सत्यमेव जयते
Government of India

Third India Water Impact Summit (IWIS)

Valuing Water | Transforming Ganga

DECEMBER 5-7, 2018

VIGYAN BHAWAN, NEW DELHI, INDIA

cGanga
Centre for Ganga River Basin Management and Studies
Indian Institute of Technology Kanpur

NMCG
National Mission for Clean Ganga
Ministry of Jal Shakti, Government of India

A CONSOLIDATED REPORT ON

THIRD INDIA WATER IMPACT SUMMIT (IWIS)

5-7th DECEMBER 2018

VIGYAN BHAWAN, NEW DELHI

MESSAGE

NARENDRA MODI

प्रधान मंत्री
भारत सरकार

Prime Minister
Government of India

It is a pleasure to learn that National Mission for Clean Ganga (NMCG) and the Centre for Ganga Basin Management and Studies (cGanga) are jointly organizing the "India Water Impact Summit" in New Delhi. The theme of the Summit – 'Showcasing and enhancing impacts of national & international efforts on Ganga rejuvenation' is a timely initiative.

Water conservation is a social responsibility. The life-giving waters of 'Maa Ganga' have nourished the spirit and lives of millions of Indians over the centuries. Our Government is committed to the cleaning and conservation of 'Maa Ganga, but this also requires a 'Bhagirath' effort by every citizen – individually and collectively.

The gathering of national and international experts at this Summit will hold extensive deliberations to explore financial avenues to develop a credible and sustainable financial model for rejuvenation of 'Maa Ganga'. I hope that all the stakeholders will also look at ways to utilize innovation and technology to develop cutting-edge initiatives that can help rejuvenate 'Maa Ganga' in its pristine form.

May 'Maa Ganga' shower Her blessings for successful deliberations at the India Water Impact Summit – 2018.

Date: 3rd December 2018

Place: New Delhi

(NARENDRA MODI)

Preface

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

RAJIV RANJAN MISHRA
Director General, NMCG
Ministry of Jal Shakti

We thank all participants from India and abroad for making the Third India Water Impact Summit a resounding success. The many insights, critical questions and observations, knowledge inputs, suggestions and constructive debate by participants based on their expertise and experiences from theworld over helped in creating a veritable treasure trove of ways and means to assimilate the multifarious avenues of River Ganga's rejuvenation and other critical aspects of managing India's water environment. Our sincere thanks go out to all participants.

The first Summit, held in 2012, was an aggregate of numerous activities that had been taking place over the previous few years in regard to managing India's water resources. The Second Summit, held in 2017, was the first full-fledged attempt to establish a new multi-disciplinary, multi-stakeholder forum to bring together policy makers at national and state levels, technology & engineering firms, finance and investment representatives, and interested civil society members to brainstorm on pressing issues of India's water environment in the background of insights and recommendations of Ganga River Basin Management Plan (GRBMP) 2015 as well as various local and global developments on water issues.

Continuing the efforts of the last Summit, the present Summit (IWIS 2018) hosted the inaugural Ganga Finance Forum for interested financial institutions and investors to brainstorm intensively through multiple interactive sessions. This was felt especially needed in the absence of adequate government finances to meet this requirement so that a framework is developed for pooling resources from global and local investors for financing new technologies, innovations and models.

Breaking new ground, the present Summit also attempted to review the many independent and multipronged efforts that have been undertaken in recent years by various Central and State agencies – some with international support – to help meet Namami Gange's goals of rejuvenation and conservation of India's National River Ganga (Ganges). Water being a State subject, meaningful action is often at the level of individual States. But each state may have its own special needs and uses for water and rivers.

Thus, a highly urbanized megalopolis State like Delhi with limited consumptive water needs but high anthropogenic water use and wastewater generation and a relatively sparsely populated and forested State like Uttarakhand with relatively little anthropogenic water use and producing even less wastewater (except during tourist seasons) offer quite different problems and challenges. Moreover, each state has its own sociocultural norms, developmental goals, and institutional practices as regards rivers and water resources management. Hence each state may approach the goal of rejuvenation and conservation of National River Ganga in its own special way considering its longstanding and dynamic relation with the river.

This Summit focused on what has been achieved so far in reviving India's National River Ganga (Ganges) at the level of her most critical basin States – Bihar, Delhi, Uttarakhand, Uttar Pradesh, and West Bengal – and what further needs to be done in these States in the light of GRBMP recommendations. It was imperative to showcase, discuss and assess these activities independently and collectively to identify the progress made and the gaps, if any, in terms of technological, institutional, legal, governance, economic and other shortcomings and constraints. Such appraisal enables course correction and provides the needed impetus for a firm and steady move towards the goals.

The Summit also considered some other issues of relevance including methodological and practicable ways of decentralizing water and wastewater infrastructure to revive local water bodies, harmonizing basin planning and management data generated by various sources, role and impact of catchment afforestation on river biodiversity, and the making of comprehensive urban river/ water management plans for our rapidly developing towns and cities. Regarding the first issue, the clean-up of River Ganga (and other highly polluted tributaries such as the Yamuna) has been an emotive subject for Indians and even global citizens. It is also a pressing health and developmental issue. But apart from River Ganga herself, water bodies in the basin also need to be revived to sustain the river ecosystem. The decentralization of water and wastewater infrastructure combined with replenishment of surface water bodies (which also implies enhanced groundwater recharge) with treated sewage and trade effluents is an apt solution, especially useful in urban locales which often face serious problems of water over-withdrawals and pollutant inflows to their water bodies.

While looking at the impacts on water bodies and rivers, the design and operation of urban water infrastructure need to be integrated into comprehensive urban river/water management plans of riparian towns to ensure the river's integrity and sustenance. Besides, such plans can significantly enhance the utilitarian, cultural and spiritual values of the river for respective towns and the region as a whole, and thereby ensure the sustainability of measures through societal support and institutional commitments. Hence urban river/water management plans were discussed as a separate theme in this Summit.

All well-prepared plans, designs and schemes for developing and maintaining the basin's water infrastructure and ecosystems are dependent on comprehensive data of different types. Presently the hydrological, water quality, biodiversity, land-use, socio-economic and other relevant data available in the country are of different standards, accuracies and resolutions due to varying measurement techniques and procedures adopted by different agencies/individuals and/or by the same agency at different times. It is essential to review the field data measurement, collection and collation procedures, and assess how to enable their easy and meaningful use. Hence the Summit discussed in depth the issue of data harmonization as a separate theme.

Another important issue discussed in this Summit concerns new technologies and innovations in water and wastewater management and allied areas such as solid waste management. Innovative environmental technologies have been emerging and coming into India rapidly in the last few decades as environmental problems multiply and diversify. Since the applications of such technologies are often primarily in the sphere of public infrastructure, many government agencies are burdened with choosing promising innovations from a profusion of appealing claims. A definitive evaluation process for the innovativeness, technical soundness, applicability, resource (such as energy, chemicals and land area) usage, and costs (Capex and Opex) is therefore essential. The ETV (Environmental Technology Verification) process initiated by cGanga and other reputed research institutes in India and abroad were discussed in order to devise appropriate protocols for such evaluation.

In concluding, we would like to thank the Indian Government and State Governments of Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Delhi, partners, panelists, speakers, staff and volunteers who put in a lot of faith and hard work into making this Summit a success. We look forward to further our efforts for evidence-based knowledge inputs for comprehensively managing India's water environment and move forward from the very promising achievements of IWIS-2018.

WORDS OF WISDOM

NITIN GADKARI

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

Minister
Ministry of Water Resources, River Development &
Ganga Rejuvenation; Road Transport, Highways &
Shipping, Government of India

■ A lot of work has been done for the Clean Ganga Mission. For the first phase, activities that are important to maintain a healthy river were taken up – 100% sewerage infrastructure for all cities along the river, toilets in every home in villages along the river, large scale scientifically planned afforestation, biodiversity conservation, bioconservation of nalas, decentralized modular STPs, etc. The National Mission for Clean Ganga has sanctioned 254 projects for more than Rs. 2,400 crores and spent about 5,000 crore rupees in the last 4 years. This year we are expecting to increase our expenditure by 3,000 crores.

■ The Namami Gange Programme sanctioned 133 projects – 32 in Uttarakhand, 40 in Uttar Pradesh, 25 in Bihar, 2 in Jharkhand, 18 in West Bengal, 2 in Haryana, 1 in Himachal Pradesh, and 13 in Delhi. For sewerage infrastructure an expenditure of Rs 19, 789 crore will create 3,969 MLD sewerage treatment capacity and lay down 4,871 km of sewerage network. One of the biggest drains in India with 140 MLD untreated sewage has now been diverted and it no longer pollutes the Ganga in Kanpur after 128 years.

■ I give my special thanks to my secretary, our DG, our Ganga team and all state governments who are cooperating with us for this great achievement and the transparent, time-bound performance of innovative models of big projects. Just wait for 2-3 months – after March 2019 you will see a significant change,

■ Aviralta was a very very crucial issue for us. I am confident that in March, April, May or June this year you will probably see Aviral Ganga. We are taking some policy measures as far as hydro-power projects are concerned, and suggesting special recommendations by which we can maintain E-flows (environmental flows).

■ The Mathura project is a very interesting thing where Indian Oil refinery will pay 19 crore rupees royalty per year to the project for clean water. Thus the waste to wealth concept will be truly implemented there.

■ I request our Secretary, Prof. Tare and the DG that we now need a good conference on conversion of waste into wealth. Organic/ fruit/ vegetable wastes from agriculture markets can be all fed into biodigester to increase the production of methane. Also bifurcating CO_2 from bio-methane we can get bio-CNG as an alternative fuel and a coal substitute, which is cost effective and pollution free. Also we have to find out how we can make value addition with the CO_2 generated.

■ I feel that 3 things are very important in Government departments: Cooperation between departments, Coordination, and Commitment.

■ I am also Minister for Waterways. We have now started Waterways between Varanasi and Haldia. We have started dredging between Varanasi to Prayagraj (Allahabad) and on 26th January 2019 we will start water transport from Varanasi to Prayagraj.

■ Today your advice, suggestions, innovative approach, help and cooperation for Clean Ganga Mission is a great satisfaction for me.

HARDEEP SINGH PURI

राज्य मंत्री (स्वतंत्र प्रभार)
आवासन और शहरी कार्य,
भारत सरकार, नई दिल्ली

Minister of State (Independent Charge)
Housing and Urban Affairs,
Government of India

■ The Nile followed by the Amazon and Yangtze are known to be the largest rivers in the world. The Ganga is roughly half their size, yet it serves roughly 450 million people, 43% of India's population.

■ In India, one cannot speak about Ganga without mentioning its spiritual importance. The religious meanings of the river and the science of its flow and geomorphology are usually combined at some level in writing about the sacred river.

■ The ministry of housing and urban affairs is supporting Namami Gange for 97 Ganga towns within 5 km of Ganga to achieve ODF (Open Defecation Free) status and for solid waste and liquid waste management projects under our Swachh Bharat Mission and Amrut Schemes respectively. Many of the Ganga town projects will soon see the light of day and should be completed by October 2019.

■ We are constructing 6.7 million individual household toilets plus half a million community toilets. We expect to complete them about two months from now, which is 8-10 months before the due completion date. But ODF also involves behavioural change, which is something very basic and paradigmatic.

■ The AMRUT plans covers all Class-I Ganga towns in 5 states plus one Class-II town of Jangipur, West Bengal for providing water supply and sewage infrastructure. The Ministry has already approved special annual action plans for the period up to 2017-18 for all 5 states.

■ The decay of the Ganga river and its surrounding environment is a result of criminal neglect over decades. The government's Namami Gange program is now slowly becoming a Jan Andolan, a project of the people, and that is indeed heartening!

SATYAPAL SINGH
Minister of State
WR, RD & GR

U P SINGH
Secretary
MoWR, RD & GR

Can Ganga become a global cause? I believe so. Culture and civilization spread to all corners of the world from this region. The literature and knowledge produced here have immensely benefitted the entire mankind. That's why Ganga is a global issue, and to collaborate for Clean Ganga is in everybody's interest.

■ I personally feel that there are three ways of how to clean Ganga: first is through faith; second is through law, get polluters through strict laws; and third is to have the right kind of people and right kind of technology.

■ For the last 20 years or so Ganga's flow has lost velocity. How to get back continuous flow in Clean Ganga? This is the challenge we have.

■ Foreign collaboration in the Ganga cleaning programme is very high. The World Bank has been supporting the Ganga programme through Rs. 7000 crores since 2009. Germany is also very active through KMW willing to provide financial assistance and GIZ providing technical assistance in the state of Uttarakhand. More than 15 countries (including Netherlands, UK, Scotland, Luxumberg, Canada, Belgium, and Slovenia) are working and collaborating with us in the water sector.

■ Our main task is to channel the introduction of new technologies and bring in other agencies in environmental management, finance and investment, entrepreneurship and skills.

For millions of Indians, Ganga is not just a river, it's not just a flow of water, it's a civilization in flow.

■ Everyday 2 million people take bath or dip in the Ganga, whereas over many long stretches of the Rhine, Danube, and Thames rivers that I saw, I never found a single person taking a dip.

■ Ganga has its own spiritual beliefs among people – that is one aspect. But it is also the bread winner of almost 40% of India's population who directly or indirectly depend on Ganga.

■ To me the major challenge today is how to have enough "water in the river". Over-extraction of water, for whatever reason, is perhaps the main problem that we are facing. Our entire flow during the lean season used to come from groundwater, but that is no longer the case because now we extract groundwater extensively. Hence we have to improve water use efficiency, be it for irrigation, industrial use, or personal use.

■ Apart from E-Flows notification for the Ganga river there are a few long term measures whichwe are taking like afforestation, biodiversity, and catchment treatment.

■ Despite all the negativities, condition of Ganga is certainly not very bad. A rich biodiversity still exists in Ganga including around 175 species of fishes and the Gangetic dolphin. They survive because through the entire length of the river the dissolved oxygen concentration continues to be 5 mg/l or more.

WORDS OF WISDOM

CECILIA ABENA DAPAAH
Minister of Sanitation & WR, Ghana

■ Large parts of Africa are water surplus but yet countries are facing severe water crisis

■ Water is a precious resource and efforts must be put in to preserve it and rejuvenate the depleting sources.

■ Ghana has embarked upon reviewing and reforming its water resources and sanitation policies.

■ The Government believes that it is important that the country spends significant amount on this sector.

■ Currently the Government spends USD 290 million equivalent to USD 12 per person per year which contributes 1.6% to the national GDP

■ The country, much like India, wants to achieve open defecation free status soon.

■ Ghana was delighted that the India Africa Water Forum is being championed and that Ghana is the first Chair of the Forum

■ Ghana looks forward to learning a lot from the Ganga River Rejuvenation programme and also bringing to West Africa technologies and solutions successfully deployed in India.

■ The Minister invited Indian engineering and infrastructure community to participate in Ghana's water projects.

STEVEN N SCHONBERGER
Director, Water Global Practice, WB

■ On behalf of the World Bank, I thank you for providing us the honour and opportunity to participate in this historic effort. All of us will be proud to say in future that we did our little to contribute to the cleaning of Ganga and restoring the flow of Ganga.

■ We are very encouraged with the progress of the last few years. The focus was on dealing with sewage treatment aspects, helping cities settled around the Ganga to have the kind of sanitation services that are good for the population and also for the river.

■ We would certainly like to share our global experience of working with river clean-ups and improving the natural environments in river basins. First of all the private sector has to address industrial pollutants, and they should be proud and should market themselves saying that we are contributors to a Clean Ganga.

■ In a federal system, the states are critical and have to be involved to ensure sustained progress. We certainly encourage the approach which India has used in many other cases of providing incentives to states through competitive transfers in response to showing results or maintaining clean Ganga and addressing the issue of flow.

■ Thirdly, perhaps the most important element, is continuing to build a relationship of people or communities with River Ganga. Our experiences from world over is that the investments being undertaken for amenities and river front development can strengthen the sense of ownership and responsibility that is critical to build accountability of the institutions concerned. Using mobile phones and other technologies, working with self-help group and others are all a part of the effort, whereby they feel responsible and hold others responsible to maintain the progress that has been made.

■ We are fully committed to continue supporting the focus on basin management approach, on flows, and on new challenges of water allocation and water efficiency.

JASPER WIECK
Deputy Chief of Mission, Germany

■ One important aspect of our bilateral cooperation development is our joining hands for the Namami Gange project. This commitment by the German government to assist India in cleaning Ganga goes back to 2015.

■ We need three things in order to clean a river: (1) you need time – in the case of River Rhine it took us 30 years.

(2) Money – in the case of River Rhine it amounts to a sum of 45 billion Euros shared by all the riparian states – Germany, France, Netherlands, Switzerland, Austria. (3) The "Right Approach", which is very well encapsulated in one sentence: "If you want a clean river, better don't pollute it".

■ You have more than a 100 huge riparian cities on the banks of Ganga river, you have factories, and you have farmers using pesticides, whose effluents all go to the Ganga river. Dealing with so many actors needs a comprehensive approach addressing all polluters in an interconnected way. This is where our development cooperation steps in, in particular in the institution of GIZ which brings all stakeholders together – the state authorities, union authorities, city authorities, industry representatives, etc., where everyone knows what his specific task is, and to give technical support to industries, companies, etc. on how to reduce wastewater production. You too must have institutions like GIZ to create mechanisms for stakeholders to interact.

■ There is also a Ganga toolbox which has been developed with the assistance of GIZ, which can be used for school education. We demonstrate what to do and what not to do, how to behave for the sake of clean Ganga.

■ India has a range of sewage treatment plants, though their current capacity may need to be enhanced. And it also needs huge wastewater collection and transport systems. We are proud to have decided on a loan through our development bank launching 20 million Euros to help in these hardware issues of India.

MAYA KADOSH
Deputy Chief of Mission, Israel

■ India and Israel have deep scientific and technical cooperation.

■ The two countries have embarked upon a joint programme to enhance their cooperation in agriculture and water sector.

■ Under this programme a number of centres of excellence are being set up across India.

■ The centres will bring advanced Israeli technologies and practices into India .

■ Israel has achieved transformation in the water sector not without its fair shares of pains.

■ The country had to introduce major water sector reforms and incentivise efficiency to reach near its water security goals.

■ Israel is willing and able to share its knowhow, introduce technologies in the Ganga rejuvenation programme.

WORDS OF WISDOM

JOZEF DROFENIK

Ambassador, Slovenia

I am happy to learn that the "India Water Impact Summit-2018" (IWIS-2018) 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.

SURESH KR. KHANNA

Minister, UD, UP

■ We have been working on piecemeal basis, such as making sundry STPs or treating other deficiencies when you notice them. If we had compact integrated plans encompassing micro-planning then we would not have reached this situation.

■ We have been strengthening our STPs speedily. We have already completed 11 plants, while 10 plants are being set up and 10 more have already been tendered.

■ We have also banned the use of plastics and tried to check industrial pollution. Now we are preparing for the Kumbh Mela. NMCG has been very co-operative for treating wastewater in about 108 drains by bioremediation and 5 drains by modular technology.

■ We will discuss the suggestions that we received today in our high level meetings and incorporate them as best as we can.

S K SHARMA

Minister, UDHD, Bihar

■ In earlier times the present day flood problems of Bihar did not exist. When floods came they spread silt all over the land and soon receded. Floods were a blessing for the people after short periods of inconvenience.

■ I want to know about the best way to de-silt rivers so that the river's depth can be increased.

■ I also want to know about irrigation facilities. Since rivers have scarce water in Bihar, it is pointless to construct new canals. It will be more prudent to save land and water wastage by transporting water through overhead pipes. Power generating turbines can also be installed wherever the pipes drop the water.

DINESH MOHANIYA

MLA Delhi Assembly & VC DJB

■ I agree that the political system of 5-year tenures causes see-saw policies. Sustainable solutions for Delhi involve sustained efforts over the long term, say 10- or 20-year period.

■ People's expectation about rivers and the water environment have to be managed. Can this be done with the help of knowledge bodies?

■ We have asked schools in Delhi to have their own STPs so that the STPs' treated waters can be used for irrigation in the schools themselves instead of using fresh water.

■ We are also starting eco-clubs in all schools. I believe that only if we instil environmental awareness from the primary level, only then shall we be able to maintain our rivers, waters and land in stable healthy conditions.

CONTENTS

Messages..... 3

Preface..... 4

Words of Wisdom..... 6

Plenary Sessions..... 16

Meet and Greet 22

Valedictory Session..... 156

SPECIAL SESSIONS : SPOTLIGHT ON THE STATES

S1 Uttar Pradesh 26

S2 West Bengal 32

S3 Delhi 38

S4 Bihar 44

S5 Uttarakhand 50

SCIENCE, ENGINEERING AND OPERATIONS

A1 Afforestation & Biodiversity 58

A2 Urban River/Water Management Plan 64

A3 Data Harmonization 68

A4 Decentralized Infrastructure and Developing Water Bodies Through Reuse of Treated Sewage/ Trade Effluents 74

WATER ECONOMICS: CREATING ENABLING ENVIRONMENT FOR SUSTAINED INFRASTRUCTURE MANAGEMENT

B1 Water Valuation, Pricing and Market Development 82

TECHNOLOGY & INNOVATION: EXHIBITS & PRESENTATION: DECENTRALIZED WASTEWATER TREATMENT

C1 • Alchemy AI (UK) 90
• Space SI (Slovenia) 92

C2 • Lyndon Water (UK) 94
• Wastewater Wizard (UK) 96
• GV Solutions (Spain) 98
• Trojan Technologies (Canada) 100
• Andicos (Belgium) 102

C3 • Boson Energy (Luxembourg) 104
• Cambi (Norway) 106
• Ground Recycling (UK) 108
• Mebiol (Japan) 110

C4 • Scotstream (UK) 111
• Blue Sky Bio (UK) 112
• GMEX - Greensphere (UK) 113

C5 • SenseQube (India) 114
• Qua-vac (Netherland) 116

GANGA FINANCING FORUM

D1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme 122

D3-4 Bringing Efficiency in Financing Ganga Restoration and Conservation Projects through Effective Use of Capital Markets, Insurance, Guarantee and Credit Enhancement Instruments 138

D5 Financing Technology and Innovation 150

INDEX

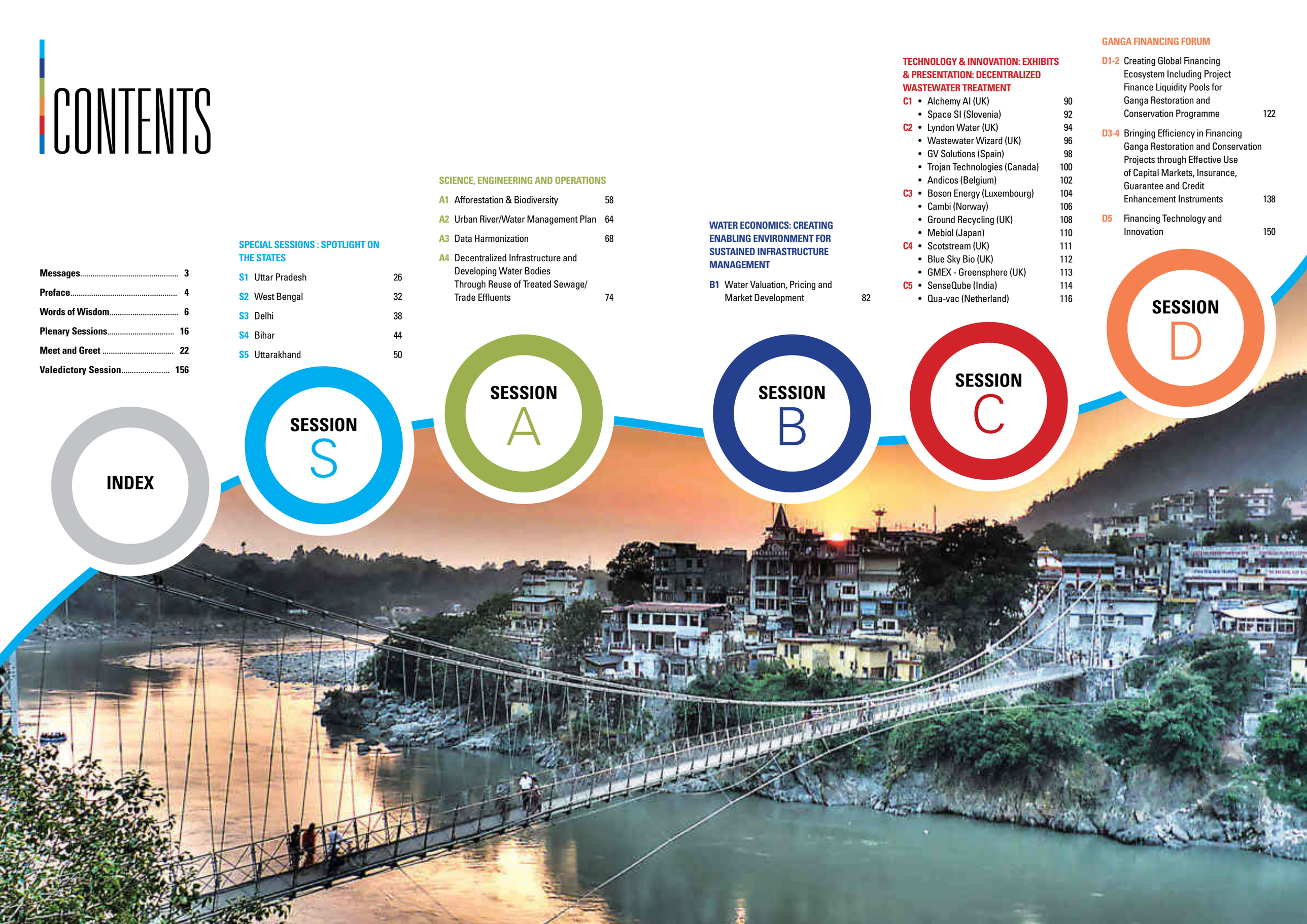
SESSION S

SESSION A

SESSION B

SESSION C

SESSION D



PLENARY SESSIONS

Harnessing national and global expertise and co-operation for Ganga's revival

PLENARY SESSIONS

Harnessing national and global expertise and co-operation for Ganga's revival

PLENARY SESSIONS

Harnessing national and global expertise and co-operation for Ganga's revival

MEET AND GREET















SESSION

S

SPECIAL SESSIONS: SPOTLIGHT ON THE STATES

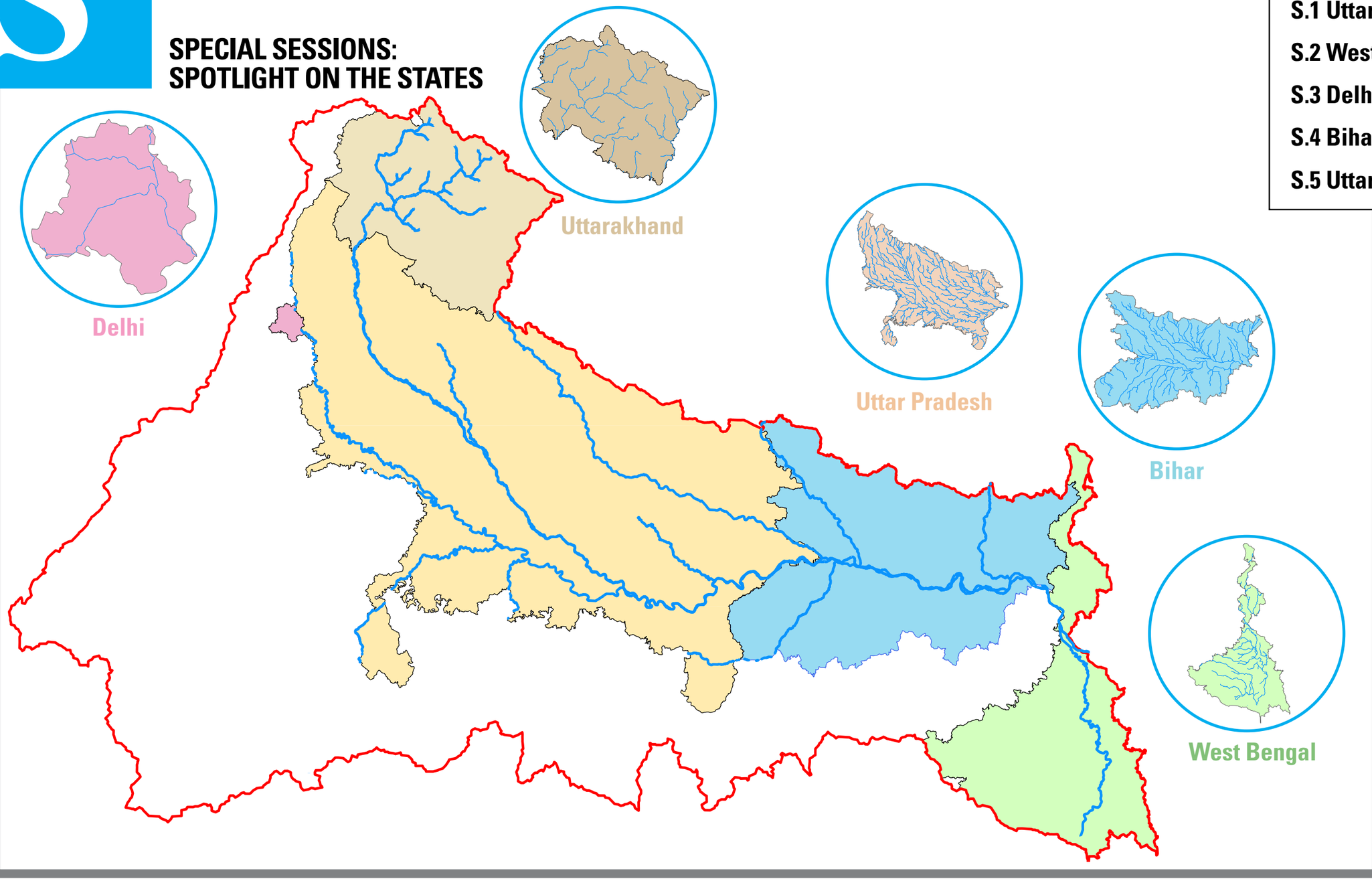
S.1 Uttar Pradesh

S.2 West Bengal

S.3 Delhi

S.4 Bihar

S.5 Uttarakhand



SESSION S1

UTTAR PRADESH

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

DAY 1:
Wednesday; December 5, 2018;
15:00 – 17:00 h

VENUE:
Hall 5, Vigyan Bhawan,
New Delhi

PRESIDED BY:
Suresh Kumar Khanna
[Minister, MoUD, UP]

CHAIR:
Rajiv Ranjan Mishra [DG, NMCG];
S P Shahi [APD, NMCG, UP]

MODERATOR:
Vinod Tare [Head, cGanga];
Pravin Kumar [Director Tech, NMCG]

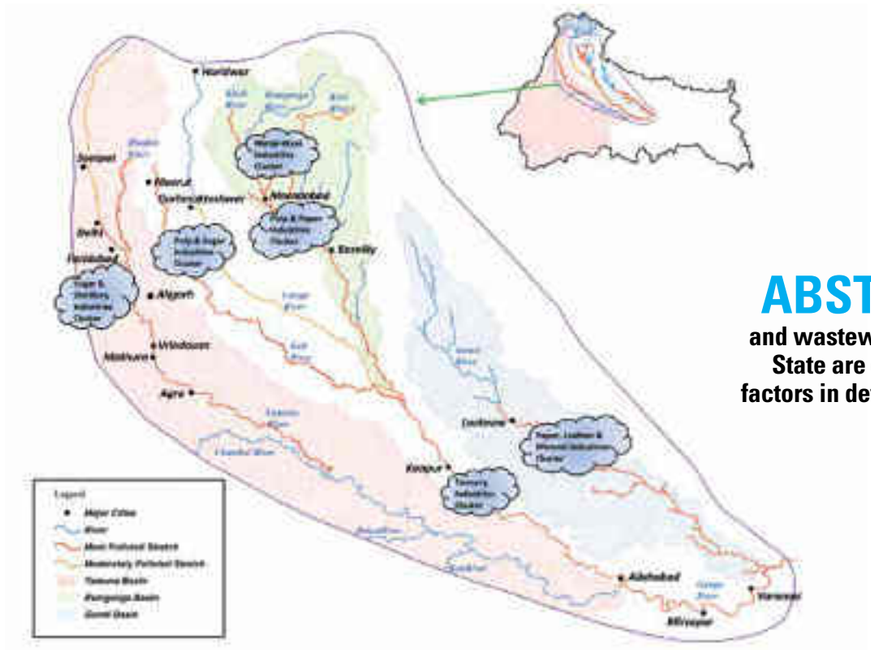
PANELISTS:
A D Mohile [Former Chairman, CWC];
Ajay Pradhan [C2S2];
Anil Sinha [WRG 2030];
Avi Harpaz [Israel];
Birgit Vogel [GIZ];
Brij Gopal [CIWSA];
Kees Bons [Deltares];
P S Rana [CIDC];
Sejal Worah [WWF];
V S Thind [International Arbitrator]

S1.1. PROBING THOUGHTS

Uttar Pradesh is a large state that covers a long stretch of River Ganga in the plains below Uttarakhand. It includes the sub-basins of many important tributaries of Ganga like the Yamuna, Kali, Ramganga and Gomti rivers. It is well populated, and has extensive agricultural lands and industries. The river has been fragmented with dams and barrages at many places, and, moreover, the main Ganga Canals (the Upper Ganga, Middle Ganga and Lower Ganga Canal Systems) effect major abstractions from River Ganga in her upper reaches in the state, which have affected the river increasingly for more than a century and disrupted the habitats of many river species like the Gangetic dolphin and affected their populations. Coupled with this problem are the large quantities of untreated and semi-treated municipal sewage from urban centres and trade effluents from industrial clusters (notably distilleries, tanneries, and pulp & paper industries) discharging into the river network. The net results are very low flows in the dry seasons and high levels of pollution in River Ganga and her tributaries which constitute a major threat to both riverine biodiversity and human. In addition to these problems, the immersion of dead bodies and animal carcasses in the river, river bed farming, sand mining, excessive groundwater withdrawals, and increasing fertilizer and pesticide laden runoff from agricultural fields have added to the problems. Figure 1 shows the most polluted river stretches in the State at a glance.

11 STPs COMPLETED

The main attempts in the State of U.P. were to enhance sewage treatment capacity – 11 STPs have been completed, 10 STP Projects are under finalisation, and the tendering process of 10 Plants have been completed.



CANAL ABSTRACTIONS

and wastewater discharges in the State are considered significant factors in deteriorated river health.

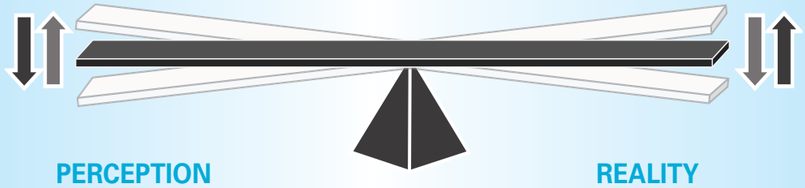
Figure 1: Most Polluted Stretches and their Pollution Sources

Overall, the developmental needs of Uttar Pradesh are pitted against various factors affecting the basin ecology that may be summarized in the following figure:

THE SUSTAINABILITY CHALLENGE:
The balance between ecology and current developmental approach

Conserve Natural Resources
Save Iconic Species and Biodiversity
Afforestation and Wetlands Development

Surface/Groundwater Irrigation
Industrial & Agricultural Growth
Urbanization and Scaleup



PERCEPTION
Populace may suffer due to lack of infrastructure, occupation/jobs, economic growth

IMPACT

REALITY
Aquatic pollution, depletion of natural resources, soil and water toxicity, water scarcity and impact on human health

SESSION S1

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

S1.2. KEY QUESTIONS TO BE ANSWERED

1. What steps have been taken to prepare comprehensive Urban River Management Plans (URMPs) for major polluting towns near rivers like 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) as well as for other Class I, Class II and Class III towns of the state?
2. What measures are being taken to ensure longitudinal connectivity with provision for E-Flows at dams, barrages and other in-stream structures?
3. What steps have been taken to promote sustainable agriculture with resource conservation measures to protect River Ganga and the basin's other ecosystems?
4. What measures are being taken to increase water use efficiency by e.g.: (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?
5. Are water withdrawals being controlled in water-scarce and water-depleting regions?
6. What measures are taken to control alien species invasions, overfishing and fishing during spawning seasons?
7. What measures have been introduced or strengthened to disseminate knowledge about River Ganga's restoration process, ground-level monitoring of the basin, and sensitization and participation of stakeholders?

S1.3. DISCUSSIONS

The Ganga River Basin Management Plan (GRBMP–2015) identified five major anthropogenic factors underlying the degradation of River Ganga namely, industrialisation, urbanisation, lifestyle changes, agriculture & other rural activities, and deforestation/ denudation. The plan also recommended several actions to rejuvenate the river under eight goal-focussed action areas or Missions, namely Aviral Dhara, Nirmal Dhara, Ecological Restoration, Sustainable Agriculture, Geological Safeguarding, Basin Protection Against Disasters, River Hazards Management, and Environmental Knowledge-Building and Sensitization. Many of the missions are interdependent, with common actions between them. The implementation of these actions should be constantly monitored and evaluated since River Rejuvenation and Conservation is a cyclic process, viz.: Generate Knowledge, Understand, Share and Discuss with people, Strategise, Formulate Policy, Legislate, Formulate Plan, Allocate Resources, Design and Implement, Regulate, Incentivise and Govern, and finally Monitor and Give Feedback.

The main attempts in the State of Uttar Pradesh were to enhance sewage treatment capacity. 11 Sewage Treatment Plants were completed, 10 STP Projects are under finalisation, and the tendering process of 10 Plants have been completed. Out of 32 other projects, 29 projects have been started and 3 are in tendering process. Attempts have also been made to ban plastic use and check industrial waste disposals. Short term planning was done for Kumbh 2019 so that 118 drains were treated by bioremedial measures during Kumbh 2019, adopting modular technologies for 5 drains. Attempts will be made to scale these on a larger level. The major goals of these projects focus on long term gains, and they can be achieved if the planning is free from time and cost overruns.

As far as municipal wastewater is concerned, the main aim is to ensure that no sewage gets into the river network. This obviously involves financial planning with reliable

TAKE AWAY POINTS

- **Micro-level planning needed for tributaries and sub-tributaries of Ganga.**
- **Capacity building and institution training in the state of UP are needed to implement the programs for clean rivers.**
- **States should be involved in policy making, deciding priority actions and allocating funds for various states as well as activities.**
- **Working group (cGanga, NMCG, CPCB) to develop further understanding on various aspects and produce standard guidelines.**

SESSION S1

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

FOR KUMBH-2019,

118 drains were treated by bio-remedial measures, adopting modular technologies for 5 drains.

estimates of sewage treatment costs being known to the respective States that bear the responsibility of sewage management.

Catchment improvement through Afforestation should connect to common people. Floodplain management by vegetation strips should be designed to withstand floods and also manage pollutants and sediment flows. Also, since agriculture is a major consumer of water, suitable interventions are needed for the agriculture sector.

S1.4. RECOMMENDATIONS AND TAKE AWAY POINTS

The main focus of sewage management projects should be to ensure that no sewage gets into the river network.

The approach to river restoration in the State must fundamentally connect to people.

Financial planning of centrally sponsored municipal sewage management projects must be sound and reliable so that respective States know their financial liability for sewage management operations.

Since agriculture is a major consumer of freshwater, suitable interventions are needed for the agriculture sector.

Urban wastewater management should be decentralized, and this aspect can be suitably inducted in the byelaws of city management rules.

SESSION S2

WEST BENGAL

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

DAY 2:
Thursday; December 6, 2018;
11:00 – 12:00 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:
Rajiv Ranjan Mishra [DG, NMCG]

MODERATOR:
Vinod Tare [Head, cGanga];
Pravin Kumar [Director Tech, NMCG]

PANELISTS:
A D Mohile [Former Chairman, CWC];
Ajay Pradhan [C2S2];
Anil Sinha [WRG 2030];
Birgit Vogel [GIZ];
Brij Gopal [CIWSA];
Kees Bons [Deltares];
P S Rana [CIDC];
Sejal Worah [WWF];
V S Thind [International Arbitrator]

DAMS AND BARRAGES,

high population density, irrigation abstractions, and industrial factors have affected the river ecology.

S2.1 PROBING THOUGHTS

The state of West Bengal lies at the downstream end of the Ganga basin. Its critical importance for the basin accrues from the vast Ganga Delta which it shares with India's neighbouring country, Bangladesh. In fact, a major part of the state lies in the flat deltaic plains characterised by high monsoon rainfall and significant 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 still functions as a port city to some extent. Besides Kolkata 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. Increased salinity in the lower reaches may have also been caused by groundwater withdrawals in the state.

S2.2. KEY QUESTIONS TO BE ANSWERED

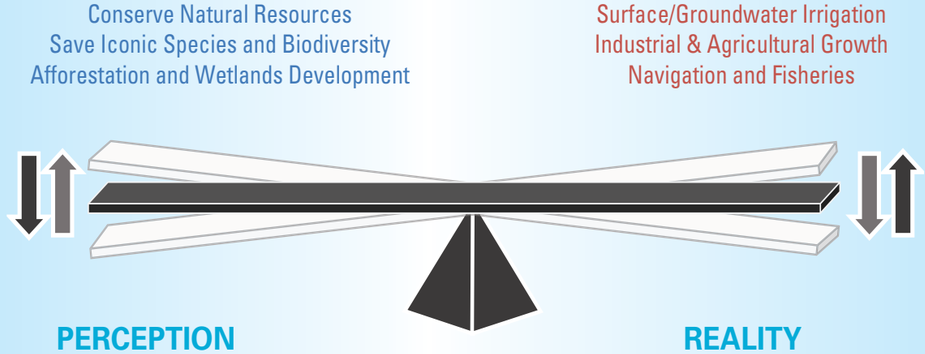
1. What steps have been taken to prepare comprehensive Urban River Management Plans (URMPs) for major polluting towns near rivers like Kolkata, Howrah, Durgapur, Asansol, etc., as well as for other Class I, Class II and Class III towns of the state?
2. What measures are being taken to ensure longitudinal connectivity with provision for E-Flows at dams, barrages and other in-stream structures?
3. What measures have been taken for flood management and river sediment flow management in the State?
4. What steps have been taken to promote sustainable agriculture with resource conservation measures to protect River Ganga and the basin's other ecosystems?
5. What measures are taken to check groundwater extraction to control arsenic spread and seawater ingress?
6. What measures are taken to control alien species invasions, overfishing and fishing during spawning seasons?

AN EXACT MASS

balance of pollutants in the river may be difficult due to variable water balance. However, definitive guidelines for reuse and recycling of water should be formulated to minimize wastewater discharges.

Overall, West Bengal's developmental needs are pitted against various factors affecting the basin ecology that may be summarized in the following figure:

THE SUSTAINABILITY CHALLENGE:
The balance between ecology and current developmental approach



SESSION S2

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

7. Have appropriate measures and guidelines been adopted to control river dredging and plying of noisy vessels, especially around Kolkata and near the river mouth?
8. What measures have been introduced or strengthened to disseminate knowledge about River Ganga's restoration process, ground-level monitoring of the basin, and sensitization and participation of stakeholders?

S2.3. DISCUSSIONS

Due to high population density as well as industrial and agricultural activities, significant amounts of wastes and pollutants are generated in the state. Though much of the waste is treated, there are still significant discharges into the river network. An exact mass balance of pollutants in the river may, however, be difficult due to variable water balance. However, definitive guidelines for reuse and recycling of water should be formulated to minimize wastewater discharges. Apart from wastewater generation, storm water management also needs to be systematized, given the high levels of monsoonal rainfall, low gradients and significant water bodies in the state.

TAKE AWAY POINTS

Apart from the more polluted downstream reaches of the river, pollution control should also focus in the upstream reaches since their benefits also cover downstream reaches.

Plan river conservation programs for tributaries in addition to the main river.

Pollution control in the river system should be promoted by incentivising pollution control on the principal of "pollute less, pay less."

Working group (cGanga, NMCG, CPCB) to develop further understanding on various aspects and produce standard guidelines.

GUIDELINES FOR REUSE
and recycling of water should be formulated to minimize wastewater discharges

SESSION S2

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

SESSION S3

DELHI

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

DAY 2:
Thursday; December 6, 2018;
12:00 – 13:00 h
VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:
Dinesh Mohaniya [MLA, Delhi & VC, DJB];
Rajiv Ranjan Mishra [DG, NMCG]

MODERATOR:
Vinod Tare [Head, cGanga];
Pravin Kumar [Director Tech, NMCG]

PANELISTS:
A D Mohile [Former Chairman, CWC];
Ajay Pradhan [C2S2];
Anil Sinha [WRG 2030];
Brij Gopal [CIWSA];
Kees Bons [Deltares];
P S Rana [CIDC];
V S Thind [International Arbitrator];
Vijay Babbar [Ex Member, DJB]

S3.1. PROBING THOUGHTS

Delhi is a relatively small state with an area of 1,484 km^2 covering only about 0.2% of the Yamuna sub-basin in Ganga basin. However, being the national capital, it has a huge population (mostly urban) of approximately 1.9 crores with a very high population density of 11,297 persons per km^2. It is reportedly the third largest conurbation in the world after Tokyo and Mumbai. This makes Delhi a concentrated source of municipal sewage generation, solid waste production (from domestic and construction sources, etc.), and a major freshwater consuming area. But, in addition to direct human needs, Delhi also has about 28 industrial clusters as well as thousands of unregulated industries in residential/ commercial areas whose effluent discharges reach River Yamuna, often after getting mixed with municipal sewage. Thus high freshwater consumption, and wastewater and solid waste disposal are two of the major problems that affect both city's civic life and River Yamuna's trickling flow. Two major barrages – the Okhla and Wajirabad barrages – that enable the supply of Yamuna waters to the city are a consequent problem for the once free-flowing Yamuna river. Many of the natural storm water drains of the city are partly encroached and carry huge amounts of sewage, thereby effectively converting them into hazardous sewage drains, while others have been entirely encroached upon over time. Thus comprehensive management of municipal and industrial wastes, freshwater consumption, encroachments of natural drains, increasing built-up catchment areas, and vulnerable wetlands, forests and river floodplains constitute some of the critical problems for river management in Delhi.

HIGH FRESHWATER CONSUMPTION,
waste generation, and encroachment of natural drains, wetlands and green areas have affected the Yamuna river grievously.

S3.2. KEY QUESTIONS TO BE ANSWERED

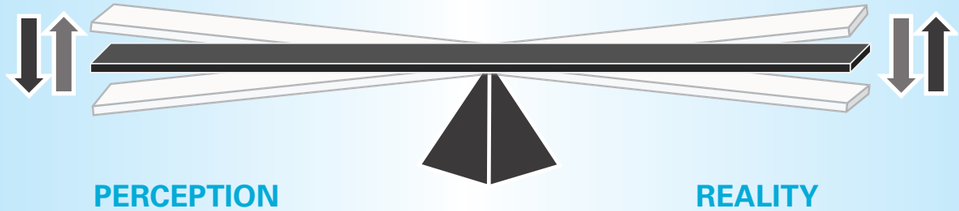
1. What steps have been taken to prepare comprehensive Urban River Management Plans (URMPs) for major polluting areas in and around Delhi?
2. What measures are being taken to control aquatic pollution, industrial and domestic waste, soil and water toxicity, and seasonal water scarcity?
3. Can community ownership of local water resources help in reducing agricultural water consumption?
4. Can irrigation water conservation technologies like Micro-Irrigation Systems be promoted significantly in water-stressed areas in India? Are low-cost innovations/ simplifications of such technologies available?
5. What measures have been introduced or strengthened to disseminate knowledge about Yamuna as a major polluted tributary of Ganga, River Ganga's restoration process, ground-level monitoring of the basin, and sensitization and participation of stakeholders?

Overall, Delhi's developmental needs are pitted against various factors affecting the basin ecology that may besummarized in the following figure:

THE SUSTAINABILITY CHALLENGE:
The balance between ecology and current developmental approach

Restoration and Conservation of Natural Drains and Lakes
Wetland and Groundwater Preservation

Non-segregation of Waste Infrastructure
Groundwater Withdrawals for Domestic, Industrial and Irrigation Uses



PERCEPTION
Populace may suffer due to lack of resources to quench immediate and ever growing needs

IMPACT

REALITY
Aquatic pollution, industrial and domestic waste, soil and water toxicity , seasonal water scarcity and impact on human health

SESSION S3

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

S3.3. DISCUSSIONS

Like other States, Delhi has been implementing many projects on sewage, effluents and solid waste management, besides operating its existing Sewage Treatment Plants and other waste handling facilities. Storm water drainage improvement, establishment of electric crematoria, ghats, and catchment improvement by plantations and wetland development, and freeing of encroached floodplains are among the other major efforts in the State. Different projects are of different durations, and overall assessment of the improvement achieved is difficult. Some pertinent issues that emerged from the discussion are:

1. Should deadlines for results assessment be longer for long term projects?
2. Storm water is not used in recharging ground water naturally. How best can storm water runoff be used for recharging?
3. How to raise water pricing?
4. The value of money always shrinks as it moves from the Centre to State and from State to local bodies. Hence, there is a need to change the approach.

S3.4. RECOMMENDATIONS AND TAKE AWAY POINTS

1. Scientific knowledge should be used for expectation management.
2. Eco-clubs should be developed in schools to enhance the knowledge at childhood level.
3. Differential pricing of water recommended for consumers e.g. depending on size of household.
4. ZLD concept recommended for industries.
5. Working group (cGanga, NMCG, CPCB) to develop further understanding on various aspects and produce standard guidelines.

SESSION S3

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

SESSION S4

BIHAR

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

DAY 2:
Thursday; December 6, 2018;
14:00 – 16:00 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

PRESIDED BY:
S K Sharma [Minister, UD, Bihar]

CHAIR:
Chaitanya Prasad [PS, UD, Bihar];
Rajiv Ranjan Mishra [DG, NMCG];
Tripurari Sharan [ACS , WRD, Bihar]

MODERATOR:
Vinod Tare [Head, cGanga];
Pravin Kumar [Director Tech, NMCG]

PANELISTS:
A D Mohile [Former Chairman, CWC];
Ajay Pradhan [C2S2];
Anil Sinha [WRG 2030];
Brij Gopal [CIWSA];
Kees Bons [Deltares];
P S Rana [CIDC];
Sejal Worah [WWF];
V S Thind [International Arbitrator]

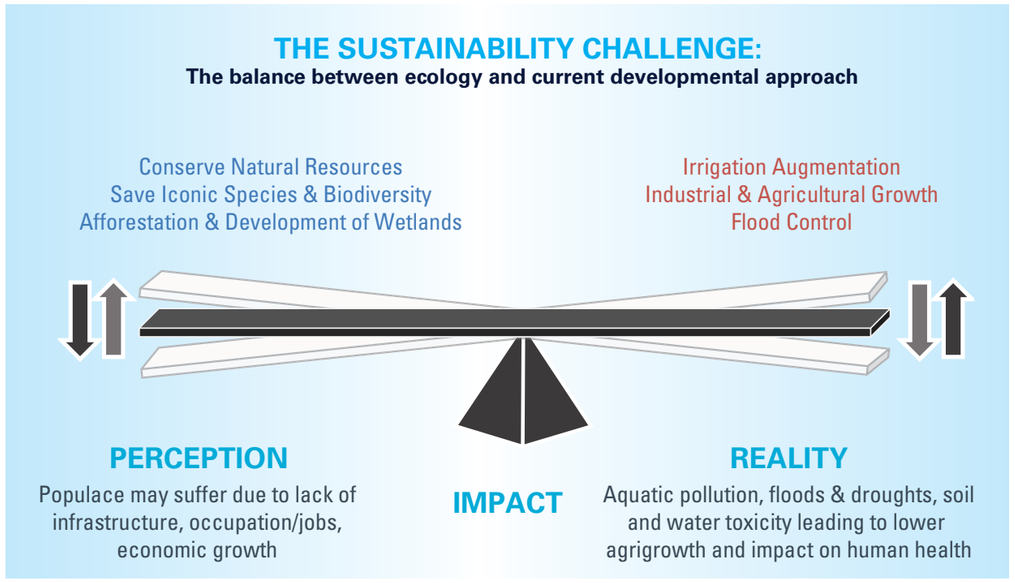
S4.1. PROBING THOUGHTS

Bihar is a fairly large state that includes a long stretch of about 400 km of River Ganga in the Middle Ganga plains downstream of Uttar Pradesh. It occupies about 11% of the Ganga basin area and covers the sub-basins of many of her important tributaries like the Ghagra, Gandak, Baghmati, Kosi, Punpun and Sone rivers. Bihar is well populated, and has extensive fertile agricultural lands, though unscientific irrigation practices and poor drainage have been affecting the land and aquatic bodies. Bihar also has many industries and nearly 200 urban centres (including 26 Class I cities) with a high population density of about 1,100 persons per km^2. 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 Son river) have been erected on some of the rivers that affect river species. Moreover, river floods being a long-standing problem in Bihar, repeated river channelization and other flood control works (like levees) have interfered with river functioning and affected river morphology and stability of many of her flood-prone rivers like Kosi. Increasing groundwater exploitation has also led to spread of arsenic-laden groundwater in Bihar.

DAMS/BARRAGES,

untreated/ semi-treated municipal sewage and structural interventions in rivers for flood control are the main cause of concern for the Ganga river network in Bihar state.

Overall, Bihar's developmental needs are pitted against various factors affecting the basin ecology that may be summarized in the following figure:



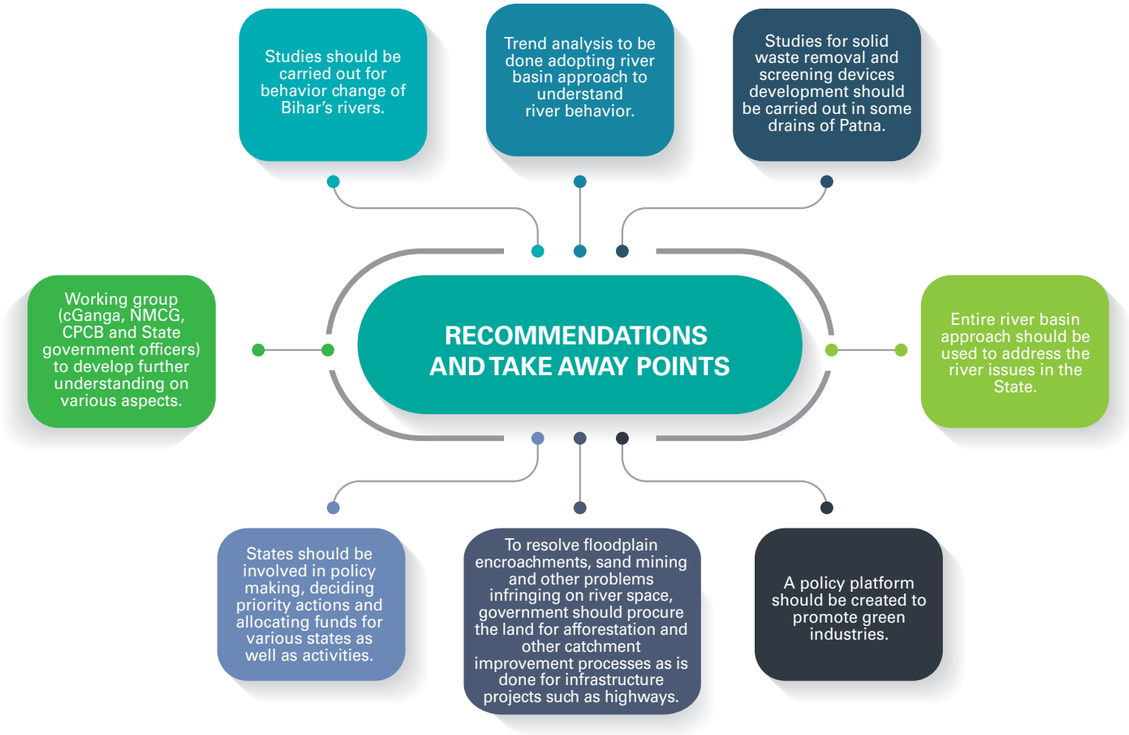
S4.2. KEY QUESTIONS TO BE ANSWERED

1. What steps have been taken to prepare comprehensive Urban River Management Plans (URMPs) for major polluting towns near rivers like Patna, Gaya, Bhagalpur, etc., as well as for other Class I, Class II and Class III towns of the state?
2. What measures are being taken to ensure longitudinal connectivity with provision for E-Flows at dams, barrages and other in-stream structures?
3. What flood management practices through floodplain zoning, drainage improvement, other non-structural measures and scientific sediment management are being adopted?
4. What measures are being taken to control aquatic pollution, industrial and domestic waste, soil and water toxicity, and seasonal water scarcity?
5. What measures are taken to promote sustainable agriculture with resource conservation measures?
6. What measures have been taken to restrict sand-mining from river beds?
7. What steps have been taken towards sustainable water resource management with protection of forests, natural drains, wetlands and lakes?
8. What measures have been taken to increase 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. What measures have been introduced or strengthened to disseminate knowledge about River Ganga's restoration process, ground-level monitoring of the basin, and sensitization and participation of stakeholders?

S4.3. DISCUSSIONS

In the present scenario of improving urban sewerage management all over the Ganga basin, Bihar is slated to reduce its municipal pollution of River Ganga significantly over the next few years through vastly increased sewage management infrastructure. However, there are many other issues that need to be addressed for meaningful conservation of River Ganga in the State. The issues of importance emphasized in the discussions are:

1. What are the means to counter adverse consequences due to floods and droughts occurring in the same year?
2. What remedies can be expected for issues emanating from the Indo-Bangladesh Ganga Water-Sharing Treaty?
3. How can siltation, rising bed levels and progressive increase in HFL of rivers be checked to minimize the chances of floods?
4. How can the structural loopholes related to Farakka barrage be addressed?
5. How can the problems of sudden shifting of river courses be solved?
6. Resolution of data sharing issues between different organizations.
7. Problems arising from instability of river beds.
8. Preventing floodplain encroachment and illegal river sand mining.



REPEATED RIVER

channelization and other flood control works (like levees) have interfered with river functioning and affected river morphology and stability of many of her flood-prone rivers.

SESSION S4

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

SESSION S5

UTTARAKHAND

Ganga River: Restoration and Conservation Efforts vis-à-vis Ganga River Basin Management Plan

DAY 3:
Friday; December 7, 2018;
11:00 – 13:00 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:
Rajiv Ranjan Mishra [DG, NMCG];
S D Singh [Resident Commissioner, UK]

MODERATOR:
Vinod Tare [Head, cGanga];
Pravin Kumar [Director Tech, NMCG]

PANELISTS:
A A Kazmi [IIT Roorkee];
A D Mohile [Former Chairman, CWC];
Ajay Pradhan [C2S2];
Brij Gopal [CIWSA];
Kees Bons [Deltares];
Martina Burkard [GIZ];
P S Rana [CIDC];
Sejal Worah [WWF];
V S Thind [International Arbitrator]

S5.1. PROBING THOUGHTS

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 (including the six major headstreams – the Alaknanda, Dhauliganga, Nandakini, Pindar, Mandakini, and Bhagirathi) and their five confluences 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 (both religious and recreational) is an important benefit for the state, and preserving a pristine river system in the region is of key importance. The entire state of about 52,989 km² area lies in the Gangabasin, comprising about 6% of the basin area. Though population density is not very high, it has several large cities (including the bustling State Capital – Dehradun), besides many tourist and pilgrimage centres that are flooded with floating populations during peak tourist seasons. While industrialization and lifestyle changes have been relatively slow in the state so far, there have been some amount of deforestation, road construction, and urbanisation (especially near the lower regions) and increased tourist traffic in recent times along with major hydro-electric projects (such as the Tehri, Srinagar

DAMS AND BARRAGES

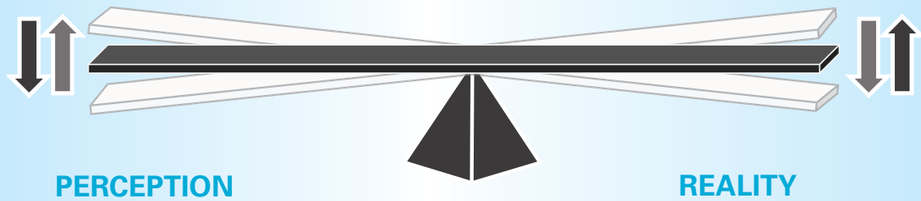
on River Ganga's head-streams, high seasonal tourist loads, and some industrial hotspots are the major factors affecting the river system.

THE SUSTAINABILITY CHALLENGE:

The balance between ecology and current developmental approach

Conserve Natural Resources
Save Iconic Species & Biodiversity
Afforestation

Tourism Development
Infrastructure
Power Generation and Distribution



PERCEPTION
Populace may suffer due to lack of infrastructure, occupation/jobs, industrial growth

IMPACT

REALITY
Calamities due to landslides and flooding causing human suffering and destruction of property

S5.2. KEY QUESTIONS TO BE ANSWERED

What measures are being taken to ensure longitudinal connectivity with provision for E-Flows at dams, barrages and other in-stream structures?

What steps have been taken to prepare comprehensive Urban River Management Plans (URMPs) for major polluting towns near rivers as well as for other Class I, Class II and Class III towns of the state?

Have adequate steps being taken to ensure proper transport, food and fuel facilities to handle peak tourist loads without stressing the region's ecosystems?

Appraisal of afforestation and slope stabilization measures along with restrictions on road and building constructions in disturbed areas.

Are there adequate restrictions on sand and gravel mining from river beds?

What measures have been introduced or strengthened to disseminate knowledge about River Ganga's restoration process, ground-level monitoring of the basin, and sensitization and participation of stakeholders?

and Koteshwar dams) fragmenting the Bhagirathi, Alaknanda and other rivers. There are also some industrial hotspots towards the plains (such as pulp & paper industries in Kashipur) discharging industrial wastes. These changes have had significant negative impacts on the Ganga river system, and they need to be addressed urgently.

S5.3. DISCUSSIONS

The state of Uttarakhand has had limited industrial or agricultural developments except in the lower reaches. Thus development pressures from the general populace are high. But it is recognized that rampant development will severely affect the State's fragile ecology and river systems, hence a balance between ecology and development is needed. Water consumption and water pricing are not critical, but waste management is an important factor in protecting Uttarakhand's ecology. Apart from municipal and industrial wastewaters, management of solid wastes – including sludge generated form Sewage Treatment Plants – is a pressing issue. Tourism – including ecotourism – also needs better management. The Bhagirathi Eco-sensitive Zone in Utttarakhand as designated by the government also needs clarity on the role of local communities, or else it should be de-notified.

Some other issues of importance that emerged from the discussions are:

1. Bamboo plantations on river banks should be adopted as a conservation measure.
2. Horticulture and forestry should be linked with livelihood of the people.
3. Mapping of high-altitude wetlands is needed.
4. Effect of hydropower projects on river water quality needs to be evaluated.
5. All tributaries of the Ganga in Uttarakhand should be considered for conservation and rejuvenation, not only the Alaknanda and Bhagirathi rivers.

S5.4. RECOMMENDATIONS AND TAKE AWAY POINTS

1. Rectify or improve solid waste and sludge management in the state.
2. The Bhagirathi Eco-sensitive Zone needs to be reviewed.
3. Bamboo plantations on river banks should be adopted as a conservation measure.
4. Horticulture and forestry should be linked with livelihood of the people.
5. Mapping of high-altitude wetlands is needed.
6. Effect of hydropower projects on river water quality needs to be evaluated.
7. Tourism, including ecotourism, needs better management from environmental and social perspectives.
8. All tributaries of the Ganga in Uttarakhand should be considered for conservation and rejuvenation, not only the Alaknanda and Bhagirathi rivers.
9. States should be involved in policy making, deciding priority actions and allocating funds for various states as well as activities.
10. Working group (cGanga, NMCG, CPCB and State government officers) to develop further understanding on various aspects.

BETTER MANAGEMENT of solid wastes including sludge generated from STPs – is essential.

ALL TRIBUTARIES

of the Ganga in Uttarakhand should be considered for conservation and rejuvenation, not only the Alaknanda and Bhagirathi rivers. Mapping of High-altitude wetlands is also essential.

SESSION A

SCIENCE, ENGINEERING AND OPERATIONS

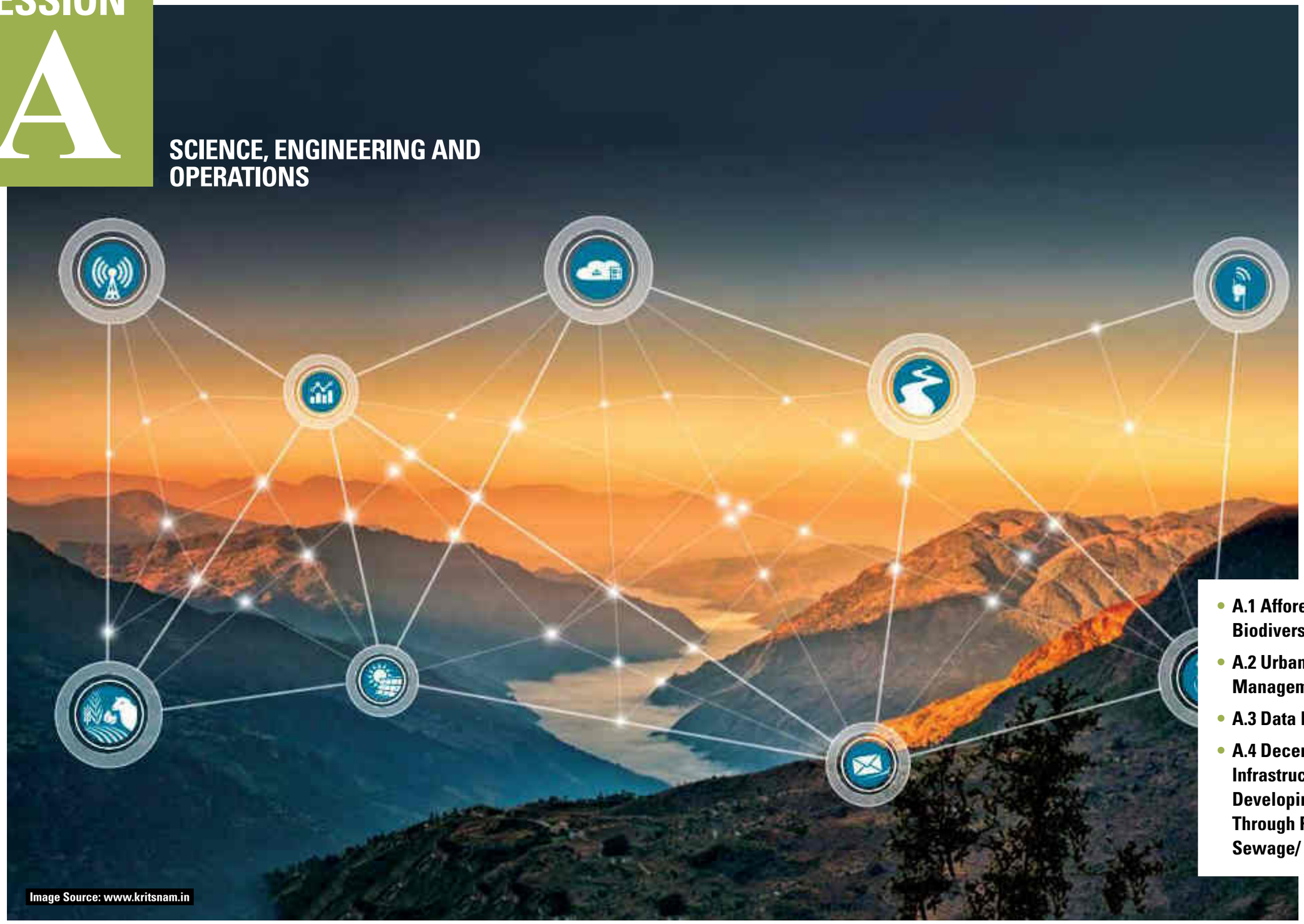


Image Source: www.kritsnam.in

- A.1 Afforestation & Biodiversity
- A.2 Urban River/Water Management Plan
- A.3 Data Harmonization
- A.4 Decentralized Infrastructure and Developing Water Bodies Through Reuse of Treated Sewage/ Trade Effluents

SESSION
A1

Afforestation & Biodiversity

DAY 2:
Thursday; December 6, 2018;
09:00 – 10:30 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:
Rajiv Ranjan Mishra [DG, NMCG]

MODERATOR:
Vinod Tare [Head, cGanga];
Rajiv Kishore
[ED, Admin & Int'l Relations, NMCG]

PANELISTS:
Brij Gopal [CIWSA];
D Ranjan [FRI];
G Manna [IARI, CIFRI];
Kees Bons [Deltares];
Ruchi Badoha [WII];
S D Singh [Resident Commissioner, UK];
Sandeep Behera [NMCG];
Sejal Worah [WWF]

A1.1. PROBING THOUGHTS

The Ganga River Basin is fertile and thickly populated, with about 43% of India's population residing in the basin. Thus, much of the basin's land area is cultivated or covered by urban and industrial use, while forests, scrublands and grasslands exist only on mountainous or hilly terrain, alpine climates and relatively dry regions. However, forests and natural vegetation play a key role in the overall basin environment and the Ganga River System by arresting high flows and soil erosion, purifying water and air, improving soil health, moderating climatic and hydrological extremes, improving dry season river flows, increasing terrestrial and aquatic biodiversity, etc. What is of major concern here is the present-day reduction of biodiversity in the Ganga River Basin and the Ganga River System, and the impact that a well designed afforestation programme can play in reviving biodiversity. In view of the multiple benefits that can accrue from afforestation in the basin, the Central Government initiated a major afforestation programme designed by the Forest Research Institute (FRI) which can improve the basin ecology and also benefit the Ganga River System in many ways.

A1.2. KEY QUESTIONS TO BE ANSWERED

1. What are the major impacts on the Ganga River System and the Basin expected from the Biodiversity and Afforestation Program?
2. What are the criteria for assessment of the Program?
3. What is the role of biodiversity in the basin's ecology and water environment?
4. What is the present status of biodiversity in the basin and river system?
5. What should be the biodiversity assessment and verification factors?
6. What are the significant aspects of WII's rapid assessment monitoring survey?
7. Is there provision for capacity development to conserve at least the existing biodiversity?
8. Is the program adequate and sustainable or is any mid-course correction required?
9. What is the implementation mechanism of the program?
10. How are economic and environmental aspects of the Program to be evaluated?
11. What are the social and developmental aspects of the Program?

FORESTS AND NATURAL

vegetation play a key role in the overall basin environment and the Ganga River System by arresting high flows and soil erosion, purifying water and air, improving soil health.

RIVER QUALITY

benchmark to be developed for institutions involved in assessing biological parameters.

A1.3. DISCUSSIONS

Indian forestry has a long history, and the Forest Research Institute in Dehradun has been regularly studying and evaluating Indian forests and providing research-based inputs for Indian forestry development. On the other hand, there is limited information on biodiversity – especially aquatic biodiversity – in India, but the Wildlife Institute of India is at the forefront of India's biodiversity knowledge. Thus the two premier organisations complement each other's knowledge expertise in designing an Afforestation Program for the buffer area along the Ganga river which can help enhance biodiversity in the Ganga River Basin. From this perspective, the concerned agencies can take up the following tasks:

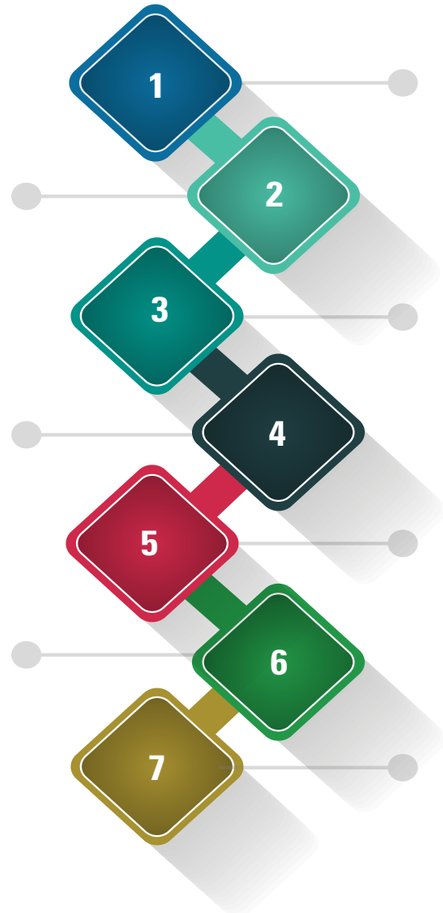
1. Base line biodiversity mapping (historical and current) in the entire basin.
2. Identification of the potential sites/ stretches/ areas for monitoring specific species.
3. Hydrological role of forests to be studied, especially with regard to temporal variations and seasonal streamflow regimes.
4. Trade off analysis for the river to be done.
5. River space studies should also be carried out.

Some other concerns that emerged from the discussions are:

1. Whether top-down effect or bottom-up approach is preferable for biodiversity assessment.
2. The type of plantation along the river/ buffer area needs to be considered. In this regard the categorization of plant species on the basis of their flood tolerance is desirable.
3. Data sharing between interested organizations need to be facilitated.
4. Benchmark to be developed for academic colleges and institutes that may be involved in the assessment of biological parameters.

A1.4. RECOMMENDATIONS AND TAKE AWAY POINTS

Rivers are frequently viewed merely as natural water courses rather than as important aquatic ecosystems that provide numerous ecosystem goods and services other than that of water. Even in terms of physical products (or ecosystem goods) river fish, sand, and nutrients (dissolved or bound up with sediments) are some key benefits meeting human needs. Besides, rivers provide many services such as navigation and transport, basin drainage (thereby minimizing basin flood and water-logging), pollution mitigation, waste removal, hydropower, groundwater recharge, recharging and fertilizing floodplains and floodplain wetlands, aquatic and riparian biodiversity, micro-climate modification, aesthetic and cultural services, etc.
To provide such goods and services (including biodiversity) optimally, a river must function efficiently to fulfil its true potential. Taking cognizance of this overall perspective, the following measures were recommended:



A river must function efficiently to fulfil its true potential of providing its myriad ecosystem goods and services.

Flood zonation and river bed zonation along river corridors need to be carried out.

Species should be appropriately selected for the restoration program for different zones and reaches of the river.

Community participation is essential for simple river health assessment. Programs by WII such as Bal Ganga Prahari, Ganga Prahari, plans to initiate Pravasi Ganga Prahari, Ganga Grandmas to be also continued to address cultural aspects of River Ganga.

Concepts from terrestrial systems do not necessarily hold for aquatic systems, and they should be not applied on rivers indiscriminately.

Ecosystem activity awareness programs should be facilitated.

Working group (cGanga, WII, WWF, CIFRI and FRI) will develop further understanding on various aspects of biodiversity and afforestation.

SESSION
A1

Afforestation & Biodiversity

SESSION
A2

Urban River/Water Management Plan

DAY 2:
Thursday; December 6, 2018;
16:30 – 18:00 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:

Rajiv Ranjan Mishra [DG, NMCG]

MODERATOR:

Vinod Tare [Head, cGanga];
Pravin Kumar [Director Tech, NMCG]

PANELISTS:

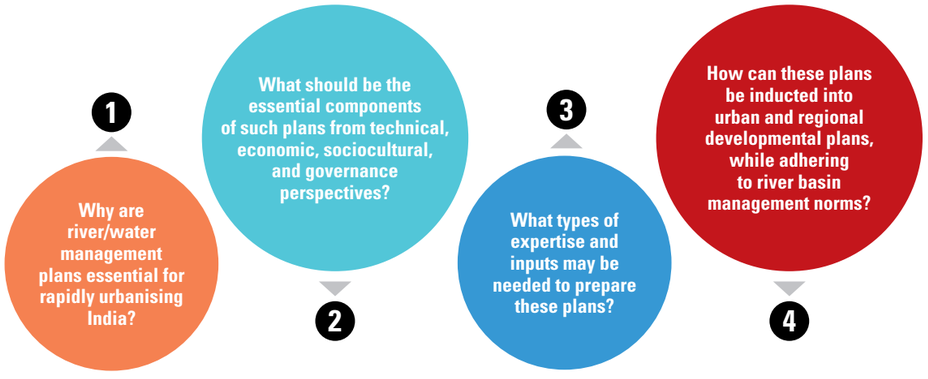
Abhishek Malhotra [AECOM];
Ajay Pradhan [C2S2];
P S Rana [CIDC];
Prabhat Singh [IREC];
Srikanta K Panigrahi [IISD];
Victor Shinde [NIUA]

A2.1. PROBING THOUGHTS

Riparian towns all over the world have had major impacts on rivers in modifying river hydrology and water quality, and consequently on the overall fluvial morphology and biodiversity, due to huge volumes of wastewater generation and extensive built-up surfaces that increase storm water runoff. In India, and in the Ganga River Basin in particular, riparian cities produce extensive sewage as well as solid wastes (including construction wastes) that have severely affected river health. Besides, increasing built-up surfaces, drying up of water bodies, clogging of surface water drains, water table depression, vanishing vegetal cover, inadequate water and sewerage infrastructure, and poor solid waste disposal processes are some key features that have been affecting the river system grievously while also harming urban life quality. These issues need to be addressed urgently since India's urbanization has been growing increasingly rapidly over time, with increasingly difficult consequences.

In view of the above, the design and operation of urban water infrastructure need to be integrated into comprehensive urban river/water management plans of riparian towns to ensure the Ganga river's integrity and sustenance as well as to sustain the overall urban water environment. Besides, such plans can significantly enhance the utilitarian, cultural and spiritual values of the river for the towns and the region as a whole, and thereby ensure the sustainability of measures through societal support and institutional commitments.

A2.2. KEY QUESTIONS TO BE ANSWERED



A2.3. DISCUSSIONS

Well-planned urbanisation will not be harmful for river functioning if the disruptive urban factors are taken care of. Since healthy urbanisation and clean water are twin goals that are directly linked to rivers and water bodies, it is necessary that they be jointly taken into the planning process. Thus it is not only green cover but wetlands too should be essential components of urban areas. Moreover, domestic sewage should be treated in small localities rather than being carried large distances for treatment so that the treated water can be re-used locally and to meet the needs of local wetlands and natural drains. Riverfront development should also fit into the socio-economic perspective of respective towns to generate interest and involve the local populace in river conservation.

TAKE AWAY POINTS

- Treat sewage as close to source as possible.
- Urban river management plan should be used as a tool to balance the twin goals of clean water and urbanisation.
- A solution to be chalked out on how to utilise the limited number of rainy days in a year.
- Out of 27% green area in the Ganga basin, 5% should be dedicated to water bodies.
- Regulate the flow of water through city by means of a city 'structure plan'.
- Socio-economic perspective to be included in planning riverfronts.
- Commercialisation of Kumbh Mela and other religious festivals should be diverted to creating water awareness as a lot of valuable water is diverted for the congregation.

SESSION
A2

Urban River/Water Management Plan

SESSION
A3

Data Harmonization

DAY 3:
Friday; December 7, 2018;
09:00 – 10:30 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:
Syed Masood Hussain [Chairman, CWC]

MODERATOR:
Sanmit Ahuja [Expert Member, cGanga];
Sundeep [Director Tech, NMCG]

PANELISTS:
Nitin Verma [WRG 2030];
Ravi Shankar [CWC];
S K Sinha [SoI];
Surya Dhruba [IITB];
Vishnu Chandra [NIC]

A3.1. PROBING THOUGHTS

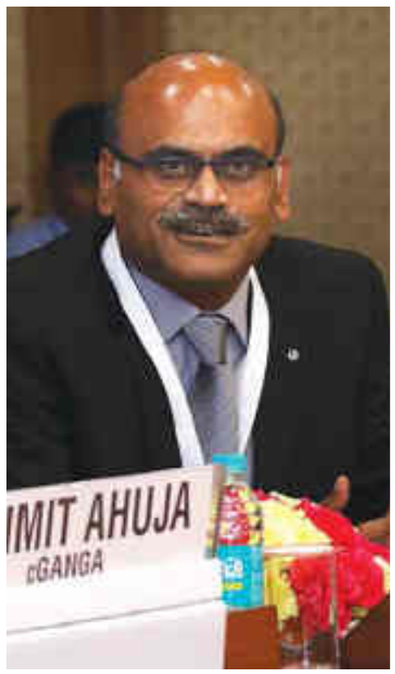
Development and management plans, designs and schemes for urban and rural infrastructure, regional and national growth (of agriculture, industry, housing, etc.), major ecosystems like forests, rivers and water bodies, combating natural calamities and disasters, and a host of other national activities are essential for maintaining and improving the state of our lives. And all such plans, designs and schemes are dependent on extensive ground data of different types such as geographic, climatic, topographic, hydrological, water quality, biodiversity, geological, land-use, socio-economic, and cultural. Many such data are needed for planning, developing and managing river basins and their water infrastructure. Comprehensive databases for these purposes have been under preparation by many agencies, but the relevant data that are available in the country are of different standards, accuracies and resolutions due to varying measurement techniques and procedures adopted by different agencies/ individuals and/ or by the same agency at different times. For instance river data may be separately collected by the Central Water Commission, State Agencies, research institutes like CIFRI, individual researchers with specific interests, etc. While some of these data may be overlapping, their accuracies and spatial and temporal resolutions may be different, making it difficult to combine different data sets for the desired purposes, whereas selective use of the data sets may be arbitrary and inadequate for the same purposes.

A3.2. KEY QUESTIONS TO BE ANSWERED

In view of the issues focussed above it is essential to review field data measurement, collection and collation procedures, and assess how to enable their easy and meaningful use by the following steps:

DATA ACCESS

A lot of data is available in India, but they are scattered and of varying quality.



A3.3. DISCUSSIONS

The role of data for evidence-based policy-making is undisputable. But since data quality varies widely, there is need to harmonise data collection and processing. This especially emanates from the need for data-sharing between various agencies like CWC, CGWB, CPCB, SPCBs, Control Boards, GSI, Survey of India, etc. which collect primary data independently. At present a lot of data are available in India but they are scattered or of varying quality. For example, high-quality groundwater data are available but with gaps. Having a robust protocol for data sharing is thus essential. Further, creating a foundation data set for all data to harmonise with it is strongly needed. For instance, the Survey of India has initiated the CODS, Geoid Model and High Resolution Datasets for new foundation datasets. Such efforts imply creating proper standards for data sharing and creating a common platform for data management and data access. Data management and access can be further refined by use of IOT, and machine intelligence (or artificial intelligence) can be further used for data interpretations along with modern modelling tools for predictive purposes. These efforts emphasize the need for data harmonisation and the creation of a central portal for data access, for example by the National Informatics Centre who have a large IT infrastructure and data centres. As a practical example from abroad, the web portal "data.gov.uk" provides open access data to firms, and it has played a significant role in the development of industries and practical applications in the United Kingdom.

TAKE AWAY POINTS

There is an urgent need to harmonise data collection and processing by different agencies for use in evidence-based policy-making in India.

Create a foundation data set for all data to harmonise with it.

Create a robust protocol with proper standards for data sharing between various agencies.

Explore the use of IOT and machine intelligence for data interpretations for varying quality and refinements of data.

Create a common platform and central web portal (such as the "data.gov.uk" portal of United Kingdom) for data management and data access for all users.

SESSION
A3

Data Harmonization

SESSION
A4

Decentralized Infrastructure and Developing Water Bodies Through Reuse of Treated Sewage/ Trade Effluents

DAY 3:
Friday; December 7, 2018;
09:00 – 10:30 h

VENUE:
Hall 2-3, Vigyan Bhawan,
New Delhi

CHAIR:
Rajiv Ranjan Mishra [DG, NMCG]

MODERATOR:
Vinod Tare [Head, cGanga];
D P Mathuria [ED Tech, NMCG]

PANELISTS:
A A Kazmi [IIT Roorkee];
Calum MacKinnon [Scotstream];
Jan Grimbrandt [Boson Energy];
Ken Jones [Ground Recycling];
Lewis Jeffrey [Lyndon Water];
Manu Bhatnagar [INTACH];
P S Rana [CIDC]

A4.1. PROBING THOUGHTS

The clean-up of River Ganga and some of her highly polluted tributaries – such as the Yamuna – is an emotive subject for Indians as well as a pressing health and developmental issue. But while considering ways and means of rejuvenating and conserving River Ganga herself, the water bodies in the basin also need to be revived in order to sustain the river ecosystem. This is because such water bodies provide useful services to the rivers and the overall water environment of the basin such as by trapping eroded soil, flood attenuation, groundwater recharging, water purification, enriching aquatic (as well as amphibian and avian) biodiversity, climate moderation, and enhancing aesthetic and cultural satisfaction. In modern times many water bodies in the basin have been stressed by water scarcity and pollution as well as encroachment and other anthropogenic activities, especially in urban locales. Augmenting fresh water inflows to water bodies is therefore very important to revitalize them and maintain them in functionally healthy conditions. A very useful means to achieve the above goal in towns and cities can be the decentralization of water and wastewater infrastructure, so that the wastewater generated in small localities can be locally treated and reused to replenish local water bodies like ponds and lakes, and even to maintain natural drains in flowing conditions. This may prove to be an economic, easily manageable and participatory approach to resolve a seemingly intractable problem.

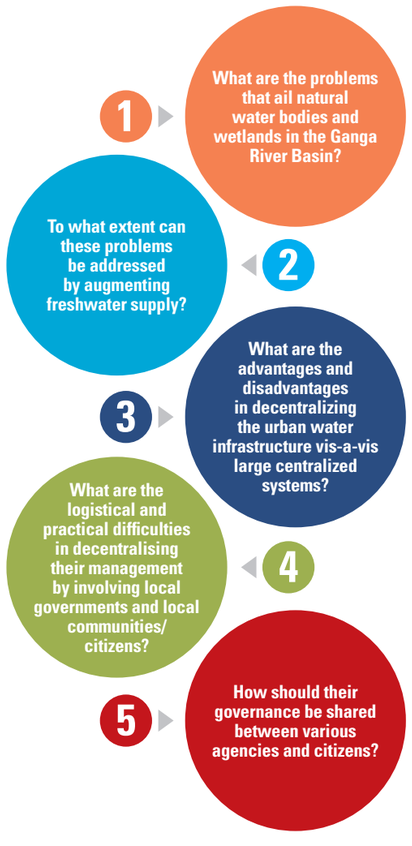
WATER BODIES
help in trapping eroded soil, flood attenuation, groundwater recharging, water purification, biodiversity enrichment, climate moderation, and enhanced aesthetic and cultural satisfaction.

SESSION A4

Decentralized Infrastructure and Developing Water Bodies Through Reuse of Treated Sewage/ Trade Effluents

A4.2. KEY QUESTIONS TO BE ANSWERED

In view of the long unresolved problems of both river degradation and poor urban water environment in the Ganga basin, the proposed solution seems welcome. Some important issues to be considered in this context are:



A4.3. DISCUSSIONS

The role of water bodies in maintaining the basin's ecological balance and improving urban environments is universally accepted. Decentralization of urban water infrastructure can play an important role in reviving and augmenting urban water bodies in the Ganga basin. But they should be taken up within comprehensive urban planning for water bodies. Institutional arrangements for decentralization of the water infrastructure can be effected through RWAs (Resident Welfare Associations) of housing colonies or other organizations of local communities in cities, but the government's (Namami Gange's) norm of "One City - One Operator" may have to be revised. Moreover, the water supply norms and wastewater generation by local communities should be monitored to ensure economic water use and minimal waste discharge. Hence water use should be metered, both at the community level and the individual household level.

Since damages to water supply pipelines over long distances have been a persistent problem, the decentralisation of water infrastructure could also involve potable water supply from local water bodies along with metered water use – metered both at the community and the individual household levels. A problematic issue here is whether all water bodies are suited for drinking water supply, especially as it depends on the types of wastewater and solid wastes received by the water bodies. Also, if the water in the water bodies are repeatedly recycled, their can be buildup of TDS. Diversion of storm water into water bodies can be a useful means both to replenish them as well as to moderate TDS. Besides, storm water needs far less treatment to make it suitable for human use. Hence storm water itself can also be stored in underground storages and used in residential colonies. A further measure to meet urban water problems is the use of water from upstream reservoirs, but this involves regional planning of water storages and use.

A4.4. RECOMMENDATIONS AND TAKE AWAY POINTS

1. Cognizance must be taken that urban water bodies are vital for basin ecology and urban environments.
2. The decentralization of urban water infrastructure in the Ganga basin can be a very useful measure for reviving and maintaining urban water bodies and drainage.
3. Urban planning must involve a comprehensive development and management plan for the water bodies.
4. RWAs (Resident Welfare Associations) of housing colonies or other organizations of local communities can be entrusted with the management of their local water infrastructure and water bodies, subject to suitable relaxation of Namami Gange's norm of "One City - One Operator".
5. Local and household water use must be metered, and wastewater discharges should also be monitored to ensure efficient water management.
6. Where water bodies are largely used by local communities on use-dischargereuse basis, the micro-water equilibrium concept may be used. Regular replenishment/ augmentation of such water bodies with storm water or from upstream storages can be particularly useful for keeping the waters fresh and controlling the possible build-up of TDS.

AUGMENTING FRESH

water inflows to water bodies is very important to revitalize them and maintain keep them functionally healthy.

SESSION A4

Decentralized Infrastructure and Developing Water Bodies Through Reuse of Treated Sewage/ Trade Effluents

SESSION B

WATER ECONOMICS: CREATING ENABLING ENVIRONMENT FOR SUSTAINED INFRASTRUCTURE MANAGEMENT

Tehri Dam in Uttarakhand

B.1 Water Valuation, Pricing and Market Development

SESSION
B1

Water Valuation, Pricing and Market Development

DAY 1:
Wednesday; December 5, 2018;
15:00 - 17:00 h

VENUE:
Hall 1, Vigyan Bhawan,
New Delhi

CHAIR:
U P Singh [Secretary, MoWR, RD&GR]

MODERATOR:
Sanmit Ahuja [Expert Member, cGanga];
Rozy Agarwal [ED Finance, NMCG]

PANELISTS:
Indrajit Dube [IIT Kharagpur];
Paritosh Tyagi [IDC];
Poul Jensen [EBTC];
Suresh Babu [WWF]

B1.1. PROBING THOUGHTS

The notion of water pricing in India is rooted in India's pre-industrial age when freshwater availability was plentiful for human needs. Hence water pricing by municipal/ government agencies responsible for water supplies is conventionally based only on the cost of treating and supplying water and ignoring the value of water (as a resource) itself. But with increasing industrialization and agricultural and urban growth, water consumption has increased by leaps and bounds over the past decades, leading to increasing water stresses and even water scarcity in many parts of the country. The increasing water consumption has been possible by extracting more and more water from water bodies – thereby shrinking or drying them up, and often by also polluting them with anthropogenic wastewater. The consequences are severe, not only for aquatic ecosystems but also for humans who depend extensively on the ecosystem services of water bodies for their lives and well-being.

Given the above scenario there is a pressing need to change our perception of water as an infinite natural resource to that of water as a renewable resource having only a finite renewal capacity in nature. For it is only through this changed perception that we can value water as a precious common resource of all our citizens – present and future – and thereby save our aquatic environment. The change in our valuation of freshwater goes hand in hand with a changed notion of water pricing, wherein the inherent cost of freshwater is included in the actual price that we pay for our water needs.

But what is the inherent cost of freshwater? One way of deciding this is to link it with freshwater availability in India. Since our water consumption levels may have reached or even exceeded nature's renewal capacity, freshwater availability is obviously limited by our usage. Hence it is obligatory that the wastewater generated by us is treated up to freshwater levels before putting it back into nature. Hence the price of freshwater itself should be considered as at least equivalent to this cost of treating the wastewater.

If water is priced with the above considerations, then evidently its cost will be much more than that currently in vogue in India. And since water supply is mainly municipal or governmental responsibility, it would be an uphill task to convince consumers to pay the increased prices without changing their value perception of freshwater. This is where water markets can play a decisive role. By practising water trading between water producers and prospective buyers, the intrinsic value of freshwater and the consequent water prices will be a readily acceptable principle. Since there exists special needs and market niches for water trading, developing a water market can facilitate the process of realistic water pricing in modern-day India.

WITH INCREASING

industrialization and agricultural and urban growth, water consumption has increased by leaps and bounds over the past decades, leading to increasing water stresses and even water scarcity.

B1.2. KEY QUESTIONS TO BE ANSWERED

WASTEWATER GENERATED

by us must be treated up to freshwater levels before putting it back into nature. Hence the price of freshwater should be considered as at least equivalent to the cost of treating wastewater.

B1.3. DISCUSSIONS

Though India as a whole may not be severely water-stressed, many parts of the country are significantly stressed, especially in the dry pre-monsoon months. Hence, even if treated and reusable wastewater is considered as a source of water in water balancing, the value of water will depend on its availability, which can vary significantly between regions and also between different time periods. Hence the price of water, or at least consumers' willingness to pay, may depend on availability. But demand-supply concept is inapplicable in the Indian water sector. Water markets can help stabilize their mismatch.

Besides availability, social, environmental and commercial factors may need to be considered in water price fixation. Water pricing should also depend on water needs for different sectors namely, domestic, civic, agricultural and industrial/ commercial sectors. In urban, industrial and commercial sectors, the principle of "Polluters Pay" should be applied to save fresh water. Valuation of water should also incorporate the ecosystem services of water bodies.

At the regional level, there are water regulatory bodies in some states like Jammu & Kashmir and Maharashtra, but their scope and effectiveness may be limited. This is partly because many river basins are inter-state that restrict State control over the basin's waters.

TAKE AWAY POINTS

Water markets have to be developed in India to ensure water-saving and overcoming demand-supply mismatches.

A framework on water pricing and regulation needs to be developed, taking into consideration overall water availability, sectoral needs and water use efficiencies.

Public incentives to save water and minimise wastewater generation should go together with penalties for overuse or wastage. For example, for municipal consumers – depending on water availability – a certain minimum amount of water supply (e.g. 50 lpcd) can be supplied free, while beyond this limit telescopically increasing prices should apply to prevent wastage and control over consumption.

Some pressing questions need to be resolved at the earliest, viz.: (a) Can there be a pan-Indian policy for water price fixation, or should such policies be framed by State Governments? (b) What should be the regulatory framework for water markets?

SESSION
B1

Water Valuation, Pricing and Market Development

SESSION C

TECHNOLOGY & INNOVATION: EXHIBITS & PRESENTATION – DECENTRALIZED WASTEWATER TREATMENT

(Image Source: www.cganga.org

- Alchemy AI (UK)
- Space SI (Slovenia)
- Lyndon Water (UK)
- Wastewater Wizard (UK)
- GV Solutions (Spain)
- Trojan Technologies (Canada)
- Andicos (Belgium)
- Boson Energy (Luxembourg)
- Cambi (Norway)
- Ground Recycling (UK)
- Mebiol (Japan)
- Scotstream (UK)
- Blue Sky Bio (UK)
- GMEX - Greensphere (UK)
- SenseQube (India)
- Qua-vac (Netherland)

SESSION C1

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

1. Alchemy AI

DAY 1:
Wednesday; December 5, 2018;
15:00 - 17:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Hadas Mamane Steindel [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur];

1.1. HIGHLIGHTS

The technology presented uses of Artificial Intelligence (AI) in various fields like flood prediction, radiology, agricultural management and others. For accurate prediction of various events, a large variety of data sets are required. Any type of data whether numerical, visual, sensor, primary or secondary data can be analysed and stored in the cloud remotely. A data scientist can access the data and then can produce a data model, which may not be aware of the entire AI system. A different group can then produce pattern maps and describe it in their own interface (dashboard) using graphs, tables or other figures. Hence, data secrecy is also maintained. In addition, the algorithms of AI system can adapt and change to a software by itself; and keep on updating with the availability of new data sets. The technology claims to provide early, timely and accurate prediction of events so that value of water can be truly realised.

1.2. KEY CONCERNS

- Financial aspects of AI system.
- Accuracy of predictions using AI when most processes are not linearly related.
- How to take care of fake data and missing data sets?

1.3. DISCUSSION

The local economic conditions can be assessed based on AI technology, for e.g. if a solid waste treatment plant is set up, there will be difference in quality of processed waste and by-products which may lead to new opportunities. Hence, by analysing all the data, socio-economic and financial propagations for a particular situation can be assessed.

The AI system is so designed that it can adjust to all processes by statistical corelations and it is flexible enough by virtue of its capabilities to ensure proper and reliable output.

The AI system can take care of complex data sets as they are well equipped with supervised machine learning. Interpolations, data generations and developing models to fit a forecasting model are embedded in it and therefore fake data and missing data problems are taken care of.

TAKE AWAY POINTS

Interpolations can be done to generate data but the idea of a forecasting model based on generated data may not be the practical idea.

Real and actual ground based data should be more relied on for reliable predictions.

The proposal is well received but the uniqueness and its cost effectiveness in the context of cGanga's mandate needs to be assessed. The proponents are encouraged to further develop the proposal in close cooperation with cGanga team.

SESSION C1

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

2. Space SI

DAY 1:
Wednesday; December 5, 2018;
15:00 – 17:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Hadas Mamane Steindel [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur]

2.1. HIGHLIGHTS

The proposal focused on use of NEMO-HD microsatellite which is an engineered composite of large and small scale systems to produce high resolution images unaffected by the monsoon time weather variations. The satellite could be controlled by joysticks; equipped with transmitters and telescopes such that it can produce real time video and multispectral images over the Ganga River Basin. The usage of false colour composites to analyse vegetation footprints, moisture content, aquatic life, contaminant compositions and other plethora of parameters could be determined in detail. The technology can also be utilised to ensure proper quality control, optimum chemical doses, proper agricultural surveillance and other complex parameters by analysing the seasonal variation and high quality remotely sensed images. The timeline and cost of the proposal is mentioned in detail in figure 2.1 and Table 2.1.

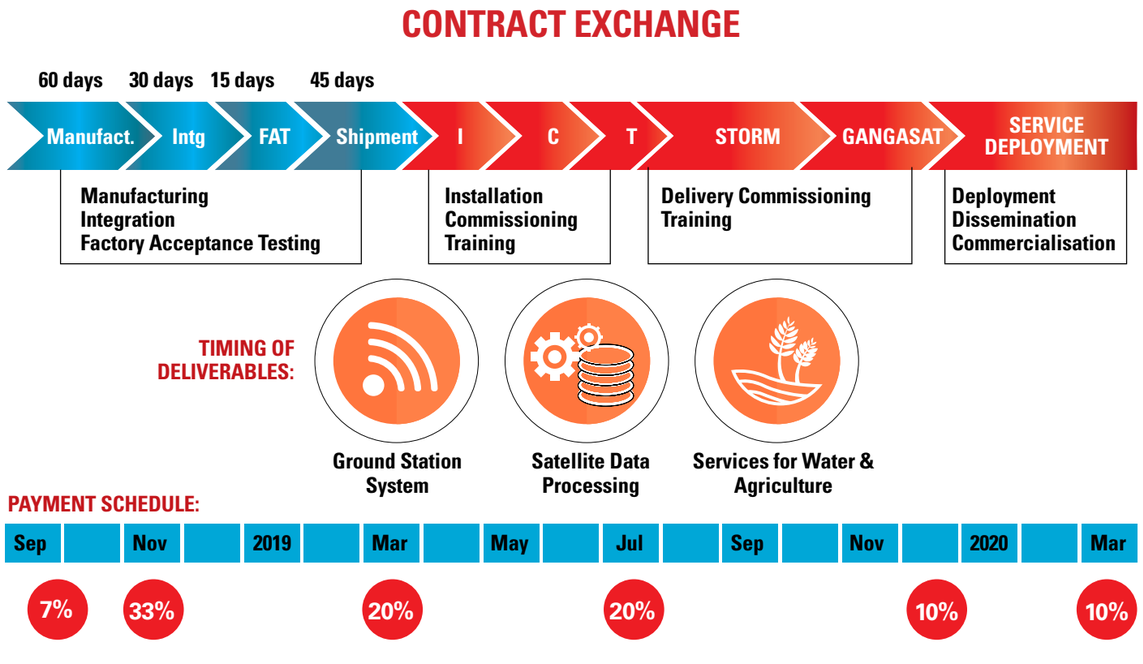


Figure 2.1. Timeline and minute details of the proposal

Table 2.1. Cost break-up of the proposal

System	Space-SI (EUR)
STREAM System for multi-statellite data acquisition	610,000.00
STORM chain for automatic processing of satellite data	400,000.00
GANGASAT services for delivery of map-ready thematic products	644,100.00
TOTAL	**1,654,100.00**

2.2. KEY CONCERNS

1. Resolution of the satellite images by NEMO-HD microsatellite.
2. Correlation between satellite data and ground measurements.
3. Whether scientists and leading corporate organizations can work collectively over Ganga satellite imagery and data?

2.3. DISCUSSIONS

1. It was discussed that for the Ganga basin, we would require higher resolution satellite imagery than what is currently available.
2. No correlation between ground and satellite data have been made for certain parameters. Some ideas and methodologies are being developed to predict and model things like chlorophyll content, cyanobacteria and other measures.
3. Scientists could contribute individually to the project and companies which show genuine interest should be allowed to get involved.

TAKE AWAY POINTS

The correlation of ground level measurements with the remotely sensed data is still to be developed for some parameters.

The satellite is unaffected by the monsoon time weather variations which could help in better resolution data during monsoon seasons.

Corporate partners who work closely with satellite imagery depending on their interests could work in tandem with scientists.

SESSION C2

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

3. Lyndon Water

DAY 2:
Thursday; December 6, 2018;
11:00 – 13:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur]

3.1. HIGHLIGHTS

The technology presented was the cultivation of duckweed plant for nutrient removal from wastewater. The major requirements for its growth were large land area, timely harvesting and proper wind control to ensure yield. Apart from nutrient removal, the harvested crop has multiple benefits including proteinaceous food for animals (Figure 3.1). The system having a footprint of 90m x 20m for growing duckweed produces an animal feed of roughly 5 kg nitrogen/hectar per day apart from water treatment (Figure 3.2).

3.2. KEY CONCERNS

1. Cross-section of the duckweed channels, cost of installation and issues related to harvesting of duckweed, and operation and maintenance of the system, particularly with seasonal variability.
2. Chemical composition of duckweed.
3. Effect of mixture of industrial and municipal wastewater on growth and quality of duckweed.
4. BOD consumed/produced per kg of duckweed.
5. Effect of evaporation on the entire process?

Figure 3.1. Multiple output options from duckweed

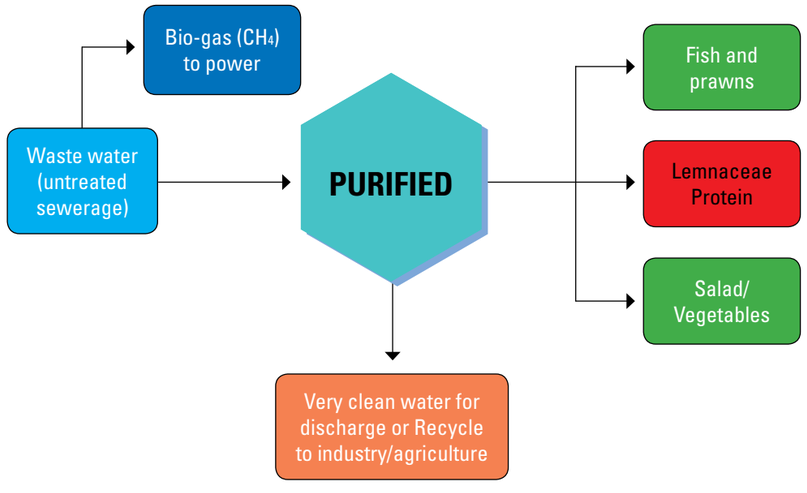
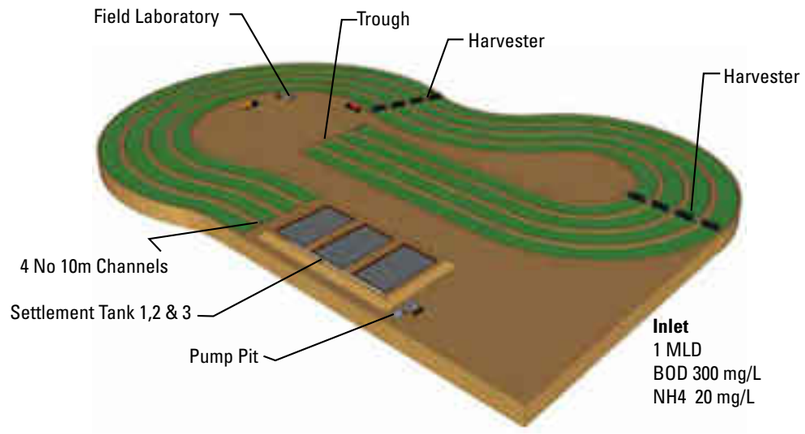


Figure 3.2. Schematic diagram of duckweed cultivation process



3.3. DISCUSSION

The water depth should be less than 600 mm for perfect yield, however under Indian wastewater circumstances flows will have larger depth creating anoxic and anaerobic zones; hence certain pre-treatments will be required. Minimal sunlight requirement is also a significant input towards its growth. The process has minimum installation cost and very less operation and maintenance cost. The required residence time is around 18 days. Duckweed is 30% protein and rest is mostly carbohydrate with some ash content. In situations like mixture of sewage and industrial wastewaters certain pre-treatments will be required. 5 kg nitrogen per hectare per day is produced from 30 tons duckweed. In addition, since no hydraulic settlement is done, extra BOD load will not hinder the process. The system will be designed as per Indian climatic condition and evaporation effect will be efficiently taken care of.

TAKE AWAY POINTS

The process has minimum installation cost with very less operation and maintenance cost. Major cost is the land cost.

The process is mainly for the treatment of municipal wastewater in a greener way.

The required residence time is around 18 days.

The by-product can be utilized as an animal feed.

The technology may have potential in Ganga River Basin in those areas where there is agricultural land and animal rearing (fish, cattle) practices are prevailing. While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C2

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

4. Wastewater Wizard

DAY 2:
Thursday; December 6, 2018;
11:00 – 13:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur]

4.1. HIGHLIGHTS

The technology consists of Vermi-Filter which uses earthworm to clarify wastewater (Figure 4.1). It uses coconut fibre as filter media (around 1m depth) (Figure 4.2). When water is put from the top in the treatment unit it percolates down and aerobic condition prevails. There is no need of excavations. The design is claimed to be simple and flexible with minimum electrical and mechanical requirement in a much lesser footprint area. It is easy to install, no foul smell, and solids also can be used as a rich and valuable garden fertilizer. Dissolved oxygen in the system increases from 0 to 3 mg/l in a single stage process with 90% reduction in total BOD, 95% in SS and 80% in COD. The treated output essentially meets the discharge standards. The energy requirement is 75% less than the STPs with conventional biological processes. The process provides additional benefits like utilization of earth worms for agriculture and provide greener space for urban development; and also use waste of coconut industry apart from treating wastewater (Figure 4.3).

4.2. KEY CONCERNS

1. Availability of filter media and its transportation cost as coconuts are not grown everywhere in India, particularly in Ganga River Basin states.
2. Provision of keeping birds away from the system.
3. TSS reduction and clogging possibilities.

Figure 4.1. Vermi-Filter existing set-ups

Figure 4.2. Vermi-Filter Process Concept

4.3. DISCUSSION

1. The filter media is mostly coconut fibre and if its availability is local then overall cost of the system is greatly reduced.
2. A mesh or net is provided on the top of system to take care of birds.
3. There will be significant reduction in TSS i.e. 180 mg/l to 44 mg/l. Clogging issues won't be there with worms. In addition, further treatment would be required as the plant doesn't provide disinfected water.

Figure 4.3. Circular economy pathways and benefits from Vermi-filter technology

TAKE AWAY POINTS

The system is low cost, provided the coconut fibre is locally available otherwise the cost of transportation may increase the operation cost.

The system provides valuable worms and rich fertilizer as an output in addition to treated water.

The treated water has to pass through disinfection chamber before putting to use.

Overall cost is mentioned to be low, however exact figures needs to be computed based on Indian local scenario.

While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C2

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

5. GV Solutions

DAY 2:
Thursday; December 6, 2018;
11:00 – 13:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur]

5.1. HIGHLIGHTS

GV Solutions are a developer, designer and manufacturer of comprehensive water treatment solutions for sewage treatment, industrial effluent management and drinking water treatment (Figure 5.1). The solutions are modular and are supplied in 20 or 40 ft container ready for deployment (Figure 5.2). The plants have smaller footprints, low power consumption, customised treatment, bankable technology and wide product range. They support the concept of decentralised sewage treatment that can promote reuse/ recycle and restoration of drains in urban regions. Depending upon the requirement extra units of treatment technologies can be rearranged. The solutions are highly customized and automated depending on the influent wastewaters.

5.2. KEY CONCERNS

1. Whether it can be customized for all types of effluent treatment?
2. Cost of installation and operation in comparison to conventional practices.

Figure 5.1. Customized solutions for wastewater

Figure 5.2. Sample wastewater treatment unit

5.3. DISCUSSION

1. The modular system is capable of handling various type of waste like tannery effluents, slaughter house effluents, textile industries, restaurants, domestic households, hospitals, paper industry, paint industry, dairy or other industrial and domestic sectors.
2. The cost is dependent upon the type of wastewater, size of modular unit and cost of transportation. However, it can be reduced significantly if units are assembled locally.

TAKE AWAY POINTS

The system was found efficient in treating all types of wastewater in less space and with lesser complications.

The only issue to be worked out in the future is the cost, which need to be calculated and negotiated properly for Indian scenario.

While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C2

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

6. Trojan Technologies

DAY 2:
Thursday; December 6, 2018;
11:00 – 13:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur]


Binhe, China; 79 MGD Plant

6.1. HIGHLIGHTS

The proposal presents water and wastewater disinfection based on UV technology. It has been tested and installed at several locations throughout the world (Figure 6.1). Instead of chlorine which is widely used for disinfection and may have direct or indirect consequences; UV technologies provide a safer, efficient and non-persistent alternative. The UV technology can treat chemical contaminants such as pesticides (e.g. Atrazine, Bromacil), taste and odour; & microorganisms such as Cryptosporidium and Giardia. From the perspective of safety, environmental impact, public health protection, treatment performance and cost also, UV has been proven to be a better technology.

Figure 6.1. Existing UV-technology set-ups

6.2. KEY CONCERNS

1. The cost of disinfection using UV technology in comparison to other methods of disinfection.
2. Efficacy in killing spores and cysts..

6.3. DISCUSSION

1. For disinfecting 1 MLD of water, it could amount to ~ 6-7 lakh rupees.
2. UV technology don't kill all genetic material like spores and cysts but research is going on.

TAKE AWAY POINTS

The UV technology is well-proven and efficient for disinfecting water. The only concern is the cost of treatment.

The technology currently is not efficient in removing spores and cysts.

The UV technology is a well-known and proven technology for disinfection. However its cost effectiveness in implementing on ground needs to be asserted. Trojan Technologies (Canada) is supporting research and development activities in India towards this effect and IIT Kanpur has set up a test bench for this to gather relevant information, particularly for application in wastewater treatment with the intent of reuse and recycling. Once such information is synthesized, it may be ready for pilot or full scale application.

SESSION C2

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

7. Andicos

DAY 2:
Thursday; December 6, 2018;
11:00 – 13:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];

D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:

A A Kazmi [IIT Roorkee];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Pawan Labhasetwar [NEERI, Nagpur]

7.1. HIGHLIGHTS

ANDICOS stands for Anaerobic Digestion by Combining Organic Waste and Sewage. The technology integrates the state-of-the-art technologies like anaerobic treatment and advanced bio-methanation process for resource recovery from waste. Raw sewage is mixed with organic waste to obtain broad range of nutrient and energy recovery systems (Figure 7.1). The technology recovers purified water, renewable energy and organic fertiliser from liquid and solid waste.

The plant can be built modularly for centralised and decentralised uses and can also be customised for large municipal installations. The company is currently running a pilot project in Hyderabad for Akshay Patra Foundation since April, 2018. The ANDICOS Waste to Energy plant has a capacity to treat approximately 1000 kg of organic kitchen waste and 2 – 6 m^3 of sewage sludge on a daily basis and will generate approximately 20 KW/H of electrical power along with 1.35 tonnes of rich organic fertiliser per day.

7.2. KEY CONCERNS

1. Handling of liquid slurry, particularly odour problems.
2. Whether it is capable of treating unsegregated waste?

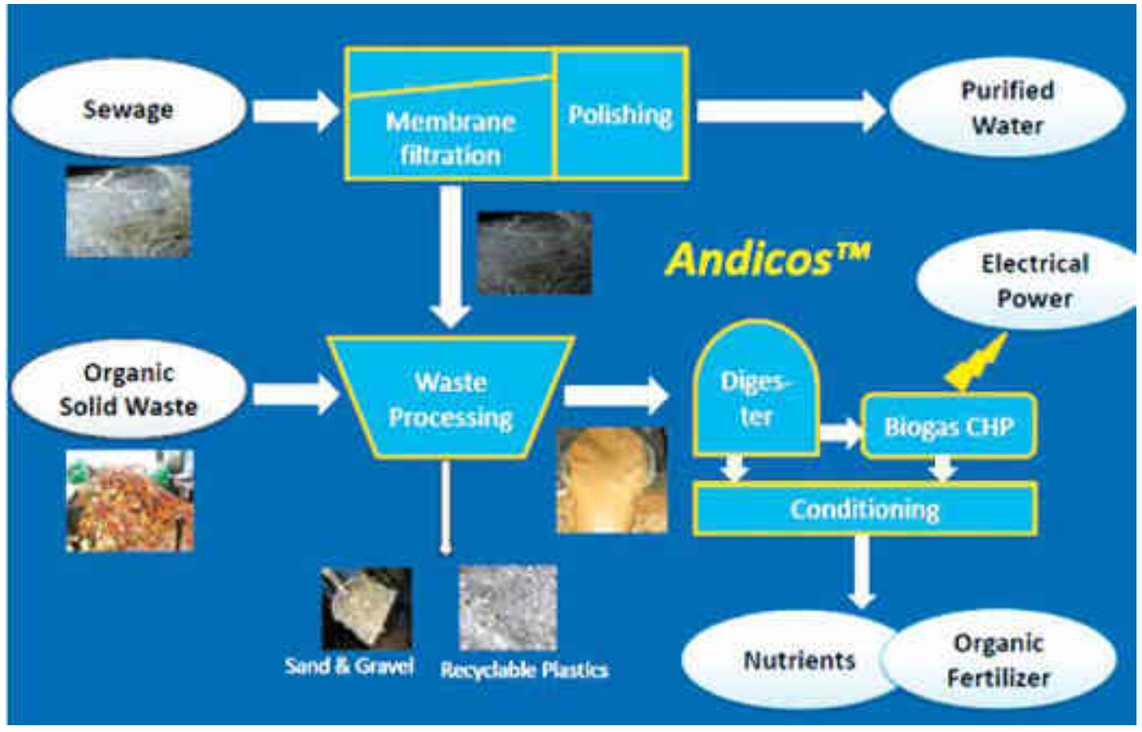


Figure 7.1. Flowchart of various processes included in ANDICOS

7.3. DISCUSSION

1. The slurry is used as a fertiliser directly.
2. The system doesn't have high degree of tolerance but if certain amount of proper kitchen waste is provided, then it can be utilised and the system will perform normally.
2. Organic fertilizer and electrical energy is also generated as a by-product.
3. Overall the system seems to be efficient and sustainable, only factor is the SWOT analysis of the technology before large scale implementation on ground.
4. The technology offers an efficient method of treating organic waste and sewage, and could be a significant contributor towards handling solid and liquid wastes in Ganga River Basin. Pilot testing of the technology is planned by IIT Kanpur under Indo-EU sponsored project at Jajmau, Kanpur.

7.4. TAKE AWAY POINTS

1. Organic sewage is mixed with kitchen waste and can be treated in a modular way.

SESSION C3

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

8. Boson Energy

DAY 2:
Thursday; December 6, 2018;
14:00 – 16:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

8.1. HIGHLIGHTS

The technology treats complex solid waste streams to a point of no residue, while effectively harvesting sustainable power for heating or cooling according to local needs. The system is based on plasma assisted gasification process combining pyrolysis, gasification and plasma treatment in a one step process (Figure 8.1). The system converts sludge organics to gases using plasma torches. Air quality standards can be met by using an APC unit. The end product is vitrified ash which is non-toxic. In addition, there is 50-90% reduction in transportation cost.

8.2. KEY CONCERNS

1. Usage/applications of vitrified slag.
2. Effect of high moisture content as Indian sludges typically have high moisture content (60% or more).

8.3. DISCUSSION

1. The vitrified slag can be used for road construction. However, the panellists expressed the view that a prior environmental risk assessment procedure is required to be followed.
2. 60% moisture content of Indian solid waste may not be suitable for the operation of plasma assisted gasification process. If sludge with high moisture content has to be put into the system, then pre-processing of waste is required. Also, the issue of air quality degradation was not properly handled.

TAKE AWAY POINTS

The gasification technology is not suitable for Indian conditions where moisture content in the sludge is greater than 60%.

Mass balance of the nutrients in all the three phases such as solid, liquid and gas was not shown.

The issue of air quality degradation during the entire system was not properly handled.

While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

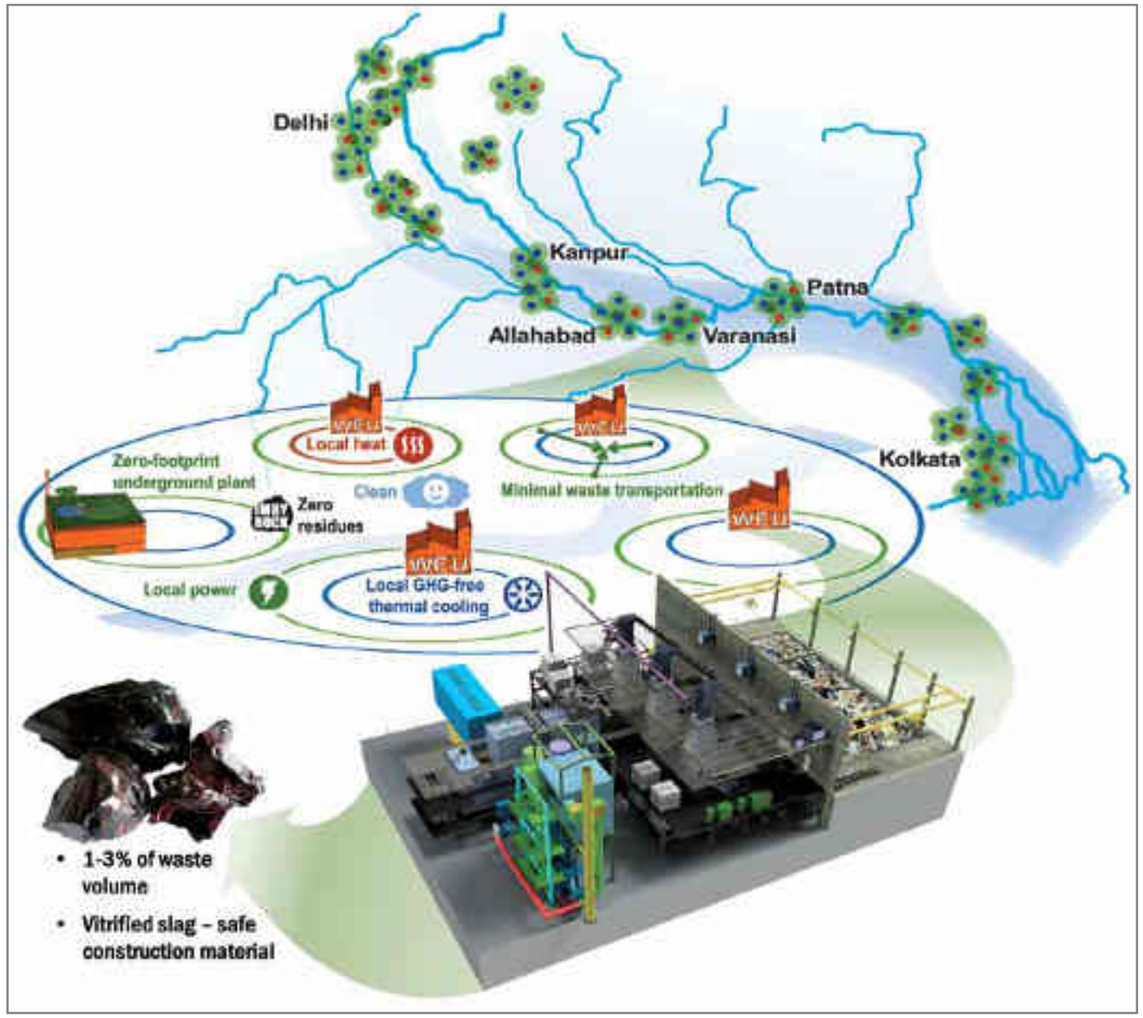


Figure 8.1. Various Treatment Units and Components of Boson Energy

SESSION C3

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

9. CAMBI

DAY 2:
Thursday; December 6, 2018;
14:00 – 16:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

9.1. HIGHLIGHTS

The technology is claimed by the proponents to excel in the wastewater sludge management area. The process involves conversion of wastewater, sludge and food waste to biogas, using a unique pre-treatment method, the Thermal Hydrolysis Process (THP) (Figure 9.1). It 'turbocharges' both existing and new biogas plants by using steam to pressure-cook materials before anaerobic digestion. The treatment units comes in compact modules depending on size of the treatment unit (Figure 9.2). Recycling bio-solids to agriculture offers lowest cost and best practicable environmental option for sewage sludge. This anaerobic digestion produces renewable biogas energy followed by dewatering and options for class A treatment, removing pathogens.

9.2. KEY CONCERNS

1. Experience of working in India at any scale.
2. High cost of installation, and operation and maintenance in India, particularly in comparison to other methods.

Figure 9.1. Sludge Line Process

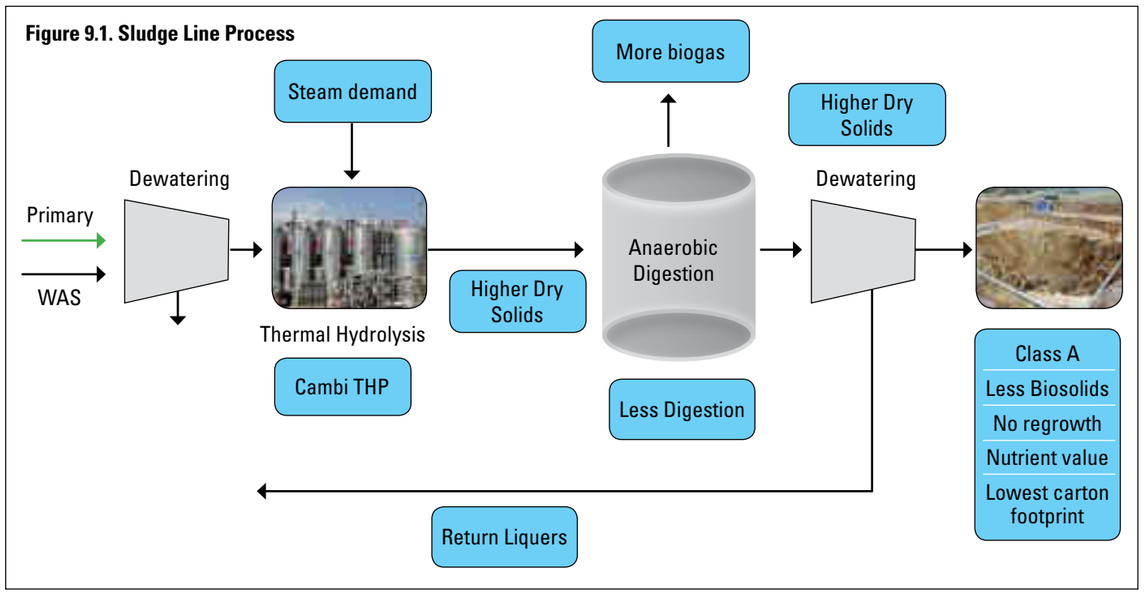


Figure 9.2. Characteristics of various modular designs

3. Value for money in terms of additional investment vis-à- vis additional resource recovery.

9.3. DISCUSSION

1. The work is progressing on demonstration of the technology consistently and communications with the Indian Agencies are on.
2. The nature of contract can be modified to reduce costs.

TAKE AWAY POINTS

The panellists seemed to be satisfied about feasibility of this technology in Indian scenario.

The project seems to positively contribute towards interventions for Ganga Clean-up, however cost negotiation based on Indian conditions needs to be done.

Pilot testing of the technology is planned by IIT Roorkee under Indo-EU sponsored project.

While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven under Indian Conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C3

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

10. Ground Recycling

DAY 2:
Thursday; December 6, 2018;
14:00 – 16:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

10.1. HIGHLIGHTS

The inventors presented a sustainable and green technology for 100% recycling of polymer based waste materials i.e. tyres (Figure 10.1). The process employed to recycle tyres is highly efficient and effective: 1-step mechanism- Ultra High-Pressure Water (UHPW) and Microwave Pyrolysis (MP) with standalone unit or in tandem with UHPW. These technologies are advanced and advantageous than conventional processes. In first step steel is recovered and in second step rubber powder is generated, both of which can be reused. By making smart modifications to the two base technologies it is possible to completely recycle much waste and scrap materials to the same high standard. The output becomes premium raw materials for direct uses in different industries (Figure 10.2). It can help in effective management of solids and improving the condition of drains flowing in the urban areas.

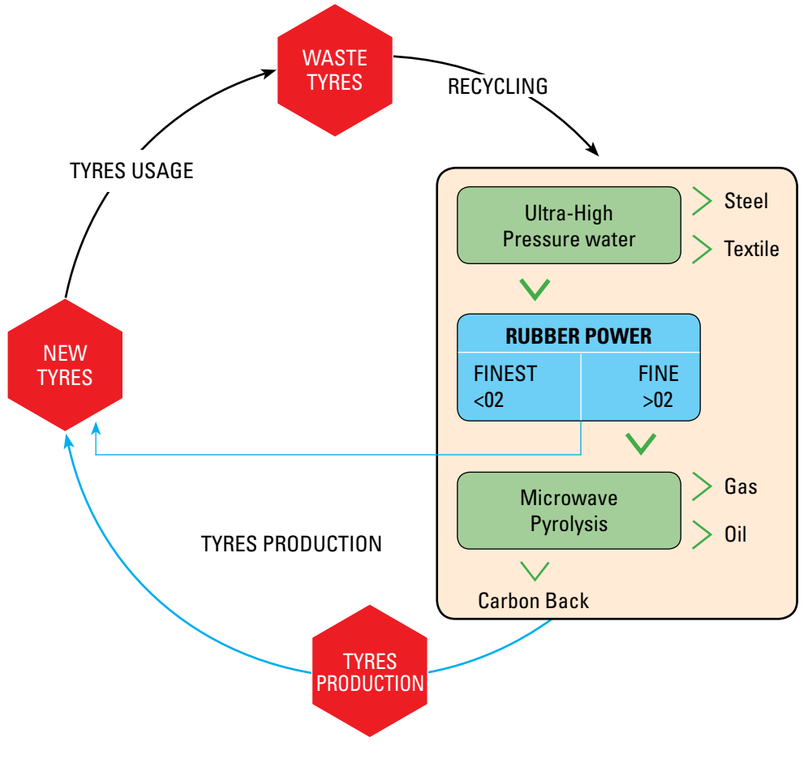
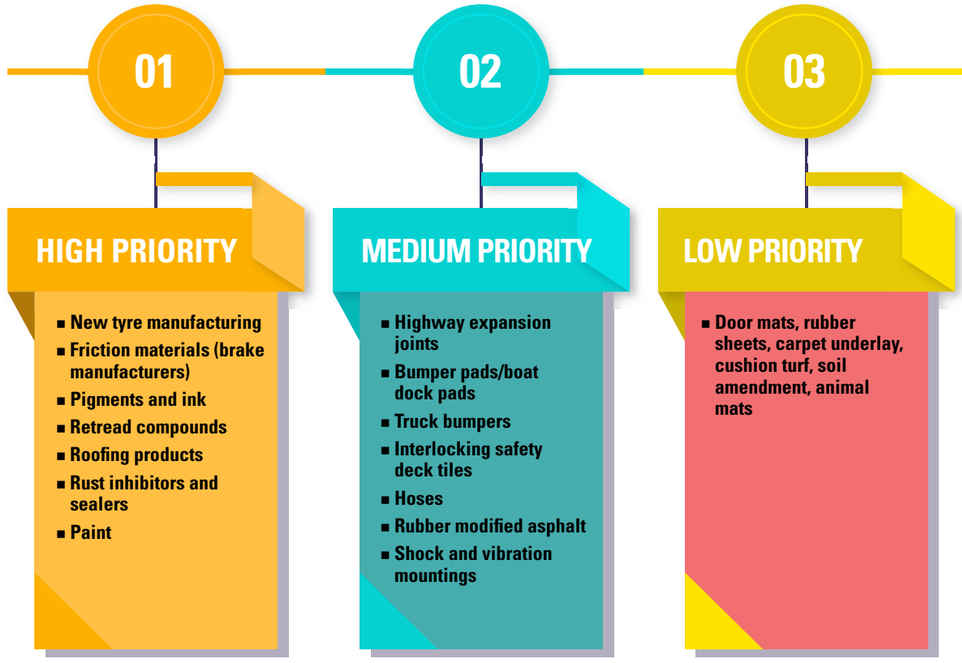


Figure 10.1. Process flow

Figure 10.2. Various output products



10.2. KEY CONCERNS

1. Developing an ecosystem for supply chain and use of recovered products.

10.3. DISCUSSION

1. The panel members were highly satisfied and looking forward to this technology in India. Jointly they mentioned this as an excellent approach and can contribute in "Clean Ganga Project".

10.4. TAKE AWAY POINTS

1. The technology seems to be beneficial and advanced with resource recovery and recycle.
2. The output product is value added and could be traded for money.
3. The technology is low cost and would be beneficial for "Clean Ganga Project".
4. While the proposed technology appears to be attractive in its class of technologies, the business case needs to be established under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C3

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

11. Mebiol

DAY 2:
Thursday; December 6, 2018;
14:00 – 16:00 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

TAKE AWAY POINT

The proposal is well received and uniqueness and cost effectiveness in the context of cGanga's mandate needs to be assessed. The inventors are encouraged to further develop the proposal in close cooperation with cGanga team.

11.1. HIGHLIGHTS

Mebiol invented the world's first hydro-membrane based farming technology to address the issues like water scarcity, reduction of arable land due to soil degradation and contamination and climate change (Figure 11.1). In this soilless farming technology one can grow crops like tomato, tulsi on top of a film. It has zero agricultural run-off. It reduces water and fertilizer consumption by 80%.

11.2. KEY CONCERNS

1. Demonstrating and establishing business case in India.

11.3. DISCUSSIONS

1. The panel members were highly impressed and looking forward to this technology in India. The technology is already well-known to most of the experts present.

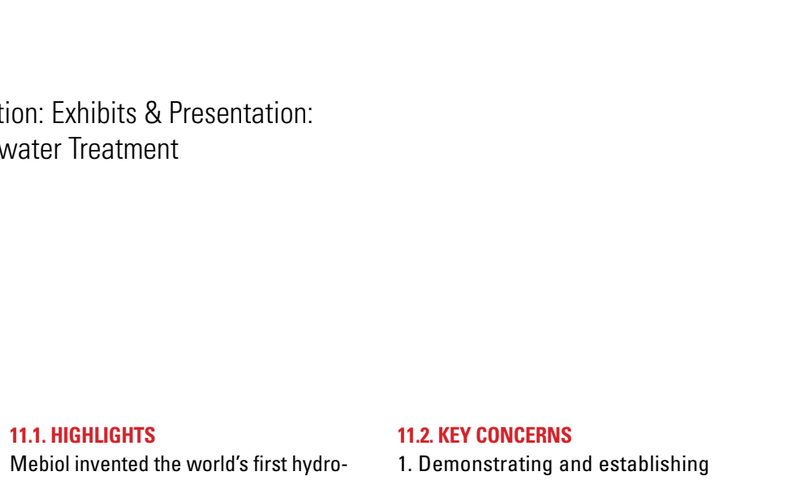


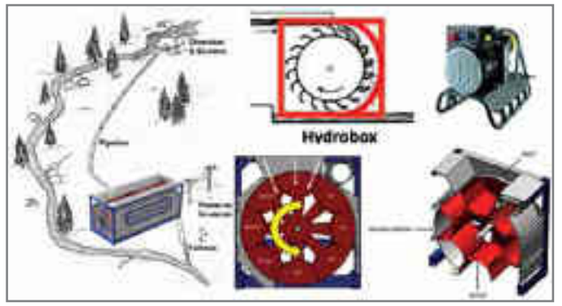
Figure 11.1. Membrane based farming technology

SESSION C4

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

12. Scotstream

Figure 12.1 Hydrobox-working principle



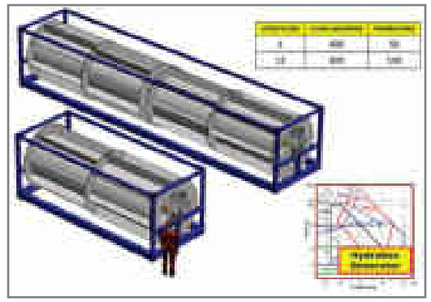


Figure 12.2. Hydrobox-size estimate

12.1. HIGHLIGHTS

The inventors presented a new concept of river hydro system i.e. 'Hydrobox'. It is specifically designed for low head applications, typically less than 10 meters (Figure 12.1). The design consists of a waterwheel mounted within a standard shipping container (Figure 12.2). This unit is easy to fabricate, transport and install. The provision of a stable electrical supply from the 'Hydrobox' will improve the social conditions of the people living in the vicinity of the Ganges River in terms of lighting and it can also be used to power wastewater systems. It will encourage entrepreneurship and the start-up of a number of businesses that need electricity, resulting in improved employment opportunities.

12.2. KEY CONCERNS

1. Rivers in the Ganga Basin typically have very high silt load. This needs to be appropriately accounted.
2. The technology could be demonstrated for canals as well.
3. Business case under Indian conditions needs to be established.

12.3. DISCUSSIONS

1. It was suggested that the inventors may get better understanding of the hydro power in India by engaging with agencies like "Alternate Hydro Energy Centre" at IIT Roorkee, particularly on issues like silt content, power purchase, etc. The device is a new invention and needs to be prototype tested in IIT Roorkee to demonstrate its operation.

DAY 2:
Thursday; December 6, 2018;
16:30 – 18:00 h

VENUE:
Hall 4, Vigyan Bhawan, New Delhi

SESSION COORDINATORS:
Sundeep Chauhan [cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP – UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Mohammad Jawed [IIT Guwahati];
Indumathi M Nambi [IIT Madras];
B K Dubey [IIT Kharagpur];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

TAKE AWAY POINTS

The panellists suggested to test this technology in Indian conditions before putting to field directly. It will build more confidence over the system and help us understand its merits and demerits.

While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C4

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

13. Blue Sky Bio

DAY 2:
Thursday; December 6, 2018;
14:00 – 16:00 h

VENUE:
Hall 4, Vigyan Bhawan, New Delhi

SESSION COORDINATORS:
Sundeep Chauhan [Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel [Managing Partner, ArkaTAP - UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar [NJS Engineers India Pvt Ltd]

13.1. HIGHLIGHTS

Blue Sky Bio presented a novel industrial fermentation technology "Hygen Bio Energy Reactor" (Figure 13.1). It can process any green organic material like sludge, food & vegetable waste, into a wide range of petrochemical refinery outputs. These outputs include biomethane, biohydrogen, fertiliser and compostable bioplastic raw materials. The conversion efficiency is 85-95 % and residence time is 5 days. It uses CO_2 for absorbing organic inputs to produce CO_2 neutral biohydrogen. The biogas contain 65% methane and 35% CO_2.

13.2. KEY CONCERNS

1. Control of H_2S and associated issues.
2. Recovery of nitrogen and phosphorus.

13.3. DISCUSSIONS

1. It may be done by aeration, biological processes, GAC or tower adsorptions.
2. The nutrients would be captured via precipitation.

Figure 13.1. Hygen Bio Rector (HBR) operation

WASTE AGGREGATION		
	Std values	
	TS(%)	VS(%)
Sewage sludge	6.0	5.5

HBR OPERATION PARAMETERS	
Residence ,me in HBR (days)	7
Flow rate to HBR (l/h)	100
Working volume HBR (m3)	16.8

FEEDSTOCK DEMAND	
	OLR: 6 kgs VS/m3/day
	6
Sewage Sludge	2400.0
Recirculated water*	0
Total flow (l/d)	2400.0

BIOGAS GENERATION: ~110 M³/DAY
DEGRADATION OF ORGANIC MATTER > 80%
BIOGAS COMPOSITION: 65% CH_4 + 35% CO_2

TAKE AWAY POINTS

The panellists were not sure about the nutrient recovery and CO_2 exchange during the process. Further interaction with cGanga Team is suggested.

Mass balance of all the components needs to be prepared.

While the proposed technology appears to be attractive in its class of technologies, the business case needs to be established under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C4

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

14. GMEX - Greensphere

DAY 2:
Thursday; December 6, 2018;
16:30 – 18:00 h

VENUE:
Hall 4, Vigyan Bhawan, New Delhi

SESSION COORDINATORS:
Sundeep Chauhan [cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP - UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
Mohammad Jawed [IIT Guwahati];
Indumathi M Nambi [IIT Madras];
B K Dubey [IIT Kharagpur];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

14.1. HIGHLIGHTS

The inventors presented a mobile app for aggregation and trading dedicated for residues/waste including dung, biomass, solids, sludge, ash and any other such materials that has an intrinsic resource recovery value. It solves the problem of identifying and managing residues/waste. A very large number of entrepreneurs can generate income by selling them to larger industrial organisations that can process such materials to generate energy and recover resources.

14.2. KEY CONCERNS

1. Inclusion of segregation of wastes.
2. Availability of data/ information.
3. Gathering of data/ information.

14.3. DISCUSSIONS

1. There is buyer of material not buyer of waste. Therefore, for some wastes, source segregation would be required.
2. The technology has a huge potential and can shape the future waste-trading market by adding value to waste materials.

TAKE AWAY POINT

The proposed solution appears to be novel but the business case needs to be established under Indian conditions. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C5

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

15. SenseQube

DAY 3:
Friday; December 7, 2018;
09:00 – 10:30 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP - UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

15.1. HIGHLIGHTS

The inventors present a new approach: "an IoT platform for agrometeorological application" (IoT: The Internet of Things). "SenseQube" is the product which is developed based on IoT (Figure 15.1). SenseQube has two modules: One is Cellular technology and other is LPWAN technology. The agro-meteorological data were taken thorough the Sense cube LP nodes over the range of 2.5 km. It deploys sensors which give real time data and it can be integrated with satellite data. It measures soil moisture, temperature, evapo-transpiration, crop water requirement, disease susceptibility and also provides alerts for any disease. It tries to optimize agricultural requirements. It can provide both current and historical data at lower cost in ready to use formats.

15.3. DISCUSSION

1. Good sensors are already available but high density of these sensors are required. The team is working to resolve the data reliability issue and trying to come up with better designs.
2. Currently the technology is only focusing on big and medium size farmers.
3. A group of 2-3 farmers can buy a model.
4. The sensors were given free to the farmers presently and cost per month is charged as EMI for the services.
5. One of the concerns about IoT techniques being used by the Indian Government Agencies like CWC is theft of the sensors and one sensor cost a significant amount.

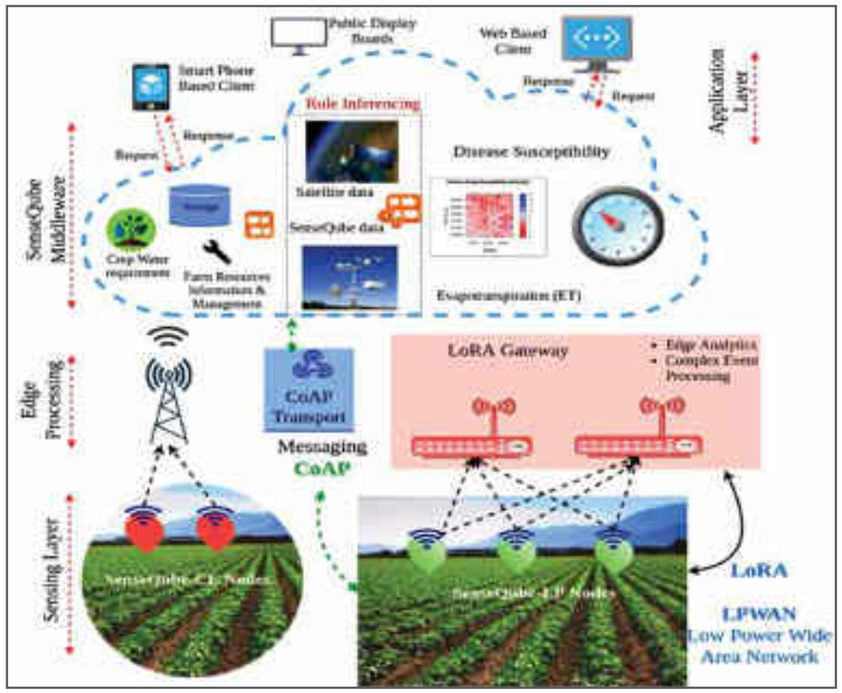


Figure 15.1. SenseQube approach: An IoT platform for Agro-meteorological application

15.2. KEY CONCERNS

TAKE AWAY POINTS

Apart from accuracy of the sensors, density of the sensors also plays a key role towards better advocacy.

Currently it is only focusing on big and medium size farmers.

The only problem from the government bodies subsidizing "Senseqube" is that agencies like CWC are already having such sensors for monitoring in the river but they are under theft.

The technology has a huge potential towards agricultural sector, however a joint meeting with CWC can be beneficial before large scale installations could be done on ground.

While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C5

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

16. Qua-vac

DAY 3:
Friday; December 7, 2018;
09:00 – 10:30 h

VENUE:
Hall 4, Vigyan Bhawan,
New Delhi

SESSION COORDINATORS:
Sundeep Chauhan
[Expert Member, cGanga];
D P Mathuria [ED Tech, NMCG];
Jana Hamel
[Managing Partner, ArkaTAP - UK]

PANELISTS:
A A Kazmi [IIT Roorkee];
B K Dubey [IIT Kharagpur];
Indumathi M Nambi [IIT Madras];
Mohammad Jawed [IIT Guwahati];
Uday Kelkar
[NJS Engineers India Pvt Ltd]

16.1. HIGHLIGHTS

The "Qac-vac Vacuflow" is a decentralized sewer collection and transportation system (Figure 16.1). This system is highly efficient and cheap compared to traditional sewer system for collection and transportation of sewage. It uses vacuum pressure to carry sewage from one point to another. This approach can be beneficial for environmentally sensitive areas and water protected areas. One of the major advantages of the system is that the sewer lines can bypass any obstacle and need not go in straight line. The system can be re-fabricated and having minimum or low maintenance but capital cost is high. This technique is already in India and having a pilot with Goa government.

16.2. KEY CONCERNS

1. Chocking of pipeline and process of cleaning.
2. Effect of intermittent power supply on the system performance.

16.3. DISCUSSION

1. The technology needs gen-sets for continuous power supply to create vacuum for cleaning of manholes.

Figure 16.1. Vacuum pump station

For trampling issue, the cutting of cables is avoided using sensors.

16.4. TAKE AWAY POINTS

Vacuum suction of sewage may be an effective technique in some areas. However, few aspects that have to be taken into conditions in Indian scenario are the cost and electricity supply. While the proposed technology appears to be effective in its class of technologies, the cost effectiveness needs to be proven. It is suggested that the proponent follows ETV process advocated by cGanga.

SESSION C5

Technology & Innovation: Exhibits & Presentation:
Decentralized Wastewater Treatment

SESSION D

GANGA FINANCING FORUM


Image Source: www.kumbh.gov.in

- D.1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme
- D.3-4 Bringing Efficiency in Financing Ganga Restoration and Conservation Projects through Effective Use of Capital Markets, Insurance, Guarantee and Credit Enhancement Instruments
- D.5 Financing Technology and Innovation

SESSION
D1

D.1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme

DAY 2:
Thursday; December 6, 2018;
D1: 09:00 - 10:30 h
D2: 11:00 - 13:00 h

VENUE:
Vigyan Bhawan, New Delhi

MODERATOR:
MODERATOR:
Sanmit Ahuja
[Expert Member, cGanga];
Rozy Agarwal [ED Finance, NMCG]

PANELISTS:
Abhishek Tripathi
[Sarthak Advocates and Solicitors];
Alon Yegnes [Vital Capital];
Anil Sinha [WRG 2030];
Arun Kumar [Axperia Ventures];
Manjay Verma [VA Tech Wabag Ltd];
Navneet Mairal [GS Bioenergy];
Raja Venkataramani
[Powertec Engineering Pvt. Ltd.];
Ram Fishman [Tel-Aviv University];
S P Singh [IIT Roorkee];
Samrat Basak [WRI India];
Sanjeev Srivastava [Aktion India];
Shilpa Bhan
[CDC India Advisors Pvt Ltd.];
Shubhomoy Ray
[Finnacle Capital Advisors Private Ltd.];
Sujatha Srikumar
[Powertec Engineering Pvt Ltd.]

D.1 Global Financing Ecosystem

D1.1. PROBING THOUGHTS

The expenditure on the entire Ganga Restoration and Conservation Programme is estimated to be in the order of USD 100 bn per annum which will be extremely difficult, if not impossible, for the government to finance. No doubt much of this expenditure is also linked to the other programmes such as Swachh Bharat, AMRUT, Digitial India, Smart Cities, etc. The introduction of water markets and effective price regime will shift a large portion of financial burden to the consumers. However, given that projects are envisaged to be financed using a PPP structure, the contractors will need deep and efficient financing pools to deliver the large-scale infrastructure. The inaugural session of the Ganga Financing Forum will provide insights into the strategies. Government wishes to adopt to support the overall development of a financing eco-system. The session will highlight the following issues/ points:

1. **The Major Components of the Ganga Restoration and Conservation Programme That Need to be Financed**
   Ganga restoration is comprised of two fundamental building blocks:
   a. Nirmal Dhara (Un-polluted water stream)
   The biggest challenge to the water body is decline in water quality due to anthropogenic activities manifesting in sewage, industrial water and agricultural runoffs. Stopping the wastes from entering the river body is the main objective under this building block.
   b. Aviral Dhara (Continuous flow of water stream)
   The river needs to flow continuously for it to be even called a river. The unchecked hydropower capacity fractures the river thereby reducing the level of water in the river-body and in turn also reducing the dilution effect. This is further exacerbated by over-extraction of water by agricultural sector for irrigation purposes.

2. **Underlying Commercial Model for Each Component**
   The principal strategy of Government of India is to encourage PPP models to finance the different facets of the Ganga restoration:
   a. Household Generated Wastewater
   - **In Urban and Peri-urban Areas**
     By encouraging use of recycle and reuse of wastewater. This entails treatment of the wastewater to levels where it can be used for non-contact purposes or process water in industrial applications e.g. in large thermal power plants, golf courses, railway-yards, stadia, etc. are the proposed off-takers who will buy treated water. Where such off-takers are not available, then by encouraging the municipality to create local area water markets. The municipality becomes the off-taker but sells the treated water downstream to households and commercial establishments. Where none of these are possible, then the Government (central and state) to provide the offtake.
   - **In Rural Areas**
     By developing aquaculture (and similar) industries so that the water bodies can not only be revitalised

PRIVATE SUPPLIERS
often sell freshwater to consumers at much higher rates when demands are high, for instance in metropolises and industrial centers during summer when municipal supplies are inadequate and local water bodies have dried up.

but form an integral part of the village's livelihood and economic development. These projects become self reliant as they generate revenue through sales of the produce and as such don't require any Government investment. The Government, however, may provide limited subsidies or other financial incentives.

b. Industrial Wastewater

- The industrial wastewater segment can be self-financing by enforcing the zero liquid discharge concept which requires industries to recycle and reuse all of the effluent generated from their factories.
- Where industries are financially not capable, the Government should provide an incentive and subsidy scheme that tapers down over 5-10 years giving industry enough time to absorb the additional costs.

c. Agricultural Runoffs

- The farming community firstly needs to adopt more water efficient irrigation practices that will reduce the water extraction.
- Secondly, the Government should run a water-rights programme that gives a quota allocation to farmers.
- The underlying financial instrument supporting both these mechanisms is a water-credit system.

d. Hydropower

- Greater adoption of run of the river hydro-power shall reduce dependency on large scale dams that have significant environmental impact. The power generated will be sold to the grid or where such a grid is not available then establishment of a micro-grid.

e. Solid Waste Management

- A significant volume of solid waste gets dumped into the river on a daily basis. This includes sludge, food waste, residual waste from religious ceremonies and plastic waste. The waste categories that have recycling or calorific value shall form the basis of establishing waste to-resource/energy projects. These will be self-financing whilst for categories where there is no real utilisation require Government support. Part of the revenue generation can come from fees generated from improved landscape and commercial activities along the river belt. This provides another basis of increasing revenue streams for the municipality.

3. The Entire Financing Value Chain

The financing value chain consists of five main segments:

a. Technology and Innovation Financing

This facility will support the acceleration of the rate of

D.1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme

technology transfer by financing technology and innovation through pilots/demonstration projects.

b. Project Development Financing

This facility will support development of a pool of highquality project reports that will attract global investors to the restoration and conservation programme.

c. Construction Finance

Availability of low-cost, long-term, non- or limited recourse concessionary finance is critical to accelerate the infrastructure development in the restoration and conservation programme. Project developers must have access to both equity and debt capital to ensure that projects get built in a timely manner. The construction finance is also underpinned by insurance, equipment lease-finance, mezzanine-bridge finance, foreign exchange hedging and export guarantee credit funding.

d. Operations Finance

It is essential that the urban local bodies develop their own revenue streams in addition to the allocation from central Government budget. This can be done through increasing the percentage of recycled revenue-water. As revenue water increases the municipalities and other government agencies are able to issue long-term bonds that will finance the operations and maintenance (O&M) of the projects. The O&M is underpinned by credit enhancement, shadow tariff, first-loss, back-stop guarantee instruments.

e. Secondary Markets

The developers and lenders will want to release their equity investment and debt financing as the projects stabilise and start generating revenues. The release of equity or cheaper refinance of debt can be done through the secondary market mechanisms such as Yield-Cos, takeout-financing and asset purchases by institutional investors.

4. The Global Eco-system for Finance

The large magnitude of capital needed for the restoration and conservation programme warrants establishing a global eco-system of finance. The partnerships that shall entail in due course will develop strategic products and platforms including but not limited to the following:

- Specialist venture finance and private equity funds
- Long term debt financing instruments – listed and unlisted
- Bonds
- YieldCos and listed buy-out vehicles

The financial centres that show interest and take the lead in developing specialist financing products for the Ganga restoration and conservation projects stand to benefit from gaining market share and access to pipeline of opportunities.

AVAILABILITY OF low-cost, longterm, non- or limited recourse concessionary finance is critical to accelerate the infrastructure development in the restoration and conservation programme. Project developers must have access to both equity and debt capital to ensure that projects get built in a timely manner.

D.2 Liquidity Pools for Project Finance

D2.1. PROBING THOUGHTS

In its most-simplest form project finance requires equity and debt contributions from project developers and lenders respectively. The lenders securities their risk by taking principal charge on the project assets and the cash flows of the project. However, in the project finance lending scenario, the lenders have no or little recourse to the corporate balance sheet or other assets of the developer. The lender must be comfortable with the project asset and liability profile. The lending institutions conduct their credit assessment based on number of factors, all of which contribute towards adding to or mitigating the risk profile of the project. If structured properly, these small interventions add up to delivering an overall risk profile with which lenders become comfortable and are able to lend to the project. The factors and associated liquidity pool structures are explained further as follows. The most crucial aspect the lender looks at is the quality of earnings which means the overall profile by which the project shall earn income. In case of wastewater treatment plants, the projects shall earn their income through a per-litre tariff paid by the Government agency or another off-taker. The developer would have arrived at the figure which includes the operations and maintenance cost, the debt servicing costs and the profit margins. Most developers would back-end the principal repayment so that they are able to create value in the project in the initial years. The lenders would look at whether the Debt Service Coverage Ratio (DSCR) is above one, which means that the projects cash flows are adequate to cover the debt payments. There are two critical factors that affect the quality of earnings: the credit rating of the off-taker and the payment mechanism that is set-up. The instruments that can improve quality of earnings and thereby liquidity for the projects are as follows:

1. **An Intermediary with a High Credit Rating**
   A poor credit-rating of the off-taker is a huge deterrent to the lenders who then worry about whether the agreed payment terms with the developer will be conformed to or not. A strong Government backed institution with high credit rating can act as an intermediary to mitigate the payment risks for developers.

2. **Government Sponsored Liquidity Pools**
   As Governments initiate major infrastructure programmes such as Ganga Restoration and Conservation, it is imperative that they look into developing liquidity pools to enable availability of long term, low-cost, non-recourse or limited recourse project finance. These can be developed through a range of mechanisms:
   - Interest rate swaps
   - Fx swaps
   - Long term Government borrowing that can be channelled via commercial banks at low interest rates
   - Creating an enabling environment for development finance institutions (DFIs) to provide wholesale lending to commercial banks that can onward lend to project developers
   - Tax incentives to commercial banks to lend to priority infrastructure sectors such as water and power
   - Classification of water as a priority infrastructure sector

3. **Mezzanine / Bridge Finance**
   The mezzanine or bridge finance providers can accelerate the construction of the infrastructure portfolio if they have clarity that there is a well functioning and liquid secondary markets or there is availability of take-out finance which can swap out the more expensive debt.
   Even though the bridge financing may be more expensive in the short run, the overall cost of finance over the lifecycle of the project will be lower.
   There are many other factors that impact the availability of project finance but creation of the complete financing value chain and enabling a robust eco-system can greatly enhance the capital pools.

IN THE PROJECT
finance lending scenario, the lenders have no or little recourse to the corporate balance sheet or other assets of the developer. The lender must be comfortable with the project asset and liability profile.

A POOR CREDIT
-rating of the off-taker is a huge deterrent to the lenders who then worry about whether the agreed payment terms with the developer will be conformed to or not. A strong Government backed institution with high credit rating can act as an intermediary to mitigate the payment risks for developers.

D.1 Global Financing Ecosystem
D.2 Liquidity Pools for Project Finance

D1|2 MAIN DISCUSSION POINTS AND RECOMMENDATIONS

1. Multiple strategies must be created to deepen liquidity pools for project finance for the Ganga Rejuvenation programme.

A number of issues were highlighted such as lack of clear revenue models, disparate risk profiles of stakeholders, massive size of the programme as such, not enough Indian public sector lenders coming forward to finance the projects, very few global water utilities present in the Indian market and slow rate of technology commercialisation amongst others.

Although the situation is not that bleak and many of the above mentioned points are being addressed, however since most initiatives are starting from a very low base, to see significant and visible impact will still take a few years.

In order to accelerate development across all fronts, it is important to mobilise investments across all fronts. Developing a diverse investor mix with different risk appetites and focus areas shall yield significant dividends in this major environmental programme.

In the early days of market initiation, the development finance institutions and impact investors will have a crucial role to play. It was noted that there are more than 300 Impact funds globally having over USD 120bn to invest immediately. In South Asia alone significant sums have already been invested. However, there is still a lot of hesitation for deployment of capital in the Ganga Basin.

a. Impact Funds:

There are many flavours of impact funds that can help overcome specific financing problems. For instance investors always have a concern that there is no incentive for underlying project-developers or sponsors to perform. As a result there is leakage of development capital as well as creation of sub-optimal assets. The Social Impact Funds/Bonds address this issue by creating an outcome based incentive mechanism. Should the asset developer/manager deliver on the target key performance indicators, they can be rewarded by lowering the overall cost of finance thereby making the projects economically viable.

The areas within the Ganga River Rejuvenation programme where impact funds can have significant impact are:

1. Shadow and top-up tariffs
2. First-loss funding
3. Credit enhancement and backstop funds
4. Developing a water market
5. Funding pilots/demonstration projects for proven technologies
6. Long term, non-recourse, concessionary finance
7. Developing market linkages

b. Diaspora Funds:

Another category of investors who might be able to accelerate development in the Ganga basin is the diaspora investors. Naturally they will have a lot more personal and emotional affinity to the project and would provide support to see it succeed. It was critically noted that the current fund structures do not encourage diaspora to invest particularly as they do not get any tax credits in their country of residence. It was suggested that the dedicated diaspora funds should be set up in each country to conform to local tax credit structures. This will encourage more and more diaspora to contribute towards the programme.

The areas within the Ganga River Rejuvenation programme where diaspora funds can have significant impact are:

a. Preparation of quality project reports
b. Projects that don't necessarily have a commercial value or revenue model
c. Building a knowledge and innovation bridge between their country of residence and India

2. The second major issue brought up in this session by almost all participants and stakeholders was to do with NMCG's own resources.

TAKE AWAY POINTS

Despite availability of significant investment capital globally, not enough is coming forward for the Ganga rejuvenation project.

National Mission for Clean Ganga's (NMCG) budgetary allocation is for a limited period only and what will it take to increase NMCG's capacity to raise own resources.

Projects becoming self-sufficient in their revenue generation – moving towards circular economy.

Establishing financing value-chain and how to create a global financing ecosystem.

SESSION D2

D.1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme

Whilst the Government remains quite optimistic that the programme shall transcend any political overtures, and that there will always be adequate capital available for the programme, the financial institutions on the other hand would want to have clear visibility of where the capital allocation will come in the long run.

References were made to other Government programmes such as the National Highway Authority of India (NHAI) which gets its revenue from a cess charged on all transactions. This gives NHAI the confidence to be able to go out and raise cheaper and long term resources from the capital markets. NMCG on the other hand is reliant on capital availability through planned expenditure. Additional spotlight was thrown on the fact that NMCG's current budgetary allocation only takes matters until the year 2020. Although this budgetary allocation will be useful for the capital construction cycle, many doubts are raised on how will the O&M component of the project be funded in the long run. Suggestions were made that the Government money is better utilised for deepening the markets rather than capital or operational spend. The most specific suggestion was to get NMCG its own balance sheet and a high credit rating that would pave the way for the organisation to start generating its own resources.

3. In continuation of the previous issue, numerous suggestions were made regarding the move towards a circular economy which will see the water become an adequately priced commodity which is a significant departure from the current situation where it is considered as a free essential item by most people.

NMCG IS RELIANT

on capital availability through planned expenditure. NMCG's current budgetary allocation only takes matters until the year 2020. Many doubts are raised on how will the O&M component of the project be funded in the long run.

D.1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme

In order to bring about this shift the right set of conditions are to be created and enabled for the local bodies who are at the coal face of water and waste-water management. They need both the incentives and the regulatory support to start valuing and pricing water. Examples from other countries such as Israel were sighted particularly their establishment of a systematic experimentation platform tantamount to bringing institutional and regulatory reforms.

4. The last significant point made was around establishing a global financing value chain for financing of the Ganga Rejuvenation programme. The most specific suggestions made were around the new innovative forms of financing that will work in tandem with the more traditional models. These are:
   - Developing a water certificate mechanism that will give its holders a monetizable currency.
   - Introducing the new financing mechanisms such as the use of tokens to securitise the underlying asset and placing the tokens on new global financing exchanges.

   It was noted by all that the most significant impact will be made by a take-out fund or a yield-co that will buy out operating assets thereby freeing up capital for both the equity and debt providers to invest into newer projects.

IT WAS NOTED

by all that the most significant impact will be made by a take-out fund or a yield-co that will buy out operating assets thereby freeing up capital for both the equity and debt providers to invest into newer projects.

SESSION
D2

D.1-2 Creating Global Financing Ecosystem Including Project Finance Liquidity Pools for Ganga Restoration and Conservation Programme

SESSION
D3

D 3-4 Bringing Efficiency in Financing Ganga Restoration and Conservation Projects through Effective Use of Capital Markets, Insurance, Guarantee and Credit Enhancement Instruments

DAY 2:
Thursday; December 6, 2018;
D3: 14:00 - 16:00 h
D4: 16:30 - 18:00 h

VENUE:
Vigyan Bhawan, New Delhi

MODERATOR:
Sanmit Ahuja
[Expert Member, cGanga];
Rozy Agarwal [ED Finance, NMCG]

PANELISTS:
Abhishek Tripathi
[Sarthak Advocates and Solicitors];
Alon Yegnes [Vital Capital];
Anil Sinha [WRG 2030];
Arun Kumar [Axperia Ventures];
Manjay Verma [VA Tech Wabag Ltd];
Navneet Mairal [GS Bioenergy];
Raja Venkataramani
[Powertec Engineering Pvt. Ltd.];
Ram Fishman [Tel-Aviv University];
S P Singh [IIT Roorkee];
Samrat Basak [WRI India];
Sanjeev Srivastava [Aktion India];
Shilpa Bhan
[CDC India Advisors Pvt Ltd.];
Shubhomoy Ray
[Finnacle Capital Advisors Private Ltd.];
Sujatha Srikumar
[Powertec Engineering Pvt Ltd.]

D.3 Global Capital Markets for Long Term Project Finance

D3.1. PROBING THOUGHTS

Whether it is raising risk capital through equity dilution or debt through issuance of bonds, capital markets can provide deep liquidity pools for quality issuers and project developers. In the context of Ganga Restoration and Conservation, capital markets can provide massive support through a range of financial instruments.

CAPITAL MARKETS FOR PROJECT DEVELOPERS

1. **Secondary Market for Refinancing Operating Assets**
   Developers can refinance their assets by issuing a bond which fixed-income investors can subscribe to. The proceeds of the bonds can act as take-out finance for the term loans that developers took out for construction and stabilisation period of the project. As the projects start to earn an income the companies holding the projects cross the threshold where they can issue the bonds.

   If refinancing through international bourses then the Masala Bond structure is now an acceptable instrument and is delivering an INR denominated loans to Indian issuers. The landed cost of such loans is cheaper than what companies can borrow locally.

   Not all developers will be able to raise long-term, non-recourse, low cost financing. However, by integrating the bond issuance strategy, and if possible having pre-agreements with the bond investors, can enable the investors to tap into standard commercial borrowing sources thereby increasing the chances of finance.

2. **Equity Release Through YieldCos**
   Many developers, in order to invest into other projects, would want to

SESSION D3

D 3-4 Bringing Efficiency in Financing Ganga Restoration and Conservation Projects through Effective Use of Capital Markets, Insurance, Guarantee and Credit Enhancement Instruments

sell out their projects or release their equity investments, if they can, once the project is completed and operating normally. However, selling these assets on a piecemeal basis may prove difficult as the portfolio must have a minimum threshold before large private equity investors, strategic investors or the likes of pension funds will consider buying them out. A YieldCo structure listed on capital markets allows that to happen. A YieldCo, much like REITs, provides a steady return (yield) to its investors who want exposure to underlying asset class, in this case water, but are not comfortable with taking on the construction risk. The investors would want a steady return once the asset is in a stable, cash generating operational period. By entering into a sale-agreement with the YieldCo before constructing the asset, the options for developers to raise construction finance become plentiful.

CAPITAL MARKETS FOR GOVERNMENT INSTITUTIONS

1. Long-Term / Ganga Bonds
   At the current moment, much of the funding for the Ganga Restoration and Conservation programme is being delivered through a central Government budgetary allocation. Given the large quantum of the capital needed, the amount any incumbent Government can create will be a lot less than what is required. At the moment the quantum of capital being deployed is well within the budgetary capacity of the Government, but as number of projects increase, this capacity will diminish rapidly. A well-structured Ganga Bond can be a powerful instrument for Government to raise low cost, long-term capital to service the operations and maintenance (O&M) obligations. If raised through domestic sources, the investors could be further incentivised with tax breaks. If raised internationally, the investors, who back the ESG (Environmental, Social, Governance) investing principles will be attracted to such a bond.

2. **Pooled Municipal Bond**
   The same principles also apply to the Urban Local Bodies to issue a long-term bond. Municipalities could come together to support the development of water projects through a pooled structure that will lower the underwriting and issuance cost.

D.4 Insurance, Guarantee and Credit Enhancement Instruments

D4.1. PROBING THOUGHTS

Achieving financial closure for project developers is a momentous moment. As months of hard-work, patience and perseverance eventually delivers the requisite capital that is needed to initiate or complete construction of the project. Whilst the capital injection by the equity investor(s) and senior lender(s) plays the most prominent role in project finance, there are many other supporting but important financing structures that enable the project to reach the financial closure milestone. These are:

1. **Guarantee Instruments**

Guarantee instruments play the most significant role in delivering financial closure. There can be all sorts of guarantees that can enhance the overall credit rating of the projects.

In infrastructure service contracts, there can be many instances where client/ off-taker disputes the level or quality of service delivery and may not release the payments to the developer/contractor. The possibility and probability of such instances will most certainly lead to lenders asking for higher levels of capitalisation of DSRA (debt service reserve account).

IN PROJECTS WHERE

the off-taker is a Government entity it can provide a backstop guarantee so that the developer and lenders are comfortable that there is a financial recourse available should there be a payment default by the off-taker.

D 3-4 Bringing Efficiency in Financing Ganga Restoration and Conservation Projects through Effective Use of Capital Markets, Insurance, Guarantee and Credit Enhancement Instruments

In projects where the off-taker is a Government entity it can provide a backstop guarantee so that the developer and lenders are comfortable that there is a financial recourse available should there be a payment default by the off-taker.

Should a Government backstop guarantee not be possible the parties can set aside an escrow account so that a few months/ years of payments are put in place already. However, an escrow mechanism is an inefficient use of cash as it blocks funds without yielding any interest payment whatsoever.

2. **Project Insurance**
It is extremely important for project developers to take out the relevant insurance policy to cover all stages of the project – construction and operations. The insurance instruments can cover a range of risks such as:
- Political risk
- Construction risk
- Operations & Maintenance risk
- Legal, Financial and Contractual risks
- Force Majeure risks

Many risks can be managed or mitigated by the various stakeholders participating in the projects. For instance, the political risk cover will not cost much in politically stable countries. The construction risk can be managed through adequate performance and bank-guarantees provided by the contractors. Similarly, the operations and maintenance risk can also be managed through the same instruments, only this time provided by the plant operator if it is different from the construction company.

Most investors and lenders would require that developers do take out specific insurance policies that cover the most critical phases of the project such as construction and operations phase.

Having the right insurance in place will increase the chances of financial closure and reduce the overall financing costs.

3. **Foreign Exchange Hedging**
Developers will choose to borrow money from the cheapest sources possible. Over the last few years Indian project finance has been supported immensely through external commercial borrowing (ECB) route. This mechanism, in compliance with Reserve Bank of India (RBI) guidelines, allows developers to tap into cheaper liquidity provided by overseas lenders.

Whilst the underlying credit provided may be cheap, there is a significant risk of currency mismatch inherent in this mechanism. The income stream of the projects will be in Indian Rupees (INR) but the financing liability is in a foreign currency such as USD, EUR, GBP, JPY etc. If the foreign exchange risk is hedged effectively, then this can be a very good source of long-term financing with costs cheaper than those available from domestic institutions.

D.3 Global Financing Ecosystem
D.4 Liquidity Pools for Project Finance

TAKE AWAY POINTS

Capital markets can serve the needs of private sector developers as well as NMCG to raise funds for its own obligations. But require clear articulation of cash flows and risks.

Innovations such as masala bonds, green bonds, tokens can help accelerate funding of projects.

Guarantee Instruments will help de-risk the project financing risk.

D3|4 MAIN DISCUSSION POINTS AND RECOMMENDATIONS

1. The capital markets world over are providers of liquidity for both equity and debt at competitive costs. But in return for providing cheaper and long-term capital, the investors require transparency and certainty from the investees or borrowers.

The participants strongly emphasized on the fact that not only in the case of Ganga Rejuvenation, but also for other high importance infrastructure projects the capital markets in India and abroad can play a very crucial role in supporting both the Governments as well as the contractors.

There are now enough precedents available for Government backed institutions to reach out to the capital markets for long-term borrowing by issuance of bonds. The infrastructure asset class in India has got a fillip through the introduction of InvITs (Infrastructure Investment Trusts) through which investors can channel funds into operating assets.

More traditional investment instruments such as bonds are also a mechanism for entities to tap into capital markets for long-term financing. If NMCG were to go to the capital markets and raise capital by issuing a bond, then its revenue streams have to be very clearly defined.

At the current time NMCG's funding is coming from budgetary allocation in the Government of India's budget cycles. This doesn't give assurance to the markets since the allocation is discretionary and can come under competing pressure from other priority areas. Whereas if NMCG were to raise its own revenues, it would give assurance to the investors that there are cash flows that can service the debt obligations.

To support this argument experts quoted National Highway Authority of India's (NHAI) example that has ringfenced income stream through a cess that the Government of India charges on petrol and diesel sale in the country.

NMCG today doesn't have any such revenue streams but should actively move towards creating one. The participants pointed out that in European nations there is a tourism cess or other surcharges and taxes that provide for the upkeep of river bodies. Others drew attention to the use of GARVEE (Grant anticipation revenue vehicle) Bonds used in the USA. These bonds rely on the fact that a sub-sovereign entity that is to receive a Federal Government grant can issue bonds to finance critical projects today. The bonds are issued in anticipation of the grant at a later date.

SESSION
D4

D 3-4 Bringing Efficiency in Financing Ganga Restoration and Conservation Projects through Effective Use of Capital Markets, Insurance, Guarantee and Credit Enhancement Instruments

2. Experts also pointed out that international capital markets are very active in support green and environmental projects. The green bond category is now well accepted particularly since it fits the ESG – Environmental, Social and Governance criteria which is becoming the defacto barometer that investors use to assess project's overall impact on the environment and communities. The Luxembourg Stock Exchange was highlighted as a pioneer in the green bond segment.

   A new category of international debt instrument, called the masala bond, has gained much traction from the investors in recent times. Investors in the masala bond, are absorbing the foreign exchange (Fx) volatility. Therefore, the borrower can tap into international capital pool without having to buy a separate foreign exchange hedge that will increase the cost of capital making the exercise futile. The liquidity in the masala bond market is limited and not every investor is able to predict the foreign exchange volatility and absorb the risk. So only those entities with strong balance sheets, proven cash flows are able to tap into this segment. The London Stock Exchange was pointed out as the platform where a number of Indian corporates have raised significant capital through the masala bond route.

   Specialist Fx funds can provide support to the more traditional borrowing routes. Investors or investees can partner with these funds to bring the overall cost of borrowing down.

   Experts pointed out that a large untapped pool is the Indian diaspora community that would be keen to invest (not just donate) into the Ganga Rejuvenation programme. The current structures make it difficult for them to find investable projects. Efforts must be made to create more investable securities to attract the investment of the diaspora communities.

   Tokenisation was highlighted as one such instrument that can create an investable security. Through this process underlying securities are broken up into smaller chunks called a token, each securitised against a piece of the project-asset.

   The securitisation is done through the help of technologies such as blockchain. Listing tokens on an international stock exchange, like any other security, can allow investors to invest without the underlying project or project sponsor having to go through the entire process.

3. In order for capital markets or any other source of capital provider to function efficiently, there must also be in place the right risk management and reduction framework. The water markets in India are still very nascent. Water is essentially seen as a public good and unlike other utilities such as power, gas, telecom, isn't yet traded publicly. The commerce around water is still done through concession agreements. The contractor who constructs and delivers the water treatment process, gets paid on delivery. In most cases the off-taker is a Municipal entity or an urban local body which do not yet enjoy good credit ratings.

   This creates a risk for the provider of the services who may find it delays or defaults in receiving their payments. NMCG has entered as a guarantee provider in this scenario that assures the contractor, lenders and investors of their payment assurance.

   This structure can be further improved by providing a credit rating to NMCG which will allow investors globally to provide capital to NMCG. But for that NMCG must also move towards revenue generation by creation of water markets and taking out a few basis points from the transaction for providing the guarantees.

   Experts pointed out that this mirrors the function of institutions such as GuarantCo, an explicit guarantee provider to projects in emerging markets. Others suggested setting up of dedicated WATER BANK which will provide project finance, guarantees and insurance products for the water sector.

A LARGE UNTAPPED pool is the Indian diaspora community that would be keen to invest (not just donate) into the Ganga Rejuvenation programme. The current structures make it difficult for them to find investable projects. Efforts must be made to create more investable securities to attract the investment of the diaspora communities.

D.5 Financing Technology and Innovation Commercialization

DAY 3:
Friday; December 7, 2018;
09:00 - 10:30 h

VENUE:
Vigyan Bhawan, New Delhi

MODERATOR:
Sanmit Ahuja
[Expert Member, cGanga];
Rozy Agarwal [ED Finance, NMCG]

PANELISTS:
Jana Hamel
[Managing Partner, ArkaTap – UK];
Jennie-Marie Larsen [ALCHEMY AI];
Nupur Bahadur [TERI];
Raja Venkataramani
[Powertec Engineering Pvt. Ltd.];
Sanjeev Srivastava [Aktion India];
Sumit Selli [LAS Group Ltd.]

D5.1. PROBING THOUGHTS

The success of critical infrastructure programmes such as the Ganga Restoration and Conservation depends a lot on the introduction of new technologies and innovations that accelerate the development of decentralised infrastructure.

These technologies complement the large infrastructure projects by filling in gaps such as reaching out to remote or inaccessible urban areas and increasing the rate of project deployment. These solutions also hold great promise in bringing the overall capital and operational costs down.

But the inventors of these technologies face a crucial barrier in introducing the solutions to market and that is "lack of financing showcase and demonstration projects".

The solutions, as good as they may be, require the Government to procure them through an open and transparent tender mechanism. However, if the technology is novel and innovative then it would be difficult if not impossible to find its operating parameters and technical specifications in the public domain, making the task of writing terms of reference for a tender even more challenging. This puts the proponents of the technologies in a "chicken-and-egg" situation i.e. to be selected for a Government project, the technologies must go through a tender, and to write the tender document the Government would want to see the technology operating.

The last few years has seen unprecedented levels of investment going into innovative companies via the venture capital route. The financing has largely been in the digital, e-commerce, software sectors where the investment required is relatively low compared to infrastructure asset classes. The costs of repeated testing and failing are insignificant in the software area, but in the engineering sector the cost of a single test can run into crores of rupees (or millions of dollars). The large quantum of investment makes the investment level fall outside the scope of many of the venture financing companies.

The large engineering companies and infrastructure developers can also double up as source of investment. But on the flip side, if large companies are bringing these solutions to market then they will be much more expensive since many layers of

overheads and marketing costs are added to the underlying solution cost. There are many Government programmes, such as India's Global Innovation and Technology Alliance (GITA) or Europe's horizon 2020 that support innovations. But the level of capital provided is no where near the level needed, and more importantly these programmes are cross-cutting and will never focus their entire efforts on a single sector, in this case water, and a particular region, in this case the Ganga River basin. Therefore, if Ganga Restoration and Conservation and other similar large programmes have to succeed then they must establish their own technology and innovation commercialisation financing mechanisms.

One such process being implemented by the National Mission for Clean Ganga is the Environment Technology Verification programme ETV. This process creates a streamlined pathway for technology pilots and demonstration projects. The Government of India underwrites the cost of the pilot project provided the technology goes through a two-step diligence process. The first is a presentation to a panel of experts. The panel shall not only assess the technical aspects of the solution but also its commercial aspects. If the solution is recommended by the panel, the Government shall issue a sanction letter to the applicant confirming to reimburse the eligible costs of the pilot project provided it meets the mutually agreed success parameters. In the second step, the applicant goes forward to implement the pilot project and on successful execution claims back the costs. This provides a win-win for all parties where the Government supports the introduction of new technologies but without taking the technical risk which must be the technology provider's responsibility. The technology provider gets the comfort that it can claim the costs back once the solution has been implemented successfully. Both parties are able to assess the technology in real operating environment. But the process doesn't still address the problem of companies being able to find the investment needed to put the capital. Commercial banks are unlikely to support such projects as the companies are likely to be small start-up initiatives. The following financing actors can fill this gap making it a unique publicprivate-partnership to address one of the biggest environmental threats facing humanity:

a. Venture Capital
b. Development Finance Institutions
c. Philanthropic Investors
d. Strategic Corporates
e. Export Finance Institutions

The collaboration could take the following nature:

1. Setting up of a dedicated investment fund to support the introduction of new technologies. The fund managers would only invest into the pilot projects provided the technology company has received the sanction letter from the Government which means they have cleared the rigorous technical and commercial duediligence (DD) process. This will be a huge value add for the fund managers since the DD costs are being taken over by Government of India.
2. Provide testing and evaluation sites – Many industries and corporates can lower the cost of the evaluation of the technologies by providing a test site in their industrial process facilities. This makes the evaluation process even more real as the technology would be tested at live sites.
3. Indigenising technologies – Many technology companies can partner up with Indian engineering companies to develop, assemble, integrate and deliver the solution out of India. This approach also fits in neatly with the Make-in-India programme.
4. Technology Co-development – Many universities and research institutions can partner up with the technology company to co-develop the solution thereby lowering the cost of the pilot project.

These are just some select structures amongst many others to develop a technology and innovation commercialisation programme.

IF GANGA RESTORATION and Conservation and other similar large programmes have to succeed then they must establish their own technology and innovation commercialisation financing mechanisms.

VALEDICTORY SESSION

Sunderban Delta

- River Basin Management as an Embedded Cyclic Process
- Challenges in Funding for STPs (Capex/Opex)
- Rupee Shrinkage in State and Center Funding
- Sustainability Challenges of the States and Recommendations
- Science, Engineering & Operations Issues and Recommendations
- Water Economics – Creating Enabling Environment for Sustained Infrastructure Management
- Technology and Innovation – Exhibits & Presentation: Decentralized Wastewater Treatment
- Finance and Investments Issues and Recommendations

1. River Basin Management as an Embedded Cyclic Process

1.1. GENERAL DESCRIPTION

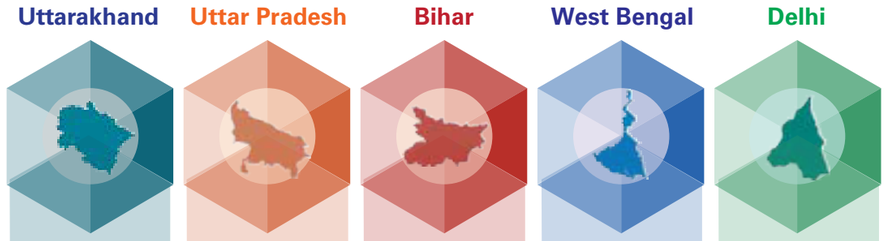
The revival and conservation of rivers are a dynamic process dependent on changing human needs and activities and developments in river science. Quite often, interventions for river conservation are decided on ad hoc basis without due diligence. For achieving the desired goal, however, river conservation should begin with the understanding of river processes and impacts of human activities, and followed by active involvement of stakeholders through communication and negotiations, strategy and policy formulations, legislation (if needed), planning, resource allocation, design, implementation and governance of interventions, and finally their monitoring and feedback. Together these sequential steps constitute a cyclic process that need to be repeated over time based on feedback from the previous cycle, new scientific insights, and/or new anthropogenic impacts coming to light.

2. Challenges in Funding for STPs (Capex/Opex)

2.1. GENERAL DESCRIPTION

There exists a huge gap between the existing sewage treatment capabilities and the actual treatment requirements in the Ganga River Basin as shown in the figure below. The key challenge in bridging this capacity gap is not in terms of scientific or technological knowledge but in terms of providing resources for the establishment of sewerage systems and STPs and, notably, their long-term OM&R requirements (Opex). Central, State and Local Body governments must take cognizance of these needs from a long-term perspective and mobilize or provision for adequate resources for a lasting solution.

2.2. STATES CURRENT STP STATUS AND REQUIREMENTS



	Uttarakhand	Uttar Pradesh	Bihar	West Bengal	Delhi
Population (Urban Census 2011)	30,49,338	4,44,95,063	1,17,58,016	2,90,93,002	1,63,68,899
Estimated Sewage Generation (MLD)	329	4,805	1,270	3,142	1,768
Existing Treatment Capacity (MLD)	109	2,709	224	448	1,504
Gap in Treatment Capacity	220	2,097	1,046	2,694	264

Note: Calculations done for Urban setting across states

2.3. Challenges in Funding for STPs (Capex/Opex)

	Uttarakhand	Uttar Pradesh	Bihar	West Bengal	Delhi
OPEX required for:					
Running Existing Treatment (Cr/Yr)	317.55	7,892.22	652.59	1,305.17	4,381.65
Gap in Treatment (Cr/Yr)	640.93	6,109.26	3,047.35	7,848.52	769.12
Total Sewage Generation (Cr/Yr)	958.49	13,998.57	3,699.93	9,153.69	5,150.77

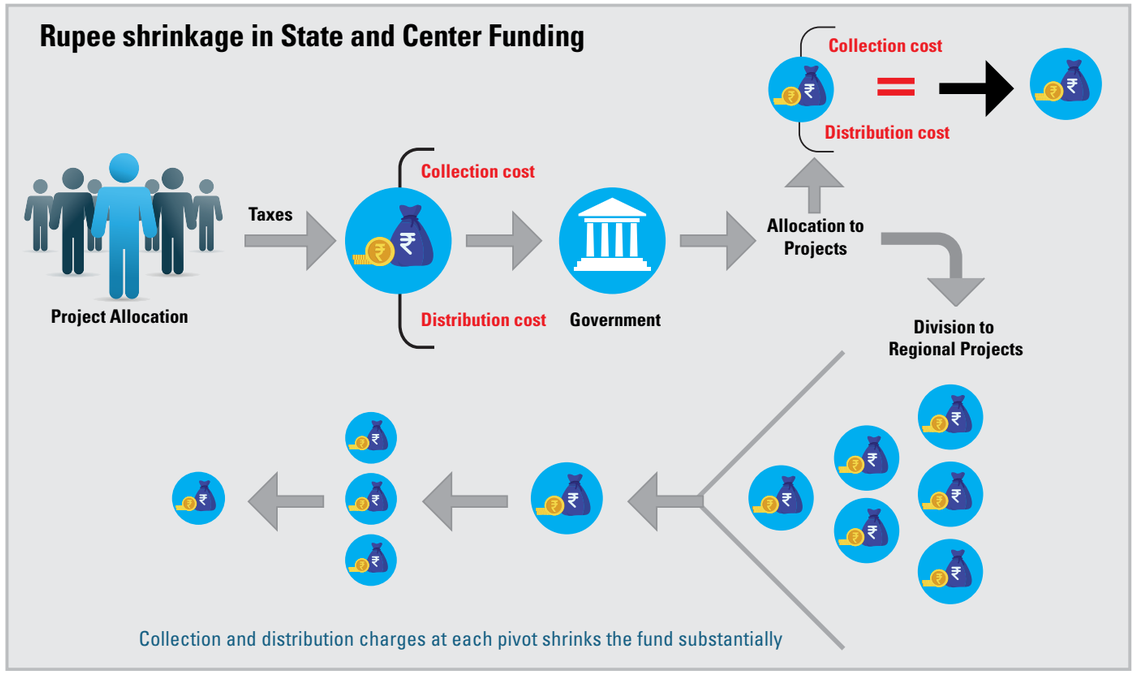
Note: Calculations done for Urban setting across states

QUITE OFTEN, INTERVENTIONS for river conservation are decided on ad hoc basis without due diligence. For achieving the desired goal, however, river conservation should begin with the understanding of river processes and impacts of human activities, followed by active involvement of stakeholders through communication and negotiations, strategy and policy formulations, legislation (if needed), planning, resource allocation, design, implementation and governance of interventions, and finally their monitoring and feedback.

3. Rupee Shrinkage in State and Center Funding

3.1. GENERAL DESCRIPTION

Governmental allocations for public wastewater management systems diminish in value as the funds are repeatedly sub-divided and distributed to State/ Regional levels, project levels and sub-project levels, with undue expenses/ losses at each sub-division. Effectively there is significant diminution in funds at the implementation stage. The value for money spent can obviously be much higher when project funds are decided and allocated at the level of Local Bodies who are directly responsible for the outcomes. Can this become the norm for municipal wastewater management in future?



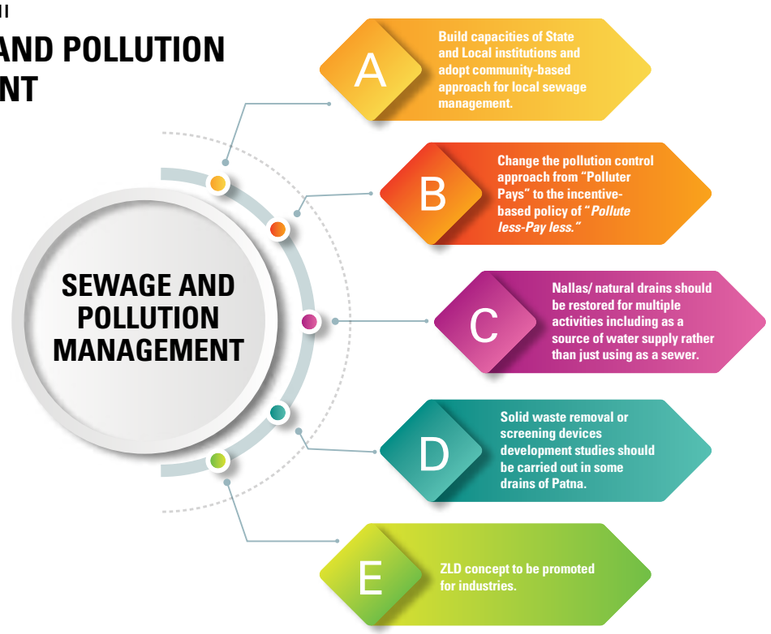
4. Sustainability Challenges of the States and Recommendations

The key recommendations for the five Ganga Basin States (Uttarakhand, Uttar Pradessh, Delhi, Bihar and West Bengal) emerging from the Summit are summarized below.

A. RIVER

- Runoff ultimately goes to the sea but it should go slowly after multiple uses and groundwater recharging.
- To clean the river — check pollution locally at grass-root levels.
- Ghats and riverfront designs should include local socio-cultural aspects.
- Studies to be done for behaviour change and trend analysis of rivers.
- Plantations to be encouraged along rivers to regulate runoff and sediment flows.
- Earthquakes and landslides in upper reaches causing siltation and rise in bed levels should be considered for pre-emptive remedial action.
- To safeguard river space, the land in river corridors should be purchased by the Government for afforestation (as is done for National Highways).

B. SEWAGE AND POLLUTION MANAGEMENT



- All tributaries of the Ganga should be taken up for conservation, not only the Alaknanda and Bhagirathi rivers.
- Entire basin approach should be used to address even local problems.
- An international working group led by cGanga should be constituted for addressing the problem of river siltation.
- Decrease abstractions from Ganga river at Bhimgoda Barrage.

C. POLICY

- Prioritize prevention rather than cure for pollution management.
- Education on the impact of Water and Wastewater Management on Health and Ecology to be spread in schools.
- Micro-planning and integrated planning should be done together for the conservation of both the main river and its tributaries.
- Institutional capacities must be built in States and Local Bodies for handling new sewage treatment technologies.
- Appropriate policy changes are needed to tap global capital, technology infusion and innovations.
- Plan future urbanization and pilot new technologies as per ETV process framed by cGanga.

D. OTHER RECOMMENDATIONS

- cGanga to develop Working groups (cGanga, NMCG, CPCB and states) for further understanding on various aspects of river/ water management and produce standard guidelines
- Education on the impact of Water and Wastewater Management on Health and Ecology to be spread in schools.
- Funds from the Central Government to States for water & wastewater management should be given as loan and not as grants.
- Create/promote social impact bonds.
- Create a governmental platform to stimulate Green Industries in the basin.
- Notification of Eco-sensitive zones in Uttarakhand State may need to be modified.
- Balance between ecology and development to be decided from long-term perspective.
- Horticulture and forestry should be linked with livelihood of people.
- Floating population to be taken into consideration for any new plan executed in Uttarakhand state.
- States should be involved in policy making, deciding priority actions and allocating funds for various states as well as activities.

STATES SHOULD
be involved in policy making, deciding priority actions and allocating funds for various states as well as activities.

5. Science, Engineering & Operations Issues and Recommendations

5.1. AFFORESTATION & BIODIVERSITY

The forests and grasslands play a key role in the overall basin environment:

- Arresting high flows.
- Arresting soil erosion.
- Purifying water and air.
- Improving soil health
- Moderating climatic and hydrological extremes.
- Increasing terrestrial biodiversity and aquatic ecology.
- Managing natural disasters.
- Flood zonation and river bed zonation along river corridors need to be done.
- Appropriate tree species for the restoration program should be selected appropriately for different zones and reaches.
- Community participation is essential for simple river health assessment. Programs by WII such as Bal Ganga Prahari, Ganga Prahari, and plans to initiate Pravasi Ganga Prahari and Ganga Grandmas to be further pursued to address cultural aspects of Ganga.
- Concepts of terrestrial systems do not necessarily apply for aquatic systems, and should not be applied wholesale on rivers.
- Ecosystem activity awareness programs should be facilitated.
- A Working Group (comprising cGanga, WII, WWF, CIFRI and FRI) will develop further understanding on various aspects of biodiversity and afforestation.

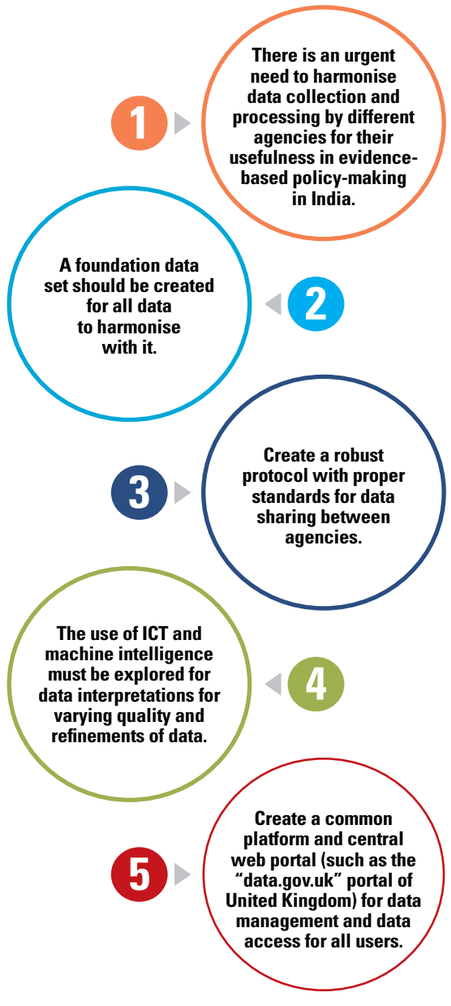
5.2. URBAN RIVER/WATER MANAGEMENT PLAN (URMP)

- Treat sewage as close to source as possible.
- Urban river management plan to be used as a tool to balance the twin goals of clean water and urbanisation.
- Solution to be found out on how to utilise the limited number of rainy days in a year.
- Out of 27% green area in the basin, 5% should be dedicated to water bodies
- Regulate the flow of water through city by means of a city 'structure plan'.
- Socio-economic perspective should be included in planning riverfronts.
- Commercialisation of religious festivals like Kumbh Mela festival should be changed to creating awareness about water needs and availability as a lot of valuable water is diverted for such congregations.

RESIDENT WELFARE ASSOCIATIONS

(RWAs) of housing colonies or other organizations of local community settlements may be entrusted with management of their local water infrastructure and water bodies.

5.3. DATA HARMONIZATION



5.4. DECENTRALIZED INFRASTRUCTURE AND DEVELOPING WATER BODIES THROUGH REUSE OF TREATED SEWAGE/TRADE EFFLUENTS

The vital importance of urban water bodies for basin ecology and urban environments must be recognised.

- Decentralization of urban water infrastructure in the Ganga basin can be a very useful measure for reviving and maintaining urban water bodies and drainage.
- Urban planning should involve a comprehensive development and management plan for the cities' water bodies.
- RWAs (Resident Welfare Associations) of housing colonies or other organizations of local community settlements may be entrusted with management of their local water infrastructure and water bodies, subject to suitable relaxation of Namami Gange's norm of "One City - One Operator."
- Local and household water use must be metered, and wastewater discharges should also be monitored to ensure efficient water management.
- Where water bodies are largely used by local communities on use-discharge-reuse basis, the micro-water equilibrium concept should be used to assess its suitability and performance. Regular replenishment of such water bodies with storm water or from upstream storages will keep the waters fresh and control the possible build-up of TDS.

6. Water Economics – Creating Enabling Environment for Sustained Infrastructure Management

- Water markets need to be developed in India to overcome demand-supply mismatches and save water.
- For a water-secure future, a pan-India regulatory framework on water pricing and regulation should be evolved taking into consideration the overall water availability, different sectoral needs, and water use efficiencies.
- Metered payments for all consumers with differential pricing for poorer consumers recommended.
- Public incentives to save water and minimise wastewater generation should go hand-in-hand with penalties for overuse or wastage. For example, for municipal consumers depending on water availability a certain minimum amount of water supply (e.g. 50 lpcd) can be supplied free, while beyond this limit telescopically increasing prices should apply to prevent wastage and control over consumption.
- Some pressing questions that need to be resolved at the earliest are: (a) Can there be a pan-India policy for water price fixation, or should such policies be framed by State Governments? (b) What should be the regulatory framework for water markets?

7. Technology and Innovation– Exhibits & Presentation: Decentralized Wastewater Treatment

The Technology & Innovation platform of IWIS–2018 attracted diverse innovative technologies, products and/ or applications for water and wastewater management from many national and international firms. The session included 16 such presentations viz.: municipal and/or industrial wastewater treatment by duckweeds (Lyndon Water, UK), vermi-filtration (Wastewater Wizard, UK), UV technology (Trojan Technologies, Canada), anaerobic treatment (Andicos, Belgium), compact modular systems (GV Solutions, Spain); solid waste treatment through gasification, pyrolysis and plasma (Boson Energy, Luxemburg); recycling of polymer-based wastes like tyres (Ground Recycling, UK); composite waste treatment by thermal hydrolysis process (Cambi, Norway); a decentralized vacuum-operated sewer collection and transportation system (Qua-Vac, Netherlands); hydromembrane based farming technology (Mebiol, Japan); industrial fermentation technology for organic wastes (Blue Sky Bio, UK); low-head river hydropower generation system (Scotstream, UK); a dedicated microsatellite to produce high resolution multispectral images for the Ganga Basin (Space SI, Slovenia); Artificial Intelligence application for flood management, agricultural water management, etc. (Alchemy AI, UK); an IoT (Internet of Things) platform for agro-meteorological application (Sense Qube, India); and a mobile app for aggregation and trading of resource-recoverable residues/ wastes (GMEX–Greensphere, UK). The technologies of Lyndon Water (UK), Wastewater Wizard (UK), GV Solutions, (Spain), Boson Energy (Luxemburg), Cambi (Norway), Qua-Vac (Netherlands), Ground Recycling (UK), Scotstream (UK), Blue Sky Bio (UK), SenseQube (India), and GMEX–Greensphere (UK) were recommended to follow the ETV process advocated by cGanga. The technologies of Alchemy AI (UK), Trojan Technologies (Canada), Andicos (Belgium), and Mebiol (Japan) were recommended to be further developed and/or tested in cooperation with cGanga, IIT Kanpur.

THE TECHNOLOGY

& Innovation platform of IWIS–2018 attracted diverse innovative technologies, products and/or applications for water and wastewater management from many national and international firms.

SOME PRESSING

questions that need to be resolved at the earliest are: (a) Can there be a pan-India policy for water price fixation, or should such policies be framed by State Governments? (b) What should be the regulatory framework for water markets?

8. Finance and Investments Issues and Recommendations

A. DEEPENING THE PROJECT FINANCE POOLS FOR DEVELOPERS AND CONTRACTORS

- The water sector must come under the priority lending sector in order to enable Indian banks to provide more liquidity into the sector.
- Developing water markets must be a priority for the Government in the long run as otherwise it will find itself constrained in its ability to continue to finance or backstop water offtake.
- It is imperative to establish the financing value chains that make available capital as the project develops from one stage to another. The three distinct financing phases are: project development, project construction, and project operations and maintenance. The different risk profiles of each stage warrant engagement with different investor categories.
- Establishment of a water finance bank can be a clear game changer for the sector. This will enable the financing teams to clearly understand the risks associated with the water sector and provide the requisite lending to the developers in the early stages of the market development. Existing banks could assume this role as opposed to establishing a new entity altogether, particularly since the role of such an entity would be to jumpstart the market.

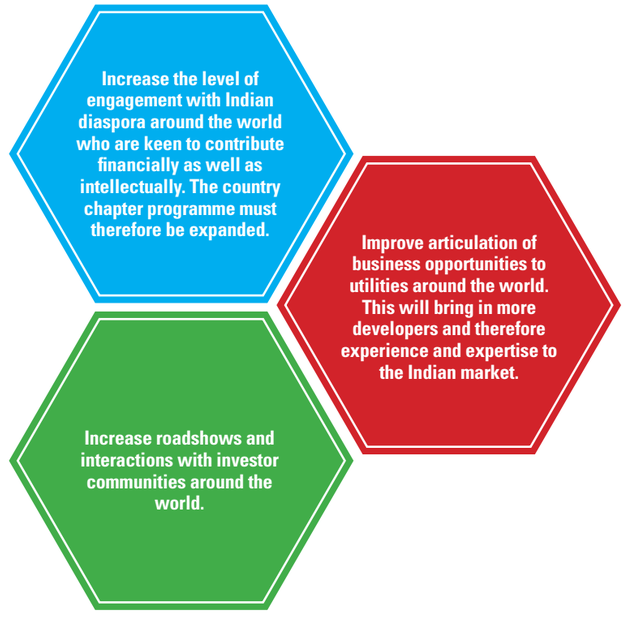
B. INCREASING NMCG'S OWN REVENUE BASE AND FINANCING CAPACITY

- The hybrid annuity model has been well received by developers and lenders alike. Lenders however want greater clarity on whether NMCG will have enough capital for the entire duration of the concession period. This can be only addressed through increasing NMCG's financing capacity and provide it a steady revenue stream through a cess (such as one available in the roads sector for NHAI).
- The financing industry must work alongside with the NMCG and project contractors to develop specific guarantee and credit enhancement instruments. This will enable faster and cheaper lending to the underlying projects.
- By strengthening NMCG's balance sheet and giving it a credit rating, the credit offtake risk for lenders will be significantly reduced. Subsequent issuance of a water/Ganga bond will also give the financial markets confidence to invest greater sums in the rejuvenation programme.

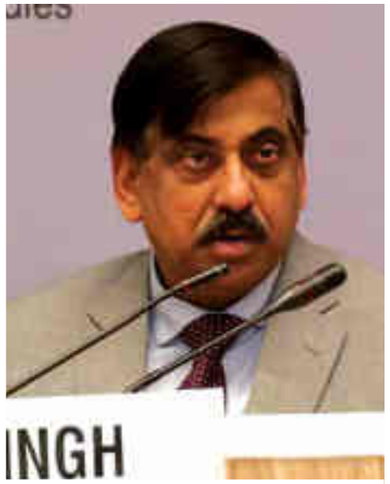
C. ACCELERATING TECHNOLOGY AND INNOVATION FINANCE

- The ETV pilot programme is a step in the right direction to increase the rate of technology transfer and innovation in the water and environment sector in India. The programme should be expanded rapidly as soon as a critical mass from the first set of shortlisted companies are able to graduate through to successfully establishing their pilot/demonstration projects.
- Bringing in corporate and impact investing partners into supporting the ETV programme can have a profound and long-term positive impact.
- cGanga must consider the prospects of setting up a dedicated fund for the ETV programme.

D. OTHER SUGGESTIONS



VALEDICTORY SESSION



Engage with Us

A. ENGAGEMENT MODELS DURING THE IWIS (ANNUAL SUMMIT)

The Summit is a great multi-disciplinary platform to showcase your efforts, solutions, knowledge through a range of strategic engagement plans. These are:

Strategic Partnerships
This engagement mode is for Government departments at all levels (central, state, municipal), public sector entities, multilateral institutions, NGOs, foundations who wish to deepen their strategic engagement with India for the Ganga Restoration and Conservation programme. It could entail releasing a special report, initiating a project, highlighting select areas of work or any other initiatives.

Sponsorship
For private sector companies or entities wanting brand recognition, the Summit offers a multitude of opportunities including but not limited to hosting lunches and networking events, display of special solutions and other showcases. Please get in touch with the Summit team for more details.

Technology and Innovation Showcase
Companies or organisations that have developed solutions, which have the potential of high impact in Ganga River Basin, can get an opportunity to present to stakeholders, potential Indian partners and investors.

Knowledge Partners
Professional Services firms and Knowledge oriented institutions are invited to partner with cGanga and NMCG to prepare and launch a number of special reports during the Summit as well as curate and organise the various Summit sessions.

B. ONGOING ENGAGEMENT MODELS

WORKING GROUPS AND TASK FORCES
Interested parties can channel their novel ideas through dedicated task forces and working groups. These groups have indepth deliberations which are summarised in form of whitepapers submitted to Government and various stakeholders. The working groups are a sub-set of 5 major task forces:
1. Science & Research
2. Engineering & Operations
3. Technology, Innovation, Entrepreneurship & Skills
4. Policy, Law & Governance
5. Finance & Investments

INTERNATIONAL CHAPTERS AND ROADSHOWS
cGanga and NMCG regularly conduct international roadshows to increase the outreach and awareness. Additionally, countries can establish their own local country chapters to channel the collective innovation and interest into India.

PILOTS/ DEMONSTRATION PROJECTS
Companies interested in introducing their solutions into the Ganga Restoration and Conservation programme can do so through pilot/demonstration projects. They must however first go through the Environment Technology Verification (ETV) process. This allows the stakeholders to assess the technologies and ascertain value for money.

Partnership Framework 2018–2020

ABOUT cGANGA

The Centre for Ganga River Basin Management and Studies (cGanga) is an eminent think-tank and the knowledge partner to the National Mission for Clean Ganga (NMCG). It was set up in 2016 under the aegis of then Ministry of Water Resources, River Development and Ganga Restoration and Conservation (now Ministry of Jal Shakti), Government of India. cGanga is managed by the Indian Institute of Technology, Kanpur (IIT Kanpur) but also includes many of India's premier science, technology, research and innovation institutions. Its core mandate is:

- To Evolve the Ganga River Basin Management Plan (GRBMP)
- Deliver Multi-Stakeholder Management
- Establish a global hub for river Science, Innovation and Management
- Develop a Strong Advocacy Forum for Ganga

In delivering its mandate, cGanga engages with all types of entities: Governmental, multi-laterals, public sector, private sector and non-governmental organisation. Many of these organisations have in their charter to support the sustainable development agenda that fits well with the overall vision of restoration and conservation of the rivers of the Ganga River Basin. The size and magnitude of the Ganga Restoration and Conservation programme requires that all actors and stakeholders collaborate and partner with each other to move closer to the goal.

cGanga HAS FOUR STRATEGIC PARTNERSHIP AVENUES

IMPACT INVESTING PROGRAMME
For investors that are keen to support the implementation of high impact initiativesthat willtransform the lives of people in the Ganga River Basin.

WORKING GROUPS
For organisations that are keen to support the development of a very specific policy solution, business model, financing framework or an integrated water resources management approach.

SUPPORTERS OF ADVOCACY AND OUTREACH
For organisations that are keen to support the general advocacy and outreach of the Ganga Restoration and Conservation programme that is popularly known as Namami Gange Programme.

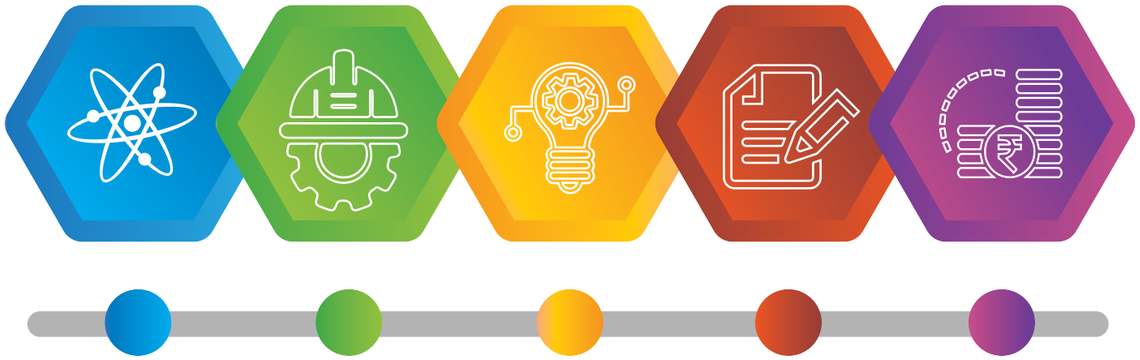
ESTABLISHMENT OF THE GANGA KNOWLEDGE CENTRE
For organisations that are keen to support the development of an advanced data, informatics and knowledge centreto supportthe developmentwith focus on conservationof Ganga River Basin.

Partnership Framework 2018–2020

WORKING GROUPS

cGanga is developing numerous working groups that shall contribute significantly to further the evolution and implementation of the Ganga River Basin Management Plan. Both Indian and international experts are invited to contribute through defined working groups and task forces. The working groups are being set up to deliver progress on the development of very specific aspects of Ganga River restoration and conservation including policy recommendations, financial instruments and business models. The working groups are set up in 5 categories as highlighted in the illustration below:

cGanga has established the following task forces and working groups for various people and interested parties to participate in the efforts.



SCIENCE & RESEARCH (SR)

WORKING GROUPS

1. Criteria for sewage treatment and river water quality
2. Water use efficiency in agriculture sector
3. Management of fixed dissolved solids and completing the natural salt cycle
4. Managing surface and ground water interaction
5. Hydraulics of river channels
6. River Health Report card framework
7. Assessment of Ecosystem services

ENGINEERING & OPERATIONS (EO)

WORKING GROUPS

1. Sustainable hydropower
2. Developing canals and urban natural drains for recreation and surface transport
3. Urban river management plan development
4. Inter-linking of water bodies at city/state scale
5. Compact/packaged wastewater and solid waste treatment solutions
6. Resource Recovery

TECHNOLOGY, INNOVATION, ENTREPRENEURSHIP AND SKILL DEVELOPMENT (TIES)

WORKING GROUPS

1. Data generation through sensor networks, remote sensing– satellites, drones & LIDAR
2. Data modelling, information and analytics
3. Developing a skilled workforce in the water sector
3. Inspiring entrepreneurship in the water sector
4. Environment Technology Verification

POLICY, LAW & GOVERNANCE (PLG)

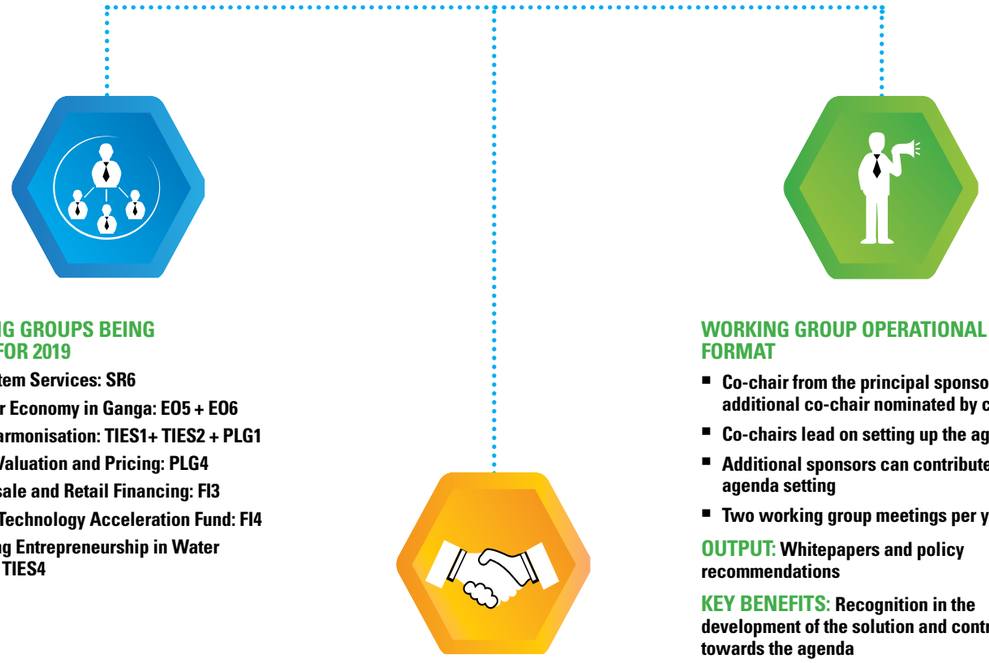
WORKING GROUPS

1. Evidence based river basin management
2. Legislation and institutional framework
3. Stakeholder outreach and management
4. Watertrading, valuation, pricing and development of a tariff regime

FINANCE & INVESTMENTS (FI)

WORKING GROUPS

1. Efficacy of PPP and Hybrid PPP models
2. Developing a Water Trading Corporation framework via enhancing credit rating of NMCG
3. Wholesale and Retail financing instruments
4. Ganga technology acceleration fund



WORKING GROUPS BEING SET-UP FOR 2019

1. Ecosystem Services: SR6
2. Circular Economy in Ganga: EO5 + EO6
3. Data Harmonisation: TIES1+ TIES2 + PLG1
4. Water Valuation and Pricing: PLG4
5. Wholesale and Retail Financing: FI3
6. Ganga Technology Acceleration Fund: FI4
7. Inspiring Entrepreneurship in Water Sector: TIES4

WORKING GROUP OPERATIONAL FORMAT

- Co-chair from the principal sponsor and an additional co-chair nominated by cGanga
- Co-chairs lead on setting up the agenda
- Additional sponsors can contribute in agenda setting
- Two working group meetings per year

OUTPUT: Whitepapers and policy recommendations

KEY BENEFITS: Recognition in the development of the solution and contribution towards the agenda

WHO CAN/SHOULD JOIN

Working groups are initially set up jointly with

organisations that have a strong interest in the topic

and are willing to play the thought-leadership role

PRINCIPAL SPONSOR

- The organisation wanting to spearhead the Working Group agenda shall nominate a senior individual as a co-chair and leads on the agenda development jointly with cGanga

ASSOCIATE SPONSORS

- Contribute to the working group agenda

INDIVIDUAL EXPERTS

- Additional national and international experts will also be invited to participate in the working group

IMPACT INVESTING PROGRAMME

The Ganga Restoration and Conservation programme can only accelerate with strong partnerships with national and international impact investors. cGanga has developed a comprehensive impact investing partnership framework to streamline and coordinate investor interest. It invites Impact Investors to participate in or develop the following financing avenues and instruments:

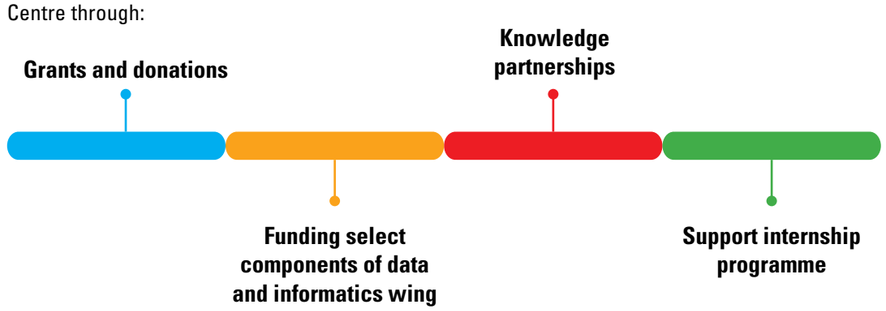
FINANCING AVENUE / INSTRUMENT	STRUCTURE
1. Ganga Technology and Innovation Fund cGanga invites global asset managers in jointly developing strategic and high impact funds that will accelerate the introduction of innovations and new technologies for the Ganga restoration and conservation programme. At this point in time funding in following categories is being sought: a. Decentralised waste water treatment b. Data and information analytics c. Ancillary services and indirect pollution abatement such as solid waste management	New fund(s) set up jointly with existing and experienced asset managers. **cGanga's Contribution** ■ cGanga will provide detailed fund set-up criteria ■ Due diligence on technology and impact on Ganga through the ETV process ■ Proprietary deal flow ■ Organising global investor roadshows **Interim Access to Deal Flow / Warehousing** Until such time these funds are established asset managers can partner with cGanga to get an interim access (or warehousing) to deal flow and due-diligence reports. This will be possible through a membership of the FI4 (Ganga technology and innovation fund) working group.
2. Ganga Bond cGanga invites global financial institutions to jointly develop a Ganga bond that will help in development of this Financial Instrument: ■ Source of funding for municipalities and Government off-takers ■ Secondary buy-out markets for project developers to release their equities and/or source cheaper debt finance	**cGanga's Contribution** ■ cGanga will support in engaging all deal participants ■ Support the institution in bond structuring ■ Deal flow ■ Organising global investor roadshows The interested institutions can support development of the instrument through the working group FI3.
3. Credit Enhancement Instruments cGanga invites family offices and global institutions to develop a range of credit enhancement instruments such as: ■ Shadow/top-up tariffs ■ Insurance ■ Fx hedging structures ■ Back-stop guarantees ■ First-loss	**cGanga's Contribution** ■ cGanga will support in engaging all deal participants ■ Support the institution in instrument structuring ■ Deal flow ■ Organising global investor roadshows The interested institutions can support development of the instrument through the working group FI3.

GANGA KNOWLEDGE CENTRE

COMPONENT	DESCRIPTION
1. Physical Campus	cGanga shall anchor itself in a building designed and developed specially for its activities. The physical campus shall be established within the larger campus of the Indian Institute of Technology, Kanpur.
2. Data and Informatics Wing	The most crucial aspect of the GKC shall be the establishment of the data and informatics wing. This wing shall house the following centres of innovation: **Data Generation and Collation** ■ Through the use of sensor networks, remote sensing through satellites, drones and LIDAR ■ Improvement of past data sets ■ Data harmonisation across data sets **Data Modelling, Information and Analytics** ■ Developing a meta-data framework ■ Big data systems ■ Artificial intelligence and deep learning ■ Data visualisation ■ Interactive data

4. HOW TO ENGAGE

cGanga invites organisations, donors, impact investors to develop the Ganga Knowledge Centre through:



5. ADVOCACY AND OUTREACH

One of the core mandates of cGanga is to increase advocacy efforts for Ganga through better and greater outreach strategies. Organisations whose core beliefs are to support the growth of sustainable development can partner with cGanga to partake in and support a number of outreach and advocacy channels.

COMPONENT	DESCRIPTION
1. India Water Impact Summit	This is the flagship event of cGanga and NMCG which brings all stakeholders together under one forum. Over 500 people participate in this Summit. The Summit provides tremendous branding and marketing opportunities to companies keen on reaching out to all the crucial stakeholders.
2. Lecture Series	cGanga is establishing a strategic lecture series that will invite eminent experts from within India and around the world to share deep insightful knowledge and inspire a generation of water scientists, engineers, entrepreneurs and other experts.
3. Exhibitions	cGanga will establish and develop a network of national and international exhibitions and information kiosks through use of innovative audio-visual technologies and touch-points.
4. International Roadshows and Chapters	International roadshows are being conducted in a coordinated manner to accelerate engagement with water experts and innovation globally. Countries can put in strategic requests to put a roadshow of cGanga and NMCG officials to their country.
5. Twinning Ganga	cGanga and NMCG are inviting other river basins to establish a twinning programme that will enable partnerships and knowledge exchange.

CONTACT DETAILS

Dr. Vinod Tare
Founding Head, cGanga
vinod.tare@cganga.org

Executive Officer–Outreach
eo_outreach@cganga.org

CONTACT DETAILS

General Enquiries and Submissions of Participation Requests:
iwis@cganga.org

For Indian Government Related Queries:
Dr. Vinod Tare
vinod.tare@cganga.org

For International Participation and Partnerships:
Executive Officer–Outreach
eo_outreach@cganga.org

For Media Enquiries:
media@cganga.org

Centre for Ganga River Basin Management and Studies