



To establish a framework for sustainable energy and water resources management, in a critical stretch and key sites in the Ganga basin

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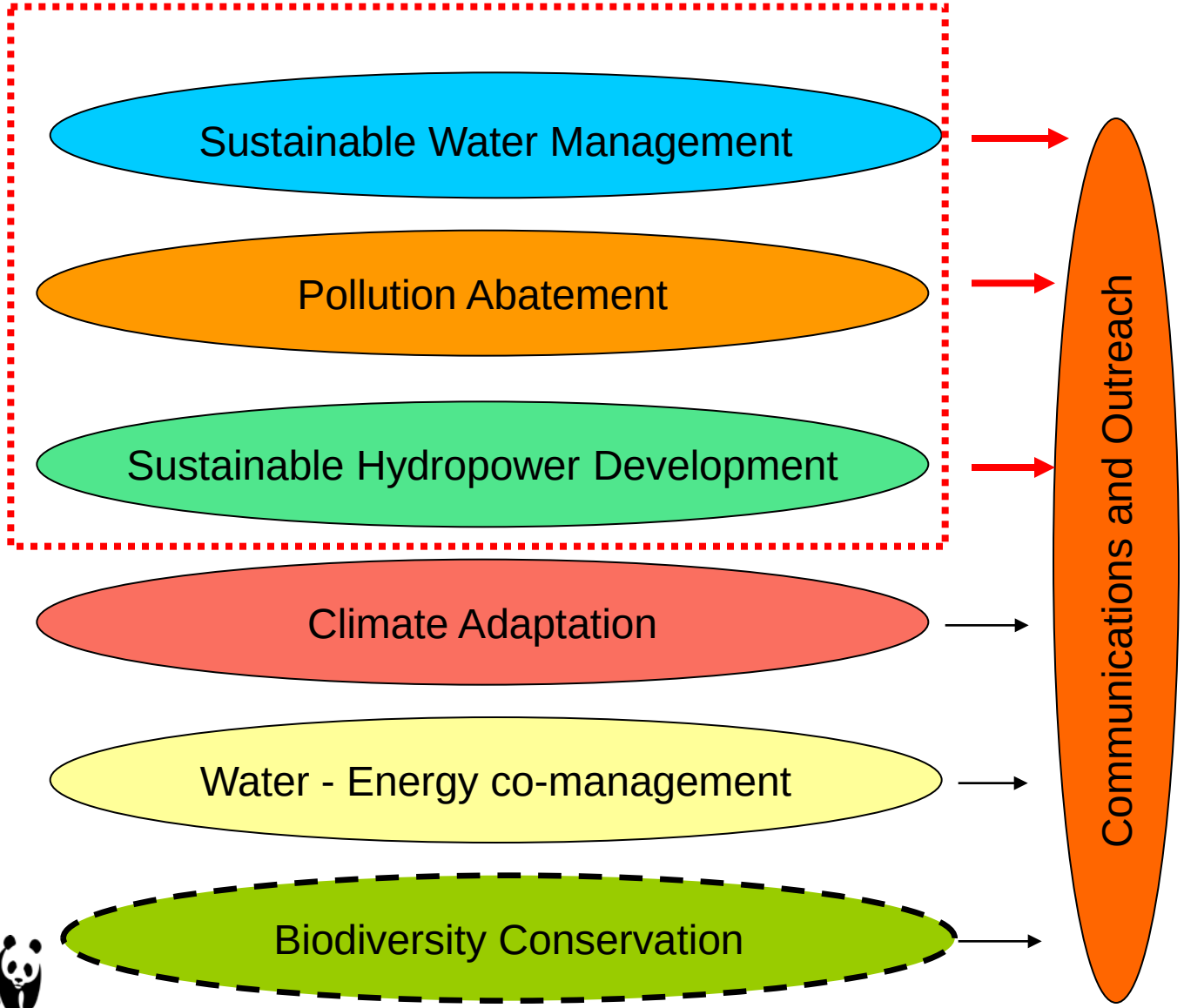
Programme Components



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The issue of water abstraction

- **Globally, many freshwater ecosystems are suffering from significant over abstraction**
- **Some of the world's major rivers are now completely dry for stretches and periods of time**
- **Most Indian rivers are highly degraded and regulated with over-extraction of water posing a threat to many river basins**
- **Nearly 60% of the waters of the Ganga are diverted for irrigation by the time it enters the plains leading to:**
  - Reduction in surface water
  - Increased dependence on ground water and depletion of aquifers
  - Loss of water-based livelihoods
  - Destruction of habitat of over 100 fish species

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Ganga River Basin

- Total length of river 2525 kms
- Basin falls in 11 states
- 43% of India's population resides (2001 census)
- Population density is 520 person/km^2, whereas national average is 312 persons/km^2
- 60% of water is allocated to irrigation
- Faces significant industrial pollution (Kanpur, Varanasi etc.)
- Immense pertinence in terms of cultural and spiritual aspects

Managing Water Stress

When such water stress is reached, a new approach to water management within the catchment is required.

• Rather than an engineering approach, these approaches seek to restore river flow through a multi-disciplinary process of managing water withdrawal.

• Effective water allocation mechanisms need to be developed that manage the use of the scarce resource.

• Ways need to be found to allocate water between competing needs within a catchment, while sufficient water is retained to ensure the continuation of ecosystem functions.

Environmental Flow

"The flows 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. So its really about using water resources fairly.

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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

Principles of Building Block Methodology

- Water can be used from rivers without unacceptably degrading them
- Set pre-defined objectives for the environmental condition of the river
- Assess a modified flow regime that will meet those objectives
- Identify the critical components (building blocks) of the flow regime that govern environmental conditions

Work in Progress

Initial Training Workshop
Delhi, November 2008

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

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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

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Objectives:

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

- Maintain sacred values

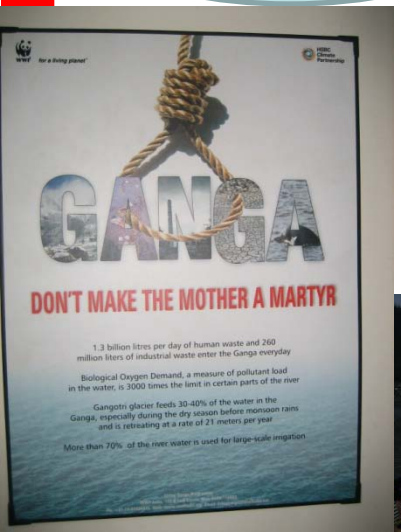
- Ecological integrity

- 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

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

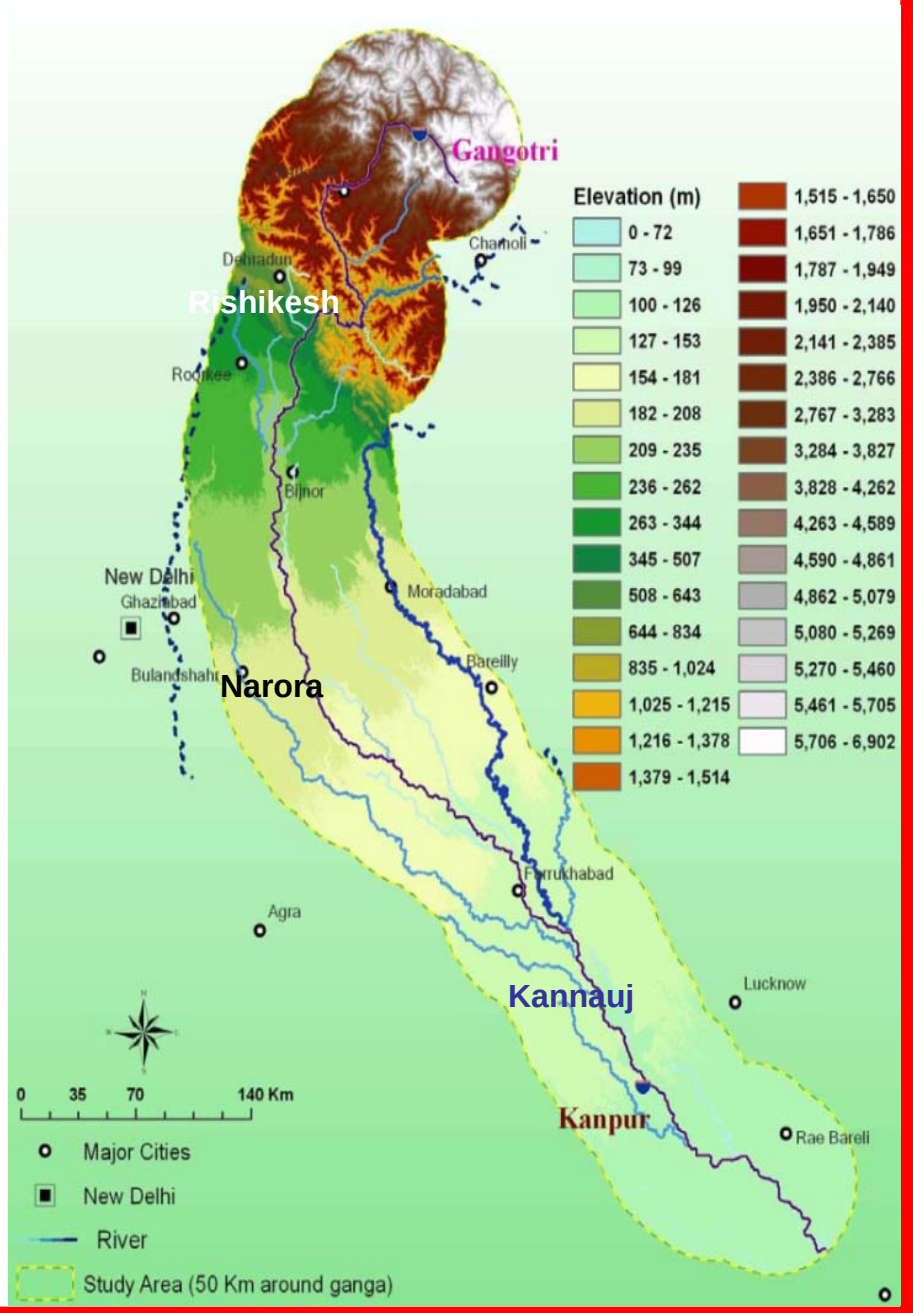
4. Economic and Livelihood objectives and Assessment of Cultural & Spiritual in stream flow required

   - 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

- **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 (Kannuaj to Kanpur)**



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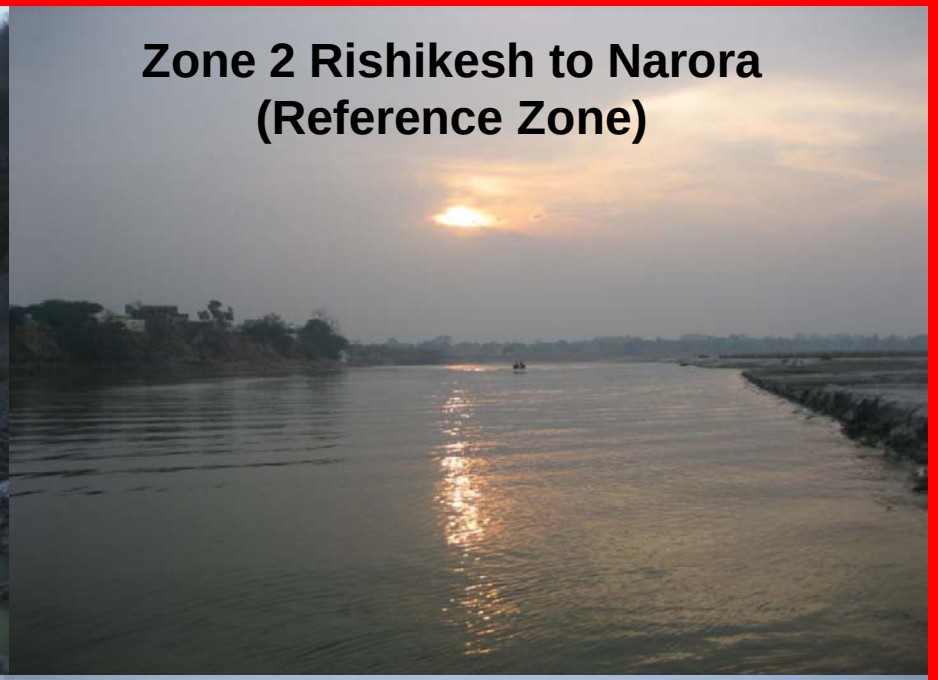
Zone 1
Gangotri to
Rishikesh


Zone 2 Rishikesh to Narora
(Reference Zone)


Zone 3
Narora to
Farrukhabad


Zone 4
Kannauj to
Kanpur

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 be large planform 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.

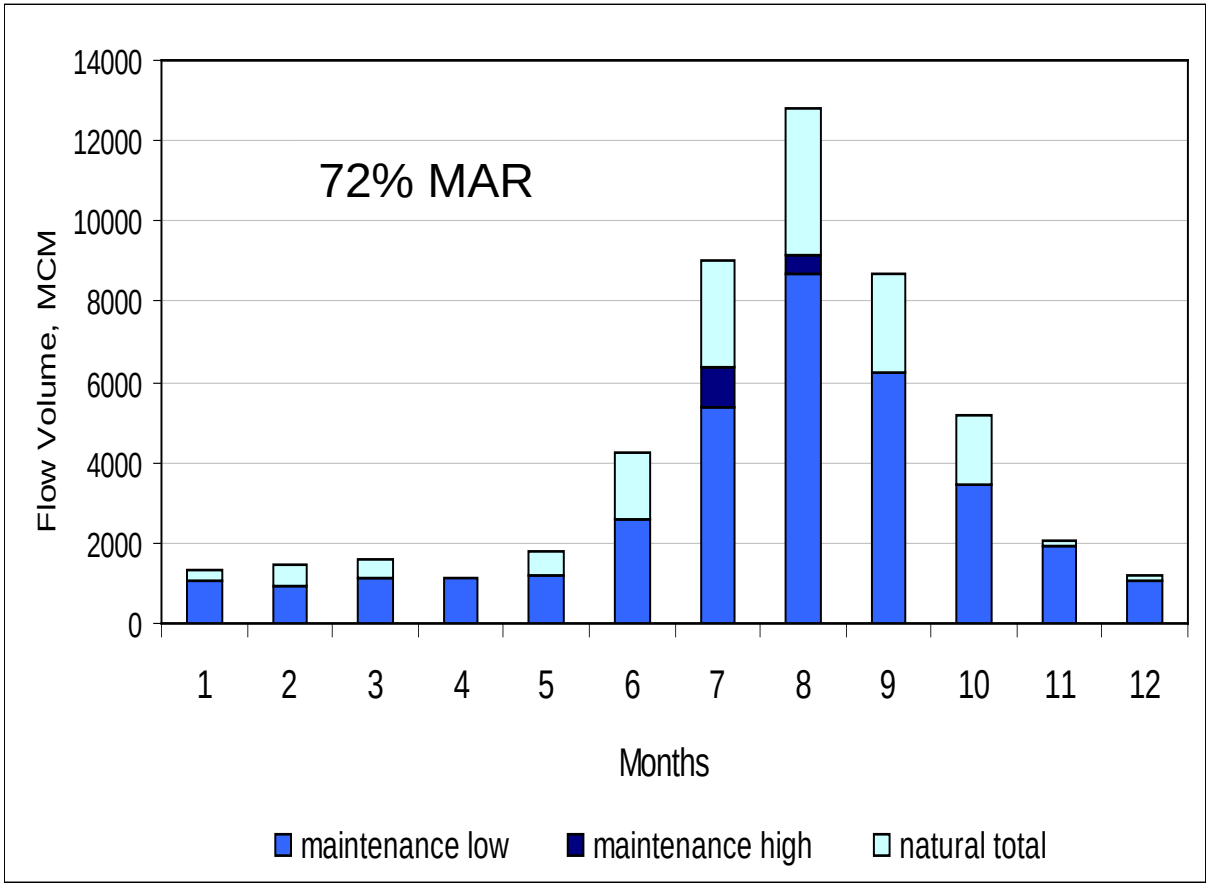
So, for a long-term E-Flow, the water volume required would be at maintenance recommendations or higher for 70% of the time, and between drought and maintenance for 30% of the time.

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.



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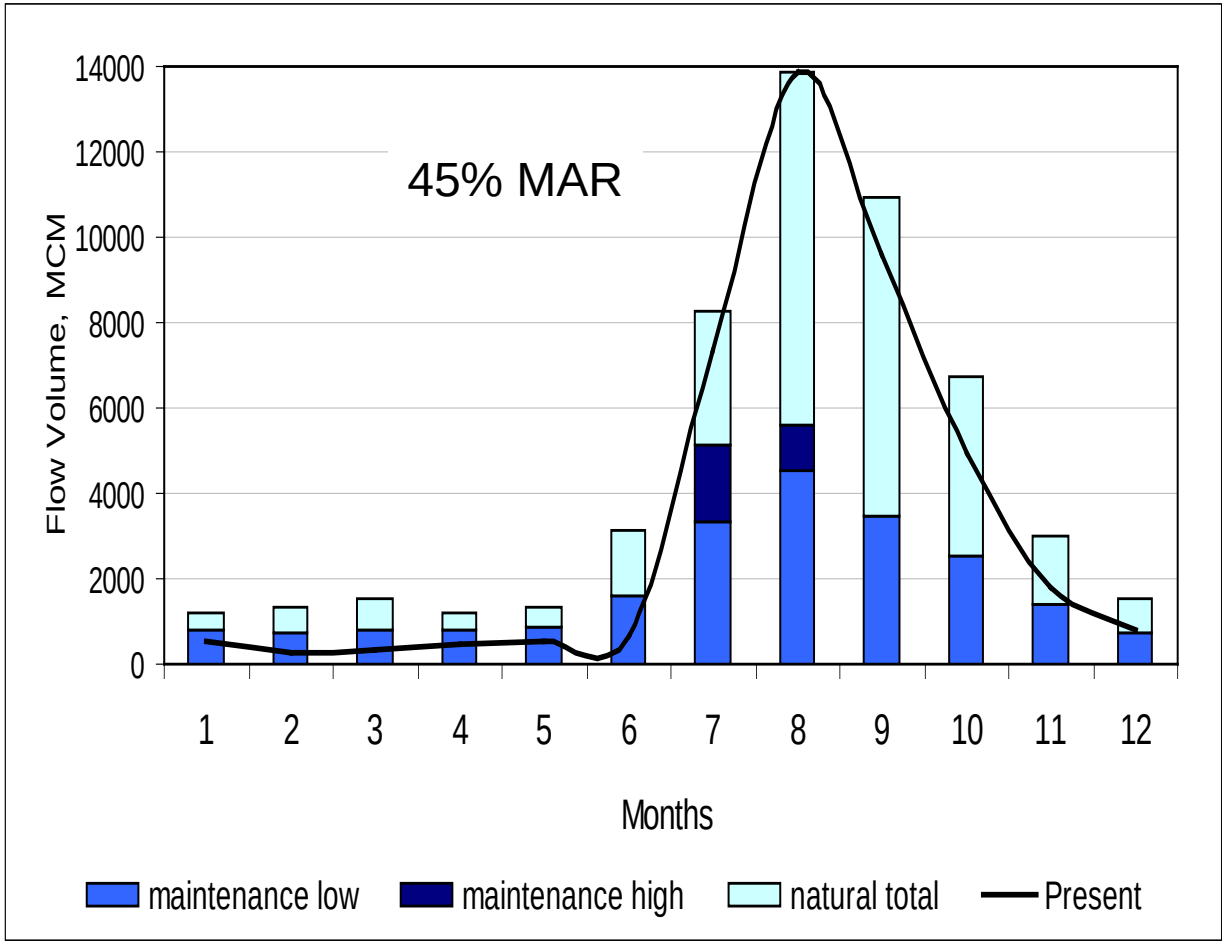
Results-Zone 3: Narora–Farrukhabad Maintenance Flows

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).



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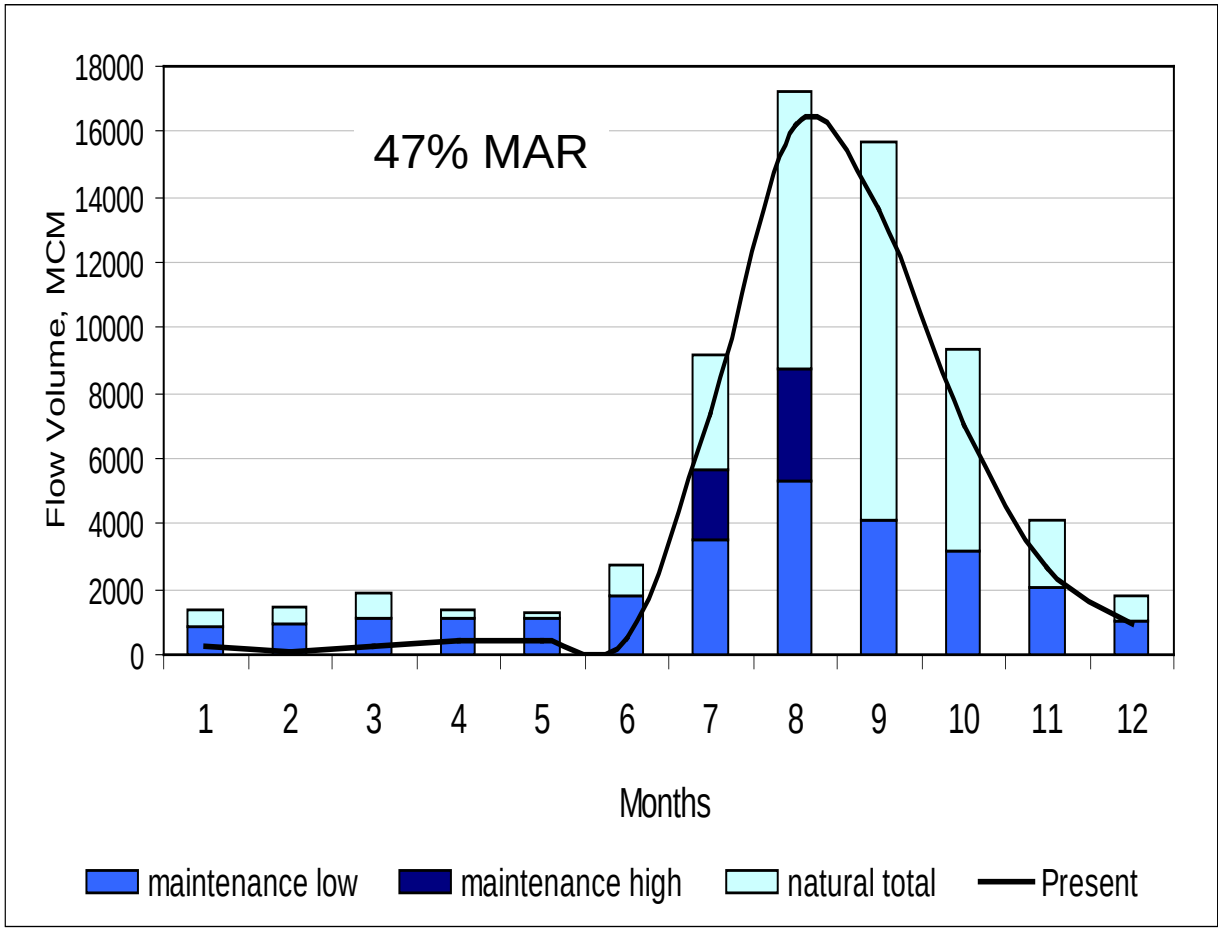
Results - Zone 4: Kanauj- Kanpur Maintenance Flows

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.



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Preliminary Conclusions

- **Present conditions at the upper site are largely acceptable**
- **Below Narora, there are major problems in terms of water quality and quantity in the lean season**
- **Conditions and motivations to improve these flows have been defined through this process**
- **Team of specialists to carry out further work is in place**

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

Current activities

- Summary Report on Assessment of E-Flows in Upper Ganga river stretch is recently published

- Coordinating E-Flows work as part of E-Flows Group of the IIT's team (engaged in development of GRBMP)

- Preparation of Detailed Report on E-Flows Assessment work under the Living Ganga Programme

Follow-up / Future activities

- Finalization and dissemination of EFA report (policy & technical)
- Refinement of EFA (short term)
- Promote implementation through policy dialogue
- Simulate basin-wide water allocation scenarios with inclusion of environmental flows - under current and future climates
- Promote EFA in other river basins in India

E-Flows and its status in Indian context

- ***Minimum Flows –***

  The minimum flow in the river should not be less than the average of 10 days minimum flow of the river in its natural state (CWC, 1992)

- **The environmental water need is estimated at 5 BCM for 2010 and is projected to rise to 10 BCM in 2025, and 20 BCM in 2050 (NCIWRDP, 1999)**

- **A High Powered Committee constituted by the River Conservation Authority recommended 40 m^3/s (D/S of Narora in Ganga) and 10 m^3/s (in Delhi stretch in Yamuna) as minimum flow for maintaining ecological system and natural self purification capacity (1999)**

Contd . . .

- **Growing debate since 2005-06 about E-Flows in India**

- **An international workshop on E-Flows organised by the National Institute of Ecology (NIE), jointly with the International Water Management Institute (IWMI), World Wide Fund for Nature – India (WWF-India), Ministry of Environment and Forests (MoEF), Ministry of Water Resources (MoWR), and the Indian Council of Agricultural Research (ICAR) in March 2005 in Delhi made following resolution regarding E-Flows:**
  - **The E-Flows requirements differ considerably in different rivers and their different reaches, and have therefore to be assessed and prescribed separately**
  - **The assessment of E-Flows requirements should employ comprehensive methods**

- **The NEP, 2006 talks about 'Freshwater Resources' and also calls for IWRM and E-Flows**

- **As a pre-condition for upcoming HePs, the Himachal Pradesh government has mandated 15% of lean season flow (2006)**

Contd . . .

- **The Working Group constituted by the Water Quality Assessment Authority (WQAA) used "modified Tennant Method" to assess the minimum flow requirements in Indian rivers (2007)**

- **GEFC - a desktop software, which has an in-built global database of simulated flow time series. The key objective of this software is to support training and initial quick assessments of E-Flows needs in river basins. (Smakhtin V., IWMI, 2007)**

- **GRBMP (under preparation) for the first time is looking into E-Flows in a comprehensive manner (2010)**

Thank You

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