



## NATIONAL MISSION FOR CLEAN GANGA

Ministry of Water Resources, River Development and Ganga Rejuvenation  
GOVERNMENT OF INDIA



# VISION GANGA

DECEMBER 2017



**Centre for Ganga River Basin Management and Studies**

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## **NATIONAL MISSION FOR CLEAN GANGA (NMCG)**

NMCG is the implementation wing of National Ganga Council which was setup in October 2016 under the River Ganga Authority order 2016. Initially NMCG was registered as a society on 12<sup>th</sup> August 2011 under the Societies Registration Act 1860. It acted as implementation arm of National Ganga River Basin Authority (NGRBA) which was constituted under the provisions of the Environment (Protection) Act (EPA) 1986. NGRBA has since been dissolved with effect from the 7<sup>th</sup> October 2016, consequent to constitution of National Council for Rejuvenation, Protection and Management of River Ganga (referred to as National Ganga Council).

[www.nmcg.in](http://www.nmcg.in)

## **CENTRE FOR GANGA RIVER BASIN MANAGEMENT AND STUDIES (cGanga)**

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this it is also responsible for introducing new technologies, innovations and solutions into India.

[www.cganga.org](http://www.cganga.org)

## **ACKNOWLEDGEMENT**

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## **SUGGESTED CITATION**

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**Ganga river in  
Himalayas mountains**



# CONTENTS

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06	River Ganga in Indian Consciousness	
08	Approach to Ganga River Basin Management	
10	Challenges and Opportunities	
12	Ganga: The River to Heaven and for Livelihood	
14	Vision for River Ganga	
15	Objectives of Ganga River Management	
16	Formulation of Missions	
18	Strategic Steps and Actions	
20	Strategic Initiatives	
23	State Mission: Uttarakhand	
24	State Mission: Uttar Pradesh	
25	State Mission: Bihar	
26	State Mission: Jharkhand	
27	State Mission: West Bengal	



# G

## River Ganga in Indian Consciousness

**THE RIVER** Ganga, along with her many tributaries, has been the source of physical and spiritual sustenance of Indian civilisation for millennia. And all through the ages, Indians held the munificent River Ganga as a Divine Body and the flow of River Ganga as the flow of Divinity. To the Indian mind, River Ganga is not only the holiest of rivers and purifier of mortal beings, but also a living Goddess—“MOTHER GANGA.” Her exalted status in Indian consciousness is encapsulated in the evocative words of Lord Sri Krishna in the Bhagavad Gita as:



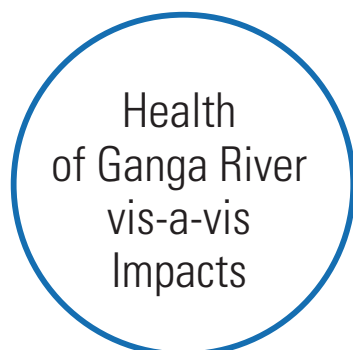
पवनः पवतामस्मि रामः शस्त्रभृतामहम्।  
झषाणां मकरश्चस्मि स्रोतसामस्मि जाह्नवी॥

“  
AMONG THINGS  
THAT PURIFY,  
**I AM THE WIND;**  
OF THE WIELDERS  
OF WEAPONS,  
**I AM RAMA;**  
OF THE WATER CREATURES,  
**I AM THE CROCODILE;**  
AND OF RIVERS,  
**I AM GANGA.**  
”

BHAGAVAD GITA, VERSE 31, CHAPTER 10



## GRBMP IMPLEMENTATION CHALLENGES



**Striking a Balance**

**Ecosystem  
services**

**Health of  
water-bodies**

**Agriculture  
& food  
security**

**Industry**

# Approach to Ganga River Basin Management Plan (GRBMP)

पारंपरिक ज्ञान के साथ आधुनिक विज्ञान और प्रौद्योगिकी  
जन ज्ञान + ज्ञान धारा

**THE** basic approach of GRBMP is: *"Apply modern science and technology in conjunction with traditional wisdom".*

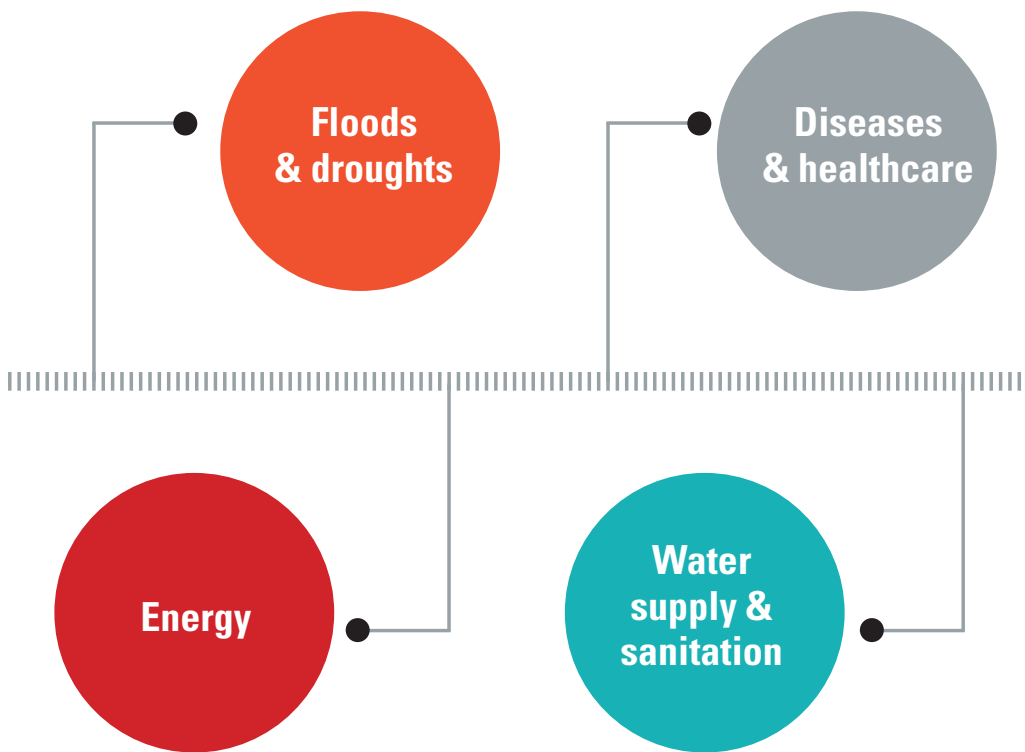
### MODERN SCIENCE AND TECHNOLOGY

The Ganga river basin comprises valuable physical resources (such as soil and water) and biotic resources (plants, animals and micro-organisms) in a dynamic balance achieved over millennia. The river network, the numerous surface water bodies and the groundwater in the basin are closely interconnected by hydrological linkages (such as surface runoff, groundwater flow, river flooding, and local evapotranspiration-precipitation cycles) as well as ecological connections (from complex food webs to activities of biological agents). Thus, functionally,

the basin is a closely interactive natural resource system in which the hydrological-ecological linkages provide for extensive material and energy transfer along with intricate biophysical communication between the river and her basin. Hence, interactive resource dynamics governs the health of both the basin and the river system. But, numerous and ever-changing human activities have rendered a new dimension to the basin dynamics. Thus, scientific evaluation of the status of the Ganga river network, its causal connection to natural and anthropogenic activities in river system and the basin, and the planning of appropriate technological interventions to reverse or arrest the river's degradation lie at the core of Ganga River Basin Management Plan (GRBMP).

### TRADITIONAL WISDOM

River Ganga's water quality is abysmal at present, posing a grave threat to health and life. But tradition has it that the properties of the river waters in earlier times were remarkable for their life-giving properties. And there were strictures on how the river should be treated by humans. Such strictures got diluted over time. But, their environmental significance should be obvious to the modern mind. And they convey a sense of deep respect for River Ganga. Thus, their essential wisdom, plus the common man's faith in the river's eternal qualities form the basis of a convergence of ideas and concerns that permeate the river's management plan. A few examples of traditional



**THE GANGA**  
BASIN EXTENDS  
OVER AN AREA OF  
**1.08 MILLION**  
SQUARE KILOMETER  
AND IS HOME TO  
**OVER 625 MILLION**  
PEOPLE

citations on River Ganga are presented as follows:

#### EXAMPLE-1

##### Ganga River's water quality in ancient literature

Ganga river's water quality had been acclaimed in ancient times. Its life-giving and healing qualities are evident from the following description in (~300 AD) meaning "The qualities of Ganga water are: Coolness, sweetness, transparency, high tonic property, wholesomeness, potability, ability to remove evils, ability to resuscitate from swoon caused by dehydration, digestive property and ability to retain wisdom":

अस्या जलस्य गुणाः शीतत्वम्, स्वादुत्वम्, स्वच्छत्वम्,  
अत्यन्तरुच्यत्वम्, पथ्यत्वम्, पावनत्वम्, पापहारित्वम्,  
तृष्णामोहध्वंसत्वम्, दीपनत्वम्, प्रज्ञाधारित्वं, इति राजनिर्घण्टः

#### EXAMPLE-2

##### Simple instructions to people for conserving the river

Each river has its own complex eco-hydro-morphological dynamics that is beyond popular comprehension. But, if related to faith, their actions can not only protect the rivers but also ensure their own safety. Thus, the following ancient edict prohibits thirteen types of human actions, combining physical restrictions and moral injunctions to ensure preservation of River Ganga as well as the safety of humans: (1) defecation, (2) gargling, (3) throwing of used floral offerings, (4) rubbing of filth, (5) flowing

bodies (human or animal), (6) frolicking, (7) acceptance of donations, (8) obscenity, (9) considering other shrines to be superior, (10) praising other shrines, (11) discarding garments, (12) bathing, and (13) making noise.

गंगां पुण्यजलां प्राप्य त्रयोदश विवर्जयेत्।  
शौचमाचमनं सेकं निर्माल्यं मलघर्षणम्।  
गात्रसंवाहनं क्रीडां प्रतिग्रहमथोरतिम्।  
अन्यतीर्थरतिचैवः अन्यतीर्थ प्रशंसनम्।  
वस्त्रत्यागमथाघातं सन्तारं च विशेषतः॥

#### EXAMPLE-3

##### Conveying complex phenomena and river ecosystems to people through faith

Rivers have different eco-hydro-morphological characteristics that are difficult to understand. But a sense of this complexity can be easily communicated to common people through faith. Thus:

त्रिभिः सारस्वतं तोयं सप्ताहेन तु यामुनम्।  
सद्यः पुनाति गांगेयं दर्शनादेव नार्मदम्॥  
(मत्स्य पुराण १८५/१०-११)

*A sin of a human being is purified by taking bath in the Holy River Saraswati for three days, in Holy River Yamuna for one week and the Holy River Ganga in one dip. However, all sins of human beings are purified only by viewing the Holy River Narmada.*

- Matsya Puran, 185/10-11



# Challenges and Opportunities

**DESPITE** being nationally revered, River Ganga has been deteriorating over a long time. It may have started noticeably due to large scale water abstractions by canals that began in the mid-nineteenth century. But, with harmful and increasingly diverse anthropogenic activities in her basin, the degradation gradually became multi-faceted. And such harmful activities have accelerated in recent decades, while limited attempts to keep the river healthy through conventional pollution control methods have proved ineffective. The direct impact of the river's degradation on humans have been the significant losses of her "ecosystem services" namely, provisioning services (e.g. food, fresh-water, fibres), regulating services (e.g. flood attenuation, groundwater recharge, prevention of salt water intrusion), supporting services (e.g. nutrient recycling, soil formation, biodiversity maintenance), and cultural services (e.g. recreation, spiritual fulfilment).

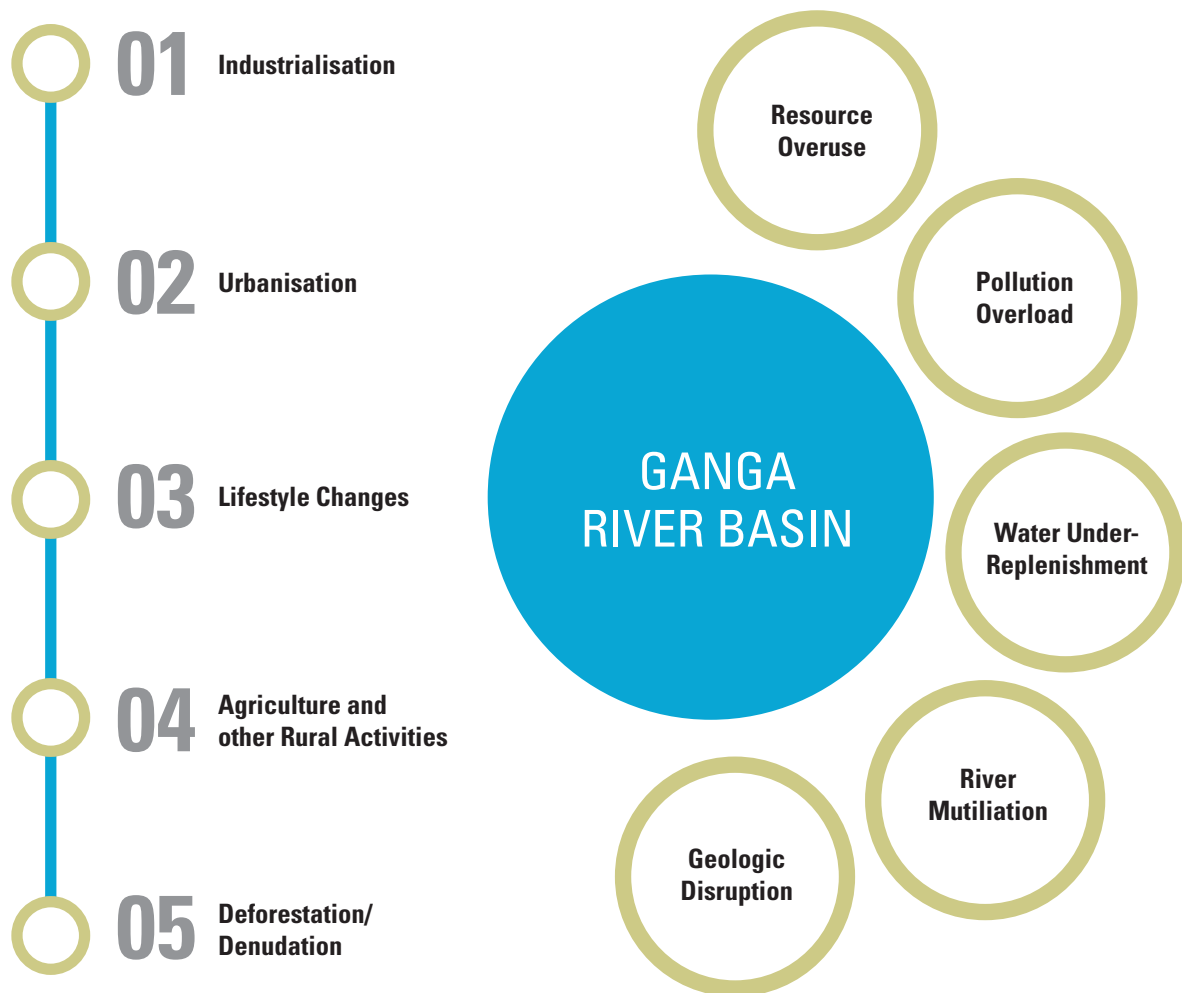
The proliferation and diversification of harmful human activities led to rapid degradation of National River Ganga and her basin since the twentieth century.

The reasons for the degradation can be broadly classified in five main groups, viz.: (i) over-use of natural resources of the basin; (ii) discharge of pollutants; (iii) reduction in water-holding capacities and replenishment of water bodies; (iv) mutilation of rivers by piecemeal engineering operations; and (v) threats to geological processes in the basin. The major human activities causing the above damages may also be clubbed under five main heads as shown in adjacent figure, viz.: (i) Industrialisation, (ii) Urbanisation, (iii) Lifestyle Changes, (iv) Agriculture & Other Rural Activities, and (v) Deforestation/ Denudation. This broad grouping, however, indicates only the key factors underlying basin degradation.

Devising appropriate remedial interventions to counter-balance them requires in-depth analysis of the problems that provide the thrust of GRBMP's investigation.

**THE PROLIFERATION  
AND DIVERSIFICATION  
OF HARMFUL  
HUMAN ACTIVITIES  
HAS LED TO RAPID  
DEGRADATION  
OF NATIONAL RIVER  
GANGA AND HER  
BASIN SINCE THE  
TWENTIETH CENTURY**

## Five Major Degradation Factors and their Anthropogenic Causes

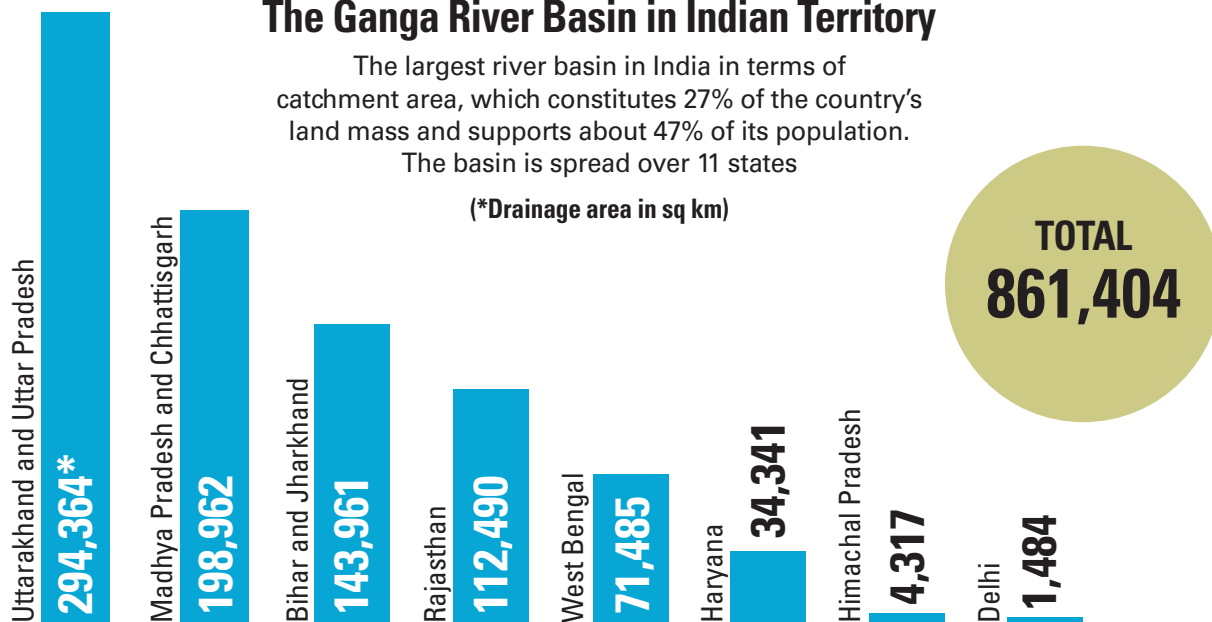


## The Ganga River Basin in Indian Territory

The largest river basin in India in terms of catchment area, which constitutes 27% of the country's land mass and supports about 47% of its population.

The basin is spread over 11 states

(\*Drainage area in sq km)



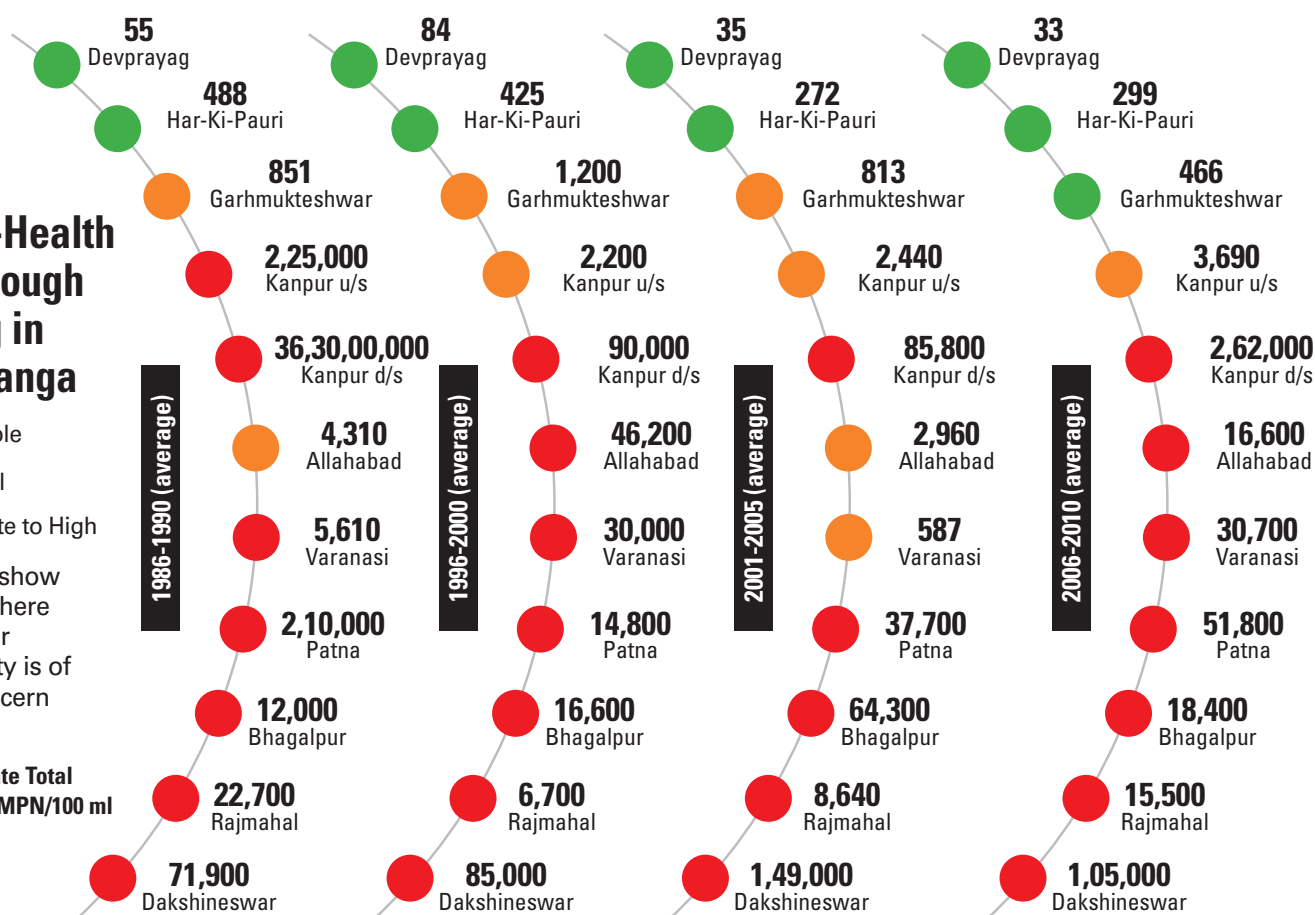


## Human-Health Risk through Bathing in River Ganga

- Negligible
- Nominal
- Moderate to High

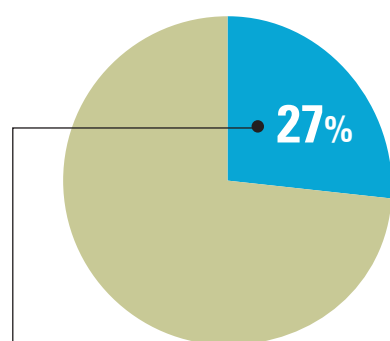
Red circles show locations where Ganga River water quality is of serious concern for bathing.

Values Indicate Total Coliforms as MPN/100 ml

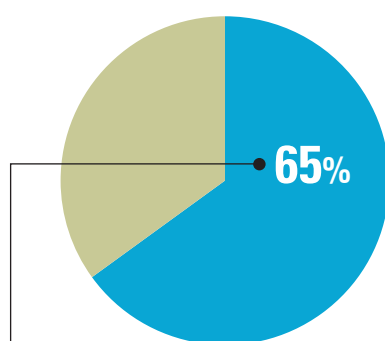


## Ganga: The River to Heaven and for Livelihood

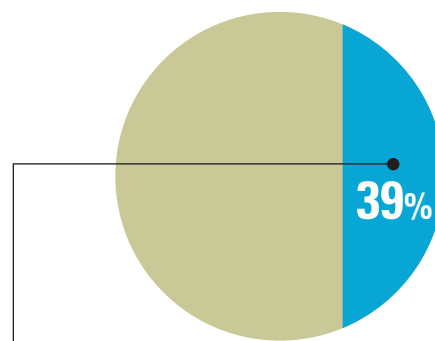
The Ganga River is one of the most sacred of the world's rivers but excessive abstraction of water and pollution is threatening her health and development in the basin.



Drainage area of the river covers nearly 27% of the total geographical area of India.

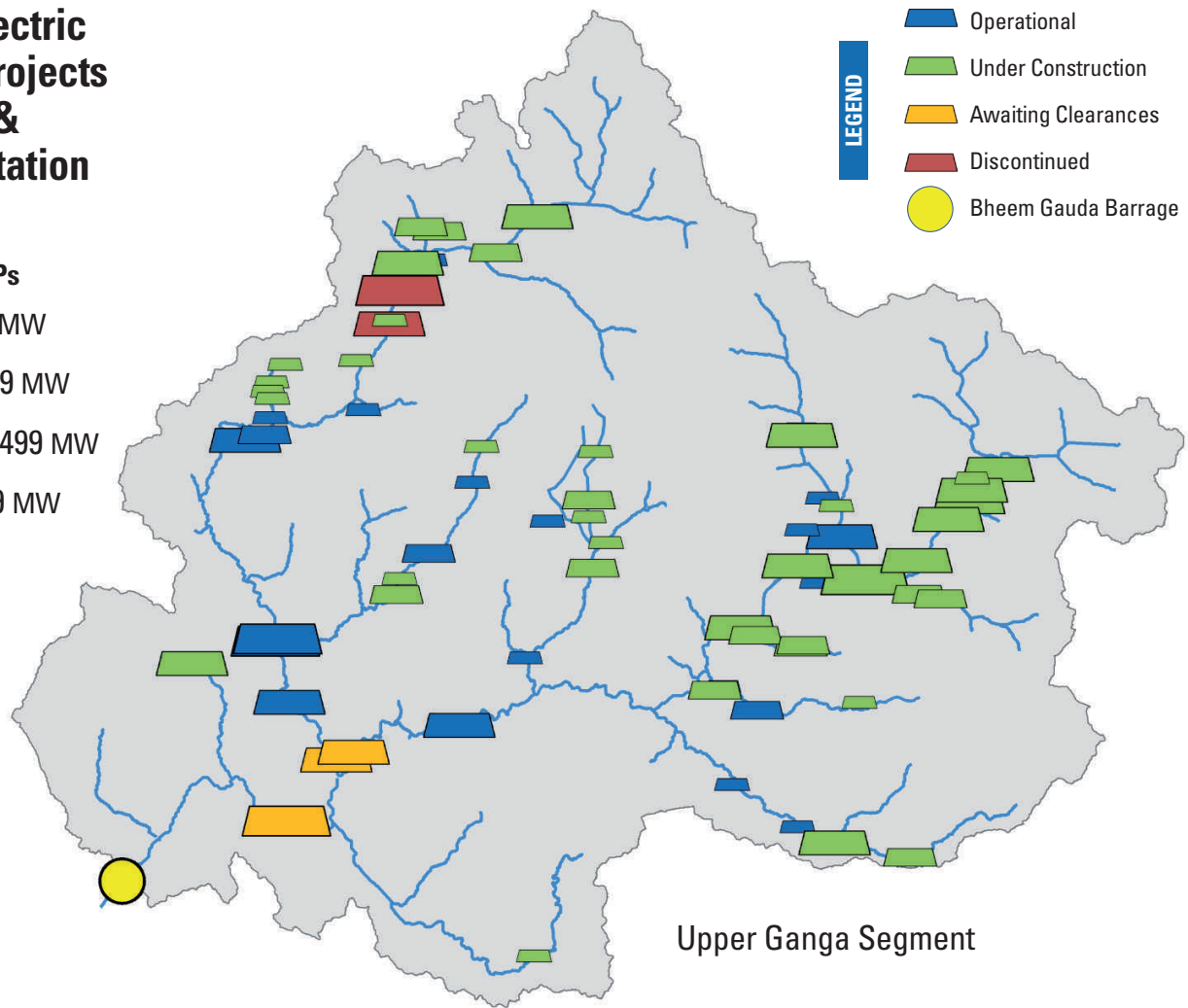
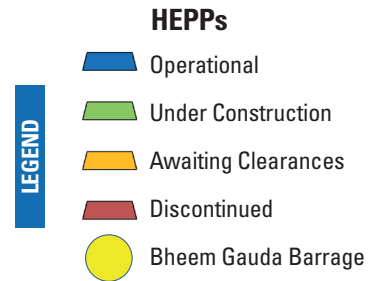
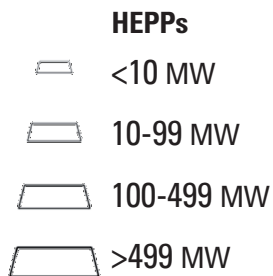


Major part of basin in Indian territory is covered with agricultural land accounting to 65.57% of the total area and 3.47% of the basin is covered by water bodies.



With 35.5% of the total water input in terms of precipitation, and covering only 27% of India's geographical area, Ganga River Basin is the second most water stressed basin having 39% of average per capita annual rainwater input amongst major Indian River Basins, next to the Sabarmati Basin.

# Hydro Electric Power Projects (HEPPs) & Fragmentation of Rivers

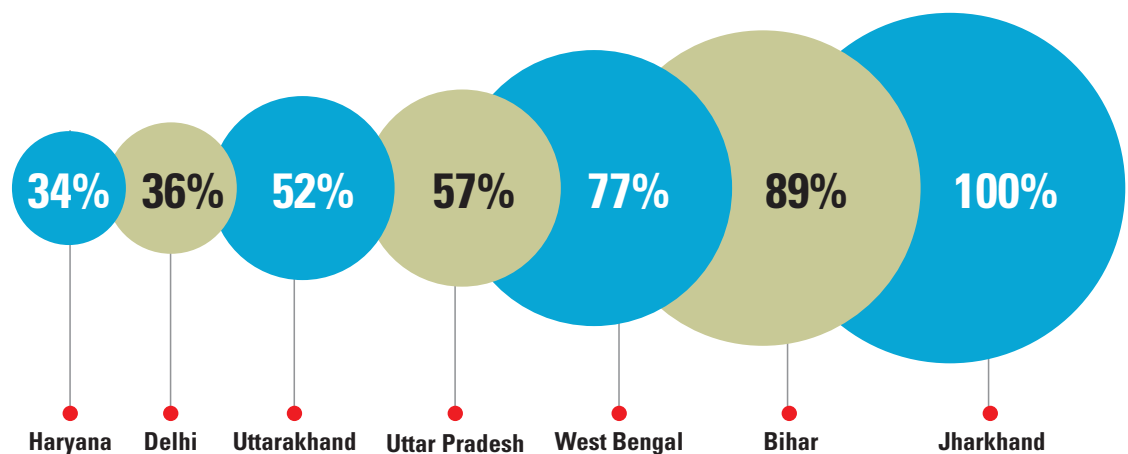


Upper Ganga Segment

## Untreated Sewage Flow into Ganga and Yamuna

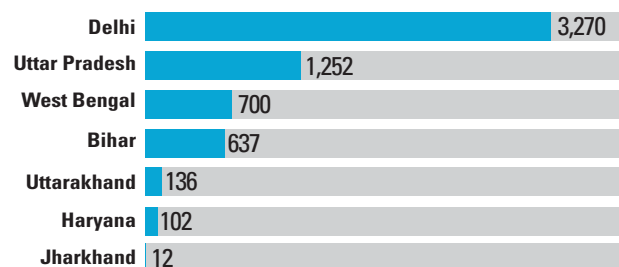
While 100% of sewage generated in the portion of the basin lying in Jharkhand state flows untreated into Ganga, Jharkhand is the least polluting state.

(State-wise estimates of untreated sewage in sampled towns)



## Sewage Discharged

(Figures in million litres per day)





## Vision for River Ganga

**IN ORDER** to preserve and invigorate National River Ganga, her essential character first needs to be grasped in a holistic manner. After extensive reviews of literature, research, in-house discussions and consultations with stakeholders, the “wholesomeness of National River Ganga”, viewed from a dynamic perspective, was determined in GRBMP to be the sanctity of the river system imbibed in the following four points:

### **I. “Aviral Dhara” (Uninterrupted Flow)**

The flow of water, sediments and other natural constituents of River Ganga are continuous and adequate over the entire length of the river throughout the year. Hence in-stream barriers, water diversions and barriers to surface runoff must be regulated.

### **II. “Nirmal Dhara” (Unpolluted Flow)**

The flow in the Ganga River Network is bereft of manmade pollution. Hence the river waters in present times should also not be sullied by polluting human activities.

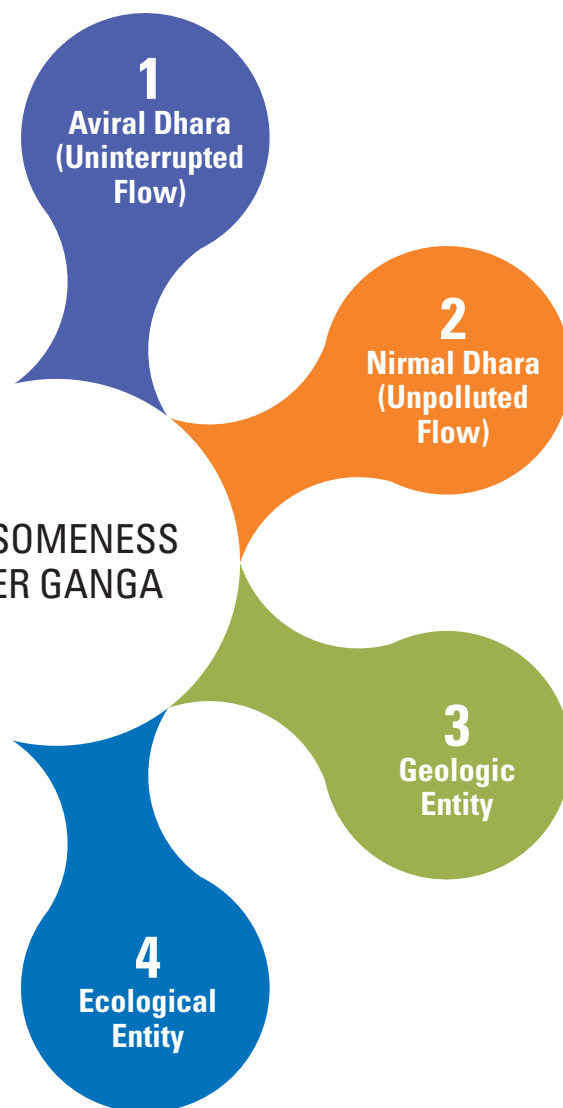
### **III. Geologic Entity**

The Ganga River System is the earth’s creations of ancient times, which may not be reparable if damaged. The geological integrity of the entire basin must therefore be protected.

### **IV. Ecological Entity**

The Ganga River System is a delicately structured balance between various living species and the physical environment, achieved by nature over thousands of years and vulnerable to irreversible changes. Over-exploitation and unhealthy interferences with the biophysical resources of the river system must therefore be abandoned outright.

## WHOLESOMENESS OF RIVER GANGA



**THE RIVER IS  
MORE THAN  
2500 KM LONG,  
BINDS FIVE  
STATES TOGETHER  
ALONG ITS MAIN  
STEM AND  
ELEVEN IN HER  
ENTIRE BASIN**



**Ghats on River Ganga in Varanasi, Uttar Pradesh**

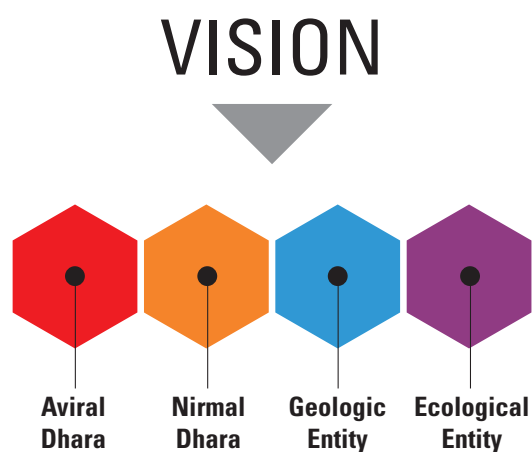
# Objectives of Ganga River Management

**BASED ON** the vision and societal needs, the main objectives of Ganga River Management have been identified as the following:

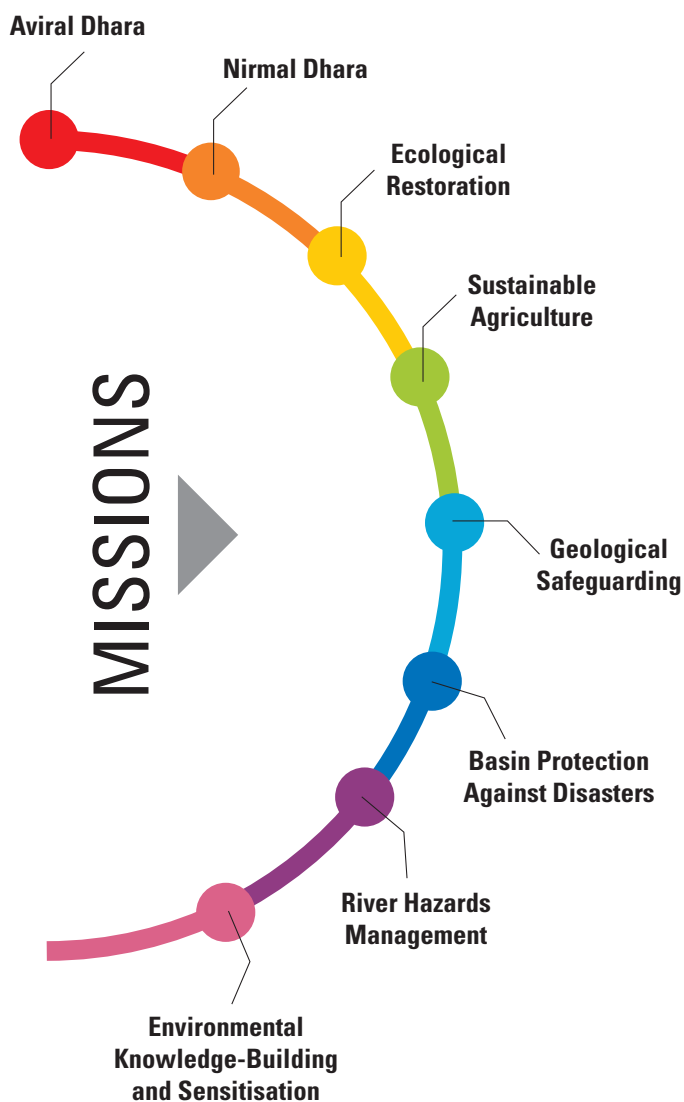
- A. Environmental Flows shall be maintained in all rivers and tributaries of Ganga River System to fulfil their geological, ecological, socio-economic and cultural functions.
- B. Water quality in all rivers and tributaries of Ganga River System shall be consistent with their governing geological, ecological, socio-economic and cultural functions.
- C. Water and other aquatic resources of the Ganga River System shall be used judiciously to enable sustainable development in the entire basin.
- D. All existing, ongoing and planned anthropogenic activities in the basin shall be reviewed or scrutinised in a transparent, inclusive manner (with consensus of all affected people and stakeholders) for the overall health of the basin.

**THE PLAN IS  
PREPARED WITH  
THE OBJECTIVE  
OF RESTORING THE  
WHOLESOMENESS  
OF THE RIVER  
GANGA**





**MISSIONS**



## Formulation of Missions

**GIVEN THE** escalating impacts of human activities on the Ganga river basin, the Vision and Objectives have guided the formulation of eight important areas where the focussed corrective actions need to be carried out in Mission mode, viz.: “Aviral Dhara”, “Nirmal Dhara”, “Ecological Restoration”, “Sustainable Agriculture”, “Geological Safeguarding”, “Basin Protection Against Disasters”, “River Hazards Management” and “Environmental Knowledge-Building and Sensitisation”. The Vision of a wholesome River Ganga and the Missions needed to be taken up to achieve this Vision are depicted in figure above.

**GANGA RIVER HAS  
A CULTURAL  
AND SPIRITUAL  
SIGNIFICANCE  
THAT FAR  
TRANSCENDS  
THE BOUNDARIES  
OF HER BASIN**



Tehri reservoir  
in Uttarakhand





# Strategic Steps and Actions

Strategic Steps and Actions for revival and long-term security of River Ganga are grouped under the different Missions

## MISSION 1

### Aviral Dhara

- i. Accurate determination of NRGB's hydrological status.
- ii. Water resources planning with emphasis on wetlands, forests and distributed groundwater and surface water storages.
- iii. Increase in water use efficiency through: (a) realistic pricing of fresh water; (b) incentives, technical assistance, and allocation of water rights and entitlements to consumers; and (c) reuse and recycling of water.
- iv. Policy shift with emphasis on water resource preservation, stakeholder control, expert guidance and regulation.
- v. Ensuring longitudinal river connectivity and E-Flows at dams, barrages, etc., and new criteria for approving such projects.
- vi. Regulating water withdrawals in water depleting regions.
- vii. Assessment and monitoring of sediment resources of the network including their quantity, quality and nutrient value.

## MISSION 2

### Nirmal Dhara

- i. Management of solid and liquid wastes generated from Domestic/ Commercial Sources.
- ii. Riverfront development, floodplain management and rejuvenation of water bodies.
- iii. Management of Industry-generated solid and liquid wastes.
- iv. Management of Polluted Agricultural Run-off.

## MISSION 3

### Ecological Restoration

- i. Restoration of longitudinal connectivity along with E-flows at dams, barrages and other obstructions.
- ii. Maintenance of lateral connectivity across floodplains.
- iii. Restoration of unpolluted rivers.
- iv. Regulation of river bed farming and sand-mining from river beds.
- v. Regulation of plying of noisy ships, dredging, and river modifications.
- vi. Control of alien species invasions, overfishing and fishing during spawning seasons.
- vii. River nutrient assessment and release of sediments trapped behind dams/barrages into downstream river reaches.
- viii. Long-term bio-monitoring of the Ganga river network.
- ix. Synergising actions with the Dolphin Conservation Action Plan—2010.
- x. Comprehensive research on ecological dynamics of the River System.

## MISSION 4

### Sustainable Agriculture

- i. Adoption of Conservation Agriculture (no tillage, crop diversification, and mulching), especially in degrading lands, to enhance soil fertility and agricultural output with resource conservation.
- ii. Promotion of Organic Farming where needed or economically feasible.
- iii. Beneficial water and nutrient application techniques in rice cultivation, such as SRI (System of Rice Intensification) and Urea Deep Placement.
- iv. Promoting other established resource conservation technologies.
- v. Promoting regional (landscape-scale) resource conservation steps to counter monotonous agro-ecosystem impacts.
- vi. Experimentation, adaptability and flexibility in agriculture to synthesise traditional knowledge with ongoing and future scientific discoveries.
- vii. Suitable policy measures and strengthening of institutional framework.

**Note on Mission Nirmal Dhara:** Project planning for urban works should begin with preparation of detailed Urban River Management Plans (URMP) for Class I towns, and subsequently also for Class II and Class III towns. The URMPs should be followed by preparation of DPRs, following which funds should be allocated for project implementation. Fund allocation should be prioritised for projects designed to prevent direct discharge of large quantities of liquid waste into the River System (Priority Level I), followed by projects designed to prevent direct discharge of large quantities of solid waste into the River System (Priority Level II), followed by projects concerning river-frame development and restoration of floodplain in urban areas along the Ganga River System (Priority Level III). Other projects under Mission Nirmal Dhara may be executed at still lower priority depending on availability of funds.



## IMPLEMENTATION MECHANISM

The implementation, monitoring, review and evaluation of the Ganga basin's problems and interventions on a long-term basis are difficult through multiple central and state organisations unless they are coordinated and over-seen by an independent agency. Hence an independent institution is recommended to be set up for this purpose. Moreover, since rivers are prima facie inter-state subjects as per the Constitution, the said institution would need adequate resources and authority (under relevant provisions of the Constitution) to oversee the activities of multiple sectoral organisations and informal sectors of society insofar as they affect River Ganga. GRBMP, therefore, includes the functional requirements of such an institution that needs to be established by an Act of Parliament, to enable an enduring mechanism for maintaining a wholesome River Ganga and sustainable growth in her basin.

### MISSION 5

#### Geological Safeguarding

- i.** Control/regulation of geologically hazardous activities including deep groundwater withdrawals, underground excavations, explosions, tunnelling, mining, hydraulic rock fracturing, and operation of large reservoirs.
- ii.** Restrictions on geomorphologically harmful land-use practices such as deforestation and construction activities on hill slopes and floodplains, excessive tillage, river bed mining, and river bank modifications.
- iii.** Improved drainage of low-lying areas and disturbed areas stabilisation.
- iv.** Mapping river migration zones and geological monitoring of basin.

### MISSION 6

#### Basin Protection Against Disasters

- i.** Routine hydro-meteorological and biological events should not be countered.
- ii.** Ecosystems should be strengthened against catastrophic disasters by preserving wetlands, promoting mixed vegetation and indigenous forests, and curbing human land-use disturbances and encroachments.
- iii.** Floodplain regulations and vegetative measures to combat extreme river floods are preferable to embankments/ levees.
- iv.** The ecology of Forest Fires and Epidemics & Biological Invasions need to be studied extensively. Until then, active interventions to counter such events should be limited.
- v.** Deforestation, road and building constructions, and unsafe debris disposal need to be strictly checked in the Upper Ganga Basin and other hilly regions to minimise land-slides and landslips.
- vi.** Early rejuvenation of disaster-struck ecosystems should be aided by re-introducing indigenous species resistant to the specific disaster types and re-creating an enabling physical environment.

### MISSION 7

#### River Hazards Management

- i.** Basin scale flood-risk maps should be prepared and linked to an online data base and flood warning system.
- ii.** Drainage improvement and land reclamation in low-lying areas should be taken up systematically and urgently.
- iii.** Assessment of soil salinity and its mitigation strategy to be taken up with use of salinity resistant crops and soil improvement practices.
- iv.** Alternatives to embankments for flood management with emphasis on 'living with the floods' concept must be emphasised; this may include floodplain zoning and other nonstructural approaches.
- v.** Research needed on sediment dynamics and its application in river management projects for sustainable river management strategies.
- vi.** Some pilot projects may be undertaken in partnership with state governments, e.g.: (a) Reactivation of paleochannels in the Kosi basin and design of flood spillway; (b) Improving drainage congestion caused by unplanned rail/road network; (c) Designing canals to drain water.

### MISSION 8

#### Environmental Knowledge Building and Sensitisation

- i.** Establishment of a comprehensive Data Bank by continuous collection, processing and storage of information on the basin's natural resources, anthropogenic activities, and environmental monitoring of basin.
- ii.** Preparation of secondary results (representative parameters, charts, tables, etc.) based on primary data.
- iii.** Preparation of documents and materials for easy understanding by non-specialised people.
- iv.** Keeping the above information in open domain for easy access by interested individuals and institutions.
- v.** Conducting educational workshops and campaigns with stakeholders and interested citizens to enable their sensitisation and comprehensive understanding of basin processes.
- vi.** Conducting ground-level monitoring and field researches of the Ganga River Basin's environment with stakeholder participation.

# Strategic Initiatives

The present-day River Ganga provides a plethora of learning opportunities as much as challenges. The river offers an unparalleled opportunity to synergise developmental aspirations and cultural diversity with deep learning and visionary entrepreneurship.

1

This requires significant improvement in our understanding of the surface and sub-surface hydrological systems. By mining past data sets and through expanding current data collection footprint we can massively increase the knowledge of the system. By then providing intelligent interfaces to critical stakeholders, policy making can truly evolve from reactive to proactive having the ability to scenario plan various eventualities.

## MOVING TOWARDS AN EVIDENCE BASED POLICY MAKING

2

A seamless single window mechanism that will allow the technology companies from around the world to participate in the river clean-up programme through a process that will take their companies from technology verification to pilot projects and to commercial scale-up.

## ACCELERATING TECHNOLOGY TRANSFER

3

Ganga basin provides phenomenal entrepreneurship opportunity to the most creative technical, scientific and business minds. Whether it is establishing an advanced sensor network with big data analytics, rejuvenating a small rivulet/ drain (nallah), or rolling out drinking water systems to communities, the Ganga basin has a plethora of challenges for entrepreneurs to solve. A dedicated platform for entrepreneurs that includes technology innovation fund and other special incentives will provide a launchpad to those with a passion to address the big environmental challenges.

## PROVIDING A PLATFORM FOR WATER ENTREPRENEURSHIP

**8** Strategic high economic impact initiatives planned to achieve the complete potential of the Ganga river basin

4

## DEVELOPING MARKET BASED MECHANISMS

Whilst the Government is putting tremendous capital behind the river clean up and rejuvenation, it is equally important to develop market based mechanisms that bring about a paradigm shift in how different riparian consume water. The first and foremost intervention is to establish the true cost of water so that all users can appreciate its value. This coupled with other mechanisms such as water rights, water trading will bring about equality and parity in water sharing and availability.

MAKING INDIA A  
GLOBAL HUB FOR  
EXPORT OF WATER  
INNOVATION

Through a sustained and intensive activity in the Ganga River basin, India stands to become one of the major export hub of knowledge around water and river basin management. The knowledge will not just be restricted to technical advancement but involve governance and community engagement aspects.

5

GLOBAL WATER  
STEWARDSHIP

India's global aspiration to be a champion of water security cannot be attained without a comprehensive outreach programme. Through the support of Indian diplomatic missions the establishment of international chapters shall help India attracting the best technical and scientific brains as well as in reaching out to solve water crises in many parts of the world through strategic partnerships.

6

7

The magnitude of the capital-spend needed to restore the River Ganga to its pristine glory is exceptionally large. Without additional other sources of finance, it would be difficult for any Government to create a budgetary allocation to provide for this amount. Innovative financial models are needed to attract additional sources of capital from both domestic and international sources. These include but are not limited to technology transfer funds, low cost, long-term and non-recourse financing, development risk capital and take-out financing in form of Yield-Co or through bond markets (Rupee denominated – Ganga/Blue bonds).

INNOVATIVE  
FINANCING MODELS

8

The communities lie at the very heart of the rejuvenation exercise. It is the anthropogenic activity set that led to the degradation of the river and it will require the collective will of all people to bring transformation in the state of the river. A range of community engagement initiatives including digital interfacing, practical education and most importantly empowerment through provision of custodianship will bring about the much needed change.

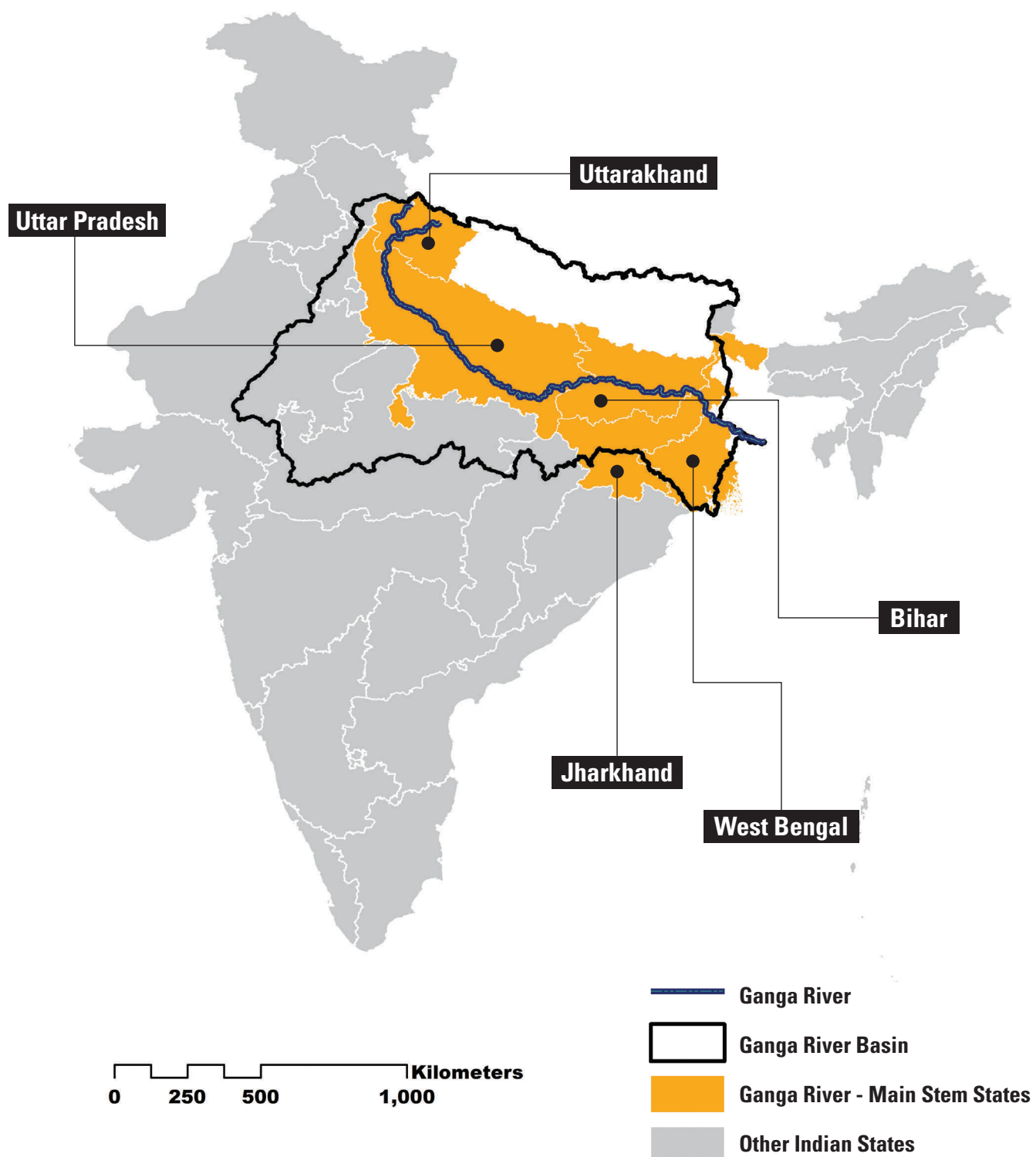
ENGAGING  
COMMUNITIES



Ganga in Allahabad



# State Ganga Missions





## Uttarakhand

**AS THE** source of National River Ganga, Uttarakhand is a most important state for ensuring the wholesomeness and integrity of the river. The river and her headstreams in the state are not only held in divine esteem by Indians, but are also a major feature of the state's picturesque setting in the Himalayan range. Hence, tourism (spiritual, religious and recreational) is an important benefit for the state, and preserving a near pristine river system in the region is of key importance. While industrialisation and life-style changes have been relatively slow in the state so far, there have been some amount of deforestation and urbanisation (especially near the lower regions) and increased tourist traffic along with major hydro-electric projects (such as the Tehri, Srinagar and Kotdwar dams) fragmenting the Bhagirathi, Alaknanda and other rivers. These changes have had significant adverse impacts on the Ganga river system, and they need to be addressed urgently.

**ALL HEADSTREAMS  
OF RIVER GANGA  
ARE NOT ONLY HELD IN  
DIVINE ESTEEM  
BY INDIANS, BUT ARE  
ALSO A MAJOR FEATURE  
OF UTTARAKHAND'S  
PICTURESQUE  
SETTING IN THE  
HIMALAYAN RANGE**

### KEY MEASURES REQUIRED AT THE STATE LEVEL

- 1 Ensuring longitudinal connectivity with provision for E-Flows along with development of sustainable hydro power.
- 2 Preparation of comprehensive URMPs for Class I, Class II and Class III towns of the state, and establishing comprehensive sewage and solid waste handling/ treatment facilities at all urban and tourist centres.
- 3 Ensuring proper transport, food and fuel facilities to handle peak tourist loads without stressing the region's ecosystems.
- 4 Afforestation and slope stabilisation along with regulation of road and building constructions in disturbed areas.
- 5 Regulation of sand and gravel mining from river beds.
- 6 Widespread dissemination of knowledge, ground-level monitoring, and increased sensitisation and participation of stakeholders.

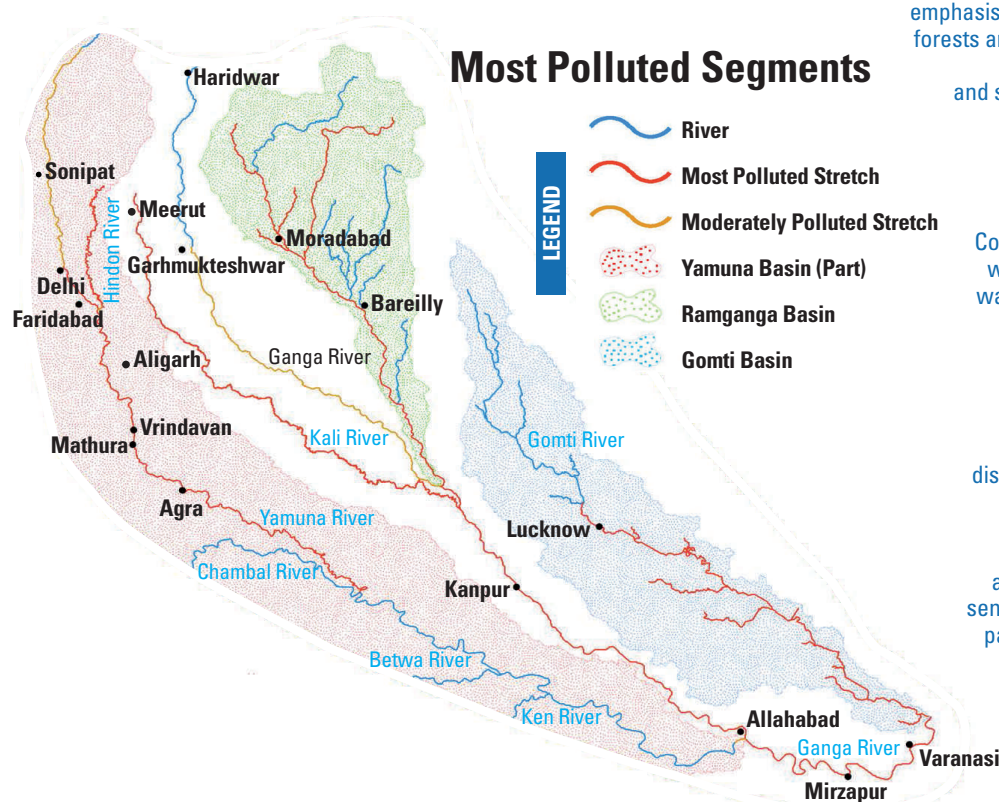


## Uttar Pradesh

**UTTAR PRADESH** is a large state that includes a long stretch of River Ganga in the plains below Uttarakhand and the sub-basins of many of her important tributaries like the Yamuna, Kali, Ramganga and Gomti. It is well populated, and has both extensive agricultural lands and industries.

The main Ganga canals (the Upper Ganga, Middle Ganga and Lower Ganga canal systems) effect major abstractions from River Ganga in her upper reaches of the state, which have affected the river over a long period of time. Coupled with this problem are the large quantities of untreated and partially treated municipal sewage from urban centres and trade effluents from industrial clusters discharging into the river and her tributaries. The net result is extremely high pollution levels in the main river and her major tributaries like the Yamuna, Kali and Gomti rivers, which constitute a major threat to both humans and river biodiversity.

The figure below shows the most polluted stretches at a glance. The immersion of dead bodies and animal carcasses in the river and the increasing chemical fertiliser and pesticide laden runoff from agricultural fields have added to the problems. In addition, dams and barrages erected on the rivers have disrupted the habitats of many river species like the Gangetic dolphin and affected their populations.



### KEY MEASURES REQUIRED AT THE STATE LEVEL

1

Preparation and implementation of comprehensive URMPs for all Class I, Class II and Class III towns of the state, and establishing comprehensive sewage and solid waste handling/treatment facilities at all urban centres. The major towns identified for priority action are Vrindavan, Mathura and Agra (on River Yamuna), Moradabad (on River Ramganga), Lucknow (on River Gomti), and Haridwar, Garhmukhteshwar, Kanpur, Allahabad and Varanasi (on River Ganga).

2

Ensuring longitudinal connectivity with provision for E-Flows at dams, barrages and other structures.

3

Developing Canals and Urban Natural Drains for multipurpose applications such as recreation and surface transport, groundwater recharge, hydropower, irrigation, etc.

4

Promotion of sustainable agriculture with resource conservation measures.

5

Regulation of river bed farming and sand-mining from river beds.

6

Water resources planning with emphasis on wetlands, forests and distributed groundwater and surface water storages.

7

Increase in water use efficiency through: (i) realistic pricing of fresh water; (ii) incentives, technical assistance, and allocation of water rights and entitlements to consumers; and (iii) reuse and recycling of water.

8

Control of water withdrawals in water-depleting regions.

9

Control of alien species invasions, overfishing and fishing during spawning seasons.

10

Widespread dissemination of knowledge, ground-level monitoring, and increased sensitisation and participation of stakeholders.



## Bihar

**BIHAR** is also a large state that includes a long stretch of River Ganga in the plains down-stream of Uttar Pradesh and covers the sub-basins of many of her important tributaries like the Ghagra, Gandak, Bagmati, Kosi and Sone rivers. Bihar is well populated, and has fertile agricultural lands, industries and urban centres.

Consequently significant quantities of untreated and partially treated municipal sewage from major towns and trade effluents from industrial clusters discharge into the river and her tributaries. The net result is high pollution levels in the main river and some of her tributaries which affect the health of both humans and the river.

In addition, a few large dams and barrages (e.g. Indrapuri barrage on the Sone river) have been erected on some of the rivers that affect river species. More significantly, repeated river channelisation and other flood control works (like levees) have affected river morphology and stability of many of her flood-prone rivers like the Kosi river.

**REPEATED RIVER  
CHANNELISATION  
AND OTHER FLOOD  
CONTROL WORKS  
HAVE AFFECTED  
RIVER MORPHOLOGY  
AND STABILITY OF  
MANY OF HER  
FLOOD-PRONE RIVERS  
LIKE THE KOSI RIVER**

### KEY MEASURES REQUIRED AT THE STATE LEVEL

- 1 Preparation and implementation of comprehensive URMPs for all Class I, Class II and Class III towns of the state, and establishing comprehensive sewage and solid waste handling/treatment facilities at all urban centres.
- 2 Flood management through floodplain zoning, drainage improvement, other non-structural measures and scientific sediment management.
- 3 Ensuring longitudinal connectivity with provision for E-Flows at dams, barrages and other structures.
- 4 Developing Canals and Urban Natural Drains for multipurpose applications such as recreation and surface transport, groundwater recharge, hydropower, irrigation, etc.
- 5 Promotion of sustainable agriculture with resource conservation measures.
- 6 Regulation of sand-mining from river beds.
- 7 Water resources planning with emphasis on wetlands, forests and distributed groundwater and surface water shortages.
- 8 Increase in water use efficiency through: (i) realistic pricing of fresh water; (ii) incentives, technical assistance, and allocation of water rights and entitlements to consumers; and (iii) reuse and recycling of water.
- 9 Widespread dissemination of knowledge, ground-level monitoring, and increased sensitisation and participation of stakeholders.





## Jharkhand

**JHARKHAND** state is located downstream of Bihar as the Ganga flows. Much of the state, located on the Chhota Nagpur plateau, is hilly and forest-covered. Major industries include mining, mineral processing, and steel industries.

Consequently there are several large cities and industrial clusters that are an important source of pollutant discharges. Besides, there are several hydro-electric projects and large irrigation dams such as the Maithon, Tilaya, Panchet and Tenughat dams on Rivers Barakar and Damodar and the Icha and Chandil dams on River Subarnarekha which affect river flows and biodiversity.

THERE ARE SEVERAL  
**LARGE CITIES**  
AND INDUSTRIAL  
CLUSTERS  
IN JHARKHAND  
THAT ARE  
**AN IMPORTANT**  
SOURCE  
OF POLLUTANT  
**DISCHARGES**

### KEY MEASURES REQUIRED AT THE STATE LEVEL

- 1 Preparation and implementation of comprehensive URMPs for all Class I, Class II and Class III towns of the state, and establishing comprehensive sewage and solid waste handling/ treatment facilities at all urban centres.
- 2 Ensuring longitudinal connectivity with provision for E-Flows at dams, barrages and other structures.
- 3 Developing Canals and Urban Natural Drains for multipurpose applications such as recreation and surface transport, groundwater recharge, hydropower, irrigation, etc.
- 4 Afforestation and slope stabilisation along with regulation of road and building constructions in disturbed areas.
- 5 Promotion of sustainable agriculture with resource conservation measures.
- 6 Regulation of sand-mining from river beds.
- 7 Water resources planning with emphasis on wetlands, forests and distributed groundwater and surface water storages.
- 8 Widespread dissemination of knowledge, ground-level monitoring, and increased sensitisation and participation of stakeholders.



## West Bengal

**THE STATE** of West Bengal lies at the downstream end of the Ganga basin. But its critical importance in the basin accrues from the vast Ganges Delta (covering the Sundarban mangroves) which it shares with the neighbouring country, Bangladesh.

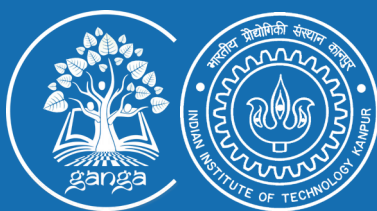
In fact, most of the state lies in the flat deltaic plains with high rainfall and frequent floods, with only the northern part covering some of the Himalayan foothills. Like much of Uttar Pradesh and Bihar, it is a fertile region that hosts a dense population and has extensive agriculture as well as many industries. Its megalopolis capital, Kolkata, located on the western edge of the delta, was earlier also a major seaport and besides has many industries in and around it (such as in the neighbouring districts of Howrah, Hooghly and North 24 Paraganas).

Industries are also clustered in Burdwan district neighbouring Jharkhand and elsewhere. As a consequence of these factors and several large hydro-electric projects and dams such as the Maithon and Panchet dams, and the Farakka, Tilpara and Durgapur barrages, River Ganga, her tributaries and the outfalls have been significantly affected.

WEST BENGAL'S  
**CRITICAL IMPORTANCE**  
IN THE BASIN  
ACCRUES FROM THE  
**VAST GANGES**  
DELTA WHICH IT  
SHARES WITH THE  
**NEIGHBOURING**  
COUNTRY,  
BANGLADESH

### KEY MEASURES REQUIRED AT THE STATE LEVEL

- 1 Preparation and implementation of comprehensive URMPs for all Class I, Class II and Class III towns of the state, and establishing comprehensive sewage and solid waste handling/ treatment facilities at all urban centres.
- 2 Ensuring longitudinal connectivity with provision for E-Flows at dams, barrages and other structures.
- 3 Developing Canals and Urban Natural Drains for multipurpose applications such as recreation and surface transport, groundwater recharge, hydropower, irrigation, etc.
- 4 Flood management through floodplain zoning, drainage improvement, other non-structural measures and scientific sediment management.
- 5 Promotion of sustainable agriculture with resource conservation measures.
- 6 Regulation of deep groundwater extraction to control arsenic contamination spreading across the basin.
- 7 Control of alien species invasions, overfishing and fishing during spawning seasons.
- 8 Regulation of river dredging and plying of noisy vessels, especially around Kolkata and near the river mouth.
- 9 Widespread dissemination of knowledge, ground-level monitoring, and increased sensitisation and participation of stakeholders.



## **Centre for Ganga River Basin Management and Studies**

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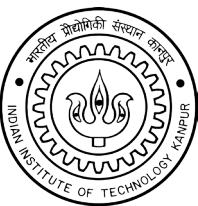
राष्ट्रीय स्वच्छ गंगा मिशन

जल संसाधन, नदी विकास एवं गंगा संरक्षण मंत्रालय

भारत सरकार



# विज्ञान गंगा



गंगा नदी घाटी प्रबंधन एवं अध्ययन केंद्र (सी गंगा)

© सी गंगा एवं एनएमसीजी 2017

दिसम्बर 2017



## राष्ट्रीय स्वच्छ गंगा मिशन (एनएमसीजी)

नमामि गंगे राष्ट्रीय गंगा परिषद की देख-रेख में चलने वाला एक महत्वपूर्ण कार्यक्रम है। राष्ट्रीय गंगा परिषद इस कार्यक्रम का क्रियान्वयन राष्ट्रीय स्वच्छ गंगा मिशन (एनएमसीजी) के द्वारा सुनिश्चित करता है। एनएमसीजी को सोसायटी पंजीकरण अधिनियम 1860 के अंतर्गत 12 अगस्त 2011 को एक सोसायटी के रूप में पंजीकृत किया गया था। शुरु में एनएमसीजी ने राष्ट्रीय गंगा नदी घाटी प्राधिकरण (एनजीआरबीए) के क्रियान्वयन शाखा के तौर पर कार्य किया जिसे पर्यावरण (संरक्षण) अधिनियम (ईपीए) 1986 के प्रावधानों के तहत गठित किया गया था। उसके बाद राष्ट्रीय गंगा नदी पुर्नउद्धार, संरक्षण एवं प्रबंधन परिषद (जिसे राष्ट्रीय गंगा परिषद कहा जाता है) के गठन के परिणामस्वरूप एनजीआरबीए 7 अक्टूबर 2016 को प्रभावी तौर पर भंग कर दिया गया और गंगा प्राधिकरण आदेश 2016 के द्वारा एनएमसीजी का वर्तमान स्वरूप अक्टूबर 2016 में सामने आया।

[www.nmcg.in](http://www.nmcg.in)

## गंगा नदी घाटी प्रबंधन और अध्ययन केंद्र (सी गंगा)

सी गंगा एनएमसीजी के तत्वावधान में स्थापित एक मंच है, और इसके घोषित उद्देश्यों में से एक भारत को नदी एवं जल विज्ञान के क्षेत्र में अग्रणी बनाना है। केंद्र का मुख्यालय आईआईटी कानपुर में है और इसमें देश के कई प्रमुख विज्ञान और तकनीकी संस्थानों का प्रतिनिधित्व है। सी गंगा का अधिदेश आईआईटी कंसोर्टियम द्वारा तैयार किया गया गंगा नदी घाटी प्रबंधन योजना (जीआरबीएमपी) के कार्यान्वयन एवं समयानुसार विस्तार में विचार मंच के तौर पर कार्य करना है। इसके अलावा भारत में नयी तकनीकों, नयी खोजों एवं समाधानों को पेश करना भी इसकी जिम्मेदारी है।

[www.cganga.org](http://www.cganga.org)

## आभार

यह विज्ञान दस्तावेज बहुत सारे विशेषज्ञों, संस्थानों एवं संगठनों का सामूहिक प्रयास है, खासकर उनका जो कि भारत सरकार को 2015 में प्रस्तुत की गई गंगा नदी घाटी प्रबंधन योजना (जीआरबीएमपी) को तैयार करने में सहायक रहे हैं। हम उन सारे विशेषज्ञों, संस्थानों और संगठनों के प्रति धन्यवाद ज्ञापित करते हैं। विज्ञान दस्तावेज के लिए फोटो एवं चित्रों का योगदान करने वाले व्यक्तियों के प्रति हम विशेष रूप से आभार प्रकट करते हैं।

## उद्धरण

सी गंगा एवं एनएमसीजी द्वारा विज्ञान गंगा

## सम्पर्क

गंगा नदी घाटी प्रबंधन एवं अध्ययन केंद्र (सी गंगा)

भारतीय प्रौद्योगिकी संस्थान कानपुर, कानपुर 208016, उत्तर प्रदेश, भारत

अथवा

राष्ट्रीय स्वच्छ गंगा मिशन (एनएमसीजी)

मेजर ध्यान चंद नेशनल स्टेडियम, नई दिल्ली, 110002, भारत

# विज्ञान गंगा

दिसम्बर 2017

गंगा नदी घाटी प्रबंधन एवं अध्ययन केंद्र (सी गंगा)

© सी गंगा एवं एनएमसीजी 2017





हिमालय पर्वत में गंगा नदी



# विषय सूची

विज्ञान गंगा • 2017

06	भारतीय चेतना में गंगा नदी	
08	गंगा नदी घाटी प्रबंधन योजना के लिए दृष्टिकोण	
10	चुनौतियां और अवसर	
12	गंगा - मोक्षदायी एवं जीवनयापन की नदी	
14	गंगा नदी प्रबंधन के लिए विज्ञान	
15	गंगा नदी प्रबंधन के उद्देश्य	
16	मिशनो का गठन	
18	रणनीतिक कदम और कार्यवाही	
20	रणनीतिक पहल	
23	राज्य मिशन: उत्तराखंड	
24	राज्य मिशन: उत्तर प्रदेश	
25	राज्य मिशन: बिहार	
26	राज्य मिशन: झारखंड	
27	राज्य मिशन: पश्चिम बंगाल	

# भारतीय चेतना में गंगा नदी

अपनी कई सहायक नदियों सहित गंगा नदी सदियों से भारतीय सभ्यता के भौतिक और आध्यात्मिक जीवन का स्त्रोत रही है और सभी युगों के दौरान, भारतीयों ने विशाल गंगा नदी को देवी एवं उसके प्रवाह को दैवीय-प्रवाह माना है। भारतीय लोगों के लिए नदियों में सबसे पवित्र गंगा न सिर्फ नश्वर का शुद्धिकरण करती है, बल्कि एक सजीव देवी "गंगा माता" भी है। भारतीय चेतना में गंगा की असाधारण महत्ता को भगवान श्री कृष्ण द्वारा भगवद् गीता में भावपूर्ण शब्दों में इस प्रकार व्यक्त किया गया है:

पवनः पवतामस्मि रामः शस्त्रभृतामहम्।  
झषाणां मकरश्चास्मि स्रोतसामस्मि जाह्नवी॥

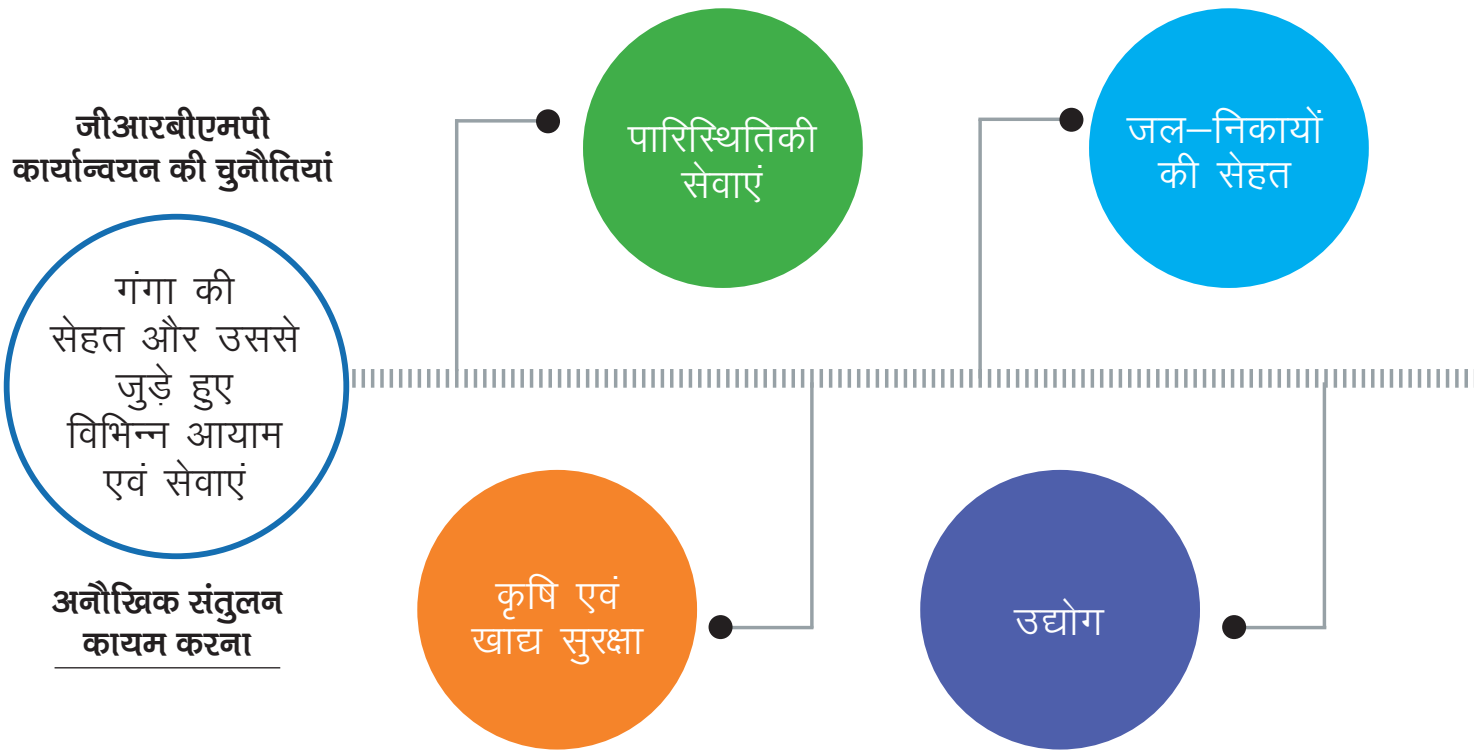
“

पवित्र करने वालों में  
मैं वायु हूँ,  
शस्त्रधारियों में  
मैं राम हूँ,  
जलचरों में  
मैं मगरमच्छ हूँ,  
और नदियों में  
मैं गंगा हूँ।

”

भगवद् गीता, छंद 31, अध्याय 10





## गंगा नदी घाटी प्रबंधन योजना (जीआरबीएमपी) के लिए दृष्टिकोण

पारंपरिक ज्ञान के साथ आधुनिक विज्ञान और प्रौद्योगिकी  
जन ज्ञान + ज्ञान धारा

जीआरबीएमपी तैयार करने का आधार  
“पारंपरिक ज्ञान के साथ आधुनिक विज्ञान और प्रौद्योगिकी का समन्वय”

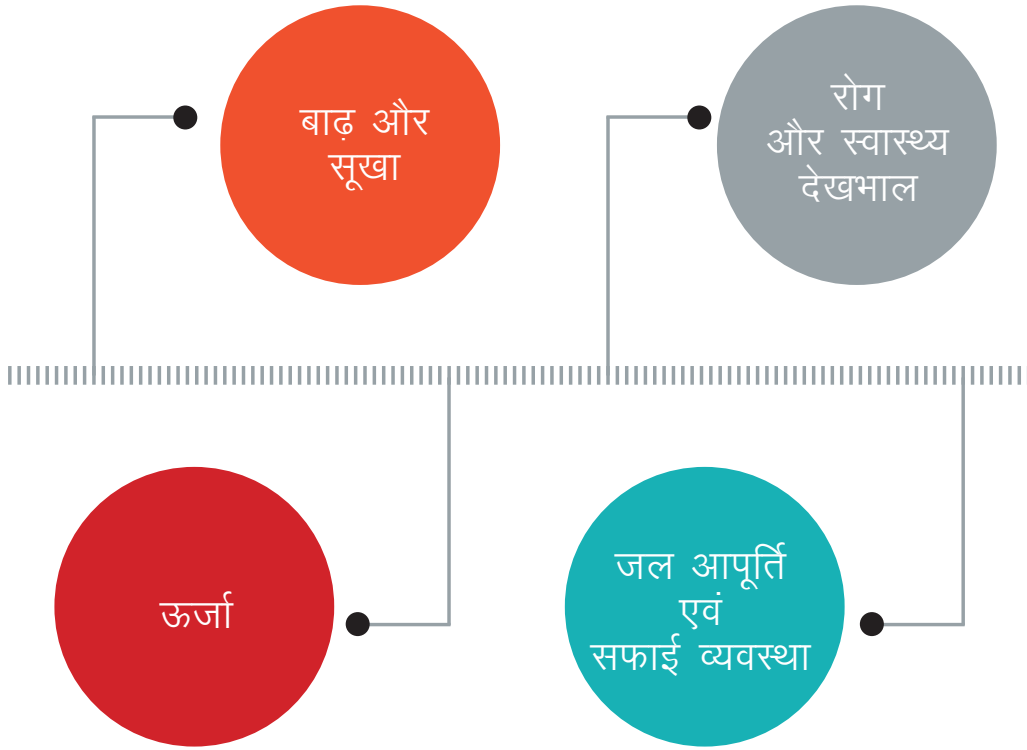
### आधुनिक विज्ञान और प्रौद्योगिकी

गंगा नदी घाटी में सदियों से बहुमूल्य भौतिक संसाधनों (जैसे कि मिट्टी, पानी और खनिज) और जैविक संसाधनों (पौधे, जीव एवं सूक्ष्म जीव) का गतिशील संतुलन बना हुआ है। नदी घाटी में जलीय श्रृंखलाओं (जैसे कि सतह प्रवाही जल, भूजल प्रवाह, नदी बाढ़ और स्थानीय वाष्पीकरण-वर्षा चक्र) एवं पारिस्थितिकी कड़ियों (जटिल खाद्य तंतुओं से लेकर जैव घटकों की गतिविधियों तक) के द्वारा नदी के नेटवर्क, बहुत सारे सतही जल निकाय और भूजल से आपस में जुड़े हुए हैं। इस तरह, क्रियाशील तौर पर नदी घाटी एक अंतः क्रिया करने वाली प्राकृतिक संसाधन प्रणाली है, जिसमें

नदी और उसकी घाटी के बीच जटिल जैविक-भौतिक संप्रेषण के साथ व्यापक सामग्री आदान-प्रदान होती है और पारिस्थितिकी कड़ियों से ऊर्जा हस्तांतरण होता है। इस तरह नदी घाटी के संसाधनों में होने वाली गतिमान अंतः क्रिया न सिर्फ नदी घाटी वरन् नदी प्रणाली दोनों की सेहत को संचालित करती है। लेकिन, लगातार बदलती हुई मानवीय गतिविधियों और अन्य कारणों ने नदी घाटी की गतिशीलता को नया आयाम प्रदान किया है। इस तरह गंगा नदी प्रणाली की स्थिति का वैज्ञानिक मूल्यांकन, नदी प्रणाली एवं नदी घाटी में प्राकृतिक और मानव जनित गतिविधियों से इसके संबंध, और नदी की दुर्दशा को रोकने या कम करने के लिए उपयुक्त तकनीकी प्रयास का नियोजन गंगा नदी घाटी प्रबंधन योजना (जीआरबीएमपी) के मूल में निहित है।

### पारंपरिक ज्ञान

गंगा नदी के जल की गुणवत्ता वर्तमान में चिंताजनक है, जो कि पर्यावरण, स्वास्थ्य और जीवन के लिए एक गंभीर चुनौती है। पारंपरिक तौर पर पुराने समय में नदी के जल की गुणवत्ता उसकी जीवनदायी गुणों के लिए उल्लेखनीय थी और इस बात के लिए नियम तय थे कि मनुष्यों द्वारा नदी को कैसे उपयोग किया जाए लेकिन समय बीतने के साथ-साथ ये नियम कमजोर होते गये और नदी का सदुपयोग, वस्तुतः दुरुपयोग में बदल गया। हम सदैव गंगा नदी के लिए अथाह सम्मान रखते हैं और व्यक्त करते हैं, लेकिन हमारे आधुनिक विचारों में गंगा नदी के पर्यावरणीय महत्व का स्पष्ट उल्लेख होना चाहिए। अतः जन साधारण का विश्वास एवं सहयोग प्राप्त करने की दृष्टि से नदी प्रबंधन योजना को आवश्यक जानकारी, प्रमाण, एवं नदी के स्वभाव इत्यादि को ध्यान में रखते हुए सभी



**गंगा नदी घाटी**  
का क्षेत्र 10.8 लाख  
(1.08 मिलियन)  
वर्ग किमी में फैला  
हुआ है और इस क्षेत्र  
में **62.5 करोड़**  
(625 मिलियन) लोग  
बसे हुए हैं।

हितधारकों के साथ विचार-विमर्श करके बनाना चाहिए।  
गंगा नदी पर पारंपरिक उल्लेखों के कुछ उदाहरण  
निम्नानुसार प्रस्तुत किए गए हैं:

उदाहरण-1

#### प्राचीन साहित्य में गंगा नदी के पानी की गुणवत्ता

प्राचीन काल में गंगा नदी के पानी की गुणवत्ता की प्रशंसा की गई है। इसके जीवनदायी और आरोग्यकारी गुणों का प्रमाण (300 ई०) में निम्नलिखित वर्णन से स्पष्ट होता है: "गंगा जल के गुण - शीतलता, मिठास, पारदर्शिता, अत्यंत स्वास्थ्यवर्धक, पौष्टिकता, पवित्रता, अमंगल को दूर करने की क्षमता, शरीर में पानी की कमी से होने वाली अचेतावस्था से चेतना लाने की क्षमता, पाचक गुण और प्रज्ञा की क्षमता"।

**अस्या जलस्य गुणाः शीतत्वम्, स्वादुत्वम्, स्वच्छत्वम्, अत्यन्तरुच्यत्वम्, पथ्यत्वम्, पावनत्वम्, पापहारित्वम्, तृष्णामोहध्वंसत्वम्, दीपनत्वम्, प्रज्ञाधारित्वम्, इति राजनिर्घण्टः**

उदाहरण-2

#### नदी के संरक्षण के लिए लोगों को सरल निर्देश

नदियों में विभिन्न जटिल पारिस्थितिकी-जलीय-आकृतिक (इको-हाइड्रो-मारफोलाजिकल) आयाम होते हैं जो कि आम समझ से परे हैं। लेकिन, यदि इन्हें आस्था से जोड़ा जाये, तो जन साधारण न केवल नदियों की रक्षा कर सकते हैं बल्कि स्वयं की रक्षा भी सुनिश्चित कर सकते हैं। इस प्रकार प्राचीन काल के सरल निर्देश गंगा नदी के संरक्षण के साथ-साथ मनुष्यों की सुरक्षा सुनिश्चित करने के लिए विभिन्न भौतिक प्रतिबंधों और नैतिक निषेधों को जोड़ने वाले निम्नलिखित तेरह प्रकार के मानव कार्यों पर प्रतिबंध लगाते हैं, - (1) शौच, (2) कुल्ला करना, (3) पूजन सामग्री का

विसर्जन, (4) शरीर के ऊपर के मल को रगड़कर बहाना, (5) मृत शरीर बहाना (मानव या जानवर), (6) खेल-कूद करना, (7) दान देने के लिये बाध्य करना, (8) फूहड़पन (9) अन्य देवस्थानों को बेहतर बताना, (10) अन्य देवस्थानों की प्रशंसा करना, (11) वस्त्र त्यागना, (12) किसी पर वार करना, और (13) शोर करना।

**गंगां पुण्यजलां प्राप्य त्रयोदश विवर्जयेत्।  
शौचमाचमनं सेकं निर्माल्यं मलघर्षणम्।  
गात्रसंवाहनं क्रीडां प्रतिग्रहमथोरतिम्।  
अन्यतीर्थरतिचैवः अन्यतीर्थं प्रशंसनम्।  
वस्त्रत्यागमथाघातं सन्तारं च विशेषतः॥**

उदाहरण-3

नदियों में अलग-अलग ईको-हाइड्रो-आकृतिक विशेषताएं होती हैं जिन्हें समझना मुश्किल है। परन्तु नदियों से जुड़ी जटिल घटनाओं और उनकी जैव प्रणालियों को समझ, जन साधारण की आस्था से जोड़कर इन जटिल वैज्ञानिक तथ्यों को आसानी से आम लोगों तक पहुँचाया जा सकता है। ठीक ही कहा गया है:

**त्रिभिः सारस्वतं तोयं सप्ताहेन तु यामुनम्।  
सद्यः पुनाति गांगेयं दर्शनादेव नार्मदम्॥**

पवित्र नदी सरस्वती में तीन दिन, पवित्र नदी यमुना में एक सप्ताह एवं पवित्र नदी गंगा में एक बार डुबकी लगाने से मनुष्य को पापों से मुक्ति मिल जाती है। जबकि, पवित्र नदी नर्मदा के दर्शन मात्र से ही मनुष्य पाप मुक्त हो जाता है।  
(मत्स्य पुराण, 185/10 -11)

## चुनौतियां और अवसर

**राष्ट्रीय** स्तर पर पूजनीय होने के बावजूद, गंगा नदी की हालत लंबे समय से बिगड़ती जा रही है। इसका एक कारण नहरों द्वारा बड़े पैमाने पर जल निकासी हो सकता है जो कि 19वीं सदी के मध्य में शुरू हुआ। लेकिन, गंगा नदी घाटी में हानिकारक और बढ़ती हुई मानव जनित विविध गतिविधियों के साथ नदी की बहुत दुर्दशा हो गई। हाल के दशकों में इस तरह कि हानिकारक गतिविधियों में बहुत तेजी आई है, जबकि पारंपरिक प्रदूषण नियंत्रण के सीमित प्रयास नदी के सेहत को ठीक रखने के लिए प्रभावी साबित नहीं हुए हैं। नदी की हालत में गिरावट का मनुष्यों पर प्रत्यक्ष प्रभाव यह पड़ा कि उसकी “जैविक सेवाओं” का अत्यधिक नुकसान हुआ है, खासकर सामान्य सेवाएं (जैसे कि भोजन, स्वच्छ जल एवं रेशे), नियंत्रक सेवाएं (जैसे कि बाढ़ नियंत्रण, भूजल पुनर्भरण, खारे पानी के रिसाव पर नियंत्रण), सहायक सेवाएं (जैसे कि पोषक पुनर्चक्रण, मृदा निर्माण, जैवविविधता कायम रखना), एवं सांस्कृतिक सेवाएं (जैसे मनोरंजन, आध्यात्मिक संतुष्टि)।

हानिकारक मानवीय गतिविधियों में तेजी से बढ़ोतरी और विविधीकरण से बीसवीं शताब्दी के बाद से राष्ट्रीय नदी गंगा और उसकी घाटी का तेजी से पतन हुआ है।

नदी के क्षरण के कारणों को मोटे तौर पर पांच मुख्य समूहों में वर्गीकृत किया जा सकता है, जैसे: (i) नदी घाटी के प्राकृतिक संसाधनों का अति-उपयोग, (ii) अपशिष्ट को प्रवाहित करना, (iii) पानी थामने की क्षमता में कमी और जल स्रोतों को पाटना, (iv) छोटे-छोटे इंजीनियरिंग गतिविधियों द्वारा नदियों की दुर्दशा, और (v) नदी घाटी में भूवैज्ञानिक प्रक्रियाओं के खतरे। उपरोक्त नुकसानकारी प्रमुख मानवीय गतिविधियों को पांच प्रमुख शीर्षकों को आपस में जोड़ा जा सकता है जैसे कि संलग्न चित्र में दिखाया गया है, (i) औद्योगिकीकरण, (ii) शहरीकरण, (iii) जीवन शैली में बदलाव, (iv) खेती और ग्रामीण गतिविधियां, और (v) वनों की कटाई/अनाच्छादन। हालांकि यह व्यापक समूहीकरण नदी घाटी की दुर्दशा के केवल प्रमुख कारकों को ही प्रकट करता है।

इन्हें संतुलित रखना एवं इनके कुप्रभावों की रोकथाम हेतु उचित उपचारात्मक उपाय सुझाने के लिए गहन अध्ययन आवश्यक है। जीआरबीएमपी में प्रमाणों के आधार पर समस्याओं के विश्लेषण एवं निवारण हेतु उचित उपायों के विकास के महत्व पर बल दिया गया है।

हानिकारक  
मानवीय गतिविधियों  
में तेजी से बढ़ोतरी  
और विविधीकरण से  
बीसवीं शताब्दी के  
बाद से राष्ट्रीय नदी  
गंगा और उसकी  
घाटी का तेजी से  
पतन हुआ है।



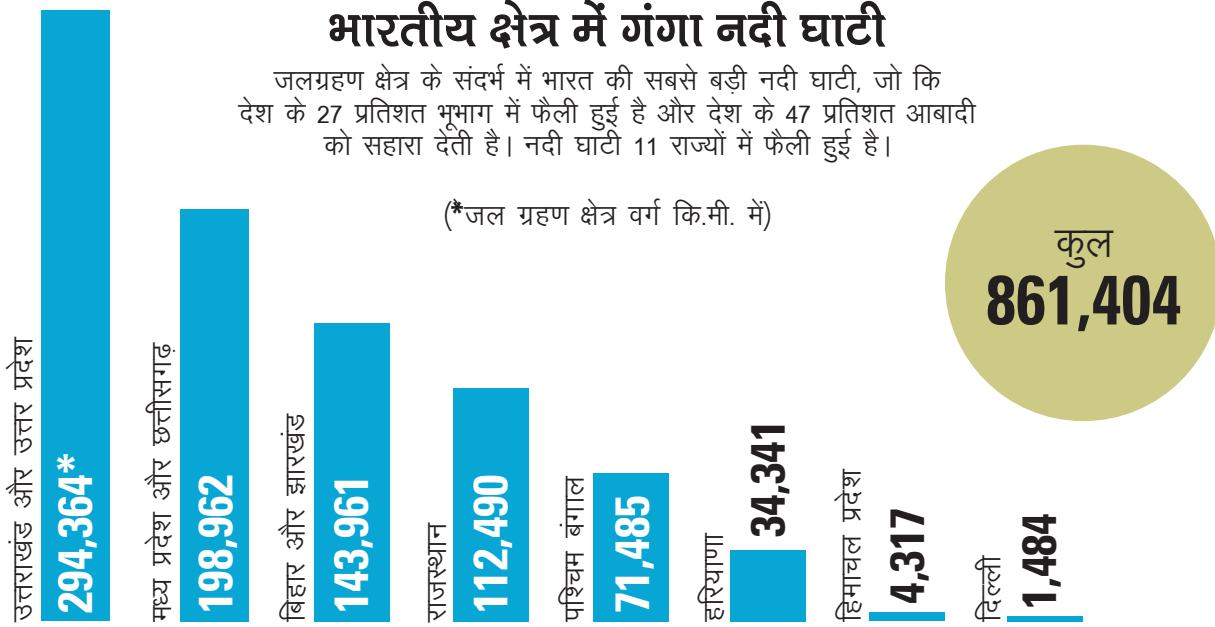
# नदी के क्षरण के पांच प्रमुख कारक और उनके मानव-जनित कारण



## भारतीय क्षेत्र में गंगा नदी घाटी

जलग्रहण क्षेत्र के संदर्भ में भारत की सबसे बड़ी नदी घाटी, जो कि देश के 27 प्रतिशत भूभाग में फैली हुई है और देश के 47 प्रतिशत आबादी को सहारा देती है। नदी घाटी 11 राज्यों में फैली हुई है।

(\*जल ग्रहण क्षेत्र वर्ग कि.मी. में)

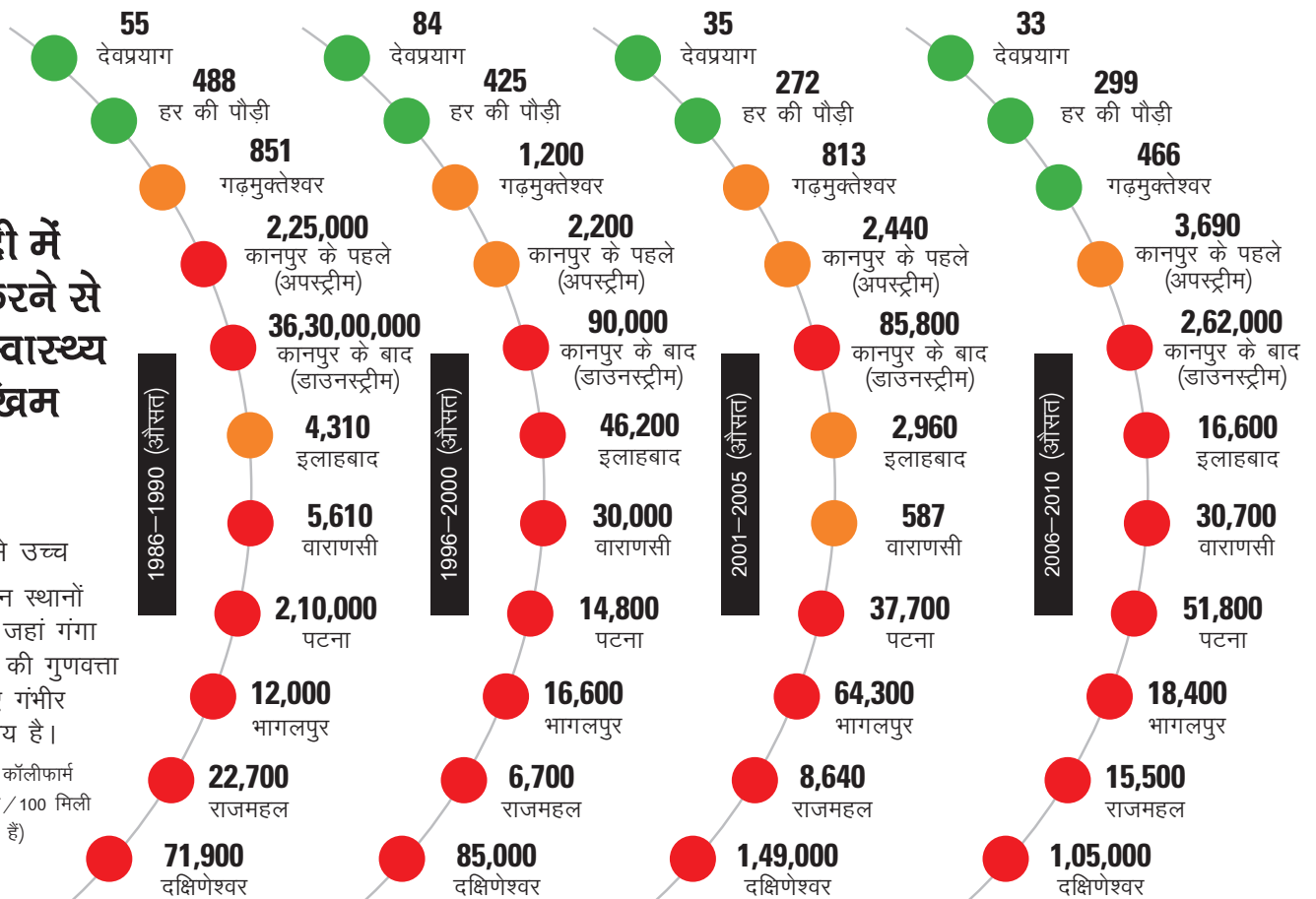


## गंगा नदी में स्नान करने से मानव स्वास्थ्य को जोखिम

- नगण्य
- नाममात्र
- मध्यम से उच्च

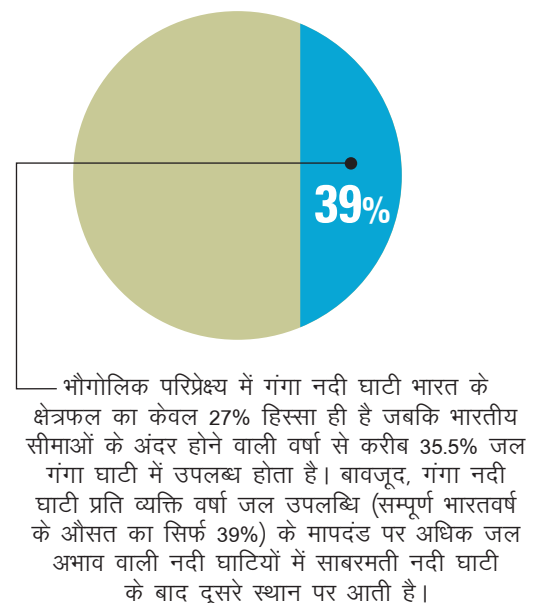
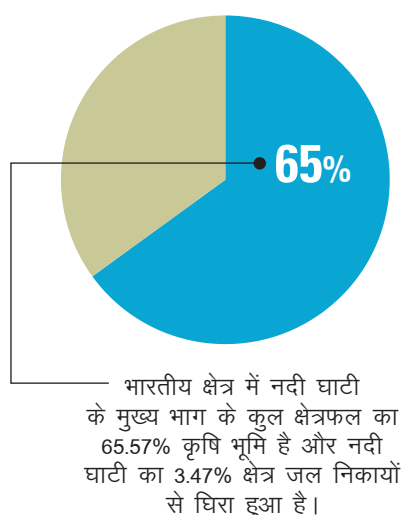
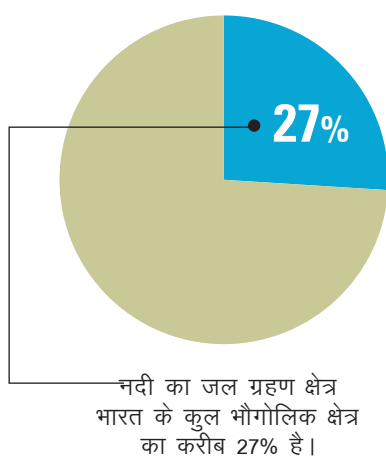
लाल गोले उन स्थानों को दर्शाते हैं जहां गंगा नदी के पानी की गुणवत्ता स्नान के लिए गंभीर चिंता का विषय है।

(मान (वैल्यू) कुल कॉलीफार्म की मात्रा एम्पीएन/100 मिली के तौर पर दर्शाते हैं)



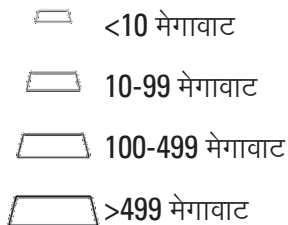
## गंगा - मोक्षदायी एवं जीवनयापन की नदी

गंगा नदी दुनिया की सबसे पूज्य नदियों में से एक है, लेकिन अत्यधिक जल दोहन एवं प्रदूषण की वजह से नदी की सेहत एवं विकास के लिए खतरा पैदा हो रहा है।

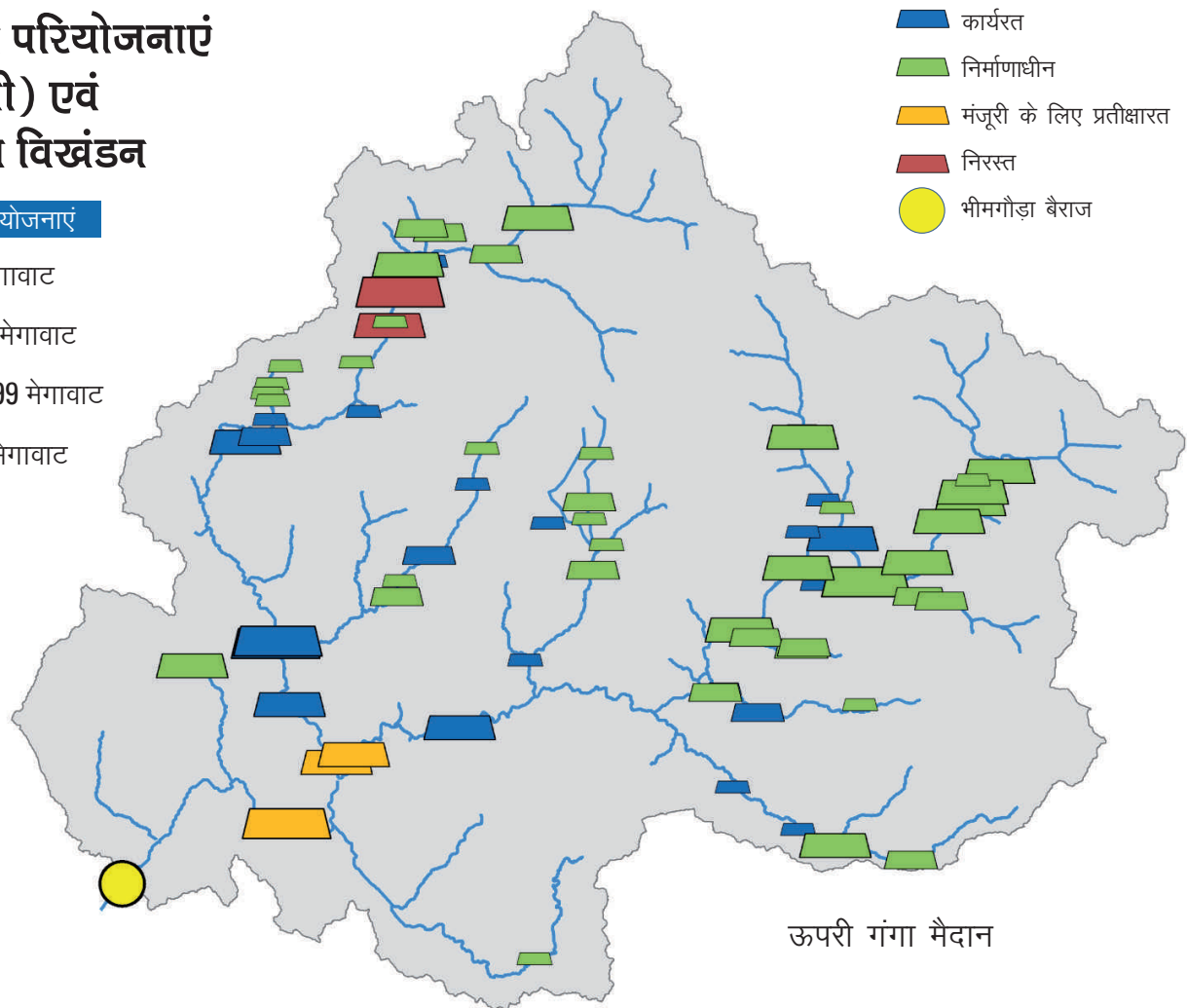


## जलविधुत परियोजनाएं (एचईपीपी) एवं नदियों का विखंडन

### जलविधुत परियोजनाएं



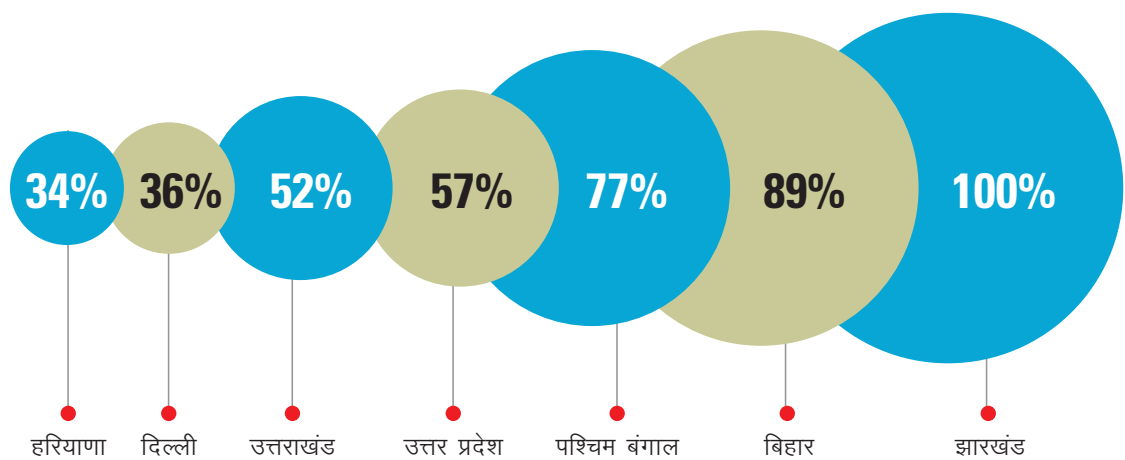
### जलविधुत परियोजनाएं



ऊपरी गंगा मैदान

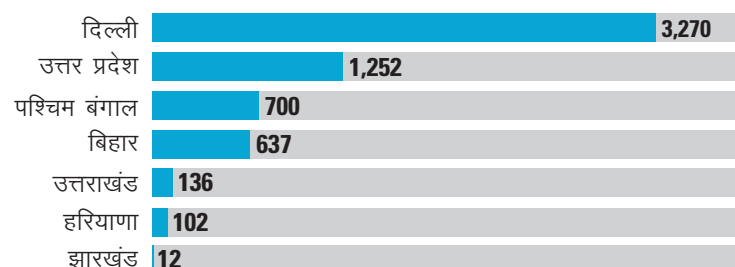
## गंगा एवं यमुना में अशोधित सीवेज का प्रवाह

हालांकि झारखंड राज्य के नदी घाटी में पड़ने वाले हिस्से से निकलने वाले सीवेज का लगभग 100% बिना शोधन के ही गंगा में प्रवाहित होता है, फिर भी झारखंड सबसे कम प्रदूषण फैलाने वाला राज्य है।



## नमूने के तौर पर चुने गये शहरों में बिना शोधन के प्रवाहित होने वाले सीवेज का राज्यवार अनुमान

(आंकड़े मिलियन लीटर प्रतिदिन में) MLD



## गंगा नदी के लिए विज़न

राष्ट्रीय नदी गंगा को संरक्षित करने और जीवंत बनाने के लिए, उसके प्राकृतिक स्वभाव को समग्र रूप से समझा जाना चाहिए। गंगा पर उपलब्ध ग्रंथों की व्यापक समीक्षा, शोध, आंतरिक चर्चा, एवं हितधारकों के साथ विचार विमर्श के बाद “राष्ट्रीय नदी गंगा की सम्पूर्णता” को गतिशील परिप्रेक्ष्य में निम्नलिखित चार बिंदुओं में समाहित किया जा सकता है, ऐसा ही जीआरबीएमपी में निर्धारित किया गया था।

### 1. “अविरल धारा” (निर्बाध प्रवाह)

गंगा नदी के जल, गाद और अन्य प्राकृतिक घटकों का प्रवाह पूरे वर्ष नदी की पूरी लम्बाई में निरंतर और पर्याप्त होना। इसलिए नदी की बाधाओं, पानी के डाइवर्जन एवं सतही प्रवाह की बाधाओं को नियंत्रित किया जाना चाहिए।

### 2. “निर्मल धारा” (प्रदूषण रहित प्रवाह)

मानवनिर्मित प्रदूषण से गंगा नदी के तंत्र का प्रवाह प्रदूषित हुआ है। इसलिए वर्तमान समय में नदी, नालो एवं तालाबों में मानव जनित अथवा निर्मित अपशिष्ट को प्रत्यक्ष अथवा अप्रत्यक्ष रूप में पहुंचने नहीं दिया जाना चाहिए।

### 3. भूगर्भिक अस्तित्व

गंगा नदी—प्रणाली प्राचीन काल की धरती की रचना है, जिसके नष्ट होने पर क्षतिपूर्ति नहीं हो सकती है। अतः पूरे नदी घाटी की भूगर्भिक अखंडता को संरक्षित किया जाना चाहिए।

### 4. पारिस्थितिकीय अस्तित्व

गंगा नदी—प्रणाली विभिन्न जीवित प्रजातियों और भौतिक वातावरण के बीच एक संरचित संतुलन है, जो हजारों सालों से प्रकृति द्वारा तैयार किया गया है और अपरिवर्तनीय बदलावों के प्रति संवेदनशील है। इसलिए नदी के प्रणाली के जैव-भौतिक संसाधनों के साथ अति-दोहन और अनावश्यक छेड़छाड़ रोकने का पूर्ण प्रयास किया जाना चाहिए।

## गंगा नदी की सम्पूर्णता

1  
अविरल धारा

2  
निर्मल धारा

3  
भूगर्भिक अस्तित्व

4  
पारिस्थितिकीय  
अस्तित्व

गंगा नदी अपने स्रोतों से गंतव्य स्थान पहुंचने तक **2500 किलोमीटर** से भी अधिक रास्ता तय करती है, जो पांच अलग राज्यों को अपनी मूल धारा से जोड़ती है और अपनी पूरी नदी घाटी में ग्यारह राज्यों को समेटे हुए है।





वाराणसी, उत्तर प्रदेश में गंगा नदी के घाट

# गंगा नदी प्रबंधन के उद्देश्य

यह योजना  
गंगा नदी  
की सम्पूर्णता बहाल  
करने के उद्देश्य  
से तैयार की  
गई है।

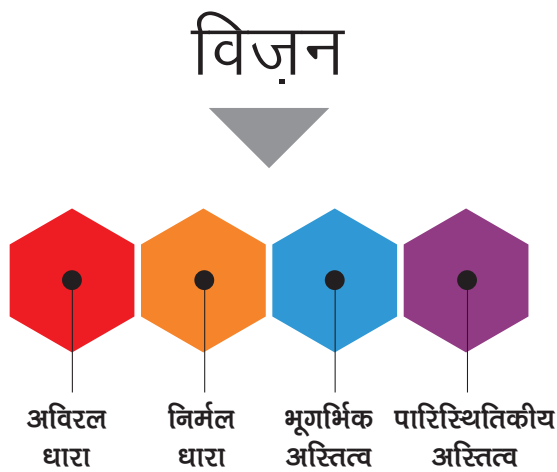
**विज्ञान** एवं सामाजिक जरूरतों के आधार पर, गंगा नदी प्रबंधन के मुख्य उद्देश्य निम्नलिखित हैं:

**क.** भूवैज्ञानिक, पारिस्थितिक, सामाजिक-आर्थिक और सांस्कृतिक कार्यों को पूरा करने के लिए गंगा नदी प्रणाली की सभी नदियों और सहायक नदियों में पर्यावरणीय प्रवाह (ई-फ्लो) कायम रखा जाए।

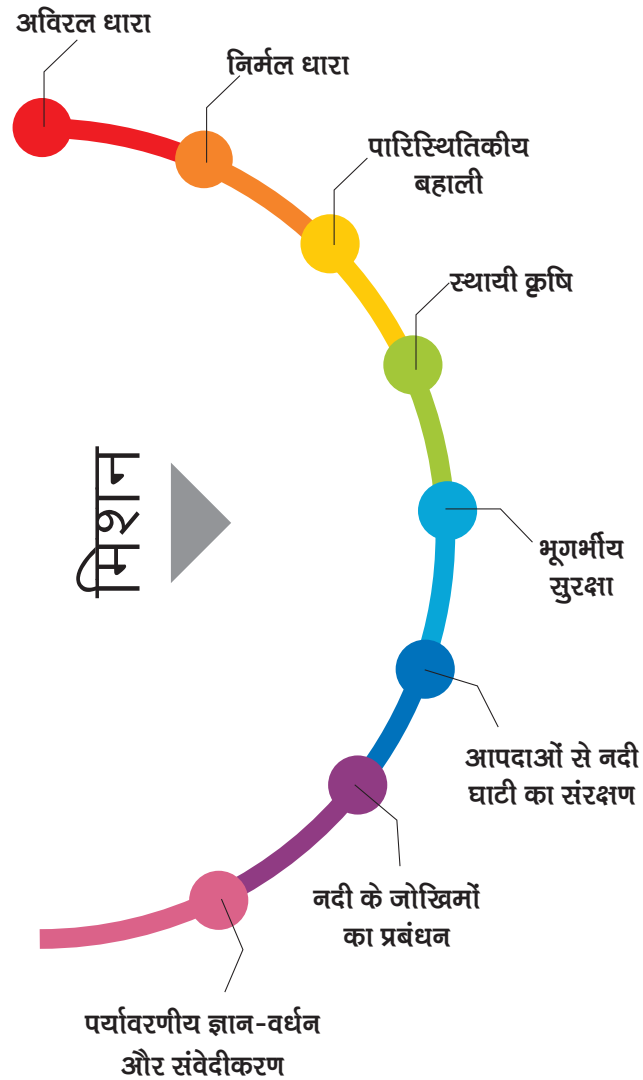
**ख.** गंगा नदी प्रणाली की सभी सहायक नदियों में पानी की गुणवत्ता उनके संचालक भूवैज्ञानिक, पारिस्थितिक, सामाजिक-आर्थिक और सांस्कृतिक कार्यों के अनुरूप हो।

**ग.** पूरी नदी घाटी में सतत विकास को सक्षम बनाने के लिए गंगा नदी प्रणाली के जल और अन्य जलीय संसाधनों का उपयोग विवेकपूर्ण तरीके से किया जाए।

**घ.** नदी घाटी की समग्र सेहत के लिए घाटी में मौजूदा और नियोजित सभी मानव-जनित गतिविधियों की पारदर्शी एवं समावेशी तरीके से (सभी प्रभावित लोगों और हितधारकों की सहमति के साथ) समीक्षा की जाए।



**मिशन**



## मिशनो की संरचना

गंगा के विज़न और उद्देश्य के दृष्टिकोण एवं गंगा नदी घाटी में मानव गतिविधियों के बढ़ते प्रभावों को देखते हुए आठ महत्वपूर्ण क्षेत्रों में मिशन रूप में कार्य करने की आवश्यकता है। अतः इन आठ क्षेत्रों में ध्यान आकर्षित कर सुधारात्मक कार्य निम्नांकित मिशनो जैसे: “अविरल धारा”, “निर्मल धारा”, “पारिस्थितिकीय बहाली”, “स्थायी कृषि”, “भूगर्भीय सुरक्षा”, “आपदाओं से नदी घाटी का संरक्षण”, “नदी के जोखिमों का प्रबंधन” और “पर्यावरणीय ज्ञान-वर्धन और संवेदीकरण” के जरिये प्रस्तावित किये गए हैं। गंगा नदी की सम्पूर्णता के विज़न को आकर देने के लिए मिशनो की संरचना को संलग्न चित्र में दर्शाया गया है।

**गंगा नदी का  
प्राकृतिक,  
सांस्कृतिक और  
आध्यात्मिक महत्व  
उसकी घाटी की  
सीमा के साथ-साथ  
सम्पूर्ण विश्व में है।**



उत्तराखंड में  
टिहरी जलाशय





# रणनीतिक कदम और कार्यवाहियां

गंगा नदी के पुनरुद्धार और दीर्घकालिक संरक्षण के लिए उठाये गये विभिन्न रणनीतिक कदमों एवं कार्यवाहियों को अनेक मिशनों के अंतर्गत वर्गीकृत किया गया है।

## मिशन 1

### अविरल धारा

1. जल संसाधनों की स्थिति का सटीक आकलन और निर्धारण करना।
2. जंगल, नम/आर्द्र भूमि, वितरित सतही एवं भूमिगत जल भंडारणों का समावेश करते हुए जल संसाधनों का नियोजन करना।
3. निम्नांकित उपकरणों/प्रणालियों/व्यवस्थाओं के माध्यम से जल के उपयोग की दक्षता में बढ़ोतरी करना – (क) स्वच्छ जल की वास्तविक कीमत तय करना, (ख) उपभोक्ताओं के लिए प्रोत्साहन, तकनीकी सहायता और जल अधिकारों एवं हकदारी का निर्धारण, एवं (ग) पानी के पुनः उपयोग और पुनर्चक्रण पर बल देना।
4. जल संसाधन संरक्षण, हितधारक नियंत्रण, विशेषज्ञ मार्गदर्शन और विनियमन पर जोर देते हुए जल नीति में बदलाव करना।
5. बांधों, बैराजों आदि पर नदी का लम्बवत जुड़ाव एवं पर्यावरणीय प्रवाह (इ-फ्लोज) सुनिश्चित करना एवं ऐसी परियोजनाओं की मंजूरी के लिए नये मानदंड तय करना।
6. जल की कमी वाले क्षेत्रों में जल-दोहन को नियंत्रित करना।
7. गाद संसाधनों की मात्रा, गुणवत्ता और पोषक तत्व के महत्व सहित उनका आकलन और निगरानी करना।

## मिशन 2

### निर्मल धारा

1. घरेलू/व्यावसायिक स्रोतों से निकलने वाले ठोस और तरल कूड़े-कचरों का प्रबंधन करना।
2. नदी-तट विकास, बाढ़ मैदान प्रबंधन एवं जल स्रोतों को पुनः बहाल करना।
3. उद्योगों से निकलने वाले ठोस एवं तरल कचरों का प्रबंधन करना।
4. खेती से निकलने वाले प्रदूषित प्रवाहों का प्रबंधन करना।

## मिशन 3

### पारिस्थितिकीय बहाल

1. बांध, बैराज और अन्य अवरोधों पर पर्यावरणीय प्रवाह (इ-फ्लोज) के साथ लम्बवत जुड़ाव को बहाल करना।
2. बाढ़ मैदानों में पार्श्व जुड़ाव (लेटरल कनेक्टिविटी) का रख-रखाव करना।
3. अप्रदूषित नदियों की पुनः स्थापना।
4. नदी-तट में खेती एवं रेत खनन को विनियमित करना।
5. अधिक ध्वनि करने वाले जहाजों के आवागमन, नदी की खुदाई, और नदी के स्वरूप को बदलने वाली गतिविधियों को विनियमित करना।
6. बाहरी प्रजातियों की वृद्धि पर रोकथाम, अत्यधिक मछली पकड़ने और विशेषतः प्रजनन वाले मौसमों में मछली पकड़ने पर नियंत्रण करना।
7. नदी के पोषक तत्वों का आकलन करना और बांधों/बैराजों के पीछे फंसे/रुके हुए नदी के गाद को डाउनस्ट्रीम में छोड़ना।
8. गंगा नदी के नेटवर्क की दीर्घकालिक जैव निगरानी करना।
9. डॉल्फिन संरक्षण कार्य योजना-2010 को शामिल करना।
10. नदी प्रणाली के पारिस्थितिकीय आयाम पर व्यापक शोध करना।

## मिशन 4

### स्थायी कृषि

1. कृषि उत्पादन, विशेषतः ऊसर अथवा डीग्रेडेड जमीन में संसाधन संरक्षण के साथ जमीन की उर्वरता को बढ़ाने के लिए संरक्षित कृषि (बिना जुताई, फसल में बदलाव, एवं खाली जमीन घास-पात से ढकना) को अपनाना।
2. जहां आवश्यक हो या आर्थिक रूप से व्यवहारिक हो वहां जैविक खेती को बढ़ावा देना।
3. धान की खेती में जल एवं पोषक तत्व के लिए लाभकारी तकनीक अपनाना, जैसे कि एसआरआई (धान की पैदावार बढ़ाने की तकनीक) एवं यूरिया डीप प्लेसमेंट।
4. अन्य स्थापित संसाधन संरक्षण तकनीकों को बढ़ावा देना।
5. नीरस कृषि-पारिस्थितिक प्रणाली के प्रभावों का सामना करने के लिए क्षेत्रीय (लैंडस्केप-मापन) संसाधन संरक्षण चरणों को बढ़ावा देना।
6. अनुकूलनशीलता तथा लचीलापन अपनाकर वर्तमान में जारी एवं भावी वैज्ञानिक आविष्कारों के साथ पारंपरिक ज्ञान को समन्वित करते हुए कृषि में अनुसन्धान को बढ़ावा देना।
7. उपयुक्त नीति और संस्थागत ढांचे को मजबूत बनाना।

**मिशन निर्मल धारा पर नोट:** शहरी कार्यों के लिए परियोजना के नियोजन की शुरुआत श्रेणी 1 के शहरों की विस्तृत शहरी नदी प्रबंधन योजना (यूआरएमपी) से करना चाहिए। उसके बाद श्रेणी 2 और श्रेणी 3 के शहरों के लिए भी यूआरएमपी तैयार किया जाना चाहिए। यूआरएमपी के बाद डीपीआर तैयार होने पर ही परियोजना क्रियान्वयन के लिए फंड आवंटित किया जाना चाहिए। फंड आवंटन में उन परियोजनाओं को प्राथमिकता दी जानी चाहिए जो नदी प्रणाली में बड़ी मात्रा में तरल कचरे के सीधे डिस्चार्ज रोकने के लिए डिजाइन की गई हों (प्राथमिकता स्तर-1), उसके बाद उन परियोजनाओं को फंड आवंटित करना चाहिए जो कि बड़ी मात्रा में ठोस कचरे के सीधे डिस्चार्ज रोकने के लिए डिजाइन की गई हों (प्राथमिकता स्तर-2), उसके बाद नदी के ढांचे के विकास और गंगा नदी प्रणाली के बगल में बसे शहरी क्षेत्रों में बाढ़ मैदान को पुनः कायम करने के लिए डिजाइन की गई परियोजनाओं को प्राथमिकता दी जानी चाहिए (प्राथमिकता स्तर-3)। मिशन निर्मल धारा के अंतर्गत अन्य परियोजनाओं को फंड की उपलब्धता के आधार पर आगे बढ़ाया जा सकता है।



## कार्यान्वयन प्रक्रिया

गंगा नदी घाटी की समस्याओं और उनके निवारण हेतु किए जा रहे प्रयासों में दीर्घकालिक आधार पर कार्यान्वयन, निगरानी, समीक्षा और मूल्यांकन विभिन्न केंद्रीय और राज्य संगठनों के माध्यम से करना बहुत ही मुश्किल है जब तक कि उनका समन्वय और निरीक्षण का कार्य किसी एक स्वतंत्र संस्था द्वारा न किया जाए। इस उद्देश्य के लिए एक स्वतंत्र संस्था की स्थापना की सिफारिश की गई है। चूंकि संविधान के अनुसार नदियां अंतर्राज्यीय विषय के अंतर्गत आती हैं, इसलिए विभिन्न क्षेत्रीय संगठनों और समाज की अनौपचारिक क्षेत्रों की गतिविधियों की देखरेख के लिए, जहां तक वे गंगा नदी को प्रभावित करते हैं, उक्त संस्था को पर्याप्त संसाधनों एवं अधिकारों की जरूरत है। इसलिए जीआरबीएमपी ऐसी एक संस्था को बहुत ही आवश्यक मानते हुए उसे क्रियाशील जरूरतों में शामिल करती है जिसे संसद के एक अधिनियम द्वारा स्थापित किए जाने की आवश्यकता है, ताकि जीवनदायी नदी गंगा एवं उसकी नदी घाटी के सतत विकास को कायम रखने के लिए स्थायी प्रक्रिया बनायी जा सके।

### मिशन 5

#### भूगर्भीय सुरक्षा

1. बड़े जलाशयों का संचालन एवं भूगर्भीय खतरनाक गतिविधियां जैसे गहवाई से भूजल निकासी, भूमिगत खुदाई, विस्फोट, सुरंग निर्माण, खनन, हाइड्रोलिक रॉक फ्रैक्चरिंग, इत्यादि पर नियंत्रण/विनियमन करना।
2. भू-आकृति के लिए हानिकर भूमि उपयोग परंपराएं जैसे कि, पहाड़ी ढलानों और बाढ़ के मैदानों पर वनों की कटाई और निर्माण गतिविधियां, अत्यधिक जुताई, नदी के तल में खनन, नदी तटों का रुपांतरण पर रोक लगाना।
3. जल निकास, विशेषतः निचले क्षेत्रों में, का उचित प्रबंधन एवं संभावित भूस्खलन, कटाव, इत्यादि क्षेत्रों का स्थिरीकरण।
4. नदी जिस क्षेत्र में अपना मार्ग परिवर्तित करती रहती है (रिवर माइग्रेशन जोन्स) उसका चिन्हीकरण एवं घाटी क्षेत्र की भूगर्भीय निगरानी करना।

### मिशन 6

#### आपदाओं से नदी घाटी का संरक्षण

1. नियमित रूप से होने वाली जल-मौसम संबंधी और जैविक घटनाओं के प्रतिरोध पर नियंत्रण।
2. पारिस्थितिकी तंत्र को घातक आपदाओं से सुरक्षित रखने के लिए नम (जलमय) भूमियों का संरक्षण, मिश्रित वनस्पतियों और स्वदेशी जंगलों को बढ़ावा, और मानव-भूमि-उपयोग से हो रहे अतिक्रमण और असंतुलन को नियंत्रित करना।
3. नदी के अत्यधिक बाढ़ से निपटने के लिए बाढ़ प्रभावित मैदान के विनियमन और पेड़ लगाने के उपाय, बांधों/तटबंधों की तुलना में बेहतर होते हैं।
4. जंगलों की आग (दावाग्नि), महामारी एवं जैविक आक्रमण की घटनाओं का बिना विस्तृत पारिस्थितिकी अध्ययन के सक्रिय हस्तक्षेप को सीमित रखना।
5. भूस्खलन और मिट्टी धसकने को न्यूनतम करने के लिए ऊपरी गंगा नदी घाटी में और अन्य पहाड़ी क्षेत्रों में वनों की कटाई, सड़क और भवन निर्माण, और असुरक्षित मलबे के निपटान की कड़ाई से निगरानी।
6. आपदाग्रस्त पारिस्थितिक तंत्रों के जीर्णोद्धार के लिए देशी किस्मों की वनस्पतियों को शामिल कर एक सक्षम भौतिक वातावरण का पुनर्निर्माण किया जाना।

### मिशन 7

#### नदी के जोखिमों का प्रबंधन

1. नदी घाटी के स्तर पर बाढ़ के जोखिम वाले नक्शे तैयार करना और उसे ऑनलाइन डेटा बेस और बाढ़ चेतावनी प्रणाली से जोड़ना।
2. निचले क्षेत्रों के जल निकास को व्यवस्थित करना और भूमि सुधार तत्काल रूप से किया जाना।
3. जमीन में खारेपन का आकलन कर लवणता प्रतिरोधी फसलों और मिट्टी सुधार व्यवस्थाओं के उपयोग से इसे दूर करने की रणनीति अपनाना।
4. बाढ़ प्रबंधन के लिए तटबंध के विकल्प के बजाय 'बाढ़ के साथ जीने' की अवधारणा पर बल देना। इसके साथ बाढ़ मैदान के क्षेत्र तय करना और अन्य गैर-संरचनात्मक दृष्टिकोण शामिल हो सकते हैं।
5. सतत नदी प्रबंधन रणनीतियों के लिए नदी प्रबंधन परियोजनाओं में गाद के आयाम और उसके उपयोग पर शोध।
6. कुछ पायलट प्रोजेक्ट राज्य सरकारों के साथ साझेदारी में किए जा सकते हैं, जैसे कि (क) कोसी नदी घाटी में अति प्राचीन (पैलियो) चैनलों को पुनः सक्रिय करना और बाढ़ के फैलाव को विनियमित करना, (ख) अनियोजित रेल/सड़क नेटवर्क की वजह से हुए जल निकास के अवरोधों को सुधारना, (ग) जल निकासी के लिए नहरों की परिकल्पना करना।

### मिशन 8

#### पर्यावरण ज्ञान-वर्धन और संवेदीकरण

1. नदी घाटी के प्राकृतिक संसाधनों, मानव-जनित गतिविधियों और घाटी के पर्यावरण निगरानी के बारे में जानकारी को नियमित इकट्ठा, विश्लेषण और संग्रहण कर एक व्यापक डाटा बैंक की स्थापना करना।
2. प्राथमिक डाटा के आधार पर माध्यमिक परिणामों (चार्ट्स, ग्राफ्स, टेबल्स आदि) को तैयार करना।
3. सामान्य लोगो द्वारा आसानी से समझने योग्य रिपोर्ट्स एवं सामग्रियों को तैयार करना।
4. इच्छुक और सक्रिय व्यक्तियों और संस्थानों तक आसानी से पहुंच के लिए उपरोक्त जानकारी को सार्वजनिक पटल (वेबसाइट) पर उपलब्ध कराना।
5. नदी घाटी की प्रक्रियाओं के लिए लोगो को संवेदनशील एवं उनमें व्यापक समझ उत्पन्न करने के लिए हितधारकों और दिलचस्पी रखने वाले नागरिकों के साथ शैक्षिक कार्यशाला और अभियान आयोजित करना।
6. हितधारकों की भागीदारी से गंगा नदी घाटी के पर्यावरण की जमीनी स्तर पर निगरानी और शोध करना।

# अनोखे आयाम

गंगा न सिर्फ हमे सीखने के तमाम अवसर प्रदान करती है वरन् उसके साथ-साथ बहुत अधिक चुनौतियों को भी न्योता देती है। नदी, विकास की आकांक्षाओं को पूर्ण करने में और सांस्कृतिक विविधता को बनाये रखने में महत्वपूर्ण योगदान तो देती ही है अपितु इसके अतिरिक्त गहरे अध्ययन और दूरदर्शी उद्यमिता (विजिनरी एंटरप्रेनरशिप) के तमाम अवसर भी प्रदान करती है।

1

इसके लिए सतही और उप-सतही जल विज्ञान प्रणालियों के बारे में अच्छी समझ की आवश्यकता है। पिछले आंकड़ों और वर्तमान आंकड़ों के संग्रहण का विस्तार करके हम व्यापक रूप से इन प्रणालियों को बड़े पैमाने पर समझ सकते हैं। तब हितधारकों के लिए एक कुशल संयोजन उपलब्ध होने से नीति निर्माण वास्तव में प्रतिक्रियात्मक से अग्रसक्रिय बन सकता है, जिससे विभिन्न संभावित घटनाओं के लिए परिदृश्य तय करने की क्षमता भी विकसित हो सकती है।

## प्रमाण आधारित नीति निर्माण की ओर

2

एक समेकित एकल खिड़की पद्धति से दुनिया भर की तकनीकी कंपनियों को तकनीकी सत्यापन के माध्यम से पायलट परियोजनाओं में भाग लेकर उसे व्यावसायिक पैमाने तक ले जाकर नदी स्वच्छता कार्यक्रम में भागीदारी का अवसर मिलेगा।

## तकनीकी हस्तांतरण को तेज करना

3

गंगा नदी घाटी सृजनात्मक तकनीकी, वैज्ञानिक और व्यापारिक प्रतिभाओं के लिए असाधारण उद्यमशीलता का अवसर प्रदान करती है। चाहे वह एक उन्नत सेंसर नेटवर्क के साथ बड़े आंकड़ों के विश्लेषण संबंधी प्रणाली स्थापित करना हो या एक छोटे से नदी/नाले को पुनर्जीवित करना हो, या समुदायों के लिए पेयजल की व्यवस्था करना हो, गंगा नदी घाटी में उद्यमियों के लिए कई चुनौतियां हैं। एक समर्पित मंच, जिसमें नये तकनीकी खोज के लिए फंड और अन्य विशेष प्रोत्साहन का प्रावधान हो, की आवश्यकता है। यह मंच उन उद्यमियों को लॉन्चपैड प्रदान करेंगे जो कि पर्यावरणीय चुनौतियों का समाधान करने का जुनून रखते हैं।

## जल उद्यमशीलता के लिए एक मंच प्रदान करना

**गंगा** नदी घाटी की पूर्ण संभावित क्षमता प्राप्त करने के लिए आर्थिक प्रभाव वाले आठ अनोखे आयामों की पहल

4

## मार्केट आधारित प्रक्रिया विकसित करना

हालांकि सरकार नदी स्वच्छता और पुनोद्धार के लिए विशाल पूंजी लगा रही है, लेकिन जल के विभिन्न प्रकार के उपभोग में एक बड़ा बदलाव ला सके ऐसा मार्केट आधारित तंत्र विकसित करना भी उतना ही महत्वपूर्ण है। पहला और सबसे महत्वपूर्ण प्रयास जल की सही लागत को स्थापित करना है ताकि सभी उपयोगकर्ता इसके मूल्य को समझ सकें। इसमें जल के अधिकार, जल के व्यापार जैसी प्रक्रियाओं को शामिल करने से जल उपयोग करने, साझा करने और उपलब्धता में समानता और समता की स्थिति आएगी।

## जल-नवप्रवर्तन निर्यात के लिए भारत को एक वैश्विक केन्द्र बनाना

गंगा नदी घाटी में एक सतत और गहन गतिविधि के माध्यम से भारत जल और नदी घाटी प्रबंधन के मामले में जानकारी का प्रमुख निर्यात केंद्र बनने की क्षमता रखता है। यह क्षमता केवल तकनीकी उन्नति तक ही सीमित न रहकर शासन और समुदाय की भागीदारी के पहलु भी शामिल करने वाले होंगे।

5

## वैश्विक जल परिचारक

भारत की जल सुरक्षा के चैंपियन होने की वैश्विक आकांक्षा एक व्यापक-पहुंच कार्यक्रम के बिना हासिल नहीं की जा सकती। भारतीय राजनयिक मिशनों के सहयोग से अंतरराष्ट्रीय खंडों की स्थापना करने से भारत को बेहतरीन तकनीकी और वैज्ञानिक समझ को आकर्षित करने में मदद मिलेगी। इसके साथ ही रणनीतिक साझेदारी के माध्यम से दुनिया के कई हिस्सों में जल-संकट को सुलझाने में भी भारत अग्रणी हो सकेगा।

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गंगा नदी की पूर्वकालीन महिमा को बहाल करने के लिए बहुत ही अधिक पूंजी खर्च करने की आवश्यकता है। वित्त के अन्य स्रोतों के बिना, किसी भी सरकार के लिए बजट आवंटन में इतनी बड़ी राशि प्रदान करना मुश्किल होगा। घरेलू और अंतरराष्ट्रीय दोनों स्रोतों से पूंजी के अतिरिक्त स्रोतों को आकर्षित करने के लिए अभिनव वित्तीय मॉडल की आवश्यकता है। इनमें कम लागत वाले, दीर्घकालिक आर्थिक मॉडल अपनाने की आवश्यकता है। इनमें प्रतिभूति सीमित वित्तपोषण, विकास जोखिम पूंजी एवं मुनाफा वाले या बॉन्ड मार्केट से वित्तपोषण (रूपये नाम वाले गंगा-ब्लू बॉन्ड) शामिल हैं, लेकिन इनको मात्र तकनीकी हस्तांतरण फंड तक सीमित नहीं होना चाहिए।

## अभिनव वित्तपोषण मॉडल

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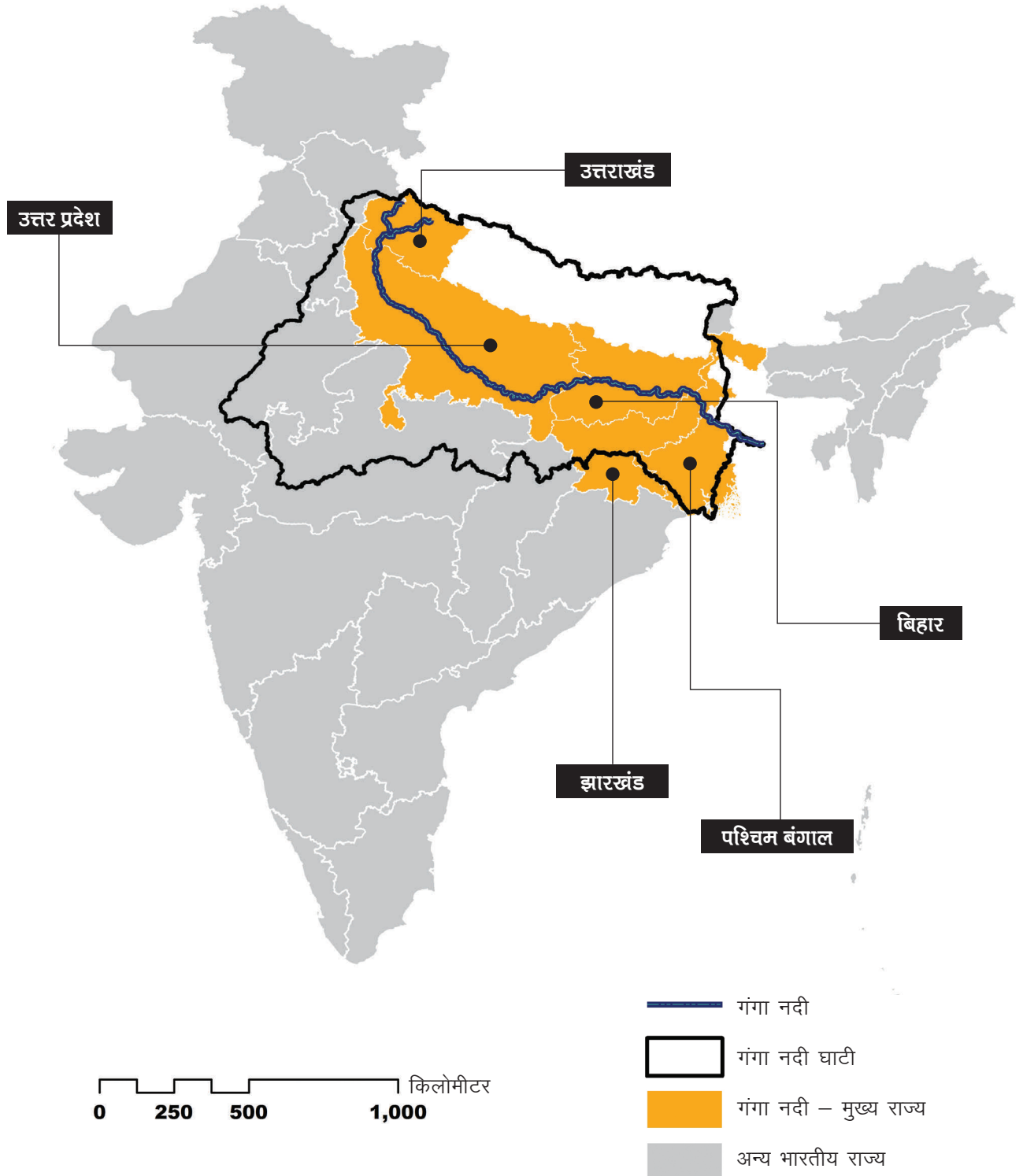
नदी पुनर्जीवन प्रदान करने के अभ्यास के मूल में समुदाय हैं। मानव जनित गतिविधियों की वजह से ही नदी की दुर्दशा हुई है और नदी की स्थिति में बदलाव लाने के लिए लोगों की सामूहिक इच्छाशक्ति की आवश्यकता है। डिजिटल इंटरफेसिंग, व्यावहारिक शिक्षा और सबसे महत्वपूर्ण तौर पर समुदाय को संरक्षक बनाने के प्रावधान के माध्यम से और समुदाय को सशक्त बनाने सहित बहुत सारे समुदाय आधारित पहल करने से आवश्यक बदलाव आएगा।

## समुदायों को शामिल करना



इलाहाबाद में गंगा

# राज्य गंगा मिशन







## उत्तराखंड

राष्ट्रीय नदी गंगा के उद्गम के रूप में उत्तराखंड, नदी की सम्पूर्णता और अखंडता सुनिश्चित करने के लिए एक सबसे महत्वपूर्ण राज्य है। राज्य में नदी और मुख्य धाराओं को भारतीयों द्वारा न सिर्फ श्रद्धा के साथ पूजा जाता है बल्कि हिमालय पर्वत की श्रेणी में नदी की सुरम्य दृश्यता भी उनकी एक प्रमुख विशेषता है। इस तरह, राज्य के लिए पर्यटन (आध्यात्मिक, धार्मिक और मनोरंजक) एक महत्वपूर्ण आयाम है, इसलिए क्षेत्र में अपरिवर्तित नदी प्रणाली को कायम रखना काफी महत्वपूर्ण है। हालांकि औद्योगीकरण और जीवन शैली में बदलाव की गति राज्य में अब तक धीमी रही है, लेकिन वनों की कटाई, शहरीकरण और प्रमुख जल विद्युत् परियोजनाओं (जैसे कि टिहरी, श्रीनगर एवं कोटेश्वर बांध) के साथ बढ़ती पर्यटकों की संख्या भागीरथी, अलकनंदा और अन्य नदियों को दूषित और प्रदूषित कर रही हैं। इन परिवर्तनों का गंगा नदी प्रणाली पर महत्वपूर्ण प्रतिकूल प्रभाव पड़ा है, जिनपर तत्काल ध्यान देने की आवश्यकता है।

**गंगा नदी की सभी मुख्य धाराओं को भारतीयों द्वारा न सिर्फ श्रद्धा के साथ पूजा जाता है बल्कि वे हिमालय क्षेत्र में उत्तराखंड की सुंदरता का एक मुख्य घटक भी है**

### राज्य स्तर पर अपेक्षित मुख्य उपाय

1. स्थायी हाइड्रो पावर के विकास के साथ-साथ इ-प्लोज के प्रावधान सहित लम्बवत जुड़ाव सुनिश्चित करना।
2. राज्य के श्रेणी 1, श्रेणी 2 एवं श्रेणी 3 के शहरों के लिए विस्तृत यूआरएमपी तैयार करना एवं सभी शहरी और पर्यटन केंद्रों पर विस्तृत सीवेज और ठोस कचरा प्रबंधन/उपचार की सुविधा स्थापित करना।
3. क्षेत्र के पारिस्थितिक तंत्रों पर बिना अतिरिक्त भार दिए, अधिकतम पर्यटकों की संख्या को संभालने के लिए उचित परिवहन, भोजन और ईंधन सुविधाएं सुनिश्चित करना।
4. अत्यधिक कटाव, संभावित भूस्खलन आदि वाले क्षेत्रों में सड़क और भवन निर्माण के विनियमन के साथ-साथ वनीकरण और ढलान का सुदृढ़ीकरण करना।
5. नदी के तल से रेत और बजरी खनन को विनियमित करना।
6. जानकारी का व्यापक प्रसार, जमीनी स्तर पर निगरानी और हितधारकों को संवेदनशील बनाना एवं उनकी भागीदारी बढ़ाना।



## उत्तर प्रदेश

**उत्तर प्रदेश** एक बड़ा राज्य है जिसमें उत्तराखंड के डाउनस्ट्रीम में मैदानों में गंगा नदी का एक लंबा फैलाव है और जिसमें यमुना, काली, रामगंगा और गोमती जैसी महत्वपूर्ण सहायक नदियों की उप-घाटियां भी शामिल हैं। यह एक घना बसा हुआ प्रदेश है और यहां विस्तृत कृषि भूमि और उद्योग दोनों पाये जाते हैं।

मुख्य गंगा नहरें (ऊपरी गंगा, मध्य गंगा और निचली गंगा नहर प्रणालियां) राज्य के ऊपरी भाग में प्रमुख जल अलगाव हैं जिसने नदी को काफी समय से प्रभावित किया है। इस समस्या के साथ-साथ काफी मात्रा में शहरी केंद्रों से अशोधित एवं आंशिक रूप से शोधित शहरी सीवेज और औद्योगिक समूहों से भयंकर रूप से दूषित गंदा पानी नदी एवं उसके प्रमुख सहायक नदियों में बहाए जा रहे हैं। इसके फलस्वरूप मुख्य नदी एवं यमुना, काली, एवं गोमती जैसी उसकी प्रमुख सहायक नदियों में प्रदूषण का स्तर काफी अधिक हो गया है, जो कि मानवों और नदी की जैव विविधता, दोनों के लिए एक बड़ा खतरा बनता जा रहा है।

संलग्न चित्र एक नजर में सबसे प्रदूषित हिस्सों को दर्शाते हैं। नदी में लाशों एवं पशुओं के मृत शरीरों को डालने एवं खेतों से रासायनिक खाद एवं कीटनाशक से युक्त पानी के अधिक बहाव ने समस्याओं को और भी बढ़ाया है। इसके अलावा, नदियों पर बने बांधों एवं बैराजों ने गंगा के डॉल्फिन जैसी नदी में रहने वाली कई अन्य जीव-जंतुओं की प्रजातियों के निवासों को बाधित किया है और उनकी आबादी को प्रभावित किया है।



### राज्य स्तर पर अपेक्षित मुख्य उपाय

1

राज्य के श्रेणी 1, श्रेणी 2 एवं श्रेणी 3 के शहरों के लिए विस्तृत यूआरएमपी तैयार करना एवं सभी शहरी और पर्यटन केंद्रों पर विस्तृत सीवेज और ठोस कचरा प्रबंधन और उसके उपचार की सुविधा स्थापित करना। प्राथमिकता के आधार पर कार्यवाही करने के लिए चयनित प्रमुख शहर वृन्दावन, मथुरा और आगरा (यमुना नदी पर), मुरादाबाद (रामगंगा नदी पर), लखनऊ (गोमती नदी पर) और हरिद्वार, गढ़मुक्तेश्वर, कानपुर, इलाहाबाद और वाराणसी (गंगा नदी पर) हैं।

2

बांधों, बैराजों और अन्य संरचनाओं पर इ-प्लोज के प्रावधान सहित लम्बवत जुड़ाव सुनिश्चित करना।

3

मनोरंजन और जल परिवहन, भूमिगत पुनर्भरण, जल विद्युत, सिंचाई आदि जैसे बहुउद्देशीय उपयोगों के लिए नहरों और शहरी प्राकृतिक जल निकास का विकास करना।

4

संसाधन संरक्षण उपायों के साथ स्थायी कृषि को प्रोत्साहन देना।

5

नदी के तल से रेत और बजरी खनन को विनियमित करना।

6

नम (जलमय)-भूमि, जंगल, वितरित भूजल एवं सतही जल भंडारणों पर जोर देते हुए जल संसाधनों का नियोजन करना।

8

जल की कमी वाले क्षेत्रों में जल दोहन को नियंत्रित करना।

10

जानकारी का व्यापक प्रसार, जमीनी स्तर पर निगरानी और हितधारकों को संवेदनशील बनाना एवं उनकी भागीदारी बढ़ाना।

9

बाहरी प्रजातियों के हमलों, अत्यधिक मछली पकड़ने एवं अंडे देने वाले मौसमों में मछली पकड़ने पर नियंत्रण करना।



## बिहार

बिहार भी एक बड़ा राज्य है जिसमें उत्तर प्रदेश से निचे मैदानी इलाकों में गंगा नदी का एक लंबा विस्तार शामिल है और इसमें गंगा की कई महत्वपूर्ण सहायक नदियों की घाटियां जैसे घाघरा, गंडक, बागमती, कोसी और सोन शामिल हैं। यह एक घना बसा हुआ प्रदेश है और यहां विस्तृत कृषि भूमि और उद्योग दोनों पाये जाते हैं।

फलस्वरूप बिना साफ हुए एवं आंशिक रूप से साफ हुए शहरी सीवेज और औद्योगिक समूहों द्वारा गंदा व दूषित जल नदी एवं उसके प्रमुख सहायक नदियों में बहाए जा रहे हैं। इसके परिणाम स्वरूप मुख्य नदी एवं उसकी प्रमुख सहायक नदियों में प्रदूषण का स्तर काफी अधिक हो गया है, जो कि मानवों और नदी की जैव विविधता दोनों के लिए एक बड़ा खतरा बनता है।

इसके अलावा, कई नदियों पर कुछ बड़े बांध और बैराज (उदाहरण के लिए सोन नदी पर इंद्रपुरी बैराज) बनाए गए हैं जो कि नदी में रहने वाले प्रजातियों को प्रभावित करते हैं। ज्यादा महत्वपूर्ण बात यह है कि कई जगह नदियों को चैनलों में बांधने एवं अन्य बाढ़ नियंत्रण कार्य (जैसे तटबंध) ने कोसी नदी जैसी कई बाढ़-प्रवण नदियों के आकार एवं स्थिरता को प्रभावित किया है।

**कई जगह नदियों को चैनलों में बांधने एवं अन्य बाढ़ नियंत्रण कार्य ने कोसी नदी जैसी कई बाढ़-प्रवण नदियों के आकार एवं स्थिरता को प्रभावित किया है।**

### राज्य स्तर पर अपेक्षित मुख्य उपाय

1

राज्य के श्रेणी 1, श्रेणी 2 एवं श्रेणी 3 के शहरों के लिए विस्तृत यूआरएमपी तैयार करना एवं सभी शहरी और पर्यटन केंद्रों पर विस्तृत सीवेज और ठोस कचरा प्रबंधन और उसके उपचार की सुविधा स्थापित करना।

2

बाढ़ मैदान क्षेत्र तय करने, जल निकासी में सुधार, अन्य गैर संरचनात्मक उपायों एवं वैज्ञानिक गाद प्रबंधन के माध्यम से बाढ़ प्रबंधन करना।

3

बांधों, बैराजों और अन्य संरचनाओं पर इ-फ्लोज के प्रावधान सहित लम्बवत जुड़ाव सुनिश्चित करना।

4

मनोरंजन और जल परिवहन, भूमिगत पुनर्भरण, जल विद्युत, सिंचाई आदि जैसे बहुउद्देशीय उपयोगों के लिए नहरों और शहरी प्राकृतिक जल-निकास का विकास करना।

5

संसाधन संरक्षण उपायों के साथ स्थायी कृषि को प्रोत्साहन देना।

6

नदी के तल से रेत खनन को विनियमित करना।

7

नम (जलमय)– भूमि, जंगल, वितरित भूजल एवं सतही जल भंडारणों पर जोर देते हुए जल संसाधनों का नियोजन करना।

8

निम्न उपायों के माध्यम से जल के उपयोग की दक्षता में बढ़ोतरी करना – (क) स्वच्छ जल की वास्तविक कीमत का निर्धारण, (ख) उपभोक्ताओं के लिए प्रोत्साहन, तकनीकी सहायता और जल अधिकारों एवं हकदारी के आवंटन, एवं (ग) जल के पुनः उपयोग और पुनर्चक्रण।

9

जानकारी का व्यापक प्रसार, जमीनी स्तर पर निगरानी और हितधारकों को संवेदनशील बनाना एवं उनकी भागीदारी बढ़ाना।



## झारखंड

**झारखंड** राज्य गंगा के मार्ग में बिहार के डाउनस्ट्रीम में स्थित है। राज्य का ज्यादातर हिस्सा छोटा नागपुर पठार पर स्थित है, जो कि पहाड़ी और वन-आच्छादित है। यहां के प्रमुख उद्योगों में खनन, खनिज प्रसंस्करण, और इस्पात उद्योग शामिल हैं।

खनिज उपलब्धता के फलस्वरूप कई बड़े शहर और औद्योगिक समूह विकसित हुए हैं जो कि प्रदूषण उत्पन्न करने और फैलाने के एक महत्वपूर्ण स्रोत हैं। इसके अलावा, यहां नदी जल प्रवाह और जैव विविधता को प्रभावित करने वाले कई जल विद्युत् परियोजनाएं एवं बड़ी सिंचाई परियोजनाएं हैं, इनमें बराक और दामोदर नदियों पर बने मैथान, तिलैया, पंचेत एवं तेनुघाट बांध एवं सुबर्नरेखा नदी पर बने इचा एवं चांडिल बांध प्रमुख हैं।

**झारखंड में**  
कई बड़े शहर  
और औद्योगिक  
समूह हैं जो कि  
प्रदूषण के महत्वपूर्ण  
स्रोत हैं।

### राज्य स्तर पर अपेक्षित मुख्य उपाय

1

राज्य के श्रेणी 1, श्रेणी 2 एवं श्रेणी 3 के शहरों के लिए विस्तृत यूआरएमपी तैयार करना एवं सभी शहरी और पर्यटन केंद्रों पर विस्तृत सीवेज और ठोस कचरा प्रबंधन और उसके उपचार की सुविधा स्थापित करना।

2

बांधों, बैराजों और अन्य संरचनाओं पर इ-फ्लोज के प्रावधान सहित लम्बवत जुड़ाव सुनिश्चित करना।

3

मनोरंजन और जल परिवहन, भूमिगत पुनर्भरण, जल विद्युत्, सिंचाई आदि जैसे बहुउद्देशीय उपयोगों के लिए नहरों और शहरी प्राकृतिक जल निकास का विकास करना।

4

अत्यधिक कटाव, संभावित भूस्खलन आदि वाले क्षेत्रों में सड़क और भवन निर्माण के विनियमन के साथ-साथ वनीकरण और ढलान का सुदृढ़ीकरण करना।

5

संसाधन संरक्षण उपायों के साथ स्थायी कृषि को प्रोत्साहन देना।

6

नदी के तल से रेत खनन को विनियमित करना।

7

नम (जलमय)-भूमि, जंगल, वितरित भूजल एवं सतही जल भंडारणों पर जोर देते हुए जल संसाधनों का नियोजन करना।

8

जानकारी का व्यापक प्रसार, जमीनी स्तर पर निगरानी और हितधारकों को संवेदनशील बनाना एवं उनकी भागीदारी बढ़ाना।





## पश्चिम बंगाल

**पश्चिम बंगाल** राज्य गंगा नदी घाटी के अंतिम छोर पर स्थित है। लेकिन नदी घाटी में इसको विशेष महत्व विशाल गंगा डेल्टा (सुंदरबन मैंग्रोज) से प्राप्त होता है जो यह पड़ोसी देश, बांग्लादेश के साथ साझा करता है।

वास्तव में, राज्य का अधिकांश हिस्सा अधिक वर्षा एवं तीव्र बाढ़ वाले सहित समतल डेल्टा वाले मैदान में पड़ता है, जिसका केवल उत्तरी भाग हिमालयी तलहटी में पड़ता है। उत्तर प्रदेश और बिहार की तरह, यह एक उपजाऊ क्षेत्र है जहां घनी आबादी बसी हुई है और यहां विस्तृत खेती के साथ-साथ बहुत सारे उद्योग भी हैं। राज्य की विशाल राजधानी कोलकाता डेल्टा के पश्चिमी छोर पर स्थित है, जो कि पहले एक बंदरगाह भी था और उसके आस-पास बहुत सारे उद्योग हैं (जैसे कि उसके पड़ोसी जिले हावड़ा, हुगली और उत्तरी 24 परगना)।

झारखंड के पड़ोसी जिले बर्दवान में और आस-पास भी बहुत सारे उद्योग स्थित हैं। इन कारकों और मैदान और पंचेत जैसी कई बड़ी जल विद्युत् परियोजनाओं एवं बांधों और फरक्का, तिलपाड़ा एवं दुर्गापुर जैसे बैराजों के फलस्वरूप गंगा नदी, उसकी सहायक नदियां और मुहाने काफी प्रभावित हुए हैं।

**नदी घाटी में**  
पश्चिम बंगाल को  
विशेष महत्व विशाल  
गंगा डेल्टा से  
प्राप्त होता है जो  
यह पड़ोसी देश,  
बांग्लादेश के साथ  
साझा करता है।

### राज्य स्तर पर अपेक्षित मुख्य उपाय

1

राज्य के श्रेणी 1, श्रेणी 2 एवं श्रेणी 3 के शहरों के लिए विस्तृत यूआरएमपी तैयार करना एवं सभी शहरी और पर्यटन केंद्रों पर विस्तृत सीवेज और ठोस कचरा प्रबंधन और उसके उपचार की सुविधा स्थापित करना।

2

बांधों, बैराजों और अन्य संरचनाओं पर इ-प्लोज के प्रावधान सहित लम्बवत जुड़ाव सुनिश्चित करना।

3

मनोरंजन और जल परिवहन, भूमिगत पुनर्भरण, जल विद्युत्, सिंचाई आदि जैसे बहुउद्देशीय उपयोगों के लिए नहरों और शहरी प्राकृतिक जल निकास का विकास करना।

4

बाढ़ मैदान क्षेत्र तय करने, जल निकासी में सुधार, अन्य गैर संरचनात्मक उपायों एवं वैज्ञानिक गाद प्रबंधन के माध्यम से बाढ़ प्रबंधन करना।

5

संसाधन संरक्षण उपायों के साथ स्थायी कृषि को प्रोत्साहन देना।

6

पूरी नदी घाटी में फैले आर्सेनिक प्रदूषण को नियंत्रित करने के लिए गहरे भूजल दोहन का विनियमन करना।

7

बाहरी प्रजातियों के हमलों, अत्यधिक मछली पकड़ने एवं अंडे देने वाले मौसमों में मछली पकड़ने पर नियंत्रण करना।

8

खासकर कोलकाता एवं नदी के मुहाने के पास नदी की ड्रेजिंग एवं शोरगुल वाले जहाजों के आवागमन को विनियमित करना।

9

जानकारी का व्यापक प्रसार, जमीनी स्तर पर निगरानी और हितधारकों को संवेदनशील बनाना एवं उनकी भागीदारी बढ़ाना।



गंगा नदी घाटी प्रबंधन एवं अध्ययन केंद्र (सी गंगा)

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# Second India Water Impact Summit (IWIS)

Valuing Water | Transforming Ganga

**DECEMBER 4-7, 2017**

VIGYAN BHAWAN & IIT DELHI,  
NEW DELHI, INDIA



A CONSOLIDATED REPORT ON  
**SECOND**  
**INDIA WATER IMAPCT SUMMIT**  
**(IWIS)**

4-7th  
DECEMBER  
2017

VIGYAN BHAWAN, NEW DELHI  
&  
IIT DELHI



# Preface



**U P SINGH**

Secretary, Ministry of Water Resources,  
River Development & Ganga Rejuvenation,  
Government of India & Director General,  
National Mission for Clean Ganga (NMCGR)



**VINOD TARE**

Professor and Founding Head of  
Centre for Ganga River Basin  
Management & Studies (cGanga),  
Indian Institute of Technology Kanpur

*W*e thank all participants from India and around the world for making the Second India Water Impact Summit, a great success. Various skills, knowledge, perspectives and sensibilities shared during the summit have helped to articulate, enlist and evaluate evidences based on different point of views. Suggestions and recommendations from every participant are highly valued and respected.

The first Summit, held in 2012, was an aggregate of numerous activities that had been taking place over the previous year or so in regard to managing India's water resources. Continuing the thrust of the previous Summit, the present Summit deliberated on both macro as well as micro issues related to the water sector moving the market dynamics towards the adoption of an integrated water resource management model. The Government of India would be deploying large amounts of capital investment in the water sector across different riparian groups – agriculture, that is estimated to take about 85% of surface water, Industry that draws nearly 9% of water and households that get only 6% of surface water. Issues of a different gauge – water quality and quantity were discussed on the same platform. The platform provided an opportunity to develop and showcase economic, technical, social and financial solutions that can be propagated into the market. In addition, the Summit infused new ideas and dynamism in India's water governance to bring together public, private and civil society actors for an overhaul of India's rural and urban water environment.

River Ganga (Ganges) was declared as a national river on November 5, 2008. The River warrants such a status as it is revered as a "living being", a holy mother for millions of Indians that not only see her as the

supreme purifier but also depend on her for their daily livelihood. What happens in the Ganga River Basin (GRB) has a large impact on the nation since nearly 50 crore (500 million) people live within the basin. The clean-up of River Ganga (and other rivers flowing into her such as the Yamuna) has been an emotive subject for millions of Indians and people internationally.

Implementing a framework of actions that stops all effluents from going into the river is the first and the foremost important mission (Mission Nirmal Dhara or Mission Un-polluted Flow). This is being purported through the Zero Liquid Discharge (ZLD) philosophy which suggests that water, once drawn out from the river body, should not be returned directly to the river. It should instead be recycled and reused, with only excesses being indirectly returned after treatment through groundwater recharge. Ofcourse this philosophy also applies to the groundwater being drawn out for various purposes. If the model is implemented in its entirety the river over the years will see a dramatic reduction in pollution levels and with fresh water coming from upstream sources and increased base flow should clean itself up.

The second major mission to restore the river is to have adequate water in the river system (Mission Aviral Dhara or Mission Uninterrupted Flow). Since the agriculture sector is the major riparian consumer of the river water (estimated to utilise 85% of the surface water), bringing greater irrigation efficiency and adopting resource-conserving agricultural methods can have dramatic impacts on the water levels and therefore on river pollution.

The water quantity issues lead to roaring debates as to which economic sections of the society have greater access to water. The answer to that is very

simple – all. There is massive room for improvement in usage of water across every single strata of society. The agriculture sector must look at numerous techniques to reduce water consumption such as crop selection, cropping pattern, irrigation techniques, irrigation scheduling, soil moisture conservation techniques, and even the most innovative methods such as urban agriculture and soil less agriculture.

Industry must also reduce its water footprint dramatically both in consumption as well as in its discharge. Common households already bear the brunt of water shortage, but even domestic water consumption can be reduced in many urban areas. Without such effort, increasing urbanisation will increasingly stress groundwater levels.

None of the above issues are new in its content, but it is in the implementation of appropriate measures where the Summit proceedings moved the discourse towards adopting a new paradigm to truly understand and appreciate water as a precious natural resource that should not be squandered or converted to poison.

It is estimated that to restore Ganga to its former glory will require over Rs 6 lakh crores (\$100bn). The Government doesn't have the luxury of that much available capital and must therefore use many new models including extensive use of Public Private Partnerships (PPP).

The term PPP is a contract between the Government and a third party to deliver certain services. The contract must be governed and monitored by a regulatory framework which provides a band for water pricing, the exact definition of water rights, and its usage. Whilst the framework may apply to concessionaire, it must also equally apply to households and the other riparian sectors such as industry and agriculture.

The India Water Impact Summit – 2017 came at an important juncture when India is poised for rapid inclusive growth that can lead to not only greater prosperity for all, but also a healthier water environment in consonance with the government's "Swachha Bharat" initiative. The Ganga River Basin Management Plan prepared by the Consortium of 7 Indian Institute of Technology (IITs) has already laid down a strategic roadmap to meet this goal in the Ganga River Basin, and the Summit further added value inputs for this basin as well as the whole of India.

A number of countries such as Canada, Israel, Australia, Singapore and parts of Europe have developed water focused innovation clusters that not only increase the rate of technology transfer but also have a net positive contribution to the GDP by creating more jobs and increased exports. As India moves towards a new

water economy, it must also develop its own innovation clusters to sustain and support this growth.

Water economy, as the world knows it, is not just piped water. It also includes those who are in distributed environments such as the rural population or the urban poor. The former is seriously affected by groundwater pollution and depleting levels, whilst the latter in many circumstances end up paying nearly 100 times more than those drawing water from the municipal pipes. The Summit recognised this water inequality and put great efforts to develop innovative models for water and sanitation in the distributed environment. At the same time, the Summit brought out new possibilities of water and wastewater management in the complete urban sector where India's population is rapidly migrating and growing.

No major development can take place without financial backing. Although PPP is one such methodology that the Government can use to finance water projects, but it is merely a different source of capital. It doesn't affect the underlying risk associated in developing water projects. The Summit highlighted some of the cutting edge financial instruments that are being developed to improve the attractiveness of water projects. Some instruments are: Water Quality Trading; Water credit wraps; water insurance; water bonds and community based financing models.

The role of civil society and faith groups is highly pronounced in the Indian context. It is imperative that the Government and all concerned actively reach out to representatives of these groups that provide a barometer to the needs of the people of India from both civil as well as religious contexts. The Summit provided a dynamic forum for interaction and collaboration with civil society and faith groups.

Whilst the Summit itself is intended to be a regular activity, but between such events cGanga will progress the discussions on each of the topics as model projects so that the recommendations can become a reality.

We thank all participants for their active engagement, not just in dialogue, but also in the development and implementation of these new models.

We would also like to thank the Indian Government, strategic partners, panellists and speakers, sponsors, and the staff and volunteers who put in a lot of faith and hard work into making this Summit a success.

The organisers have decided to establish a new multi-disciplinary, multi-stakeholder forum that would bring together policy makers at national and regional levels; technology and engineering firms; finance and investment representatives, and the civil society. cGanga look forwards to meaningful engagement with one and all across the globe.





Ganga in Himalayas mountains, Uttarakhand

## MESSAGE



मंत्री

जल संसाधन, नदी विकास, गंगा संरक्षण,  
सड़क परिवहन, राजमार्ग एवं पोत परिवहन  
भारत सरकार

**Minister**

Water Resources  
River Development, Ganga Rejuvenation,  
Road Transport, Highways and Shipping  
Government of India



**NITIN GADKARI**

I am glad that the “India Water Impact Summit - 2017” (IWIS-2017) is being organized jointly by the Centre for Ganga River Basin Management and Studies (cGanga) and the National Mission for Clean Ganga (NMCG) to bring together national and international experts and key stakeholders for wide-ranging discussions and exchange of ideas on India’s water and environment infrastructure and managing our river basins holistically.

Fresh water is a valuable and critical natural resource for a developing country like India and river basins are their repository along with other resources. What makes water critical is its limited availability in the country as well as its being bound up with other natural resources that are the essential ingredients of vibrant life and development in the country.

With rapid industrialization, urbanization and agricultural growth, India’s water needs are becoming increasingly varied and intense, thereby producing increasing and unforeseen pressures on our water bodies. Simultaneously increasing amounts and different types of wastewaters are being generated, which need to be de-polluted to prevent the receiving water bodies from suffocation.

I am extremely pleased, therefore, that IWIS-2017 will brainstorm over key aspects of our water environment management like municipal and industrial wastewater recycling and reuse, innovative management approaches to urban water bodies and drainage, agricultural water management, sustainable hydropower generation, revival of rivers and water bodies, and creating institutional mechanisms to foster innovative management and policy changes in the water environment sector.

I am confident that, by bringing together a wide gamut of multi-disciplinary experts and stakeholders for wide-ranging debates on many well-thought out topics, IWIS-2017 will help in chalking out a strategic and socio-culturally acceptable pathway to manage our river basins scientifically and create an exemplary water environment in the country, thus providing great impetus to India’s all-round sustainable development.

I wish the Summit a great success.

Date: 29<sup>th</sup> November 2017

Place: New Delhi

**(NITIN GADKARI)**



Ghats on the Bank of Ganga  
River at Varanasi, Uttar Pradesh.



## MESSAGE



मंत्री

पेयजल एवं स्वच्छता  
भारत सरकार, नई दिल्ली

Minister of Drinking Water and Sanitation  
Government of India, New Delhi-110003



UMA BHARTI

I am very pleased to know about the second “India Water Impact Summit “ (IWIS-2017) being jointly organised by the Centre for Ganga River Basin Management and Studies (cGanga) and the National Mission for Clean Ganga (NMCG) for exhaustive discussions on critical aspects of India’s water environment infrastructure, and managing our river basins sustainably by renowned national/ international experts and stakeholders.

Since I have had close interactions with NMCG (in initiating rigorous cleaning programs of National River Ganga) and the IIT Consortium in preparing a very comprehensive Ganga River Basin Management Plan 2015, I am well aware of their efforts to handle their challenging tasks. The proposed IWIS-2017, therefore, comes to me as very enthrusting news, since I believe that it will help us to expand our understanding and develop easily implementable state-of-the-art solutions to many thorny problems pertaining – not just to the holy Ganga river – but to other rivers of our country as well.

Our nation has been bestowed with many natural resources, not the least of which is water. But it is intricately tied up with other natural resources like soil, nutrients, micro-organism, plants and animals, and ofcourse our own worldly and spiritual lives. And our rivers are a reflection of our vital dependence on this multi-faceted resource. So if modernity has introduced new demands and depredation on our water bodies and rivers, modern scientific knowledge can also combine with our traditional and ground knowledge systems to evolve appropriate solutions for a healthy and life enhancing water environment.

Therefore, I much appreciate that IWIS-2017 will deliberate over such pressing aspects of our water infrastructure and environment like wastewater recycling and reuse, agricultural water conservation, environmentally benign hydropower generation, rejuvenation of our rivers and water bodies, management innovations for efficient urban drainage, and evolving new institutional and management mechanisms for the water environment sector. I have no doubt that the outstanding multi-disciplinary experts and stakeholders participating in the Summit will contribute to a clearer and foolproof roadmap for reviving our rivers and water bodies while enabling faster economic and national development for a long time to come. I wish cGanga and NMCG great success for IWIS-2017.

(UMA BHARTI)



## MESSAGE



**NITISH KUMAR**



मुख्यमंत्री  
बिहार

Chief Minister  
**Bihar**

I am happy to learn that the “India Water Impact Summit-2017” (IWIS-2017) is being jointly organized by the Centre for Ganga River Basin Management & Studies (cGanga), IIT Kanpur and the National Mission for Clean Ganga (NMCG), Government of India, for incisive discussions by national and international experts and major stakeholders about Ganga River Basin Management.

River Ganga remains the central theme for millions of Indian for its religious, cultural, economical and social integration. While Ganga and its tributaries used to flow in its pristine glory, it carried many minerals, microbes and nutrients to the plains which naturally made itself purifying and fertile. Over time, Ganga has lost her pristine glory and presently is on the verge of losing its incessant flow and purity.

As the upper riparian States of Ganga have constructed a number of dams, barrages and other structures, there is a decrease in flow of river Ganga since last several decades. On the one hand the flow of river Ganga has been affected due to de-forestation and mining activities in the hills, while on the other hand, enormous quantity of silt from hills is reaching the plains. Due to decrease in flow in river Ganga large quantity of silt gets deposited in river bed. As a consequence its bed has risen, its water carrying capacity has decreased, tendency of meandering and braiding has increased, resulting in increased shoal formation. The shoal formed in flow area of river Ganga is not even getting submerged during flood due to which intensity and extent of flood in Bihar has increased.

Hence, to get a long term solution for the above problem, a Silt Management Policy is required to be framed at national level which should cover not only Ganga but all rivers in maintaining Aviralta and Nirmalta as well as for betterment of Environment & Eco-system.

After the construction of Farraka Barrage the natural flow of river Ganga has been obstructed. The silt upstream of the Barrage which used to flow out during the flood is now getting deposited in river bed. Due to this the flow width of river Ganga has increased and the back water now reaches Patna and is moving further upstream. Time has come for re-evaluation of the utility of Farakka Barrage. Many environmentalist and specialist had from time to time expressed their views on the effect of Farakka Barrage and its ill-effects. The answer to it cannot be found until the matter is examined encompassing all issues in a coordinated manner.

The diminishing lean season flow in Ganga in Bihar portion is one of the prime concern of Bihar. To maintain an environmentally acceptable lean season flow in this portion is essential not only for the ecology & environment of the river system but also for the very existence of the Ganga itself. In the light of the International agreement on Farakka, it becomes even more sensitive issue. So, a mechanism is urgently required which may assure the release of proportionate/sizable amount of water into Ganga from the upper basin states in lean seasons.

In the last 45 years or so, the number of dense habitations has increased manifold in the vicinity of Ganga in Bihar. This has caused increased demand of Ganga water for the population in one hand and the increased hazard due to flood every year on the other hand. All these require a coordinated approach involving both Centre and State to provide the population a healthy and safe life with enhanced quality.

It is our view that the work of National Water Way -1 should be based on ground reality and environmental balance. We vehemently oppose any type of Barrage on this water way. A comprehensive view has to be taken for development of the water way encompassing the problem of enormous silt and its management, river morphology, ecology, environment, Vikramshila Gangetic Dolphin sanctuary and problem arisen due to Farraka Barrage.

To focus on these issues related to incessant flow of River Ganga, an International Conference at Patna on 25-26 February 2017 and another Conference at New Delhi on 18-19 May 2017 were organized by Water Resources Department, Government of Bihar. The outcome and declarations of these conferences have been submitted to Government of India for needful action.

As our state's development has gathered pace, our water needs are also increasing and more domestic and industrial wastewaters are being produced. Since these changes stress our water environment, better safeguarding and sustainability considerations will be required to ensure unfettered development of our agriculture, industry and civic life. State Government is working towards stopping the flow of treated or un-treated sewage into the river and alternatively use the treated sewage for irrigation. In its Agriculture Road Map 2017-2022, the Government has decided to create organic corridor along both banks of the river Ganga in the State.

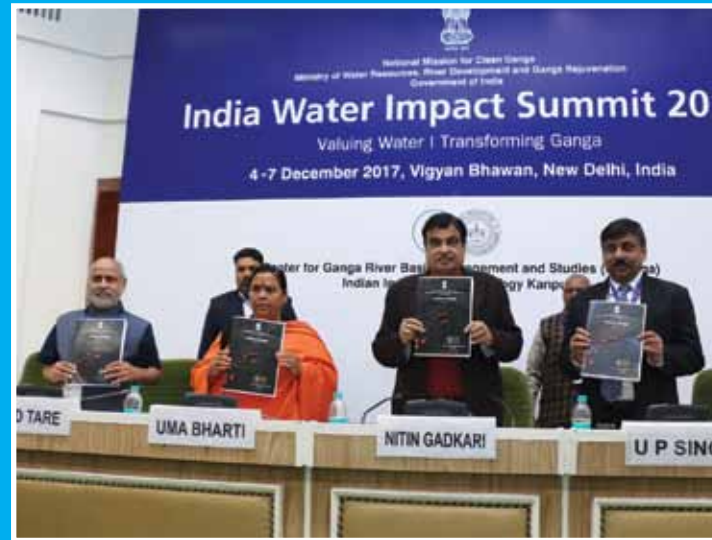
In the background of the abovementioned critical issues, I am delighted that IWIS-2017 will discuss many key aspects of our water and environment infrastructure, such as municipal and industrial wastewater treatment and reuse, revival of rivers and water bodies, innovative methods to manage urban water bodies and drainage, agricultural water conservation, and new management strategies for the water and environment sector.

I am confident that the Second India Water Impact Summit will prove beneficial to both India and our State. I wish the organizers a very successful Summit and look forward keenly to the insights and opinions that emerge from it.

**(NITISH KUMAR)**



# INAUGURAL SESSION





## HIGHLIGHTS OF SPEECHES



### UP SINGH

Secretary, Water Resources, River Development & Ganga Rejuvenation, GoI & DG, NMCG



### VINOD TARE

Professor & Founding Head, cGanga, IIT Kanpur



### UMA BHARATI

Minister of Drinking Water and Sanitation, GoI



### JOHN SWINNEY

MSP  
Deputy First Minister & Cabinet Minister for Education and Skills, Government of Scotland

- Years ago, I did not understand why the then Secretary said, "The next world war will not be fought over oil but over water". Today, I know that we are already water-stressed. Due to population growth, India's per capita availability of water is about one-fourth of what it was at the time of Independence.
- Due to climate change the rainfall distribution in time and space has become weird, causing more floods and more droughts in India.
- 80% of our water usage is for agriculture, but our irrigation efficiency of merely 38%, can be easily improved by methods such as piped irrigation supplies instead of open canals, and micro-irrigation systems instead of conventional irrigation.
- Groundwater (GW) Management is also an area of concern. In much of Punjab and Haryana GW is being so over-exploited that there will be no GW left after 10-15 years, whereas in Bihar, Jharkhand, Odisha, Chhattisgarh, and N-E India GW exploitation is very low.
- It's not only water quantity, water quality is also a matter of concern.
- In India water resource development is less important today; what we have to really cater for is water resource management. Our focus must shift from supply side management to demand side management.

- Our approach to conservation and management of the Ganga River Basin is unique and adopts modern science and technology in synergy with ancient knowledge and traditional wisdom – the traditional knowledge of our people.
- River Ganga holds an exalted status in Indian consciousness as evident from Lord Krishna's evocation in the Bhagwad Gita:  
**पवनः पवतामस्मि रामः शस्त्रभृतामहम्।  
झषाणां मकरश्चास्मि स्रोतसामस्मि जाह्नवी॥**  
"I am the wind among things of purification, and among warriors I am Rama – the hero supreme. Of the fishes in the sea I am Makara – the wonderful, and among all rivers – the Holy Ganga."
- Traditional wisdom, driven into people's consciousness as faith, encapsulates all our modern ideas of human actions that are harmful for the river as well as humanity. For instance, the "shloka"  
**गंगां पुण्यजलां प्राप्य त्रयोदश विवर्जयेत्। शौचमाचमनं सेकं निर्माल्यं मलघर्षणम्।  
गात्रसंवाहनं क्रीडां प्रतिग्रहमथोरतिम्। अन्यतीर्थरतिंचैवः अन्यतीर्थं प्रशंसनम्।  
वस्त्रत्यागमथाघातं सन्तारं च विशेषतः॥**  
prohibits 13 actions (namely defecation, gargling, throwing of used floral offerings, rubbing of filth, flowing bodies (human or animal), frolicking, acceptance of donations, obscenity, considering other shrines to be superior, praising other shrines, discarding garments, bathing, and making noise) to protect River Ganga.
- Again, traditional knowledge judges each river as distinctly different from one another. But since the complexities of rivers cannot be easily understood by lay people, the same awareness can be achieved through faith. Thus the "shloka"  
**त्रिभिः सारस्वतं तोयं सप्ताहेन तु यामुनम्।  
सद्यः पुनाति गांगेयं दर्शनादेव नार्मदम्॥**  
(मत्स्य पुराण १८५/१०-११)  
(which literally means "A sin of a human being is purified by taking bath in the Holy River Saraswati for three days, in Holy River Yamuna for one week and in Holy River Ganga in one dip. However, all sins of human beings are purified only by viewing the Holy River Narmada"):
- In managing the Ganga River Basin we strive to ensure economic development – but while preserving the river. This is the vision of our Hon'ble Prime Minister Shri Narendra Modi-ji and our Ministers Uma Bharti-ji and Nitin Gadkari-ji. And we adopt the principle of "Sabka sath sabka vikas", thereby including national and international people, concepts and technologies to achieve our objectives.

- Before coming to politics I gave religious discourses. I was heard by Rajmata Vijaya Raje Sindhiya in 1969. That time I was 8 years old. She brought me into BJP. When Nitin Gadkari-ji became the National President of BJP, he brought me back into the party.
- I became Chief Minister of Madhya Pradesh in the year 2003. Nitin Gadkari was already my Development and Roads guru. My second massiha was our current Prime Minister, whom I called up early morning every day regarding day to day Cabinet issues. In this way he became my Governance Guru.
- I have distributed Ganga Jal to all Lok Sabha and Rajya Sabha members. Muslim members asked, "What does Uma Bharti want"? When told that I wanted an Act on River Ganga to be cleared unanimously by Parliament, they replied that we are all together on this issue and will support it unanimously.
- I started meeting people like Chandi Prasad Bhatt, G. D. Agarwal, Sundar Lal Bahuguna, Vinod Tare, Kazmi, Kamal Jain, Nayan Sharma. I became the minister for Ganga and Nitin-ji supported me a lot. We analyzed the situation – where IIT consortium was our comrade.
- Ganga's work cannot be completed by ego. I wrote to Prime Minister that Ganga is a River of Torrents and not a River of Hunger. Ganga is not a river for making profits. Ganga is the river to give. There should be no exploitation of Ganga any further. Its continuity, cleanliness and E-flow should be ensured.
- I requested Prime Minister that I should be freed from responsibilities of the ministry. The new work he allotted me was "Swachhata Abhiyaan" and "Rural drinking water". And in Swachhata Abhiyaan, again Ganga is there.
- We have to learn from Rhine and Thames to restore our rivers. But with differences – Ganga will also be a river to take a dip in.
- The format of the Ganga Act has been submitted, so also the de-silting report, the water quality report by NEERI, and tree plantation report by FRI. And the ETP and STP plan by Nitin Gadkari-ji is on fast track. As many people associated with Ganga are here today, I hereby announce that I want to see each and every project to be implemented by October 2018 – not the end of every project, but the beginning or middle of every project. If it is not done by October 2018 then I myself will undertake "Great fasting" and "Great Prayer" at Prayag Triveni Sangam. With these words, I thank IIT consortium, greetings to all scientists, and my guru Nitin Gadkari-ji.

- I extend my good wishes and active involvement of the Scottish government as partners in working for a project of enormous passion to ensure that the key water challenges facing India, and particularly of the Holy River Ganga, are resolved.
- Water is a vital part of Scotland's natural capital comprising 70% of the area and 90% of the entire volume of United Kingdom's inland surface water. We recognize that our economy, environment, health and wellbeing are all based on water.
- Scotland and India are already working successfully together. The collaboration on "Ganga River Health" project, funded by the Scottish government and led by the UNESCO Center for Water, Law, Policy & Science at the University of Dundee, will take forward our hydro-nation strategy with the central aim of developing and growing the value of water resources in a responsible and sustainable way.
- The World Economic Forum identified India as a top global risk in terms of impact in 2015. India is in a period of significant change, which puts considerable pressure on an under-developed water infrastructure. That is why we have committed our support to the Ganga River Health project.
- It is a huge pleasure for us to share our expertise acquired over the years in Scotland to work with our colleagues in India and make a positive difference to enhance the natural environment of River Ganga and contribute to improving the health, wellbeing and sustainability of people of this wonderful country in a spirit of friendship and cooperation for the benefit of all.



## HIGHLIGHTS OF SPEECHES



**NITIN GADKARI**

Minister, Water Resources,  
River Development, Ganga Rejuvenation,  
Road Transport, Highways and Shipping, GoI

- I congratulate the Centre for Ganga River Basin Management and Studies (cGanga) and National Mission for Clean Ganga (NMCG) for organizing India Water Impact Summit (IWIS). cGanga is our knowledge partner for Namami Gange Programme and so far as Government of India is concerned, we are very open, transparent about the new technologies, new innovations and successful practices in the world.
- In the 21<sup>st</sup> century knowledge is most important. Science, technology, innovation, entrepreneurship and research are knowledge-based, and use of knowledge for wealth creation is the future of our country.
- There are two main problems in our country – one is water and the second is poverty. But the main reason for poverty itself is water shortage.
- More than 3000 TMC of the Godavari river waters go to the sea every year without being properly used. Why are we not using this water for irrigation and drinking purposes in water-scarce areas of Karnataka, Andhra Pradesh, Telangana? I have appointed an expert committee to look into that.
- For the last 10 years I am working with an NGO and have completed 25-30 water conservation projects with clear socio-economic impacts. The World Bank has assured us 6000 crores of finance, and with that I am confident of implementing an innovative water conservation plan in areas where water levels are very low.
- If there is a will, there is a way. And if there is no will, then there are only surveys, discussions, seminars, committees, and sub-committees.
- The Namami Gange project has four parts. One part is related to water recycling. We can convert sewage water into clean water for use in the power industry, railways and irrigation. There are 12 thermal projects on the Ganga run by NTPC. I request the Power Minister to use recycled water for their power generation.
- The second part relates to the construction of Ghats, Moksha Dhams (Cremation Facilities), parking places, roads, and Dharma Shalas (facilities for tourists/communities generally made available free or at nominal charges). Seven corporate bodies have already committed to spend 1000 crores for this. But we also need contribution from at least 1 crore people.
- The third part is under Uma Bharti-ji's guidance. We have 4500 villages on the Ganga, and we want their integrated development as Ganga Grams.
- The fourth part is plantation. Here again, with Uma-ji as Chairman, we expect to plant almost 10 crore trees on the Ganga river front with cooperation from educational institutions, paramilitary forces, police forces, NSS, and NGOs.
- The fifth important thing, where too I need cooperation from Uma Bharti, is not to keep Namami Gange as an exclusive government project. We have to bring it into the public domain for Jana Sahbhag – social participation.
- Lastly, research and study are very important. Kindly give your suggestions to the concerned department and to me. I am a student of management, not a scientist or engineer. You tell me. And, with your support, it will be implemented. I thank you all.



**FRANC MATJAŽ  
ZUPANČIČ**

State Secretary, Slovenia

- Slovenia is a member of the 28-nation European Union that enjoys prosperity, stability and growth. It is a knowledge-based society that stimulates high value- based innovations, technology, science, research and infrastructure. Ranked 3rd in the Global Innovation Index with science and research excellence, we are sharing our expertise globally and especially with India and Indians.
- Slovenian and Indian societies are historically well-connected. For instance, we have a common language source. And Gandhiji's teachings of Satyagraha and Non-Violence substantially influenced our society a couple of decades ago.
- The Slovenian government gives major attention to the European call for Smart Specialization, which is a trigger for additional improvements of our innovations.
- We are focusing on clean water, smart living, and green environment. We seek collaborations in fields such as smart factories and cities, and sustainable food, which can be directly linked with Indian counterparts like Clean Ganga and Wastewater Management.
- Slovenia is fully committed to sustainable development. We strongly support the program Ganesha, guided by the entities Ict-lot and Smart City to provide sustainable ideas and systems to people. Slovenia is already working with India in small villages along with smart cities by the end of January. Praise Lord Ganesha, the protector of our planet, and remover of obstacles.



**JAN LUYKX**

Ambassador of Belgium in India

- Belgium and India have had excellent relationships for 70 years, which we are taking to another level in this century. This innovative relationship is in the context of new global challenges – including how to preserve our rivers.
- Belgium was the first country where the industrial revolution took place in the 19th century, and we developed many techniques and technologies to face the consequent challenges. Now we are developing newer technologies to face challenges that have developed since the end of the 20th century. ... And these solutions can benefit India too!
- In the 1990s I was responsible for negotiating environmental directives in Brazil. In 1997 we negotiated an ambitious Framework on Water as part of these directives, and its implementation is successfully ongoing as of now.
- Belgium is keen to work with India on sustainable development and management of water resources. Our collaboration has been reinforced by the annual conference jointly organised recently by the Belgian company, Vito, and the Indian government.
- Vito, in collaboration with Infosys, has also set up a model wastewater treatment plant with energy resource recovery, and are planning more such projects. Belgian companies are (also) looking forward to collaborate with Indian authorities at the central, state and local levels.
- We have also signed an MOU with cGanga this year to set up a Belgian Desk of cGanga to help and facilitate cGanga's activities in our overall scheme.

## HIGHLIGHTS OF SPEECHES



**BOB PENTER**

Chief Executive,  
Waikato River Authority,  
New Zealand

- International collaboration for treating wastewater systems is essential since no country has a complete solution. The issue transcends political boundaries.
- Last week, in Singapore, their water engineers shared with me the challenges and opportunities for river restoration. In the week before that, we had co-hosted an international river science symposium in Singapore on the theme of multiple aquatic values. The issues discussed in them are as relevant for River Ganga as for other rivers of the world.
- Yesterday there was a panel discussion on governance and legal structure needed for Ganga river basin. In the past a similar conversation in New Zealand had led to our passing a legislation on River Authority for our rivers.
- The aim of river management is to have healthy rivers since rivers sustain aquatic lives as well as prosperous communities. River management must be an intergenerational approach for river restoration.
- Our River Authority administered a quarter billion dollars for river cleaning initiatives. Many of these initiatives combine traditional knowledge with cutting age technologies.
- You need to adhere to a vision for saving River Ganga. There is considerable support from my country and the global community to make improvements in the Ganga River Basin through cooperation and sharing of knowledge. Particularly, we would like to work with cGanga on developing Report Card Approach adopted by us for Waikato River in New Zealand for river Ganga.
- We have to identify ourselves with rivers: "I am the river and the river is me."



**BINDESHWARI PATHAK**

Founder, Sulabh International Social  
Service Organisation, Delhi

- In the year 1968 I was asked by the Joint Secretary to find a solution to cleaning of feces of untouchables – which was one of Mahatma Gandhi's dreams. I lived in a colony of untouchables and cleaned toilets myself to understand their pain.
- Gandhi wrote that "Indians are ready to face the bullets of the British but unable to eat with untouchables". It was so hard those days. But it was necessary to improve both sanitation conditions and the conditions of human scavengers.
- I invented the two-pit technology in which two pits are attached to the toilet system. One pit is used at a time. Only when the first one is full, the other one is used. Roughly after two years the pits contain mostly granular fertilizer rich in nitrogen, phosphorus and potassium.
- The Government of Bihar initially applied our technology for 200 toilets and, seeing their success, gradually converted sanitation systems from bucket system to Sulabh technology, thereby curbing open defecation and human scavenging.
- Only 732 towns and cities in India have sewerage systems and that to only partially. Thus public toilets need to be connected to septic tanks or biological digesters. In Bihar, we have successfully provided street lighting from the digesters' biogas.
- The two-pit toilet system was declared the best practice in Istanbul in 1996. Any state government can use this system.



**RAJIV RANJAN SINGH**

Minister, Water Resource  
Department, Government of Bihar

- The Ganga is not merely a river but part of the lives of millions of people. In its pristine glory Ganga and her tributaries carried many minerals, microbes and nutrients that made the Ganga waters self-purifying and fertile. But due to a series of human interventions, it has lost its glory. ... Ganga in Bihar is no more a matter of pride and joy, it has become a source of immense suffering.
- At the entry point of River Ganga in Bihar near Buxar the flow is only 400 cumecs. But Bihar is burdened with the national duty to deliver minimum 1500 cumecs of water through River Ganga at Farakka under the Indo-Bangladesh Treaty.
- Low discharges in River Ganga have resulted in ever increasing sedimentation. Hence, floods have become a regular phenomenon, causing extensive damage to cash crops and basic infrastructure, as well as massive dislocation of vital services.
- Floods have become more recurrent and for longer durations due to Farakka Barrage. The Barrage also appears to contribute to regular aggradations of the river bed by arresting the flow of sediment. Extensive scientific study of the Farakka Barrage from the viewpoint of its sediment transport capacity, high looseness factor, and retrofitting of sediment sluicing should be done.
- Dredging for National Waterways project should be put on hold until a scientific study on the impact of dredging on erosion is done.
- It should be the joint responsibility of the Ganga Basin States to provide water to the Ganga to meet India's obligation to Bangladesh.



# CONTENTS

Waterfront city of Varanasi

## INDEX

<b>Preface.....</b>	<b>4</b>
<b>Messages.....</b>	<b>7</b>
<b>Inaugural Session.....</b>	<b>12</b>
<b>Highlights of Speeches.....</b>	<b>14</b>
<b>Pilot/Demonstration Projects.....</b>	<b>140</b>

## SESSION S

<b>S1</b> Environmental Technology Verification (ETV) framework	<b>24</b>
<b>S2</b> River Health and Assessment of Eco-System Services	<b>28</b>
<b>S3</b> Debate on Policy, Law and Governance of Ganga River Basin	<b>36</b>
<b>S4</b> Exploring Market Mechanisms for Promoting Resource Recovery from Solid and Liquid Wastes	<b>50</b>

## SESSION A

<b>A1</b> Criteria for Sewage Treatment and River Water Quality for Designated Uses – Report Card Framework	<b>56</b>
<b>A2</b> Water Use Efficiency in Agriculture Sector	<b>60</b>
<b>A3</b> Management of Fixed Dissolved Solids and Completing the Natural Salt Cycle	<b>64</b>
<b>A4</b> Managing Surface Water/Groundwater Interaction and Hydraulics of River Channel(s)	<b>68</b>

## SESSION B

<b>B1</b> Delivering on Sustainable Hydropower – Run of the River and E-Flows	<b>74</b>
<b>B2</b> Developing Canals and Urban Natural Drains for Recreation and Surface Transport	<b>78</b>
<b>B3</b> Urban River Management and Interlinking of Water Bodies at City Scale	<b>82</b>
<b>B4</b> Compact/Packaged Wastewater and Solid Waste Treatment Solutions	<b>86</b>

## SESSION C

<b>C1</b> Data Generation through Sensor Networks, Remote Sensing through Satellites, Drones and LIDAR	<b>92</b>
<b>C2</b> Data Modelling, Information and Analytics	<b>98</b>
<b>C3</b> Developing a Skilled Workforce in the Water Sector	<b>102</b>
<b>C4</b> Inspiring Entrepreneurship in the Water Sector	<b>108</b>

## SESSION D

<b>D1</b> Moving towards Evidence Based River Basin Management	<b>118</b>
<b>D2</b> Efficacy of PPP and Hybrid PPP Models	<b>122</b>
<b>D3</b> Wholesale and Retail Financing Instruments and Strategies for Capital Investment in Ganga River Basin	<b>128</b>
<b>D4</b> Water Trading, Valuation, Pricing and an Effective Tariff Regime	<b>134</b>



# SESSION S



- **Environmental Technology Verification (ETV) Framework**
- **River Health and Assessment of Eco-System Services**
- **Debate on Policy, Law and Governance of Ganga River Basin**
- **Exploring Market Mechanisms for Promoting Resource Recovery from Solid and Liquid Wastes**



# Environmental Technology Verification (ETV) Framework

## DAY 1:

Monday; December 4, 2017;  
10:00 - 11:15 h & 11:45 - 13:00 h

## VENUE:

Committee Room A – Vigyan Bhawan Annex, New Delhi

## CHAIR:

Mr D P Mathuria, National Mission for Clean Ganga (NMCg)

## MODERATOR:

Mr Sanmit Ahuja, cGanga

## PANELIST:

Mr Sundeep Chauhan, cGanga;  
Mr Richard Allan, James Hutton Institute, UK; Mr Jan Grimbrandt, Boson Energy, Luxembourg;  
Mr Poul Jensen, EBTC, Europe; Mr Mayank Chauhan, LogicLadder; Mr Harsha K, Kritsnam Technologies;  
Ms Anita Roy, Luri Water Systems GmbH; Mr Nitin Verma, 2030 WRG, IFC; Dr Ibrahim Hafeezur Rehman, VITO India;  
Mr Morten Hegge, Cambi, Norway; Mr Dinesh Kumar, Trojan Technologies;  
Mr Nigel Slaughter, Ligar Polymer, NZ

## S1.1. PROBING THOUGHTS

The rate of innovation in the environmental and clean-tech sectors is unprecedented. All prospective clients wanting to adopt the solution, the investors and lenders to the project and environment regulators will want that the claims made by the inventor/ manufacturer about the achievements of the proposed technologies are verified by an independent and qualified body.

India is a huge market for many such new innovations and Ganga River Rejuvenation Programme (popularly referred as Namami Gange Programme) is one of the most attractive opportunities in the world in the water and environmental sector. National Mission for Clean Ganga, Ministry of Water Resources, River Development and Ganga Rejuvenation, GOI, receives numerous requests from Indian and international technology providers to adopt their solution in the river clean-up initiative. As attractive these solutions may be, these should still go through an independent assessment of the solution.

In India's case (and perhaps of other countries of similar socio-economic settings) the technologies being proposed by companies from advanced and developed nations, as attractive and relevant as they may be, will have an adaptation and localisation barrier to cross. Whether these issues relate to operating parameters or total lifecycle

cost of deployment, every India based client will want to know if and whether the solution will work in India.

## Environmental Technology Verification (ETV)

An ETV is verification and a validation process done by an independent body made up of experts on a new or innovative technology or a solution that is being introduced into the market. The process is transparent and all results are made public. The process will remain constant for all technologies, but the individual steps and experts that are validating the technology shall change.

## The Benefits of an ETV Process

1. It confirms that the technology delivers what it claims in a wide range of operating conditions and at what costs.
2. It benchmarks technologies against other existing similar solutions.
3. It is not a pass/fail certification process but a consultative process along with the technology developers so that all aspects are fully assessed and validated. If there are deviations or gaps then those are highlighted in the verification report.
4. It obviates the need for multiple verifications as the technology developer would want to market it as widely as possible.

## How is an ETV Programme Structured?

Based on global best practices, the ETV programme is at a national level and must have the following building blocks:

1. National Steering Group
2. Verification Bodies
3. Testing Labs and Bodies
4. Accreditation Body
5. Pool of Experts
6. A critical mass of technology manufacturers and inventors
7. An all-party consultation group.

## What are the Various Steps in an ETV Process?

An ETV process typically has the following stages:

1. Initiation through contact between the applicant and the examiner
2. Evaluation, calibration, expectations and KPIs are set
3. Technology Readiness Level is evaluated/established
4. A contract is signed between the Verification body and the applicant
5. Processes are agreed including

responsibility division and verification protocol

6. Tests are planned
7. Tests performed
8. Verification report is prepared
9. Results are published

## S1.2. KEY QUESTIONS TO BE ANSWERED

1. Why is the ETV process needed in India?
2. Who are the stakeholders and how will it be set up?
3. How to make the process smooth and efficient?
4. How to make the process affordable and not extremely expensive?

## S1.3. DISCUSSIONS

The interest in River Ganga system is immense and numerous technological innovations are made to the Government agencies on a daily basis. However, there is no streamlined mechanism to screen such technologies. It is absolutely imperative that an ETV process is established in India. The system should

# NEW OPPORTUNITIES

India is a huge market for many new innovations in the environmental and clean-tech sectors and Ganga River Rejuvenation Programme (popularly referred as Namami Gange Programme) is one of the most attractive opportunities in the world in the water and environmental sector.



be applicable to International technology companies wanting to enter the market as well as the Indian technology innovators that are keen to commercialise their solutions. India's ETV application can and should cater to specific needs of the country. These are:

- The process must provide a benchmark on the optimum cost of the solution
- Whilst most ETVs globally cater only to new technologies, the ETV India must also accept technologies that can be retrofitted in older infrastructure assets
- It must also continuously evaluate improvements and evolutions of a particular type of technology
- Must take into account cultural and social settings of India
- Must develop and provide a decision support tool for urban local bodies

and stakeholders who are required to make procurement decisions on technologies

- Must work alongside with a technology commercialisation process which can provide financial and commercial inputs to ETVs panel of experts.

Great care must be taken to ensure that the ETV process doesn't become a technology recommending body, objective or standards setting body. Allowing these processes to creep into the scope of ETV framework shall compromise the integrity and efficacy of such a model. However, the knowledge and knowhow in the ETV community can most definitely be of help to those institutions and departments who are responsible for establishing environmental goals and objectives.

#### S1.4. RECOMMENDATIONS

Although globally most countries have a single ETV body, but that may be a difficult task to achieve in India in a short span of time. It is recommended that Ministry of Water Resources, River Development and Ganga Rejuvenation establishes an ETV for water sector. Other Ministries can take a cue from this and establish their own ETV processes. The Government can merge all ETVs a few years down the road. cGanga shall be responsible for establishing and managing the ETV for the water and wastewater sector in India. In doing so it will co-opt many other national institutions of high repute.

Globally, the ETV programme is operational in European Union, Canada, Denmark, Japan, Philippines and South Korea. India along with China, Indonesia, Singapore and other selective nations remains a keen observer wanting to adopt

the ETV framework. An international working group was established in 2008. The working group formally invites nominees from NMCG and cGanga to join the working group as observers.

Following two-step process is suggested:

- Process 1: ETV process shall certify if the technology is fit for purpose in India
- Process 2: A commercialisation process which shall certify if the technology and more importantly its management is fit for commercialisation in India.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group TIES5.

## TAKE AWAY POINTS

A working group with Indian and International experts to brainstorm and provide guidance in establishing India's ETV programme.

India invites other countries to take part in establishment of the Indian ETV framework.

Include major national institutions in the establishment.

Set up a technical working group in which individual experts can become members.

Initiate immediately with an interim ETV process till complete framework is established.

# River Health and Assessment of Eco-System Services

**DAY 1:**  
Monday, December 4, 2017;  
10:00 - 17:00 h

**VENUE:**  
Committee Room B –  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Dr Andrew Allan,  
University of Dundee, UK

**MODERATOR:** Mr Suresh Babu,  
WWF-India; Mr Suresh K Gurjar,  
IIT Kanpur; Mr Shyam Prasad,  
IIT Kanpur

**PARTICIPANTS:** Dr S P Singh,  
IIT Roorkee; Dr Dipti Nayak,  
IIT Roorkee; Dr P M Prasad,  
IIT Kanpur, Dr Chiranjib  
Chaudhuri, IIT Kanpur;  
Dr Pranab Mohapatra,  
IIT Gandhinagar;  
Mr Nitin Kaushal, WWF-India;  
Mr Arjit Mishra, WWF-India;  
Dr Craig Hutton, University of  
Southampton, UK; Dr Chris  
Spray, University of Dundee, UK;  
Dr K D Joshi, NBFGR, Allahabad;  
Dr Prakash Nautiyal, HNB  
Garhwal University, Srinagar;  
Dr Rachel Helliwell,  
The James Hutton Institute, UK.

**S2.1. PROBING THOUGHTS**

Under the umbrella of the Indo-UK project scientists from different Indian and UK institutes are jointly researching on the health of river Ramganga and its implication on the eco-system services that it offers. However, due to geographic diversity there are some gaps in understanding of the project among different groups. A platform is needed which can serve as a mode of communication between different groups so that they can discuss on the aspects of project objectives and background, structure, financing and management arrangements, and Ramganga River itself.

**S2.2. KEY QUESTIONS TO BE ANSWERED**

1. Factors affecting river zonation
2. Data availability, gaps and model requirements, etc.
3. Project management, communications, publications and IP strategy

**S2.3. DISCUSSIONS**

The overall objective of the project is to “Produce and demonstrate a feasibility study on the Ramganga River Basin that will address research and policy requirements in support of the restoration of Ganga within the context of the Ganga River Basin Management Plan”. Understanding of the project was done by both UK and India team. It was also emphasised that IIT Kanpur would like to incorporate modelling if it is substantially different than earlier studies. Also, IIT Kanpur would like to have additional data collection to address some of the gaps currently in the system and capacity building which again addresses areas where UK team may bring some fresh perspective on the issues being discussed under this project. The new research and capacity building should ultimately translate to some key policy guidelines that will directly impact the

health of river Ramganga. Finally, the learning from this study should become a template or at least provide a broader framework for the entire Ganga River Basin.

**WORK PACKAGES CURRENTLY IN THE DELIVERY FRAMEWORK:**

WP1: Defining River Health project scope (Tare/Spray)  
WP2: Biophysical process understanding and modelling (Halliday/Tare)  
WP3: Governance and Scenario co-production (Allan/Prasad)  
WP4: Ecosystem Services Mapping (Spray/Singh)  
WP5: Establishing and Quantifying the Connection between Water quality and Community Health and Livelihood Systems (Hutton/Babu)  
WP6: Developing an Integrative Framework and Strategy for River Health (Halliday/ Tare)

WP7: Identification of Key Policy and Investment Relevant Outcome (Ahuja)  
WPs 8 and 9: Dissemination and Management

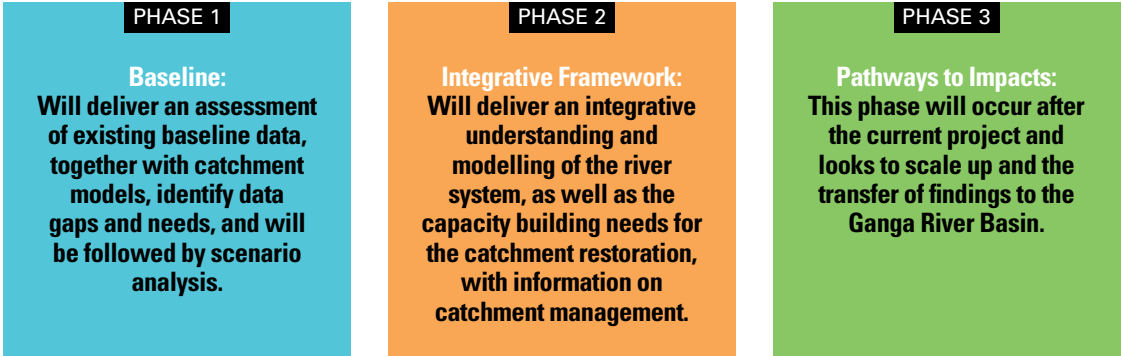
Each work package listed above, explains the status on who is the lead, what are the deliverables and deadlines. The group to discuss on the following items as well:

- a. data (availability and needs) and sharing;
- b. spatial aspects: the extent to which we need to harmonise river zonation, stakeholder communities, land use mapping and ecosystem services;
- c. shared terminology across the project - e.g. ecosystem services; social-ecological systems?
- d. how much time Indian partners can realistically spend on project;
- e. communications
- f. planning for the rest of this tranche of the project;

**INDO-UK PROJECT**

A platform is needed which can serve as a mode of communication between different groups so that they can discuss on the aspects of project objectives and background, structure, financing and management arrangements, and Ramganga River itself.

THE FOLLOWING POINTS DESCRIBE THE UNDERSTANDING OF THE PROJECT:



The output of the project should be a series of trans-disciplinary models of current and plausible future states within a broad integrated framework. These will cover biophysical, socio-environmental, economic and governance issues for the Ramganga pertaining to pollution sources, pathways and sinks. A detailed road map for the upscaling of the integrated framework from the Ramganga River Basin to the Ganga River Basin to a fully integrated, scenario-led, probability-based Bayesian model capable of assessing plausible impacts of river interventions and policies.





- g. planning for the next tranche (including addressing the technical needs question);
- h. the project approach to publications (including need for a joint Indian and UK publication plan to frame the data/IP debate).
- i. The linkage between bio-physical and socio-economic ecosystem services and how biophysical measurements and stakeholder needs are all integrated into the project.

#### S2.4. RECOMMENDATIONS

River zonation work that has been completed for Ramganga River for various other projects such as E-flows requires clarifications on following:

- a. Definition of river health classes
- b. Components of River Health and development of an indicative unified index.

- c. Establishing the thresholds.
- d. Criteria for zonation.
- e. Approach towards defining socio-ecological zones.

#### A. DEFINITION OF RIVER HEALTH CLASSES

##### NEAR-PRISTINE:

- a. Reaches with minimal human interference.
- b. Even the most sensitive species are present in natural abundances.
- c. All natural biophysical processes are operational.

##### SLIGHTLY MODIFIED:

- a. Reaches with some evidence of human interference, but still functionally intact.
- b. There may be some reduction in the abundance of sensitive species, but they are not at risk of disappearance, even during extreme events.

- c. Slight or negligible effects on natural biophysical processes.

##### MODERATELY MODIFIED:

- a. Reaches with clear evidence of human interference, but still largely functionally intact.
- b. Reduction in the abundance of sensitive species, and possible risk of disappearance for the most sensitive, during extreme periods (e.g. drought, floods or pollution events).
- c. Observable effects on natural biodiversity and biophysical processes.
- d. Water quality may be moderately modified, with the possibility of industrial waste, agricultural runoff, and/or domestic waste.
- e. A shift from sustainable river-based livelihoods to other livelihoods is observed.

- f. All cultural activities and rituals are carried out with hesitation.

##### DEGRADED:

- a. Reaches with evidence of considerable human interference and functionally disturbed.
- b. Sensitive species absent (except during rare improved flow and/or water quality conditions).
- c. Increased abundance of hardy species.
- d. Serious erosion and sedimentation may be evident, with significant effects on natural biodiversity and biophysical processes, which will only be partially intact.
- e. Serious modifications to channel morphology may be present, with significant reduction in longitudinal connectivity.
- f. Dominance of introduced or exotic





## CRITICALLY DEGRADED

Floodplains drained and disconnected from the river, completely modified for agriculture or industrial uses, no surviving wetlands, flooding regime significantly reduced, diverted or intercepted.

- riparian plant species, which may be invasive.
- g. Floodplains usually modified for agriculture, occasional surviving modified wetlands, lateral connectivity lost.
- h. Religious rituals, other than cremation, are not carried out.

### CRITICALLY DEGRADED:

- a. Reaches dominated by human interference.
- b. Sensitive species will be absent, and dominated by hardy species, some of which may be disease vectors.
- c. Very little natural biodiversity will be apparent (hardy species).
- d. Serious erosion and sedimentation may be evident, to the extent that channel morphology will have been permanently altered (possibly channelised), longitudinal connectivity is completely lost and river is reduced to isolated pools.
- e. Riparian vegetation dominated by exotic invasive species.
- f. Floodplains may have been drained and disconnected from the river, but will anyway be completely modified for agriculture or industrial uses, no surviving wetlands, flooding regime may have been significantly reduced, diverted or intercepted.
- g. No religious or cultural activities are carried out.
- h. Cremation is not practised if alternative sites are available.

Zonation used for E-flows assessment has six zones. These zones were based on several factors such as geomorphology, river slope, terrain etc.

### B. RIVER-HEALTH BASED ZONATION – RAMGANGA RIVER

WWF-India presented another way of

zonation based on the current health of the river. River Style (geomorphologic) based zonation has been completed by IIT consortium as part of cGanga work. There are four zones based on this approach as listed below:

- a. Himalayan, partly confined flood plain and channel braided.
- b. Valley-Interfluvial, unconfined floodplain and channel braided.
- c. Valley-Interfluvial, partly confined floodplain and channel braided.
- d. Valley-Interfluvial, unconfined floodplain, Channel Partly confined and braided.

### The cGanga work includes several other classifications such as:

- a. Agro-Climatic Zones.
- b. Socio-economic zones: urban, peri-urban and agrarian zones.
- c. Socio-Ecological Zones.

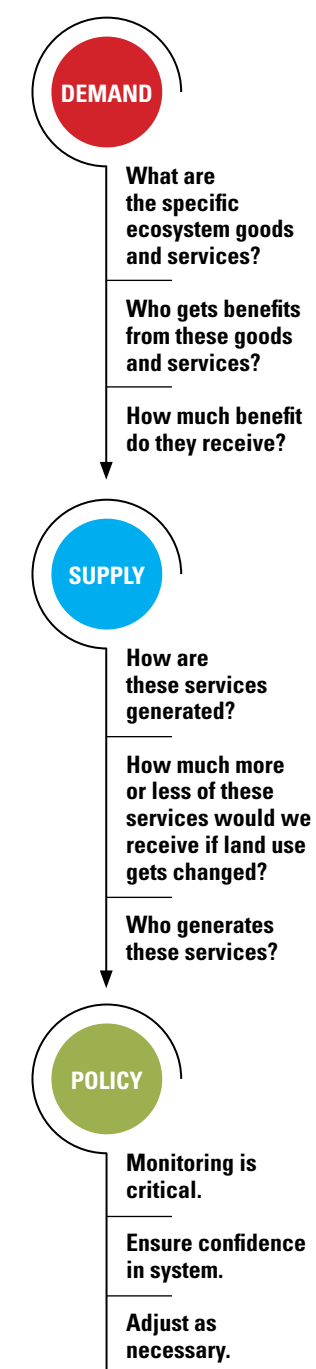
### VISION FOR RIVER HEALTH AND RIVER HEALTH INDEX DEVELOPMENT:

Additionally, WWF mentioned their recent work in the Ramganga basin about connecting benefits/river ecosystem services affected by the river characteristics and developing a simple framework for creating river health index. This comprises of various components such as:

- a. Catchment health
- b. Channel and flow health
- c. Water Quality Index
- d. Biota Health
- e. Community Perception

A composite River Health Index was developed based on the above components. Different zonation methodology currently available for the Ramganga river was discussed and was unanimously agreed that, the most suitable zonation methodology will be

## IDENTIFICATION OF ECOSYSTEM GOODS AND SERVICES



## ECOSYSTEM SERVICES

Ecosystem integrity as well as the goods and services offered by the rivers in India are getting adversely affected by changes in quantity, quality and flow regimes

retained for the current India-UK project.

### C. MAPPING AND ASSESSMENT OF ITS ECOSYSTEM SERVICES

Following points were made on mapping and assessment of its ecosystem services by Dr. S.P. Singh, IIT Roorkee:

- Ecosystem integrity as well as the goods and services offered by the rivers in India are getting adversely affected by changes in quantity, quality and flow regimes.
- Growing water abstractions for agriculture, domestic, industrial and energy use are leaving many rivers running dry, while others are becoming severely polluted.
- Hence, recognition of river ecosystem and its services are urgently necessary for sustainable utilisation and management of river basin.
- Therefore, identification, quantification and valuation of river ecosystem goods and services will help in policy discussion and formulation.

A literature survey on eco-system services includes evolution stages of eco-system services, categories of eco-system services such as provisioning services, regulating services and cultural services. River basin ecosystem management should include the following points:

- Identification of ecosystem goods and services of river basin.
- Involvement of the ultimate beneficiaries and key stakeholders.
- Comparison of the two states of river ecosystems – pristine and the present or managed in future.
- Policy Decision-making and Planning.

IIT Roorkee team presented objectives and details of their work as follows:

- This project studies one of the tributaries of the River Ganga in India, i.e., Ramganga and aims to identify and evaluate its ecosystem goods and services.
- By engaging stakeholders for overall assessment of its health.
- The main objectives of the study are identification, quantification and monetary valuation of different ecosystem services of Ramganga river basin.

#### OBJECTIVES:

- To review literature on baseline of ecosystem services and their valuation in general, highlighting the case of the river Ramganga in particular.
- To identify different benefits in terms of goods and services acknowledged by stakeholders/ provided by the river basin ecosystems and map the distribution of ecosystem services and associated bundle with spatio-temporal variation.
- To estimate the economic value and do ecosystem services mapping and analysis.
- To suggest policy measures for river basin management plans by integrating ecosystem services.

Estimation of economic value of ecosystem goods and services and their mapping and analysis include:

- Primary survey of households.
- Application of GIS and Remote Sensing.
- Stakeholders' Analysis (SA).
- Categorisation of economic values and services.
- Provisioning Services.
- Regulating Services.
- Cultural Services.

### D. IDENTIFICATION OF THE BOUNDARY AREA OF THE STUDY

- Identify the main ecosystems in the basin area and ecosystem services present (both produced or consumed elsewhere).
- Identify key stakeholders.
- People who currently manage river basin (manage land use).
- People who benefit from the services.
- People who are in decision making responsibilities of Ramganga basin area.
- Identification of issues for problem solving and decision making by involvement of public participation.

IIT Roorkee Team, based on the data collected from 8 districts in UP and 3 districts in UK, has identified the goods and services in the Ramganga basin. Specifically, following has been done:

- Block-wise demographic data has also been acquired for all districts in both states
- Analysis of GSDP has been done for different sectors such as Agriculture, Industries, Mining and Quarrying, manufacturing and services.
- Land use pattern has also been analysed for the basin area.
- Buffer villages (0 to 5 kms) in the Ramganga basin have also been identified for conducting the primary survey.
- Mapping work has also been started for the entire basin linking eco-system services to the district level demographic data.

### E. PUBLICATION AND IPR ISSUES:

- India team is of the opinion that the team that collects data and has primary responsibility of acquiring the data gets the primary authorship of

the publication that comes out of the analysis based on that dataset.

- Similarly, if the bio-physical and hydrological models that have been built by IITK and cGanga over the past few years are used for any analysis, the primary authorship resides with the Indian team.
- Any publication coming out of this study should either create new set of data or build new models for primary authorship.

#### DATA SHARING:

A common drive has been created by the UK team for data transfer purposes. Indian team has already uploaded the hydrological SWAT model and all the relevant and supporting data to the common drive.

- Water quality data has also been uploaded to this site for use by UK team.
- UK team has already reviewed the model and data on the common drive.
- UK team wanted the ecological data to be uploaded by the Indian team as well. Indian team wanted to know how exactly the data will be used and what publications are expected from the analysis before providing the ecological data.
- Metadata for all datasets will be developed and used and updated by all team members.

#### HOW TO ENGAGE:

Please note that the deliberations of this group are currently restricted to UK-India teams working on the project river health, however subject matter experts who are interested in contributing more to eco-system services can do so online at the cGanga website (How to engage with us) and select working group SR6.



## TAKE AWAY POINTS

Data sharing protocol will be developed by the UK team.

Data use plan should be provided.

Communication protocols will be developed by both the teams for the entire group as well as for individual work packages.

IPR issues and publication plan will be worked out between Dr. Tare and Dr. Allan.



# Debate on Policy, Law and Governance of Ganga River Basin

## S3\_A: COMPREHENSIVE LEGISLATION ON RIVER GANGA

[DISCUSSION ON 'WHY A DEDICATED LAW IS REQUIRED', OBJECTIVE AND PURPOSE OF THE ACT]

### DAY 1:

Monday; December 4, 2017;  
10:00 - 11:15 h

### VENUE:

Committee Room C–  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Mr Shashi Shekhar,  
Formerly with MoWR,  
RD & GR, Gol

**MODERATOR:** Dr Indrajit Dube,  
IIT Kharagpur

**PANELIST:** Dr Bharat  
Jhunjhunwala, Independent,  
Srinagar, Uttarakhand;  
Mr Paritosh Tyagi, Formerly with  
CPCB; Dr A K Gosain, IIT Delhi

### S3A.1 PROBING THOUGHTS

National River Ganga, along with her many tributaries, has been the source of the spiritual and physical sustenance of Indian civilisation for millions of years. Almost 43% of the population lives in the Ganga River Basin. To the Indian mind, river Ganga is not only the holiest of the rivers and purifier of mortal beings, but also a living Goddess. Apart from the social and spiritual influence, river Ganga also contributes significantly to the economy of all the states through which she flows along with her tributaries. She has an immense contribution to irrigation, power generation, transportation and many more. So, Ganga has several influences on the peoples' life.

There is an outcry in past decades regarding river pollution, river mutilation, river health including ecology and bank erosion, protection of marine life, floodplain encroachment, etc. There are several initiatives taken by the government in the past to cope up with the ever-increasing challenges due to rising population on the river banks through Ganga Action Plan (GAP) I and II and river basin management initiatives. The solutions were looked through technology interventions, but the question remained at the end as to why even after decades there has been little or no improvement in the river condition. The intellectuals and thinkers over series of deliberations and Brain storming sessions proposed that engineering interventions

alone cannot be the solution to the complex problem. The idea emerged as to have a dedicated legislation to create a custodian Institute for the protection of Ganga. The legislation should prescribe do's and don'ts on the river basin and violators would be brought under the law. The counter voice however suggests that existing laws can effectively be used to protect the river basin.

The first proposition, i.e. dedicated legislation on river Ganga, is subject to several challenges. Legislative division of power between Centre and the States is one amongst them. There are also number of institutions operating on the river basin under different layers of laws enacted during the colonial era, or independent India. To establish coordination between fragmented institutes through unified legislation may pose an immense challenge.

Some positive note on these challenges are, one, the Parliament has overarching power in the matter where the states are in conflict relating to sharing of water from interstate River in public interest (List I entry 56); second it can enact a law on a subject matter which transcends spirituality, faith, belief and socio-cultural practices; geography, geomorphology, water resources and its users; livelihood; and environment, and which traverses many state boundaries and jurisdictions.

Counter view suggests existing

anti-pollution laws are sufficient to deal with the issue of pollution in Ganga. If effective coordination between the different institutions may be achieved, then the problem might be addressed. In this thought, pollution in the river takes prominent position, and other issues get subdued.

But the thoughts converge on two issues, i.e., urgent need to regulate activities that affect wholesomeness of the river; and develop a policy to promote activities to preserve the Ganga.

### S3A.3.DISCUSSIONS

As water is getting scarce nowadays, the need has arisen to manage it scientifically. Rivers are a comprehensive system. With active discussion on whether the existing environmental law is enough to protect the wholesomeness of river Ganga, following key points arose:

- If Central Government is negative and wants to kill Ganga for political will, Central law is disastrous. If Central laws are positive and State laws

### S3A.2. KEY QUESTIONS TO BE ANSWERED

- Are the existing environmental laws and other laws relating to river sufficient to protect wholesomeness of river Ganga?
- Is a dedicated law necessary for the preservation of river Ganga?
- Should there be a custodian Institute for entire Ganga River Basin?
- Is it statutorily feasible and does the Indian Parliament have the power to enact comprehensive legislation?
- Should the comprehensive law amend a number of ancillary legislations like water pollution act, environmental act and other central legislation?
- Can this act override some of the existing state legislations operating in the basin?

# 43%

Almost 43% of the Indian population lives in the Ganga River Basin. To the Indian mind, river Ganga is not only the holiest of the rivers and purifier of mortal beings, but also a living Goddess. Apart from the social and spiritual influence, river Ganga also contributes significantly to the economy of all the states through which she flows along with her tributaries

- are negative, then also disastrous. Therefore, a distribution of power approach should be adopted and too much power to a single authority should be avoided.
- b. Since the problem is holistic in nature so basin approach should be apt, where different states under a basin have to participate and bound by law where CMs of states should be on board.
- c. Issues that should be addressed before formulating a new legislation are: (i) How the law will be implemented? (ii) Is there any parallel institution for law implementation? (iii) What is needed to bring the basin back, taking care of river health? (iv) What are the ground truth parameters based on knowledge? (v) Need to look from all angles including environment and hydrology, (vi) Minor detailing is impossible, hence law should be good enough to be implemented without the details.
- d. Debates in Parliament and its standing committee suggested that river basin management act must be there. So definitely there is a need of act. Law does not mean Central Government. It's a federal structure, and the law should be evidence and knowledge based, in consultation with stakeholders. Law should include a scientific co-ordination model. Whether the centralised legislation overwrite the existing ones is another point to be looked upon for that constitutional articles related to water supply, storage and state water disputes has to be analysed. However, the functions of the state should be better guided and coordinated. Knowledge and legislation must be put together. The question at state level is, what is the yield of the basin? The answer has to be clear among states with certainty.

- e. Riverine ecosystem must be saved. Separate clear laws on catchment, floods, marshes, wetlands, etc. must be there and all kinds of storages should be protected and preserved. How much water and in what manner should it be divided? These questions on equity should very well be stated. After diversion, downstream states should have a right to ask for compensation. Knowledge based diversion for longitudinal connectivity must include our ancestral vision, holistic needs and inferences from local habitants.
- f. "Who should own the river? If Ganga is a lively creature, there has to be parents of Ganga. Who are Ganga's parents? We."

#### S3A.4. RECOMMENDATIONS

There should be a dedicated legislation for Ganga. The centralised law should promote knowledge-based custodian institute to manage the River Basin. The complexities

of the challenges on the basin ranging from river pollution, river mutilation, river health including ecology, river hydrology, river bank erosion, protection of marine life, floodplain encroachment, engineered diversion, hydro-power plant, etc. should very well be acknowledged. In addition, inclusion of provisions regarding the flow of the river, nature of activities allowed on the basin and boundary conditions for all stakeholders' actions should be defined. The custodian institute could be a body, corporate or independent of the government. The act should include broad guidelines about the activities of the institute. It should also be the custodian of knowledge on Ganga and involved in evidence-based basin management.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group PLG2.

## TAKE AWAY POINTS

The parliament should enact dedicated legislation on Ganga River Basin for protection and restoration of river wholesomeness.

The act should incorporate knowledge-based custodian institute.

The institute should be a body corporate and function independently of the government.

The statute should include the boundary conditions for all stakeholders' activities.



# Debate on Policy, Law and Governance of Ganga River Basin

## S3\_B: INSTITUTIONAL FRAMEWORK

[DISCUSSION ON TYPE OF THE CUSTODIAN INSTITUTE (INCLUDE THE STRUCTURE, FUNCTION, DUTIES AND POWER) AND ITS INTERACTION WITH OTHER EXISTING INSTITUTES]

**DAY 1:**  
Monday, December 4, 2017;  
11:45 - 13:00 h

**VENUE:**  
Committee Room C–  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Mr Sanjay Kundu,  
MoWR, RD & GR, Gol

**MODERATOR:** Dr Indrajit Dube,  
IIT Kharagpur

**PANELIST:** Dr A K Gosain,  
IIT Delhi; Mr Paritosh Tyagi,  
Formerly with CPCB; Dr Bharat  
Jhunjhunwala; Independent,  
Srinagar, Uttarakhand

### S3B.1. PROBING THOUGHTS

To propose a model custodian Institute for Ganga is a difficult task due to complexities of the issue. The Institute needs to regulate stakeholder behaviour, resolve the conflict between them, monitor built environment on the basin, regulate engineering interventions, address river wholesomeness and pollution, social, religious and economic activities on the basin and manage the different stakeholders' interest. Till now there are several institutional models prescribed by different groups. Out of that two have emerged as top contenders against each other. The IIT Consortium suggested 'knowledge disseminating regulatory model Institute' and Justice Giridhar Malviya Committee appointed by Ministry of Water Resource suggested 'Multi-layer administrative Institutional model'.

The IIT consortium has based the Institutional model on two objectives, i.e. the institute should be the custodian of the river health and wholesomeness of the river. To achieve that goal, the Institute should be knowledge driven. The Institution is modelled like a regulator which will address the conflict between different stakeholders, promote good governance in the basin by prescribing do's and don'ts, create awareness between the stakeholders through advocacy, indulge in scientific evidence-based policy forming. The institute should maintain the knowledge repository on Ganga and her basin. The Institute should also have investigation wing to examine and suggest remedial measures to the ever increasing dynamic challenges due to human intervention and over usage of river resources. The Institute is designed to promote harmony with all

other functioning Institutes on the basin. This model can be implemented without changes in the law in force.

The model suggested by Justice Malviya Committee stressed on the administrative solution of river pollution. The objective and the focus of the Institute is to create a multi-layer administrative body to monitor the built environment and engineering intervention on the basin. The proposed institution will replace existing administrative body, i.e. National Mission for Clean Ganga and will constitute Ganga Volunteer Force. The proposed bill has not taken into account the other institutions operating on the basin and the stakeholder interactions with the proposed institution.

### S3B.3. DISCUSSIONS

The legislation body should be of three layers. First layer would directly interact at central level where PM, CM are

involved. Second layer would be a link between first and third layers. Last, third layer would be of local bodies/ existing institutions.

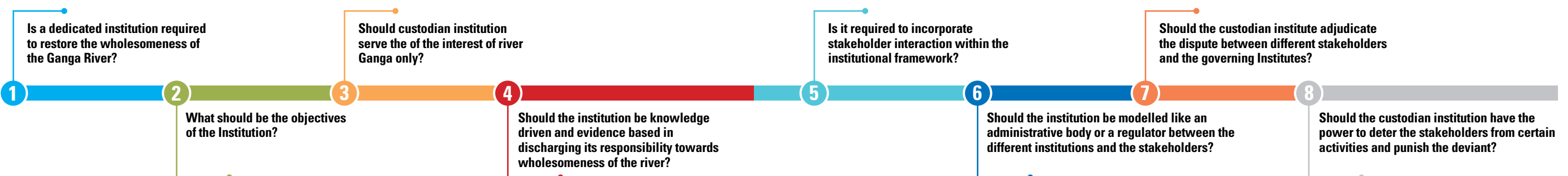
Contrary to this the possibility of single institute to execute all of these functions is doubtful. Segmentwise dedicated bodies was thought to be better option. Based on which, we have to build an institution that will coordinate. Multiple institutes give data that suits them after filtering. What data to choose for analysis? The body will decide and generate evidences. There should be a mechanism for coordination. Currently, there is hardly any communication between CWC's and IIT's. Unless you build accountability of top layer (appointment of top layer outside government control), it cannot be achieved. When statutory bodies given control of governing bodies, then government cannot dictate how bodies work. It was also stated that

## INSTITUTIONAL MODELS

Till now there are several institutional models prescribed by different groups. Out of that two have emerged as top contenders against each other

|||||

## S3B.2. KEY QUESTIONS TO BE ANSWERED







Environment ministry is doing everything to destroy the environment.

Another outcome was a 4 layer body (Planning, Construction, Operation and Maintenance, Monitoring). Data must be transmitted to Centre and state weekly. There should be a technical person involved in Panchayat. Basic understanding will be there if it's a knowledge based core team. Handle pollution where it originates from. Stormwater drains should be for drainage, not a sewer. Following key points were identified in achieving this:

- Public participation
- Fundamental duties of stakeholders
- Water literacy

In addition, coordination and administration should be at district level, where CPCB (deals with pollution only) and CWC (deals with surface water flow) work as a team, for better results.

Without data, proper functioning won't be possible. IIT's have the capacity to build and utilise the knowledge based on data as CWC cannot do

basin management studies alone and therefore, needs to be outsourced. Government also need to build the capacity of institutions. Ministry cannot do it alone so it needs to partner with other institutes. Institutes should not hold data but promote data governance. Even if data is generated and knowledge is extracted, the question is who will act on it? Central government has a mandate still don't act on it. To address this few more issues were presented:

- How do the Panchayats convey their problems in the absence of a technical man?
- How to build a team? It should not be given any judicial powers as can cause more complications.
- State should involve and control municipalities/Panchayats from where the River flows.
- States should also use companies, PSUs, foreign companies and other ministries like sanitation.
- IIT's need to be force multipliers.
- Glaciers should also be considered.

#### S3B.4. RECOMMENDATIONS

The significant aspects of multi-layered and multiple stakeholders on Ganga River Basin need to be identified. These stakeholders should be incorporated/organised under numerous administrative circulars, bye-laws and acts of state-legislations and Parliament. These stakeholders (i.e. executive body, commission) play a distinctive role in basin management which cannot be replicated by one single authority. For this, the constitution mandate regarding division of legislative power should be taken into account while developing the custodian institutional structure. The institute should be the custodian of all knowledge regarding Ganga River Basin, actions, directives, orders of the institution regarding preservation and restoration of the river, all governed by scientific evidences. It should also play an active role in knowledge dissemination within the stakeholders, make provision for regular interaction amongst stakeholders and suggest measures to increase public

participation in the Ganga River Basin management system. The custodian institute should have following features:

- It should be a multilayer administrative body
- It should accommodate representatives from different layers of the government
- It should coordinate with various stakeholders in their activities
- It should formulate a holistic programme for the entire river basin
- It should issue guidelines and formulate policies time to time
- All stakeholders should have prior consultations and permission from the custodian Institute body for any major changes

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group PLG2.

## TAKE AWAY POINTS

The Act should promote and incorporate a custodial institute

The Institute should promote, develop, collect and classify all knowledge regarding Ganga River Basin

The institute should communicate and coordinate with all the participating stakeholders in the basin

Knowledge dissemination through advocacy within stakeholders should be the crucial role of the Institute

Institute should develop a system for regular stakeholders' interactions



# Debate on Policy, Law and Governance of Ganga River Basin

## S3\_C: ROLE OF STAKEHOLDERS IN PRESERVATION OF THE BASIN

[DISCUSSION ON HOW THE KNOWLEDGE CREATION INSTITUTES ON GANGA SHOULD INTERACT WITH DIFFERENT STAKEHOLDERS THROUGH THE CUSTODIAN INSTITUTE]

**DAY 1:**  
Monday, December 4, 2017;  
14:00 - 15:15 h

**VENUE:**  
Committee Room C-  
VigyanBhawan Annex,  
New Delhi

**CHAIR:** Dr Vinod Tare, IIT Kanpur

**MODERATOR:** Dr Indrajit Dube,  
IIT Kharagpur;

**PANELIST:** Dr A K Gosain,  
IIT Delhi; Mr Paritosh Tyagi,  
Formerly with CPCB;  
Dr Bharat Jhunjhunwala,  
Independent, Srinagar,  
Uttarakhand; Mr Risabh Sancheti,  
Supreme Court of India

### S3C.1. PROBING THOUGHTS

One-third of Indian geography is a part of Ganga River Basin. A number of activities over the years have been taking in the Basin. This ranges from power generation to agriculture, religious to social- economic activities. Stakeholders are located in different stretches of the river Ganga in different forms to carry out these activities. The stakeholders include different layers of government institutions including the local bodies, civil societies, activist groups, faith leaders and traditional societies. The activities of one stakeholder affect the other stakeholders as well.

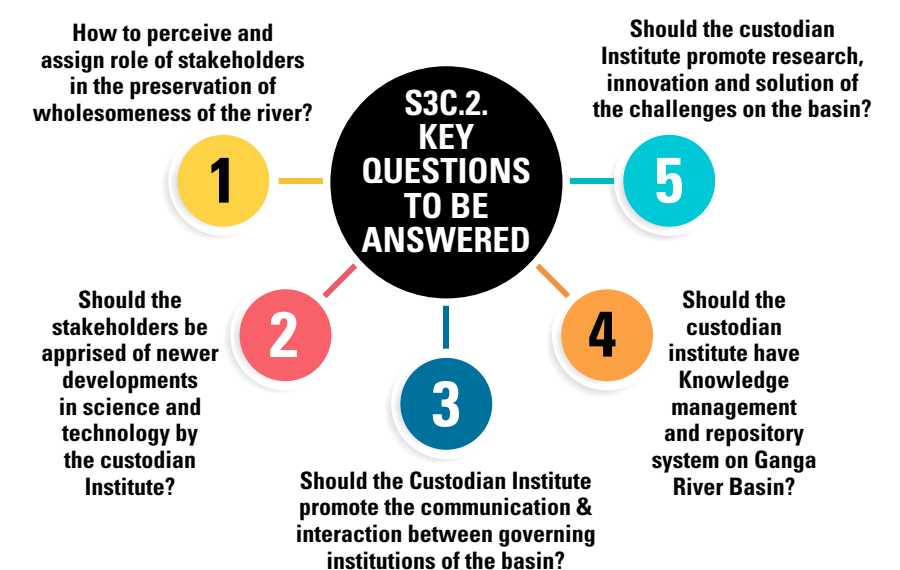
The construction of a dam in upstream affects the people in downstream.

Similarly, the discharge of sewage from the upstream ULB's (Urban Local Bodies) affects the health condition of the downstream population. Diversion of the water through the canal and river mutilation affect the people in the downstream, and it has a great impact on the river health, marine and her wholesomeness. River navigation and industrial waste create a danger to river species which disturbs river health and river bio services. Cremation and other religious activities contribute to the river pollution in addition to domestic and industrial pollution.

So, the challenge is how to create a sustainable framework to manage

all the activities on the basin and promote stakeholders' participation in the preservation of wholesomeness of the river. Towards this end, there have been enormous efforts by different stakeholders. The need of the hour is to put them in a single thread.

Putting the solution in a single thread can be achieved through three approaches. First, creating more awareness among the participant stakeholders about the cleanliness and wholesomeness of the rivers based on scientific evidence and the benefit the stakeholder would drive out of that process; second, equip the stakeholders with scientific knowledge and innovation





## NEW INITIATIVES

The best way to make people aware is to demonstrate, educate about alternative models (more scientific manner) of the existing practices in different segments of social, religious, economic, ecological, environmental and hydrology related aspects.



to combat the pollution in the river; third, the creation of centralised accessible knowledge management repository system.

The dedicated and custodian institution should play an important role in facilitating interaction to restore the wholesomeness of the river.

### S3C.3. DISCUSSIONS

Every person living on the river bank is a stakeholder. Communities are essentially a part of it. It is necessary to fulfill the essential demands such as E-Flows, drinking water and agriculture. Resources must be used in sustainable manner both quality and quantity wise. However, there is always a conflict between stakeholders wanting to preserve water and those wanting to take water. To minimise this, there should be some mechanism for compensation. Here, putting economics to work, is one of the solution.

### S3C.4. RECOMMENDATIONS

Few initiatives could be taken depending upon case to case for preservation of basin:

- Tax must be imposed on open dumping of sewage, so that treating sewage is economical.
- Meet the needs of stakeholders, they should be given alternative things.
- The best way to make people aware is to demonstrate, educate about alternative models (more scientific manner) of the existing practices in different segments of social, religious, economic, ecological, environmental and hydrology related aspects.
- Mechanism of maintaining a balance between multi-stake holders.
- Custodian institutes can identify common aligned and non-aligned interests.
- Economics: Carrot and stick policy.
- Economics: Polluter pays principle.



## TAKE AWAY POINTS

Different stakeholder participation within the holistic plan will ensure preservation and speedy restorations of the river basin.

The bottom-up approach should be provided for stakeholders' participation in the preservation of the basin.

The custodian institute should provide an alternative model of the existing practices.



# Debate on Policy, Law and Governance of Ganga River Basin

## S3\_D: ADJUDICATION OF DISPUTES

[DISCUSSION ON "SHOULD THE INSTITUTION (I.E. COMMISSION/AUTHORITY) HAVE SUMMARY ADJUDICATORY POWER AND SHOULD THERE BE DEDICATED ADJUDICATORY FORUM AGAINST THE ORDER OF COMMISSION/AUTHORITY OR IT SHOULD BE HEARD BY NGT"]

**DAY 1:**  
Monday, December 4, 2017;  
15:45 - 17:00 h

**VENUE:**  
Committee Room C –  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Dr Vinod Tare, IIT Kanpur

**MODERATOR:** Dr Indrajit Dube,  
IIT Kharagpur

**PANELIST:** Mr Puskal Upadhyay,  
CGDA; Mr Risabh Sancheti,  
Supreme Court of India;  
Dr Bharat Desai, Centre for  
International Legal Studies,  
JNU; Dr A K Gosain, IIT Delhi;  
Mr Paritosh Tyagi, Formerly  
with Chairman, CPCB; Dr Bharat  
Jhunjhunwala, Independent,  
Srinagar, Uttarakhand.

### S3D.1. PROBING THOUGHTS

Managing the Ganga River Basin is more than addressing the river pollution. To have the wholesomeness of the river, one needs to understand the river morphology, biodiversity, hydrology, sociology, economics, and the boundary condition of the policy and laws. So the adjudication institute should have a strong understanding of techno-socio and legal issues.

The custodian Institute will discharge a number of executive and quasi-judicial functions in dealing with stakeholders, governmental agencies and mitigating their disputes. The access of stakeholders to multiple adjudicatory forums may defeat the purpose of the

special law. River basin management is a special knowledge domain that travels beyond environmental governance and pollutions. So, judges should have an understanding of the subject of basin management beyond the realms of laws and dispute settlement.

There is possibility of large litigation in future from the decisions of the custodian institute, even after advocacy and capacity building within stakeholders by the custodian institute. Changing the prevailing practice allows a challenge.

The biggest debate remains over the standalone appellate authority against the decision of custodian institute or existing Green Tribunal, which may be sufficient to cater to future disputes.

### S3D.3. DISCUSSIONS

What kind of disputes? How to identify generic disputes? NGT (National Green Tribunal) is not only pollution based but anything concerned with environment should be dealt. Legislations have been adequate but things remain on paper, orders are not being taken seriously. Adjudication is a skill that judges develop over time. In addition, 'Amicus Brief' which is a speculative legislation where wrongdoers are punished within the system should find a place. Custodian institute must have the statutory power, power to intervene anyone affecting Ganga. Judicial bodies should be trained in respective technical matters so as to facilitate better and timely judgments.

### S3D.4. RECOMMENDATIONS

The problem about the disputes of different nature would be inevitable. It is necessary to make an attempt to foresee types of future conflicts and classify them in categories. Instead of regular courts and tribunals that decide many of these disputes, the custodian institution should be empowered with statutory 'amicus brief'. On any dispute of river basin, the courts/tribunals should seek mandatory advice from custodian Institute.

#### HOW TO JOIN:

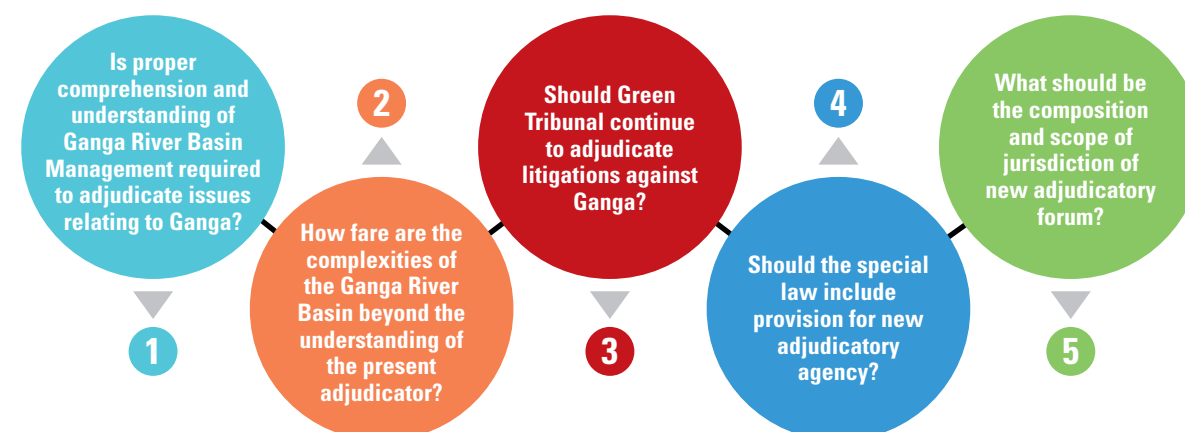
Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group PLG2.

## TAKE AWAY POINTS

The act should empower the custodian institute with the 'amicus brief'.

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## S3D.2. KEY QUESTIONS TO BE ANSWERED



# Exploring Market Mechanisms for Promoting Resource Recovery from Solid and Liquid Wastes

[INDUSTRIAL, DOMESTIC AND AGRICULTURAL]

## DAY 1:

Monday; December 4, 2017;  
14:00 – 15:15 h & 15: 45 –17:00 h

**VENUE:** Committee Room A –  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Mr D P Mathuria, NMCG

**MODERATOR:** Dr Vinod Tare,  
IIT, Kanpur & Mr Nitin Verma,  
WRG 2030,IFC

## S4.1. PROBING THOUGHTS

This Special Session was designed to explore projects on resource recovery from wastewater and sludge in the Ganga River Basin from a demand side/business perspective. It is widely recognised that this would require multi-stakeholder (industry/business, practitioners, academicians, civil society and government including policy makers and administrators) engagement.

Globally, a paradigm shift is emerging from a linear to a more circular economy. Though it has been well established that wastewater can be a valuable resource for energy generation and nutrients (e.g. nitrogen, phosphorous, etc.), the returns from such resource recovery often cannot be in excess of investments on treatment unless value of water is considered or economic losses due to direct or indirect adverse impacts of discharge of partially treated/processed wastes are incorporated through policy implications via viability gap funds (VGF).

In India, and particularly in the Ganga River Basin, the gap between wastewater generated and treated is large, resulting in untreated wastewater flowing into water bodies with highly polluted surface and groundwater, and a deteriorating eco-system as a result. At the same time, wastewater can be seen as a single most reliable water supply source for the future in highly water stressed (urban) settings.

Wastewater market opportunities are

speculated for private investments and a more circular economy can create value for local communities as well. What is required to ensure that such speculations become reality? How multi-stakeholder engagement could be used as a means for this? Are there evidence based well documented case studies/projects available that can be of relevance in Ganga River Basin? What pre-requisites are necessary to replicate such project in the Ganga River Basin? It is to answer these questions that this Special Session was planned. The session was divided in following two sub-themes.

### A: Opportunities for Wastewater Recycling and Resource Recovery in India

Moderated discussion on key topics, principles of collaboration, etc.:

1. Topics of interest with high business potential under the theme of circular economy
2. Process of aligning between government and private sector to avoid conflict of interest
3. Mechanism for Public-Private-Community-Partnerships to drive this forward
4. Identification of proposed demonstration projects – request for proposals

### B: Exploring Business Models with Potential for Revenue Generating Opportunities

Panel discussion on way forward within six months:

1. Selection of demonstration pilots
2. Need for advisory/expert group to guide pilot projects
3. Project preparation & prefeasibility studies, etc.

## S4.2. KEY QUESTIONS TO BE ANSWERED

**1** Exploring business models and trigger for market driven approaches in Ganga River Basin with demonstration projects (including alignment with Hindon/RamGanga multi-stakeholder rejuvenation programs)

**2** Formation of a multi-stakeholder thematic taskforce to guide and steer pilot initiatives and evaluate potential to replicate and scale up successful cases in the Ganga River Basin, particularly in the smaller sub-basins of the tributaries of Ganga river such as Hindon, RamGanga, Gomati, Kshipra, etc.

## S4.3.DISCUSSIONS

NMCG receives a large number of offers from technology providers and project developers seeking to promote technologies for resource recovery. It becomes difficult to discern the benefits and drawbacks of the various technical proposals. In addition, it is unclear why most new projects awarded by NMCG are without the design elements for resource recovery. Based on the data of the existing STPs in the Ganga River Basin, it is apparent that a large number (nearly 50% of STPs) of sewage/wastewater treatment projects have been built with the required technology and infrastructure for resource recovery, however, most of these facilities are generally reported to be under performing with respect to energy recovery.

NMCG clearly anticipates that waste sludge management from sewage/wastewater treatment facilities will be a major cost centre and operational problem for most STPs. The problems are due to lack of safe sludge disposal especially in high density populated areas. Therefore, NMCG is keen on supporting resource recovery from waste treatment/management facilities. The recently awarded sewage treatment projects on hybrid-annuity PPP models have a clear well defined incentive mechanism for private sector to propose and develop resource recovery.

## WASTE WATER

In India, and particularly in the Ganga River Basin, the gap between wastewater generated and treated is large, resulting in untreated wastewater flowing into water bodies with highly polluted surface and groundwater, and a deteriorating eco-system as a result.





There is strong interest from government to partner with private sector around new business/ technology models focusing on resource recovery. A focus on towns along mainstream of Ganga was suggested as the larger facilities potentially provide the right economies of scale for resource recovery projects.

International good practice cases show that there are feasible business cases for resource recovery, including availability of relevant technologies. Resource recovery from waste cannot be looked at as a standalone activity, it is critical to incorporate resource recovery elements right into the design of waste treatment facilities. Reuse water tariffs (for reuse by industry) can go down if cost of water treatment can be reduced through energy and nutrient recovery. Development finance support is available to evaluate innovative proposals for resource recovery opportunities. However, technology companies and projects developers usually find it difficult to mobilise such funding sources without a clear ask from the government agencies in India. It is critical to define the risk profile for resource recovery projects and ensure

that the right risk-return framework is created for private sector. Private sector is able to undertake design, technical and execution related risks, however, risks linked to sustainable availability of waste resource or policy changes cannot be borne by the private sector. For successful resource recovery projects, good quality data on the quality and amount of wastes is critical to ensure understanding of key design elements which is necessary for proper risk profiling. The quality of detailed project reports and risk-reward framework in such projects becomes critical. Some key contractual issues highlighted during rendezvous include:

- Unreliability of data (parameters at moment of tendering cannot change after contracting, e.g. characteristics and volumes of wastewater inflow).
- Unreliability of government adhering to payment obligations.
- Lack of strong regulations and enforcement that are not creating the required framework for enabling resource recovery from waste.

#### S4.4. RECOMMENDATIONS

There is a definite need to promote the

concept of Resource Recovery (RR) from waste streams. RR from waste is not a technical challenge but a business challenge that requires supporting policies, good planning, design and risk-reward sharing framework for successful implementation. RR pilot projects can be broadly classified into the following three areas:

- RR amendments at existing waste management facilities such as existing wastewater treatment plants.
- Incorporating RR requirements in new projects that are currently under planning or design stages.
- Promoting the concepts of circular economy principles and supporting pilot projects that look at creating innovative market-led business models for RR. For example, setting up combined RR systems for high organic strength industrial waste streams and fecal sludge.

RR initiatives could be taken by setting up of a multi-stakeholder task force by NMCG, with potential support from cGanga and 2030WRG, with the objective of developing a concept note on RR opportunities and enabling framework for

RR projects. Call for Expressions of Interest (EOI) for pilot projects could be another option, where a public call for EOI would be opened by NMCG/cGanga inviting private sector (technology companies and project developers) to submit their conceptual ideas for resource recovery. The EOIs received by NMCG/cGanga would then be technically evaluated by cGanga under the proposed/upcoming Environmental Technology Verification (ETV) framework and/or vetted by a multi-stakeholder group (consisting of international/ local experts, private sector and government). The key objectives of the initial evaluation/vetting would be:

- Prioritisation of initiatives and creation of enabling environment for pilot projects.
- Provide logistical and facilitation support to the project developers for innovation, partnerships, and new business models.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group E06.

## TAKE AWAY POINTS

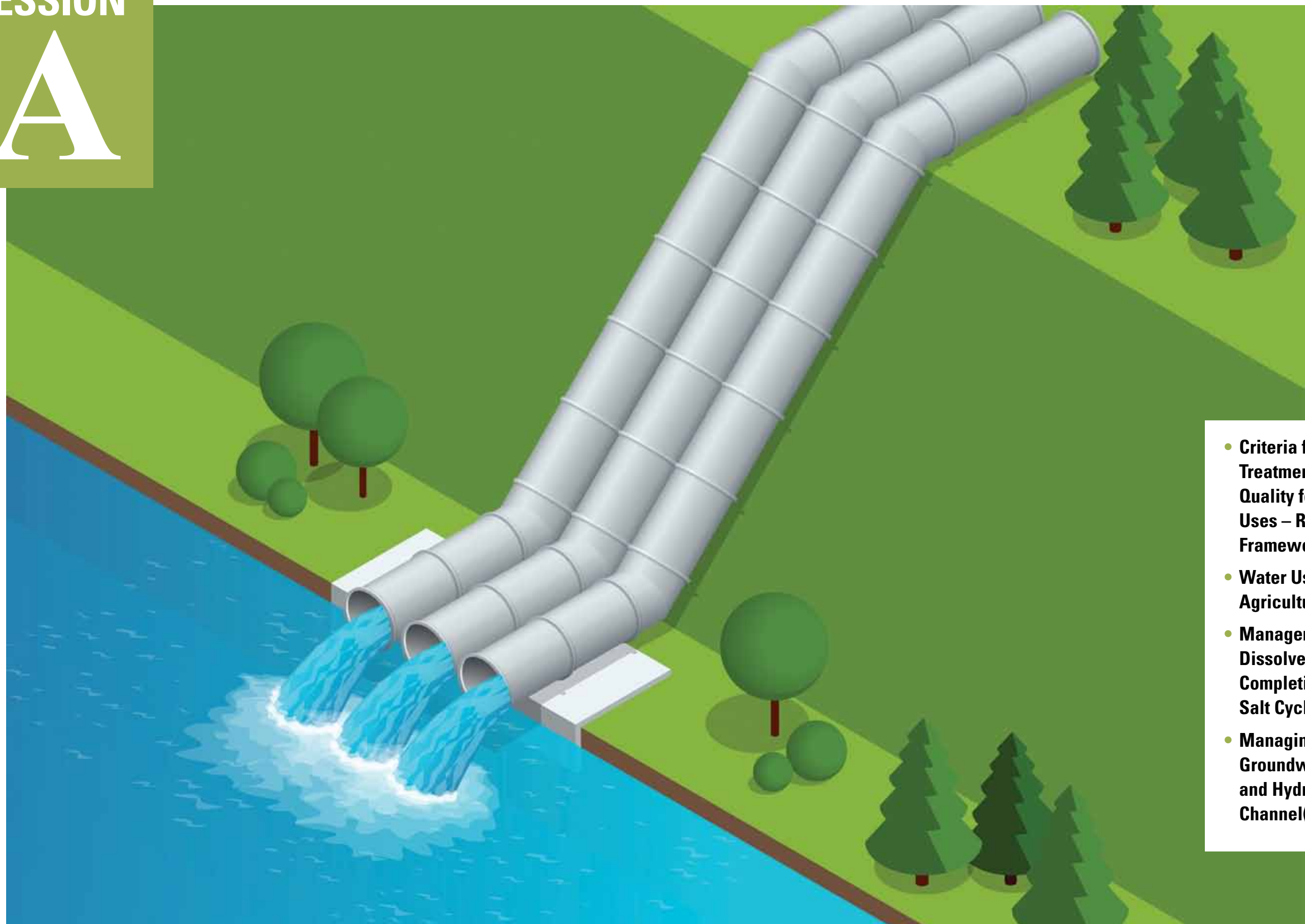
RR initiatives could be taken by setting up of a multi-stakeholder task force.

Call for Expressions of Interest (EOI) for pilot projects.



## SESSION

# A



- **Criteria for Sewage Treatment and River Water Quality for Designated Uses – Report Card Framework**
- **Water Use Efficiency in Agriculture Sector**
- **Management of Fixed Dissolved Solids and Completing the Natural Salt Cycle**
- **Managing Surface / Groundwater Interaction and Hydraulics of River Channel(s)**

# Criteria for Sewage Treatment and River Water Quality for Designated Uses – Report Card Framework

## DAY 2:

Tuesday, December 5, 2017;  
14:00 - 15:15 h & 15:45 - 17:00 h

## VENUE:

Committee Room A – Vigyan  
Bhawan Annex, New Delhi

**CHAIR:** Dr Kalyan Rudra, West  
Bengal Pollution Control Board

**MODERATOR:** Dr Vinod Tare,  
IIT Kanpur

**PANELIST:** Dr Naresh Singhal,  
University of Auckland,  
New Zealand; Dr A AKazmi, IIT  
Roorkee; Dr Indumati M Nambi,  
IIT Madras; Dr Anshuman, TERI;  
Dr N N Rao, NEERI;  
Dr Pawan Labhsetwar, NEERI;  
Mr D P Mathuria, NMCG;  
Mr Sundeep, NMCG

## A1.1. PROBING THOUGHTS

India's wastewater generation has been increasing rapidly over the past decades with increasing industrial and urban activities. This has led to the growing problem of protecting the environment from being overloaded by sewage discharges from urban centers. The main control mechanism adopted in India to tackle this problem has been to prescribe increasingly stringent standards of wastewater release into inland areas. But these standards prescribe fixed norms of discharge across the whole country irrespective of the possible environmental impacts of such discharges in different areas or at different times. Thus, implementation of such norms across the board implies that pollutant discharges can be as high in already polluted areas as in relatively unpolluted segments, thus making the highly polluted segments prone to degenerate entire ecosystems while other segments are barely affected by the incoming effluents. As such the standards may need to be revised to meet the ecosystem requirements at different periods of time at different places.

A second point to note is that the discharge standards themselves may be based on scientific criteria that are theoretically correct in laboratory conditions, but they may have varying implications in the real environment. For instance, the water quality required for

bathing may be quite different from that of drinking, and such requirement may even vary due to climatic or other factors. Hence, the standards may need updating from the usage point of view.

Thirdly, financial resources for urban sewage treatment in India seem to be grossly limited. Hence many towns and cities treat only a small part of their sewage adequately, while the rest is discharged completely untreated. In general, however, the initial treatment ("primary treatment") system costs only about 20-30% of an entire STP but removes some 50% of its pollutants. "Secondary treatment" is less cost efficient (it may cost around 50% and remove another 40-50% of pollutants), and "tertiary treatment" is even less cost-effective (it may remove only 5-10% of the total pollution load at a cost of about 20-30% of the total, although tertiary treatment may be particularly effective in removing pathogens). In view of these issues, the question arises whether a hierarchical set of standards should be adopted for sewage discharges under different categories, such as "Compulsory" (achievable by primary treatment alone), "Highly Desirable" (achievable after secondary treatment), and "Desirable" (achievable with tertiary treatment included).

|||||

## A1.2. KEY QUESTIONS TO BE ANSWERED

To decide upon the above possible changes in sewage discharge standards so that the overall environmental goals can be achieved at a much lesser cost to the nation, some issues that may need to be considered in detail are:

1

Instead of uniform sewage/ effluent discharge standards across the board, should we move towards a more dynamic and segment-specific approach? That is, should we adopt a framework that takes into account the pollution status in a particular part/stretch of river or water body or ecosystem over a particular season or time period?

3

The transition from a fixed discharge standard regime to a dynamic one can be expected to raise some problems, e.g. due to differentiated responsibilities of wastewater producers, due to different mechanisms that may be needed for monitoring and standardisation, etc. Hence, how should such a dynamic regime be rolled out and monitored?

5

Should the discharge standards for sewage be staggered in different achievable categories, so that the overall impact on aquatic ecosystems will be positive in the medium term in comparison to present trends?

2

Should only the pollution levels in the river stretch be considered, or should the consideration be based on the overall biogeochemical or ecological requirements of the stretch?

4

Should the sewage and trade effluent discharge standards be reviewed against the expected water usage of the receiving water body?

6

Since the overall aim of the above measures is to improve the status of our rivers and other water bodies, how can we measure the progress that is achieved? Should a Report Card Framework be developed for different river segments? What should be the structure and parameters of such a Report Card?

50%

In general, however, the initial treatment ("primary treatment") system costs only about 20-30% of an entire STP but removes some 50% of its pollutants.





## TAKE AWAY POINTS

No relationship between  
BOD and health hazards.

DO is better parameter  
to capture variation.  
BOD is just an indicator  
of biodegradability of  
substances present  
in water.

Revision of water quality  
norms for designated  
uses of water bodies for  
communicating the impacts  
to communities and  
sewage treatment norms  
considering value for  
money spend is required.

cGanga may constitute  
task force to prepare a  
report on above.

## GENERATION OF WASTE WATER

**Due to steady increase of industrial and urban activities, the wastewater generation has increased tremendously in the recent times. This in turn has resulted in ecological problems especially surrounding the urban centres.**

### A1.3. DISCUSSIONS

• There lies a difference between criteria and standards. Criteria are based on cause and effect relationship. If there are standards for something, then there must be a technology to measure it. Few topics worth discussion include:

- Water quality norms for the water bodies.
- To what extent we should treat effluents whether domestic or industrial?
- How do we make sewage treatment a sustainable business?

• Every hydrological system is unique when it comes to water quality characteristics. When it comes to the standards, these should not be uniform for all places as every hydrological system has its own special properties and they are unique. Assimilative capacity of the hydrological system should be kept as criterion when any standards are being set. With lesser availability of water resources, the government is bound to have stringent standards.

- There is a need to give the right message to the society about the status of our rivers. When we say that BOD level in river is high and it is not good for bathing, do we really have some scientific evidences to show that the BOD is impacting the human health directly? What is the science perspective on using BOD norm for bathing purpose? In the current guidelines for bathing purpose require a BOD of 3 mg/l or less. However, there is no scientific evidence that exposure to greater BOD can lead to health hazards if the dissolved oxygen is 5 mg/l or more. However, there can be other harmful bio-materials or chemicals present in the water which requires careful investigations. BOD does not capture impacts of any such things.
- There could be a situation where DO is in excess saturation value and BOD can still exists at the same time. Take an example of high DO in day time (because of eutrophication) and very less DO at night time, this may harm aquatic life in the system. DO can give more information than monitoring of BOD at any station. BOD may not help us in

monitoring the actual situation rather it gives the wrong impression/message to the society and world that our rivers are not even good for bathing.

### A1.4. RECOMMENDATIONS

Every community should have at least primary treatment on the priority basis. Many of the small urban and village centres release their sewage untreated. However, a basic primary treatment only costs about 20-30% of the entire STP cost and it removes more than 50% of the pollutants. Further, we can have three levels of treatment i.e., Compulsory, Highly desirable and Desirable. A small task force which can suggest on such parameter identification and give a brief presentation in two months could be constituted.

Due to steady increase of industrial and urban activities, the wastewater generation has increased tremendously in the recent times. This in turn has resulted ecological problems especially surrounding the urban centres. However, the stringent norms which are fixed for entire country are neither suitable

from environmental consideration nor achievable economically. Thus, a revision of these norms is required with keeping protection of the ecosystem in mind.

Valuing water is utmost important. Sewage/effluent treatment business would not be sustainable only by recovering the energy and nutrients unless treated water sale by local bodies through promotion or allowing appropriate pricing of water. What should be the right price? Currently, Central government is mainly paying for all these treatment plants and facilities. Central government may pay to State government and make them understand that this treated effluent is a resource for them. Local bodies should take burden of these facilities and they should decide the pricing.

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working groups SR1 – criteria for sewage and river water quality and SR5 – report card framework.



**PANELIST:** Dr J Adinarayana, IIT Bombay; Dr S P Singh, IIT Roorkee; Dr Yuichi Mori, Mebiol, Japan; Dr Bob Ferrier, James Hutton, UK; Dr Kalyan Rudra, WBPCB; Mr Harsha Karumanchi, Kritsnam Technologies; Mr Paritosh Tyagi, Formerly with CPCL.

The agriculture sector in India is vital not only for the nation's food security, but also because it provides direct and indirect employment and livelihood to more than half the country's population. Its contribution to the nation's GDP, however, is less than even 20%. And, yet, in terms of natural resource use, agriculture occupies the greater part of India's land area and consumes nearly 85% of water every year. Moreover, India's agricultural water use is among the highest in the world, but the crop yield per unit of land and water is among the poorest. While a significant part of the cultivation is rain-fed, irrigation efficiency in surface water irrigated areas is very poor. Often, irrigation applications are far in excess of crop water requirements. Many areas have been over-irrigated for decades, leading to leaching of nutrients, soil erosion and degradation, reduced crop yields, and pollution of groundwater or

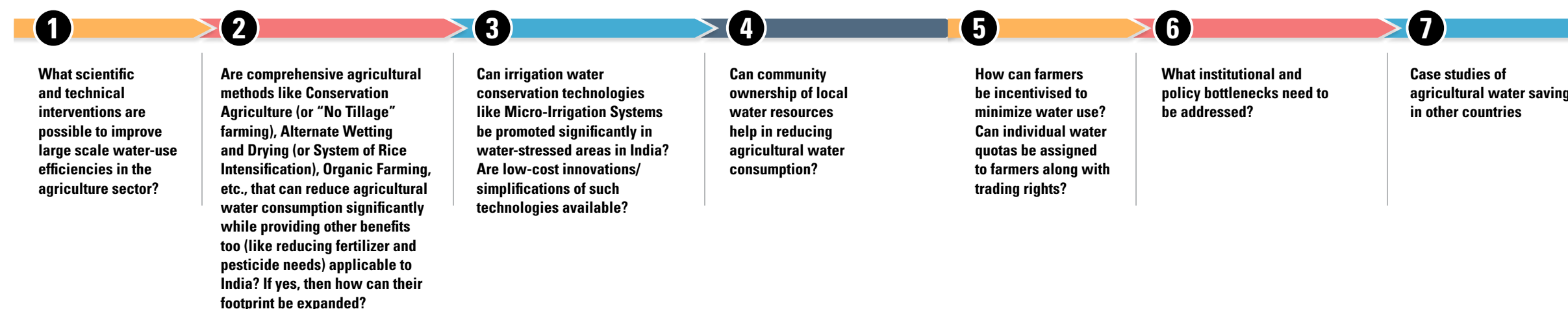
Since agriculture is a critical area on account of national food security and mass livelihood issues, any attempt to reform agricultural practices need to take these concerns into account. Thus, water use minimization in agriculture will have to consider not only technical feasibility but also agricultural productivity, cost-benefit analysis, technological sophistication, socio-cultural traditions, and availability of infrastructural and knowledge support systems, training, and agricultural extension services.

- Pricing and metering of flow
- Legislation on metering of flow for the irrigation
- Water entitlement on farm level
- Irrigation scheduling for low flow and high flow conditions
- Use of recycled water in irrigation

- Considering water as a system, a better understanding of the entire system based on critical zone studies is required. It can include advanced monitoring systems such as ZOCDs, related monitoring techniques, real time monitoring and analysis platform that may help the public to understand the situation. Using genetic tools to improve the crop productivity is another option. New crops which are heat tolerant and efficient in water and nutrient use are needed to be developed. Also, it is necessary to maintain the soil fertility and carbon balance. Achieving this requires developing new technology and tools. Other few ways to increase efficient water utilization are:
- Alternative cropping, e.g. dry variety paddy cultivation. Change in cropping pattern may help in better use of water

**85%**  
The contribution of agriculture to the nation's GDP is less than even 20%. And, yet, in terms of natural resource use, agriculture occupies the greater part of India's land area and consumes nearly 85% of water every year.

**Some issues of critical importance that arise in considering the above problem are:**



- b. Less use of chemicals in agriculture. Use of organic farming
- c. Soil less farming technology, requires 70 percent less water

The issue of ground and surface water contamination by the chemicals being used in agricultural sector is big, however, no such study, other than in Bihar region by Government of Bihar in association with NIH, have ever been done in Indian context in fields probably because the level of pollution is not alarming as yet. However, the applications of treated sewage were unsuccessfully done in past resulting in heavy metal and pesticides entering in our groundwater and food chain.

The importance of water distribution through institutional reforms needs to be understood. Take an example of irrigation water situation in Uttar Pradesh, where irrigation water is being diverted to non-irrigation purposes and this has resulted in increased demand of water in other sectors causing scarcity of water for irrigation. Determining of right amount and

right time of water needed for irrigation is the key issue to be resolved while it comes to the efficient use of water for irrigation, through canal system. There is a need for accuracy in survey while planning for canal system. Major failures in canals occur due to:

- a. Design Failure
- b. Inaccurate survey
- c. Conjunctive use issue at tail end
- d. Corrupt practices of water use

#### A2.4. RECOMMENDATIONS

The issue of economic scarcity of water is equally important as to the physical scarcity. The unauthorized use of water creates an indirect water market in the canal command area. There is a need of measuring the water supplied to the farmers which can eventually help in identifying the losses and determining the pricing of water if policy allows. Water pricing is the need for improving the present condition of water resources. In Uttar Pradesh, paddy,

sugarcane and wheat are covering more than 80 percent of gross irrigated area. Improvements in the irrigation literacy and change in agriculture pricing policy may help in improving the efficient use of water for irrigation. There is a need to develop water credit system in agriculture systems. Pricing of water appropriately can reduce the misuse of water and create a market for water trading. If policy allows, water user association can themselves decide the price and amount of water to be used for irrigation and other uses.

#### FEW OTHER IMPORTANT CONCERNS THAT NEED TO BE ADDRESSED ARE:

- a. Resolve the issue of unreliable and untimely water supply to the farmers; which made them to start using the groundwater, which is more reliable source of water
- b. Measure the supplied/used water in terms of cubic meter rather than in terms of irrigated hectare area

- c. Encourage market mechanism strategy to link the water use efficiency to the market
- d. Loss of water due to evaporation and wet soil should be identified as a major loss and shall be accounted
- e. First critical observatory established in the Ganga Basin, managed by IIT Kanpur being used in monitoring and analysing the water use in farms through real time monitoring. Such technologies should be looked upon
- f. Crop intensification, micro irrigation, restructuring canal systems, and network for data collection such as soil moisture, water use, etc. need to be intensified.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working groups SR1 – criteria for sewage and river water quality and SR5 – report card framework .

## TAKE AWAY POINTS

Use advanced monitoring systems, real time monitoring and analysis to overcome the data lag and insufficiency

Studies on use of treated water used in agricultural sector in Indian context have to be done

Most efficient water utilisation techniques should be adopted and farmers to be better trained on that

Restructure canal systems

Water pricing mechanism is to be expeditiously implemented to improve water use efficiency

Create a market for water trading

Take up pilot studies on soil less agriculture and urban/ house-hold agriculture.



# Management of Fixed Dissolved Solids and Completing the Natural Salt Cycle

## DAY 3:

Wednesday, December 6, 2017;  
14:00 - 15:15 h & 15:45 - 17:00 h

**VENUE:** Committee Room A –  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Dr Kalyan Rudra, West  
Bengal Pollution Control Board

**MODERATOR:** Dr Vinod Tare,  
IIT Kanpur

**PANELIST:** Mr Sajid Hussain,  
TWIC; Mr Sundeep, NMCG;  
Dr Anubha Goel, IIT Kanpur;  
Dr Sanjeev Chaudhari, IIT  
Bombay; Dr N N Rao, NEERI;  
Dr Praveen Kumar, NMCG;  
Dr Indumati M Nambi,  
IIT Madras; Dr Brijesh Dubey,  
IIT Kharagpur.

## A3.1. PROBING THOUGHTS

One of the significant ecosystem services provided by rivers is the removal of wastes or excess materials accumulating in the basin and their eventual transport in the sea. Every river has a natural capacity to carry such wastes, and we take advantage of this function in many ways. However, one type of waste that is often overlooked is soluble solids or salts generated from various activities in terrestrial environment. The removal of excess salts from the basin to the ocean by rivers is part of the natural salt cycle, and until human activities multiplied since the industrial revolution, a natural salt equilibrium on terrestrial surfaces had been established by the periodic flushing of salts through runoff and percolation leading eventually into oceans (where the dissolved solid concentration averages about 35,000 ppm or 3.5% while more than a few hundred ppm of salt in surface waters may be harmful for terrestrial ecosystems and for human consumption). But this salt cycle has been affected in the modern age

by various industrial activities such as chemical and pharmaceutical industries, tanneries, dyeing and textile units, mining, etc., and, at least indirectly, by lifestyle changes. Such activities can generate huge quantities of salts, whose disposal into the environment is very harmful, but nor can the salts be indefinitely accumulated at site.

The question arises whether rivers can be used to transport the surplus salts (that are non-hazardous) to the oceans without causing harm to the rivers themselves. This obviously means the need to assess rivers' capacities to transport the salts (considering especially the effect on aquatic life) and decide upon means to utilize any spare capacity. In the case of Indian rivers, the monsoon period (wet period) is a time when such capacity should be spare, if not during other periods. This, however, implies that there should be some means to store the soluble solids in situ for a part of the year before they are flushed out during the rainy season.

## A3.3. DISCUSSIONS

Water has both conservative and non-conservative pollutants of concern. One of the major services of river is carrying the excess material (waste) from the basin and transporting them in the sea. The advantage of this function of river can very well be used within its carrying capacity. However, for industrial salts the tolerance of such ecological system (river) is very low, i.e. using river as transport means can result into ecological hazards. The question is:

- Can we use rivers to complete the salt cycle during the monsoon period?
- For this we need to have variable discharge standards for monsoon and non-monsoon period, can we have such variable standards and how appropriate it would be?

Treated sewage may have nutrients in it but conservative pollutants as salts can cause problem for the root zone of the soil. Reverse Osmosis system, commonly used in household to remove salts to produce acceptable quality drinking water, increases water loss and results in discharge of large quantities of salt laden water in an unregulated manner.

Although sea is the sink for all salts, local farmers and fisherman have observed the absence of seaweed in the area where desalination effluents are being discharged. This clearly shows salts entering sea has some adverse effects even though the salt concentration in the sea is much higher than the salts in the effluents. It calls for formal studies by

academic and government institutions for understanding the effect of salts on different water bodies.

It is well acceptable that industrial waste should undergo primary, secondary, and tertiary treatment. After that it should go into the RO plant. The high salt concentration wastewater produced from RO could undergo evaporation treatment and salts could be:

- stored in an underground cave,
- reused after crystallization separation of salts,
- discharged during high flow after dissolving it with the wastewater.

## Some of the bottle necks in these solutions are:

- Irrigation use can potentially degrade the soil through increased salinity
- Underground storage in lined reservoir avoids soil degradation but the storage can be limited with time and there can be shortage of space
- Release of salts during the high flow can be dangerous because there could be organic or metal impurities present in the remaining waste, which could be harmful to aquatic life.

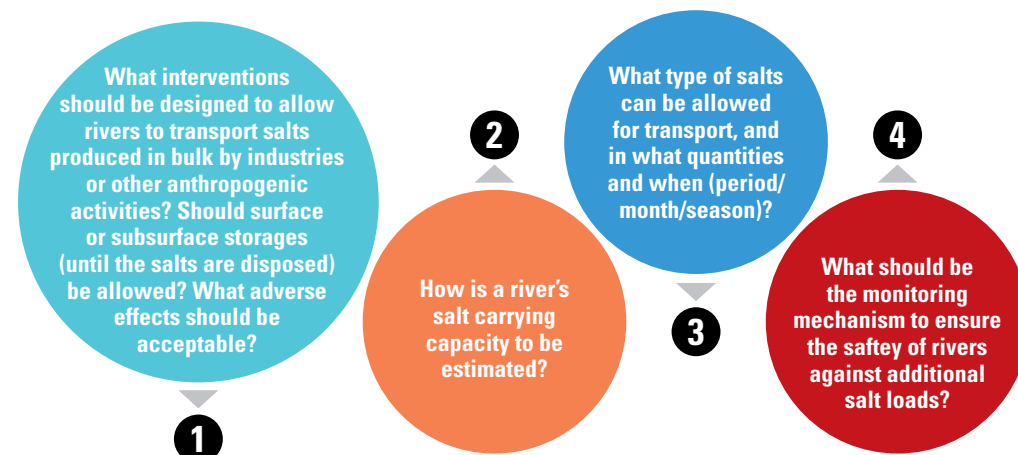
Treatment and reuse could be the viable solution rather than treatment and discharge. There are issues with direct discharging of salts in rivers no matter whether it is lean season or wet season. Also, if one opts for desalination processes and crystallizes the salt there is no point in releasing it into the river, reuse would be better option in that case. The issue with such processes is their economic viability.

## RIVERS' CAPACITIES

The question arises whether rivers can be used to transport the surplus salts to the oceans without causing harm to the rivers themselves. This obviously means the need to assess rivers' capacities to transport the salts and decide upon means to utilise any spare capacity.

## A3.2. KEY QUESTIONS TO BE ANSWERED

Several issues of concern in considering this possibility arise e.g.







Allowing release of salts during monsoon may prevent innovation and give escape route to polluters for not doing enough for the environment.

#### A3.4. RECOMMENDATIONS

The soil of Ganga basin is important as the river itself, and if people are not comfortable with releasing the salts into water, it will end up with accumulating the salt on land which harms the soil of basin and eventually the river itself. Currently, with available data, situation and resources, it is best to release the salts into river. Here the major question arises:

- What interventions should be designed to allow rivers to transport salts produced in bulk by industries?
- Should surface and sub-surface storage, until the salts are disposed, be allowed? What adverse effect should be acceptable?
- How to estimate the salt carrying capacity of a river?
- What kind of salt should be allowed to transport with identification of allowable quantity and season?
- What should be the monitoring mechanism to ensure the safety of rivers against additional salt?

Huge amount of salts are being used in Jajmau area, Kanpur. A list of different salts and the study of market opportunity of these salts like sulphate, chloride will help in finding answers to the above questions. Another way is that polluters should pay and should have all the facilities to treat/recycle and reuse the salt and finally send the remaining salt to the hazardous dump site. Such polluting industries should be dislocated to the land near to the sea, where the salt can be dumped into sea. Else, at least industries should be forced to make viable solution of such problems. Industry should never be given free hand to dump the salt in river and there should be a monitoring body to have control of such industries. A monitoring body should be made which can eventually be responsible for controlling any kind of salt released in rivers. Here government needs to take some harsh decision on polluters.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group SR3.

## TAKE AWAY POINTS

ZLD option is the way to go and whatever the state of art technology available to minimise use of salts and reuse of salts should be exploited to its full potential. However, to reduce carbon footprint and availing services of transporting the salts by rivers during the high discharge period without significantly impacting the river ecosystem should be seriously explored.

## SALT WATER

A monitoring body should be made which can eventually be responsible for controlling any kind of salt released in rivers.

# Managing Surface / Groundwater Interaction and Hydraulics of River Channel(s)

## DAY 4:

Thursday, December 7, 2017;  
10:00 - 11:30 h

## VENUE:

Room No. 121, New Lecture  
Hall Complex, IIT Delhi

**CHAIR:** Dr M A Chitale Formerly  
with MoWR, RG&GR, Gol

**MODERATOR:** Dr Vinod Tare,  
IIT Kanpur

**PANELIST:** Mr Alan Jenkins,  
Centre for Ecology & Hydrology  
(CEH), UK; Dr B S Murty,  
IIT Madras; Dr Kees Bons,  
Deltares, Netherlands

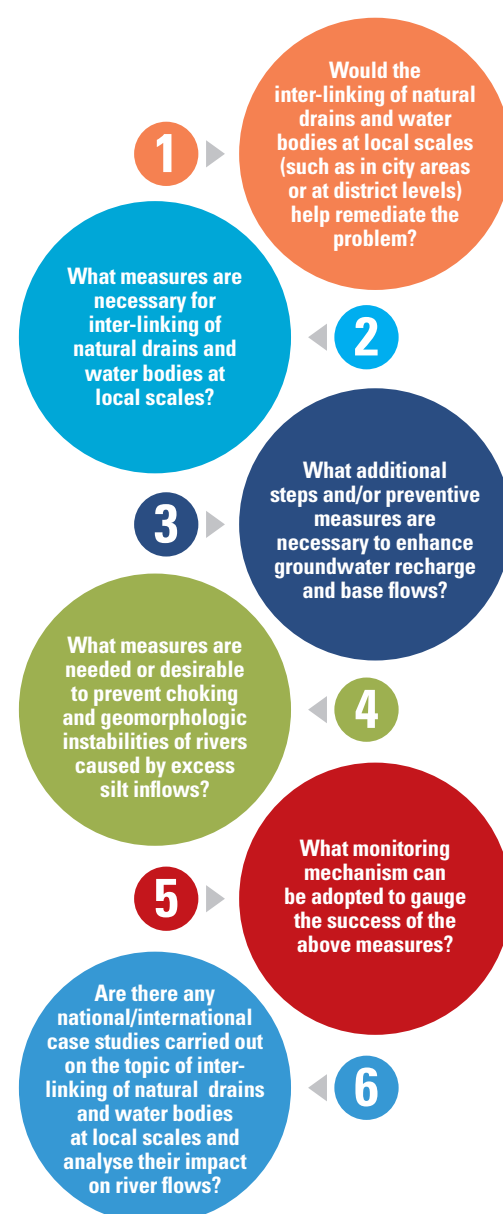
## A4.1. PROBING THOUGHTS

Anthropogenic activities in river basins result in substantial changes in land use, land cover, and waterways. For example, increased urbanisation and infrastructural developments (such as roads), deforestation, agricultural tillage, land-filling and compaction, drying up of water bodies, and construction activities have been the norm in India. These changes often lead to rapid overland flow causing increased soil erosion, reduced percolation of surface runoff, and enhanced suspended loads in rivers and streams, although sometimes human activities can also block flow paths and cause water-logging or even flooding. These effects not only impact river channel morphology, but also change the dynamics of surface water and groundwater interaction, which often results in decreased base flows in rivers.

Further greater flood peaks and flood damages, and the drying up of rivers in lean seasons, often have grave consequences for human settlements and river biodiversity. Thus, new strategies for managing surface water – groundwater interaction and river channel hydraulics need to be evolved in order to maintain sustainable Environmental Flows in rivers along with moderate flood peaks.

## A4.2. KEY QUESTIONS TO BE ANSWERED

Some possibilities to address this task and the issues of concern are:



## A4.3. DISCUSSIONS

Ponds have been extensively used as a source of water supply especially in the Ganga basin. Quality of groundwater has been affected due to sewage percolation. Groundwater recharge has been happening through sewage. Sediments in the Ganga basin at many locations are loaded with arsenic, iron and such components. Anthropogenic activities, particularly availability of degradable carbon through land application of sewage/fecal solids are reported to be the main cause of the mobility of the above-mentioned constituents in the groundwater.

Most of the river stretches were influent rivers fed by groundwater have become water losing stretches (effluent stretches). As a result, water released from the upstream storages does not reach downstream of the river. Also, in the course of time, many rivers/drains have become waste carrying rivers. Land in general has become so dry and thirsty that the water released from the upstream storages gets sucked up in the upper stretches itself. Hence, the usage of rainwater to be promoted for recharge of groundwater. Any river eventually rushes to the sea, but this can be slowed down to make it usable for recharging groundwater. That is to say in the monsoon period, rainwater can be used for groundwater recharge and stored in the aquifers as much as possible so that the same can be made use of during the non-monsoon months to enhance the base flows. This can be facilitated

by understanding the state-of-the-art tools dealing with groundwater-surface water interaction through research and development. Suggestions can be given to the government as to what actions can be taken to stabilise the water table.

Groundwater quantity available in the Ganga basin is almost 20 to 30 times more than the surface water storage. In the last 100 years, due to surface and groundwater interaction, largest volume has been recharged from agriculture. There is not much data available in the basin for deep aquifers. We know that there is a fresh water surface layer, below is a saline layer which is thicker in the western basin than the eastern part of the basin. Then data from further below aquifer is unknown. There could be a huge fresh water reservoir replenished from the mountain side. Especially in the eastern part there is organic Gondwana sediments and young Himalayan sediments which contain arsenic combined with organic material and combined with rate of exchange of material create mobility of arsenic. In the eastern part, shallower layers have that risk because the organic layer is natural so you simply have to pump to get the mobility of arsenic. In the west we do not have this organic layer.

River and groundwater interaction is much localised. Catchment development by local recharge using check dams and natural depressions are more useful. This is more important for local recharge and arresting rainwater. There is no single solution that fits all. We really need to

## NEW STRATEGIES

New strategies for managing surface water – groundwater interaction and river channel hydraulics need to be evolved in order to maintain sustainable Environmental Flows in rivers along with moderate flood peaks.



look at different regions of the basin. Areas such as mountain peaks need to be protected. Solving the continuity equation at different scales and different regions of the basin to figure out where the change in storage is happening may be useful. For example, in the Kaveri river basin, there has been more upstream catchment development, which resulted in using water upstream rendering low water availability at lower streams. The gap has to be bridged between multiple small interventions from check dams to ponds by parameterizing them into models so that we can look at the hydrological behaviour of multiple sub basins within a large system. This can be connected to a value added future scenarios such as change in the population and other patterns, and hence if the model is working well then we can simulate the nature of the change in hydrological response. Thereby, comparisons such as different crop types, also comparison

between large reservoir and multiple smaller storage systems can be made. This can be used for evidence based rational decisions to help government.

#### A4.4. RECOMMENDATIONS

In terms of spatial and temporal scales, we have to depend upon models, without which there is no way to get handle on these issues. The present day models have evolved enough to quantify uncertainties arising due to lack of historical data. We need to start simultaneously the data gathering and application of models particularly for the things that we need the answers. In addition, integration of these models with the socio economic models to see where the benefit is going and whether the society is ready to live with that redistribution because equity has to be maintained for it to be sustainable. From the hydrological point of view, it is known that there is a lot of information so the need is to focus on

involving other groups such as geologists, geographers, socio-economists, ecologists, agronomists, etc. Few other issues to be considered are:

- a. Check dams are probably the most effective way to recharge groundwater but it may not help to maintain the E-Flows.
- b. The more important question is that India is moving from agricultural sector to service sector. This is putting heavy burden on hydrology/ water. It is more important to answer how to deal with this situation of stress on water resources.
- c. The power of the model for planning purpose is the fact that it addresses these different sectors such as agriculture, energy, water, etc. Looking at each component is a limited way of understanding the system. So, a system based approach that brings together these interdependencies is needed
- d. The models should connect the groundwater, surface water and atmospheric water.
- e. Government has to set the objectives. Scenarios have to be put in place according to priorities.
- f. There is a consensus on the idea that society should decide on future and objectives to set up. However, the implementation is with the government. The role of the government is to act as a coordination body.
- g. We need to get people from different backgrounds and all aspects of society together. This includes politicians, stakeholders in land management. Not only science, we need social understanding, financial mechanisms.
- h. All these aspects are surrounded around the people. Hence, we need local management decisions.
- i. Models can do the job of making people understand some specific issues and make them understand what future they want to be part of.
- j. India is changing rapidly that is socially and economically. Agriculture is also changing. These changes have to be kept in mind while we make a report of any futuristic considerations. It should not only be a scientific input but also a sociological input. We need a group of social scientists. All studies/ programs need to be planned with enough involvement and input from village Panchayats or people or municipal councils.
- k. The working plan is driven by essentially Engineers/Administrators. There is no input as what the society wants. There is some input which comes from civil society organisations but this is exactly not from the society but the activists. So, one side is the engineers or technologists driving their own project and other side is the activists. Hence, there is a huge gap in this process.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group SR5.



## TAKE AWAY POINTS

Hydraulic modeling can be used for making evidence based rational decisions to help the government.

The models should connect the groundwater, surface water and atmospheric water.

Interlinking of water bodies (ponds/drains) at local scale is feasible and should be taken-up on priority. Generation of high resolution digital elevation models using state-of-the-art technologies (use of drones/lidar surveys) must be given very high priority.





# SESSION B

Tehri Reservoir, Uttarakhand



- Delivering on Sustainable Hydropower – Run of the River and E-Flows
- Developing Canals and Urban Natural Drains for Recreation and Surface Transport
- Urban River Management and Interlinking of Water Bodies at City Scale
- Compact/Packaged Wastewater and Solid Waste Treatment Solutions



# Delivering on Sustainable Hydropower – Run of the River and E-Flows

## DAY 2:

Tuesday, December 5, 2017;  
14:00 - 15:15 h & 15:45 - 17:00 h

**VENUE:** Committee Room B –  
Vigyan Bhawan Annex,  
New Delhi

**CHAIR:** Dr M A Chitale, Formerly  
with MoWR, RD&GR, GoI

**MODERATOR:** Dr Ajay Pradhan,  
CEO, C2S2 Pvt Ltd

**PANELIST:** Dr M K Goel, NIH  
Roorkee; Mr Paritosh Tyagi,  
Formerly with CPCB; Mr  
Madhav Kejriwal, Harsil Hydro,  
Mr Sandeep Singhal, UJVNL,  
Dehradun; Mr Gagan Agrawal,  
Sikkim Power Development Co.

### B1.1. PROBING THOUGHTS

Hydropower is the second-largest energy producer in India (after thermal energy). Hence its importance in meeting India's energy demands is undeniable. Moreover, with increasing emphasis on clean energy production, a renewable and emission-free resource like hydro-energy can only be expected to receive increasing boost in coming years and decades, given that India has considerable hydro-energy potential. The maximum hydro-energy potential lies in the Himalayan rivers in Northern and North-Eastern India, and some of it has already been tapped. Among many hydropower projects that have been executed or planned for Indian rivers, therefore, most are in North and North-East India.

Large hydro-electric projects are executed by constructing dams across rivers and diverting water locally for operating the turbines. In upland river stretches, steep gradients often also enable the construction of series of dams (with their respective power

generation units) in a single stretch of the river. But dams create enormous problems for the environment. For instance, they fragment the rivers into disjointed segments of semi-quiescent pools or reservoirs (sometimes with nearly dry stretches between them), which have fractured river habitats and affected river biodiversity grievously due to barriers in upstream-downstream migration. Sediment trapping behind dams has also probably led to increased geomorphologic instabilities and loss of fertility in downstream river stretches and riparian areas. Land submergence by reservoirs upstream of dams has uprooted human settlements and/or disrupted forests and wildlife. Thus, while still being a form of "clean and renewable energy", hydropower has caused many environmental damages in India. There is an urgent need therefore, to minimise such damage by new hydropower plants as also to find the means for eliminating, or at least reducing, the harmful effects of existing hydro-electric units.



## HYDRO-POWER PROJECTS

There is an urgent need to minimise damage caused by new hydropower plants as also to find the means for eliminating, or at least reducing, the harmful effects of existing hydro-electric units.

### B1.2. KEY QUESTIONS TO BE ANSWERED

Some relevant issues for addressing these problems, especially for the purpose of securing river health are:

1

Are relatively small run-of-the-river hydroelectric projects less damaging to rivers in comparison to large dam projects? What criteria should be adopted for designing and/or assessing whether a run-of-the-river project is environmentally safe?

2

To ensure E-Flows and maintain longitudinal connectivity in rivers (i.e. avoid fragmentation of the river habitat), what means/ devices – such as river pass – can be adopted in the context of dams and barrages?

3

Can "river pass" or other means be also adopted to ensure adequate flow of sediments in rivers with dams or barrages?

4

Is it techno-economically feasible for large hydropower projects with dams to significantly reduce land submergence and other negative consequences?

# ASPECTS OF E-FLOWS

**Water after its use in power generation should not come back to river. Sudden release of flows should be avoided to protect the ecology downstream. Local people should be involved in monitoring of E-Flows by putting marks and then calibrating with the scale.**



## B1.3. DISCUSSIONS

Integral elements of sustainable development are economics, engineering and environment. The challenge is to meet the increased demands from the same, rather reducing quantity of water. Filling of groundwater reservoirs is of utmost importance for this.

Sudden release of flow harms ecology even if design facilitates sediment release. River attains life due to turbulence so if you are inserting turbines IN stream, it is NOT 'run of the river'. It is agreed that more storage required, but why IN the stream? There could be other options:

- Storage in hills
- Bowls
- Gorges
- Water diversion

### In-stream alternatives:

- side weirs
- split streams by walls so flow maintained
- have cascade of hydropower plants

Reservoirs increase recharge. Infiltration wells have limited capacity. Small hydropower plants can come up without much regulatory clearances and are hence easy for implementation. Their short-term effects could be muck dumping/blasting, however, in long term it can regulate flows.

### Dams have been used for:

- Flood prevention (Ex: Tehri dam 90 m level rise in 2 days; in absence of dam, more severe effects)
- E-Flows provision during drought. Hydropower is a long-term resource

as compared to solar energy. Disposal of solar panels in long run can cause disturbance. In Norway, >95% energy is obtained from hydropower. 3 hydropower plants in north Sikkim – 3,3,5 kW meets the energy requirement of the whole area. Cascades could be an option but they are opposed as certain minimum river stretch is required for rejuvenation.

## B1.4. RECOMMENDATIONS

Developers and environmentalists are always at conflict. To minimise this conflict, few practical aspects of E-Flows have been listed:

- Building block methodology is most comprehensive but hardly any studies are being carried out.
- Honesty should be ensured in record systems.
- Very active participation of local people is the solution, people must be heard during public hearings.

In the Himalayan stretch, low water levels are maintained in winter but the energy requirement is more. Is seasonal tradeoff of power between states possible instead of annual % share?

Water after its use in power generation should not come back to river. Sudden release of flows should be avoided to protect the ecology downstream. Local people should be involved in monitoring of E-Flows by putting marks and then calibrating with the scale.

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group E01.

## TAKE AWAY POINTS

Filling of groundwater reservoirs

Other options like river pass should be looked into.

Local people should be involved in monitoring of E-Flows

Feasibility of storage in hills, bowls and gorges should be studied.

Public hearing should be addressed instead of being managed.



# Developing Canals and Urban Natural Drains for Recreation and Surface Transport

**DAY 3:**  
Wednesday, December 6, 2017;  
10:00 - 11:15 h & 11:45 - 13:00 h

**VENUE:**  
Committee Room B – Vigyan  
Bhawan Annex, New Delhi

**MODERATOR:** Dr Vinod Tare,  
IIT Kanpur

**PANELIST:** Dr Paul Bryant,  
Lyndon Water, UK;  
Dr P P Mujumdar, IISc  
Bangalore; Dr Rakesh Khosa,  
IIT Delhi; Dr Sanjeev Chaudhari,  
IIT Bombay; Dr Kees Bons,  
Deltaris, The Netherlands;  
Mr Prabhat Singh, IREC;  
Dr Manu Bhatnagar, INTACH,  
New Delhi

## B2.1. PROBING THOUGHTS

Canal irrigation has been a major factor in India's agricultural growth since the nineteenth century. The Ganga river basin itself has a huge network of canals in North India. Other major rivers like the Narmada, Brahmaputra, Godavari, Kaveri and Krishna also irrigate vast agricultural tracts through their canal networks. But canal waters are used not only for irrigation; they are also tapped by industries and municipalities (for urban water supplies), besides bathing, washing and other sundry purposes by rural folks. Even hydropower is generated from canal falls. However, canal networks are not used for either recreation or surface transport, even when the main and branch canals are large and run long distances. Yet transport by canals can be much more economic than road transport, especially for agro-industries (such as pulp &

paper mills, sugar mills and distilleries), construction, mining, forestry and other industries located within or near canal command areas. Evidently, the potential for utilizing canals for transport and recreation needs to be evaluated.

While canal networks are spread over the vast hinterland, most urban centers in India are extensively covered by natural drains or nallas that carry storm water drainage. Inadequate development of urban sewerage over decades, however, have converted many of these storm water drains into sewage-carrying channels all through the 8-9 months of dry weather every year. This naturally poses public health hazards like disease-outbreaks and foul odor. Like canals, however, other useful ends can be achieved if these drains run with cleaner flows so that they can be used for recreation and transportation, both of which have a high demand in urban centers.

## B2.3. DISCUSSIONS

Not lining canals is a usual practice which actually facilitates seepage resulting in groundwater storage. Sewage can be used as an opportunity to ensure perennial flow in drains. At the same time, care must be taken to prevent infiltration of sewage in ground. The cost of water transportation from a large distance is more than treating the sewage at the point of its generation. To achieve this, few questions arise:

- Can we have water space similar to green space which is proposed in town planning?
- Can we ensure seepage of good quality water?
- Usage of canals for recreational purpose?
- How to solve flooding problem?
- Anthropogenic blocking of drains – who will improve drains?

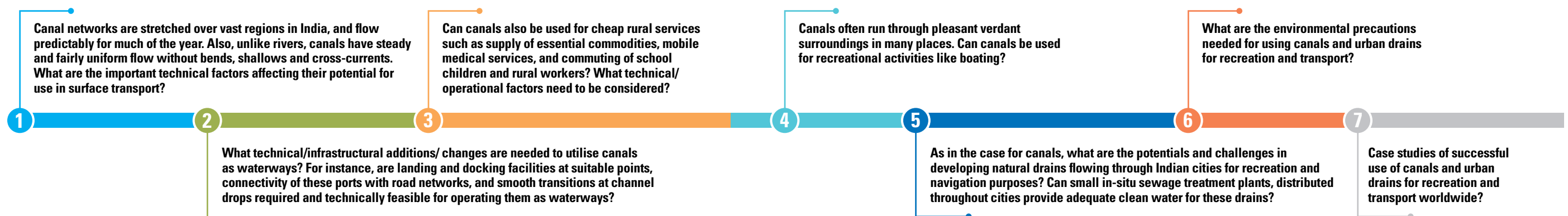
Take an example of Amsterdam where canals are used for navigation. No single bridge in the port of Amsterdam. Second example is of the riverfront restoration already done at Ahmedabad. Third is of Singapore, which earlier used to take drinking water from Malaysia, now is self-sufficient. They have used the spaces beautifully where people meet with the nature, combining environment (ecology)+ water bodies+ communities.

Inland water transport is one of the four main sources of transport. Below 400 km inland water transport will work. In addition, monsoon variability is a threat to Ganga. Points to be considered for inland water transport are infrastructure, reliability, frequency, volume, siltation and distance for goods, transport and services between end user destination and port. The major issue to fix drains is the initial cost. San Antonio, 20 billion made immediately by restoring drain. Technical

|||||

## B2.2. KEY QUESTIONS TO BE ANSWERED

To achieve the desired ends outlined above, several issues need to be examined viz.:





feasibility and cost are important points to be considered in inland water transport.

Government of India is already spending huge amount on sewage treatment with hardly any benefits. To initially start with, can we create a pilot on Sisamau drain, Shahdara drain or Assi river restoration? Simultaneously, can we go for Hoogli river and make it like Kerala backwaters for recreational purposes? Or Najafgarh drain in Delhi, Gurgaon to Agra stretch can be taken as pilot canal for transport and navigation.

Larger cities can have stretches to start with but smaller cities could be problematic. One major issue on large scale is seasonality and depth of water

as for sustainable reservoir operation, a uniform flow needs to be maintained.

#### B2.4. RECOMMENDATIONS

Treated wastewater could be reused to maintain the necessary depth in drains i.e. recovery of water from sewage should be adopted. At city level, river or drain restoration may be done for transport and navigation purpose. Few important points need to be considered are:

- Recovery of water from sewage
- STP design should be sustainable and treat water as energy
- Erratic rainfall so water budgets are tighter
- Evaporation consideration

- Urban citizens must communicate with nature, special places where nature and people can meet should be developed
- Land value along channel can be recovered and money can be generated
- Inclusion of Ghats
- Water transport across and along the drains should be thought of.

Upper Ganga canal was initially designed for transport, navigation and irrigation purpose. Water depth available in all seasons is around 8ft. Sufficient water is available till Bundelkhand. The basic concern is that the infrastructure

(storm water, sewerage system) is of limited capacity. Few other points to strengthen the workability of inland water transport system include:

- What is assurance that investment is utilised? A feasibility study to know the economic viability needs to be done.
- Solid waste management is important.
- Focus should be given on 'Polluter Pays' principle.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group E02.



## TAKE AWAY POINTS

To come up with a deliverable model, "developing drains and canals" should be stated as an objective needs to be stated in "Namami Gange" program.

In Namami Gange – ecological importance of drains should be stated.

Government funds should be in the form of loan.

Long drains can be developed for navigation/ transport purpose whereas short length drains can be developed for recreational activities and for ecological restoration.

Feasibility studies for economic viability (like case studies from Netherlands).

For canal restoration, inland water transport and developments, three issues of prime importance were identified as techno-economic feasibility, maintenance of depth & volume in drains and getting rid of stink/smell.

'Polluter Pays Principle' must be implemented immediately



# Urban River Management and Interlinking of Water Bodies at City Scale

**DAY 3:**  
Wednesday, December 6, 2017;  
14:00 - 15:15 h & 15:45 - 17:00 h

**VENUE:**  
Committee Room B – Vigyan  
Bhawan Annex, New Delhi

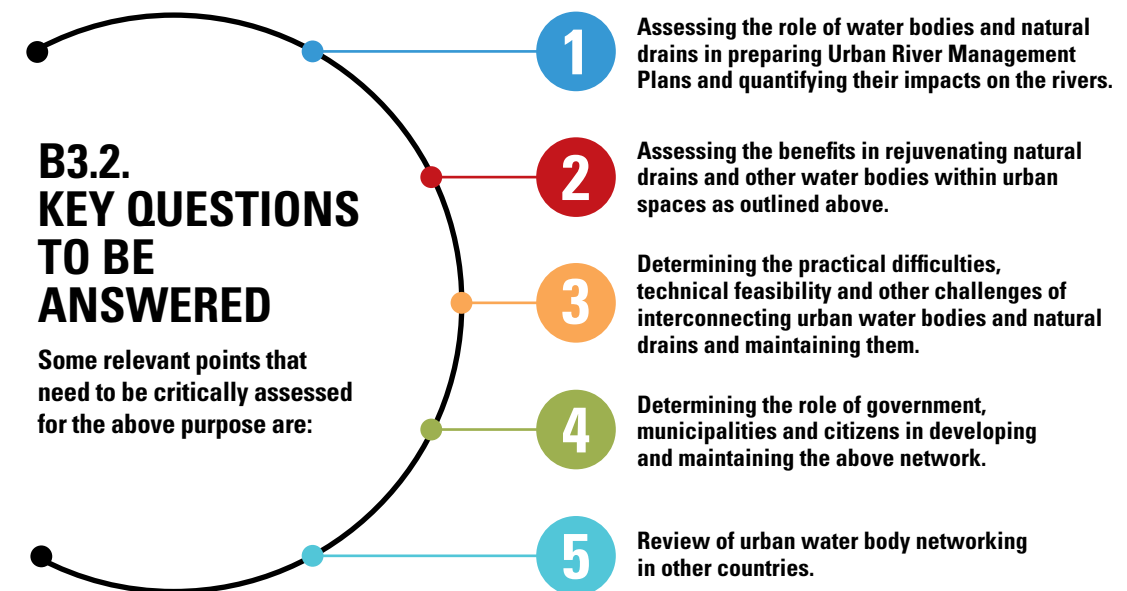
**MODERATOR:** Dr P S Rana,  
Construction Industry  
Development Council

**PANELIST:** Mr Puskal Upadhyay,  
Joint CGDA, GoI;  
Dr P P Mujumdar, IISc  
Bangalore; Dr Ravi Chopra, PSI,  
Dehradun; Dr Rakesh Kumar,  
Director, NEERI;  
Dr Sanjeev Chaudhari,  
IIT Bombay

## B3.1. PROBING THOUGHTS

Managing a river as it flows through the urban spaces has become very challenging due to two main reasons: (i) abstraction of water for fulfilling increasing demand due to unplanned and often runaway urban growth, and (ii) discharge of untreated or partially treated sewage and trade effluents into the river. Further, a number of water bodies within the cities are disappearing as they become dry due to loss of catchment areas (due to greater built-up areas and loss of vacant spaces) and dumping of solid wastes in them. Thus, their ability to naturally treat wastewaters, attenuate floods, and store moisture in urban catchments gets considerably reduced. This not only affects the receiving rivers or water

bodies adversely, but also aggravates urban problems like flooding, excessive dryness in summer, foul odor, soil pollution, loss of urban flora and fauna, and reduced groundwater recharge. Urban river management can be much easier and comprehensive as well as beneficial to the cities themselves if urban water bodies and the drains that flow through cities are rejuvenated to provide a healthy, aesthetic urban landscape. Such rejuvenation should be possible by preventing/controlling polluted discharges into the water bodies and drains, and by inter-connecting them so that the water bodies and drains can replenish one another instead of overflowing into surrounding lands and/or discharging rapidly into rivers.







## THE REAL CHALLENGE

How do we manage our rivers during extreme conditions is the real challenge. Firstly, direct pumping of water from ground should be avoided. River policy should state that sewers intercepting rivers should be prevented in floodplains.

### B3.3. DISCUSSIONS

For urban rivers, major bottlenecks are low flow, garbage dump, banks encroachment, conversion of rivers to roads e.g. Khan market. Urban river destruction begins with watershed. River cleaning projects undergo temporary garbage removal activities which are not very effective, as they do not ensure permanent cleanliness of river. Few good examples already in the country are:

- Beautification of riverside development at Ahmedabad
- Revival of Sukhumajri, Uphnekal, Aravari
- Navi Mumbai ponds (Dutch method of managing floods)

### For developing urban water bodies following points need to be considered:

- Decentralised wastewater treatment plants
- STP selling clean treated water to industry at reasonable rate
- Water balance should be as local as possible i.e. each block/area have its own water and wastewater management
- 'Think global act local' should be the basis of planning
- City sanitation plan – no connection with rivers
- Gap should be properly bridged between city sanitation plan and river management plan
- Impact of CRZ (Coastal Regulation Zones) on water bodies must be addressed, CRZ has led to water bodies being used for open defecation alone
- 5% city area to be reserved for water bodies

### B3.4. RECOMMENDATIONS

Cities are dependent on monsoon. Also, a pressurised distribution system to supply good quality water using high technology has developed. How do we manage our rivers during extreme conditions is the real challenge. Firstly, direct pumping of water from ground should be avoided. River policy should state that sewers intercepting rivers should be prevented in floodplains. If sewer systems do not function properly, heavy penalty must be imposed and if they function properly, provision of rebate should be there.

As a demonstration project, Hindon river should be connected to Yamuna River with the help of 3 lakes; one on upstream, one at Gaziabad and last one downstream. Every city with major rivers should have lakes on upstream and downstream side of city – this will make connectivity of water to sea in regulated and controlled manner. These lakes will take care of groundwater recharge. Also, if wastewater from communities is treated, there is no need of drainage system. Open water channels can only be kept to carry treated water. Each sector of city should have water body interconnected to each other. Ecology, sociology and politics should be taken care of in interlinking e.g. Kaveri dispute, Punjab Haryana conflict. It should be noted that bore well recharge is extremely dangerous and should be avoided. Natural way of recharging is highly encouraged.

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working groups E03 – Urban River Management and E04 – Interlinking of water bodies.



## TAKE AWAY POINTS

Each city should have a lake at its centre

A certain hectare could be developed in such a way that it would be self-sustainable in terms of treating its sewage, solid waste, recycling & reusing the treated effluent and products of solid waste treatment

Develop 5% of the total area as water bodies in each city, just like 22-23% of area is mandatory to develop as green belt

Restore drains and nallas which currently are dumped with solid waste and sewage

Set the conditions of drains and water quality in cities, as an indicator of achievements of planning projects like City Sanitation Plans and City Development Plans by Government

TSS, BOD and fecal coliform were identified as the important parameters for measuring drain water quality

# Compact/Packaged Wastewater and Solid Waste Treatment Solutions

**DAY 4:**  
Thursday, December 7, 2017;  
10:00 - 11:30 h

**VENUE:**  
Room No. 310, IIT Delhi,  
New Delhi

**MODERATOR:** Dr Brajesh Kumar  
Dubey, IIT Kharagpur

**PANELIST:** Dr Naresh Singhal,  
University of Auckland, NZ;  
Mr Devesh Sharma, Aquatech,  
USA; Mr Nigel Slaughter,  
Ligar Polymers, NZ;  
Mr Jan Grimbrandt, Boson  
Energy, Luxembourg;  
Dr Ligy Philip, IIT Madras

## B4.1. PROBING THOUGHTS

Long distance conveyance of water, sewage and solid waste imposes a major burden on cities not only in terms of expenditure but also operational problems. City water intake structures and water treatment plants are often located outside cities or near city boundary, from where they are delivered and distributed by pipelines (often by pumping) to sprawling city areas. Likewise, domestic sewage tapped from households and establishments is transported to large sewage treatment plants (often located outside cities) and to subsequent discharge points by extensive sewerage pipelines, while solid wastes are transported to appropriate disposal or treatment sites (also located outside cities). In all cases, huge transportation costs and potential health and environmental problems (due to leakages, spills, choking of pipelines, etc.) are a major concern for municipal authorities. Many cities, however, have overcome this problem of centralised

water supply by abstracting groundwater or tapping surface water (if either source is available) from different city locations, and, after any needed treatment, distributing the water locally. But the same is not true for sewage and solid wastes, although the same principle may be also applied in these cases.

Decentralization of sewage treatment and solid waste processing can be much more economic and a better strategy overall than centralised schemes due to grossly reduced transportation distances, particularly since small-scale reuse and recycle technologies are increasingly available today. In the case of sewage, decentralised treatment has the added advantage that the treated wastewater can be reused locally, thereby reducing the load on fresh water supplies? However, the availability of space for decentralised schemes and managing many small systems simultaneously are a challenge considering the environmental hazards that can be posed by even one malfunctioning system.



## B4.2. KEY QUESTIONS TO BE ANSWERED

Several issues concerning this option may need to be examined or more adequately evaluated, such as:

**1**  
Large, centralised STPs have been the norm in India for many decades, and their problems and benefits are well known. But what are critical problems of working with compact/ packaged STPs?

**2**  
Review of technologies available for small-scale/ packaged STPs.

**3**  
What is the overall trade-off between large centralised STPs and conglomerates of smaller decentralised STPs built within the localities/city space?

**4**  
What should be management strategy (including role of citizens) for decentralised sewage treatment and how should they be monitored?

**5**  
Case studies of packaged STPs and decentralised sewage treatment systems (with or without reuse) operating in India and abroad.





#### B4.3. DISCUSSIONS

The technologies for the compact/ packaged STPs do exist and it has been in practice worldwide. The concern is how to implement these solutions in Indian scenario. If the reuse of treated wastewater within the same property is made mandatory then that will raise the interest of the residents of that community to ensure that the treatment plant is working properly and meeting all the standards. Then comes the issue of capacity building and making common people aware of basic parameters and technology.

#### B4.4. RECOMMENDATIONS

The basic technologies to be adopted have to be simple and effective. To achieve this few points were emphasised:

- cGanga should do an overview of the available technologies and have a ranking/guidance system of technology selection based on geographical, climatic, wastewater parameters, level of treatment and economics of the treatment alternatives
- Capacity building will be required in terms of simple training programme to teach people how to run and

- monitor these packaged systems
- "Polluter Pays Principle" could be implemented as part of this packaged solution
- To take care of economy of scale, a combination of packaged solutions for certain communities and regular sewage treatment plant for others
- The local people who will use the packaged solutions should be part of the decision making process
- Bring the solution under the roof of leading government programmes like Swachh Bharat, JNNURM, Integrated Low Cost Sanitation Scheme,

National Biogas and Manure Management Programme.

The fertilizer subsidy being provided by government to fertilizer companies, to mix compost with their product, has helped in selling compost these days. Concern was that how long an activity such as compost can survive on subsidy?

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group E05.



## TAKE AWAY POINTS

Make water/wastewater treatment as close to the community as possible

Make a mandate to use treated wastewater

Capacity building in terms of teaching people to run packaged systems

"Polluter Pays Principle" could be implemented as part of this packaged solution

A combination of packaged and regular sewage treatment plant system should be employed

The local people using packaged solutions should be part of decision making process

cGanga should prepare a ranking/guidance system of technology selection based on geographical, climatic, wastewater parameters, level of treatment and economics of the plant alternatives

Solutions should be brought under common roof of leading government programmes like Swachh Bharat, JNNURM, Integrated Low Cost Sanitation Scheme, National Biogas and Manure Management Programme



# SESSION

# C



- **Data Generation through Sensor Networks, Remote Sensing through Satellites, Drones and LIDAR**
- **Data Modelling, Information and Analytics**
- **Developing a Skilled Workforce in the Water Sector**
- **Inspiring Entrepreneurship in the Water Sector**



# Data Generation through Sensor Networks, Remote Sensing through Satellites, Drones and LIDAR

## DAY 2:

Tuesday, December 5, 2017;  
14:00 - 15:15 h & 15:45 - 17:00 h

## VENUE:

Committee Room C – Vigyan  
Bhawan Annex, New Delhi

## CHAIR:

Mr A Seshagiri Rao, TCIL

## MODERATOR:

Dr Surya Dhurba; IIT Bombay  
& Mr Mayank Chauhan,  
LogicLadder

## PANELIST:

Dr Jon Tunncliffe, University  
of Auckland, New Zealand;  
Mr Tomaz Rodic, Space-  
SI, Slovenia; Dr Jure  
Lempe, Senes, Slovenia;  
Mr K Sri Harsha, Kritsnam  
Technologies, IIT Kanpur;  
Mr Vijay Pandey, Uniphos  
Envirotronic Limited,  
Valsad; Mr Atindra Chandel,  
Sensgrow Inc, Mountain  
View; Mr Kanwaldeep Singh  
Kahlon, GeoKno India Pvt Ltd;  
Mr Chakresh Jain, Capricot  
Technol. Pvt. Ltd Slaughter,  
Ligar Polymer, NZ

## C1.1. PROBING THOUGHTS

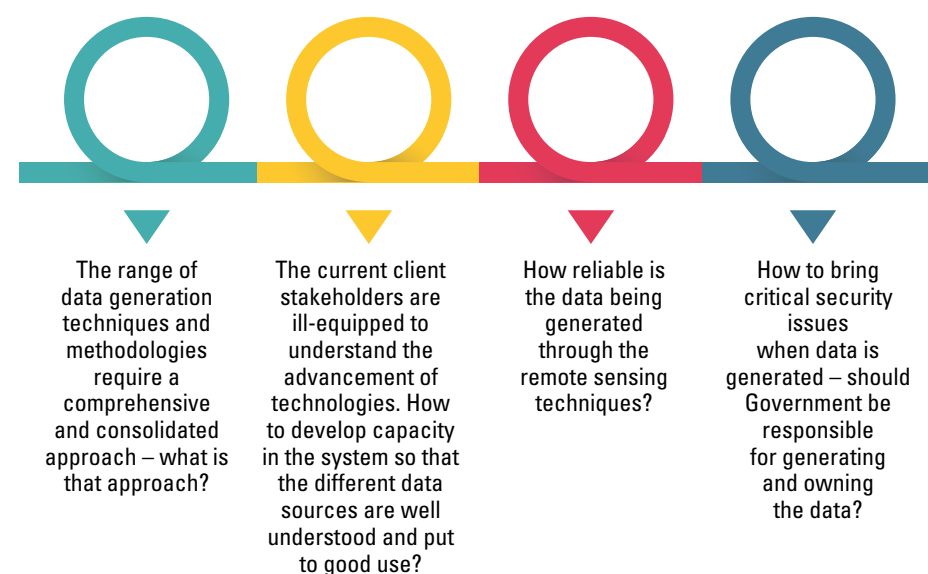
Data is today changing depending on how we work, decide and allocate budgets - It might be helping to cure a disease, increase revenue, target ads or improving the environment around you. In general, data is simply another word for information. But when it comes to remote sensing, especially in the context of environmental monitoring, the data refers to information that is machine generated and machine-readable as opposed to human-generated or human-readable. So one of the important aspects

of environment data is that it is mostly sensor generated. This brings in some challenges and lot of opportunities.

## Today environment data collection is being revolutionised by three things:

1. Falling sensor and microcontroller costs and improved coverage with low cost of public networks
2. Internet of Things (IoT) has improved as to how we acquire reliable data at an affordable cost
3. New technologies for data generation like Drones and LiDAR

## KEY CHALLENGES FACED WITH THE INUNDATION OF TECHNOLOGIES AND SENSOR PROLIFERATION



## Data collection or river monitoring can be categorized into following two applications:

- a) For River Study - Data is acquired for a specific study of the river via sampling and surveying.
- b) For Monitoring Impact - Data is acquired on a continuous basis to monitor improvements or degradation in river health - water quality and flow.

The following data can be collected in Ganga River Basin using sensors, satellites, LiDARs and drones:

## A. Imagery Data for monitoring river habitat and hydro morphology

Drones and digital photogrammetric techniques now provide an alternative approach for monitoring river habitat and hydro morphology. Drones are used for high resolution image acquisition.

Image processing can then be used for monitoring and mapping physical habitat of the river.

Drones can be used for a) Water level and flow, b) Narrow-band spectral reflectance for habitat mapping, c) Bathymetry, d) Thermal maps, d) Developing digital surface models of the river, etc.

## B. LiDAR and satellite data for monitoring river morphodynamics

River morphodynamics study is

important for improving the quality of the aquatic environment. Monitoring the spatial and temporal variation in physical river parameters is important for understanding and improving habitat quality and distribution. Surveying of water bodies by remote sensing is challenging due to presence of vegetation and ray propagation through both air and water. Airborne LiDAR Bathymetry (ALB) allows fluvial topography to be mapped in high resolution of greater than 20 points/m<sup>2</sup> and height accuracy of <10 cm for both the aquatic and the riparian area. A green laser is used for the water body, while an infrared laser is used for the detection of the water surface, the land surface, and the vegetation above it.

## C. Continuous sensor data for monitoring river water quality and flow

Regardless of the nature of application, one would need online monitoring that provides real time data to all stakeholders, allowing them to arrest potential issues before they grow into larger environmental problems. These continuous monitoring techniques can be used for monitoring: a) Nutrients, b) Water Quality, c) Eutrophication, d) Turbidity and Sediment, e) Flow Measurements, f) Flood monitoring and warning.

The above can be measured through:  
a) Stream Gauges, b) Velocity, c) Sensors

## ENVIRONMENT DATA

One of the important aspects of environment data is that it is mostly sensor generated. This brings in some challenges and lot of opportunities.



for Water Quality parameters such as Temperature, pH, Dissolved Oxygen, BOD, COD, TSS, etc.

Today multi-parameter water quality sonde are available at affordable prices. Coupled with this IoT data loggers and external power connectivity allow data acquisition in real time. A typical monitoring system would consist of the following:

- Multi-Parameter Sonde
- IoT Data logger
- Power Supply - Solar and Battery Bank
- Monitoring Software - IoT device management, Big Data Storage and Analytics

Site selection is very important for the quality and reliability of online data. The following are important considerations for online monitoring sites:

- Network signal strengths are good or

excellent (better than -70 dBm for cellular )

- Straight section of the river to prevent flow variation related issues
- Installed away from manmade structures like bridges, gates etc.
- Accessible for periodic calibration and maintenance
- Locations safe from vandalism and pilferage e.g. installed in sections of river passing through private or government estates
- Use a vertical stilling well whenever possible

It is important to maintain data quality for online monitoring system through:

- Regular maintenance like cleaning sensors
- Periodic calibration
- Periodic verification through portable equipment or lab testing
- Software based data validation

#### D. Human generated data by community via mobile app

Most communities that reside near rivers are emotionally, economically or spiritually attached to the river. River Ganga holds a special bond with most Indian. Today more than 300 million people have smart phones in India. Mobile app that helps engage the masses can be used to generate data on river status and/or abuse like: Gauge and Discharge, Illegal mining, Pollution incidents, Garbage disposals, etc.

While monitoring and analysis of data can help understand the current state of the river health or create policies for its improvement; community engagement can create an insurance against its deterioration.

Accurate, timely and geo tagged data captured using above techniques can be used for active monitoring and creating right programmes to preserve and restore the lost glory of Ganga.

#### C1.2. DISCUSSIONS

There is a need to have an evidence-based river basin management system. For this measurement and management of data is required. Initially, identification of issues in river basin management has to be made. Some of them are identified as follows:

- Develop new protocol and scale them
- Integrate with Ganga basin measurements and the organisation who own and manage the census
- How to deliver for end use and connect to the people

To start with, a collection of various types of data with requisite resolution should be made. Dataset should very well be shared among the partners (e.g. New Zealand has a national archive where it has a server which provides all river lines and associated facilities). There should also be a set of standards and guidelines for people to follow. Secondly, huge amount of data

### GENERATING DATA

**Accurate, timely and geo-tagged data captured using latest techniques can be used for active monitoring and creating right programmes to preserve and restore the lost glory of Ganga.**





## DATA STANDARDISATION

The ideal framework for data collection would be a combination of GIS, satellite, crowd sourcing (portable data) and LIDAR data.

is available but we need to extract the required data for different issues, for this specialized training is required for image processing. Thirdly, India lacks a geoid i.e. if we want to calculate the water flow correctly, a geoid is needed. Base data should be made available and connected to each other with regular monitoring system for temporal study. DEM (Digital Elevation Model) and IOT (Internet of Things) can indicate how much water can come (Real time flood monitoring). Fourthly, LIDAR surveys are expensive, but the return is exponential. If LIDAR surveys could be done on Ganga, then benefits will be manifold e.g. assessing hydrological aspects of the basin and sub-basins. Finally, we need to have a DPR (Detailed Project Report) on planned data and have an IOT system designed over that.

Problems to apply IOT with continuous data collection are sensor selection and network selection. Network selection depends on sensor density. GPRS is good enough for low density. Surface data can be collected using public network. But for subsurface data collection, we need to have LoRa (Long Range WAN) technology. Data security and integrity is very important.

### C1.3. RECOMMENDATIONS

Most data are diversely collected by various people of different background. Therefore, no standardisation of collected data. Hence, standardisation of data should be done. This could be done by replacing humans by machines (sensors). Humans can only transfer the data. Ideal framework would be a combination of GIS, satellite, crowd sourcing (portable data) and LIDAR data. Environmental monitoring is challenging,

for example, river Ganga, the matrix is always changing and many ETPs, STPs are being constructed in the Ganga basin. Hence a technology should advance further such that the same can be applied to any matrix.

Parameters such as conductivity, dissolved oxygen can be continuously monitored. But COD, BOD and nitrate are designed for offline measurement. Although UV/VIS is a strong contender when water quality is not complex.

There has to be a tight timeline for data to be transferred to the projects. For this few other points could be considered:

- Provide unique interface and high internet speed to make things simple
- Mobile app to be developed to get various parameters such as water level
- Crowd sourcing can be done for data collection
- Understand what stakeholders want and trace back the technology
- Practices to integrate the technologies
- Hybrid approach can be adopted (high quality and low quality stations for better output). Many sensors do not require high accuracy e.g. Water level. Hence hybrid approach would be beneficial
- Accuracy required/achieved should be specified
- End use requirement must be clearly defined

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group TIES1.

## TAKE AWAY POINTS

For data generation of river habitat, morphology, water level, DEM, mapping, we need to use continuous data

Check whether the data is becoming internet smarter. Discrete data should be connected to devices

Ability to access the data

Data variation needs to be addressed

Global traceable standards to be adopted

Accuracy of the data to be assessed and improved

Hybrid approach i.e. high and low quality data

End use requirement has to be specified

Accreditation of business to be done

Statistical models have to be developed. Measurement of uncertainty is very important for the decision makers to understand

# Data Modelling, Information and Analytics

**DAY 3:**  
Wednesday, December 6, 2017;  
10:00 - 11:15 h & 11:45 - 13:00 h

**VENUE:**  
Committee Room C– Vigyan  
Bhawan Annex, New Delhi

**MODERATOR:**  
Dr Craig Hutton, University of  
Southampton, UK & Mr Mayank  
Chauhan, LogicLadder

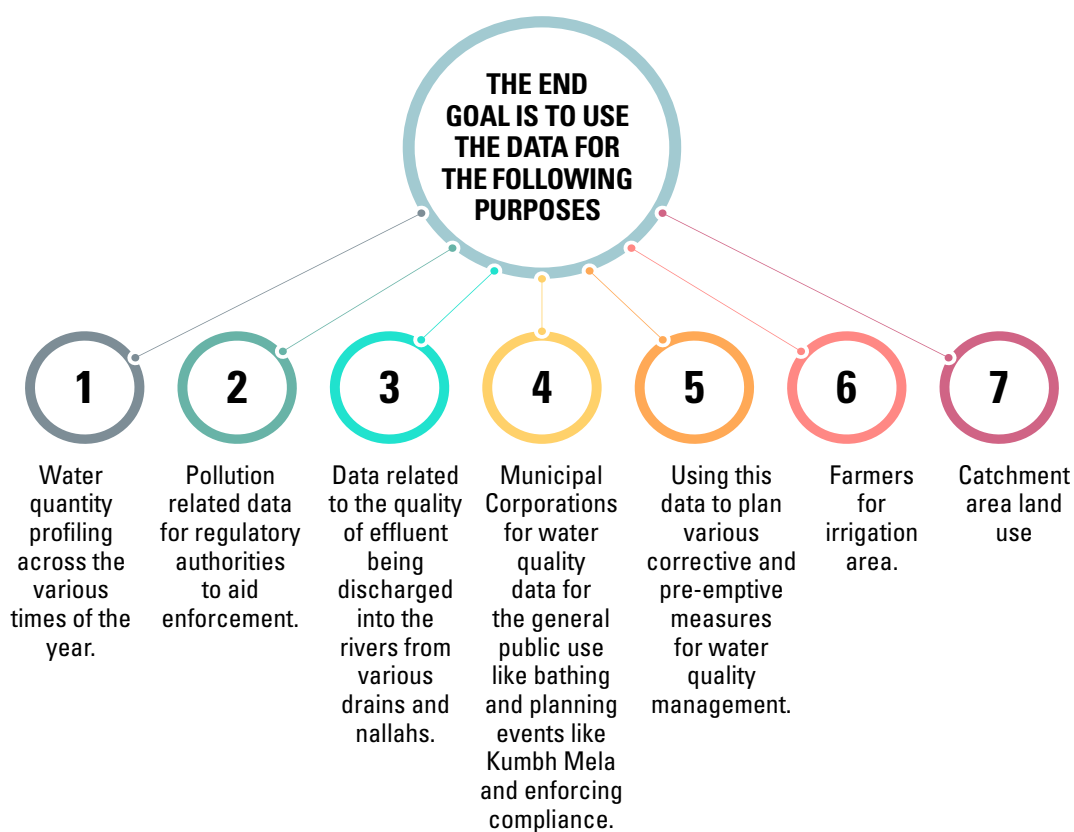
**PANELIST:**  
Dr Alan Jenkins, Centre for  
Ecology & Hydrology (CEH), UK;  
Mr Michael Groves, Topolytics,  
UK; Dr Naresh Singhal,  
University of Auckland, NZ;  
Ms Almitra H Patel, National  
Expert, Swachh Bharat Mission,  
GOI; Dr Sakthivel Beemaraja,  
Geokno India Pvt Ltd., Delhi;  
Mr Prasun Bansal, Bansal Group

## C2.1. PROBING THOUGHTS

Once data is generated it needs to be processed through models which are eventually stitched together using systems-dynamics approach to deliver the detailed analysis that various stakeholders need. The myriad of stakeholders within India, particularly in the Ganga River Basin requires a unique approach to provision of

analysis to the Government.

The most important question is what can be achieved with the data that has been generated. The same philosophy applies to the data that will be generated for the Ganga River Basin that was discussed as a part of Session C1 – “Data Generation through Sensor Networks, Remote Sensing through Satellites, Drones and LIDAR”.



As there will be immense amount of data that is generated, through the application of various technologies that were discussed in Session C1, converting this data to useful insights and actionable information is of utmost importance to achieve the end objective.

This data can be used to develop a range of indicators to assess the health of Ganga River Basin such as water quality, sediment quality, sea grass, macro algae and phytoplankton, and catchment pressures such as river flows, land use, etc.

Integrated assessments of main river flow and its tributaries health provide an understanding of current condition as well as inform on the likely responses to climate change or future development. Data from sensor networks can be used.

**Flow Monitoring Network:** Models to assess water quality and waterway health can help to understand the current condition of the basin and the effectiveness of the action being taken and planned by NMCG.

**Improve Water Quality:** The water quality data is extremely important so that water quality improvement plans can be developed to improve current water quality in the main river, tributaries and streams in their catchments and to prevent any additional deterioration.

Catchment models can be developed using the data to support water quality improvement plans – they quantify the sources of nutrients flowing into rivers based on land use in the catchment, and are used to predict the impact of management practices on nutrient loads.

**Remedial Actions:** The corrective actions that are planned by NMCG like appropriate places to put STPs/ETPs to handle untreated discharges into the river or oxygenation plants to address low dissolved oxygen levels that impact aquatic life. Soil data can be used for soil amendment to treat high nutrient levels in subsoil drainage.

**Public use of Ghats:** Citizen and population residing in the vast basin have impact on their daily life based on the quality of water. Water quality data can be used to maintain a public information system that can advise the public on the water quality for bathing and this can be used to restrict or regulate public activities for better water quality management.

**Land use planning and development:** Effective land use and planning can be done based on the data that is available for the catchment areas. There are many other ways in which the data generated

## DATA ANALYTICS

The data can be used to develop a range of indicators to assess the health of Ganga River Basin such as water quality, sediment quality, sea grass, macro algae and phytoplankton, and catchment pressures such as river flows and land use.





can be modelled and analysed for improvement and better management of the Ganga River Basin.

Ganga is an extensive aquatic system and its management is a shared responsibility across many stakeholders. There should be seamless flow and analysis of data across these stakeholders. It requires cooperative relationships between land owners, land managers, catchment groups, state government agencies, and local governments.

A single specialised agency for Ganga River Basin management will help to cut the response time and make it more effective.

#### **C2.2. KEY QUESTIONS TO BE ANSWERED**

1. What are the global best practices around the data analytics particularly when there are multiple data sets available for the same eco-system? Examples include the systems dynamics approach.
2. Can a single big-data platform serve the needs of all stakeholders? For example provide multiple dashboards or will such an approach be too unwieldy?
3. Who owns the data?
4. Do we need to develop an approach around an open source system or given the critical use of this data, keep it closed and secure from potential hacks and/or contamination.

#### **C2.3. DISCUSSIONS**

For data modeling few issues that were addressed are:

- a. Analysis of data to help NMCG
- b. Modeling related to Ganga river basin management
- c. Identification of stakeholders and

their requirements, engage them in arranging and grouping of data. Make data available to people

- d. Authorised data collection
- e. Perspectives of problems faced by Ganga river: flood risk, pollution level
- f. Datasets: specific standards don't exist. With standards, data is valuable
- g. Authenticity and availability of data(system dynamic approach); real time transfer in STPs monitoring sensors
- h. Validity and cross referencing of the models

#### **C2.4. RECOMMENDATIONS**

Data also needs to be cross-referenced in different datasets. It must be open on policy level as well as to public. Science is the means of communication to the society by bridging the gap between quantitative and qualitative part of data. A public information system is needed. The problem is the community itself. People are not able to maintain the mandate. The information made available should be actionable and at appropriate time otherwise major disputes among states could arise.

Availability of data is questionable. Even river discharge and rainfall data are not available. Scientific background of data acquiring is not good e.g. waste management- reports give different results. A public information system is needed. Data has to be shared without any sense of fear or blame.

#### **HOW TO JOIN:**

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group TIES2.

## TAKE AWAY POINTS

One nodal management system has to be developed to guide the stakeholders and a special task force to be enforced for data management

Exchange of data has to be done at policy level

Standardisation of metadata

Invitation to people to join the working group for data management

There should be seamless flow and analysis of data across various stakeholders.

# Developing a Skilled Workforce in the Water Sector

## DAY 3:

Wednesday, December 6, 2017; 14:00 - 15:15 h & 15:45 - 17:00 h

## VENUE:

Committee Room C– Vigyan Bhawan Annex, New Delhi

## MODERATOR:

Mr Sundeep Chauhan, cGanga

## PANELIST:

Dr Anirban Gupta, IEST, West Bengal; Ms Anita Roy, Luri Water Systmens, GmbH; Mr Paritosh Gupta, IL&FS-Water; Dr Praveen Saxena, MNRE; Mr Iztok Lesjak, Technology Park, Ljubljana, Slovenia; Mr Prashant Singh, Capricot Technology; Dr Sejal Worah, WWF-India

## C3.1. PROBING THOUGHTS

The urban population in India is growing rapidly. The urban population is going to be over 50% from the current of 32%. Annual per capita water availability is expected to decline to 1,140 cubic meters by 2050, from 1,545 cubic meters in 2011. With a growing economy and changing lifestyles the pressure on already strained water resources is increasing. Most cities in India are water stressed, with no city having 24/7 water supply. The coverage of sanitation has increased but resource sustainability and slippages are very common in that coverage. Moreover, in cities with more than one million people, the official water supply after 35% loss in leakages is just 125 litres/day per capita which is considerably lower than the demand of 210 litres/day per capita. An estimated 160 million latrines and septic tanks contribute to 80% of the pollution of the national surface waters. Reform is needed which reduces non-revenue water, groundwater exploitation, considers waste as a resource, and looks at the water cycle in a holistic way.

Urban water security through a holistic approach implies managing water resources and its waste in a new integrated way, with a focus on considering the whole urban water cycle as one system within the watershed, aiming for water security through diversity and optimum use of all potential sources

of water. This is further to manage the better utilisation of natural systems for water and wastewater treatment, considering storm water/rainwater catchment systems as a potential source and strengthening leakage management and maintenance, strengthening resilience of urban water systems. Grey water can be reused for irrigation, urban agriculture and industrial processes, treated or untreated depending on the purpose of its use and its legislation; nutrients in wastewater (grey and black) can be used for energy production and fertilizer production. Wastewater disposal and treatment is a very major problem in most Indian cities. Non-collection of wastewater and discharge of untreated wastewater into low-lying areas or various water bodies causes severe water and land pollution problems. Proximity to water body, local conditions and financial constraints determine the place and method of wastewater disposal. Recycling/reuse of wastewater is practiced in very few urban centres and wherever it is done, it is mostly used for agriculture or horticultural purposes. Recycling/reusing wastewater will reduce the demand for fresh water, thereby also postponing the capital investment requirements for water augmentation. Surface water and groundwater are the sources of India's water supply.

In order to overcome the challenges

faced by India, it is essential to develop adequate skill manpower to match with the huge investment made by Government in creating facilities in the water and wastewater sectors. It is proposed to allocate at least 5-7% of capex into creating, developing and training skill manpower for operation and management of such facilities.

The onus is on companies, ULBs and industrial plant units. NSDC is playing an important role.

## Water Supply Engineering Technicians Skills Training Areas based on responsibilities

1. Manage and control technical processes;
2. Operate, monitor, inspect, maintain

and repair water extraction, treatment, delivery, storage and distribution facilities;

3. Install pipelines, assemble and dismantle the facilities;
4. Examine customer facilities;
5. Carry out, to a limited extent, switching operations and repairs to the electrical facilities in waterworks;
6. Take samples of drinking water for self-monitoring, and determine and evaluate quality parameters to a limited degree;
7. Document and evaluate work procedure and operational processes;
8. Recognise fault and react independently;
9. Work in a cost effective,

## HUMAN RESOURCES

In order to overcome challenges faced by India, it is essential to develop adequate skilled manpower to match with the huge investment made by the government in creating facilities in the water and wastewater sectors.



- environmental and hygiene-conscious manner;
10. Apply relevant legal provisions, technical regulations and work safety regulations and observe quality management guidelines;
  11. Act in a customer-oriented manner and make use of information and communication technologies

**Water Supply Engineering Technicians Skills Training Areas:**

**Drinking water processing facilities:**

1. Management (waterworks plant manager, frequently academically educated or, with small waterworks, qualified as Water Technician);
2. Analysis and operation supervision (examination of water quality and sludge);
3. Process control (control room);
4. Operation and maintenance of facilities (machines, plant and filter technology);
5. Disinfection;
6. Management of protective zones;
7. Data management and documentation;
8. Safety management;
9. Quality management

**Drinking water distribution networks:**

1. Management (plant manager, frequently academically educated or, with small waterworks, qualified as Water Technician);
2. Work planning (e.g. resource planning, logistics);
3. Water storage;
4. Operation and maintenance of water distribution networks;
5. Leak location and repair;
6. Illegal tapping;
7. Water meter management;

8. Domestic connection management;
9. Operation and maintenance of pumping facilities;
10. Mobile water distribution (e.g. tanker vehicles);
11. Data management (GIS);
12. Safety management;
13. Quality and hygiene management

**C3.2. DISCUSSIONS**

What is the journey of learning and skills in water and wastewater treatment sector?

- a. Pretty tardy and woefully lacking in skills
- b. Low wages makes it unattractive
- c. Wastewater is considered hazardous
- d. Unwillingness of people to work in the plants

What impact will automation have on this sector? It would be welcomed with SCADA control and remote sensor enabled management as would control the platform of central control panels and would avoid odor/smells and infections. This will raise plenty of possible scenarios for employment growth and more automated plants with high technology come to fore. Both centralised and decentralised plants would be able to provide employment to thousands of people in all categories, viz-engineering, maintenance, etc. In addition, following key points were also discussed to promote better skill force development:

- a. Skilling should be the duty of government, private sector, civil society and Academia
- b. 5-7% CAPEX goes into creating, developing and training personnel in the O & M budget
- c. Developing a one-year PG programme in water and sanitation



**JOB OPPORTUNITIES**

Both centralised and decentralised plants would be able to provide employment to thousands of people in different categories such as engineering, maintenance.

- d. Many Standards defined in CPHEEO Manual and CPCB guidelines need to be revisited and perhaps amended
- e. The loans for projects to ULBs should have a proper O & M manual and there should be tests post training for proper understanding. Jugaad management should be strictly discouraged.
- f. Identifying the gaps – Ecosystem management should guide solutions.

- g. Water has health and agriculture productivity connection. Bring them on a common platform when developing learning modules.
- h. In Slovenia, Training manuals are skillfully written, skills taught, examined and certification given before manpower is employed/

- Skills exist in Silos and sectorization is a challenge. WWF has many training programmes.
- deployed. Every aspect of water and wastewater skills is addressed as per EU standards. That includes industrial CETPs. Slovenia would be happy to share and do pilots with cGanga
- i. cGanga could develop water plant operators course under Centre for Excellence at NMCG and IIT Kanpur
- j. CWC, MoUD, CPCB, MoWR should agree to rewrite manuals under one body and work with cGanga to standardise knowledge, develop curricula, provide expertise and upgrade technology and multidisciplinary knowledge. Be a real Think Tank.
- k. High technology, online sensors, satellites, drones etc. should be understood and used. This may require massive up-skilling in future. IS India FUTURE ready?
- l. Companies in water sector should have apprenticeship programmes. cGanga could help.
- m. Cultural aspects of River basins should be understood. Cremation, rituals on ghats may be revisited. How can India leapfrog and yet keep the traditions alive? Traditional knowledge and wisdom should be saved and practiced.
- n. cGanga should encourage more accreditation agencies under ETV and should bring latest learning to this sector

### C3.3. RECOMMENDATIONS

People take water supply for granted as there is not any kind of water management system. The problem is not the lack of skills or expertise, but lack of co-ordination among same or different sector people. Also, there is a gap of unity rather than individual skills, which makes

the water sector backward. There is not a single organisation like National Skill Development Corporation. Although, most of the technological revolutions can very well be applied in water sector. Few other options to promote skilled workforce are:

- a. A comprehensive PG interdisciplinary course, may be of 1 year, should be compulsory to all water sector employees. Importance of water security should be included into the curriculum
- b. Look water sector as sector of employability and well paying. It could be done in combination of public and private sectors
- c. It has to be observed in a similar fashion as IT sector
- d. CoE (Centre of Excellence) of Ganga should be established for knowledge sharing between private, government and NGO employees
- e. Skill development programmes (similar to plumber, welder) should be available for plant operators, river gauging staff. People could be employed either for lifetime or contract
- f. Water sector should be challenging and well paying

Everyone in water sector cheats, don't follow standard practices. The reason for lethargy is lack of incentives for good performance. If the spirit is created within job, low level employees will be proud of it, and wrongdoers should be punished accordingly.

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group TIES3.

## TAKE AWAY POINTS

Development of coordination among different expert group

Water sector has to be observed similar to IT sector, with higher employability, salary and knowledge

CoE of Ganga should be established for knowledge sharing between private, government and NGO employees

Skill development programmes (similar to plumber, welder) should be available





# Inspiring Entrepreneurship in the Water Sector



**DAY 4:**  
Thursday, December 7, 2017;  
10:00 – 11:30 h

**VENUE:**  
Room No. 408, New Lecture  
Hall Complex, IIT Delhi,  
New Delhi

**MODERATOR:**  
Mr Sundeep Chauhan, cGanga  
& Mr Sanmit Ahuja, cGanga

**PANELIST:**  
Ms Hannah Simcoe-Reed,  
NVH Tech, UK; Ms Poul  
Jensen, EBTC, Denmark;  
Mr Prashant Singh, Capricot  
Technology; Mr Chakresh  
Jain, Capricot Technology

## C4.1. PROBING THOUGHTS

**If there is a need and people are prepared to pay to satisfy it and the consideration paid leaves enough on table for the person who came forward to organise it -There is a business. Person who takes the risk to organise is an Entrepreneur.**

Water is a Business. Water used to be free. In fact, it still is — at least in nations blessed with plentiful clean tap water like the U.S. — but that doesn't stop the world from spending over \$100 billion on bottled water a year. This strange industry is exploding world over.

The worldwide crisis of freshwater supplies is so great that it is now a commonly held belief that the wars of the 21st Century will be fought over water. Water represents the last of the global commons to come under the control of market forces.

### What is at Stake?

The global water industry is valued at about \$400 billion annually. This includes everything from privately owned and/or operated municipal and regional water systems, bottled water, dams and waterways, water desalination and purification systems to large-scale water exportation via super-tankers. The private water sector in the United States generates more than \$80 billion a year

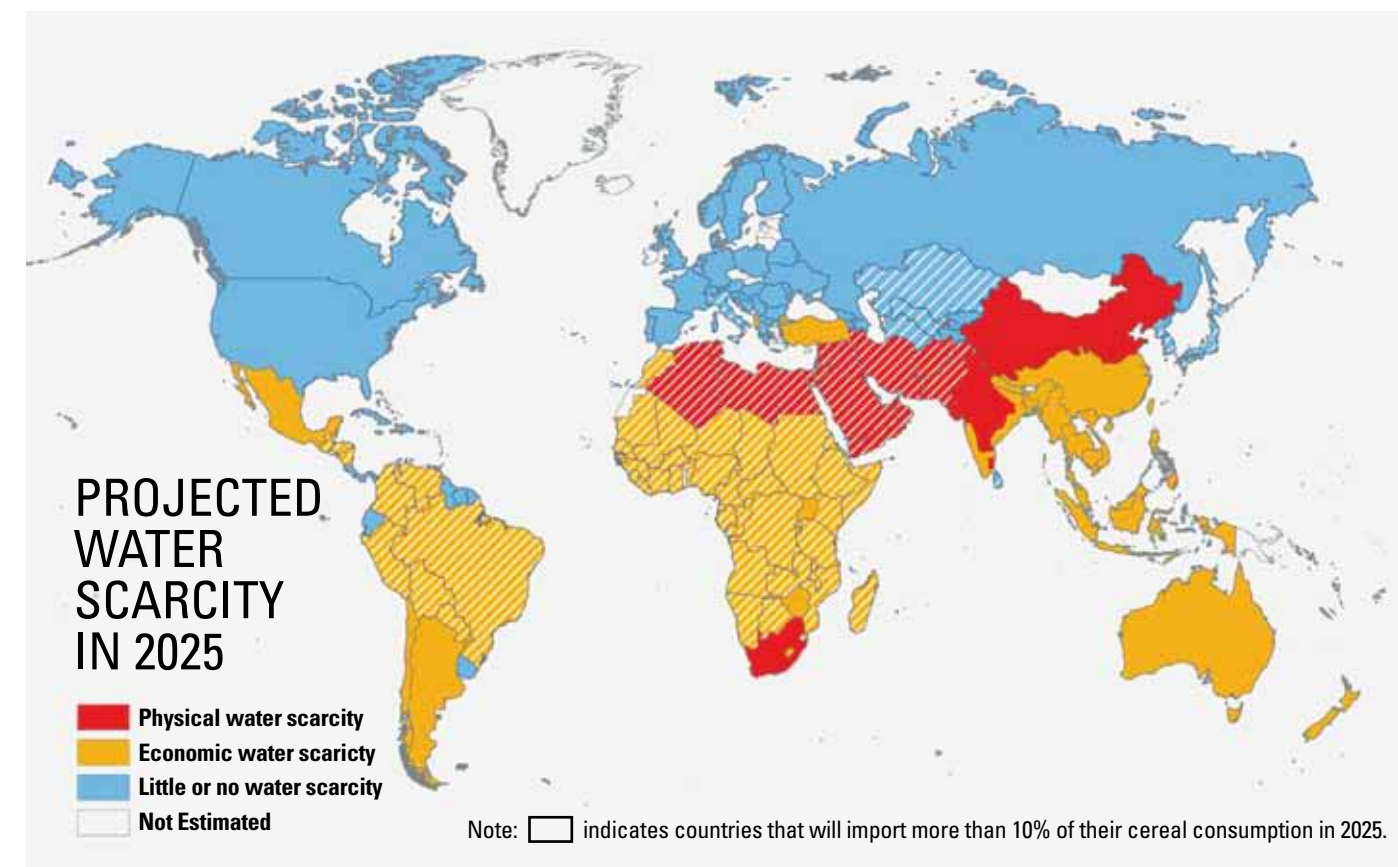
in revenues. "Water stock fundamentals look good, and over time, the stocks should continue showing gains, if not outperforming the market," says Schwab.

### Sustaining Life versus Sustaining Profits

Access to safe drinking water is now regarded as a basic human right, enshrined by the UN General Assembly and Human Rights Council, and yet 783 million people – 11% of the world's population – are still living without it.

There is a fundamental and inherent contradiction in privatising finite natural resources like water. Since the goal of corporations, it to maximise profits, commercial purveyors of water have no incentive to promote conservation, which is the most fiscally and environmentally prudent way to manage water. The idea is that we must now consider the social value of water and not simply surrender it to the highest bidder.

Without proper regulation and equitable distribution requirements in place, the privatisation of finite natural resources essential to life, such as water, will inevitably lead to a two-tiered society – those who can afford to purchase it in adequate quantities and those who cannot. Avoiding this outcome will require preservation of tax-supported municipal water systems that are accountable to citizen oversight, rather than relying on private corporations.



**11%**

**Access to safe drinking water is now regarded as a basic human right, enshrined by the UN General Assembly and Human Rights Council, and yet 783 million people – 11% of the world's population – still do not have access to it.**



The free hand of the market allows for price discovery and investments in infrastructure. Its principles even underpin virtual water trading.

#### The Entrepreneur's choices

Water is scarce and is getting scarcer. It is necessity and is basis of life. Providing much needed water is not just a business, it is sensitive business. In many cultures and religions, it is a part of the beliefs and practices. 'Ganga Jal' in India amongst multiple connotations is considered pure, wholesome and holy. Providing water is a sure business but denying water is a crisis.

So how does one make it a business and what is that model which renders the business of selling the product without denial, a profitable and prudent business? These are the issues that an Entrepreneur

must confront with and solve.

The awareness of water as a 'Resource' and that it has value have changed the scenario. There is also the move towards increasing privatisation, introduction of right price recovery by Governments, efforts at Innovative products and services in the sector and willingness on the part of population to accept value and pay for water.

#### C4.2. IMPERATIVES FOR SUCCESS

**There are basics of this business that could be discussed:**

1. Offer what people want to buy, not just what you want to sell-Hear the Customer.
2. Get cash flowing ASAP-tendency is water is free so be sensitive to it.
3. Always find new ways to keep

costs low- you can't deny as it is a fundamental right

4. When planning, always overestimate expenses and underestimate revenues-High quality is basic and no price is the rule.
5. Focus on sales and marketing- Establish that it is a product.
6. Test and measure everything- water has the tendency to flow.
7. Accept that learning more equals earning more- catch the trend before others.
8. Don't discount, add value- Water has no alternative/competitor.
9. Get a coach- Don't reinvent the wheel, Industry and knowledge already exist.
10. Industry is ready to buy used water or primary treated water. Explore.

#### C4.3. DISCUSSIONS

The true wealth of state consists in the number of its inhabitants, in their toil and industry. Water is critical to health, food, energy and overall wellbeing of flora and fauna. It is critical to healthy ecosystem and climate moderation. We work to become, not to acquire and thus water continue to be the centre of civilizational development and survival.

Water availability is steeply declining in India and is hovering around 135 lcpd. Groundwater recharge is low and declining rainfall, heat and overdrawn has rendered vast areas critical. Salinity, arsenic, uranium rendered water in many areas not fit for human or crops. On the other hand, the water sector is highly unregulated, prone to high political and social risks. In such form it is not

## WATER SCARCITY

Water availability is steeply declining in India and is hovering around 135 lcpd. Groundwater recharge is low and declining rainfall, heat and overdrawn has rendered vast areas critical.



## MANPOWER TRAINING

**cGanga could play a vital role in partnership with Indian government, private entities and foreign governments for learning development and dissemination.**

amenable to market pricing across the globe. Regulatory risk is predictable in EU but not so in India. In Europe, water infrastructure is old and has little funding for R & D. It is regulated by sound policies guaranteed by the Parliament. Countries like Scotland, there is one authority.

In India except for a National Water Policy 2012, which is a guideline, the water is a state subject. There is no central water regulator. With water becoming dangerously critical both in terms of availability and quality, the central authority may come to fore. All river basins become matters of National Water Security. Water and environmental regulators should work in tandem. India has a thriving water industry, but is fragmented. India has several companies with good engineering and technological capabilities, however modest project management skills and woefully lacking in O & M.

Technology use is conservative as most plants use ASP, power generation

through methane and SBR technologies. Few places are also there where technology adaptation is slow. One way to enhance technology adaptation is via cGanga, where cGanga through ETV should verify technologies. Once done, entrepreneurs should latch on and capitalise.

Most PQ's (Precision Questioning) for projects have conditions that new entrepreneurs cannot match. A mechanism to make PQs technology neutral is required. Also, many technologies have not been tried hence they do not qualify. Once ETV process is in place, such companies who successfully pass the scrutiny, would be able to qualify and bid. PSU's may incubate some technologies and collaborate with technology suppliers.

ULB (Urban Local Bodies) owned STPs may become **water factories**. They could supply untreated sewage to industrial units. Primary treated water

could be supplied to water intensive industries like paper, power plants, refineries, chemical plants etc. Already Mahagenco and Chennai metro are buying and selling treated/ raw used water. Since not all cities have sewer connectivity, decentralised treatment facilities are required. There is scope for small 1-5 MLD plants across the country. Treated water could be recycled or used for irrigation.

Digitisation, IOT is ushering in high technology for monitoring plant performance and pollution. Many companies in this space could bring in sensor based remote solutions. Drones and satellite geo tagging would be used as plant assets. Thus, Plants of the future would be high technology entities. Manpower would be highly trained but fewer in numbers. Better quality of employment would happen. Manpower intensity will be replaced by manpower quality. This opens a new

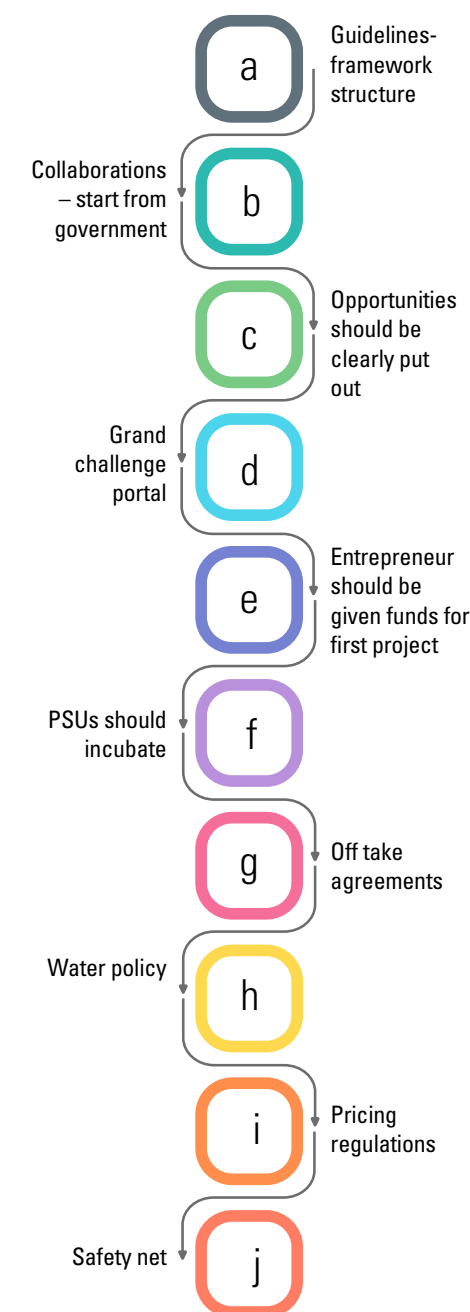
avenue for skills and certification. Many new companies would mushroom to cater to this new demand. cGanga could play a vital role in partnership with Indian government, private entities and foreign governments for learning development and dissemination.

The support system should be a mentor company, who shall be reimbursed when reached bench mark. Also, the projects should be designed in self-sustaining manner. The overall system could be assessed in the form of small pilot projects. Also, most Government doesn't know actual cost of delivering water. There is a need to define the cost of water and environmental, social and economic impacts of that cost.

### C4.4. RECOMMENDATIONS

Basic agenda nowadays in water sector is to sustain life and generate profit simultaneously. To reframe the Indian water sector to emerge as an IT sector,

### CURRENT SCENARIO IN INDIA IS FRAGMENTED WATER SECTOR WITH SUBSIDISED WATER SUPPLY CHAIN. IDENTIFYING AND LISTING THE NEEDS AS





## DEVELOPING A PORTAL

A major recommendation was to design a portal under cGanga with focus on grand challenges faced by both Indian and foreign entities and to invite out of the box ideas and inventions, publish case studies and reports.

entrepreneurship should be promoted. Following key points were identified for the same:

- Need predictability and reliability
- Well defined clear and simple policies, bidding process
- Provide an environment to sustain entrepreneurship
- Policy adherence
- Constant policy
- Assure degree of decrease in risks
- Prevent rapid flux
- Cut out risk factor

Risk could be economic, financial, social, environmental regulations or policy adherence. Other risk factors include:

- Old infrastructure
- Restrictions on increase of price but need to provide minimum fixed amount of water
- Constant sell, merger and acquisition
- Unemployed to cut the price
- To reduce cost, need R&D but no funds available

Few inferences from foreign countries have been listed:

- Huge commitment to deliver safe water (UK)
- Public ownership, offers certainty for supply chain to have clear policy base and investment cycle of 25 years (Scotland). Water Resources Act 2013, in Scotland is appraisable and could be implemented in India too.

List of areas as for entrepreneurs willing to work in Indian water sector are:

- Decentralised system
- Consultant type projects
- SME can bring new technology in decentralised system
- Packaged WW systems

- Data generation
- Water mappings
- For Well-defined process driven- big companies
- For Output driven innovation SMEs

The flowchart should be identify problems- classify them in category- use transformation entrepreneurship- ask for solution. **A major recommendation was to design a portal under cGanga** which should include following:

- Populate that with grand challenges faced by both Indian and foreign entities
- Invite out of the box ideas and inventions, publish case studies and reports after before/ after ETV verification
- Upload pilot studies modus operandi and results
- Follow developments on scaling up from Lab-Pilot- Commercial scale
- Organise Annual Entrepreneurship meet under NMCG banner
- Organise Meets in all Cities under Ganga Basin and invite CMs to the meets. Pick up projects for pilots and involve local leaders in projects
- Create India Water Fund. Invite experts to debate in a one-day workshop. SREI, Banks, Multilaterals, Bilateral, state government finance leaders, etc. may be invited to debate a structure. This will help various areas for financing- VGF, Bridge Loans etc.

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group TIES4.

## TAKE AWAY POINTS

Indian water sector to emerge as an IT sector, entrepreneurship should be promoted

Entrepreneur should be given funds for first project

PSUs should incubate

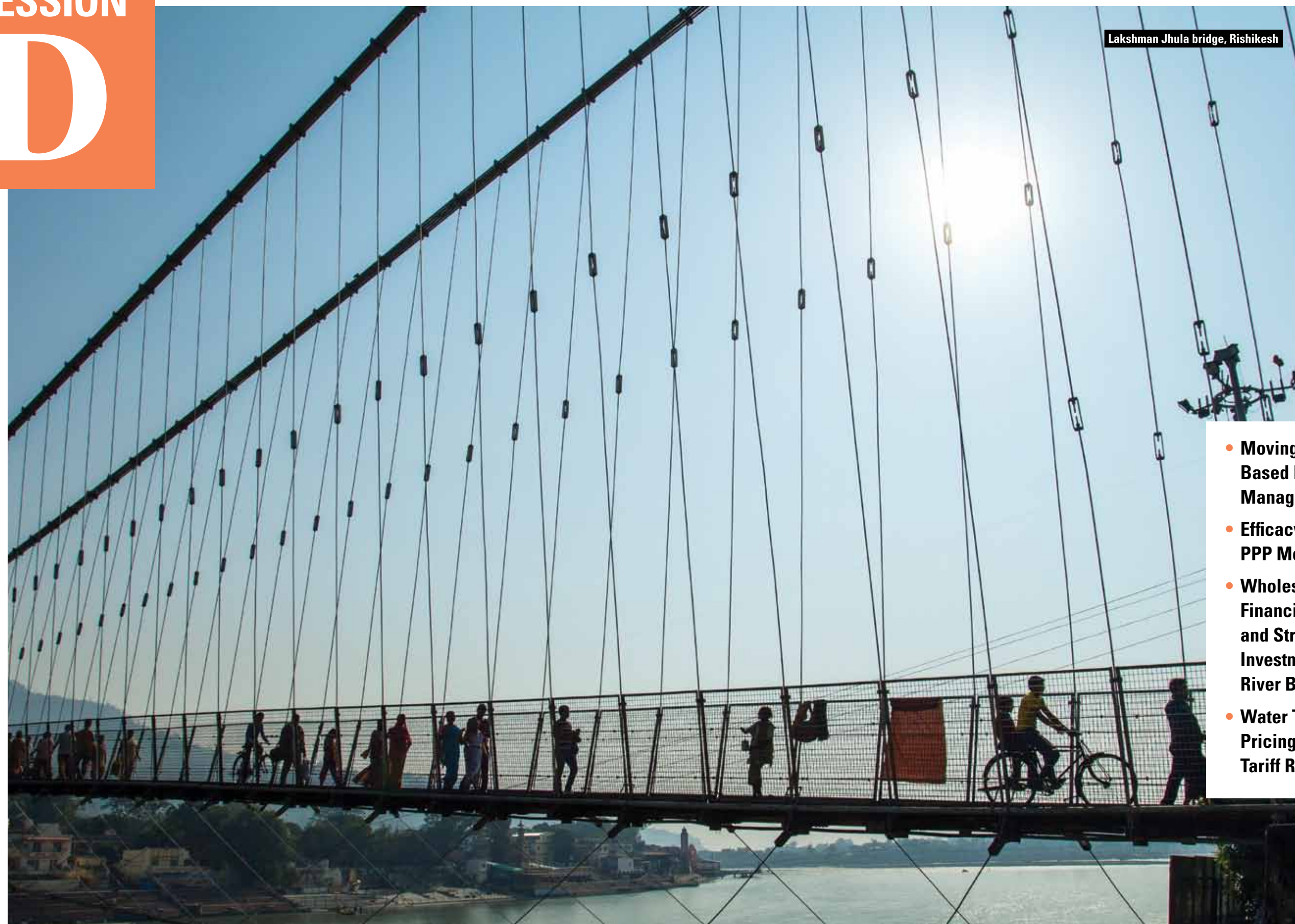
Follow developments on scaling up from Lab-Pilot- Commercial scale

Organise Annual Entrepreneurship meet under NMCG banner

Organise Meets in all Cities under Ganga Basin and invite CMs to the meets. Pick up projects for pilots and involve local leaders in projects



# SESSION D



Lakshman Jhula bridge, Rishikesh

- Moving towards Evidence Based River Basin Management
- Efficacy of PPP and Hybrid PPP Models
- Wholesale and Retail Financing Instruments and Strategies for Capital Investment in Ganga River Basin
- Water Trading, Valuation, Pricing and an Effective Tariff Regime

# Moving towards Evidence Based River Basin Management

## DAY 2:

Tuesday, December 5, 2017;  
14:00 - 15:15 h & 15:45 - 17:00 h

## VENUE:

Committee Room D – Vigyan  
Bhawan Annex, New Delhi

## CHAIR:

Dr Anil Mohile, Formerly with  
CWC, MoWR, RD&GR, GoI

## MODERATOR:

Mr Sanmit Ahuja, cGanga

## PANELIST:

Dr Kees Bons, Deltares,  
The Netherlands;  
Dr Andrew Allan, University of  
Dundee, UK; Mr Bob Pentter,  
Waikato River Authority, NZ;  
Dr R N Sankhua,  
Basin Planning, CWC;  
Dr Satya Prya, World Bank;  
Dr A S Dhingra, MoWR,  
RD&GR; Dr A K Gosain, IIT  
Delhi; Mr Avinash Tyagi, ICID

### D1.1. PROBING THOUGHTS

The water and environment sectors are lagging behind their peers in the energy, urban development and transportation industry when it comes to using evidence as a basis of policy making. The main driver behind such an approach is lack of comprehensive and critical data sets. This issue is even more stark in the context of Ganga River Basin where the existing data sets are all too fragmented, mostly analog and those that don't go too far back in time so that we can understand how the river system has changed with the increase in anthropogenic activities over the last few decades.

It is never too late to start moving towards a river basin management approach that is evidence based and integrated. The wide proliferation of sensor networks and huge cost reductions in remote sensing, advancement in data storage and analytics, and the great leap in systems dynamics and decision support systems now make the shift towards an evidence based policy making not only possible but as the only way to do so.

### D1.2. KEY QUESTIONS TO BE ANSWERED

1. Need for developing an urban river management plan (URMP) around how the river and urban water bodies interact.
2. The river flow data sets which is very

critical to understand the state of the river systems.

3. How irrigation and agricultural sector is extracting surface and ground water?
4. What is the interaction between surface water and groundwater?
5. At what rates are aquifers depleting or getting recharged?
6. Soil condition scenarios.
7. What is the state of water quality at different spots along the river, its tributaries?
8. What are the pollution discharge sources, who are the major polluters, what is the compliance situation with each of the major polluters?
9. Encroachment issues in the basin.
10. Embankments and how their state affects the rivers.
11. Flooding and silting issues.
12. Sand-mining and issues with related activities.
13. Biodiversity data sets.
14. Religious and spiritual activities, melas (events), ghats, crematoria.
15. Inter-linking of rivers and validation of data/information on the basis of which interventions are planned.
16. Land cover and land use.
17. Groundwater and surface water status.
18. System hydrology
19. Demography and population
20. River health

21. Water bodies – algae cover and restricted drainage due to water hyacinth
22. Which bodies are shrinking and which ones are expanding

- a. Ganga Flood Management system
- b. Extent of human and infrastructure risk
- c. Multiple approach method to improve efficacy
- d. Modernisation of schemes

### D1.3. DISCUSSIONS

There is a lot of data present but it is very confusing as many of these data are incorrect. The river restoration projects are required to be formulated on evidence based river basin management system. An institutional framework independent of government, like cGanga, is a good initiative for this. cGanga and existing institutes such as National Institute of Hydrology should consider undertaking studies to support the following.

Evidence based programme will help in increasing the efficiency. Several historical decisions such as (i) decision to divert water from Ganga during British rule to irrigate areas with less rainfall, and (ii) extraction of groundwater for irrigation using tubewells/pumps as part of Green revolution resulting in decreasing groundwater level, are difficult, if not impossible to reverse through regulations without evidences. At the same time, there is a need to maintain hydrological

## EVIDENCE-BASED APPROACH

The water and environment sectors are lagging behind their peers in the energy, urban development and transportation industry when it comes to using evidence as a basis of policy making.





## TAKE AWAY POINTS

Evidence based planning will need a decent investment and monitoring network

Multidisciplinary nature of issues need to be identified

Coordination in managing information by an independent, creditable and transparent institutional framework is necessary.

health of the river basin or its sub-basin. Reliable hydrological and groundwater models are needed. However, it is also important to take proactive measures for following.

- Enhanced awareness of farmers regarding hydrology of rivers
- Prior dialogues regarding possible conflicts on water.

### D1.4. RECOMMENDATIONS

Policies are necessarily to be made on the basis of evidence, though general perception also plays a significant role.

More detailed studies with provision of collating high resolution data should be encouraged. Much of the modeling potential has been exploited with data sets made available. For a quantum jump in this exercise it is mandatory to move towards investments in collation of high resolution and creditable data. Such investments would save excessive expenditure on field interventions as well as reduce public outrage due to creation of non-performing assets. Another major key factor towards this approach is transparency. If all stakeholders

are involved and data/information is made available in public domain, then data transparency and accuracy will automatically be regulated.

At the same time it must be clearly understood that not all data can be made public. For that a legal framework and enforcement mechanisms should be developed which could give information on meta-data belonging to a stakeholder. For this, following few important points need to be considered.

- Policy should be coherent as every stakeholder seeks his own benefit

- Due diligence is done on information/ data provided by different sources
- Review and validation process of data/information collected/provided is in place
- Evidence based planning will need a decent monitoring network

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group PLG1.

# Efficacy of PPP and Hybrid PPP Models

## DAY 3:

Wednesday, December 6,  
2017; 10:00 - 11:15 h &  
11:45 - 13:00 h

## VENUE:

Committee Room D – Vighyan  
Bhawan Annex, New Delhi

## CHAIR:

Mr Hitesh Makwana; NMCG,  
MoWR, RD& GR

## MODERATOR:

Mr Sanmit Ahuja; cGanga

## PANELIST:

Mr Howard Barrie, Eversheds  
Sutherland, UK;  
Mr D T V Raghu Rama Swami,  
School of Infrastructure, Amity  
University; Mr Abhay Kantak,  
Crisil Infrastructure Advisory;  
Mr H N Bhatt, HNB Engineers  
Pvt Ltd; Mr Sudeep Kumar  
Sinha, Deloitte;  
Mr Yasuhiro Tokunaga, Metito;  
Mr Ashish Kale, Yes Bank

### D2.1. PROBING THOUGHTS

Public Private Partnerships (PPP) have been slow to take off in the water sector despite several attempts. The initial attempts in early to mid 1990s tried replicating models from other parts of world without sufficiently incorporating the local context. However, over the last decade several home-grown models have emerged on both water supply and wastewater treatment which hold a lot of promise.

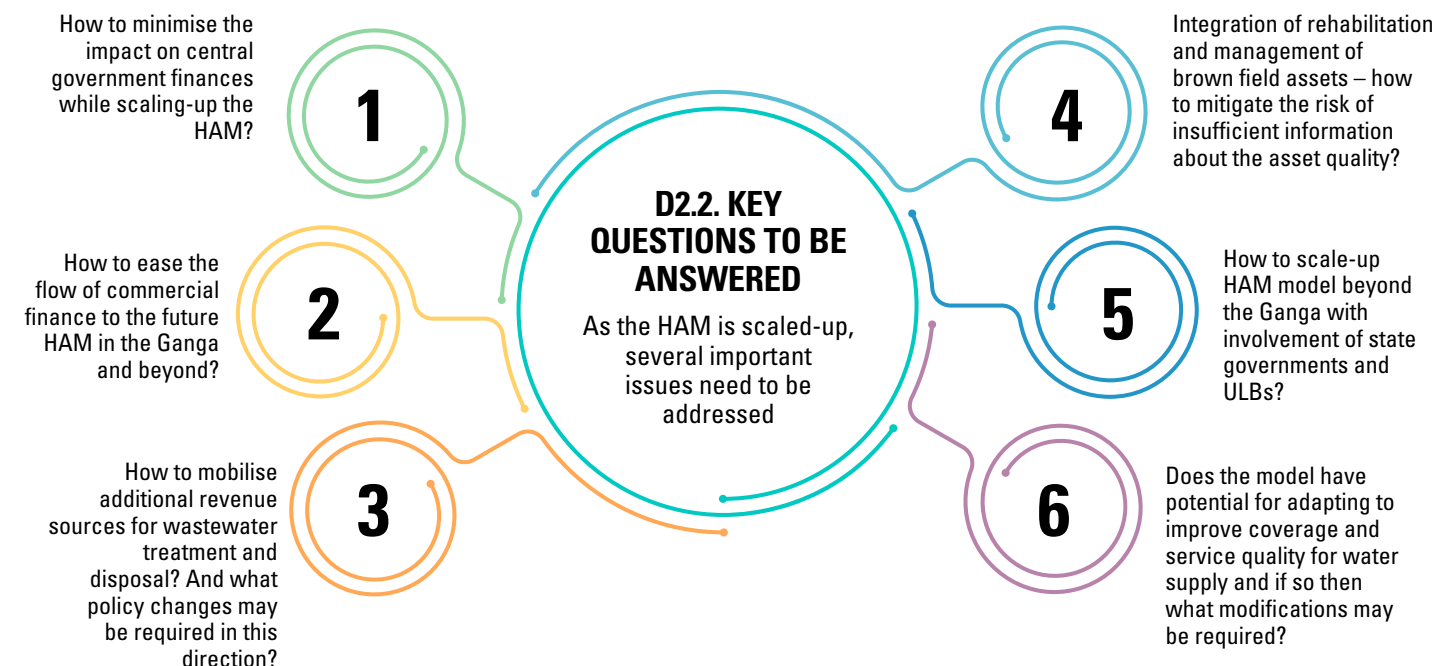
One such innovation has been the Hybrid Annuity Model (HAM) for wastewater treatment. Adapted from the highways sector, the HAM has achieved a balanced allocation of risks wherein the construction and performance risk along with responsibility for financing is borne by the private sector while the government takes responsibility for making annuity payments to cover the capital and recurring costs over the concession period. In a sector where user revenues do not yet cover the O&M costs, the HAM can crowd-in private sector financing the expertise. The response to the first two HAM contracts bid out by NMCG in Haridwar and Varanasi has been very positive with more than half-dozen private players, domestic and international, participating in the bids. Both contracts have been awarded at lower than estimated costs and one of the contracts has already achieved financial

closer within record time. The HAM is proposed to be scaled up across other towns like Allahabad, Patna and Kolkata.

Assessments undertaken by CPCB show that approximately 63% of the STPs in India are operational (CPCB 2015). Even those that are working operate at below the treatment capacity and often fail to meet the effluent discharge standards. Going forward the Namami Gange programme envisages bundling brown field STPs and non-operational STPs into HAM contracts. On the one hand this will ensure that a private operator has comprehensive responsibility for wastewater treatment in a city, the contracts need to appropriately deal with the asymmetry of information while managing brown field assets.

### D2.3. DISCUSSIONS

There has been immense technological development in the wastewater treatment globally. Much emphasis now is on resource recovery, particularly on the energy side to make the projects economically viable. Whilst there is still a question mark on the level of resources recovered from the wastewater streams, particularly if they will be significant enough, but there definitely will be enough of an economic contribution possible to make the prospects worthwhile. The most significant resource that can be recovered is energy trapped



in the form of gases generated by the wastewater stream.

The Indian market is not seeing too many PPP projects coming through the pipeline in the urban water and wastewater sector. The reasons, although many, can be categorised in two broad segments:

- a. Availability of enabling infrastructure such as land, energy and network.
- b. Preparedness of the Urban Local

Bodies to create projects and attract investment into it.

The lack of availability of electricity for critical utility infrastructure in many of the cities and towns in India is crippling for the plant operators. The Government must provide reliable and continuous electricity supply to these assets or incentivise plant owners and operators to recover as much energy from the system as possible so that the reliance on grid infrastructure



is reduced. This can only be done if the energy generation potential within the wastewater treatment plants is seen as a systemic resource.

Urban set up will mostly be a cost-centre. The gap between the capital need and the availability of capital is so huge that Government has to resort to PPP and variants of PPPs such as the Hybrid Annuity Model (HAM) to attract private sector capital. This form of capital will always be more expensive, particularly in the early days, and all stakeholders must resign to this fact. Trying to force pricing down through artificial pressures shall only result in inferior contracts or inferior assets. But even if in the early days of market development, the cost of infrastructure is on the higher side, it is still acceptable as this is a sign of a genuine market. Convergence will definitely happen around the BOT contracts as HAM model is accelerated.

#### D2.4. RECOMMENDATIONS

The major issues of the public private partnership identified are:

- Not enough successful PPP model in the urban water and wastewater sector
- No special "financing or tax incentive" treatment given by the Government to water or wastewater sector
- Capacity with Urban Local Bodies (ULB) is extremely limited
- Initial financing of PPP/HAM projects will always be more expensive
- A huge number of technological choices available making it difficult for ULB stakeholders to assess and select the right technology class

Therefore firstly, efforts must be put in place to deepen the market and attract

more and more players into it. Some special incentives include:

- Bring water and wastewater under priority lending sectors as prescribed by the Reserve Bank of India
- Discounted electricity tariffs for the wastewater sector
- Incentives for energy generation on site

Secondly, under National Mission for Clean Ganga (NMCG) basket of projects, 118 projects (Dec 2017), need to be put forth to the private sector for development. It has to be properly structured and/or segmented. It is important to segment these properly so that the market can develop strategic approaches around them. Some segmentations are:

- Centralised v/s Decentralised infrastructure
- Greenfield v/s Brownfield infrastructure
- Segmentation based on capacity
- Segmentation based on availability of crucial infrastructure such as land, electricity and grid
- Performance parameters of greenfield and brownfield assets

Thirdly, the biggest issues that project sponsors (ULBs) face is the growing number of technology choices available for wastewater treatment. These range from biological to advanced chemical systems. The range of technologies also brings in an added dimension of capital cost. The biological systems are of much lower capital costs than the chemical systems. This confuses the decision makers as they don't have the requisite knowhow to adequately assess the technologies.



## 118 PROJECTS

Under National Mission for Clean Ganga basket of projects, 118 projects, need to be put forth to the private sector for development. It has to be properly structured and segmented. It is important to segment these properly so that the market can develop strategic approaches around them.



This problem gets further exacerbated when bids are invited and the qualification criteria is quality of water at output and cost of treatment. If the parameters such as land footprint, which is much higher in the biological systems, and electricity consumption/generation are not incorporated in the bid selection criteria, it will cause much confusion in the market. The Environment Technology Verification (ETV) framework shall greatly assist

the stakeholders in assessing the right technologies. All projects must be tagged with the right technology classes before the bids are invited.

So far decentralised infrastructure asset class has not been considered for PPP structuring. This is one of the missed opportunities to make significant progress in creating wastewater treatment capacity in the Ganga River Basin. There is enough technological advancement in smaller treatment system category that warrants a



major policy push to attract bidders. The only challenge with such an asset class is small size of the projects.

To overcome this particular problem, the cluster approach provides a great solution where concessionaires could be allocated an area within which they could install and operate a large number of small wastewater treatment systems. This would bring in operational and capital efficient segment with attractive investment class.

Finally it is important to standardise the procurement procedure, documentation such as concession agreements and other legal documentation to make the PPP framework more efficient.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group FI1.

## TAKE AWAY POINTS

A working group of Indian and international experts to brainstorm and provide guidance in developing PPP models is required

Develop special incentive mechanisms to attract high quality developments in the sector

Technology choices must be standardised and fixed for a particular location prior to bids being invited

Actively promote decentralised infrastructure asset class

Create a suite of standardised bid documents and model concession agreements



# Wholesale and Retail Financing Instruments and Strategies for Capital Investment in Ganga River Basin

**DAY 3:**  
Wednesday, December 6, 2017;  
14:00 - 15:15 h &  
15:45 - 17:00 h

**VENUE:**  
Committee Room D – Vighyan  
Bhawan Annex, New Delhi

**CHAIR:**  
Mr Rozy Agarwal, NMCG,  
MoWR, RD & GR, GoI

**MODERATOR:**  
Mr Sanmit Ahuja, cGanga

**PANELIST:**  
Mr Paul, Wood Worlds Water  
Fund; Mr Hari Har Mishra,  
CGDA, GoI; Mr Madhav Kumar,  
NMCG, MoWR, RD&GR, GoI;  
Mr Sourav Daspatnaik,  
Svaccha SREI Co.;  
Mr Hirander Misra, GMEX Group,  
UK; Mr Ashish Kale, Yes Bank

## D3.1. PROBING THOUGHTS

The need for addressing all the needs for river restoration and rejuvenation is in excess of USD 100bn. The current project financing pool available from banks and private sources is inadequate to finance this outlay. In order to accelerate project throughput, it is essential to make provision for wholesale financing facilities. The different instruments that will be discussed and recommended for development of the market include:

### 1. Establishing the Financing and Investment Value Chain

The four critical phases of the financing and investment value chain that need to be fully developed and operational at all times in order to accelerate the investment throughput are:

- Technology transfer and commercialisation finance
- Project development finance
- Construction finance
- YieldCos

### 2. Project Development and Construction Finance – Need for Development Finance and Real Risk Capital

As the wastewater treatment market begins to find its feet there is a strong need for development finance institutions to play a crucial role in investing in the early stage development cycle and construction finance. In the Indian

scenario it is imperative that the financial closure is done as swiftly and efficiently as possible. Long drawn out development cycles are a drag on developer's resources and not having clarity on project finance is also a major deterrent.

Should the development investor and construction finance lenders work in tandem with each other to make this cycle more efficient?

### 3. Creating Exit Options and Long Term Investors

Development investors block a lot of funding into the project equity. It can be hugely beneficial for them and the market if there are ample exit options available. If the long term investors – such as pension funds and insurance funds demonstrate their willingness to invest in “income yielding” assets then it can give a huge boost to flow of risk capital in the market.

Instruments include:

- Ganga/Blue bonds
- Dedicated YieldCos

### 4. Financing Decentralised Infrastructure

The pace of innovation in the sustainability sector has brought on the horizon a number of technologies that are apt for small-scale decentralised deployment. Development of decentralised systems can address the many water related needs of communities

and farmers particularly in areas where large centralised infrastructure projects are either untenable or financially unviable. However, with limited Government resources available and commercial capital finding these projects unable to meet their financing criteria makes it difficult for proponents of decentralised projects to raise finance.

- Decentralised infrastructure is best suited for impact investors. What financing models and instruments are available?
- Pooled infrastructure financing
- Community owned infrastructure models

## 5. Other Instruments

- Guarantees
- Insurance
- Buyers credit
- Equipment financing

## D3.2. DISCUSSIONS

The Gross Budgetary Fund of Government of India has a total current allocation of INR 20,000 crores (INR 200 bn / circa USD 3bn). This may help in financing the capital expenditure part of the project, but will not cover the large operations and management expenditure related to assets. The urban local bodies (ULB) must under all circumstances develop

# \$ 100 BILLION

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their own revenue stream to cover the cost of water treatment. Poor credit rating of ULBs is a major challenge and affects the bankability of projects. Investment market also needs to be deepened and it is imperative that efforts should be made to increase availability of capital. The two most critical aspects for provision of financing to the market are:

- Credit Rating and Quality of revenue streams
- Enabling of the entire financing value chain from development to long-term capital

The poor credit rating of various ULBs particularly in the Ganga basin will prove to be a significant deterrent to investors and lenders when they assess the overall credit risk. Improving the credit rating of the ULBs, although is much needed for systemic improvement, is perhaps outside the scope of considering financing of water projects. A much more prudent alternative is to consider an intermediary Government agency that can provide crucial guarantee to the risk investors. To deepen the pool of investors and the availability of capital for investments into the project it is essential that the entire financing value chain is enabled. The financing value chain has 3 major categories:

- Capital for preparation of quality detailed project reports
- Availability of development and construction capital
- Long term investors to hold the operating assets until end-of-life

If any of the three categories is missing or sparsely populated, then there is a direct impact on the availability of capital even for the rest of the categories.

National Mission for Clean Ganga (NMCG) is already playing both the roles

of capital provider and guarantor for various PPP and Hybrid Annuity projects. The role of NMCG should be enhanced by not only strengthening its balance sheet but also provide it a high credit rating. This would send a very strong signal to the market that the Government is taking measures to improve the bankability of the projects and attract greater private sector capital to the water sector.

### D3.3. RECOMMENDATIONS

Inadequate number of poor quality detailed project reports (DPR) has a direct correlation on bankable projects which in turn keeps investors at bay. Increase in both the number as well as quality of DPR is must. Whilst the Government (both Central as well as the State) has to provide necessary investment to develop the project reports, other sources of financing such as Corporate Social Responsibility (CSR), bilateral and multi-lateral donor funding could also be a necessary tool to build the DPR bank. In addition, a typical concern of investors is around the quality of the project reports. It would be a very worthwhile exercise to invest in preparation of model project reports which could deliver the appropriate quality benchmark.

A number of domestic and global equity funds are keen to provide the risk capital to the sector but there is a shortage of debt-financing stalls in funding of many projects. The Indian banks require that water sector be specifically brought under Reserve Bank of India's priority lending sector list.

On the capital market side, as companies start to develop and operate assets and assuming that the overall quality of the revenue streams improves, bond financing can become a critical



## MAJOR CHALLENGE

Poor credit rating of ULBs is a major challenge and affects the bankability of projects. Investment market also needs to be deepened and it is imperative that efforts should be made to increase availability of capital.





## GANGA-BLUE BONDS

NMCG should consider issuing Ganga-Blue bonds that will certainly inspire a whole group of prospective issuers and establish an international bond pricing benchmark for long term investors.

success factor in making available a pool of capital. Masala Bond has already proven a significant source for top tier Indian institutions. NMCG should consider issuing Ganga-Blue bonds that will certainly inspire a whole group of prospective issuers and establish an international bond pricing benchmark for long term investors.

The final segment of long-term investors will want to see steady operations, timely payments so that the Yield-Co market can be firmly established. The secondary buyouts will perhaps take a while to take-off such transactions that would require very deep and long established primary investment market. Greater bond-issuances will most

definitely attract yield-seeking investors. As an initial step, progressive global investors, particularly sovereign wealth and pension funds, should partner with NMCG to establish take-out financing vehicles which will give the necessary exit to development and construction investors to redeploy their investment returns into a newer pipeline.

### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working groups FI2 – Credit rating of NMCG, FI3- wholesale and retail financing instruments, FI4 – Ganga technology acceleration fund.



## TAKE AWAY POINTS

A working group with Indian and international experts to brainstorm and provide guidance in establishing the financing value chain

NMCG to immediately initiate the process of credit rating and being an explicit off-taker/guarantor

Earmark a portion of CSR and Clean Ganga fund for high quality DPRs

Aim to issue the Ganga-Blue bond in the next 12-24 months

# Water Trading, Valuation, Pricing and an Effective Tariff Regime

## DAY 4:

Thursday, December 7, 2017;  
10:00 - 11:30 h

## VENUE:

Room No. 408, New Lecture  
Hall Complex, IIT Delhi,  
New Delhi

## MODERATOR:

Mr Sundeep Chauhan, cGanga

## PANELIST:

Mr Sanmit Ahuja, cGanga,  
Ms Hannah Simcoe-Reed,  
NVH Tech, UK; Ms Poul Jensen,  
EBTC, Denmark;  
Mr Prashant Singh, Capricot  
Technology; Mr Chakresh Jain,  
Capricot Technology

## D4.1. PROBING THOUGHTS

### Water Valuation

Water pricing is one of the most contentious issues in Governance of water in India's towns and cities. The general belief is that water is a free(ly) available commodity and people are mostly averse to a significant increase in tariffs. Decades of highly subsidised water has created a false economy where most people do not understand its value.

As India moves towards addressing water security issues and is adopting PPP/Hybrid-PPP/PFI models to fund water utility assets, the need for a clear tariff regime becomes paramount. But any tariff regime is based on baseline value or true cost of water. The complexity in establishing the true cost lies in the fact that it depends upon a number of variables – availability of water resources, quality of water that is available and quality of water that is desired.

In order to move towards a structured pricing/tariff framework, water must be valued as a commodity. And to do so it is important that the concept of "true cost/value" is firmly established. This is not to be confused with the market price of water. The matter of "who pays for it" will depend on other micro-economic conditions such as demographics and demand.

Creating efficient mechanism to provide water to various users through

a transparent allocation framework can address many water resource challenges in India including – over-extraction, over-pollution, water-hoarding or excessive and inequitable provision to one segment at the cost of other.

### Water Rights

Development of a water rights and trading framework can bring about transparency and appreciation of water as a valuable resource. Water in India is essentially a State subject; however with Ganga classified as a national river, it complicates matters around the ownership structure of water as a commodity. Assuming the ownership is properly defined then how are the rights managed across the various sectors – agriculture, industry, hydropower (dams/storage), transportation and municipal (household)?

### Water rights can be put in two broad categories:

- Water rights based on land
- Water rights based on flowing water
- Use based where those who are not land owners can have the right to receive clean water

Should India move towards a more well-defined water ownership structure across the different riparian? If so, then how are these rights established and dispensed.

- Can a rights trading framework be structured in a complex system such as Ganga?
- Who would establish the allocation to various riparian?

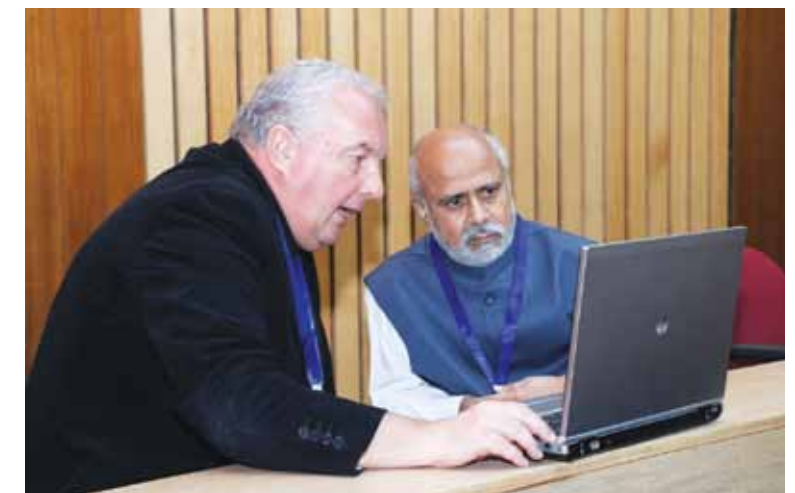
## D4.2. DISCUSSIONS

Establishing a benchmark real cost of treating and delivering water for each particular city or region would help bring about greater transparency and aid communication to all stakeholders of the value of the water resource. A methodology for calculating such a benchmark cost involves the gathering of all relevant financial and operational cost data related to delivering treated water in each particular city/region. This total cost of production can then be divided by

the total volume of freshwater supplied, with the result being a benchmark Rs/m<sup>3</sup> cost of delivering water to that particular location. Big data analytical tools can then also be applied, to model the expected impact on that benchmark cost over time of a wide range of economic, hydrological and environmental externalities e.g. drought, demographic change, capital spending, etc. whichever are thought to be most relevant for each location. The benefits to various stakeholders of such water supply cost benchmarking include:

### A) For Government & Regulatory Authorities

- Enhanced water supply security:  
Enables measurement and





comparison of the economic viability and lifecycle cost of various water supply technologies compared with current practice, enabling selection of the most efficient and economically and environmentally sustainable.

- Policy Innovation: Enhances infrastructure planning capabilities and provides benchmark for better informing tariff setting objectives.

#### B) For Water Asset Operators

- Greater insight into outcomes: A holistic view of the financial costs and impact of owning water-related assets and adopting new technologies.
- More efficient decision making: Widens knowledge of the impact on water delivery costs of a wide range of financial and environmental factors and demonstrates immediately the financial impact of changes in capex and opex spending across the whole supply system.
- Greater risk mitigation: Better risk management through enabling enhanced understanding of that risk.
- Optimised Investment: Enhanced project selection due to better overview and ability to compare risks and costs of each individual investment choice.
- Improved delivery: More efficient operations due to greater understanding of the impact on cost of a wide range of economic and environmental phenomena.

#### C) For Corporate Users of Water & Private Sector Investors

- Greater insight and transparency into returns: A holistic view of the impact

of a wide variety of water-related costs on financial returns.

- Greater comparison of investment choices: Enhanced and more granular comparison between project investment choices, through measuring the impact of water costs on those projects and the risk management challenges associated with such costs.
- Greater risk mitigation: Better risk management through enabling enhanced understanding of water-related cost risk.
- Optimised Investment: Enhanced project selection due to better overview and ability to compare risks and costs of each individual investment choice.

#### D4.3. RECOMMENDATIONS

##### Water Rights Trading

The price discovery enabled by a water rights trading system can contribute to more efficient use and preservation of the resource by providing economic signals to users of water. It can also encourage investment in water infrastructure by providing investors with a more transparent demonstration of the economic opportunity available in supplying water to a particular location.

To implement a water rights trading model, however, would require development of sufficiently robust regulatory infrastructure, governance mechanisms and property rights enforcement structures, with further complications likely to arise about how the development of such a system would accommodate and/or replace the way that the ownership of water taken from the Ganga is currently considered.

As ownership of water, the related

supply infrastructure and the pricing of it is currently viewed as largely and/or exclusively a public sector area of activity, any water rights trading along the Ganga Basin may therefore be restricted to that between state entities- i.e. between ULBs, between States, etc. – which then take responsibility for distribution of the resource they have secured to their respective residential, commercial, agricultural user, etc.

A cap and trade system for water, similar to those in pollution markets, could be administered by a Ganga River authority, potentially NMCG. An annual/seasonal cap would be set of the total amount of water available for allocation. The authority could allocate to each riparian entity entitlements for a share of the total available water in the Ganga system each year/season, with the size of those entitlements initially based on historically assessed water use of each entity. The regulatory authority would then establish annually/seasonally how much actual water can be allotted to each entitlement held, based upon hydrological and climate data models. Entitlements and/or allocations can then be freely traded between different parties. Each riparian party could choose whether it wishes to sell entitlements or buy more. Funds raised from selling entitlements could be ring-fenced, to be used in the purchase and deployment of water use efficiency and conservation technologies. The authority could also take a small percentage of each trade to build, for example, a common Ganga conservation fund.

The prices realised for entitlements within this traded market would constitute a water extraction cost, which each riparian entity can factor into the

overall benchmark cost of delivering a particular water source to its population. Each riparian entity can then conduct more effectively the cost-benefit, cost-effectiveness analysis, etc. that would inform them whether it is more advantageous to be a seller of water to or buyer of water from other parties at any particular time. Such benchmark supply cost analysis would also help each party determine a basis for negotiation of a price at which they would be willing to settle for water entitlement transfers to or from the other party.

##### Wholesale water sales and retail supply competition

Social and political pressures make it difficult to expose residential and domestic consumers, particularly low income, to tariffs based on full cost of supply. But a wholesale and retail trading mechanism for water supplied to commercial and industrial users could reduce the subsidy burden on government and actually help improve service provision and reduce cost for such users.

The operator of the water supply infrastructure i.e. the ULB or its appointed operator — can sell a certain percentage of water produced from their network to retail suppliers of water, who can then compete for the business of commercial/industrial users of water. While it entails ending any subsidy regimes currently available to such users, the competitive market of retail suppliers would help encourage better service and more regular supply, for which many commercial/industrial users already have to pay a price well above official rates from suppliers outside the formal network.

Such a system could also encourage

## WATER RIGHTS TRADING

The price discovery enabled by a water rights trading system can contribute to more efficient use and preservation of the resource by providing economic signals to users of water

the co-opting of what are now suppliers of water outside the formal supply system—such as private water tanker operators—into the formal supply network and give ULBs greater regulatory control over them. The water to be supplied would be taken only from a single source—i.e. ULB-owned and/or regulated infrastructure—and so reduce use of bore wells by private suppliers currently outside the formal supply system, which can often contribute to significant depletion of groundwater resources. Such competition among retail suppliers would help to encourage better customer service and more innovation among suppliers as they vie for customers—e.g. quality/volume assurance mechanisms, demand monitoring, fixed/spot contract pricing arrangements, etc. The ULBs would also gather more information as such a system develops about supply/demand dynamics and price elasticity for various consumers, enhancing infrastructure and tariff planning.

The ULB could use the ongoing benchmark supply cost as the basis for the price that it charges retail water suppliers. Revenue from such wholesale water sales would provide the ULB/infrastructure operator with a revenue stream that is above cost recovery levels, helping sustain supply infrastructure and a continued subsidy regime for customers less able to pay full cost i.e. lower income residential users.

Price signals created by the market for commercial/industrial water users would indicate to infrastructure developers/technology providers the potential economic opportunity and returns available from investing in that location, encouraging investment and innovation.

#### HOW TO JOIN:

Participants wishing to join the working groups can do so online at the cGanga website (How to engage with us) and select working group PLG4

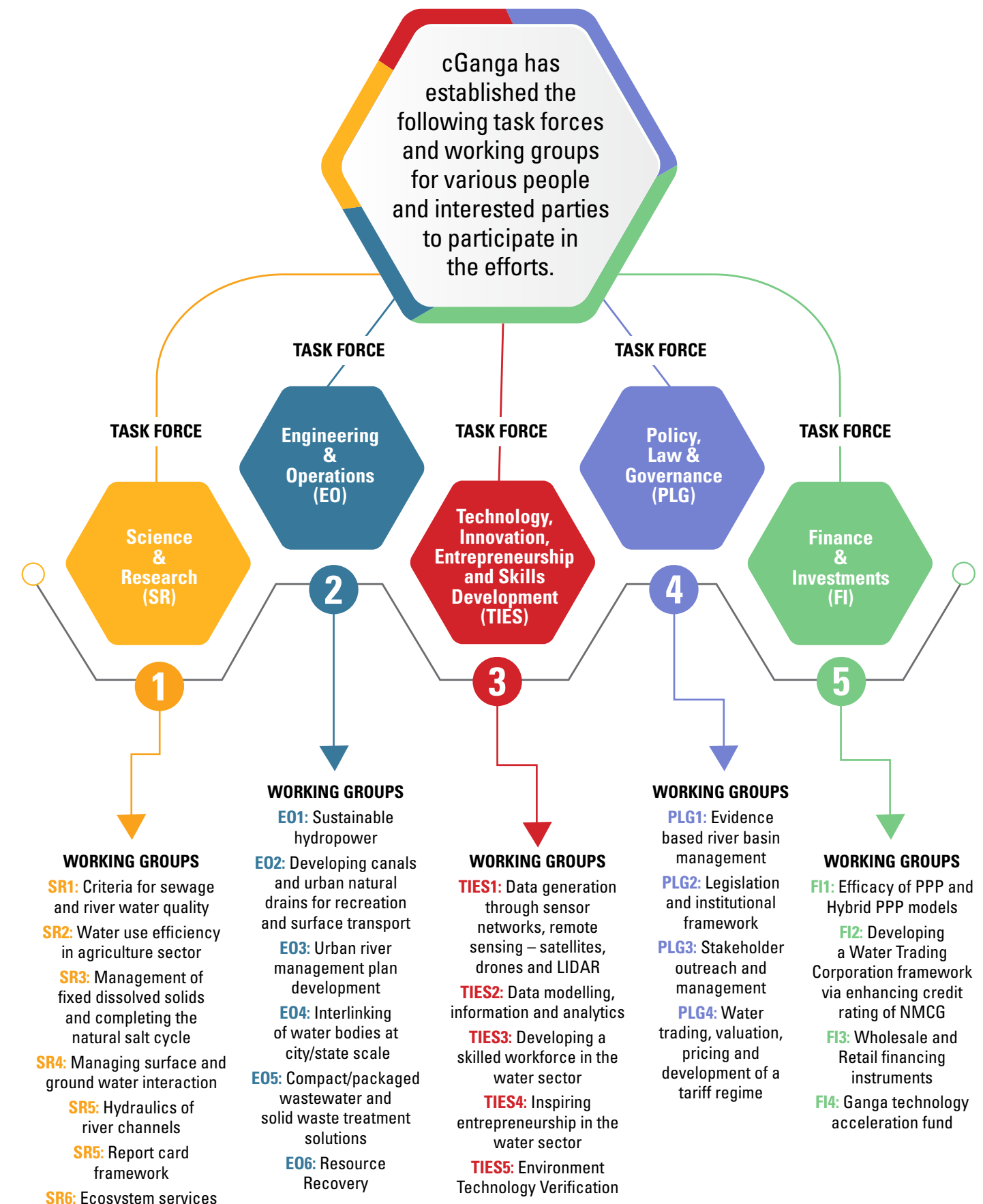
## TAKE AWAY POINTS

Immediately establish a pilot in 5-6 cities to ascertain true cost of water

Develop a working group on water rights trading



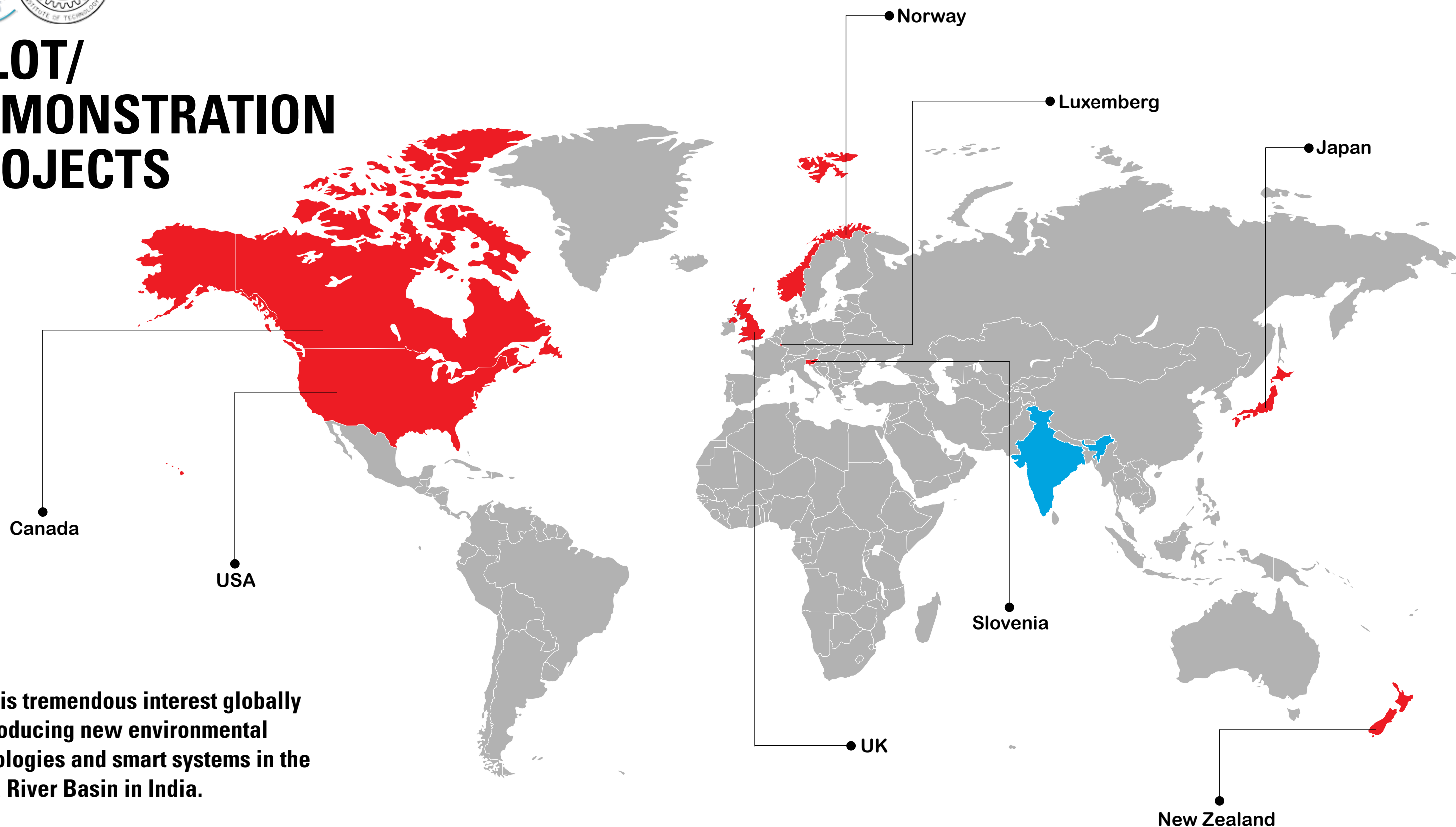
## HOW TO PARTICIPATE IN VARIOUS ACTIVITIES







# PILOT/ DEMONSTRATION PROJECTS



**There is tremendous interest globally in introducing new environmental technologies and smart systems in the Ganga River Basin in India.**

# Pilot/Demonstration Projects

The following list illustrates some innovative solutions from around the world that can potentially be game changing for the Ganga River Basin according to their developers. They have also expressed their desire to collaborate with cGanga to demonstrate the solutions in India. cGanga has invited the developers to enter into the ETV process so as to better understand and validate the following aspects of the solution: (i) How the solution /technology works, (ii) How it delivers under the Indian climatic and operational conditions, (iii) What are its resource requirements including land, energy and workforce, and (iv) what social, economic, financial and environmental impact does the solution / technology deliver.

