

NATIONAL MISSION FOR CLEAN GANGA

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

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Centre for Ganga River Basin Management and Studies

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DECEMBER 2017

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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 12th 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 7th October 2016, consequent to constitution of National Council for Rejuvenation, Protection and Management of River Ganga (referred to as National Ganga Council).

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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

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ACKNOWLEDGEMENT

This vision document is a collective effort of a number of experts, institutions and organisations, in particular those who were instrumental in preparing the Ganga River Basin Management Plan which was submitted to the Government of India in 2015. Contributions to the photographs and images for this vision document by individuals are gratefully acknowledged.

SUGGESTED CITATION

Vision Ganga by cGanga and NMCG

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<u>River</u> <u>Ganga in</u> <u>Indian</u> <u>Consciousness</u>

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: ۲

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.

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पवनः पवतामरिम रामः शस्त्रभूतामहम्।

झषाणां मकरश्वरिम स्रोतसामरिम जाह्नवी॥

BHAGAVAD GITA, VERSE 31, CHAPTER 10

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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

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citations on River Ganga are presented as follows:

EXAMPLE-1

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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 जल्स्य गुणाः शीतत्वम्,स्वादुत्वम, स्वछत्वम, अत्यन्तरूच्यत्वम्, पथ्तत्वम्, पावनत्वम्, पापहारित्वम्, तुष्णामोहध्वंसत्वम्, दीपनत्वम्, प्रज्ञाधारित्वंच, 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 क्रीड़ां प्रतिग्रहमथोरतिम्। अन्यतीर्थरतिचैवः अन्यतीर्थ प्रशंसनम्। वस्त्रत्यागमथाघातं सन्तारंच विशेषतः।।

EXAMPLE-3

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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

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<u>Challenges</u> and Opportunities

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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 multifaceted. 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 counterbalance 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

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Five Major Degradation Factors and their Anthropogenic Causes



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



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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.



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<u>Vision for</u> <u>River Ganga</u>

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

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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. Overexploitation and unhealthy interferences with the biophysical resources of the river system must therefore be abandoned outright.



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

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Ghats on River Ganga in Varanasi, Uttar Pradesh

<u>Objectives</u> <u>of Ganga River</u> <u>Management</u>

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

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Environmental Knowledge-Building and Sensitisation

<u>Formulation</u> 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

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Strategic Steps and Actions

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

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MISSION 1	MISSION 2	MISSION 3	MISSION 4
Aviral Dhara	Nirmal Dhara	Ecological Restoration	Sustainable Agriculture
 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. v. Regulating water withdrawals in water depleting regions. vi. Assessment and monitoring of sediment resources of the network including their quantity, quality and nutrient value. 	 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. 	 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. 	 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.

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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.

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MISSION 5

Geological Safeguarding

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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 hydrometeorological 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 landuse 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.

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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.

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v. Conducting educational workshops and campaigns with stakeholders and interested citizens to enable their sensitisation and comprehensive understanding of basin processes.

vi. Conducting groundlevel monitoring and field researches of the Ganga River Basin's environment with stakeholder participation.

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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 enterpreneurship.

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MOVING TOWARDS AN EVIDENCE BASED POLICY MAKING

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. 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.

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ACCELERATING TECHNOLOGY TRANSFER

Ganga basin provides phenomenal entrepreneurship opportunity to the most creative technical, scientific and business minds. Whether it is establishing an advanced sensor network with

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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

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.

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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.

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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.

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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

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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

INNOVATIVE FINANCING MODELS

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capital from both domestic and international sources. These include but are not limited to technology transfer funds, low cost, long-term and nonrecourse financing, development risk capital and take-out financing in form of Yield-Co or through bond markets (Rupee denominated – Ganga/Blue bonds).



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

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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.

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Ensuring longitudinal connectivity with provision for E-Flows along with development of sustainable hydro power.

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Ensuring proper transport, food and fuel facilities to handle peak tourist loads without stressing the region's ecosystems.

> 5 Regulation of sand and gravel mining from river beds.

KEY MEASURES REQUIRED AT THE STATE LEVEL

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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.

Afforestation and slope stabilisation along with regulation of road and building constructions in disturbed areas.

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

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

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Uttar Pradesh

UTTAR PRADESH is a large state that includes a long stretch of River Ganga in the plains below Uttarakhand and the subbasins 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.

Haridwar

Delhi

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).

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Promotion of sustainable agriculture with resource conservation measures

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

KEY MEASURES REQUIRED AT THE STATE LEVEL

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

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

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



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.



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

River Sonipat Most Polluted Stretch 8 LEGEND Meerut **Moderately Polluted Stretch** Moradabad Control of water Garhmukteshwar Yamuna Basin (Part) withdrawals in water-depleting Bareilly **Ramganga Basin** Faridabad regions. Ganga River . Aligarh Gomti Basin 10 Vrindavan Kali Rive Mathura Gomti Rive Widespread dissemination of knowledge, Agra amuna River ground-level Lucknow monitoring, Chambal River and increased Kanpur sensitisation and participation of Betwa River stakeholders.

Most Polluted Segments

Allahabad qa Riveı Varanasi Mirzapur





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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, Baghmati, 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. 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.

> 3 Ensuring longitudinal connectivity with provision for E-Flows at dams, barrages and other structures.

> > 5 Promotion of sustainable agriculture with resource



conservation

measures.

planning with emphasis on wetlands, forests and distributed groundwater and surface water shortages.



Widespread dissemination of knowledge, groundlevel monitoring, and increased sensitisation and participation of stakeholders.

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KEY MEASURES REQUIRED AT THE STATE LEVEL



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

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6 Regulation of sand-mining

from river beds.

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.

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 VISION GANGA • 2017

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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.

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.

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

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KEY MEASURES REQUIRED AT THE STATE LEVEL

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



Afforestation and slope stabilisation along with regulation of road and building constructions in disturbed areas.

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

6 Regulation of sand-mining

from river beds.

8 Widespread dissemination



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

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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).

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Industries are also clustered in Burdwan district neighbouring Jharkhand and elsewhere. As a consequence of these factors and several large hydroelectric 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

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.

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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.



species invasions, overfishing and fishing during spawning seasons.

9 Widespread dissemination

of knowledge, groundlevel monitoring, and increased sensitisation and participation of stakeholders.

KEY MEASURES REQUIRED AT THE STATE LEVEL

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

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Flood management through floodplain zoning, drainage improvement, other non-structural measures and scientific sediment management.

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6 Regulation of deep

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groundwater extraction to control arsenic contamination spreading across the basin.

Regulation of river dredging and plying of noisy vessels, especially around Kolkata and near the river mouth.



Centre for Ganga River Basin Management and Studies

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