

# Ganga River Basin Management Plan Interim Report

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by

Consortium of 7 “Indian Institute of Technology”s (IITs)



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Bombay



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## Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government constituted the National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Governments for effective abatement of pollution and conservation of the Ganga river. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin Management Plan (GRBMP). A Consortium of 7 “Indian Institute of Technology”s (IITs) was given the responsibility of preparing the GRBMP by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. A Memorandum of Agreement (MoA) was signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This is the Interim “Ganga River Basin Management Plan”. The thrust of this Plan is to relate the diverse environmental degradations occurring in the basin with their causal factors, and thereby frame a roadmap for redeeming National River Ganga Basin’s Environment. The task involved different thematic groups of experts from 7 IITs and other premier organizations identifying different causal factors and assessing their impacts on the basin to synthesize the findings and recommendations in fulfillment of the important missions identified in the Plan. This report covers the main issues of concern and recommends corrective measures. While major changes in the final Plan are not foreseen, our studies have not achieved closure on all aspects; hence there could be additional actionable recommendations in the final Plan.

The progress in preparing this Plan was affected by several factors. On the one hand, co-ordination between experts working in different institutions was not always speedy. On the other hand, the progress depended on obtaining relevant primary data from nodal government agencies, which was often tardy and circuitous. This also affected the timely co-ordination between related thematic groups. It is hoped that data availability in future will become simpler and faster.

Many people contributed directly or indirectly to the preparation of this Plan. A wide range of stakeholders were consulted through various workshops, seminars and informal discussions, and many people freely gave their suggestions and comments on many substantive issues. This document is therefore truly a collective effort that reflects the cooperation of many people, particularly members of the IIT Team and keenly interested members of the general population.

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## Executive Summary

**Overview:** National River Ganga, along with her many tributaries, has been the source of physical and spiritual sustenance of Indian civilization for millennia, and consequently, her well-being is of prime national concern. The physical environment of the National River Ganga Basin (NRGB in short) is governed by a complex combination of natural and manmade processes. With proliferation and diversification of human activities, the resulting environmental degradation has greatly increased in recent decades. The Ganga River Basin Management Plan (GRBMP) seeks ways and means to strengthen the basin environment against the identifiable adverse impacts. It may be noted here that, since the aquatic systems of NRGB – consisting mainly of rivers/ streams, groundwater and water bodies – are hydraulically connected by groundwater flow (besides other hydrological and ecological connections) in much of the basin, the GRBMP adopts the Ganga river system as the primary environmental indicator of NRGB.

**Anthropogenic Factors:** Uncontrolled anthropogenic activities are a major cause of NRGB's environmental degradation in recent times. The degradations may be grouped under five main heads: (i) over-withdrawal of fresh water from the basin; (ii) discharge of pollutants into the aquatic environment; (iii) reduction in water-holding capacities and replenishment rates into water bodies, aquifers and ecosystems; (iv) mutilation of rivers by piecemeal engineering operations; and (v) changes in geological factors governing aquatic systems. The major human activities affecting the aquatic environment of NRGB in modern times may also be grouped under major heads as follows: Industrialization, Urbanization, Lifestyle Changes, Agricultural and Other Rural Activities, and Deforestation/Denudation.

**Key Features of NRGB:** NRGB is the largest river basin in India, covering more than a quarter of her land area, and hosting about 43% of her population. Annual rainfall in the basin is quite high towards the east and north, but decreases progressively towards the west. In terms of surface and ground water resources, NRGB is fairly rich. They include many wetlands (including freshwater and saline lakes) spread across the basin, which perform crucial ecosystem services for the basin. Besides, a highly productive multi-aquifer system spread over much of the basin boosts the basin's water yields. The river basin itself was formed by alluvial deposits of Himalayan sediments since the rise of the Himalayan mountains millions of years ago, and, even in present times, the Ganga river carries very high sediment loads to the sea. The river network is characterized by deep gorges in the Himalayan zone, meandering patterns in the plains, and braiding in the delta region. Ganga river's valley mapping shows significant diversity of valley widths and geomorphic features in different reaches. Flora and fauna in the river also show significant biodiversity, indicating variations in substrate, habitat, and trophic status in the river system.

**Concepts and Objectives:** National River Ganga – whose wholesome qualities have been praised over the ages – has been flowing with her life-giving qualities since ancient times. The wholesomeness of the river may be grasped in terms of four defining concepts: *Aviral*

Dhara” (or “Continuous Flow”), “Nirmal Dhara” (or “Unpolluted Flow”), Geologic Entity, and Ecological Entity. To plan the recovery of a wholesome National River Ganga, the task of analyzing the basin status was broken up from the whole to its parts into eight Thematic Groups, namely: *Environmental Quality and Pollution; Water Resources Management; Fluvial Geomorphology; Ecology and Biodiversity; Socio-economic and Socio-Cultural; Policy, Law and Governance; Geo-Spatial Database Management; and Communication*. Each thematic study is conducted by select groups of IIT faculty members and allied experts, and seven important missions were identified for focused interventions: “*Aviral Dhara*”, “*Nirmal Dhara*”, “*Ecological Restoration*”, “*Geological Safeguarding*”, “*Disaster Management*”, “*Sustainable Agriculture*”, and “*Environmental Knowledge-Building and Sensitization*”. Based on the findings, action plans are formulated to counter harmful anthropogenic activities in NRGB and promote helpful activities.

Mission Aviral Dhara: For a given geological-climatic setting, alluvial rivers achieve stability through long-term balance between various parameters such as water and sediment flow rates, temporal variations of flow, terrain gradient, and seepage flow rates. “*Aviral Dhara*” emanates from this long-term balance of rivers. A direct violation of *Aviral Dhara* is due to dams and barrages, which snap the longitudinal connectivity in rivers and alter river water and sediment flows. However, since NRGB is hydraulically connected by ground water flow, water withdrawals/recharges from different regions of the basin also affect the river. Thus, while longitudinal connectivity in rivers is a prerequisite for *Aviral Dhara*, maintaining Environmental Flows (or E-flows) needed for the sustenance of rivers also depends on judicious management of the basin’s waters. Available data indicate that human water use has been increasing rapidly of late, and probably increasing beyond the renewal capacity of the basin. Hence, either (i) water availability in the basin must be increased through *increased storage*, preferably by “distributed storage” in locally manageable and eco-friendly water bodies and aquifers, and/or (ii) water demands must be reduced through more *efficient water use*. These issues call for both technical interventions and changes in government policies on NRGB’s water resources. For dams and other structures that disrupt or change river flows, the maintenance of E-flows in the river network is essential, besides fulfilling other safety criteria. The estimated E-Flows for select locations in the Upper Ganga reach – which has many existing and potential hydropower sites – have been presented to enable their inclusion in the design and operation of these dams and barrages.

Mission Nirmal Dhara: The Ganga river’s present-day water quality is abysmal due to anthropogenic wastes polluting the river network in various ways. The main approach in GRBMP has been to identify the types of pollutants, their sources of generation, and the feasibility of collecting and treating them to the degree needed for reuse and/or safe environmental disposal. Urban and industrial wastewaters are major point sources of pollution that need immediate remediation. For municipal wastewaters it was found that it is economically feasible to treat them to the point where they can be re-used for non-contact purposes, the cost of such additional treatment being only about 1 paisa per litre at

2010 price levels. It is therefore recommended that all Class 1 Towns of NRGB immediately embark on such treatment through competent service providers under the Design-Build-Finance-Operate model, whereby the service provider receives remuneration for providing reusable-quality water over a reasonably long contract period. It is also recommended that all fresh water withdrawals from the basin be priced at least 50% higher than the recycled water, considering the minimum costs of full treatment in nature. For major polluting industries (*such as tanneries, pulp and paper units, distilleries and dyeing units*) in NRGB, the cost of treatment for reuse purposes are higher, but these costs are much less than the damage caused to NRGB otherwise, justifying the expenditure on such treatment.

**Mission Ecological Restoration:** The ecological balance in the Ganga river network has been critically affected in recent times, with major indicator species (such as Dolphins, Trouts, Carps and Hilsa fishes) having dwindled or disappeared. The analyses indicate that the ecological status can be largely restored by adhering to the principles of “Aviral Dhara” and “Nirmal Dhara” by ensuring river connectivity, unpolluted E-flows and variable flow regimes. Additional measures needed are the protection of spawning and breeding grounds of native species, elimination of competing exotic species from the Ganga river network, and protection of rivers from resource overexploitation and human encroachments.

**Mission Geological Safeguarding:** Modern anthropogenic activities – such as underground explosions, excavations, tunneling, rock fracturing, and mining, and operation of large reservoirs – can damage the geological formations supporting the basin’s aquatic systems. Over-withdrawal of ground water from confined/ semi-confined aquifers may also create unbearable overburden pressures, causing aquifer disintegration and land subsidence. Geomorphologically, rivers and wetlands are vulnerable to various land-use stresses. Land-uses needing immediate control are deforestation, construction activities on riverbanks and fragile slopes, agricultural practices that increase soil erosion, sand mining from river beds, urban, industrial and infrastructure projects that adversely affect drainage patterns, and local flood control works and river bank modifications.

**Mission Disaster Management:** The main potential disasters arising from the Ganga River network are floods and water-borne diseases. While the causes of floods in mountainous reaches and in plains are different, floods are not entirely preventable, and protection of life and valuables are the main option. Besides, flood waters carry valuable nutrient-rich silt to floodplains, enhancing soil fertility. For control of floods in floodplains, natural flood attenuation methods by vegetation and wetlands are preferable to ill-conceived structural measures. On the other hand, water-borne diseases from rivers can be largely controlled by the twin focus on Aviral Dhara and Nirmal Dhara in the Ganga River System.

**Mission Sustainable Agriculture:** Agriculture has grown tremendously in NRGB since the 1960’s, and irrigation water use has also increased concomitantly. Hence water depletion in NRGB is significantly attributable to growing agricultural consumption, calling for more efficient irrigation practices and alternate cropping patterns. Besides, agriculture is also a major source of water pollution, especially due to chemical fertilizers and pesticides, many

of which may be highly toxic, chemically stable, and/or biomagnifying through the food chain. This necessitates the promotion of bio-fertilizers and bio-pesticides in place of chemical fertilizers and pesticides.

Mission *Environmental Knowledge-Building and Sensitization*: Environmental planning and management combines diverse fields such as water resources, land resources, biological resources, river dynamics, geological phenomena and atmospheric processes as well as traditional wisdom and grassroots knowledge. Hence, it is necessary to build a comprehensive data bank to enable meaningful analyses and obtain quantitative indicators of NRGB's status. This data bank should also be accessible to citizens to inform and sensitize them about NRGB's environment and to enable people's participation in the environmental upkeep of NRGB. The data bank, therefore, needs to be complemented with community-specific educational material and programmes on NRGB's environment.

Conclusions: Specific anthropogenic activities that should be *Prohibited, Restricted* or *Promoted* in NRGB have been identified in GRBMP. Their implementation and future development would require the co-ordinated efforts and co-operation of government and non-government institutions, key stakeholders and civil society. It is envisaged that only a dedicated, knowledge-based, empowered and stakeholder-involving agency would be able to pool in the collective knowledge and resources for environmental rejuvenation of NRGB. The implementation, monitoring, review and evaluation of environmental problems and interventions on a long-term basis are therefore recommended through an independent Commission. The said Commission would need adequate resources and authority to co-ordinate and oversee the activities of multiple sectoral organizations and informal sectors of society for the conservation of NRGB in a transparent manner. GRBMP, therefore, includes the functional requirements of the Commission proposed to be established by an Act of Parliament to bring the Commission into effect.

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