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Government of India

**NOVEMBER**
**22-24th, 2023**
**New Delhi**

# 8th India Water Impact Summit (IWIS)

Valuing Water | Transforming Ganga

**&**

# 1st Climate Investments Technology Impact Summit (CITIS)

Climate Impact = Deep Technology + Robust Policy + Innovative Finance

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

सत्यमेव जयते
NITI Aayog
National Institution for Transforming India

G20
भारत 2023 INDIA

# A CONSOLIDATED REPORT ON

# 8th India Water Impact Summit (IWIS)

Valuing Water | Transforming Ganga

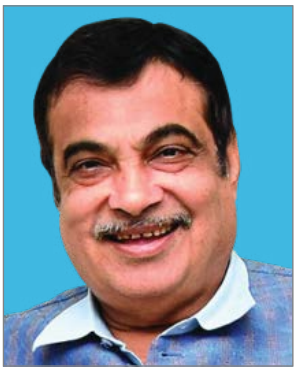
# &

# 1st Climate Investments Technology Impact Summit (CITIS)

Climate Impact = Deep Technology + Robust Policy + Innovative Finance

**22nd - 24th NOVEMBER 2023**

**Dr Ambedkar International Centre (DAIC)**
**New Delhi**



सत्यमेव जयते

Azadi Ka Amrit Mahotsav

सड़क परिवहन एवं राज्यमार्ग मंत्री
भारत सरकार

**Minister for Road Transport and Highways**
Government of India

# MESSAGE

It gives me immense pleasure to know that the 8th India Water Impact Summit and the 1st Climate Investments and Technology Impact Summit (IWIS-CITIS-2023) organized jointly by Centre for Ganga River Basin Management and Studies (cGanga), National Mission for Clean Ganga (NMCG), Niti Aayog and G20 India Secretariat in New Delhi on "*Development vis-a-vis Land, Water and Rivers*" are being held together in New Delhi in during November 22-24, 2023. Given the wide scope of its agenda, I expect the Summit to give us a unique opportunity to view India's steady progress in multiple fields as our economy rapidly overtakes that of many developed countries in recent years.

Today, our country is not only one of the largest world economies, it is also a torchbearer in sustainable development in many ways — our transitioning to green energy, major agricultural advancements, improved educational and healthcare standards, conservation of rivers, water bodies, forests, and wildlife, infrastructure development, and a technological innovation paradigm that are the cynosure of the rest of the world. Among these, My Ministry has made rapid progress in developing our transport infrastructure through a vast network of high-grade roads and bridges, ports and jetties, inland waterways, and much more. Simultaneously, my Ministry has kept in focus the safety and preservation of our ecological assets and cultural and archaeological heritages that are part and parcel of our government's conservation efforts.

I have noted with interest that IWIS-CITIS-2023 will consider many intersections of our land, water and rivers in the context of social and climatic changes such as lifestyle, policy issues, sludge management, reuse / recycling of wastewater, innovations in technology and business, climate investments in the water sector, and a global coalition for river science and management. I wish the joint organisers of IWIS-CITIS-2023 every success for the Summits and look forward to the outcomes.

16 November 2023

**Nitin Gadkari**

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

जल शक्ति मंत्री
भारत सरकार

**Minister for Jal Shakti**
Government of India

# MESSAGE

I am heartened to learn that the twin Summits – the 8th India Water Impact Summit and the 1st Climate Investments and Technology Impact Summit (IWIS-CITIS- 2023) – are being organized in November 2023 by the joint efforts of National Mission for Clean Ganga (NMCG), Centre for Ganga River Basin Management and Studies (cGanga), and Niti Aayog for national and global experts, key stakeholders, technology innovators and investors to probe *"Development vis-a-vis Land, Water and Rivers"* in depth. It is particularly notable that the Summit is being held under the aegis of India's G20 presidency.

At this historical juncture when we have begun to make giant strides in transforming India into a developed country, unforeseen problems have arisen from the world at large – devastating pandemics, internecine conflicts and, of course, the vagaries of rapid climate change leading to increased natural catastrophes. It is remarkable that we have faced these problems with fortitude until now, and remain committed to improving the lives of our billion-plus population at all costs and make us "Atmanirbhar" in all respects. We have made remarkable progress in such people-centric programmes as *Swachh Bharat* and *Jal Jeevan Mission* that have been lauded all over the world. Simultaneously, our government has also focussed on reviving and conserving our water resources and aquatic ecosystems with exemplary programmes for rivers, wetlands, coastlands and aquatic biodiversity along with other terrestrial resources such as forests, wildlife and soils.

I am pleased to note that IWIS-CITIS-2023 will consider both land and water resources together along with lifestyle aspects, sludge management, reuse/recycle of wastewater, technological & business innovations, policy interventions, climate-related investments in the water sector, and establishing a global coalition for river science and management. I am also delighted to learn that IIT Kanpur and National River Conservation Directorate has proposed to set up centres for preparing river basin management plans for Mahanadi, Narmada, Godavari, Krishna, Cauvery and Periyar at 11 Institutes similar to that of cGanga. I wish the organisers of IWIS-CITIS-2023 every success in this venture, and hope that it gives us valuable inputs to shaping our future governmental actions.

16 November 2023

**Gajendra Singh Shekhawat**

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

जल शक्ति एवं खाद्य प्रसंस्करण
उद्योग राज्य मंत्री
भारत सरकार

**Minister of State for Jal Shakti**
**and Food Processing Industries**
Government of India

# MESSAGE

It gives me great pleasure to know that the twin Summits 8th India Water Impact Summit and First Climate Investments and Technology Impact Summit (IWIS- CITIS-2023) are being held in November this year jointly organised by the National Mission for Clean Ganga (NMCG), Centre for Ganga River Basin Management and Studies (cGanga), Niti Aayog, and notably the G20 India Secretariat to deliberate on "*Development vis-a-vis Land, Water and Rivers*" by national and foreign experts, stakeholders, government representatives, technology providers and financiers.

Over the last nine years we have made tremendous progress in forging a common strategy of development with environmental sustainability in India. Thus, while we have made astounding progress in technology, manufacturing, agricultural, health and many other sectors resulting in rapid improvement in the wellbeing and livelihoods of our citizens, we have also improved the conditions of many of our rivers, lakes, wetlands, coastal areas, mangroves, forests and other natural resources through a people-centric and future-ready vision. A lot of our efforts are now also involved in the design and putting in place measures to combat and ameliorate the likely climate change impacts. For this, we definitely need the active involvement of all stakeholders and experts to chalk out a path of minimum risk and maximum benefit in the water sector as also in other areas of natural resource management.

I am extremely pleased that IWIS-CITIS-2023 will deliberate upon land, water and rivers, sludge management, water recycling/ reuse, lifestyle aspects, technology innovations, climate financing for water sector, and global alliance for river science and management. I wish the organisers of IWIS-CITIS-2023 very successful summits, and await their outcomes.

17 November 2023

**Prahlad Singh Patel**

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

जल शक्ति एवं जनजातीय कार्य राज्य मंत्री
भारत सरकार

**Minister of State for Jal Shakti & Tribal Affairs**
Government of India

# MESSAGE

I am glad to know that the 8th India Water Impact Summit and the 1st Climate Investments and Technology Impact Summit (IWIS-CITIS-2023) are being organized by the National Mission for Clean Ganga (NMCG), Centre for Ganga River Basin Management and Studies (cGanga), Niti Aayog and G20 India Secretariat to facilitate the brainstorming of ideas by national and international experts, stakeholders, administrators, technology developers and investors on "Development vis-a-vis Land, Water and Rivers". The co-organization of the Summits by G20 India Secretariat this year is especially welcomed.

India has undergone many fundamental changes for the better in the past nine years ever since the Government of India opened the gates of governance to all stakeholders, resulting in a vibrant exchange of ideas and enthusiastic participation of the whole country in nation-building. The Ministry of Jal Shakti, too, has been actively in the forefront of this drive with a knowledge-based reshaping of our water resource management. On the one hand we have learnt to evaluate our water resources in much greater detail, and on the other hand we have balanced supply against demands much more reliably. These measures may take time to percolate down to state, town and village levels, but our progress has been tremendous so far, with crores of Indian villagers benefitting from our "Har Ghar Jal" programme for instance. Likewise, the Hybrid Annuity mode of STP projects adopted by NMCG has resulted in very satisfactory results that have also been acknowledge by the whole world.

It interest me greatly that IWIS-CITIS-2023 will consider many interactive aspects of land, water and rivers in Twin Summits under one cover, besides technological and business innovations, climate investments in the water sector, and pursuing a global coalition for river science and management in line with Hon'ble Prime Minister's message to the world of "वसुधैव कुटुम्बकम्". I wish the organisers of IWIS-CITIS-2023 all success, and look forward to the recommendations.

18 November 2023

**Bishweswar Tudu**

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

जल शक्ति मंत्रालय
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
भारत सरकार

**Ministry of Jal Shakti Department of Water Resources River Development & Ganga Rejuvenation**
Government of India

# MESSAGE

I am very pleased to learn that the 8th India Water Impact Summit and the 1st Climate Investments and Technology Impact Summit (IWIS-CITIS-2023) are being organized together jointly by National Mission for Clean Ganga (NMCG), Centre for Ganga River Basin Management and Studies (cGanga), Niti Aayog and G20 India Secretariat in New Delhi for many national and international experts, government leaders, administrators, technological innovators, business representatives, and investors to discuss many aspects on many aspects on the theme of "*Development vis-a-vis Land, Water and Rivers*".

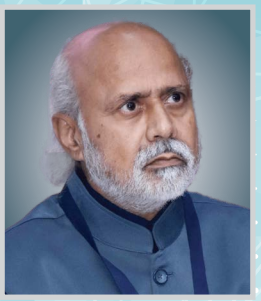
Our country has been growing rapidly in recent times with many spectacular achievements on this earth and in space to our credit. Working with multiple stakeholders, academics and committees, our government's efforts have helped Indians to achieve tremendous improvement in their lives with systemic improvements in agriculture and irrigation, water resources development, rejuvenation and conservation of rivers and water bodies, forests and land management, and other foundational steps. Our ministry is also successfully handling the Namami Gange Mission, which has found a place in the first ten UN World Restoration Flagship programmes.

I am happy to note that IWIS-CITIS-2023 will deliberate upon land and water resources and rivers considering STP sludge management, reuse/ recycle of wastewater, lifestyle aspects, innovative technologies and business models, policy issues, climate-related investments, and a global coalition for river science and management. I wish the dedicated organisers of IWIS-CITIS-2023 all success in their endeavour.

21 November 2023

**Debashree Mukherjee**

# Preface



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

**G ASOK KUMAR**
Director General
National Mission for Clean Ganga (NMCG),
Ministry of Jal Shakti, GoI

On behalf of the Centre for Ganga River Basin Management and Studies (cGanga) led by IIT Kanpur, National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti (Govt. of India), and NITI Aayog, we warmly welcome all participants from India and abroad to the twin summits, 8th India Water Impact Summit (IWIS-2023) and the 1st Climate Investment and Technology Innovation Summit (CITIS 2023).The Namami Gange programme, being implemented by NMCG, is an integrated mission for the restoration and conservation of River Ganga and its tributaries. Towards this goal, a strategic comprehensive Ganga River Basin Management Plan (GRBMP-2015) was developed by a consortium of 7 IITs, which is being further evolved by cGanga led by IIT Kanpur. cGanga acts in the capacity of a comprehensive think-tank to NMCG in its stated goals and objectives vis-à-vis the Ganga River Basin. Namami Gange aims to restore the wholesomeness of the river by ensuring Aviral Dhara and Nirmal Dhara, and maintaining its geomorphological and ecological integrity. Integrated River Basin Management (IRBM) approach is followed in Namami Gange with multi-sectoral and multiagency interventions such as: (i) for pollution abatement (Nirmal Ganga), (ii) for improving river flows (Aviral Ganga) and ecology, (iii) to strengthen people's river connect (Jan Ganga), and (iv) to facilitate diversified research, scientific mapping, and evidence-based policy formulation (Gyan Ganga). India Water Impact Summit, which was started as a one-time event a decade ago, has now become an annual event organized jointly by NMCG and cGanga. In the 7th Edition of IWIS, NITI Aayog extended its support in organizing the event. In the 8th edition we are further delighted that the twin summits are included in the G20 India events.

At the outset, a brief overview of the past seven Summits is outlined here to throw light on the background to the theme of the present IWIS. The first Summit, held in 2012 during the preparation of the Ganga River Basin Management Plan (GRBMP) by the IIT Consortium, was an aggregate of the then prevailing activities on India's water resource management. The 2nd Summit,

# THE EIGHTH SUMMIT,

**focuses on land, water and rivers – their interdependence as healthy systems of nature, that is Samarth Ganga and Productive Land considered together in the context of the national initiative on Lifestyle for Environment**

held in 2017, attempted to establish a new multi-disciplinary, multi-stakeholder forum to bring together policy makers at national and regional levels, technology and engineering firms, finance and investment specialists, and interested civil society members to brainstorm on pressing issues of India's water environment. The 3rd Summit, held in 2018, reviewed the manifold efforts undertaken by government agencies to meet Namami Gange's goals of rejuvenation and conservation of India's National River Ganga, especially in the most critical Ganga Basin States – Bihar, Delhi, Uttarakhand, Uttar Pradesh, and West Bengal. The 4th IWIS in 2019 went further to explore ways and means of integrating science and policy for Integrated Water Resource Management, to assess and prepare for major water impacts in urban and rural areas of India, and developing new and innovative financing mechanisms through the Water Finance Forum initiated in IWIS-2017. The ideas and suggestions that emerged from these four Summits led us to seek comprehensive means to integrate river conservation into India's developmental path in the 5th IWIS (IWIS-2020) from the perspective of Arth Ganga, an ancient Indian concept. IWIS-2020 also intensified efforts to financially strengthen water management and river conservation in India through synergy between planners, executors, financiers, investors and regulatory bodies. A more focused assessment was attempted in the 6th IWIS (IWIS-2021) to evaluate the different types of river resources, their usefulness for ecosystem services for human benefit, and the adverse effects of over-extraction and misuse of these resources on the ecosystem services. This exploration was aimed to help chalk out feasible pathways for sustainable river resource planning and management over the long term to meet the concerns of diverse stakeholders and to aid planners, policymakers and financiers. In order to resolve the issue of divergent impacts of different activities carried out by different agencies and governments for developmental or social purposes, the convergence of five P's, namely, People, Policies, Plans, Programmes and Projects, were considered crucial in the "Samarth Ganga" framework to achieve Sustainable Development Goals (SDGs). Thus, the thrust of deliberations in

# THIS YEAR'S IWIS

**is coupled with another Summit – The Climate Investment and Technology Impact Summit (CITIS). CITIS is streamlined to bind potential investors with technology providers after review and testing of new technologies and innovative business models, implementation of proven new technologies, adopting suitable financing mechanisms, and collaborating within multiple sectors that are intricately linked with climate, air, land, rivers and water management**

the 7th IWIS (IWIS-2022) was to understand, elaborate, delineate potential causes of divergence, and formulate strategies for convergence through collation of views expressed in the Summit.

In the eighth Summit, the focus is on land, water and rivers – their interdependence as healthy systems of nature, that is Samarth Ganga and Productive Land considered together in the context of the national initiative on Lifestyle for Environment. The first issue to be considered is Lifestyle for Land Productivity and Sludge Management, wherein the changing status of agricultural lands under intensive agriculture and how to ensure their sustained health and fertility are to be examined along with the efficient management of large quantities of sludge generated from India's Sewage Treatment Plants (STPs). In the second major issue to be addressed in the Summit, key aspects of Lifestyle for Rivers are to be probed along with the recycle/ reuse of wastewater. The recycle/ reuse of wastewater has been a long-attempted endeavour in the India, and the creation of a Water Market may be the best way to promote cost-efficient recycle/ reuse. Hence ways and means of creating a Water Market need to be chalked out.

Financial resources and technological experimentation, and business innovations are essential for sustained efforts in land and river management, especially in the context of climate change challenges. This year's IWIS is coupled with another Summit – The Climate Investment and Technology Impact Summit (CITIS). CITIS is streamlined to bind potential investors with technology providers after review and testing of new technologies and innovative business models, implementation of proven new technologies, adopting suitable financing mechanisms, and collaborating within multiple sectors such as energy, agriculture, urban management, transport, and infrastructure development that are intricately linked with climate, air, land, rivers and water management. Thus, the first CITIS this year will present new technologies andapplications being developed worldwide that can significantly improve India's river and land management scenario.

Finally, we wish to thank our strategic partners, panellists, speakers, staff and volunteers who have worked hard and contributed enthusiastically to make this Summit a success. We hope that you find IWIS-CITIS-2023 to be as constructive and exciting as the previous seven Summits. We look forward to your valued participation.

# TWIN SUMMITS AT A GLANCE

## Day 1: Wednesday 22 November 2023

| Time | India Water Impact Summit (IWIS) | Climate Investments & Technology Impact Summit (CITIS) |
|---|---|---|
| 1000 – 1130 | | Special Session: River City Alliance<br>**Venue: Conference Hall 1**<br>CITIS 1: ETV/Tech presentations - 1<br>**Venue: Conference Hall 3** |
| 1130 – 1200 | **Tea/Coffee Break** | |
| 1200 – 1400 | **Inaugural Session**<br>**Venue: Bhim Hall** | |
| 1400 – 1500 | **Lunch** | |
| 1500 – 1630 | IWIS 1: Samarth Ganga & Productive Land - I<br>**Venue: Bhim Hall** | CITIS 2: ETV/Tech presentations - 2<br>**Venue: Conference Hall 3** |
| 1630 – 1700 | **Tea/Coffee Break** | |
| 1700 – 1830 | IWIS 2: Lifestyle for & Economics of Rivers - I<br>**Venue: Bhim Hall** | CITIS 3: ETV/Tech presentations - 3<br>**Venue: Conference Hall 3** |
| 1830 – 1900 | **High Tea** | |

## Day 2: Thursday 23 November 2023

| Time | India Water Impact Summit (IWIS) | Climate Investments & Technology Impact Summit (CITIS) |
|---|---|---|
| 0930 – 1100 | **CITIS Plenary**<br>**Venue: Bhim Hall** | |
| 1100 – 1130 | **Tea/Coffee Break** | |
| 1130 – 1300 | IWIS 3: Samarth Ganga & Productive Land - II<br>**Venue: Bhim Hall** | CITIS 4: Investing in Water<br>**Venue: Conference Hall 1** |
| 1300 – 1400 | **Lunch** | |
| 1400 – 1530 | IWIS 4: Lifestyle for & Economics of Rivers - II<br>**Venue: Bhim Hall** | CITIS 5: Investing in Energy<br>**Venue: Conference Hall 1** |
| 1530 – 1600 | **Tea/Coffee Break** | |
| 1600 – 1730 | IWIS 5: Digital Tools for River Basin Management<br>**Venue: Bhim Hall** | CITIS 6: Investing in Waste<br>**Venue: Conference Hall 1** |
| 1930 – 2230 | **Dinner** | |

## Day 3: Friday 24 November 2023

| Time | India Water Impact Summit (IWIS) | Climate Investments & Technology Impact Summit (CITIS) |
|---|---|---|
| 0930 – 1100 | IWIS 6: Inducting Samarth Ganga Concept in Preparing Basin Plans for Six Major Rivers of India - I<br>**Venue: Bhim Hall** | CITIS 7: Investing in Food & Agri<br>**Venue: Conference Hall 1** |
| 1100 – 1130 | **Tea/Coffee Break** | |
| 1130 – 1300 | IWIS 7: Inducting Samarth Ganga Concept in Preparing Basin Plans for Six Major Rivers of India - II<br>**Venue: Bhim Hall** | CITIS 8: Investing in Transport<br>**Venue: Conference Hall 1** |
| 1300 – 1400 | **Lunch** | |
| 1400 – 1530 | **CITIS Valedictory**<br>**Venue: Bhim Hall** | |
| 1530 – 1600 | **Tea/Coffee Break** | |
| 1600 – 1730 | **IWIS Valedictory**<br>**Venue: Bhim Hall** | |
| **END OF 8th IWIS and 1st CITIS** | | |


# INDEX

# E N T S

## INDIA WATER IMPACT SUMMIT (IWIS)



## CLIMATE INVESTMENT & TECHNOLOGY IMPACT SUMMIT (CITIS)

November 22, 2023

# Inaugural Session of IWIS 2023

**INTRODUCTION:**

IWIS-CITIS-2023 was inaugurated with introductory speeches by Mr. G. Asok Kumar (Director-General, NMCG) and Prof. Vinod Tare (Head, cGanga, IIT Kanpur), followed by the speeches of the Chief Guest Mr. Nitin Gadkari (Hon'ble Minister, Minister of Road, Transport and Highways, GoI), Special Guest Ms. Debashree Mukherjee (Secretary, Ministry of Jal Shakti, GoI), and the Keynote Speaker Dr. Igor Papič (Ambassador, Republic of Slovenia). The substantive aspects of the deliberations are presented as follows.

**DAY 1:**
Wednesday, November 22, 2023
12:00 – 14:00 hrs

**CHAIR:**
Vinod Tare [Founding Head – cGanga, IIT Kanpur]
G Asok Kumar [DG, NMCG]

**CHIEF GUEST:**
Nitin Gadkari [Hon'ble Minister, Minister of Road, Transport and Highways, GoI]

**GUEST OF HONOUR:**
Debashree Mukherjee [Secretary, Ministry of Jal Shakti, GoI]

**KEYNOTE SPEAKER:**
Igor Papič [Ambassador, Republic of Slovenia]

## G Asok Kumar, DG, NMCG


NMCG has been holding the Indian Water Impact Summit for the last many years in association with cGanga, with very important decisions and policy matters emerging from it. This time a Green Summit – the Climate Investments and Technology Impact Summit – has been added.

Rivers in India were respected for centuries.

But in the last hundred years or so many rivers got polluted. And many streams dried up. Now many polluted rivers have been cleaned with a commitment of over 40,000 crore rupees, and a lot of technology has also been developed.

We place all our efforts on a scientific platform based on the guidelines set by a consortium of

# WE PLACE ALL

**our efforts on a scientific platform based on the guidelines set by a consortium of seven IITs – the premier technology institutions in this country. We have thus four major pillars of action – Nirmal Ganga for Clean Water in the river, Aviral Ganga for good quantity of water flowing continuously in the river, Gyan Ganga for getting river knowledge, and Jan Ganga for connecting the river and people**


seven IITs – the premier technology institutions in this country. We have thus four major pillars of action – Nirmal Ganga for Clean Water in the river, Aviral Ganga for good quantity of water flowing continuously in the river, Gyan Ganga for getting river knowledge, and Jan Ganga for connecting the river and people. And recently, in 2019, our prime minister, who is the driving force behind the Namami Gange program, suggested the new pillar of Arth Ganga.

The Namami Gange programme has moved from sewage treatment plants to whole scale river basin management, involving people and all stakeholders.

We now have no stretches of polluted river in the main stem of Ganga, with drastically improved river water quality and biodiversity, and the number of dolphins has increased from 2000 to 4500, which is an indication that the water is much cleaner.

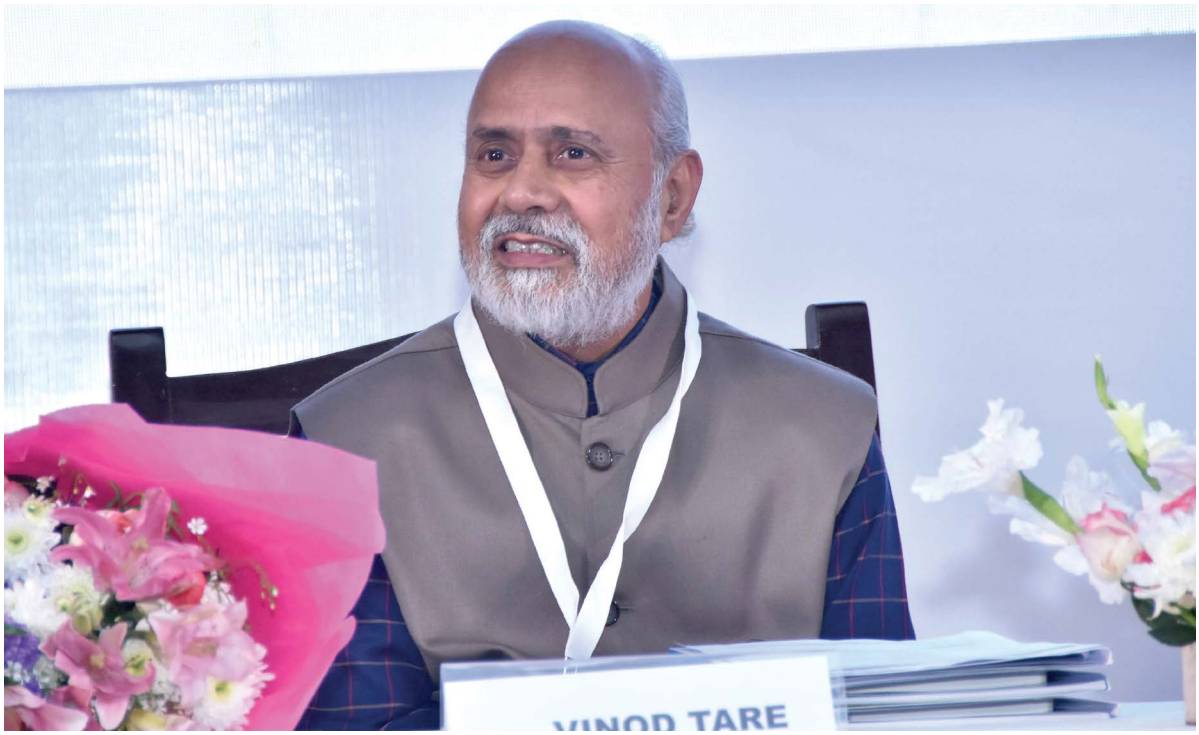
I welcome Shri Nitin Gadkari Ji, our former Jal Shakti Minister, who introduced the very successful HAM model which was a game changer for Namami Gange and is much appreciated by the World Bank and other funding agencies.

The UN has recognized us as one of the top eco-restoration programs in the world.

November 22, 2023

# Inaugural Session of IWIS 2023

## Vinod Tare, [Founding Head – cGanga, IIT Kanpur]




We started the first India Water Impact Summit in 2012. Subsequently, we have continued this exercise on various issues, related to various topics. And the Prime Minister gave us the direction that it should also be related to the economics of the river and the meaning of the river or the spirit of the river.

Our responsibility is to make sure that the ability of the river remains intact, so that the river continues to serve humanity and society forever, and that is what we call Samarth Ganga or capable river.

What is required of us to make sure that a river is Samarth is, first, not obstructing its flow and making sure that it has sufficient water – that is what we call Aviral Ganga. The second responsibility is to make sure that the quality of water that flows in the river is that required for the indigenous aquatic flora and fauna to flourish, which is the concept of Nirmal Ganga. The third pillar is Gyan Ganga – understanding about rivers, and this can be done only when we have public participation, which is the fourth pillar – Jan Ganga. But all this is to have development around rivers, and that is where the concept of the central pillar comes in – Arth Ganga. If we can adopt and strengthen these five pillars, then we will have Samarth Ganga, which is our responsibility.


In earlier Summits we have talked about how to finance various kind of projects, what kind of innovations – technology innovations – should be introduced in India from all over the world. This endeavor has grown sufficiently large for us to have an independent summit on its own, and that is why we have started the Climate Impact and Technology Innovations Summit.

At the road show in London, we saw some promising new technologies, and I'm happy to inform that now those technologies have been Indianized and adopted. Soil-less agriculture is one of these technologies.

We also need the concept of decentralization of sewage treatment with a number of small STPs rather than big centralized ones. So we have tested and piloted another plant in Pune, and now we are ready to scale it up, to a full scale system. Its advantage is that it requires one-tenth of the space as that needed for technologies that are presently being used, and the energy requirement is also less. It's a kind of hybrid of ancient concepts and the novel concepts, adopting modern scientific tools and techniques,

The third thing that we took up is the management of used tires. We piloted a technology to recycle all materials and it can be reused in the industry as well, and we are now ready to scale it up. Without the ill effects of pyrolysis, carbon is recovered in this technology.

Our sugar and distillery sector was a very dirty kind of sector, which was changed by the policy of blending ethanol with diesel. And now people are trying to make not only ethanol but also many other products from sugar. It will help not only in our development, but also in cleaning up our environment.

The president of India, in the joint parliament session in 2019, approved the preparation of river basin plans for six other major Indian River basins through many national institutions all over India along with the experience of cGanga. And, I am delighted to inform you that we are almost ready to lunch establishment of centers for six river basins at many institutions on the lines of cGanga, with leadership and coordination provided by cGanga, IIT Kanpur.

**OUR RESPONSIBILITY**
**is to make sure that the ability of the river remains intact, so that the river continues to serve humanity and society forever, and that is what we call Samarth Ganga or capable river**

November 22, 2023

# Inaugural Session of IWIS 2023

## Nitin Gadkari, [Hon'ble Minister, Minister of Road, Transport and Highways, GoI]


There are three important facets of our society: one is ethics, the second is ecology and environment, and the third is economy.

We have a lot of constraints as far as government budget is concerned, and we need to adopt two important philosophies: one is conversion of knowledge into wealth through innovation, entrepreneurship, science, technology, research, skills and success; and the second important philosophy is conversion of waste into value, since no material or person is waste.

One of our very successful projects was in Mathura, where with 40% government grant and 60% coming from the investor, the Indian Oil refinery is purchasing clean water recovered from 30MLD STP of Mathura at 20 crore rupees per year. The project is economically viable since Indian Oil is saving 5 crore rupees per year by not buying freshwater for 25 crore rupees.

My request to all scientists is, if the technology is good, proven, and economically viable, with availability of raw materials and marketability of the finished product, then we need to find out some way by which it can be implemented with 40% coming from the government and remaining 60% from elsewhere with priority.

Eight years earlier, we decided to sell treated sewage water from Nagpur to Khorade and Khappar Gheda

**WE NEED TO ADOPT**

**two important philosophies: one is conversion of knowledge into wealth through innovation, entrepreneurship, science, technology, research, skills and success; and the second important philosophy is conversion of waste into value, since no material or person is waste**

power projects, and for the last 7 years, we are selling sewage water to the Government of Maharashtra for power projects and earning 300 crore rupees per year. So given the budgetary constraints, we need to sell our products and have the confidence to make a project viable even with only 10% of the money needed. To give an example, in the road sector our budget is only 120 crore rupees, but we aim to invest Rs. 500 crore rupees annually.

In the InvIT model adopted by us to launch NHAI bonds (with AAA credit rating) about 4-5 months ago, we were heavily over-subscribed. Then, for the first time we decided that instead of selling bonds only to big and rich investors – foreign or Indian – we reserve 25-50% of the bonds for small people, and we will pay them 8.05% interest per year, i.e. at more than the Bank Deposit rates. Besides, they should get their interest payments every month. So common people, like retired government employees, are investing in our bonds,

In the Indian Oil laboratory in Srinagar, they have invented a special culture by which they are generating fertilizers. It increases the soil fertility 3 times more in terms of NPK value and organic carbon.

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In India we presently need 80 lakh tons of bitumen annually, out of which the capacity of India's refineries is only 50 lakh tons, and 30 lakh tons have to be imported. So we took a decision to add 15% rubber powder with bitumen, which costs only about 30 rupees whereas bitumen costs 50 rupees. So there is saving for both sides since, by adding 15% rubberized bitumen, we can increase the strength of bitumen and also solve our bitumen shortage. There was a ban on import of waste tyres and I requested our minister to allow them to be imported to India, and with appropriate technology we create more jobs and wealth for the country,

In the water department, too, in particular in the cleaning of rivers, we need to find out some way of generating money. As an example, on the Goa river in Goa, I am insisting on my officer to make a big river gallery on the bridge where you can see the whole of Goa, and we will take 500 rupees as a ticket. With 1 lakh people coming every day we will get back the cost of the bridge from that river gallery,

My suggestion to Prof. Tare is that by making Ganga clean, by using religious sentiments and other things, we should devise how to make a new innovative, economically viable model, to get some returns from it. This is the time when every department can generate new income for the government, and in our welfare state, democratic state, we are committed to the poor people.

Regarding spent wash in our distilleries, which is a hazardous material, we are now burning them in boilers and getting potash, which is largely imported in our country. Now we also have a project in Panipat, started by Indian Oil in which we are making 1 lakh litre of bio-ethanol from rice straw, and 150 ton of

# MY SUGGESTION TO

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bio-bitumen and bio-aviation fuel. So there are a lot of technologies available.

We have to protect our ecology and environment. At the same time, we have to think about the development of our country. If there is no coordination between development and ecology and environment, then it will be lost.

Every year we lose thousand of crores of rupees because of floods. To tackle this problem, why can't we have a water grid just as we have a power grid by connecting one river to another river?

For a big project like dam the capital cost is very high. In place of dams we can make water conservation projects,

My suggestion is that, by using both public and private investment and by combining economic viability with research, we get some revenue from it and make a project viable. We can at least reach up to the level where 40% of the money comes from the government and 60% is borne by private investment on hybrid basis. So different types of new innovative approaches are possible.

In the society of which I am chairman, we are doing 186 projects in Punjab, Haryana and western Uttar Pradesh, converting dry straw into biocides and bio-fertilizers, thereby also resolving the problem of air pollution, water pollution and sound pollution in India.

Immediately after the seminar you need to plan the policy and implementation programs and also make financial audit and performance audit, which are very much important.

People who are good and honest take good decisions and get things done. But if you don't want to take decisions, then take VRS and go home.

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## Debashree Mukherjee, [Secretary, Ministry of Jal Shakti, GoI]


This year we were faced with twin crises. There were floods in North India and at the same time we were also dealing with drought, with Tamil Nadu and Karnataka states almost at war over the sharing of Kaveri waters because there had been less than usual monsoon in the Kaveri delta.

The Jal Jeevan Mission and the Swachh Bharat Mission are two of our flagship programmes. And, they are some of the largest investments in the world in ensuring universal access at the household level to drinking water and sanitation. But the challenge before us is to sustain those investments considering that 60% of the drinking water systems set up under the Jal Jeevan Mission are groundwater based. If we cannot ensure water security for our communities, those investments are at risk. This is compounded by climate change which hits the water cycle.

We are seeing are extreme precipitation events, for instance in Sikkim and in Himachal Pradesh this year. We are also seeing prolonged dry spells. So, while the overall quantum of water will remain the same, we have to find ways in which to manage the variations in terms of time and in terms of geographies.

In the context of water security, there are three big areas of work. One is improving river health. Namami Gange is showing us the way, but we need to take it forward to other river systems and ensure that the


rivers are in the kind of health that they can sustain both riverine systems, provide water for irrigation, for drinking and sustain our economy to improve river health. The second big area of work is to improve water use efficiency. Agriculture comprises about 83-84% of the water that we use. So how can we make water use in agriculture more efficient to free up water for nurturing our ecosystems and as well as other development needs? The third area that we think is critical is managing storage. It is not just about large storages in dams and reservoirs, where we can lose about 50 billion cubic meters of water storage to sediments by 2050, i.e. about the capacity of 7 Bhakra Nangal dams. But also managing local level storages, which is our ponds, water bodies and pokhars, and the biggest storage under our feet – groundwater. How can we improve and monitor our storage? In parallel, underpinning all these three things is, how do we improve water governance, holistic water governance?

The second big area is technology, innovation, and adoption. While we will get cutting edge technology and innovation, how do we encourage adoption and ensure that the technology that we apply doesn't become small islands of excellence?

And the third major area is communities, everybody's participation, water being everybody's business, the Jan Ganga, as Dr. Tare said.

We know what's happening in robotics, applications in artificial intelligence, possible applications in blockchain technology that can work to improve our water resource management and water use efficiency. But one major area of concern is water use efficiency, particularly in agriculture. We have had drip and micro irrigation systems available for a long time. However, less than 2% of the area under micro irrigation is based on surface irrigation sources. So basically, our micro irrigation systems depend on our groundwater. So how can we promote micro irrigation and improving water use efficiency in our surface irrigation systems? We have set up a Bureau of Water Use Efficiency. It is working out its mandates, strengthening itself, and hopefully in the next one year, it will become a more effective organization.

We are also working with multiple agencies. Under the National Hydrology Programme, we have the Variants database under India WRIS, which tries to bring together water data from across various areas and parts of the ministry and also from state governments, from Pollution Control Board, and all related agencies. So we are looking at holistic water data for holistic water management.
I encourage people here to visit that water data repository and come back to us and tell us how better can we present that data.

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## Igor Papič, [Ambassador, Republic of Slovenia]


When we are solving real problems, problems in the field, then it's not enough to work within one ministry. I'm glad we have representatives of different ministries from India at this event.

Over the year that we have been in office now, we reorganized our research agency such that we don't have only one agency responsible for research, covering primarily fundamental research. We added the pillar of innovation whose aim is, first, to improve knowledge transfer: how to improve the transfer of knowledge from academia to the real world – usually to the industry, but also to the broader society. The other very important goal of this reorganization is to improve collaboration between different sectors within the government.

I'm very supportive of the term Society 5.0. We don't talk anymore only about industry 4.0, but now we switch to Society 5.0. What does this mean? It's not just the problem of further technological development. It's also the issue of how to incorporate social sciences, humanities, ethics, and so on, to prevent technology misuse, etc.

I would like to congratulate you on the 8th India Water Impact Summit. It has become a traditional annual gathering of very diverse stakeholders, from scientific experts to government officials where you address crucial challenges and potential solutions in water and other sectors. Due to the increasing need for successful climate change mitigation and adaptation, global challenges have to be jointly, simultaneously, and coherently approached. Modern management of complex problems demands new technological innovations by which you can satisfactorily realize the set objectives. Therefore, this twin summit is, in my opinion, a very useful format of integrated approach with a high added value.

In the last two years Slovenia has experienced severe impacts of climate change – devastating droughts, forest fires, and widespread floods that were unknown in the history of Slovenia. This year we had the most severe floods ever experienced in Slovenia. Therefore, we organized multi-sectoral assessments of causes and consequences and the analysis revealed the reality of ecosystems and identifying strong links to intense scientific and technological support for climate actions.

Also, the analysis revealed high potentials for more integrated implementation of new scientific, technological, and socio-economic approaches to improve water, food, energy, and of course climate security.

Slovenia is one of the most water-rich and bio-diverse countries in the world with dense river networks, more than a thousand lakes, numerous aquifers, and more than four times the EU average of available water per capita. These figures testify to the extraordinary water resources of our country. Slovenia's remarkable biodiversity is also evidenced by the fact that in addition to other protected areas, our country has the largest volume of so-called Natura 2000 areas among all EU member states.

Water is of course a fundamental natural resource and a key factor in sustainable development of society. It is increasingly becoming a political medium, a factor of peace and stability in the world as it connects sectors, regions, and countries. The water-climate connection is increasingly recognized in the world as one of the key areas of adapting to climate change and mitigating the

**WATER IS OF COURSE**

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IWIS-PLENARY SESSION

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impacts of humans and ecosystems. Nevertheless, the upcoming Climate Conference, COP-28, will be only the second one which includes water as the thematic programme.

In 2024-25 Slovenia will preside over the Convention on the Protection of the Mediterranean Sea from Pollution and from 2024-27 for the Convention on the Protection and Use of Trans-Boundary Water Forces and International Lakes which has the UN's status of a global convention. This confirms our active engagement in sustainable regional and global water diplomacy activities as well as our competencies in water management which we like to share with other countries including India

According to our joint commitment to the UN Water Action Agenda and Global River Basin Coalition, we will bring into the Global River Basin Coalition not only scientific knowledge and technologies but also RTD and user partner networks from Europe, Africa, North and Latin America and Caribbean countries where Slovenian space and digital sectors are working on highly innovative pilot solutions to enhance holistic management of river

# WE ADDED THE PILLAR

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basin ecosystems and climate actions. Slovenia's Center of Excellence for Space Sciences and Technologies is committed to develop cost-effective technologies and applications for advanced acquisitions of satellite data and generation of innovative digital models to enhance holistic management of blue and green water.

We are also planning to develop infrastructures in trans-boundary ecosystems by taking into account interconnectivity of geo- and bio-physical phenomena in connecting the different lands, rivers and seas in changing climate conditions.

Same science, different technologies and a wide variety of socio-economic approaches are adopted around the globe to aim at Sustainable Development Goals (SDGs). This offers great opportunities to partners from international coalitions to learn from each other in the scope of transcontinental initiatives on river basin science and management. Due to the ever increasing intensity and frequency of disasters related to climate changes, we are highly interested in innovative ways for financing investments for the development of new blue and green infrastructures where government efforts are complemented with private investments. Slovenia is readily interested in them and willing to contribute.

Global challenges demand global responses. Recently the world is facing triple crises in climate change, water and biodiversity. Water is a prerequisite for biodiversity, and well-preserved ecosystems provide us with clean water and thus health and quality of life. Both resources are indispensable goods but with fast social development their conditions are deteriorating. Ensuring access to water and a favourable state of biodiversity are therefore major challenge. We strive for a comprehensive approach in preserving these strategic resources which is especially important when adapting to climate change. Low cost data acquisition techniques using micro- and nano-satellites have proven to be very suitable to tackle these problems.

I'm really looking forward also to start more intensive collaboration between Slovenian and Indian scientists.

During my discussions today I said, “Yes, first we have to solve some problems that we posed in the past, but in future we have to prevent new problems from coming up. In that way we have to work towards green transition.”

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## Sanmit Ahuja, Expert Member, cGanga

Mr Gadkari mentioned how to create the right economics. That is the fundamental vision and objective of CITIS which is to create the right economic framework and on the other side led by Dr Tare we will talk about the Samarth Ganga framework for land, water and rivers.

Both Dr Papič and Mr Gadkari talked about floods. That is where principally our partnership is focused on, not just looking at flood management but understanding what floods have done and what have we done in the past. We go back in history to see water and the data-based decisions we can make.

## 8TH IWIS 2023: THEME I

November 22 & 23, 2023

# Development vis-à-vis Land, Water and Rivers

**DAY 1 & 2:**

Wednesday, November 22, 2023
15:00 – 16:30 hrs
Thursday, November 23, 2023
11:30 – 13:00 hrs

**MODERATOR:**

Vinod Tare [Founding Head, cGanga]
Sanmit Ahuja [Expert, cGanga]

**DIGNITARIES ON THE DIAS:**

Adarsh Pal Vig [Chairman, PPCB]
Anshumali [Professor, IIT(ISM) Dhanbad]
Bishu Karmakar [Member Secretary & Scientist-B, TSPCB]
Gurudas Nulkar [Professor & Director, Gokhale Institute of Politics and Economics, Pune]
Rajiv Sharma [Former Chief Secretary, Govt. of Telangana]
Usharani Patnaik [Sr. Environmental Scientist, SPCB, Odisha]
Vekatesh Dutta [Professor, BBAU Lucknow]


The 8th India Water Impact Summit (IWIS) presented an exhibition of past achievements of IWIS and held intensive expert discussions on the main theme of "Samarth Ganga" in the context of the ongoing national initiative of Lifestyle for Environment. Within that it stressed on "Productive Land" (highlighting the inter-dependability of Land and Rivers), and "Lifestyle for Rivers".

IWIS also launched a "Global Coalition for River Science and Management", which would provide a platform for hosting the best practices around management, tools and techniques for understanding, monitoring, and managing different aspects of river systems around the world.

The 8th IWIS elaborated on "Samarth Ganga" in the context of ongoing National initiative of Lifestyle for Environment emphasizing on "Productive Land" and "Lifestyle for Rivers." It launched a "Global Coalition for River Science and Management" to share best practices worldwide around the world.

### THEME I: SAMARTH GANGA AND PRODUCTIVE LAND

#### 1. Preamble

There are several aspects of river systems that are influenced by the terrestrial part such as flow momentum resulting either in land erosion or deposition of sediments leading in formation and/or diversion of channel(s), chocking and/or reduction in carrying capacity of channel(s) that can be better understood and appropriately managed if catchment area (land, vegetation, forest cover, etc.) is handled properly. Also, water abstractions from the river systems (rivers, ponds, reservoirs, wetlands, subsurface/aquifer waters, etc.) could be appropriately regulated by efficiently managing water requirements for achieving desired land productivity (food, fiber, etc.). Likewise, river systems

# THE 8TH IWIS

**elaborated on "Samarth Ganga" in the context of ongoing National initiative of Lifestyle for Environment emphasizing on "Productive Land" and "Lifestyle for Rivers." It launched a "Global Coalition for River Science and Management" to share best practices worldwide around the world**


can receive water evenly despite uneven distribution of rainfall by managing surface and sub-surface flows by maintaining appropriate land use and land cover. Therefore, it is important to develop understanding on interdependence of land and water systems. Therefore the two sessions on the theme namely, Samarth Ganga and Productive Land I & II, were aimed at deliberating some dimensions of this grand challenge with following background information made available to the delegates.

### 1.1 Desertification and Land Degradation

Land degradation is an issue of increasing global concern. It threatens not only the productivity of land but also water quality, human health and the fundamentals of ecosystems on which all life forms depend. It has also close connection with other major global issues, particularly climate change and biodiversity. It has been estimated that globally around 24 billion tons of fertile soil and 27,000 bio-species are lost each year. While land degradation is acutely felt in the world's arid lands, some 80 per cent is actually occurring outside these areas. For this reason, there is an urgent need to halt and reverse land degradation for ensuring food, water and environment security as well improving living conditions of population residing in such areas. Desertification, along with climate change and the loss of biodiversity were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit which paved the way for the conceptualization and formulation of the United Nations Convention to Combat Desertification (UNCCD). The Convention's 195 parties, including India, work together to improve the living conditions for people in drylands, maintain and restore land and soil productivity and mitigate the effects of drought.

Despite erratic rainfall, balancing river water involves regulating surface and sub-surface flows via land management. Understanding the land-water interdependence is vital. Lifestyle adjustments and prudent human interventions in land-water systems are crucial for sustainable management.

The most significant process of desertification/ land degradation in the country is Water Erosion (increased to 11.01% in 2018-19 from 10.98% in 2011-13 and 10.83% in 2003-05). The second most significant process is Vegetation Degradation (9.15% in 2018-19, 8.91% in 2011-13 and 8.60% in 2003-05). Area under desertification (arid, semi-arid and dry sub-humid regions of the country) during 2018-19 was estimated to be 83.69 million ha area whereas, during 2011- 13 was estimated to be 82.64 mha; and, during 2003-05 it was estimated to be 81.48 mha. Thus, there is a cumulative increase of 1.05 million ha area under desertification from time frame 2011-13 to 2018-19. The increase in

# Development vis-à-vis Land, Water and Rivers




area under desertification from 2003-05 to 2011-13 is 1.16 million ha. The most significant process of desertification in arid region is observed to be wind erosion, and in semi-arid and dry sub-humid regions vegetation degradation and water erosion dominates (SAC, 2016).

Desertification is the continuous degradation of land under the influence of natural and anthropological causes in arid, semi-arid and dry-sub humid conditions. Desertification affects two third countries of the world and one third of the earth's surface, on which one billion people live (one seventh of world's population). The processes of desertification and land degradation are observed to have accelerated during recent years. As per United Nations Convention for Combating Desertification (UNCCD), Desertification is defined as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities" (UNCCD, 1994). Here "land" means the terrestrial bio-productive system and "land degradation" means reduction or loss of biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) Soil erosion caused by wind and/or water; (ii) Deterioration of the physical, chemical and biological or economic properties of soil; (iii) Long term loss of natural vegetation, etc. (UNCCD, 1994).

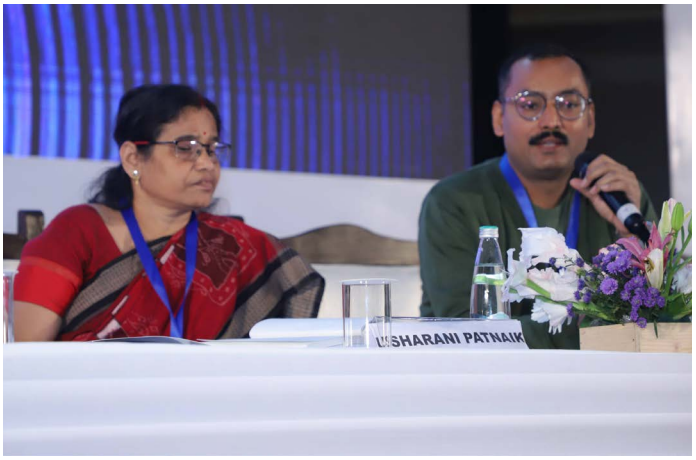
Human-induced vegetation loss quickens soil degradation, fostering desertification. Soil lacking vegetation cover faces heightened erosion by wind and water, causing organic matter loss and reduced fertility. Diminished water retention and nutrients intensify pressure on vegetation survival.

## PROCESSES OF DESERTIFICATION/ LAND DEGRADATION

### Vegetation degradation:

Vegetation degradation is observed mainly as deforestation / forest-blanks / shifting cultivation and degradation in grazing / grassland as well as in scrubland. At places, agriculture is observed within forest lands, this has also

Bijay-Singh, and Yadvinder-Singh, (2004). "Potassium nutrition of rice-wheat cropping system." Adv. Agron. 81, 203e259.
SAC (Space Application Centre) (2016): "Desertification and Land Degradation Atlas of India", ISRO, Govt. of India.
UNCCD, 1994. "United Nations Convention to Combat Desertification". UNEP, Geneva.




been classified under vegetation degradation within forest area. Vegetation is an important factor in the protection of soil and soil fertility as well as the rate at which surface runoff and percolation occurs resulting in significant impact on groundwater recharge and soil erosion. Destruction of vegetation, most often by human activities accelerates soil degradation leading to desertification. When soil loses vegetation cover, it becomes more susceptible to wind and water erosion. Removal of top soil by water or wind erosion results in loss of organic material leading to decrease in soil aggregation and stability, and hence soil fertility. The water-holding capacity and the nutrient content of the soil are reduced when organic material is lost, which is an additional strain on vegetation survival.

Productivity of land depends on adequate water and nutrient uptake from the soil. Thus, besides soil moisture, soil fertility depends on the adequacy of nutrients in forms that are easily available for plant uptake. This, in turn, depends not only on the presence of nutrients in the soil, but also on soil biodiversity, especially microbes (like bacteria and fungi, but also micro-fauna) and invertebrates (like earthworms), that recycle and process the nutrients appropriately from organic matter and help stabilize soil structures (cGanga and NMCG, 2015).

Forest soils have efficient nutrient recycling by virtue of their rich and optimized soil biodiversity. This enables the growth and sustenance of vegetation without any external supply of nutrients (except what little may accrue from airborne particles and runoff/ groundwater from upland sources minus what is lost through outflows). But cultivated soils have much poorer nutrient recycling capacity due to progressive nutrient depletion through plant growth and their harvesting as well as due to significant loss of topsoil and nutrient washout (leaching) from tilled farmlands. Hence, traditionally, farmlands would have to be left fallow for one or two years to recover their fertility after every few years of cultivation unless the nutrients could be replenished through periodic flooding.

Chemical fertilizers applied in modern agriculture overcome the above problem, but they disrupt the nutrient

cGanga and NMCG (2015), "Ganga River Basin Management Plan: Mission 4: Sustainable Agriculture", January, 2015.

# Development vis-à-vis Land, Water and Rivers

balance of soils by selectively increasing the availability of macronutrients such as N (or N, P & K) while many other macro- and micro-nutrients essential for plant growth get rapidly depleted from the soil, thereby dwindling soil fertility over crop cycles. This loss of soil fertility also results in significant adverse impact on soil microbes, which further reduces the ability of plants to absorb water and nutrients from the soil. Thus, soil fertility depends largely on the level of Soil Organic Matter (SOM) or Soil Organic Carbon (cGanga and NMCG, 2015), which is an indicator of the adequacy not only of organic carbon (required by soil biota but not by plants) but also on various essential nutrients required by plants and soil organisms, since organic compounds from plant and animal sources include a varied mix of various essential nutrients. Thus, composted plant/animal residues and animal dung are known to promote high long-term agricultural productivity. SOM also enables better bonding between soil particles, thereby minimising the loss of soil particles, nutrients and water (soil moisture) through erosion and leaching that otherwise pollute nearby aquatic ecosystems with high soil and nutrient inputs.

The closest approximation to maintaining soil fertility and nutrient adequacy in agricultural fields to that in forest soils is when the agricultural fields: (i) remain relatively undisturbed from mechanical ploughing ("no tillage" or "minimum tillage"), (ii) is adequately supplied with organic matter through mulching (which also prevents topsoil erosion and evaporation), and (iii) by adopting crop diversification (or crop rotation) as in mixed forests.

Crop residues left in fields in small landholdings are generally much less since they are harvested through manual labour, leaving very short stalks that are often ploughed into the soil for the next cropping season. Other post- harvest crop residues serve to provide animal fodder, domestic fuel, composted manure, and sundry other purposes. Mechanical harvesting of crops leaves large amounts of plant material behind in the fields. For rapid removal of the plant stalks before the next crop season, they are often burnt in situ, leading to significant air and water pollution over vast regions.

### 1.2 Crop Residue Management and Rivers

The inter-dependability of Land and Rivers occurs in multiple ways involving physical, chemical and biological aspects. They include material transfers from one to the other involving energy, chemical and biological changes that may enrich or impoverish land ecosystems and waterbodies in different ways depending on the nature, quantities and rates

# ANTHROPOGENIC LAND

**use, primarily in agriculture, significantly alters soil ecosystems through tillage, irrigation, and fertilizers. While agriculture consumes substantial water, urban activities pose a greater risk to water quality, with wastewater laden with pollutants discharged into waterbodies**

of material movement. Hence both land use and water use have concomitant effects on land and waterbodies.

Geographically, anthropogenic land use is most significant for agricultural purposes, which often involves extensive tillage, irrigation, and fertilizer application, all of which significantly alters the soil ecosystem. On the other hand, while water consumption is also very high in agriculture and has its major impact on waterbodies, water quality deterioration occurs more significantly in urban uses, whence the wastewater generated by households and urban institutions is loaded with organic and inorganic pollutants that is usually discharged after treatment into nearby rivers and waterbodies with the potential risk of fouling the waterbodies. These adverse phenomena need to be mitigated both through institutional and lifestyle measures.

Anthropogenic land use, primarily in agriculture, significantly alters soil ecosystems through tillage, irrigation, and fertilizers. While agriculture consumes substantial water, urban activities pose a greater risk to water quality, with wastewater laden with pollutants discharged into waterbodies.

Soil health is an envelop term that may be broadly conceptualized in terms of biological productivity to support plant growth (Brevik, 2009) or generally as "the capacity of a soil to function, within ecosystem and land use boundaries, to sustain biological productivity, maintain environmental quality, and promote plant and animal health" (Doran, 2002; Doran and Zeiss, 2000). Soil health is generally indicated by physical, chemical and biological indicators, as presented in Table 1.

Physically, soil texture is a basic attribute that partly determines the other physical properties, viz. Figure 1

Chemical properties of soil are related to properties that directly affect plant nutrition. Plants need an adequate supply of nutrients to grow and reproduce. There are at least 17 nutrient elements that most

**Table 1. Commonly used Indicators of Soil Health (Brevik, 2009)**

| Physical Indicators | Chemical Indicators | Biological Indicators |
|---|---|---|
| Texture | pH | Microbial biomass |
| Bulk density | Organic matter | Earthworm populations |
| Penetration resistance | Total carbon | Nematode populations |
| Aggregate stability | Total nitrogen | Arthropod populations |
| Water holding capacity | Cation exchange capacity | Mycorrhizal fungi |
| Infiltration rate | Major and minor nutrients | Respiration rate |
| Depth to hardpan | Electrical conductivity | Soil enzyme activities |
| Depth to water table | Heavy metals and other plant toxins | Pollutant detoxification |
| Porosity | | Decomposition rate |
| Erosive potential | | |
| Aeration | | |

Brevik, Eric C (2009): "Soil Health and Productivity", from: "Plant Growth and Crop Production, Encyclopedia of Life Support Systems", Ed.: W. Verheye, EOLSS Publishers (http://www.eolss.net)
Doran, J.W., and M.R. Zeiss (2000): "Soil health and sustainability: Managing the biotic component of soil quality". Applied Soil Ecology, 15, 3–11.
Doran, J.W., "Soil health and global sustainability: translating science into practice, Agriculture, Ecosystems & Environment", Volume 88, Issue 2, 2002, Pages 119-127, ISSN 0167-8809, https://doi. org/10.1016/S0167-8809(01)00246-8.

# Development vis-à-vis Land, Water and Rivers


**Figure 1. Soil Texture Depending on Percentages of Sand, Silt and Clay (Source: USDA Natural Resource Conservation Service).**

plants need for productive growth and development namely, carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, zinc, manganese, boron, copper, chlorine, iron, nickel, and molybdenum (cGanga and NMCG, 2015), of which at least 13 are very important, viz.

**Nitrogen:** Improves growth, grain and fruit development and leaf quality
**Phosphorus:** Promotes blooming and root growth
**Potassium:** Improves fruit quality, disease resistance and drought tolerance
**Sulfur:** Essential for chloroplast formation
**Calcium:** Aids nutrient transport within the plant
**Magnesium:** Activates growth enzymes, essential for chlorophyll formation
**Iron:** Essential for chlorophyll formation
**Manganese:** Essential for photosynthesis and nitrogen metabolism


**Boron:** Essential for fruit and seed development
**Copper:** Aids photosynthesis and reproductive development
**Zinc:** Regulates plant growth and sugar metabolism

The biological component of soils is very complex as it depends on a vast range of physical and chemical factors, with bacteria and fungi playing a key role in breaking down complex organics for nutrient uptake by plants. In a nutshell it is best visualized by the Soil Food Web as shown in Figure 2.

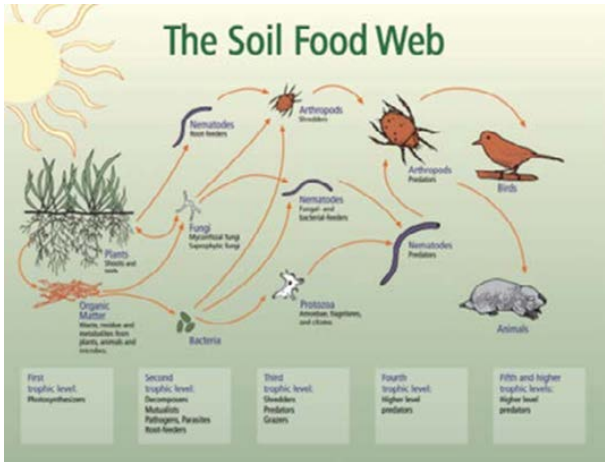



**Figure 2. The Soil Food Web Describing the Various Feeding Relationships of the Organisms in the Soil (Source: USDA Natural Resources Conservation Service).**

# WATER EROSION,

**notably sheet erosion within agricultural lands, dominates land degradation in the country, constituting 10.98% of Total Geographical Area (TGA) in recent years. This loss of soil cover arises from rainfall and runoff, intensified by agricultural practices like tillage.**


Water erosion, notably sheet erosion within agricultural lands, dominates land degradation in the country, constituting 10.98% of Total Geographical Area (TGA) in recent years. This loss of soil cover arises from rainfall and runoff, intensified by agricultural practices like tillage.

In the above context, it is useful to survey the broad impact of agriculture on India's land. According to SAC, around 96.40 mha area of the country (29.32% of the Total Geographic Area or TGA) was undergoing land degradation during 2011-13, while during 2003-05 the area undergoing desertification or land degradation was 94.53 mha or 28.76% of TGA (SAC, 2016).

There is obviously an urgent need to stop and reverse the process of land degradation at various levels to combat desertification and land degradation, for which sustainable management of soil and water resources are required. The most significant process of land degradation in the country was identified by SAC as Water Erosion (10.98% of TGA in 2011- 13 and 10.83% in 2003-05), which refers to loss of soil cover mainly due to rainfall and/ or surface runoff water, of which sheet erosion (or rill erosion) occurs mostly within agricultural lands (SAC, 2021) due to the loosening of soil by tillage and other agricultural interventions. The loose topsoil is easily eroded by rain and runoff, carrying away valuable minerals, organic carbon

# Development vis-à-vis Land, Water and Rivers

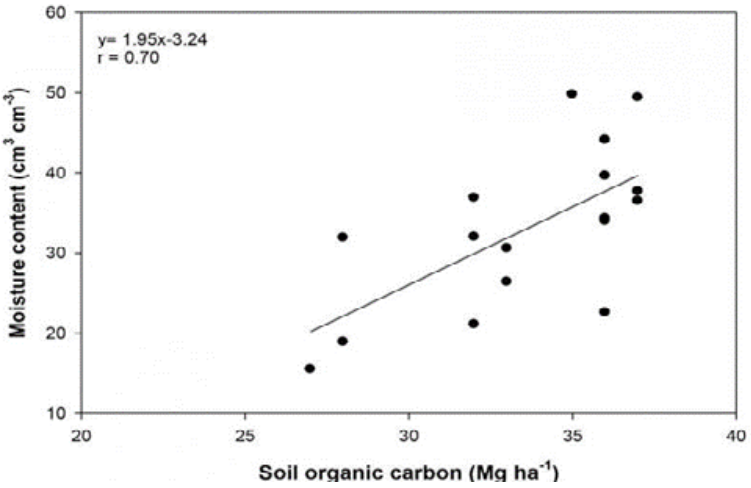



**Figure 3. Increase in Soil Moisture Storage Capacity with Increase in Soil Organic Carbon in 10 Years Tillage and Crop Rotation Study (Al-Kaisi et al., 2014)**

and other nutrients with them. The loss of soil organic carbon (SOC) also reduces the water holding capacity and microbial population of sandy and loamy soils, as shown in Figure 3.

### a) Generation of Crop Residues in Indian Agriculture

A considerable amount of crop residues is generated in India from cereal crops like rice, wheat and maize as well as sugarcane due to intensive agricultural practices (Figure 4) rather than increasing conservation agriculture practices in many other countries.

Sugarcane, rice, wheat and coarse cereal contributed the majority of crop residue with production estimates of 141.1 Mt, 122.6 Mt, 110.3 Mt and 71.3 Mt respectively. Among cereal crops, rice, wheat, maize and millets together contributed 70% of crop residue followed by fiber crop.

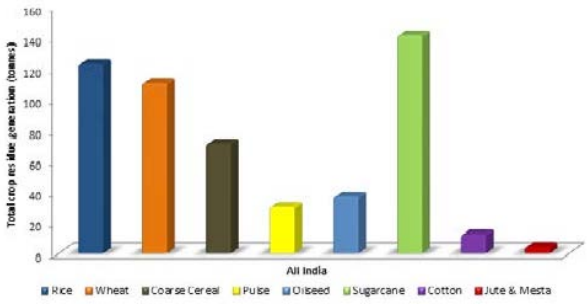



**Figure 4. Total Crop Residue Generation (tonnes) in India during 2014-15 (Source: Ministry of Statistics and Program Implementation (Data Source: MOSPI, 2013-14)**

### b) Crop Residue Burning

The burning of rice residue and sugarcane trash is a routine practice at many places in northern Indian Plains due to their poor suitability as fodder and immediate removal required from the fields for timely seeding of wheat crop. In addition to the cost and time savings, farmers derive other benefits of weeds, diseases and pests control by burning the crop residues.

Crop residue burning has detrimental consequences, as it not only harms the environment but also results in the loss of valuable nutrients contained within the straw. Carbon, nitrogen, phosphorus, potassium, and various other nutrients, as depicted in Table 2, are forfeited at rates ranging from 20% to 100% when crop residues are burned.

This loss of essential nutrients undermines soil fertility and agricultural sustainability. Following are some of the concerns as a result of the burning of the crop residues.

Al-Kaisi M.M., Douelle A., Kwaw-Mensah D., "Soil microaggregate and macroaggregate decay over, time and soil carbon change as influenced by different tillage systems", J. Soil Water Conserv., 69 (6) (2014), pp. 574-580, 10.2489/ jswc.69.6.574
SAC (Space Application Centre) (2021): "Desertification and Land Degradation Atlas of India", ISRO, Govt. of India.

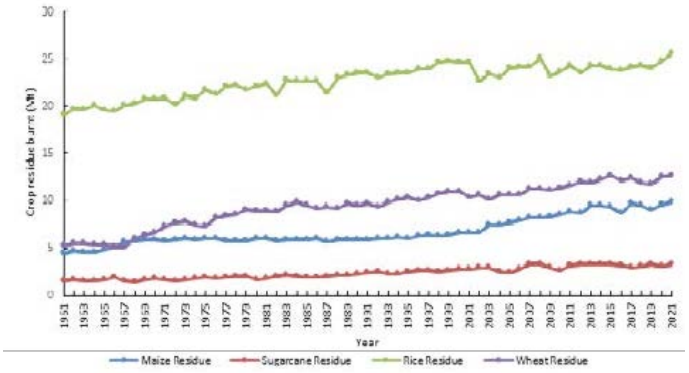



**Figure 5. Trend in Crop Residue Burnt in India during 1961-2021 (Data Source: Food and agriculture Organisation, 2021)**

**Table 2. Loss of Nutrients via Burning of Crop Residue (Source: Meena et al., 2022)**

| Nutrients | Quantity |
|---|---|
| Organic Carbon | 3850 million kg |
| Nitrogen | 59 million kg |
| Phosphorus | 20 million kg |
| Potassium | 34 million kg |

- One ton stubble burning along with 199 kg ash releases 3 kg of particulate matter, 60 kg of carbon monoxide (CO), 1460 kg of carbon dioxide ($CO_2$) and 2 kg of sulphur dioxide ($SO_2$).
- About 25% of N and P, 50% of S and 75% of K uptake by cereal crops are retained in crop residues, making them viable nutrient sources (Goud et al., 2022).
- About 90% of N and S and 15-20% of P and K contained in rice residue are lost during burning.
- Burning of 23 million tonnes of rice residues in NW India leads to a loss of about 9.2 million tonnes of C equivalent ($CO_2$-equivalent of about 34 million tonnes) per year and a loss of about 1.4×105 t of N (equivalent to Rs 200 crores) annually (NAAS, 2017).
- Loss of carbon from soil results in reduced microbial activity, affect soil nutrient cycling potential, soil detoxifying capacity and other soil function in long term.

### c) Crop Residue Usage

- India produces a vast quantity of crop residues, which find applications in agriculture, industry, and energy generation.
- India's annual crop residue production exceeds 686 million tonnes (Mt), with cereal crops contributing approximately 368 Mt to this total (Hiloidhari et al. (2014)).
- Within the category of cereal crops, rice and wheat take the lead, contributing approximately 154 and 131 Mt, respectively, to the overall crop residue production in India. Generation of crop residues is highest in Uttar Pradesh (60 Mt) followed by Punjab (51 Mt), and Maharashtra (46 Mt). Among different crops, cereals generate maximum residues (352 Mt), followed by fibres (66

**Table 3. Quantum of Rice Residue Burned in India Every Year in Three States**

| State | Total cultivable area in Kharif (lakh ha) | Area under Kharif Paddy (Lakh ha) | | | Paddy Straw Generated (Million ton) | Paddy Straw man-aged (million ton) | | | Paddy Straw Burnt (million ton) | Paddy area burnt (lakhha) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Basmati | Non- Basmati | Total | | In-situ | Ex- situ | Total | | |
| Punjab | 42 | 4.36 | 27.07 | 31.43 | 19.99 | 9 | 3.5 | 12.5 | 7.49 | 12.57 |
| Haryana | 38 | 7.32 | 6.58 | 13.9 | 7 | 5.15 | 1.1 | 6.25 | 0.75 | 2.15 |
| UP | 128.73 | 25.89 (1.89)* | 34.10(0.015)* | 59.99 (1.91)* | 27.70 (0.68)* | - | - | -- (>0.67) | (NA) (146 Ton)* | NA |

Goud P. S., Usha R. I., Venkata S. T., and Chandrasekhar K., "Effect of crop residue incorporation and potassium releasing bacteria (KRB) on growth and available, nutrient status of Maize" (Zea mays L.), The Pharma Innovation Journal 2022; 11(9): 2097-2100.
Meena, H.N.; Singh, S.K.; Meena, M.S.; Narayan R. and Bheem Sen. (2022). "Crop Residue: Waste or Wealth?", Technical Bulletin 2022, published by ICAR-Agricultural Technology Application Research Institute, Zone-II, Jodhpur, Page No. 1 – 30.
NAAS 2017. "Innovative Viable Solution to Rice Residue Burning in Rice-Wheat Cropping System through Concurrent Use of Super Straw Management System-fitted Combines and Turbo Happy Seeder". Policy Brief No. 2, National Academy of Agricultural Sciences, New Delhi. 16 p.

# Development vis-à-vis Land, Water and Rivers

Mt), oilseeds (29 Mt), pulses (13 Mt) and sugarcane (12 Mt) (IARI, 2012).

- The cereal crops (rice, wheat, maize, millets) contribute 70% while rice crop alone contributes 34% to the crop residues. Wheat ranks second with 22% of the crop residues whereas fibre crops contribute 13% to the crop residues generated from all the crops (IARI, 2012).
- In India, crop residues primarily serve as cattle feed and a source of cooking fuel. However, in nations such as China, Indonesia, Thailand, Bangladesh, and Sri Lanka, these residues are harnessed as feedstock for bioenergy generation, the production of organic fertilizers, and the paper industry.
- Managing rice residue, especially in the Indo-Gangetic Plains of India, presents significant challenges. In this region, the rice-wheat cropping system is intensively practiced, and farmers prioritize timely wheat seeding in fields where rice has been harvested using combine harvesters (Sidhu et al., 2007, Singh et al., 2020).
- The narrow time frame available between rice harvesting and wheat sowing, the unavailability of suitable residue handling machinery, and the labor-intensive nature of manual residue removal (Kumar et al., 2023), results in a substantial annual surplus of crop residue production in India, estimated at 178 Mt, of which approximately 87 Mt is subjected to burning.

### d) Crop Residue Utilization in Selected Countries

It is important to note that in a big country like China, where about 700 Mt crop residues are generated annually, 31% of crop residues are left in the field, 31% are used for animal feed, 19% are used for bioenergy generation and 15% are used as fertilizer (Jiang et al., 2012). Some of the nutrients contained in about 31% used as animal feed eventually returns to the soil.

### e) SOC in Indian Soils

- Using the extensive database of the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Bhattacharyya et al. (2008) estimated that Indian soils contain only 9.55 and 24.04 Gt organic C (SOC) out of about 13.69 and 46.50 Gt of total carbon in the top 0.3 and 1 m soil, respectively.
- Sreenivas et al. (2016) estimated SOC, soil inorganic C and total soil C pool size of India at 22.72 ± 0.93, 12.83 ± 1.35 and 35.55 ± 1.87 Gt, respectively, in the top 1 m.
- The Indian contribution to the global SOC pool is in the order of 20–25 Gt for the top 1 m. With an annual C emission of about 566 million tonnes from the Indian sub-continent (Carbon Dioxide Information and Analysis Center database, CDIAC), the required C sequestration rate for India would be about 23–28 per mille as opposed to the global requirement of 4 per mille.

Hiloidhari et al. (2014): "Bioenergy potential from crop residue biomass in India", Renewable and Sustainable Energy Reviews, Volume 32, 504-512.
IARI, 2012, "Crop residues management with conservation agriculture: Potential, constraints and policy needs". Indian Agricultural Research Institute, New Delhi, vii 32 p.
Sidhu et al. (2007): "The Happy Seeder enables direct drilling of wheat into rice stubble", Australian Journal of Experimental Agriculture, 47, 844–854.
Singh, A. et al. (2020): "Achyranthes aspera (prickly chaff flower) leaves- and seeds- supplemented diets regulate growth, innate immunity, and oxidative stress in Aeromonas hydrophila-challenged Labeo rohita", J. Appl. Aquacult., 32 (3): 250-267.
Kumar, N., Chaudhary, A., Ahlawat, O. P., Naorem, A., Upadhyay, G., Chhokar, R. S., Gill, S. C., Khippal, A., Tripathi, S. C., Singh, G. P., "Crop residue management challenges, opportunities and way forward for sustainable food-energy security in India: A review, Soil and Tillage Research", Volume 228, 2023, 105641, ISSN 0167-1987, https://doi.org/10.1016/j. still.2023.105641.

**Table 4. Pattern of Crop Residues used in Select Countries**

| Country | Major utilization |
|---|---|
| India | Cattle feed, cooking fuel, on-field burning |
| China | Bioenergy, fertilizer, field retention |
| Indonesia | Fertilizer, animal feed |
| Thailand | Bioenergy |
| Bangladesh | Bioenergy |
| Pakistan | Animal feed |
| Nepal | Animal feed |
| Philippines | On-field burning, bioenergy |
| Afghanistan | Animal feed, cooking fuel |
| Sri Lanka | Paper Industry |

- Promotion of pulses and legumes (for their unique SOC build-up properties), diverting a part of fertilizer subsidy and efficient use of available crop residues (679 Mt annually) and municipal solid wastes (64.8 Mt annually) along with green manuring and suitable cropping systems (rice-based) may help to improve or at least curb declining trends in SOC stock in Indian soils.

  Stakeholders consulted at the ICAR-Indian Institute of Farming Systems Research (Modipuram) estimate the area under cover crops to be around 1.94 million hectares, while mulching covers around 20 million hectares.

  Utilizing crop residues on farmlands, whether for soil cover, mulching, or as soil additives alongside composted organic waste like animal dung or biochar, enhances Soil Organic Carbon.

### f) Crop Residue Management and Soil Health

- Soils in the Indo-Gangetic Plain contain low organic matter content and are being consistently depleted of their finite reserve of nutrients by crops (Bijay-Singh et al. 2004).
- Excessive nutrient mining of soils is one of the major causes of fatigue experienced by soils under the Rice-Wheat system.
- The quantities of nutrients removed by rice and wheat are greater than the amount added through fertilizers and recycled. Removal of all the straw from crop fields leads to K mining at alarming rates because 80% to 85% of the K absorbed by the rice and wheat crops remains in the straw (Singh and Singh 2004).
- There are numerous benefits of residue retention on cropland, especially if maintained as surface mulch and combined with direct seeding of crops without 'normal' tillage.

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Bhattacharyya T., Pal D.K., Chandran P., Ray S.K., Mandal C., Telpande B., "Soil carbon storage capacity as a tool to prioritize areas for carbon sequestration Curr." Sci., 95 (2008), pp. 482-484

Jiang D, Zhuang D, Fu J, Huang Y, and Wen K (2012) "Bioenergy potential from crop residues in China: Availability and distribution, Renewable and Sustainable Energy Reviews", 16:1377- 1382.

Sreenivas K., Dadhwal V.K., Kumar S., Harsha G.S., Mitran T., Sujatha G., Suresh G.J.R., Fyzee M.A., Ravisankar T., "Digital mapping of soil organic and inorganic carbon status in India, Geoderma", 269 (2016), pp. 160-173

# Development vis-à-vis Land, Water and Rivers

- The incorporation of crop residue improved soil fertility status as judged by organic carbon and available P and K contents (Prasad et al., 1999).
- Residues retention improves soil physical (e.g., structure, infiltration rate, plant available water capacity), chemical (e.g., nutrient cycling, cation exchange capacity, soil reaction), and biological (e.g., SOC sequestration, microbial biomass C, activity and species diversity of soil biota) quality (Beri et al. 1992, 1995, Bijay-Singh et al. 2008, Singh et al. 2005).

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**UTILIZING CROP**

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Beri, V., Sidhu, B. S., Bhat, A. K., Pal-Singh, Bhupinder, et al. (1992). "Nutrient balance andsoil properties as affected by management of crop residues." In M. S. Bajwa (Ed.), "Proceedings of the International Symposium on Nutrient Management for Sustained Productivity" (pp. 133e135). Ludhiana, Punjab, India: Department of Soils, Punjab Agricultural University, Vol. II

Bijay-Singh., Shan, Y. H., Johnson-Beebout, S. E., Yadvinder-Singh, and Buresh, R. J. (2008). "Crop residue management for lowland rice-based cropping systems in Asia". Adv. Agron. 98, 117e199.

Prasad, Rajendra & Bandla, Gangaiah & AIPE , K.. (1999). "Crop residue management in a rice-wheat cropping system on growth and yield of crops and on soil fertility". Experimental Agriculture. 35. 427 - 435. 10.1017/S001447979935403X.|

Singh, G., Jalota, S. K., and Sidhu, B. S. (2005). "Soil physical and hydraulic properties in a rice-wheat cropping system in India: Effects of rice-wheat straw management". Soil Use Manage. 21, 17e21


## 2. PROBING THOUGHTS

The visible world we are living in is a manifestation of an invisible world: the world of the soil. Brimming with diverse life forms, the vibrant invisible world beneath us is just another biosphere that we call the pedosphere. The pedosphere is not uniform throughout the planet; it comprises diverse ecosystems influencing the entire planetary life. A pinch of fertile soil teems with millions of living organisms. For instance, a mere teaspoon of native grassland soil shelters between 600 million and 800 million bacteria, spanning approximately 10,000 species. Fungi, measuring miles in length, coexist in that same teaspoon, along with 10,000 individual protozoa and 20 to 30 beneficial nematodes representing up to 100 species.

The realms of monera, protista, and fungi kingdoms find their dwelling in the soil. Numerous plants, including algae, contribute to the rich tapestry of life within the soil, as do a myriad of animals, ranging from small larvae and earthworms to larger reptiles and mammals. The soil ecosystem is a vibrant mosaic of life, and it serves as the foundational support for life above ground. The well-being of the visible world depends fundamentally on the health and prosperity of this hidden subterranean life.

In Hindu philosophy, soil is held sacred, echoing an ancient proverb among traditional Indian farmers: “Feed not the plants, but feed the soil, so that the soil itself nourishes the plants.” The soil is perceived as a living system, an ecosystem, and nurturing it is seen as a moral obligation.

Productivity is, in fact, an ecosystem function. Soil fertility arises from the intricate web of decomposition processes orchestrated by microorganisms within the soil. The greater the population and diversity of these microorganisms, the higher the fertility of the soil ecosystem, leading to increased productivity.

Soil fertility is intricately linked to biodiversity, and this relationship extends to above-ground ecosystems. Biodiversity within the soil is imperative for enhanced carbon sequestration. This, in turn, contributes to the reduction of global warming and aids in mitigating climate change.

Remarkably, the soils of the world store twice as much carbon as the entire plant biomass globally. Soil without carbon is no soil; it turns into a dead surface. It is photosynthesis that by incorporating

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# Development vis-à-vis Land, Water and Rivers



carbon into soil infuses life into the invisible world of the soil. Thus, there is a direct connection between the soil ecosystem and the above-soil ecosystem. This carbon capture by the soil is indispensable for maintaining environmental balance and the climate equilibrium of our planet. Contrary to the common notion that soil is a mere inexpensive resource, it is the most precious one – a sacred foundation for the well-being and sustainability of life on Earth.

The combined actions of chemosynthesis, pedogenesis, and photosynthesis give rise to a remarkable interconnected "substance" encompassing the rhizosphere, pedosphere, and phytosphere, respectively. These spheres maintain a continuous flow of air, water, and nutrients, intricately linked through three distinct phenomena.

Someone has rightly said, your smile is directly proportional to soil fertility. Your sustainable and happy future flows from fertile soil.

The pertinent issues addressed for the theme revolve around sustainable land and water management, focusing on the interplay between agricultural practices, soil health, water quality, and environmental sustainability. The key concerns include their impact on soil health and air quality, highlighting the necessity of integrated approaches for sustainable environmental solutions. The discussions aimed to address the complexities of sludge management, the importance of returning organic matter to soil, and the need for collaborative efforts among various stakeholders in this domain.

## 3. DISCUSSION

### 3.1 Key Points Raised

*a) Management of Crop Residues:*

- The best practices for handling crop residues, particularly in the context of burning versus other methods of disposal or reuse.
- The environmental impact of burning crop residues, such as air pollution and soil degradation.

*b) Sewage Sludge Management:*

- Economic, environmental, and social aspects, highlighting sustainable and local solutions.

*c) Economic and Environmental Sustainability:*

- The need for solutions that are both economically viable and environmentally sustainable. This includes exploring the potential for using crop residues as

# YOUR SMILE IS

**directly proportional to soil fertility. Your sustainable and happy future flows from fertile soil**


soil enhancers or in energy production, while considering the economic implications for farmers.

*d) Integrated Land and Water Management:*

- The necessity of an integrated approach that considers the interdependence of land and water resources is emphasized. This includes the impact of agricultural practices on water quality and river health, and vice-a-versa.

*e) Policy and Public Participation:*

- The role of government policies, public-private partnerships, and community engagement in achieving sustainable land and water management.
- The importance of creating a market for sludge-based products and public trust over these initiatives.

*f) Farmer's Perspective and Challenges:*

- Understanding the perspective of farmers, their practices, and the challenges they face in adopting alternative methods for residue management.

*g) Technological Innovations:*

- The potential for technological solutions, such as biogas production and biochar, in managing agricultural residues.
- An emphasis on finding localized solutions that consider regional differences in soil type, crop practices, and water availability.

*h) Challenges in Implementation:*

- The challenges in implementing sustainable practices, including the need for infrastructure development, financial incentives, and overcoming socio-economic barriers.

## 3.2 Concerns

The key points addressed in the theme reflect the complexity and multidisciplinary nature of the challenges in sustainable land and water management, emphasizing the need for integrated, economically viable, and environmentally friendly solutions.

- Role of stakeholders, including scientists, policymakers, and industry representatives, to address the complex challenges of managing agricultural residues, particularly in terms of soil enrichment and pollution control.
- Need for solutions that are economically viable, environmentally sustainable, and socially acceptable.
- The best practices for utilizing crop residues, considering the economic, environmental, and technological aspects.
- The crop residue cycling in agricultural fields considering long-term sustainability and the challenges of implementing feasible alternatives to burning residues.
- The challenge of managing crop residues, especially in regions like Haryana, Punjab, and Delhi. The burning of crop residues and its environmental impact, including air quality degradation, is a key concern.
- The need for returning organic matter to the soil for maintaining soil health is emphasized using various sustainable methods such as use of biosolids.

# Development vis-à-vis Land, Water and Rivers



### 3.3 Potential Solutions

- Proposed solutions include application of agricultural residues as soil enhancers, developing markets for sludge-based products, and adopting technologies like biogas and biochar production.
- Emphasis on the need for local solutions that consider regional differences in soil type, crop practices, and water availability.
- Establishing standards and policies for effective management and advocating for context-specific standards and adaptable approaches.
- Developing tailored standards considering diverse water usage needs.
- Advocating for integrated river basin management by encouraging cross-disciplinary collaboration and research.
- Rejuvenating existing water bodies using treated water and integrating them into urban planning.
- Optimizing water quality alterations using four stages of treatment combining electro-mechanical and natural/nature-based solutions as proposed by cGanga through river restoration and conservation manual.

## 4 RECOMMENDATIONS AND TAKE AWAY POINTS

The best usages of crop residues are in situ applications on the farmlands. Such residues can be used for soil cover or mulching as well as soil additives along with other organic wastes such as animal dung, preferably after composting or as biochar. Such addition increases the SOC resulting in healthier soils with rich biodiversity, high nutrient levels, and good water holding capacity, thereby reducing irrigation requirements, topsoil loss, and fertilizer application. The reduced irrigation and soil erosion are a definite benefit for rivers and waterbodies in return. Other local uses of crop residues such as fodder for domestic animals are equally environment-friendly ways of handling crop residues.

- **Integrated Policy Development:** Integrated policies consider the interdependencies between land and water management, ensuring that solutions are environmentally and economically sustainable.
- **Public-Private Partnerships:** Emphasis on the importance of public-private partnerships to tackle

# THE DEVELOPMENT

**of market mechanisms for sludge based products, such as biosolids, is seen as a key solution to manage waste and improve soil health**


the challenges of sludge management and agricultural residues. Collaborations between various stakeholders are considered crucial.

- **Market Creation for Sludge-Based Products:** The development of market mechanisms for sludge-based products, such as biosolids, is seen as a key solution to manage waste and improve soil health.
- **Local and Tailored Solutions:** Recognizing the importance of local solutions that consider regional differences in soil type, crop practices, and water availability, and encouraging the development of practices that are adapted to local conditions.
- **Community Engagement and Public Trust:** Underlining the need for effective communication and building public trust in environmental initiatives, which is vital for their success.
- **National Soil Conservation Program:** There should be thrust on a national soil conservation program, like the national river conservation program, emphasizing the need for public spending and support for soil health initiatives.
- **Closing the Loop of Nutrients at an Appropriate Scale:** Nutrients in wastewater should be captured in biomass/sludge and returned to nearby soils rather than gasifying and creating a much larger loop as is the existing practice in some of the treatment options.
- **Sustainable Land Use Policies:** The formulation of sustainable land use policies that balance environmental, economic, and social factors.
- **Environmental Sustainability:** Stressing the importance of returning organic matter to the soil or the rights of soils to retain certain portion of the organic produce to maintain its health like the environmental flows for rivers, and the need for sustainable practices in sludge management.

## 8TH IWIS 2023: THEME II

November 22 & 23, 2023

# Lifestyle for and Economics of Rivers

**DAY 1 & 2:**

Wednesday, November 22, 2023
17:00 – 18:30 hrs
Thursday, November 23, 2023
14:00 – 15:30 hrs

**MODERATOR:**

Vinod Tare [Founding Head, cGanga]

**DIGNITARIES ON THE DIAS:**

A K Singh [Secretary to Government, WRD, Government of Kerala]
Anshuman [Director, Water Resources, TERI]
Nalin Kumar Srivastava [Deputy Director General, NMCG]
P S Rana [SPCB Punjab]
Sanmit Ahuja [Expert, cGanga]
Santosh G Thampi [Professor (HAG), NIT Calicut]
Somasekhar Rao [Director (Technical), ACIWRM]


## 1. PREAMBLE

Managing and sustaining lifestyles and economics of rivers are interlinked. Sustainable development is unrealistic without focus on river centric economy. In other words, economic growth should be linked positively to the rejuvenation and conservation of river systems. Also, river systems cannot be healthy without management of catchment area in a way that supports conservation of rivers. There are many aspects of lifestyles that influence river systems and catchment area. The two significant aspects are (i) how food (energy and nutrition) demand and supply are catered to, and (ii) how wastes (residues) are managed. These two aspects were deliberated upon under this theme in two sessions with the objective of evolving strategy for river basin management.

### 1.1 Municipal Wastewater Management and Soils

A major issue faced in municipal wastewater management is the treatment level before discharging into waterbodies. After adequate removal of major inorganic and organic pollutants through primary and secondary treatment, the levels of nutrients like N and P still tend to be high, necessitating additional/ tertiary treatment before discharge to prevent the rampant growth of water hyacinth and other aquatic weeds due to excessive nutrient enrichment of waterbodies and slow-moving river waters that deplete dissolved oxygen and turns fatal for aquatic biota. An environment-friendly option proposed earlier by cGanga is the four-stage water-recycling process, wherein nutrient removal from the water is effected by allowing hyacinths to proliferate in dedicated wetlands before the nutrient-removed water is allowed to mix safely into natural waterbodies. The hyacinths can be periodically harvested and applied to nearby agricultural fields as mulch and organic soil additives, thereby benefitting both waterbodies and land in a single stroke.

# MANY ASPECTS OF

**lifestyles that influence river systems and catchments area. The two significant aspects are (i) how food (energy and nutrition) demand and supply are catered to, and (ii) how wastes (residues) are managed**



Sustainable development necessitates a river-centric economy, tying economic growth to river rejuvenation and conservation. Healthy river systems rely on catchment area management that prioritizes river conservation, forming an essential symbiotic relationship for their well-being.

### 1.2 Lifestyle impact on Land and Waterbodies

Among various lifestyle aspects affecting both land and waterbodies is food. Humans have varied choices of food today within the ambit of dietary requirements for nutrition. Broadly, these choices may be categorised in terms of Plant-based foods, Dairy-based foods, and non- vegetarian food products. The production of each of these categories have different land and water footprints (besides energy, transportation and other requirements), which can guide us in choosing healthy food that is also environmentally sound. The Tables 5 and 6 show the estimated land and water requirements for such foods.

It is evident that a significant lifestyle aspect concerning food emphasizing on plant products as against animal products can be of great advantage in saving land and water, which are otherwise over-burdened with our food requirements given that India only has a about 2.4% of the world's land area and 4% of the world's freshwater. Given the relatively lower costs of plant products in general, changing food habits can be easily achieved through a concerted campaign highlighting the needs and advantages subject to our dietary needs, cultural traditions and culinary choices.

Shifting towards plant-based food over animal products could significantly save land and water. India, with only 2.4% of land and 4% of freshwater globally, benefits from this sustainable lifestyle choice.

# Lifestyle for and Economics of Rivers

**Table 5. Land Requirement for Producing per unit of Food**

| Food Type | Area Needed (sq.m./ kg) | Reference |
|---|---|---|
| Rice & Wheat | 2.8 | OurWorldInData.org/environmental-impacts-of-food |
| Pulses | 15.57 | OurWorldInData.org/environmental-impacts-of-food |
| Millets | Approx. 7–11 | https://idronline.org/article/agriculture/millet-cultivation-histo- ry-and-trends/ |
| Milk | 8.95 | OurWorldInData.org/environmental-impacts-of-food |
| Eggs | 6.27 | OurWorldInData.org/environmental-impacts-of-food |
| Meat | 12.22-369.81 | OurWorldInData.org/environmental-impacts-of-food |

**Table 6. The Water Footprint of Some Selected Food Products from Vegetable and Animal Origin**

| Food items | Water footprint per ton ($m^3$ / ton) | | | | Nutritional content | | | Water footprint per unit of nutritional value | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Green | Blue | Grey | Total | Calorie (kcal/kg) | Protein (g/kg) | Fat (g/kg) | Calorie (litre/ kcal) | Protein (litre/g protien) | Fat (litre/g fat) |
| Sugar crops | 130 | 52 | 15 | 197 | 285 | 0.0 | 0.0 | 0.69 | 0.0 | 0.0 |
| Vegetables | 194 | 43 | 85 | 322 | 240 | 12 | 2.1 | 1.34 | 26 | 154 |
| Starchy roots | 327 | 16 | 43 | 387 | 827 | 13 | 1.7 | 0.47 | 31 | 226 |
| Fruits | 726 | 147 | 89 | 962 | 460 | 5.3 | 2.8 | 2.09 | 180 | 348 |
| Cereals | 1,232 | 228 | 184 | 1644 | 3209 | 80 | 15 | 0.51 | 21 | 112 |
| Oil crops | 2,023 | 220 | 121 | 2364 | 2908 | 146 | 209 | 0.81 | 16 | 11 |
| Pulse | 3180 | 141 | 734 | 4055 | 3412 | 215 | 23 | 1.19 | 19 | 180 |
| Nuts | 7016 | 1367 | 680 | 9063 | 2500 | 65 | 193 | 3.63 | 139 | 47 |
| Milk | 863 | 86 | 72 | 1020 | 560 | 33 | 31 | 1.82 | 31 | 33 |
| Eggs | 2592 | 244 | 429 | 3265 | 1425 | 111 | 100 | 2.29 | 29 | 33 |
| Chicken meat | 3545 | 313 | 467 | 4325 | 1440 | 127 | 100 | 3.00 | 34 | 43 |
| Butter | 4695 | 465 | 393 | 5553 | 7692 | 0.0 | 872 | 0.72 | 0.0 | 6.4 |
| Pig meat | 4907 | 459 | 622 | 5988 | 2786 | 105 | 259 | 2.15 | 57 | 23 |
| Sheep/goat meat | 8253 | 457 | 53 | 8763 | 2059 | 139 | 163 | 4.25 | 63 | 54 |
| Beef | 14,414 | 550 | 451 | 15415 | 1513 | 138 | 101 | 10.19 | 112 | 153 |

*Source: https://link.springer.com/article/10.1007/s10021-011-9517-8; https://hess.copernicus.org/articles/15/1577/2011/hess-15-1577-2011.html*

# SUBSTANTIAL RETURNS

**($1 investment resulting in a $4 return) are linked with the outcomes of sewage treatment in various countries, including India, suggesting the potential profitability of investing in sewage treatment. This indicates wise investments in sewage treatment can yield significant returns, making it financially viable**


## 2. DISCUSSION

### 2.1 Key Points Raised

*a) Circular Economy and Material Circularity*

The feasibility of achieving circularity at scale, emphasizing varying dimensions of circularity for different materials.

- ***Investment in Sewage Treatment:***
- Substantial returns ($1 investment resulting in a $4 return) are linked with the outcomes of sewage treatment in various countries, including India, suggesting the potential profitability of investing in sewage treatment. This indicates wise investments in sewage treatment can yield significant returns, making it financially viable.
- ***Pricing and Affordability of Water and Wastewater:***
- The sufficiency of current water and wastewater pricing structures in India and water affordability raises concerns about the economic aspect of water and sewage. It prompts consideration for a fair and sustainable pricing model.
- ***Political, Social, and Economic Aspects:***
- Observations on political complexities and challenges in water recycling in urban locations such as in Bangalore and the treatment of wastewater as a social need highlight the interconnectedness of water issues with politics, economics, and society.

*b) Moral Implications of Water Pollution and Extraction*

Questioning the morality of freely extracting and selling polluted water raises ethical concerns. This approach potentially creates an incentive to pollute further, which conflicts with environmental responsibility. It prompts reflection on whether such practices align with ethical considerations.

*c) Challenges and Solutions in Water Management*

- Challenges associated with energy consumption, system complexities, defining circularity dimensions, and combining technical and administrative innovations indicate the need for a comprehensive intervention approach.
- Emphasizing education to prevent pollution and promote responsible water use leads to focusing on community involvement and awareness.

# Lifestyle for and Economics of Rivers




- Decentralised sewage treatment, retrofitting infrastructure, and treating water at multiple locations highlight potential solutions to enhance efficiency in wastewater treatment.

### *d) Technological Advancements and Adoption Challenges*

- Stressing the importance of improved technologies and updating existing ones to reduce costs and improve efficiency highlights the ongoing need for technological advancements in wastewater treatment.
- Acknowledging skepticism towards new technologies suggests challenges in their adoption.
- Referencing successful models like the Netherlands' pollution charge system and discussing challenges faced in different countries like India and Ireland.

### *e) Project Gestation Periods and Terminology Perception*

- Concerns about prolonged project gestation periods and the suggestion to rephrase terminology to mitigate conflicting perceptions indicate the need for more efficient project management and effective communication strategies.
- Highlighting the lack of progress in implementing proposed plans and questioning investment priorities in sewage treatment without a coherent river management strategy.

### *f) Environment-Friendly Practices and Adherence to Standards*

- Emphasizing nature-inspired sewage treatment methods, utilising industrial wastewater for environmental rejuvenation, and adopting European Standards while considering affordability reflect an interest in environmentally friendly practices and global benchmarks.

### *g) Effluent Discharge Norms*

- Confusions are raised in the implementation of effluent discharge standards through an order NGT and those set by the regulating ministries such as MoEF & CC.
- Debating the necessity for standardized regulations versus application-based solutions in addressing wastewater-related issues.
- Questioning the appropriateness of conservative water quality norms and the potential implications of adopting a more liberal approach without adequate study.
- Debate over uniform standards, regional implications, and the need for scientific studies to guide policy.

## 2.2 Thrust Areas

- **Charging the Polluter and Water Valuation:** The necessity of charging polluters and valuing water to encourage efficient usage through incentives or regulations.
- **Developing Water Resources from Wastewater:** Investment in wastewater to transform drains into potential water bodies and maximising water resource usage.
- **Segment Identification for Water Trade:** Identifying sectors ready for water trade and starting with industrial and commercial sectors.



- **Decentralisation of Wastewater Treatment:** Advocating for decentralised treatment closer to the source to improve city drains and create an economy around drainage systems.
- **True Economics of Wastewater Treatment:** Highlighting the importance of considering the comprehensive cost of treatment beyond basic costs per volume.
- **Environmental Responsibility and Water Resilience:** Emphasizing rejuvenation of natural water bodies for resilience rather than solely relying on expensive solutions.
- **Ethical and Environmental Implications:** Ethical concerns about freely selling polluted water and advocating for a different approach.
- **Policy Interventions and Implementation Gap:** Highlighting the need for cohesive policies, reviewing standards, involving communities, and bridging the gap between policies and actual implementation.
- **Water Usage Disparities and Challenges:** Emphasizing disparities in water pricing and usage across different sectors and highlighting challenges in water management, including pollution and leakage.
- **Technological Appropriateness and Resource Recovery:** Addressing the suitability of technologies across different city tiers, advocating for resource recovery from wastewater, and discussing challenges in scaling up successful projects. Assessment of the effectiveness and longevity of specific technologies like Membrane Bioreactors (MBR).
- **Water Transport and Infrastructure:** The costs and challenges associated with water transportation, successful projects, and opposition to infrastructure projects.
- **Nature-inspired Solutions and Integration into Existing Systems:** Considering nature-inspired treatment solutions, reusing treated water, and synchronising efforts for overall water quality improvement.
- **Compliance, Standards, and Regulatory Role:** Highlighting conflicts between different standards, compliance concerns, the importance of environmental standards, and the role of a water regulator.
- **European Standards, Affordability, and Environmental Impact:** The historical development of standards in Europe, affordability concerns, and the assessment of environmental impact of efficient treatment processes.

### 2.3 Concerns

- Challenges and complexities in achieving profitability and scalability in water management, especially in the context of a circular economy.
- Water conservation, wastewater treatment, and efficient utilisation of water in the regions with abundant rainfall.
- Leveraging private sector expertise and the role of governments in encouraging and supporting technology platforms for organised water and wastewater utilisation.
- In the existing scenario major challenges in the water and wastewater field are related to rising

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# Lifestyle for and Economics of Rivers

water costs, inadequacy of treatment capacities, resistance from local communities to adopt technological alterations, policy changes, and the integration of treated wastewater into water policies.

- Analyses of cost dynamics, adherence to standards, integration of treated water into drainage systems or rivers, and ensuring collective participation in wastewater treatment.
- Exploring various wastewater treatment methods, deliberating on the best approach for altering water quality, and discussing citizen and corporate involvement in preventing water contamination.
- To establish correlation between standards, development, balancing stringent standards with affordability, and environmental advantages of efficient wastewater treatment processes.
- Successes and scepticism faced in implementing newer, potentially more efficient technologies in wastewater treatment.

### 2.4 Solutions

- Proposed approaches and strategies for sustainable wastewater management requires alterations in regulatory frameworks, promote incentivization, promote decentralised systems, Implement waste-to-resource approaches and adopt novel innovative solutions.
- One of the strategies for sustainable wastewater treatment is to treat waste closer to the source of pollution and to develop perpetual water bodies for direct potable use/ reuse.
- Develop water resources by utilising treated water for various purposes like agriculture, industry, and domestic use.
- Convert drains into rivers and restore water bodies to support indigenous aquatic life and ecosystems.
- Advocate for transparent and accountable water management systems like the Netherlands model, where citizens understand what they pay for water services.






# PROPOSED APPROACHES

**and strategies for sustainable wastewater management requires alterations in regulatory frameworks, promote incentivization, promote decentralised systems, Implement wasteto-resource approaches and adopt novel innovative solutions**


- Warn against creating a false market where free water, taken after pollution, is sold, emphasizing the need to maintain water's value and discourage pollution-driven practices.
- Utilise programs to assist smaller towns in selecting suitable wastewater treatment technologies.
- Direct policies towards industries valuing treated water, such as the hydrogen industry for green hydrogen production.
- Advocate for a collaborative platform involving multiple government agencies and the private sector to provide grassroots solutions. Implement synchronised strategies for widespread water quality improvement.
- Highlight the importance of retrofitting existing infrastructure for improved functionality and efficiency.
- Advocate for better wastewater management practices to reduce wastage and prevent further pollution of water bodies.
- Explore the possibility of replicating successful industrial water recycling practices for common use.
- Encourage a cultural shift towards embracing treated wastewater usage.
- Highlight the potential of advanced filtration to treat wastewater effectively and generate energy from resultant sludge.
- Allocate sustainable charges towards wastewater treatment for high-quality service.
- Implement region-specific strategies for water pricing.
- Emphasize the need for location-specific solutions and engagement with local stakeholders and industries.
- Impose technological advancements and capacity

# Lifestyle for and Economics of Rivers


building for successful wastewater augmentation projects.

## 3. RECOMMENDATIONS AND TAKE AWAY POINTS

### 3.1 Policy Implementation and Governance

- Encourage the government to implement pollution charge systems for industries to promote responsible wastewater treatment.
- Advocate for transparent and accountable governance involving citizens in decision-making processes about wastewater usage and treatment.
- Advocate for policies encouraging implementation of novel eco-friendly technologies for sustainable wastewater treatment.

### 3.2 Decentralised Treatment and Technology Adoption

- Emphasise the need for decentralised treatment plants and efficient monitoring systems to treat wastewater before it enters the riverine ecosystem.
- Decentralised solutions should be aligned with local conditions for effective management of rivers and settlements.

### 3.3 Educational and Awareness Initiatives

- Emphasize the necessity of educating and raising awareness among consumers about the safety and benefits of recycled water.
- Stress the role of public education, capacity building, and involvement of medical professionals in

**ALIGN WATER AND**
**wastewater related efforts with 'Sustainable Development Goals (SDGs)', by highlighting the importance of water supply augmentation, quality, and public acceptance to meet these goals**


ensuring successful acceptance and consumption of recycled water.

### 3.4 Global Goals and Sustainable Development

- Align water and wastewater related efforts with 'Sustainable Development Goals (SDGs)', by highlighting the importance of water supply augmentation, quality, and public acceptance to meet these goals.
- Promote environmental friendly practices of wastewater treatment to achieve sustainable future goals.

### 3.5 Behavioural Changes

- Encourage lifestyle changes and community involvement to reduce water consumption and prevent water contamination.

### 3.7 Technology and Research

- Encourage further research and investment in technologies converting industrial wastewater to hydrogen.
- Emphasize the importance of assessing the longevity and effectiveness of different technologies before implementation.

### 3.8 Customization and Adaptation

- Recommend tailoring standards and solutions in a case and location specific manner, overcoming scaling bottlenecks in wastewater recycling and reuse.
- Emphasize the importance of balancing stringent regulations with relaxed standards after thorough scientific research.

November 23, 2023

# Integrated Digital Systems for River Basin Management

**DAY 2:**
Thursday, November 23, 2023
16:00 – 17:30 hrs

**MODERATOR:**
Vinod Tare [Founding Head, cGanga]

**DIGNITARIES ON THE DIAS:**
Anshumali [Professor, IIT(ISM) Dhanbad]
Kees Bons [Deltares, Netherlands]
Somasekhar Rao [Director (Technical), ACIWRM]
Tomaz Rodic [CEO, SpaceSi]


## 1. PREAMBLE

This session began with showcasing some of the best digital platforms that are being used around the world for managing river basins.

- Satellite remote monitoring including penetrating cloud-cover
- Floods, surface and ground water monitoring
- Digital Twins of catchments and valleys
- Drone and LIDAR based systems
- Advanced sensor-based AI systems / and other systems

Subsequently the participants deliberated on best practices in governance of river basins and systems. Critical issues that covered were:

1. Water quality monitoring
2. Water quantity and resources monitoring
3. Ground water and surface water extraction management
4. Decision support systems to manage the critical issues / and other approaches

## 2. PROBING THOUGHTS

The proliferation of satellites and all kinds of real time sensors over recent years has led to an explosion of data collection, offering extensive information about Earth's surface water. Satellite remote monitoring includes penetrating cloud-cover and providing information related to floods, surface and groundwater monitoring, Digital Twins of catchments and valleys etc. Other tools like Global Water Watch and Aqua Monitor provide real-time monitoring and analysis of water bodies globally, aiding in assessing reservoir levels, changes in water occurrence, and erosion/sedimentation patterns. Digital technologies lead to data collection and interpretation and have their own constraints. All the issues related to data collection technologies, data accuracy, and its utilization to overcome the existing challenges, and planning, policy,

# GLOBAL WATER WATCH

**and Aqua Monitor provide realtime monitoring and analysis of water bodies globally, aiding in assessing reservoir levels, changes in water occurrence, and erosion/sedimentation patterns. Digital technologies lead to data collection and interpretation and have their own constraints**


and governance are discussed and summarized under the theme.

## 3. KEY POINTS RAISED

- How could the available technologies be applied to map the space that river needs regularly and on some occasions?
- The challenge of insufficient information is due to the predominant use of optical satellite data without cloud penetration.
- The causes of disappearance of small watersheds in Trans-boundary River Basins? The focus is also on to understand the alterations responsible for the degradation of smaller watersheds within trans-boundary river systems.
- Harnessing the capability of the micro-satellite system developed by the Slovenian Center for Space Sciences and Technologies.
- Investigating the impact of human activities on the natural boundaries of rivers and the subsequent disappearance of river systems due to land allocation for various developmental projects.
- The diverse applications of the satellite, from tracking maritime traffic to environmental monitoring and disaster assessment.
- The significance of higher resolution and higher temporal frequency data collection in specific regions, especially river basins.
- The reliability of the cloud-based services for data storage and accessibility.
- How can the available river-related data be linked with ongoing and proposed programs for river monitoring?
- What are the novel ways to achieve ecosystem couplings by exploring the interconnections between water, soil, vegetation, and meteorological conditions?
- How is the satellite data used to study the previous

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# Integrated Digital Systems for River Basin Management

flood events and their impact on the existing ecosystem?

- Use of satellite data to assist in disaster management, flood assessment, and ecosystem monitoring to aid civil protection and disaster preparedness.
- How to identify suitable information gathering systems for specific contexts?
- Advantages for creating dynamic models to fit ecosystem behaviours and maintaining updated models according to current conditions.
- Review the sensitivity in data distribution, accessibility, and security measures, particularly in certain riverine systems like river Ganga.
- Impact of Global Water Watch which enables users to examine reservoirs worldwide, track fluctuations, and establish area-depth-volume relationships crucial for effective water resource management.
- Impact of the transformation of perennial rivers into seasonal which emphasises the loss of water bodies, reduction in rainfall, and increased agricultural pressure affecting river health.
- Exploring the challenges posed by competing and conflicting land uses in the context of river conservation and the necessity of land allocation for river preservation.
- SpaceSI's role as a Copernicus Relay Center and its satellite functionalities.
- The concern regarding the resolution of historical data, which inquiries about the system's capability to monitor smaller entities like 10x10 meter ponds and/ or large water bodies dating back to 1985.


- Environmental issues like forest fires, river basin monitoring, plastic pollution detection, and the impact of floods on ecosystems and urban areas.
- Reliability of the modern sensor-based approaches over traditional methods for water quality monitoring.
- Different ways and means to engage citizens in data collection through employment and payment mechanisms.
- Different mechanisms to engage local communities, schools, and colleges to gather real-time information

**SATELLITE-BASED**

**tools in conjunction with ground observations can rapidly identify and address issues related to water bodies, such as leakage, erosion, and changing water patterns, facilitating effective management**




using hybridization of conventional and advanced techniques.

## 4. CONCERNS

- Analyzing the necessity and efficacy of monitoring approaches and to understand the implications of diverse information gathering systems.
- How digital tools offer immediate insights into issues such as dam leakage, erosion, and morphological changes in water bodies, aiding in prompt problem identification and potential solutions.
- Addressing the issues related to the underutilization of available data models and advocating for their broader applications in the field of hydrology and geo-morphology, acknowledging the limitations but emphasising the potential gains.
- The possibility of enhancing the system by incorporating feedback for un-recognised water bodies or those without names.
- Discussing a 60-year past analysis which showed a significant decrease in rainfall and its direct correlation with increased agricultural fields exerting pressure on surface water bodies.
- Information on the number of streams and their density that can provide crucial insights into the morphometry of watersheds.
- Scope for the utilisation of multi-payload satellite capabilities for various purposes such as environmental tracking, ecological monitoring, and conflict resolution related to transboundary rivers.
- Integration of multispectral data to estimate water quality indicators, pollution detection, and mapping terrain for 3D reconstruction.
- Modeling water catchment areas, river flows, and flood predictions using digital twin models derived from satellite data.
- The system's ability to provide continuous information on water bodies since 1985 was debated, including the potential integration with LiDAR satellites to gather water level and area information automatically.
- Exploring possibilities of integration and

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# Integrated Digital Systems for River Basin Management



collaboration with existing monitoring stations for a unified, reliable, and digitally accessible database.

- Limitations in current satellite data acquisitions during flash floods and exploring cloud sourcing as a potential solution to complement satellite data.
- Acknowledging the existing citizen science initiatives and their potential applicability for data collection.

## 5. SOLUTIONS

- **Application of Satellite-based Tools:** Satellite-based tools in conjunction with ground observations can rapidly identify and address issues related to water bodies, such as leakage, erosion, and changing water patterns, facilitating effective management.
- **Land Allocation for Rivers:** The need to allocate specific land for river space, devoid of the land allocated for roads and infrastructure development.
- **Classification of Rivers:** Suggesting the classification of rivers into different categories, akin to species classifications, to determine the level of endangerment and aid in policy making.
- **Data Acquisition Strategy:** Utilising satellite data to study and calibrate ecosystem models for different geographical areas in India.
- **Monitoring and Modeling:** Integrating real-time modelling with monitoring for accuracy and cost-effectiveness.
- **Dynamic Model Implementation:** Implementing dynamic models that adapt to the changing environmental conditions in real-time.
- **Strategy in Data Collection:** Emphasising the importance of a strategic approach rather than indiscriminate data collection.
- **Technology Upgradation:** Integrated LiDAR satellites should be used to enhance data collection with updated hydrological information such as water level aiming to provide insights into water storage.
- **Involvement of Public for Data Collection:** Proposing the idea of "crowd sourcing data" from the public to supplement existing monitoring efforts.
- **Data Processing and Standardization:** Emphasising the need for a dedicated unit to process, validate, and standardise data from multiple sources, including crowdsourced information, for meaningful scientific analysis.
- **Digital Database Implementation:** Need a centralised digital database for effective water resource management.
- **Data Credibility and Third Party Assessment:** The credibility of data should be examined through involvement of academic institution and outside government interference.
- **Determining Key Parameters:** Crucial parameters for river monitoring and the cost implications associated with various monitoring methods should be determined.

# INTEGRATED LiDAR

**satellites should be used to enhance data collection with updated hydrological information such as water level aiming to provide insights into water storage**

- **Enhancing Monitoring Density:** More frequent and denser information should be gathered, particularly in terms of water levels, flow rates, and water quality for modeling and data assessment.
- **Combined Desktop and Field Analysis:** The combination of satellite data and ground observations enhances the utility of Earth observation, offering a more comprehensive understanding of water-related phenomena.
- **Synergy and Collaboration:** Stressing the need to avoid duplication of efforts among different agencies and promote synergy for collective progress.

## 6. RECOMMENDATIONS AND TAKE AWAY POINTS

### 6.1 Satellite Data Contribution:

- Emphasising more towards the importance of tailoring information systems to unique situations.
- Encourage wider adoption and exploration of satellite-based tools like Global Water Watch and Aqua Monitor among hydrologists to maximize their potential in real-time water resource management.
- Stress the importance of combining satellite data with local observations for a comprehensive understanding of water-related dynamics and emphasise the need for further exploration and utilisation of available data models in hydrology.
- Emphasising the importance of preserving small watersheds using scientific tools and techniques to maintain the health of larger river ecosystems.
- Advocating the delineation of administrative boundaries around natural river boundaries and implementing policies to safeguard and conserve river systems based on data-driven analysis and classification.
- Specific river monitoring and the potential for broader global accessibility of water-related information.

### 6.2 Collaboration Opportunities:

- Encouraging collaboration with local authorities and environmental agencies for comprehensive ecosystem studies and data processing units to maximise the usefulness of gathered data for scientific analysis and decision-making.
- Emphasising the importance of international collaboration in utilising satellite data for a global perspective on river basin management.
- Encouraging participation from countries across continents to join in the collaboration for future advancements in satellite-based environmental monitoring and disaster management.
- Collaboration between stakeholders, possibly within a new centre, could aid in further development and exploration of these data capabilities.
- Collaborative efforts between Slovenia and India, along with plans to form an international coalition to expand the application of satellite technology for global river basin management.

### 6.3 Emphasising Preparedness:

- Stressing the importance of continuous model updates for better preparedness against natural events like floods in the future.

### 6.4 Gridded Data Publication:

- Suggesting the publication of processed, standardised gridded data for extensive river lengths .

### 6.5 Holistic View in Data Collection:

- Suggesting a broader perspective beyond typical civil engineering measurements to incorporate biological indicators.

### 6.6 Summit Upshot:

- Reinforcing the objective of the water impact summit as a platform for diverse perspectives without judgments or absolutes.

November 24, 2023

# Inducting Samarth Ganga Concept in Preparing Basin Management Plans for Six Major River of India

**DAY 3:**
Friday, November 24, 2023
09:30 – 11:00 hrs
11:30 – 13:00 hrs

**MODERATOR:**
Vinod Tare [Founding Head, cGanga]

**DIGNITARIES ON THE DIAS:**
A K Singh [Secretary to Government, WRD, Government of Kerala]
Pradeep Kumar Agarwal [Joint Secretary, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India]
Purnendu Bose [cGanga, Professor, IIT Kanpur]
Sabita Madhvi Singh [Scientist D, NRCD]


## 1. PREAMBLE

Hon'ble President of India in his address at the Joint Session of the Parliament in June 2019 stated the following:

"…. My Government is fully devoted to make the flow of Ganga uninterrupted and pollution free. Recently, encouraging evidence of revival of aquatic life at several locations along Ganga have been reported. This year, during the Ardhakumbh in Prayagraj, the cleanliness of Ganga and amenities provided to the devotees have made news throughout the world. My Government has enhanced the dignity and self-esteem of every person who contributed towards the successful organization of Ardhakumbh by honouring them.

Under the 'Namami Gange' scheme, my Government will further accelerate the campaign for closure of drains releasing effluents in the river Ganga. On the lines of river Ganga, the Government will also endeavour to clean up other rivers such as Cauvery, Periyar, Narmada, Yamuna, Mahanadi and Godavari….."

Earlier a strategic Ganga River Basin Management Plan (GRBMP - 2015) was prepared by consortium of 7 IITs led by IIT Kanpur. In March, 2016, MoA was signed between IIT Kanpur and MoWR, RD&GR (now Ministry of Jal Shakti) to establish Centre for Ganga River Basin Management and Studies (cGanga in short) to provide continual scientific support for implementation and dynamic evolution of the Plan. Centre for Ganga River Basin Management and Studies (cGanga), approved by the Board of Governors of IIT Kanpur, has now been set up and operational at IIT Kanpur that serves as a knowledge body to the National Mission for Clean Ganga (NMCG), Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD & GR), Ministry of Jal Shakti, GoI.

# THE TWO SESSIONS

**under the theme, the project teams and experts deliberated on inducting the concept of Samarth Ganga (Capable Rivers) in preparing the river basin management plan and the expected requirements of and outcome from carrying out such exercise**


On the lines of GRBMP, it is proposed to carryout Condition Assessment and prepare River Basin Management Plan for six rivers namely, Mahanadi, Narmada, Godavari, Krishna, Cauvery, and Periyar, to enable preparation of action plans for conservation/rejuvenation of entire stream network of these rivers. It is proposed to engage Indian Institutes of National Importance located in some of the Basin States of these six river basins.

In the two sessions under the theme, the project teams and experts deliberated on inducting the concept of Samarth Ganga (Capable Rivers) in preparing the river basin management plan and the expected requirements of and outcome from carrying out such exercise. Learning from GRBMP and experience of implementing flagship Namami Gange programme could serve as the basis.

## 1.1 General

India is bestowed with 4% of world's water resources (India-WRIS 2015) and 2.4% of the world's land resources (cGanga and NMCG, 2015). Rivers have been the heart and soul of India's growth and culture. Many of the large river systems are perennial, but some of their tributaries are seasonal. Besides the Ganga and Brahmaputra systems, the other major river systems are Sabarmati, Mahi, Narmada, Tapi, Brahmani, Mahanadi, Godavari, Krishna, Pennar and Cauvery. Over the decades, booming industrial and agricultural growth, population growth, rapid urbanization, infrastructural developments, etc. have had considerable impact on India's natural resource base and waste generation. This has often had a damaging impact on the ecological status of India's numerous rivers, waterbodies, and other ecosystems.

# Inducting Samarth Ganga Concept in Preparing Basin Management Plans for Six Major River of India

The GRBMP provided a framework in the government's endeavor to conserve and restore the Ganga River through the National Mission for Clean Ganga (NMCG). Subsequent discourses and reaching out to diverse experts led to further developments in comprehending and addressing the various river-related issues in the country through identification of the roles of river basin ecosystems, importance of natural resource management and ecosystem goods and services of rivers, multi-stakeholder participation in river management, importance of small (lower order) rivers/ tributaries, waterbodies and other basin ecosystems, and impact of alternative developmental processes in synchronizing river conservation with development. This advanced knowledge informs the design of the programme for rejuvenating and conserving six major rivers of India (other than river Ganga and her tributaries), namely Mahanadi, Narmada, Godavari, Krishna, Cauvery & Periyar.

## 1.2 Objectives

Every river in nature is characterized by typical river functions that together define its hydrological, chemical, geological, spatial, and ecological integrity. Rivers impacted by human activities in the river basin – and sometimes within the river channels

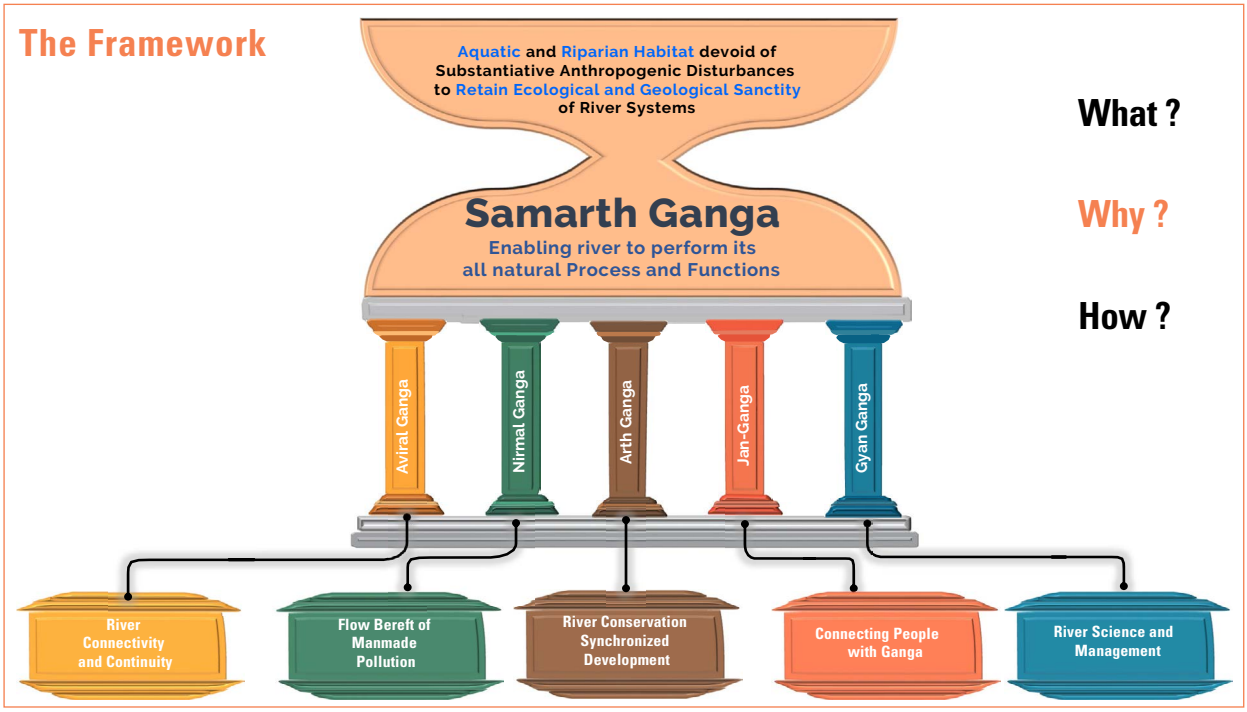


**Figure 6. The concept of Samarth Ganga**


themselves – may lose some of their functional capabilities, which compromises their integral nature. River restoration, therefore, is necessarily the means to make such rivers functionally able (or capable) once again to ensure optimal ecosystem services for human benefits. This is the basic concept of Samarth (meaning "Able") Ganga as applied to River Ganga, but also to any other river since the word Ganga relates to all rivers in the Indian context. Since the success of this restoration and conservation process is dependent on a convergence of the vision of an able river, scientific understanding, developmental actions and people's involvement, Samarth Ganga rests on the five pillars of concerted action as depicted in Figure 6.

The main objective of establishing the Centre is to develop an integrated river basin management plan for restoration and conservation of the wholesomeness of the rivers by improving their ecological health substantially which have been significantly affected by the competing human demands for river resource uses in the entire river basin. This entails assessment of existing conditions of the river and preparation of a road map/plan for comprehensive rejuvenation and conservation of the riverine ecosystems in their entirety by analyzing anthropogenic impacts on them in detail. In achieving this objective, both essential and desirable characteristics of river such as continuous flow, un-polluted flow, longitudinal and lateral connectivity, and river as an ecological entity need to be included.

The specific objectives include:

- To assess the geo-morphological, hydro-meteorological, bio-physical, socio-cultural, and socio-economic condition of various ecosystems

**RIVER RESTORATION,**
**therefore, is necessarily the means to make such rivers functionally able (or capable) once again to ensure optimal ecosystem services for human benefits**

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# Inducting Samarth Ganga Concept in Preparing Basin Management Plans for Six Major River of India

(wetlands, forests, grasslands, agro-ecosystems. etc.) and human habitations in the entire river basin.

- To assess the insufficiency or excess of river resources (especially water, sediment, nutrients, flora and fauna, energy, and space) and of pollutants and other harmful materials in different river stretches and tributaries, and identification of stretches where they have been significantly affected by anthropogenic factors.
- To assess the ecosystem goods and services available from the river and its tributaries for the given river resources and pollutants, and the change in these goods and services over time due to anthropogenic factors.
- To assess the impact of anthropogenic activities including agricultural, industrial, urbanization, infrastructure, forestry, groundwater abstraction, etc. on the riverine ecosystems and its trends.
- To assess/identify non-local and/or natural adversities (such as geological processes, climate change, etc.) affecting the river basin.
- To formulate suitable interventions for restoring the wholesomeness of the river including alternative measures in view of possible implementation constraints.

### 1.3 Scope of work

Major rivers and their tributaries need to be holistically studied adopting a basin-wide approach considering the major human activities that have been affecting the river ecosystems such as industrialization, urbanization, lifestyle changes, agricultural & other rural activities,

**HUMAN AC TIVITIES in river basins and direct interventions impact river ecosystems and their services. Evaluating anthropogenic effects, considering natural and global factors like climate change, while identifying stakeholder roles in river revival and conservation, is crucial**

deforestation/denudation, dams/ barrages, engineering flood control measures, infrastructural developments, etc. A comprehensively assessment of all such factors to identify the existing conditions affecting the river ecosystem and suggesting future course of actions for their remediation is necessary. For each major river and its tributaries, an assessment of its ecological status is to be carried out with verifiable ecological, hydrological, and geomorphological indicators/ parameters (quantitative and qualitative). Spatial and temporal inter-connections between surface waters, groundwater, soil/ sediment, and terrestrial flora and fauna as well as biodiversity of the different ecosystems in the river basin and their eventual contribution to the natural resource base of the river network should be established to evaluate the goods and services expected from hypothetically (or previously) un-impacted (reference state) state of rivers. For resources that mainly come into the river from the larger basin (such as water and sediment) a mass balance (water balance, sediment budget, etc.) over the entire basin and over sufficiently long duration is needed. The impact of human activities in the basin and of direct human interventions in the river networks may then be assessed to evaluate the anthropogenic effects on the river ecosystems and their goods and services in different stretches and at different times. The results may be further qualified by any natural or global factors (e.g. climate change, plate tectonics) that are found to affect the rivers. The role of different stakeholders of the rivers and their importance and roles in reviving and conserving the rivers need to be identified. Along with any additional factors that may be relevant, these findings may be synthesized to formulate a cohesive action plan for integrated basin management of each river.

Some specific themes that may be considered for assessment for specific thematic areas may broadly be in line with Ganga River Basin Management Plan – 2015 (cGanga and NMCG, 2015) prepared by Consortium of 7 IITs.

Human activities in river basins and direct interventions impact river ecosystems and their services. Evaluating anthropogenic effects, considering natural and global factors like climate change, while identifying stakeholder roles in river revival and conservation, is crucial.

### 1.4 River Basin Organisations and Strategic Plan

Studying river basin organizations across the globe and suggesting suitable organization, process and strategies for achieving the objective of rejuvenating and conserving the riverine ecosystems keeping national and local practices, legislative framework, institutional strengths and weaknesses, and stakeholder roles in mind should also form part of the River Basin Management Plan. The study team may review the current legislations (both central and state government) in place in environment protection, rules, regulations from statutory bodies, orders and judgments passed by various courts and tribunals in the country, policies, programmes, etc. for arriving at suitable rejuvenation and conservation strategy.

The focus of the study may include:

- Enhancement of and inclusion in central/ state plans, projects and resources based on basin-wide perspectives to enable river conservation-synchronized development.
- Defining the parameters of and strengthening regional cooperation for the management of interstate rivers.
- Comprehensive monitoring, dissemination and communication of the River Network and Basin conditions.

cGanga and NMCG, 2015, "Ganga River Basin Management Plan (GRBMP)- Extended Summary; Volume 1: Main Plan Document; Volume 2: Mission Reports; Volume 3: Thematic Reports", January 2015

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- Stakeholder-inclusive and Accountable River Basin Organizations.

While preparing the strategic plan the study team may:

- Align with the Strategic Indicators and with Sustainable Development Goals, where relevant to water-related or renewable resource related issues.
- Ensure clarity of meaning, reflecting the Monitoring Parameters that are needed for each issue.
- Only include matters that most resonate with the Basin needs, particularly in relation to resource balance and ecosystem health.
- Distinguish, wherever needed, between overarching outcomes and concepts such as resilience, sustainability, the water, food, and energy nexus, etc. and specific indicators that enable an assessment of status and trends.

### 1.5 Data Interpretation and Presentation

River Restoration and Conservation is a cyclic process involving many steps as per Data Framework prepared by cGanga (cGanga and NMCG, 2019). The first three steps, namely Understanding, Communication and Negotiation are critical to the overall success, and needs to be done scientifically as well as by engaging with all stakeholders through synthesis of available information and evidence. As such data and information collection, its analysis, and interpretation is the most crucial and resource intensive.

The condition assessment and river basin planning study should be pegged basically on secondary data. Wherever possible the Study Team may use GIS data available to analyze and present the report by using, Satellite ortho-imagery for recent 3 years pre

& post monsoon; {High Resolution Multispectral Scanner (MSS) satellite image of 50 cm} including current year. Other relevant data for the individual components mentioned above can be collected from the respective government agencies. In case any specific data required for analysis is to be procured, the Study Team may indicate the same in the approach and methodology along with indicative cost of the same.

The Study Team is expected to comprehensively assess the status and specify corrective actions with indicative cost for revival of each component. While addressing the issues, reversible and irreversible conditions have to be clearly brought out in the reports. Also, all interventions that are currently in vogue under various schemes of Central/State/Local Governments and by Non-Governmental Organizations should be taken into consideration while preparing final recommendations. Further the report should indicate the approach for project structuring such as direct government investment, Private investment as part of business or through Corporate Social Responsibility route, and Public Private Partnerships.

### 1.6 Assumptions & Constraints

The proposed study involves two implicit assumptions, namely:

- Healthy ecosystems within the river basin have positive impacts on rivers through a naturally balanced supply of renewable resources and moderation of harmful inputs, but disturbed/ impacted ecosystems have limited ability to carry out these functions, and hence can affect rivers adversely.
- Anthropogenic activity generally impacts rivers negatively or neutrally. However, it is possible for anthropogenic interventions to also have positive impacts on river ecosystems – hence interventions can be designed to meet this target.

The work of preparing river basin management plan is envisaged to have the following main constraints:

- The work is intended to be carried out primarily by analyzing secondary data. However, requisite secondary data may not exist in sufficient detail for all river resources, status of ecosystems, diverse human impacts, evaluation of ecosystem services, and historical information about the rivers and their basins. Hence, wherever necessary, and feasible within the given time frame, primary data may be collected.
- The legal and institutional framework and financial constraints within which the river restorations can be actually carried out may be complex and difficult to fully assess. Hence different technological intervention options may be considered and compared with respect to their relative merits and demerits.

### 1.7 Deliverables

- Inception Report identifying the substantive issues of the study, proposed methodology, perceived constraints, specific river stretches, tributaries and ecosystems to be quantitatively assessed, and

cGanga and NMCG, 2019, "Concise Manual and Guide for River Restoration and Conservation", December 2019



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proposed timeline (with milestones giving verifiable and measurable indicators).

- Comprehensive assessment of the hydrological, geomorphological and ecological status of the river, river basin and its main ecosystems.
- Maps, tables, illustrations, etc. delimitating river resources and ecosystem goods and services available from different stretches of the main-stem river and its major tributaries, indicating stretches with significantly affected resources and diminished ecosystem goods and services.
- Scientific assessment of environmental flows (flow quantities with depths, widths, etc. as relevant) for different river stretches and major tributaries.
- Estimating sustainable river resource uses for both the renewable resources that come mainly from the basin – such as water, sediment and nutrients – and those generated within or intrinsic to the river – such as kinetic energy (stream power), river space (including flow channel, riverbanks, floodplains and hyporheic zone), flora, fauna and biodiversity, and genetic resources.
- Formulation of measures to conserve and/ or moderate key ecosystems in the river basin such as wetlands, forests, and agro- ecosystems.
- Formulation of measures to contain or nullify the negative impacts of ongoing or pre-existing anthropogenic activities in the basin, and also of any non-local or natural adversities as a Strategic Plan for implementation.
- URMP, Urban River Management Plans (i.e. how to manage rivers in various Urban Centers), and RRMP, Rural River Management Plans (i.e. how to manage rivers in various Rural clusters) for main stream and its tributaries. Such plans are expected to elaborate on how various central, state, and local governments policies and programmes could be better coordinated and optimally utilized to manage rivers in Urban and Rural areas.

**THE WORK IS**

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- A time-bound Strategic Plan for implementation of the measures along with measurable and verifiable indicators for monitoring, evaluation and feedback control through a well-defined mechanism of participation by all key shareholders for rejuvenation and conservation of rivers.
- Identification of key shareholders (Central Govt., State Govt., Local Bodies, local communities, civil society organisations, businesses, and citizens, etc.) of the rivers and their roles in river restoration and conservation, and the Desired Institutional Framework and any Policy and/or Legislative changes desired for successful implementation of the Strategic Plan.

## 2. EPILOGUE

The framework of Samarth Ganga(meaning capabilities of the rivers to perform theirs functions and processes to deliver on ecosystem services are not compromised by river-human interaction)developed jointly by the Centre for Ganga River Basin Management and Studies (cGanga) led by IIT Kanpur and NMCG, Ministry of Jal Shakti for preparing the river basin management plans was deliberated uponin details by various national and international experts including representatives of more than a dozen institutions (IITs, NITs, CSIR-NEERI, etc.), NGOs, Governments officials from various states and central governments of India. The highlights of the programme are as follows:

- River Ganga is just not a biophysical entity but represents spirit of rivers and in Indian culture the Ganga is invariable used for all rivers.
- The focus of river restoration is the central pillar of Arth Ganga out of the five identified pillars, implying recognizing the spirit of rivers and river centric economic development.
- The enabling pillars are Gyan Ganga (knowledge about river systems) and Jan Ganga (by the people and for the people).
- The indicative pillars are Aviral Ganga (adequate flow in rivers) and Nirmal Ganga (quality flow in rivers commensurate with needs of the indigenous biota).

It was generally agreed that the above framework could be adopted for rejuvenation and conservation of almost all rivers. It was agreed by all institutions proposed to take up the condition assessment and management plans for basins of six major rivers of India Mahanadi, Narmada, Godavari, Krishna, Cauvery, and Periyar.

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Development vis-à-vis Land, Water and Rivers
&
1st Climate Investments and Technology Impact Summit
[CITIS - 2023]


NAMAMI GANGE
India Water Impact Summit
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&
Climate Investments and
[CITIS - 2023]
JAYAKUMAR KV

CLOSING SESSION

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# Valedictory Session of IWIS 2023

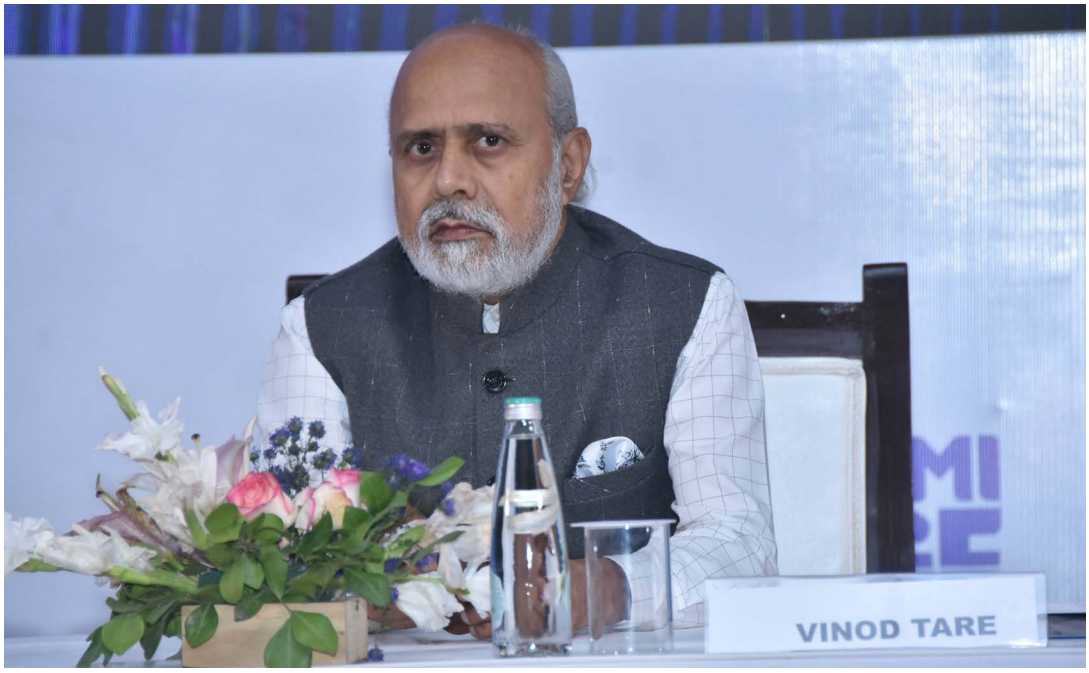
**INTRODUCTION:**

The Valedictory Session IWIS-CITIS 2023 was conducted by Prof Vinod Tare (Head, cGanga, IIT Kanpur), Mr Sanmit Ahuja (cGanga) and Mr Sandeep Chauhan with presentations of the summaries of technology presentations, discussions, views, recommendations and conclusions of the twin summits. The substantive contents of the deliberations are presented as follows:

**DAY 3:**
Friday, November 24, 2023
16:00 – 17:30 hrs

**DIGNITARIES ON DIAS:**
Vinod Tare [Founding Head – cGanga, IIT Kanpur]
Sanmit Ahuja [Expert Member, cGanga]
Sundeep Chauhan [Expert Member, cGanga]

## Vinod Tare, Founding Head - cGanga




We started the first India Water Impact Summit in 2012 while preparing the Ganga River Basin Management Plan by the Consortium of 7 IITs. This was followed by six more versions of the India Water Impact Summit. What we learnt during those summits is what we actually mean when we talk about Ganga rejuvenation and restoration. After a lot of deliberations what we arrived at is that we have to make sure that all our river systems remain capable of delivering their processes and functions, and that is what we call Samarth Ganga – that a river should remain "Samarth", meaning "capable" in Hindi or Sanskrit. And to do that we need to strengthen the five pillars.

It is good to see clean rivers, but unless and until we talk about the economy around it, it's not going to work. So our target has been to restore and conserve the river so that it contributes or adds to our GDP by about 3% or so. The central

# IT IS GOOD TO

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pillar is of course Arth Ganga and the left two pillars are what we want to achieve with respect to rivers – that we want to make them flow and the quality of flow should be commensurate with what is required to sustain survival and growth of indigenous aquatic and riparian biota at that particular location. And this cannot be done unless and until we have a good understanding of the river systems and that's the third pillar – Gyan Ganga, our knowledge about river systems. And certainly public participation is important. So another pillar is the Jana Ganga. This is the concept that we actually evolved during the second to sixth India Water Impact Summits.

The government says that we are fulfilling the five essential P's: we have Political Will, Public Spending, International Cooperation and Partnerships, Peoples' Participation, and Perseverance. So these are the five P's.

Now there are five other P's which are important, which we discussed in the seventh edition of the IWIS. They are: Policies, Programs, Plans, Projects, and involved in all these things are People. And unless and until we bring in convergence in all these things we are not going to succeed.

One of the things that we talked about earlier is that rivers alone cannot be managed unless and until we manage the land. And that is why we have to talk about Samarth Ganga as well as Productive Land: because the problems of the land are from the water and problems of the water are from the

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land. And the solutions also lie with each other. So we need to take them together.

It is also important to talk about the lifestyle and the economics around the river.

We are gathering and collating information, data and knowledge around river science and management, and creating infrastructure to house and disseminate these at IIT Kanpur. Within India we are also building up this framework. We have a number of institutions joining in it. The last two sessions of 8th IWIS essentially focused on how we transfer whatever knowledge we have of the concept of Samarth Ganga to other river basins. One of the things that we realized is that we not only have to learn new things but we have to unlearn some of the concepts that we had earlier.

**RIVERS ALONE CANNOT**

**be managed unless and until we manage the land. And that is why we have to talk about Samarth Ganga as well as Productive Land: because the problems of the land are from the water and problems of the water are from the land. And the solutions also lie with each other. So we need to take them together**

# IF SOILS HAVE TO BE

**kept productive, the right of soils also has to be recognised. It is from that point of view that it was suggested that like water policy, we also have a soil policy. And just as environmental flows are different for different rivers and different stages, so also for the soil**

In November this year we faced the problem of air pollution. And the problem essentially originated from the agricultural side, or, at least, exaggerated by agricultural practices. We have a lot of crop residues and because we do not have a way to utilize it in the limited time available, what is being practiced is burning them. So this was one challenge coming from the soil side and getting into the air and water side, and we thought that we should debate on novel and noble approaches to deal with the same.

Another issue that we looked at is from the water side. We produce a lot of sludge. What should happen to that? Should it go to the land? We came up with recommendations for what to do with it. And there was a convergence in the sense that everybody agreed that STP sludge should ultimately find their way on to land, not in the form of land-fill but in the form of land applications so that we make our soil healthy. Normally we look at whatever is applied to the soil as fertilizer. But organic carbon – carbon contained in the soil or organic matter in the soil – is also important. and sludge can do that job well. So it is important to recognize that and not look at STP sludge as fertilizers but as soil conditioners to prevent the loss of topsoil.

The same is also true for crop residues. We think of whatever comes from agriculture as being for our use. But it is also important that soil has the right to use certain parts of it. And unless and until we return that to the soil, soil will not remain healthy. So similar to the concept of environmental flows, we have to make sure that soils also have certain rights on organic matter, on certain materials. And that has to be given to them.

If soils have to be kept productive, the right of soils also has to be recognised. It is from that point of view that it was suggested that like water policy, we also have a soil policy. And just as environmental flows are different for different rivers and different stages, so also for the soil. We have to have what should be the composition of the soil in different regions depending upon different types of soil.

In the case of rivers, we talk about river health. Similarly we should also talk about soil health. Soil health means many things, not just the physical structure or chemical composition, but the microbiology or biology of the soil. Unless and until we see the microbiology, which in terms of rivers is indicated by keystone species or indicator species, so also in soil: unless we see earthworms in the soil, we cannot say that the soil is healthy no matter whatever physical structure and/or chemical composition. Ultimately, in agriculture, in cultivable soil, if we see earthworms, then we can say that the soil is healthy. This is the concept around which consensus has been built and the subject matter needs to be further evolved.

Another important thing that came up is how we monitor rivers. A comprehensive river monitoring scheme was discussed and it was found that we ultimately have to develop river monitoring programme with application of cloud sourcing,

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advanced technologies and engagement of all stakeholders. We have to collect and then analyze the particular information and make it available for various uses.

Another of the objectives was to ground new solutions. We have been working on bringing new solutions, scrutinizing them, helping them to work under Indian conditions, help them develop their business under Indian conditions, and now three such solutions have been grounded and we are ready to scale them up. One such solution is for agriculture, where we have been working on soil-less agriculture – membrane-based agriculture – and we not only learned about it, we indigenized and piloted it in Pune on a relatively big scale. We have now done almost all the calculations and it is a business on its own. So we can do this kind of agriculture even with barren land, even on urban rooftops. It is very innovative, it saves on water. Our objective is to at least have 50,000 rupees per month per acre of income for the farmers from one acre of the land. And those are the calculations we have done and we believe this will happen on its own. So that's the first solution.

**ULTIMATELY,**

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The second one we worked on was decentralized wastewater treatment system. Again, we are bringing that solution and adopting it in India. We have tried this on a pilot scale in Pune on a reasonably big scale, with a plant of about 2.5 MLD being installed and run. And now we are ready to adopt it on a regular basis, and are almost in the process of negotiating with the government to have the plant set up. And I hope that will be a game changer when we want to apply decentralized wastewater systems and to clean our drains. The main constraint was the space, and this particular technology requires only one-tenth of the space that is required for normal treatment plants. And the energy consumption is less or at least comparable to other plants.

The third solution that we have is the use of end-of-the-life tyres. This is also an environmental concern. We have advanced sufficiently and are ready to scale it up.

Last year we released river atlases for the states of Uttarakhand and Uttar Pradesh and the basins within those states. This year we have worked on the state of Bihar and part of Madhya Pradesh. We have completed the river atlas for the state of Bihar and basins within that like Kul, Punpun, Ken and the Sindh river basins.

We have also been working on the issue of STP sludges. And we have been working in collaboration with Norway. They have supported this study. And yesterday we released the report of STP sludges in India.

Since cGanga has to be more professional, we are now looking at delivery through a professional foundation. So we have established a Special Purpose Vehicle for this called Samarth Ganga Foundation. Of course, Samarth Ganga Foundation has many other initiatives. Like whatever strategies, approaches and solutions we discuss here, how do we ground them? We will also initiate now the National Soil Rejuvenation Initiative. We will also have the National Water Market Initiative. And we have just started the global consortium for river science and management. And for that IIT Kanpur has signed an MOU with Samarth Ganga Foundation. So we will be working on behalf of cGanga through the Samarth Ganga Foundation. And provide all the professionalism that is required over and above the knowledge and strength that comes from IIT Kanpur and cGanga on this.

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## Sanmit Ahuja, Expert Member, cGanga

We finished Phase 1 of the ETV which is a successful demonstration of the technologies. The commercial model is now ready and the solutions are available to government and other stakeholders for buying them. Now the task is to enter the phase two of the ETV program which is how you get scale.

The ETV program was well beyond our mandate. We were initially hitting a continuous roadblock on how to create an enabling vehicle through which a lot of the recommendations over the last few years can actually get implemented. Within the existing academic system it was not possible for us to do it and neither is it with the government. So we needed an autonomous vehicle, not outside but with a very strong bond to cGanga, IIT Kanpur and NMCG. And that autonomous unit is the Samarth Ganga Foundation. It was started very much on the Samarth Ganga or Arth Ganga framework. So it's to operationalize and implement many of these initiatives.

The ETV program has also grown in leaps and bounds. We started our journey with a very small workshop six years ago. We now have over 50 technologies that are going through the process. And, again, we were also struggling with the rate of acceleration that was needed to deliver because we didn't have the processing capacity. The Samarth Ganga Foundation will become the vehicle to increase that processing capacity.

# Sundeep Chauhan, Expert Member, cGanga


The first presentation of this year's ETV was made by a company called HydroPoop. It is about extreme decentralized water recycling solutions. It's largely for apartments, embedded systems in the apartment. It takes care of bathroom water but doesn't yet take care of the kitchen waste which has got oils etc., and they are working on it.

The second company was Park Environment Tech India, who presented closed loop wastewater treatment for the recycled paper industry. They are working on specifically for recycled "gattawalas" as we say in Hindi, i.e. waste paper. They are working at 23 odd sites in India, although India has a sizable capacity of about 700 sites. And, worldwide, they are working on 1500 installations. Their experience is that it is a very fragmented industry, which will take 2-3 years to consolidate.

The third presentation was done by Viven, a big 8.8 billion dollar international group¸ already present in 100 countries with almost 22,000 workers. They are working on stormwater and sewer solutions, water and gas distribution solutions, indoor climate solutions, drinking water, etc. They said they are pioneers for introducing pipelines which we call CPVC now in India and across the world. They have 16 manufacturing plants with almost 100,000 plumbers trained across the country. We requested them to share what type of training programs they are doing.

The fourth company was Pleneus PV who works on real time water quality monitoring. And I like their term "IoUT" – Internet of Underwater Things. They are doing a pilot with NMCG for wireless water quality monitoring in Patna. They said that it is an experiment. It has succeeded in some of the pilots in Netherlands, and it should work in India. And they also claim to calculate 16 parameters, which we would like to learn – how they calculate BOD, DO and the other parameters through this wireless technology.

The fifth company was RHDHP who presented a reader technology which they partnered with VA Tech Wabag. Unfortunately, in the last 8 years, there have been only

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2 installations. They have also developed an AI-powered system called AquaSuit suite. Which is into analytics and autopilot, and some smart optimized solutions. Now there are a huge number of applications. They have started implementing in India.

The sixth company is Colson. They are working in 2 areas – sludge to energy and another technology called Digest Mix, which is digester mixing through heating.

The seventh company was SolitaryNet, an NGO. They are working on multi-stakeholder areas, mostly into pollution prevention and basically supporting circular economy. They are addressing water and air pollution. They are working on reduction in water use using state of the art solenoid walls, new flow meters, turbo extraction plants for the tanneries in Kanpur – tannery sludge to make paver blocks, in the textile industry using the sludge part and making paver blocks, and skilling programs and capacity building. Some of the programs they would share with us.

The last company was Bio Petroleum, who made two presentations. One was based on Israeli technology about three pillars process – process automation for advanced biological treatments. And they have software tools which are into business intelligence with AI/ML. There was a demo which looked good. They also have an ACT bioremediation process with Chemostat which measures nitrogen, phosphorus and microbial growth. We saw it, but in 20 minutes one cannot see everything. They are welcome to show us how it works. They are already doing pilots in GIDC, Naroda and other places in India. The second presentation by the same company was about Puremi, which is about data-driven excellence. It is cloud-based analytics for improved sewage plant performance. Again, a lot of parameters – hundreds of them. They did give a demo, but we have to see how it works. They are also into cloud-based analytics.

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# Valedictory Session of IWIS 2023

## Sanmit Ahuja, Expert Member, cGanga


On the CITIS themes both government and industry were very keen on innovation. The real risk for government is what if the innovation does not work. So why is government saying we are very happy to support innovation aspect if there is no guarantee that it works? The current bureaucratic set up or the civil service evaluation set up is quite punishing. And civil servants do not want to stick their neck out. So that's why the framework of the ETV program creates the highly trustworthy bridge. If the governments know that the technology has gone through a particular process and evaluated thoroughly from all angles – technology angle commercial, financial angle, etc., and once the companies start to demonstrate their efficacy, it becomes a lot easier to say that it's ready for mainstreaming and scaling up. In fact, the three technologies that were exhibited, we have seen, have been taken through these stages.

The thematic sessions covered water followed by energy followed by waste. And today there was a recurring theme across all the sessions. In the initial days when a technology is new,

the government's ability to create a market is of significant value. For instance, if the NMCG is the guarantor of payment, only then the hybrid projects started to roll out. Otherwise the developers were not very keen. Forget the developers, the lenders were not very keen to give money to the developers. So creation of the market was a resounding message across all the five sessions.

There were a number of other ideas that came up. On the water side, the most popular idea was creation of the water market. How decentralized wastewater treatment solutions can create the water market. On the energy side, just look at more solar and bring down our pay. But we need to also give enough space to new technologies or solutions that are proven. At the same time, so also for biofuel and biogas. We need to put a lot of weight behind these solutions. Green hydrogen and even concentrated solar power for storage and energy storage should be promoted. Moving on to waste, again, the market was the biggest focus area. And standardization of waste. Creating a new class, giving it an industry status. Bringing in hybrid priority sector lending were the main concerns and recommendations that the investors suggested.

On food and agriculture, the two big issues were market linkages for farmers and using new innovations to increase farmer's income. Like the one that we just demonstrated – Membrane Based (Soil less) agriculture. And, on the sludge side, creating a national soil policy.

On the transport sector, there was a big focus on infrastructure, more than on the actual PVs. Enable infrastructure and new disruptive solutions. On the decentralized off-grid energy charging systems there were two very interesting ideas on waste to hydrogen to fast charging. Or methanol to fast charging. The government representative said that enough policies have already been created but the OEMs are not moving at a quick pace. And the OEM space is very much limited by the market's own absorptive capacity. So not enough vehicles are being stored, nor enough charging infrastructure. So again, a circular argument. To break out of this circularity, requires focusing on decentralized infrastructure, while grid infrastructure strengthens over the next decade or so.

Finally, the panel said that technologies should be affordable and accessible.

**ON FOOD AND**

**agriculture, the two big issues were market linkages for farmers and using new innovations to increase farmer's income. Like the one that we just demonstrated – Membrane Based (Soil less) agriculture. And, on the sludge side, creating a national soil policy**

# Inaugural Session

**DAY 2:**
Friday, November 23, 2023
09:30-11:00 hrs

**KEYNOTE SPEAKERS:**
G Asok Kumar [Director General, NMCG]

**MODERATOR:**
Vinod Tare [Founding Head, cGanga]

**PANELLIST:**
Nalin Kumar Srivastava [Executive Director (Projects), NMCG]
VSDL Surendra [Director (UNES), Ministry of External Affairs]
Kharlo Quinonez [Head, Cooperation Affairs, Embassy of Mexico]
Anitha K Sharma [Counselor for Urban Development, The Royal Danish Embassy]
Kim Cook Andersen [Counselor for Finance and Investments, The Royal Danish Embassy]
Charles Miduk Somara [1st Secretary of the Embassy of Indonesia in New Delhi]
Ni Made Mahatma Devi [Attaché Economy, Embassy of the Republic of Indonesia]
Japchu [1st Secretary, Royal Bhutanese Embassy]
Luit Jan Dijkhuis [Programme Manager, Embassy of Netherlands]
Hilina Mekonnen [Office of the Prime Minister, Embassy of the Federal Democratic Republic of Ethiopia]
Shoubhik Ganguly [Senior Infrastructure Advisor, British High Commission]
Dhana Kumari Joshi [1st Secretary, Embassy of Nepal]
Jun Tsumori [Counsellor, Embassy of Japan]
Ram Avtar [Faculty, Environmental Earth Science, Hokkaido University, Japan]
Ibrahim Mamdouh Fouda [Second Secretary Political-Economic Section, Ambassador of Arab Republic of Egypt]
Nilaya Mitash [Principal Operations Coordination Specialist, Asian Development Bank]


## SESSION BRIEF

The high-level panel convened, alongside prominent climate investors, to deliberate and introduce new investment paradigms tailored specifically for technology-driven climate solutions. Recognizing that climate change is an intricate challenge demanding multifaceted responses, the discussions will emphasize that the depth of climate impact necessitates the convergence of deep technology, rigorous policy frameworks, and innovative financial mechanisms. This holistic approach underscores the complexity of climate change mitigation and underscores the need for a comprehensive and integrated strategy to address this global imperative.

# THIS HOLISTIC

**approach underscores the complexity of climate change mitigation and underscores the need for a comprehensive and integrated strategy to address this global imperative**


## KEY POINTS DISCUSSED

### 1. CONFLUENCE OF POLICY, TECHNOLOGY AND FINANCE

Bringing advanced climate solutions to marketis not just about technological challenges, but also about economic, operational, legal, financial and social issues. This requires confluence points where technology, policy and finance can come together to provide answers and pathways to the climatic degradation. The inaugural CITIS summit is that very confluence where different stakeholders come together to address some of the biggest systemic challenges that India and the world are facing.

Climate change is a large systemic problem and much like large ships that are slow to turn and move, big systems are slow to react. Whereas the need is for systems to be agile and respond quickly. This will require a paradigm shift in our thinking where multi-disciplinarity is the new singular-discipline. This means that leaders and managers will

# Inaugural Session


need to adapt to understanding technology, policy and finance in order to guide us through the maze of systemic complexity.

## 2. INTERNATIONAL COOPERATION

Nations facing the same problems will get united through joint technology and solutions development approach. For example, with regards to climate change water sector has the maximum manifestation, such as floods and droughts. Therefore, nations facing these critical issues must come together to share the burden of joint development, joint deployment and global proliferation.

Slovenia and India have come together to solve one such shared problem which is understanding the system dynamics around flooding. The two nations are cooperating in developing advanced remote sensing capabilities via satellite platforms to understand systemic behaviour river basins particularly during monsoon season and floodings.

Systemic challenges can rarely be studied in a lab, and we need to move from indoor lab to a real-world lab to develop more practical solutions that have a higher probability of coming to market. The Ganga river system in India is one such lab that can be offered for providing a global test-bed facility for climate related systemic problems that affect water resources of any country.

Energy transition is another such major problem that is affecting the world. Green hydrogen has been identified as a molecule that will help the world decarbonise its industrial processes. A trilateral cooperation

# THE GANGA RIVER

**system in India is one such lab that can be offered for providing a global test-bed facility for climate related systemic problems that affect water resources of any country**


# Inaugural Session

**TO CONVERT**
**technology into a solution requires a lot of value-addition by industry. This includes establishing supply chain, systems-integration, turnkey-installation capabilities and long-term operations and maintenance of the solutions**

is in the offing between Slovenia, India and Japan where the three nations can come together to accelerate the pace of development and deployment.

A lot of technological innovation has already taken place in developed world countries. If these technologies do not find the market-place in high growth countries such as India and other similar nations, then the solutions will continue to sit on shelves or at best be confined to their domestic regions, which will not the move the needle on combating climate change.

India has all the ingredients to become a global interlocuter and accelerator of disruptive climate solutions.

## 3. ACCELERATING TECHNOLOGIES TO MARKET

There is already a lot of innovation that is taking place at the grassroots level. But scale and monetisation will have to come in the form of government procurement of these innovations. However, government never buys technologies, but buys in the whole solution. To convert technology into a solution requires a lot of value-addition by industry. This includes establishing supply chain, systems-integration, turnkey-installation capabilities and long-term operations and maintenance of the solutions. So it is not just technology that is the answer, but the whole solution stack built on top of the technology intellectual property layer that is critical.

That said, Government's role in addressing critical climate infrastructure such as water-health, air-health, soil-health etc is of the utmost importance. Thus, governments must be the first adopters of these solutions, and in doing so must give a clear signal to market proponents of its willingness to procure so commercialisation pathways can develop accordingly.

# Inaugural Session

The investments made by governments, particularly in novel and disruptive solutions should be no-regret investments. And in doing so the, bureaucratic set up must also be incentivised and insulated from any sub-optimal results or even failures, for there are lessons to be learned in those failures so that as the rate of investments as a percentage of GDP.

## 4. NAMAMI GANGE PLATFORM AND ARTH GANGA CONCEPT

Government's role in procuring critical solutions has already been demonstrated. The Namami Gange flagship programme of government of India for rejuvenation and restoration of Ganga river basin has already increased waste water treatment capacity manifolds.

The programme now shifts towards a concept called Arth Ganga, which means to keep the "economic value" of water and river systems at the centre and develop sustainable development approaches that both conserve the environment and generate economic wealth for its stakeholders.




Monetisation of treated water by way of creating local area water markets is one such example. When water is treated to secondary and tertiary levels, then it can be used for a number of downstream purposes such as horticulture, commercial and industrial purposes. Recycle and reuse of treated waste-water will develop a downstream market that will reduce ground water extraction and diversion of water from nature thereby increasing the water preservation and recharging rates.

Use of treated, homogenised and stabilised sludges generated in sewage treatment plants (STPs) for top-soil rejuvenation purposes is another such example where the waste/liability of one department (municipal) is an asset/ resource for another department (agriculture). India's top soil requires rejuvenation to increase soil yields and conservation rates, and move the nation to more organic and sustainable farming.

Government can offer funding for either proven solutions or limited funding for piloting. Large scale financing has to come from private sector and markets which generally have been found lacking for not lack of interest but more not having clarity on the investment models.

## 5. TECHNOLOGY ECONOMICS HAVE TO BE EXPLOITED AND FINANCED THROUGH EMERGING FINANCIAL MODELS

Efficiency gains of technologies will pay for the technology deployment itself. However,

# Inaugural Session

until those gains are quantified by data and evidence, the buyers of the end-solutions will sit on the fence and not commit. Therefore solution provides must put a lot of emphasis on total lifecycle costs and provide like-for-like comparisons to the end buyers to enable faster decision making.

If lifecycle costs are cheaper then money will become available as a number of new financial models are already on the anvil. Infrastructure-as-a-service model is fairly prevalent in sectors such as energy, roads, telecom, where the end-consumer pays for the unit produced and/or consumed. Governments can provide the guarantee mechanisms so as to give confidence to the lenders and equity investors.

For critical services such as water, which is seen as a public good, regulating the cost of commodity is critical, and for that the government has to keep the overall solution costs affordable. The hybrid annuity model (HAM) is one such construct that enables delivery of critical infrastructure the construction of which is funded by the contractor and paid for by the government on delivery of critical milestones provided quality parameters are met.

## 6. PARAMETERS FOR BUYING QUALITY

If government establishes quality parameters

# THE HYBRID ANNUITY

**model (HAM) is one such construct that enables delivery of critical infrastructure the construction of which is funded by the contractor and paid for by the government on delivery of critical milestones provided quality parameters are met**

and is rigid about the floor price, then quality will increase automatically as the supply side-eco-system will have to step up to meet the required standards.

This should apply to both infrastructure services as well as knowledge & knowhow based consulting services.

Only if the quality parameters are established and standardised will the nation be able to deploy critical infrastructure faster.

## 7. SCALE IS CRITICAL

The enabling environment for achieving scale must have rapid technology commercialisation pathways, robust policy frameworks and innovative financial solutions, the holy trinity of impact. Each sector, segment and nation will have its nuances, but for most part the formula for delivering scale will require an integrated approach. Once the First of a Kind (FOAK) solution is delivered, there are multiple financing pathways for the Nth of a kind (NOAK).

# CITIS 1 TO 3

November 22nd to 24th 2023


**CITIS PLENARY / 1 - 3**

Wednesday, November 22, 2023
to Friday, December 24, 2023

**KEYNOTE SPEAKERS**

Igor Papič [Minister of Science and Innovation, Slovenia]
G Asok Kumar [DG, NMCG]

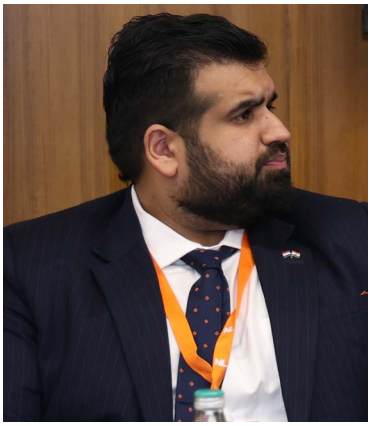
**MODERATOR**

Mohammad Jawed [Professor, IIT Guwahati]
Sundeep Chauhan [Expert member, cGanga]
Brijesh Sikka [Advisor, NMCG]

**OTHER PANELIST**

Cristian Valdes Carter [Country Director, Innovation Norway]
KN Sreekumar [Vice President, Sustainability, Siemens]
Ruchira Shukla [International Finance Corporation (World Bank Group)]
Sanmit Ahuja [Expert Member, cGanga]
Vinod Tare [Founding Head, cGanga]

# Technology & Innovation



HARIT VIRMANI
**Hydraloop**

## EXTREME DECENTRALIZED WATER RECYCLING SOLUTIONS FOR SUSTIANABLE WATER SMART CITIES

### ABOUT THE COMPANY

a. Showcased the journey from 2015 to 2023. First Patent in 2015 to multi product organisation in 2023.
b. Claim to save up to 45% on water and wastewater, reduce their carbon footprint, and keep full comfort of living with low maintenance decentralized greywater recycling solutions.
c. Hydraloop collects water from bath and shower, washing machine and dryer as well as condensation water from heat pumps and air conditioners.
d. Hydraloop's sustainable technology treats the greywater in six cleaning steps, resulting in clean, clear, safe, and disinfected water for non-potable use. The treated water is redistributed to toilets, washing machines, and optionally for garden irrigation and/or topping up swimming pools.
e. The treatment process does not use chemicals, filters or membranes. Controlled by central processor and smart use of air pressure, to stimulate the law of communicating vessels, the following sequential treatment processes apply: Sedimentation - Sediment is collected at the bottom of tank; Floatation - Floating dirt (hair, soap) is purged via central skimmer into the sewer; Dissolved air floatation - Tiny air bubbles will travel upwards, collecting small particles; Foam fractionation - Soap and suspended solids are skimmed off; MBBR - Biological treatment by aerobic bioreactor; UV disinfection - Every 4 hour by UV-light.
f. Treated water meets stringent European, US and international quality standards for reuse as non-potable water.
g. Selling two products- Hydraloop 300- For single-family housing with 4-5 persons and Hydraloop 600- For larger communities up to 10 persons.
h. For multi-family housing, and larger operations such as hotels, office buildings, mosques, shopping centers, student housing, sports clubs, airports, and more - Modular and scalable made-to-measure.
i. Proven technology: Hydraloop Cascade installation with 14 H300 units in a most difficult 300 student housing, now also ready for social housing.
j. Another product- Hydraloop Device Manager- 24/7 remote monitoring, ticketing and over-the-air software updates. Easy to use app for end-user with key data and grey water use priority setting capabilities.

### ADVANTAGES CITED

- Saves on water bills ranging from 25% and 45%
- Increases the resale value of the property
- Provides up to 17 LEED points
- The property can sell faster vs. non-sustainable properties
- Helps the developer access green finance
- Releases pressure on infrastructure: lower OPEX and CAPEX for authorities
- Contributes to meeting 4 UN SDGs


**Save 25 % to 45% of water and wastewater**

**No chemicals or filters: sustainable**

**Internet connected**

**Low energy consumption**

**NSF350 safety certified**

**Low noise**

**Easy installation**

**Ideal for garden irrigation and flushing toilets**

## COMMENTS BY THE EXPERT PANEL

*Products and processes are patented. The panel finds that the product applications are useful and do tick SDGs but technology is standard. Useful in construction industry serving SMART cities. Does not work with oily discharge. May showcase used cases to the panel in case the company onboards the ETV process.*

# Technology & Innovation

SUCHIT DEKIVADIA
**Paques**
**(Skion Water Company)**

## ABOUT THE COMPANY

**Biological wastewater and gas treatment:**

- Presence in 61 countries with 450 plus people.
- Operates via its operational subsidiaries.
- Is a global provider of water and wastewater treatment solutions for industrial and municipal customers.
- Works closely with its operational subsidiaries to support them in capturing the synergies from being part of Skion Water.
- As a group provides its customer base across the world with "one stop shop" tailor-made solutions for any water treatment problem.
- Invests into innovative water technology companies if they are synergistic with its operational companies.
- SKion is the investment company of German entrepreneur Susanne Klatten.
- SKion invests in companies with revenues between 300 million and 2.5 billion Euros. In doing so, they pay attention to sustainable competitive advantages, proven management structures and an integrity-based corporate culture.
- Primarily active in the following sectors: industrial goods and services, electrical engineering, optics, renewable energy / closed-loop material cycles, IT / digitization, and medical technology.
- Together with existing portfolio companies, also invests in smaller companies in the field of water technology.

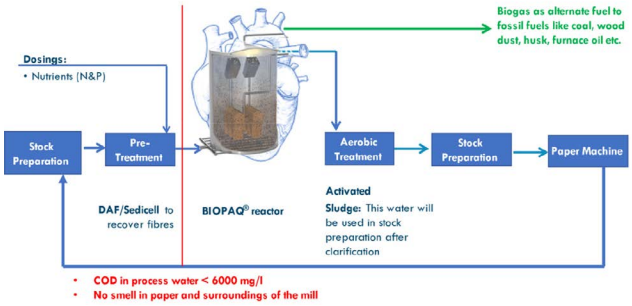
**Have products that they have mostly invented:**

- Biopaq, Thiopaq, Annamox, Biopaq@ Rise are some of the technologies deployed aross 3500 locations.
- Serving with Biogas production equal to the natural gas requirement of 2.8 million households in Netherlands.
- Currently in India, ZLD integrator are deployed in industries. Have a fully integrated factory in India.
- PAQUES has 840 installations in the pulp & paper industry across the globe. Are a leading force in wastewater technology for the industry. They are into pulp and paper, food, beer & beverage, chemicals, municipal waste, ethanol, energy (landfill digestion) and others.
- Specialise in ODOR FREE paper. Working on 23 installations in India. Serving a fragmented paper recycling industry in India.
- Patented an advanced granular technology.

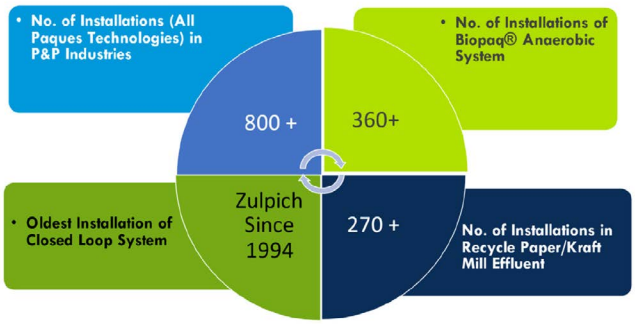
## COMMENTS BY THE EXPERT PANEL

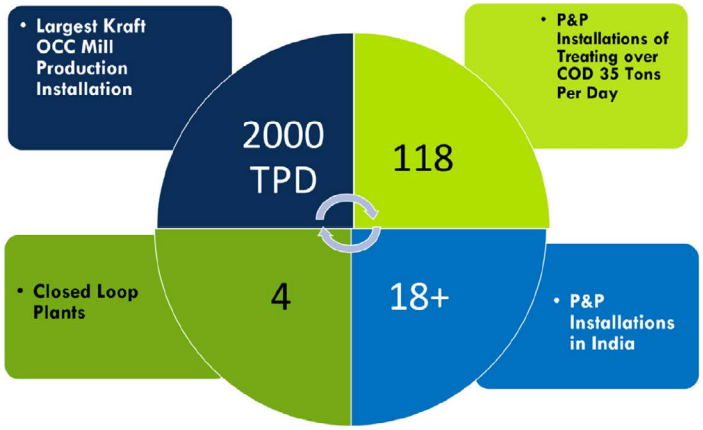
*Novel technologies. Already working well and expanding in India. TRL / CRL score is high. May be in the higher VIPERS steps. Explore with a meeting.*

## The Anaerobic BIOPAQ® Reactor Is The Beating Heart Of The Recycle Paper Mill

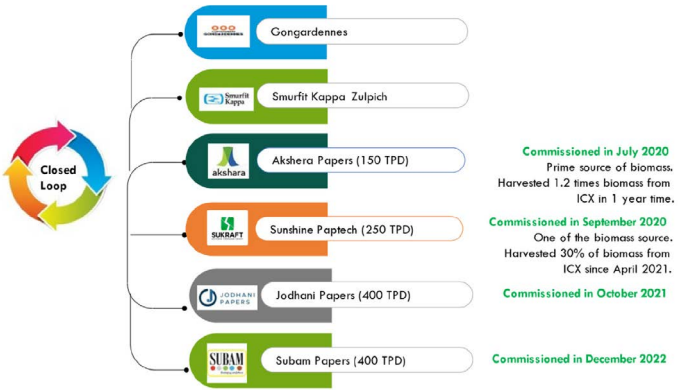



## Fact Check Of Paques in the PAPER Industry




## Paques Has Successfully Commissioned The Below Plants In Closed Loop




## CASE STUDY 1(Maharashtra): Mill Water Characteristics Comparison With Closed Loop Operation

| S. No | Parameters | Before CLP Implementation | After CLP powered by Biopaq® |
|---|---|---|---|
| 1 | pH | 6.02 | 6.7 |
| 2 | TSS (mg/l) | 465 | 350 |
| 3 | TDS (mg/l) | 22500 | 8000 |
| 4 | Calcium (mg/l) | 3046 | 650 |
| 5 | VFA (meq/l) | 463 | 20 |
| 6 | Paper odour | Yes | No |
| 7 | Sulphate | 1250 | 650 |
| 8 | SCOD (mg/l) | 47400 | 5200 |
| 9 | Biogas generation (m3/d) | 0 | 3000 - 3500 |

## CASE STUDY 2: Akshera Papers



## Mill Water Characteristics Comparison

| S. No | Parameters | Before Closed Loop System - Jan'2020 | After Closed Loop System powered by BIOPAQ® - May'2021 |
|---|---|---|---|
| 1 | pH | 5.56 | 6.5 – 7.2 |
| 2 | TSS (mg/l) | 800 | < 300 |
| 3 | TDS (mg/l) | 24400 | 9000 - 11000 |
| 4 | Calcium (mg/l) | 5130 | 600 |
| 5 | VFA (meq/l) | 300 | 20 |
| 6 | Paper odour | Yes | No |
| 7 | SCOD (mg/l) | 57700 | 4500 |
| 8 | Biogas generation (m3/d) | 0 | 2400 |
| 9 | Paper production (TPD) | 150 | |

## Current MARKET POSITION

CII (CONFEDERATION OF INDIAN INDUSTRY) HAS RECOGNIZED US AS ONE OF THE TOP 50 INNOVATIVE COMPANIES OF 2022 IN THE COUNTRY

IN A DECADE, WE HAVE GROWN FROM A SMALL TEAM WITH A BIG DREAM TO A THRIVING ORGANIZATION RECOGNIZED AS THE LEADERS IN WASTEWATER AND GAS TREATMENT IN INDIA

## THOUGHT LEADERSHIP POSITIONING

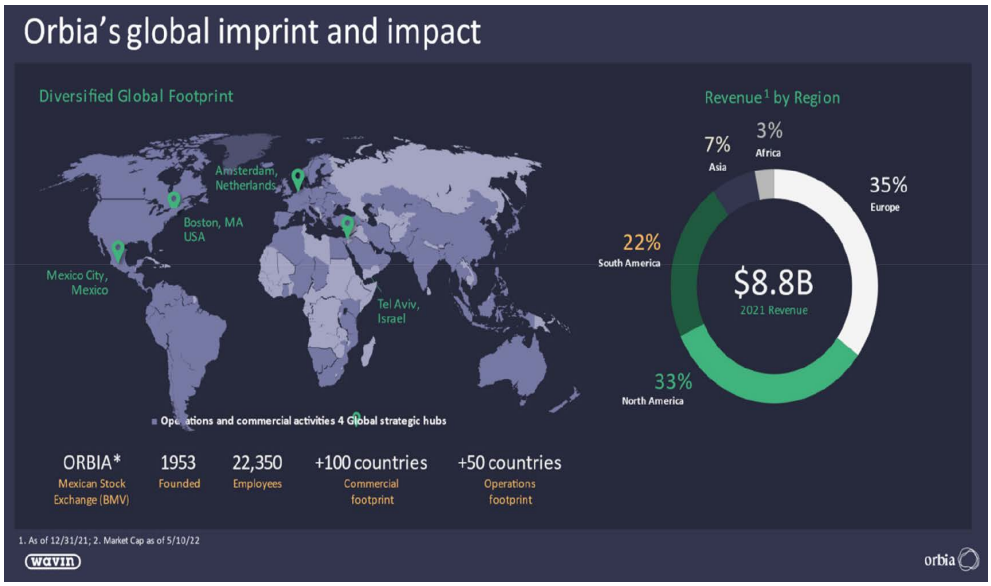

**These are successful case studies and endorsed by leading laboratories.**
**PAQUES calls wastewater as source of energy and resources.**

# Technology & Innovation

MANISH KHANDELWAL
**Wavin**

## ABOUT THE COMPANY

**Orbia's history and global presence:**

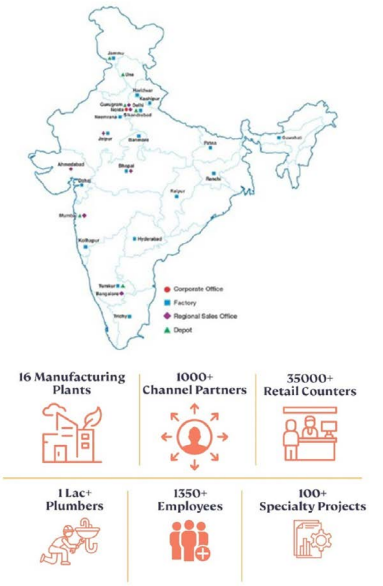



**Showcases Wavins portfolio and revenues**

# The Journey

| | |
|---|---|
| **1955:** | When it all began, Wavin invented the world's first PVC pressure sewer pipe. |
| **1988:** | People want the plumbing in their buildings to be silent. When low noise is a building requirement, the Wavin AS system gives the best performance of any plastic pipe. |
| **1997:** | The Wavin infiltration units were the answer to a growing demand to handle peaks in rainfall and to better control rainwater discharge. Wavin infiltration units attenuate rainwater and can have it slowly discharged into the surrounding soil. |
| **1998:** | Wavin Tigris K1 plastic press-fittings are made from high-performance PPSU (polyphenylsulfone) performing well in even the most challenging water conditions. These systems banish corrosion concern, delivering long-life performance at competitive cost. |
| **2002:** | Wavin's Tegra manholes are easy to install, easy to access, versatile and durable, making these the ideal choice for all public sewer systems. |
| **2005:** | World's first cleanable storm water systems. |
| **2013:** | The new Ekoplastik PPr Fiber Basalt pipe uses innovative materials to real advantage. The new generation P-RCT material gives the pipe an increased resistance to higher temperatures and high pressure. The basalt fibers add to the benefits by reducing thermal expansion. |
| **2015:** | With Wavin Q-Bic plastic units, underground tanks built quickly and easily. These units are suitable for both attenuation and infiltration of rainwater. Wavin Q-Bic is designed for trouble-free inspection and cleaning – ensuring maximum long-term performance. |
| **2018:** | Section underfloor heating control system, & 360° filter road gully. |
| **2019:** | New generation Wavin AS+, low-noise system |
| **2020:** | World's first fitting with acoustic leak alert (Tigris) & New Generation AquaCell. |
| **2021:** | World's first Plastic Road made from renewable plastic. |

Wavin India footprints




**Biological wastewater and gas treatment:**

They have trained plumbers and other technicians through their capacity building programs.

Showcased some of the case studies in modern rainwater harvesting.

**Two Marquee products**


## COMMENTS BY THE EXPERT PANEL

*Wavin has high quality products. Already working. TRL/ CRL is high. May be a candidate for scaling up once technology solutions at reference sites are vetted by the expert panel.*

# Technology & Innovation

ABHIJEET SANGANI
**Planys**

## ABOUT THE COMPANY

**Specialises in collection of underwater data.**
Until now primitive methods used with Divers, Survey boats, or not done at all.

Challenges include Complex logistics, Safety of human divers, Frequency of survey is limited, Data volume is very less, Reporting is inefficient and underwater networks do not exist.

Challenges include, High-frequency waves attenuate, Acoustic waves have limited range and Cross-medium propagation of waves is not possible.

### IoUT – INTERNET OF UNDERWATER THINGS

**Provide a gateway for connecting the IoUT and the IoT world**

- Drone at surface / underwater simultaneously coordinate with an underwater sensor network and the global communications.
- Enabling infrastructure such as 5G, offshore broadband will be required.

**Introduce IoT capable computing platform to the marine industry**

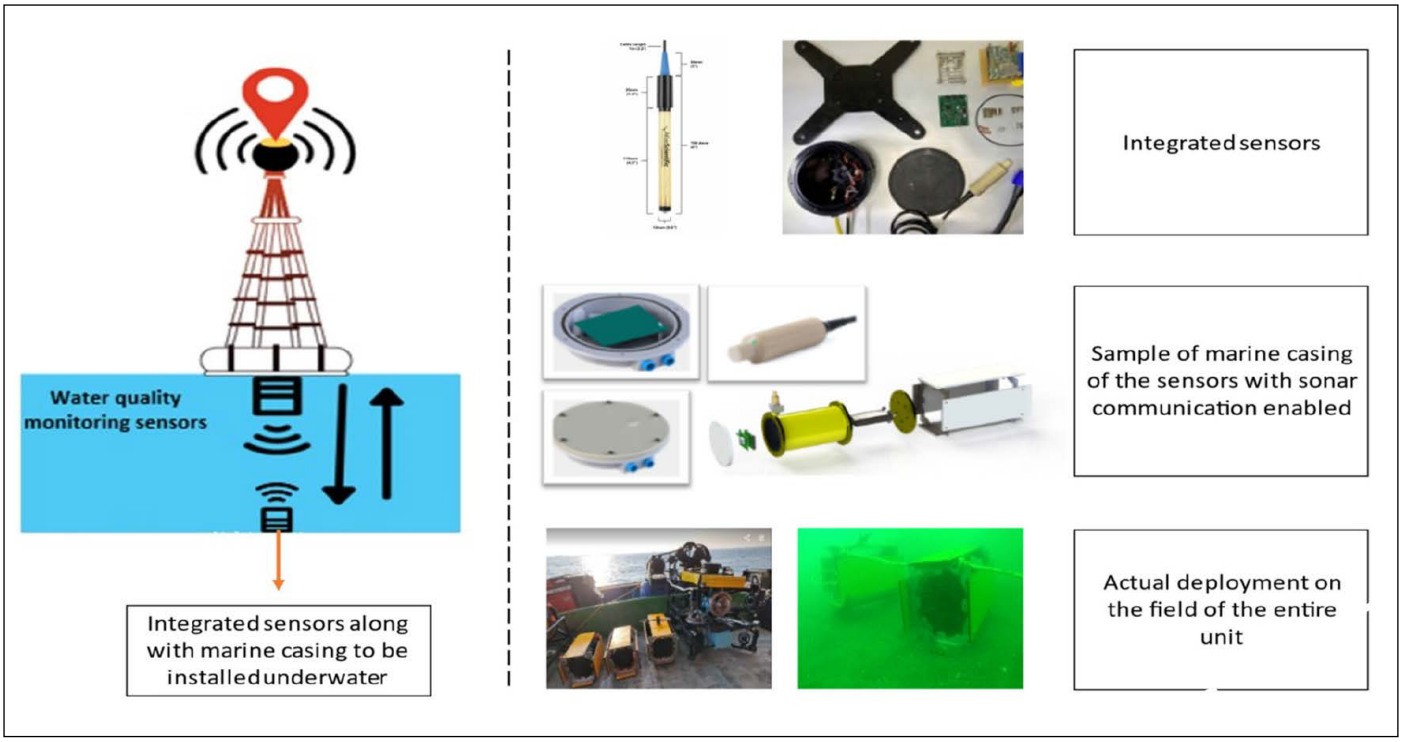
- IoT based development boards replace conventional marine grade computing devices.
- IoT modems to augment the underwater communication hardware bridging IoUT and IoT.
- Reap benefits such as compactness, high computing power, low cost etc.

The company is deploying a pilot in Patna. The ETV panel may be invited to see the performance.

Aims to capture the following parameters- through IoUT- To be seen how it is done, accuracy, robustness of systems etc.

1. **BOD**
2. **DO**
3. **EC**
4. **pH**
5. **Temperature**
6. **Ammonia**
7. **Chloride (Salinity)**
8. **COD**
9. **TSS**
10. **Turbidity**
11. **Colour**
12. **Fluoride**
13. **Nitrate**
14. **Potassium**
15. **Microbiology parameters: Faecal Coliform and *E. coli***

**THE DEPICTION:**




## COMMENTS BY THE EXPERT PANEL

*The challenge is to capture real time accurate data with sensors. There is always a debate on sensor based data accuracy. Complexity is high. Calibration is a challenge.*

*New Terminology IoUT. Underwater data capture and transmission is challenge. SONAR etc. have defence ramifications. To see how the pilot in Patna performs. Maybe an ETV candidate to learn new technologies of underwater data generation through emerging protocols.*

# Technology & Innovation

SANTOSH KUMAR UPPAL
**Rhdhv**

## ABOUT THE COMPANY

140 years of experience in Industry, Water, Ports & Infrastructure. Top 50 independently owned engineering companies. Workforce of 6,000 in more than 140 countries. 1,000 water professionals including (waste) water treatment, process & digital water experts.

Active in India with a good reputation in water engineering design and other services. Over 28 years of Established presence in India and 50 years on project delivery.

Delivered Projects with project cost over USD 5 billion in last 10 years to various Clients in India.

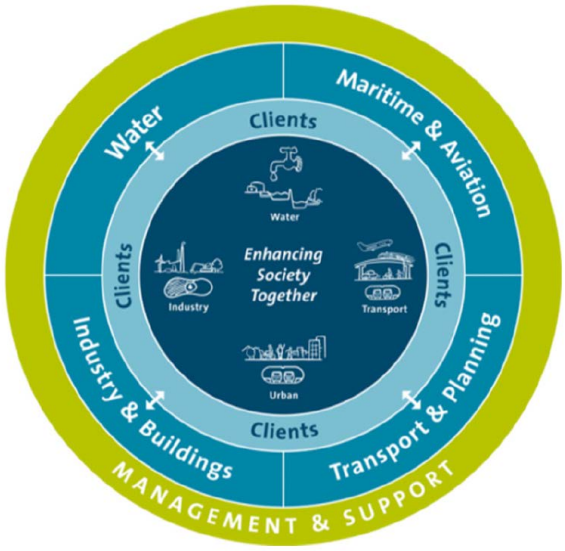
Extensive working experience with ULB's; State Governments, Central Government Ministries in India.

Extensive working experience with international funding agencies like the World Bank, ADB, JBIC etc. in India.

Experience on various Infrastructure Projects in India.

The Company's Quality Management System (QMS) complies with the requirements of ISO Certified 9001: 2015, ISO 14001: 2015 and OHSAS 18001: 2007.

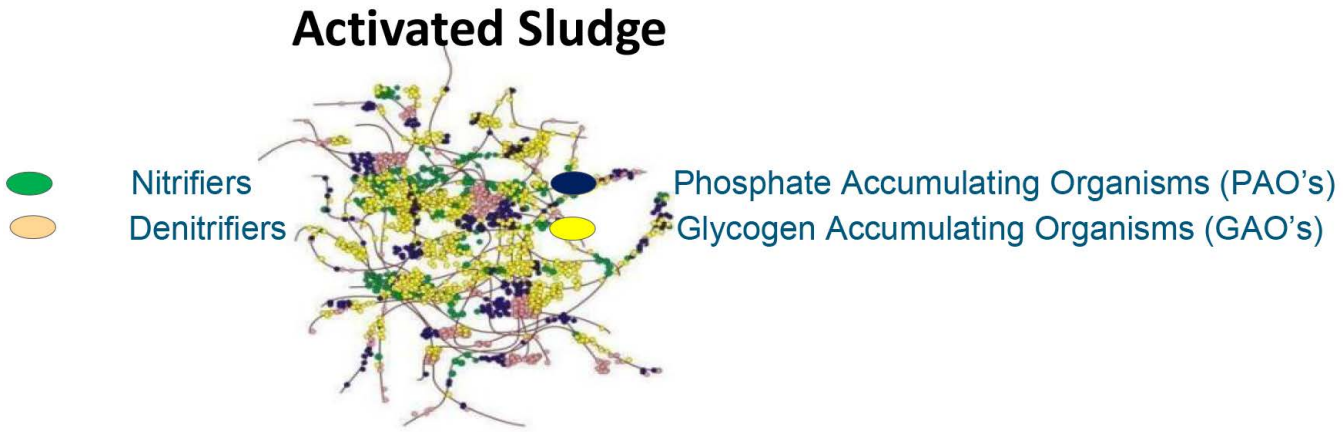
## AREAS OF OPERATIONS

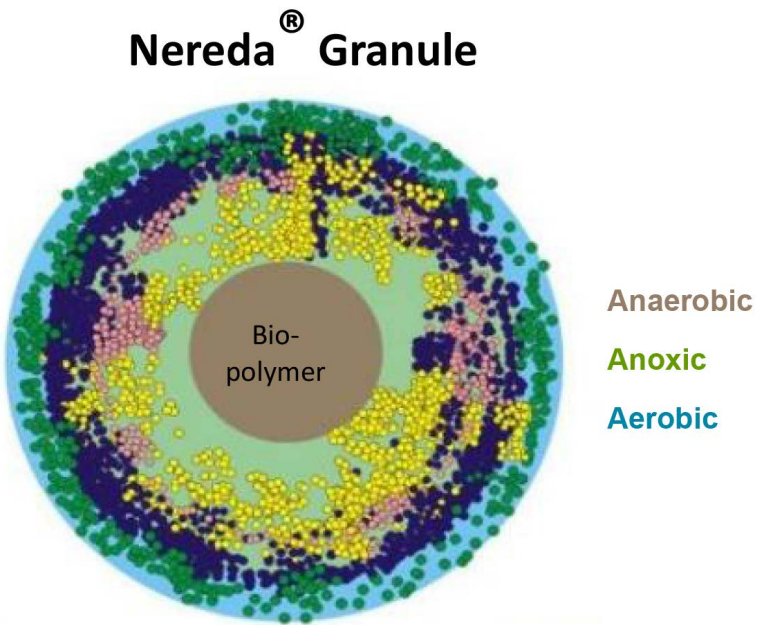


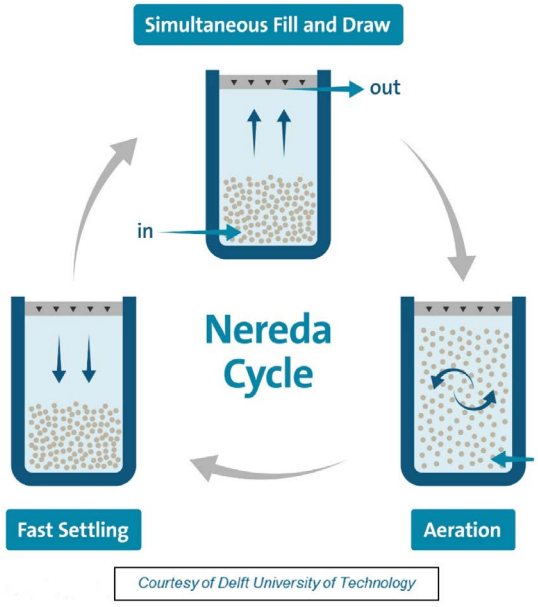

## CONCEPT TO COMMISSIONING

## PART A : SHOWCASED NEREDA TECHNOLOGY.

No support media or plastics required to create the granule.



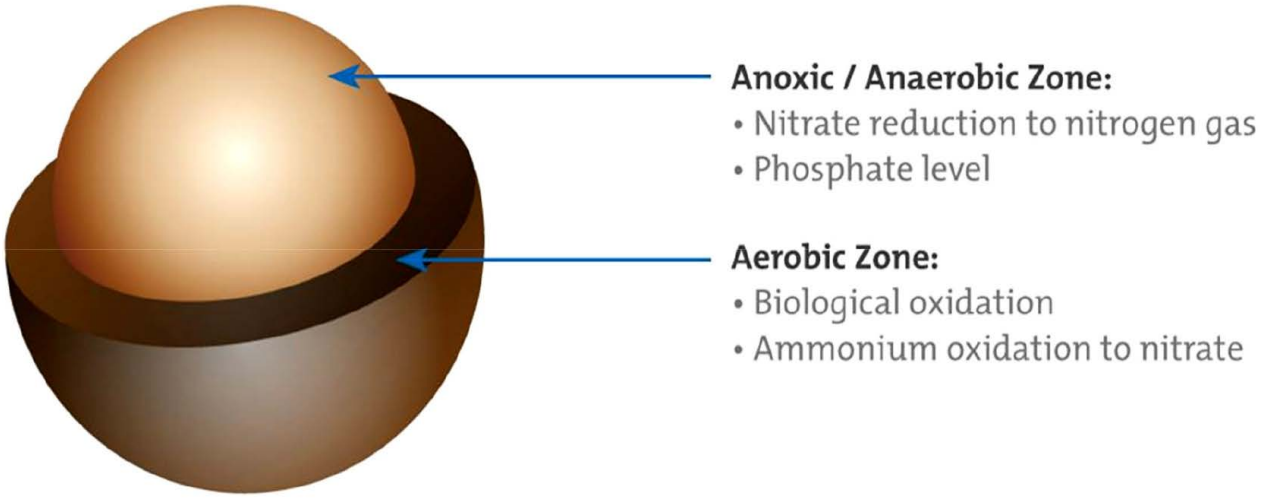




## KEY ASPECTS OF NEREDA

- No media
- No clarifiers
- No moving decanter
- No mixers
- No sludge return pump
- No sludge recirculation pump
- One single reactor for BOD removal, ammonia removal, N and P removal
- Low energy consumption
- Low life cycle cost

# Technology & Innovation




- Extensive simultaneous biological COD, N- and P-removal
- Low energy consumption
- Sustainable technology
- Easy operation

## NEREDA VS CAS

- 30-50% energy saving
- Upto 4 times less footprint

**On the left upper side- Garmerwolde A/B Plant**

Capacity: 140,000 p.e.

Flow: 347 l/s

**On the right bottom side**

## GARMERWOLDE NEREDA PLANT

- Treating same flow
- 50% energy use
- < 25% footprint
- No/minimal chemicals

## PART B: KAUMERA- NEREDA GUM

Concept of from waste to resource. Nereda granules are 15 – 20% Kaumera. Extracting this portion reduces sludge treatment and disposal cost. Kaumera extraction reclaims a valuable biopolymer from the Nereda sludge.
The extracted Kaumera is a valuable raw material with promising applications.

Kaumera aerobic granular sludge- leads to:

- Sludge reduction of 15~ 25%.
- Allows conversion of approx. 30% of Volatile Solids (VS) Nereda excess sludge into valuable raw material.
- Kaumera recovery as a sustainable raw materials and an additional revenue stream.

**Applications:** Coating Agent, Super Absorbent Biopolymer, Paper & Board Coating, Bio stimulant, Binding Agent and Bio nanocomposite materials

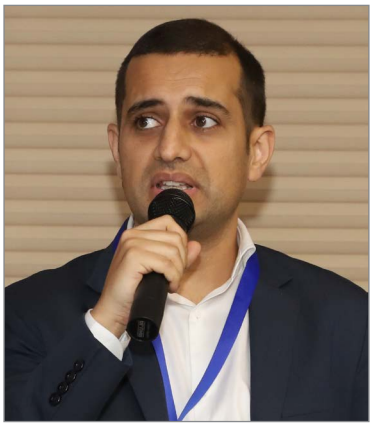
## PART C: AQUASUITE, AN AI-POWERED ANALYST AND AUTOPILOT

- Showcased products from the Suite for drinking water, measuring leakages and many other parameters. Uses machine learning from pressure & flow data to locate leaks.
- There are major developments in Industry 4 applications in the water sector- IoT, AI, ML etc. The whole suite of applications was showcased but not discussed in detail due to paucity of time.

## COMMENTS BY THE EXPERT PANEL

*The Panel appreciated the NEREDA technology but was surprised to find only two installations in last 8 years.*
*The exclusive license is given to VA Tech Wabag ltd. No cogent reason was given about thin deployment of Nereda.*
*The panel may invite the company to make a detailed presentation once again. Nereda gum applications sound novel. AI suite shows useful applications. It is already being used for many applications like leak detection and process optimization through ML. The three areas deserve deeper discussions with our expert panel.*

# Technology & Innovation



SAMIR KHAN
**Colsen Denmark**

## ABOUT THE COMPANY

Company founded in Hulst, Netherlands in 1989.
Address water, energy and environment.
Main areas of operations are:

- Wastewater treatment plants
- Waste to biogas
- Nutrient recovery
- Permits
- Soil & environmental expertise

### 1. THE COMPANY PRESENTED SLUDGE TO ENERGY TECHNOLOGY

Uses Anaerobic digestion at 55°C that results in:

- Higher biogas production
- More compact installation
- Biosolids Class A according US EPA 503

*Higher Sludge Degredation (50% VSS Degredation)*

Further the company declares that it:

- Produces green energy from wastewater sludge
- Produces more energy
- Has lesser equipment so needs lesser power
- Decreases sludge output of STP
- Reduce usuage of Polymer for dewatering
- Reduce the handling cost of the sludge (transport etc)
- Increases sludge quality output of STP
- Allows land application of sludge so less pressure on the land fill sites
- Sludge can be utilized as fertilizer by the farmers which will reduce their dependence on chemical fertilizer. (This is now under discussion under our emerging sludge policy)
- Easy retrofit of existing installations (We have to check this onsite)
- Same equipment pre and post digestion
- Only changing the mixer as thats the most critical aspect and tank insulation

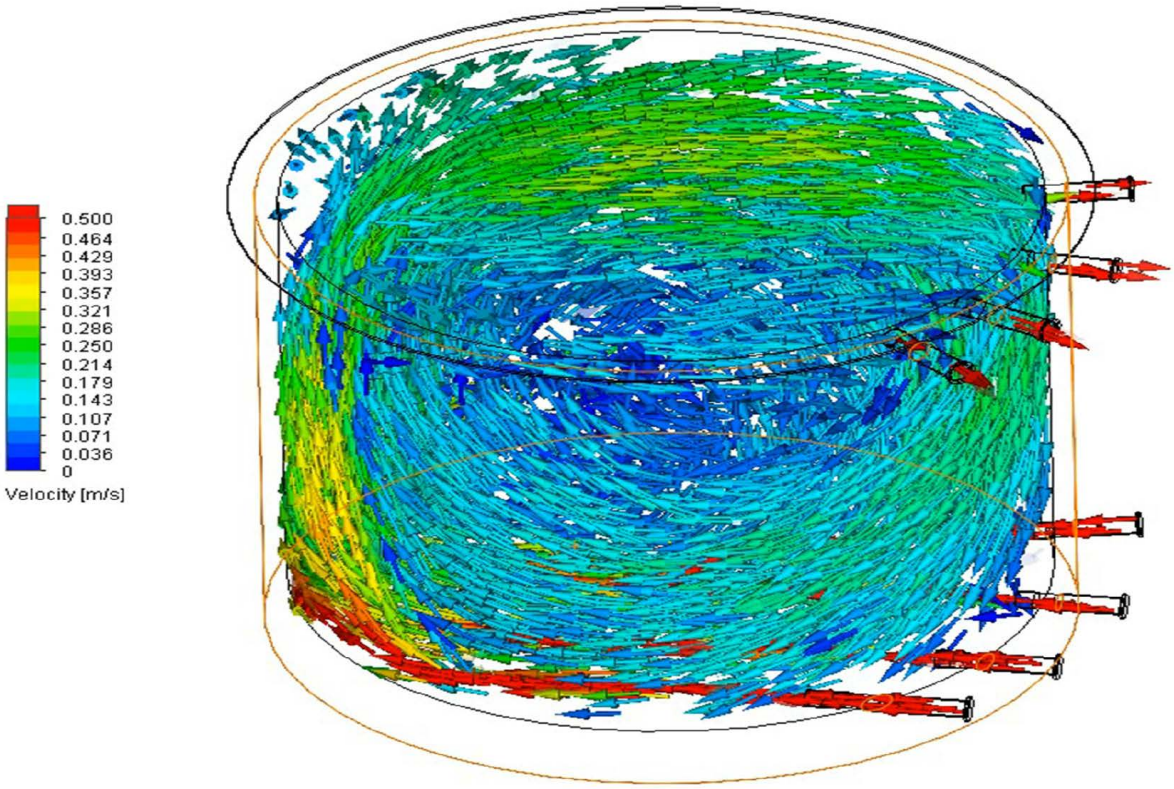
Showcased the comparison between mesophilic and thermophilic processes, whereby, thermophilic process is seen a superior.

*Discussed creation of class A and B biosolids.*

### 2. PRESENTED DIGESTMIX®

**Advantages Enunciated**

- Low energy consumption
- Prevention of foam and scum
- No settling of sand
- No equipment inside tank
- Easy maintenance
- Heating and mixing at once




Colsen declared that Digestmix is:
Cost effective way to produce Class A Biosolids

- **CAPEX and OPEX**

**Net Energy production higher than all technologies**

- Equipment Requires less power and more Biogas is generated

**Simple and robust in operation**

- With 0.00 downtime of Class A biosolids and energy production

**MAKE IN INDIA**

- Over 90% of the installation is locally made

**Also they have an Indian partner involved supply for the localized system and supply of:**

- Thermophilic Digester & Buffer Tank
- Insulation for the Tank with piping, fittings and accessories
- Control Panels with Instruments, cabling and accessories
- Pre-Thickening and Pumping systems
- Biogas Line (Flare, Gas holder, Biogas Engine etc)

## COMMENTS BY THE EXPERT PANEL

*Technology is novel. Addresses many aspects of sludge problem. ETV panel may look at Pilots to vet technology from cost effectiveness, bio solids generation, energy consumption, ticking aspects of UN SDG etc. Doing a pilot with Okhla plant using the digester with digestmix technology. Also doing a study with IIT Roorkee. Small teams with high technology need a thorough vetting before unleashing on the Indian landscape.*

# Technology & Innovation

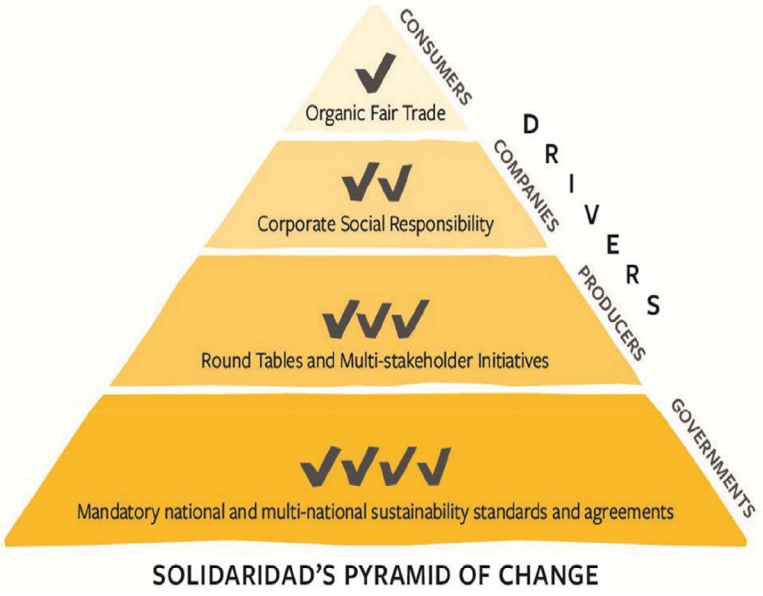
TATHEER ZAIDI
**Solidaridad Netherlands**

## ABOUT THE COMPANY

Solidaridad is an international NGO rooted in the Netherlands, which embodies commitment to sustainable development worldwide. With a rich heritage, Solidaridad champions solidarity, fostering positive change in social and environmental landscapes globally.

The presence is depicted below:


Follow a multistakeholder approach:



**THE DETAILS INCLUDE:**

1. Pollution Prevention: Encourages open communication among stakeholders to track and improve the social and environmental aspects, including pollution prevention, of the supply chain.
2. Collaborative Initiatives: Solidaridad adopts a multistakeholder approach in the leather and textile industry, fostering collaboration among diverse stakeholders including producers, businesses, NGOs, and government entities.
3. Supply Chain Engagement: Promoting dialogue and cooperation to address challenges such as labor conditions, environmental impact, and sustainability.
4. Capacity Building: Building the capacity of all stakeholders involved, providing training and support to ensure that best practices in sustainability and responsible business conduct are understood and implemented.
5. Policy Advocacy: Advocate for policies that promote ethical and sustainable practices in the leather and textile industry, influencing change at both local and global levels.
6. Transparency and Traceability: Implementing a multistakeholder approach, Solidaridad emphasizes transparency and traceability, encouraging open communication among stakeholders to track and improve the social and environmental aspects of the supply chain.

Leather and textiles sector are the most challenging sectors in pollution area. Major areas that need addressing and redressal:

1. Water Pollution: High water use, poor treatment, and untreated wastewater harm the environment.
2. Chemical Usage: Hazardous chemicals threaten both the environment and human health due to limited eco-friendly practices.
3. Waste Management: Inadequate practices lead to solid waste accumulation, compounded by ineffective disposal and recycling.
4. Air Pollution: Industrial emissions worsen air quality without cleaner production, and limited eco-friendly methods add to the issue.
5. Lack of Sustainable Practices: Industry struggles with eco-friendly production, hindered by resistance to change.
6. Regulatory Compliance: Inadequate compliances persist, contributing to pollution challenges.
7. Resource Depletion: Overexploitation of resources causes pollution, with uneven adoption of sustainable sourcing compounding the problem.
8. Worker Health and Safety: Worker exposure. to hazardous chemicals poses health risks, complicating efforts for environmental and occupational safety.

**CASE STUDY:**

A solenoid valve that reduces water consumption has been piloted in tannery waste treatment.

Fleshing process in the tannery is highly water intensive as it requires continuous flow of fresh water. Solidaridad has retrofitted the machine by installing a solenoid valve and a micro-processor to the conventional machine, that auto cuts the supply of water. It helps to save around 50% of fresh ground water which was otherwise discharged as waste.

# Technology & Innovation

## CASE STUDY-WATER FLOW METER & SMART WATER SAVING SYSTEM

Tanners used to perform the visual assessment of amount of water to be used during the drum operation. This resulted in over consumption of Water chemicals. Solidaridad has installed water flow meters that accurately measure the amount of water used in the process drums. Tanneries have scaled-up this model due to its cost effective nature.

| SWaSS | | | |
|---|---|---|---|
| S. No. | Particular | Unit of Measurement | Value |
| 1 | Conventionally required water in processing per kilogram | Liters | 45 |
| 2 | Conventionally water required to process 100 Hides (i.e. 2500 Kg, considering each hide is of 25 Kg) | Liters | 112500 |
| 3 | Water required after installing SWaSS to process 100 hides (i.e. 2500 Kg, considering each hide is of 25 Kg) | Liters | 73125 |
| 4 | Total Water Saved in Processing 100 Hides | Liters | 39375 |
| **5** | **Total percent of water saved in processing 100 Hides** | | **35.00%** |

SWaSS is an automated PLC based system encompassed of a pressure pump, digitally operated solenoid valve, water flow meter and a logical controller to control the water flow into the process drums. Tanneries have co-contributed for installation of this equipment.

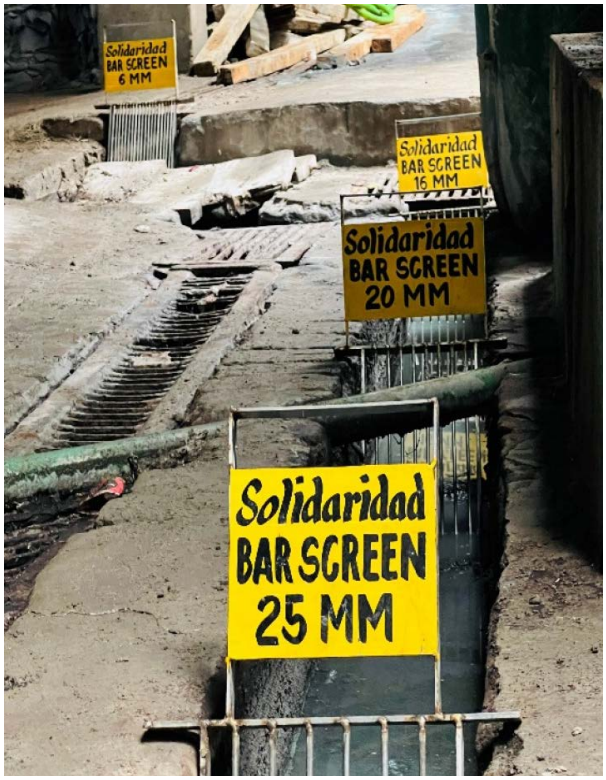
| S. No. | Particular | Unit of Measurement | Value |
|---|---|---|---|
| 1 | Conventionally required water in processing per kilogram of raw hide | Liters | 45 |
| 2 | Conventionally water required to process 100 Hides (i.e. 2500 Kg, considering each hide is of average 25 Kg) | Liters | 112500 |
| 3 | Water required after installing flow meter to process 100 hides (i.e. 2500 Kg, considering each hide is of average 25 Kg) | Liters | 78750 |
| 4 | Total Water Saved in Processing 100 Hides (2-3) | Liters | 33750 |
| **5** | **Total percent of water saved in processing 100 Hides** | | **30.00%** |

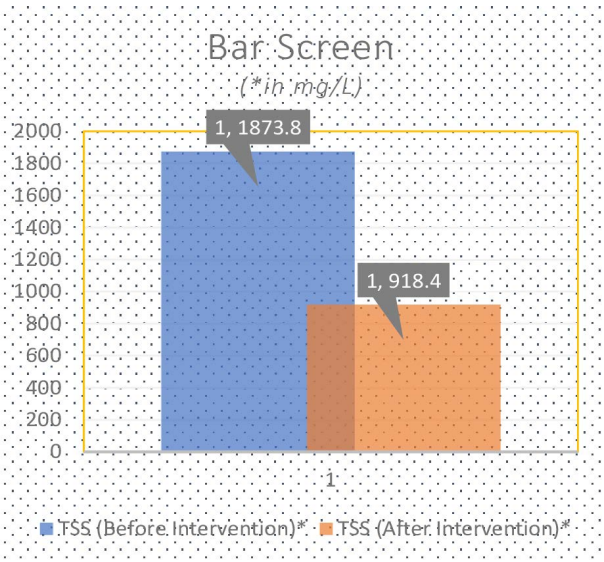
## CASE STUDY- BAR AND DRUM SCREEN

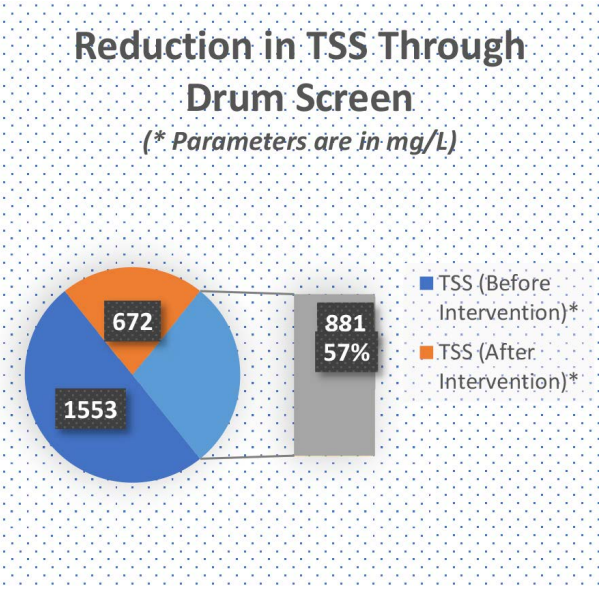
Bar screens have been installed in tanneries to effectively remove the coarse and floating materials from wastewater that could damage subsequent process equipment like pumps, impellers, etc. More than 50% of suspended matters can be removed by using bar screens. Solidaridad designed bar screens are durable, easy to maintain and comes in customizable multiple various screen sizes.

## DRUM SCREEN

Drum Screen is an automated screen installed in the primary effluent treatment plants to reduce the suspended solids which are lesser than 3 mm. Tanneries have observed up to 57% reduction in suspended solids.By using drum screen one can efficiently reduce the pollution load in the outlet stream; preventing clogging of channel. It enhances the efficiency of P-ETP and lowers the effluent treatment cost.



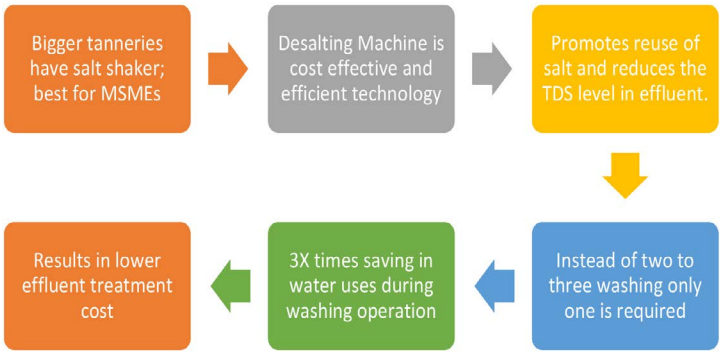



# Technology & Innovation

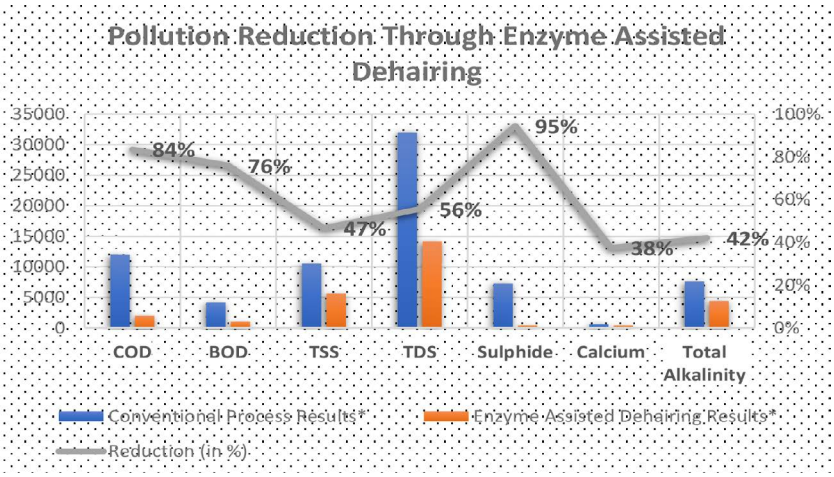
## CASE STUDY- DESALTING MACHINE

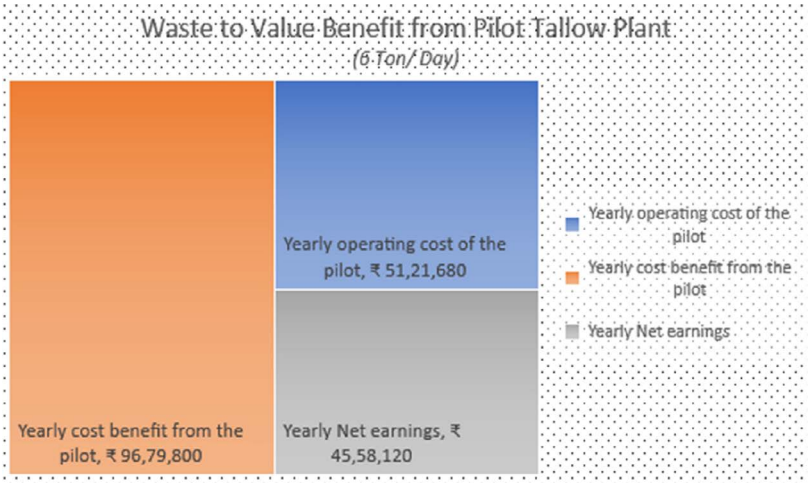
Solidaridad successfully pilot tested and implemented this technology, demonstrating a reduction in TDS to around 33%. It is cost effective and better alternative for salt shaker machine. It has proved to be a time efficient method to desalt and maintains the quality of the hide.




## CASE STUDY- ENZYME ASSISTED UNHAIRING

Enzyme-assisted unhairing method to remove animal hair from the hides primarily focuses on reducing the amount of chemicals used in the unhairing process.




## CASE STUDY- TALLOW EXTRACTION PLANT

Out of the total solid waste generated within the tannery, 60% comprises of the fleshing waste. Earlier fleshing was disposed off in an unscientific manner into open land near the drains. This was causing discomfort in the nearby residential areas and was seen as one of the primary cause of river pollution. Some unscientific processing of this fleshing was also performed which was causing foul smell.

***Inauguration of pilot tallow extraction plant was done by Mr. G. Asok Kumar, DG NMCG***

## CASE STUDY- TANNERY SLUDGE TO PAVOR BLOCKS



### SKILLS DEVELOPMENT

Solidaridad in association with stakeholders plans to train more than 150,000 tannery workers.

### PORTAL- LTIP

Solidaridad has developed a Leather Trade Intelligence Portal (LTIP) to promote and ensure traceability in India's leather industry. This new-age digital model is transforming the leather sector by allowing tanneries to self-assess and declare their environmental and social performance. Furthermore, the portal also acts as an information database highlighting the industry's sustainability performance, besides providing expert solutions to implement responsible, social and environmental practices.Till date 6 tanneries have submitted data on self-assessment portal.

**Textiles waste is also converted to Pavor Blocks.**

### COMMENTS BY THE EXPERT PANEL

*This is a well established NGO doing pioneering work in finding micro solutions through technology inputs. Already awarded by NMCG. Textiles and leather effluent treatment is complex. Multistakeholder approach, Waste to useful products, Skilling through CoE at Kanpur for leather and at Panipat for textiles should help the sector.*

*ETV panel may invite them for a focused area that addresses above sectors and ticks sustainability, adaptation/ mitigation, decarbonization etc.*

# Technology & Innovation

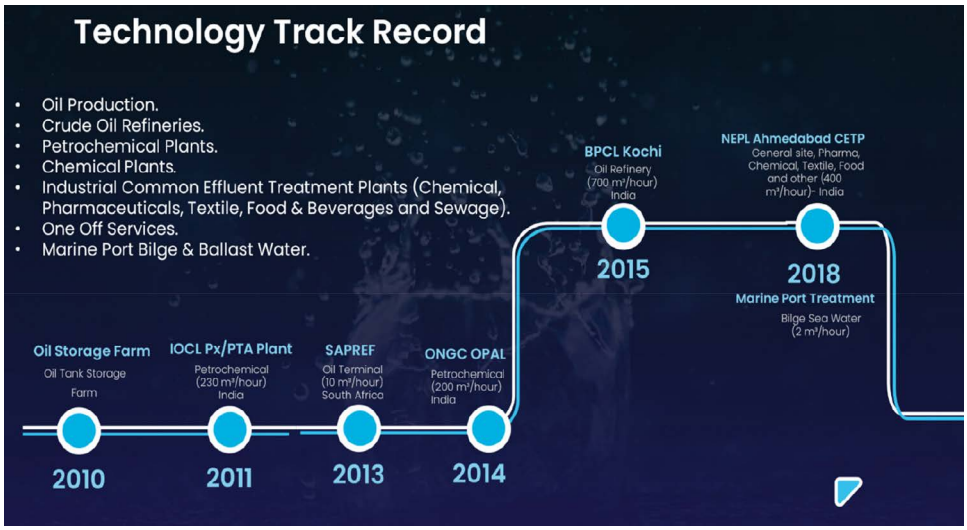
DEVENDRA S FONIA
**Bio Petroclean India**

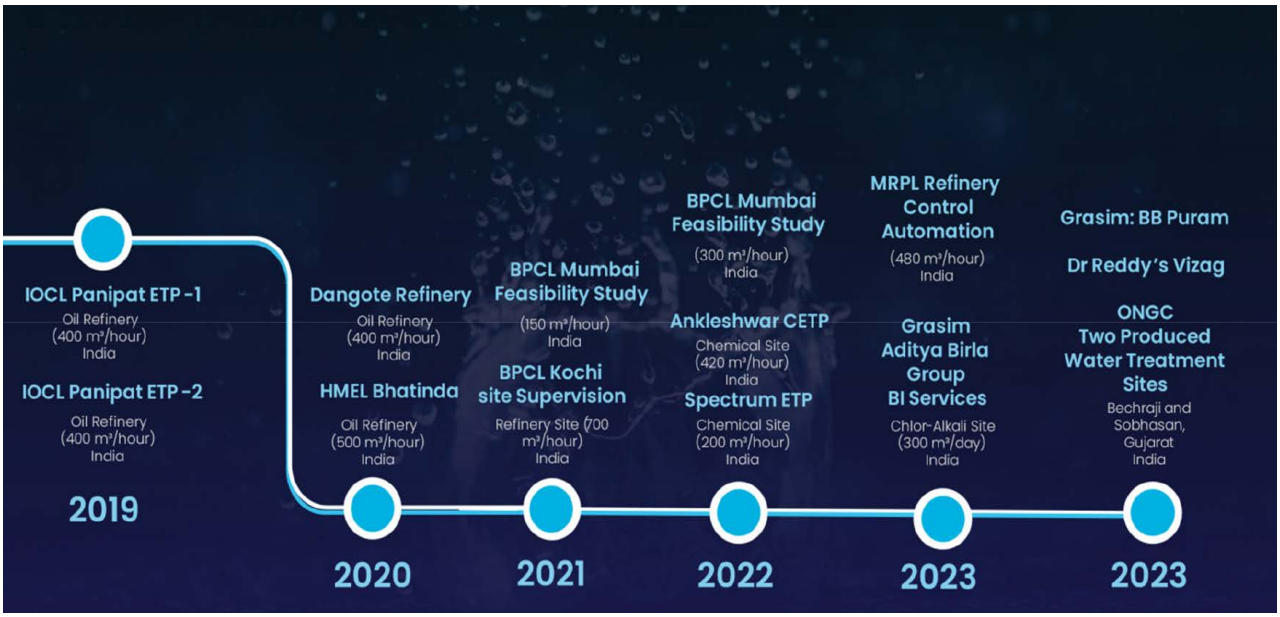
Efficient Industrial Wastewater Treatment: The Chemostat Bioreactor Advantage

## ABOUT THE COMPANY

**The company is owned by David, an Israeli Scientist.**

The journey in India is delineated below:



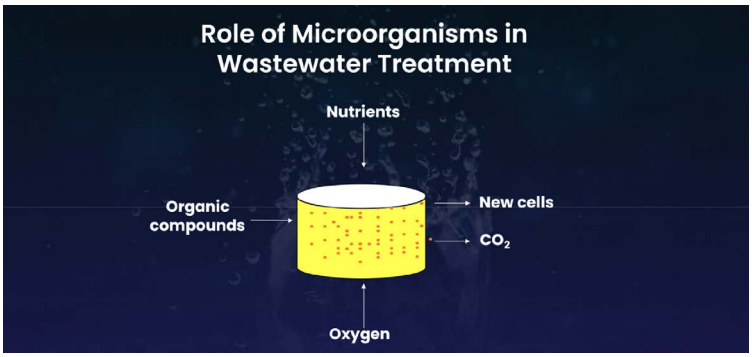
**The company addresses three areas:**

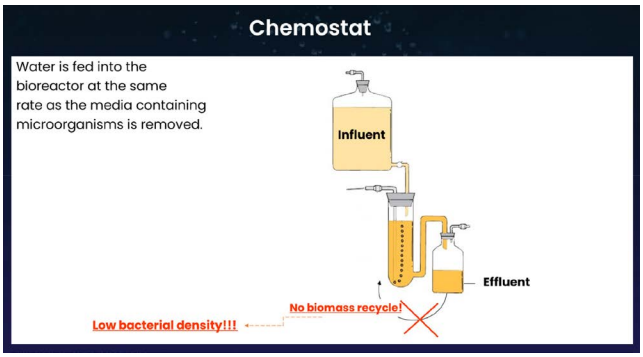
1. Fluctuations in wastewater parameters through process automation
2. Challenging contamination through advanced biological treatment
3. Digitization through BI- AI/ ML

**Products/ Services**

## ACT BIOREMEDIATION

1. Optimal Biomass Concentration, lower sludge
2. Young Bacteria (Age = Retention time), Higher metabolic rates
3. Bacteria in the Log Phase (exponential growth). Bacteria adapts to high and low organic loading rates
4. Robust Bio-Reactor (real-time adjustment to fluctuations in dissolved organics) Bio-Reactor
5. Tolerant to high levels of TDS, Treats difficult streams (high phenols, ammonia, glycols, BTEX etc.)
6. No Upsets



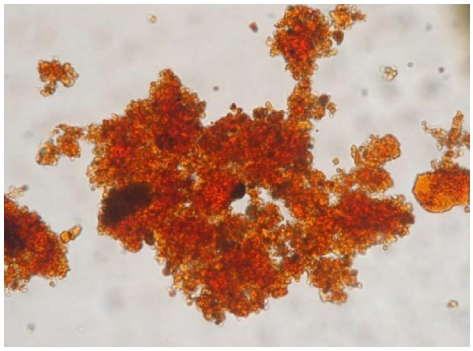





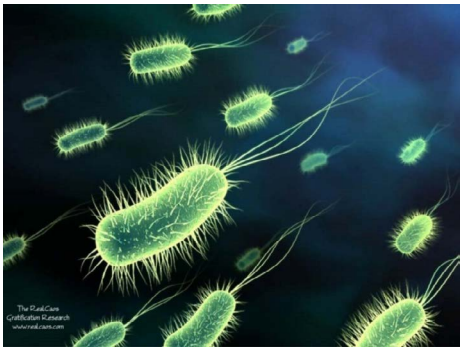
**ACT Vs ASP**

BPC-ACTTM results with significantly lower MLSS levels comparing with Activated Sludge

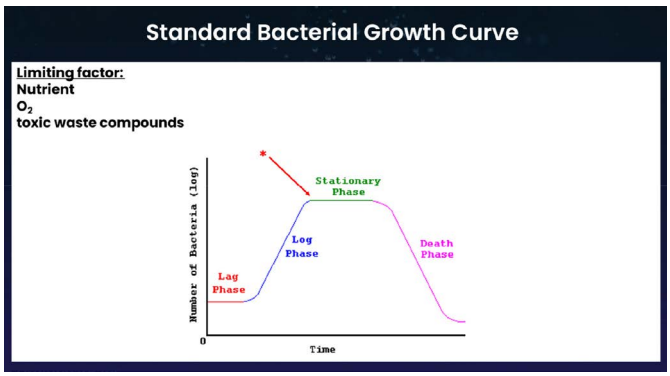
## REDUCED CELL AGGREGATION



**AGGREGATE- FLOCKS**



**SINGLE BACTERIA**




The above data has to be vetted with pilots or going entities.
Claims stable TDS/ BOD/ COD at outlet with wide fluctuations on the inlet side. Also manages Ammonia and Sulphides well.

# Technology & Innovation

DEVENDRA S FONIA
**Bio Petroclean India**

Data-Driven Excellence: Cloud-Based Purebi, Analytics For Improved Sewage Treatment Plant Performance

## ABOUT THE COMPANY

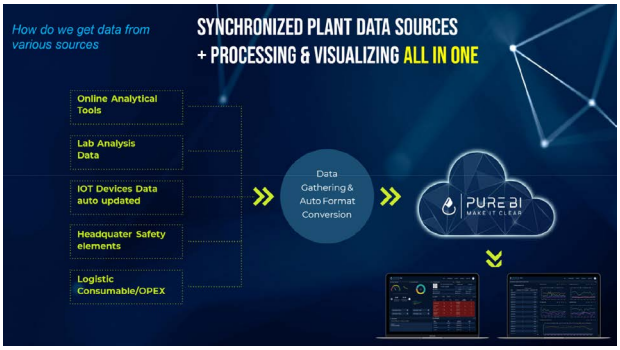
Main treatment challenges in wastewater treatment is about Sustainable Quality, Unoptimized OPEX, insufficient knowhow and poor productivity.

**A Process management system can address above challenges but Why is it not WIDELY available for water Treatment?**

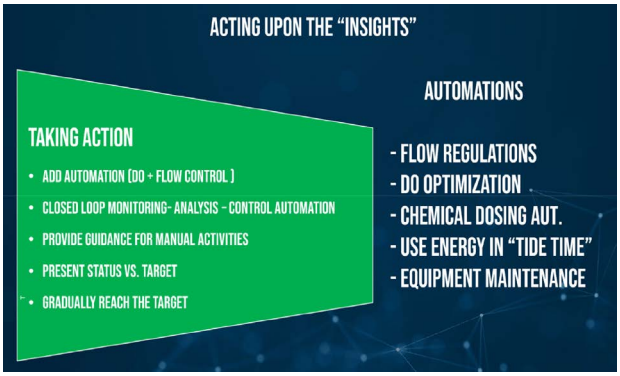
## PROBABLE REASONS FOR HIGH BARRIERS:

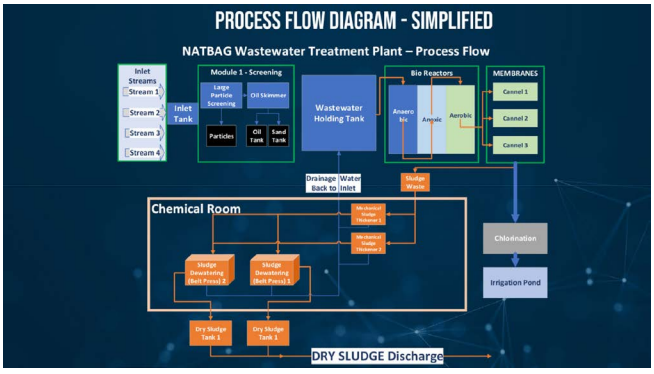
- Process Complexity
- High Knowhow & Attention requirements
- Associated implementation – S/W development CAPEX & OPEX
- Long deployment time
- Life cycle S/W maintenance

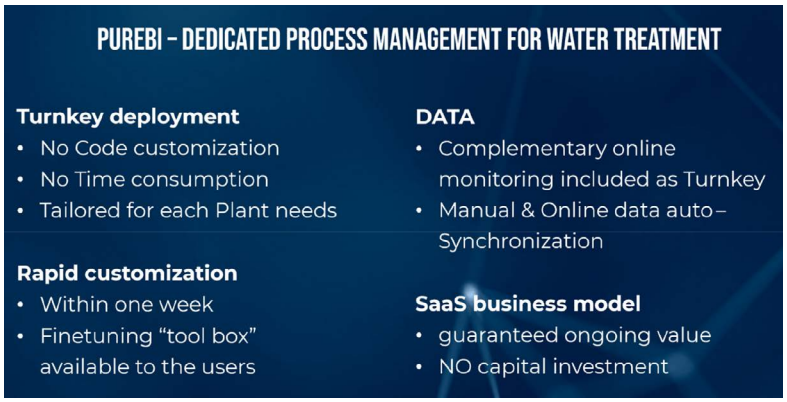
## PICTORIAL /PPTX EXPLANATIONS:

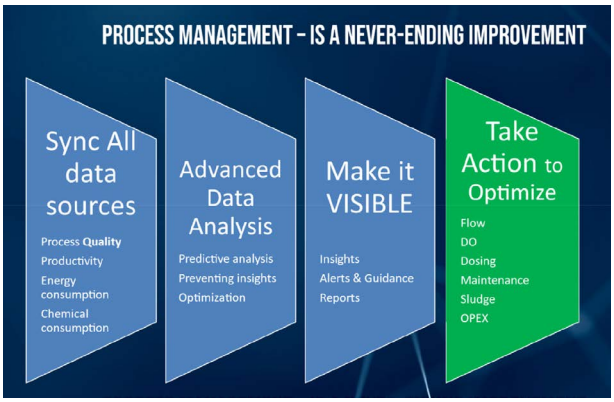






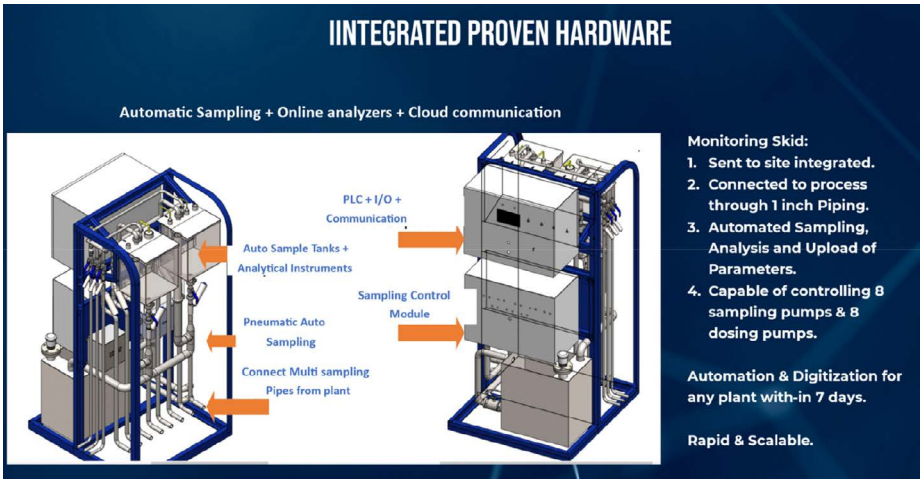






## PUREBI- CONCLUSIONS

- Utilizes Cloud to reduce costs
- Integrated with analytical hardware
- Rapid installation and scalability
- No capital Investment
- Guarantees Value without the risk




## COMMENTS BY THE EXPERT PANEL

*PureBI is apart of the new developments in digitization of water value chain. Other companies like DigitalPANI are also coming in the market. Likely to develop quickly into an AI driven tool. ETV system may assist in developing pilots and also check out existing systems deployed by the company. Accuracy of authentic data capture is the key. BI can be built on top of data sets.*

CITIS 4

November 23, 2023

# Investing in Water

**DAY 2:**
Friday, November 23, 2023
11:30-13:00 hrs

**MODERATOR:**
Sanmit Ahuja [Expert Member, cGanga]
Sundeep Chauhan [Expert Member, cGanga]
Bhaskar Dasgupta [Executive Director (Finance), NMCG]

**PANELLIST:**
Ajay Popat [President, Ion Exchange India Ltd]
Rakesh Mehrotra [Associate Professor, Delhi Technological University]
Samir Shah [Managing Partner, Peak Venture Partners]
Siddharth Desai [Jt. Managing Director, Kishor Pumps]
Starlene Sharma [Founding Partner, Green Artha]
William Ryan [Scientist & Innovations Director, Smart Ops]

## SESSION BRIEF

Investing in water infrastructure and management is paramount to achieving water resilience and water security on a global scale. As we strive for universal water coverage, it becomes imperative to address the challenges of reducing water pollution and increasing water use efficiency. These objectives are not only essential for safeguarding our ecosystems but also for meeting the growing demands of our burgeoning population. Sustainable investments in technologies and practices that promote cleaner water sources, advanced purification methods, and smart distribution networks are crucial steps in this endeavor. By channeling resources into these areas, we not only ensure the availability of clean water for all but also fortify our resilience against water-related challenges, ultimately contributing to a more sustainable and secure future.

# SUSTAINABLE

**investments in technologies and practices that promote cleaner water sources, advanced purification methods, and smart distribution networks are crucial steps in this endeavor**


## GRAND CHALLENGES PRESENTED

1. No water pricing – no water market
2. Tackling industrial effluent problem – organized and unorganized sectors
3. How to develop a comprehensive water data infrastructure

## KEY POINTS DISCUSSED

### 1. Water use efficiency

Water use efficiency in India is currently facing significant challenges, particularly in the agriculture sector. Despite having a population comparable to China, India's fresh water consumption exceeds that of China by 30%. This disparity highlights the inefficiencies in India's water usage. One of the key issues contributing to this problem is the country's cropping pattern, which is not sustainable considering the available water resources. The current approach to water management and agricultural practices in India needs urgent reassessment to improve water use efficiency and ensure long-term sustainability.

# Investing in Water

## 2. Recycle – Reuse of water is important

Recycling and reusing water is of paramount importance, especially in a water-stressed country like India. Implementing Zero Liquid Discharge (ZLD) systems is crucial in regions where large areas are facing water scarcity. In India, the challenge is twofold: not only are there vast water-stressed regions, but also in areas with abundant water, there is often a lack of necessary infrastructure and energy resources to pump water over long distances. Moreover, creating a revenue stream from water is essential for attracting investments into the sector. This concept, known as 'Revenue Water', underscores the need to view water not just as a resource to be conserved, but also as an asset that can generate economic benefits, thereby encouraging more sustainable and efficient water management practices.

NMCG is already starting to move in the direction of creating a "valuable commodity" out of waste-water. This is demonstrated through the IOCL-Mathura project where treated waste-water is being sold to the refinery.

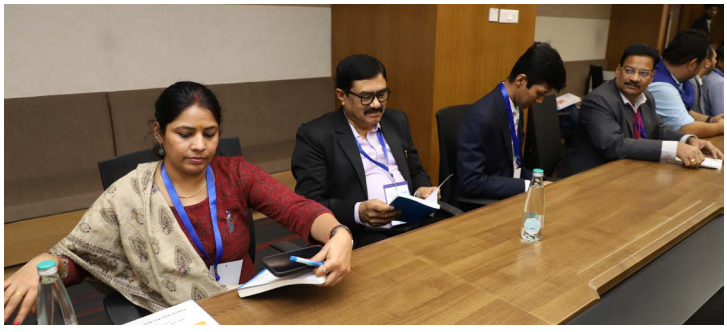
## 3. Pricing of water is critical aspect for the nation

The pricing of water is a critical aspect that needs careful consideration. This is illustrated by the Diamond Paradox, where a non-essential item like a diamond is highly valued, whereas water, crucial for human survival, is often undervalued. This undervaluation largely stems from the historical perception of water

# 'REVENUE WATER',

**underscores the need to view water not just as a resource to be conserved, but also as an asset that can generate economic benefits, thereby encouraging more sustainable and efficient water management practices**





# Investing in Water

as an abundant and essential commodity, rather than a scarce resource. It is vital to recognize the true value of water, which goes beyond mere cost or price. Creating a pricing structure that reflects this value is essential. This means establishing a system where affluent, commercial, and bulk users pay according to the real value of water. At the same time, subsidizing water for other sections of the population is acceptable, provided there is clear recognition and understanding that such subsidies are in place. This approach can help in managing water resources more effectively while ensuring fair access for all.


### 4. Water cannot be seen as a standalone commodity

Water should not be viewed as a standalone commodity; instead, it demands a comprehensive understanding that encompasses its impact on various domains. It is essential to look at water through a 360-degree lens, considering its significant effects on agriculture, health, transport, power,

industry, and the overall economy. Additionally, water plays a central role in resource security, particularly in the context of trans-boundary conflicts and domestic intra-riparian disputes. While water is generally regarded as a public good, it often functions as a private-good or a pseudo-public good. This misclassification is largely due to the application of misplaced economic models, exacerbated by a lack of data and evidence around water governance. Understanding water's multifaceted role and its complex interactions with various sectors is crucial for developing effective management and governance strategies.

### 5. Data around water usage

Data plays a crucial role in shaping effective water usage policies. For instance, gathering data on water usage in the agricultural sector, such as the intensity of water consumption by different crops across various regions of the country, is vital. Equally important is the creation of a water-balance-sheet for each city, which

**IT'S ESSENTIAL TO**

**look at water through a 360-degree lens, considering its significant effects on agriculture, health, transport, power, industry, and the overall economy. Additionally, water plays a central role in resource security**

# Investing in Water

helps in understanding the specific demand and supply dynamics. Additionally, developing cross-departmental water audits can lead to a more holistic approach to water management. Beyond these measures, it's essential to comprehend, quantify, and appropriately price the value of embedded water in India's exports. While this may not necessarily lead to taxation, it can ensure that goods are adequately priced, reflecting their true water footprint. This comprehensive data-driven approach is key to sustainable water management and policy formulation.

## 6. Water as a service model

The concept of water as a service is gaining traction, primarily because customers show a willingness to pay for a quality and consistent water supply. However, to capitalize on this trend, it's essential to develop more projects that attract serious contractors. These contractors are generally ready to invest in water infrastructure projects, especially if there's a guarantee of an offtake agreement. It's crucial, though, not to leave contractors solely responsible for market creation, as this typically falls under the government's purview. In this context, the




role of a market-maker becomes critical. This entity can bridge the gap between government responsibilities and contractor capabilities, ensuring that the projects not only get off the ground but also meet the expectations for quality and consistency that customers demand.

## 7. Role of a Market-Maker in the water sector

The role of a market-maker in the water sector can be understood by drawing parallels with other sectors, such as renewable energy. In these sectors, an intermediary entity often provides long-term guaranteed off-takes. Such an entity, typically with a robust credit rating, acts as a buffer for contractors against the fluctuating credit ratings of municipalities across the nation. This arrangement

**IT'S ESSENTIAL**

**to comprehend, quantify, and appropriately price the value of embedded water in India's exports**

# Investing in Water

instils confidence among investors and lenders by significantly lowering the risk of default. As a result, the presence of a market-maker not only helps in increasing the market size but also plays a crucial role in attracting capital into the sector. This model, successfully implemented in other industries, could be a game changer for the water sector, enhancing investment and stability.

## 8. Technology in the Value chain of water

Incorporating technology into the water sector's value chain requires a deep understanding of the entire ecosystem. Technology innovators must recognize that after the technology intellectual property company, there exists a comprehensive value chain. This chain includes original equipment manufacturers, system integrators, EPC (Engineering, Procurement, and Construction) contractors, project developers, and ultimately, the end clients. It's crucial for technology inventors to consider the value of service provided by each actor in this chain when pricing their products. This approach allows end clients to comprehend the true value of the innovation, enabling them to make informed comparisons between different technologies on a like-for-like basis. By acknowledging and integrating the

# THE ROLE OF A MARKET-MAKER

**in the water sector can be understood by drawing parallels with other sectors, such as renewable energy. In these sectors, an intermediary entity often provides longterm guaranteed off-takes**

roles and contributions of each component in the value chain, technology introducers can enhance the overall effectiveness and appeal of their innovations in the water sector.

Emerging technologies on the landscape are:

- Sequential Continuous Flow Reactor technology for decentralised waste-water treatment
- Realtime monitoring of industrial effluents streams
- Resource recoveries from industrial effluents streams
- Forward osmosis for better recovery of waste-water
- Developing datasets for water bodies
- Remote sensing for flood plain mapping
- Water trading market – digital platforms
- STP sludges treatment and hygienisation
- Mobile sludge dewatering systems
- Micro-plastics removal from water
- Recycling water for high-quality industrial uses such as electrolyzers for green-hydrogen production and semiconductor manufacturing.

CITIS 5

November 23, 2023

# Investing in Energy

**DAY 2:**

Thursday, November 23, 2023
14:00 – 15:30 hrs

**MODERATOR:**

Sanmit Ahuja [Expert Member, cGanga]
Sundeep Chauhan [Expert Member, cGanga]
Bhaskar Dasgupta [Executive Director (Finance), NMCG]

**PANELLIST:**

Amit Agarwal [Hi-Tech Enterprises]
Animesh Das [Director (Member Secretary), Tripura Biotechnology Council, Department of Science Technology & Environment, Govt. of Tripura]
BB Das [ACES, SPCB, Govt. of Odisha]
Ganesh Kulkarni [MD, Hindustan Agriculture]
Hirander Misra [CEO, GMEX Group]
Manpreet Singh [Partner, Climate & Energy, PwC]
Nish Balashanmugam [Country Manager, Green Hydrogen Organisation]
Pieter Jansen [Managing Director, Abrimix (Pty) Ltd]
Rajan Varshney [Deputy General Manager, NTPC Ltd]
Sanjay Guleria [Director, NJS Engineers India Pvt Ltd]
Siddharth Desai [Director, Kishor Pumps Pvt Ltd]
Subhash Kumar [Director, ACME]
Suvarna Bhat [Joint Managing Director, HNB Engineers Pvt Ltd]
Tanmay Pawale [COO, Biopipe Global Corp]

## SESSION BRIEF

Investing in the energy sector is pivotal as we navigate the complex journey of the energy transition. Achieving a sustainable future demands a diverse energy mix that combines renewable sources, fossil fuel alternatives, and innovative technologies. In this context, green hydrogen and biofuels emerge as promising game-changers in our battle against carbon emissions. These clean energy sources have the potential to significantly reduce our carbon footprint and offer a bridge towards a more sustainable energy future. Moreover, as we continue to harness renewable energy, the development of efficient energy storage systems takes precedence.

Our goal should be to ensure round-the-clock access to renewable energy, mitigating the intermittent nature of sources like wind and solar power. By directing investments towards these key areas, we can accelerate the energy transition and drive meaningful progress towards a cleaner, more sustainable energy landscape.

## GRAND CHALLENGES PRESENTED

1. Green hydrogen is essential to reduce emissions in hard to abate sectors
2. Biofuels and Biogas must play a greater role in net-zero transition

# CLEAN ENERGY

**sources have the potential to significantly reduce our carbon footprint and offer a bridge towards a more sustainable energy future. Moreover, as we continue to harness renewable energy, the development of efficient energy storage systems takes precedence**

3. Enabling Round the Clock green power is essential to decarbonisation

## KEY POINTS DISCUSSED

1. Energy transition already happening but there are certain financing and economic inhibitors that need to be addressed along the way:

Both the Indian Government and industry remain fairly confident on achieving the 500 GW renewable energy target by 2023. However, in achieving this target certain structural challenges remain, particularly in energy economics and financing. These are:

- Demand on the grid to upgrade both its aggregate carrying capacity and to take on intermittent power has increased significantly. The grid infrastructure development need must be more pronounced in policy matters.

- Banks are getting overexposed on sector and counter-party risks. This can be addressed by faster churning of capital through bond markets and down-selling, but also bringing segments of renewable energy under prioritylending sectors.

- Demand for debt finance will increase 5 to 7-fold particularly as new sunrise sectors such as green hydrogen and EV charging infrastructure usher in.

# Investing in Energy


- Creation of secondary buy-out markets are required for these entities to exit their equity investments in order

- How large fossil-fuel based energy companies will transition across, must be debated at length and a separate investment asset-class called "transition" finance be created.

- The Government is also facing a transition financing conundrum, and that is because of the large tax revenues it collects on fossilfuels. If the consumption comes down, so will the Government revenues. Although, there will be newer revenue streams as a result of the economic activities and investments around the new energy sectors.

- Role of market-makers cannot be estimated.

- There is no structural clarity on the role of carbon financing.

- Round the clock-power is essential to energy transition goals of the nation.

### 2. Concentrated Solar Power can deliver "firm-power"

The inherent limitation of solar, wind or hydropower is its dependency on availability of the natural resource in sunshine, winds and adequate flow of water in the rivers respectively. This leads to the intermittent nature of power supply that prevents a "complete" transition to renewable energy forms. Furthermore, if there is no supply of round-the-clock green power then sectors like green hydrogen will stumble as they are wholly dependent on 24x7 supply of renewable power as an input.

There is a growing concern that battery storage

# GREEN HYDROGEN

**holds massive potential particularly to decarbonise hard-to-abate (HTA) sectors. India's National Green Hydrogen Mission aims to establish a 5MMT of annual GH2 production capacity by 2030 which will avert nearly 51MMT of $CO_2$ emissions**

cannot be India's answer to providing round-theclock renewable power as besides scale-limitations, it also has supply chain issues that would make the country dependent on critical metals and minerals. In the same vein pumped hydro can also not be a panacea as it has geographical limitations.

Could concentrated solar power could perhaps fill a significant gap. Whilst it may have higher capital costs, but the assets long-life means amortisation can be over longer periods, thereby reducing the levelized cost of energy delivered. India has made attempts to launch CSP in the past, and perhaps it is time to have a look at it again.

### 3. Green Hydrogen and hard-to-abate sectors

Green hydrogen holds massive potential particularly to decarbonise hard-to-abate (HTA) sectors. India's National Green Hydrogen Mission aims to establish a 5MMT of annual $GH_2$ production capacity by 2030 which will avert nearly 51MMT of $CO_2$ emissions.

On the consumption side there is an established market for hydrogen consumption with India already consuming nearly 6 MMT annually. The two sectors that are the most prolific users are.

Fertilizers (in form of ammonia) and refineries which between then consume 48% and 46% respectively. Steel sector is the other major sector that consumes nearly 5% of the current volume being consumed.

These hard-to-abate sectors should be the priority areas for the first use cases, as the other sectors such as transport, energy-storage and distributed energy will take time to develop.

Depending upon natural gas prices, the cost differential between grey and green hydrogen can be significant to justify a business case for

# Investing in Energy


procurement of $GH_2$ in the HTA sectors. In the fertilizer sector, there may be reluctance for the fertilizer companies to pass the cost on to the farmers who are already massively subsidised by the Government. Although a similar sentiment may prevail in the refineries sector, the actual impact of using $GH_2$ in the refinery process, may only have a negligible impact on the price of refined oil. Both sectors will need some regulatory push in form of target-mandates and price support in form of subsidies to make the transition. In either case this will jump-start the $GH_2$ market in India.

### 4. Biogas and Biofuels

Due to a strong underlying agrarian base, India has a huge potential for bioenergy:

- Power generation potential from biomass > 25 GW
- Power generation potential using bagasse-based cogeneration > 15 GW
- Biofuel production potential > 60,000 KLPD
- Biogas generation potential > 55,000 TPD

Fuel supply reliability remains the single biggest challenge to unlock the growth of the bioenergy sector. This is underpinned by the highly unorganised nature of biomass

**THE BANKS ARE**

**reluctant to lend as they need a few years of operating data to commit finance to the solution. This situation is ideal for using a "capacity leasing" model, where the electrolyzer OEM (original equipment manufacturer) may offer the solution on either a lease finance (akin to dry leasing of aircraft) or offer a fully operational lease (akin to wet leasing of aircraft**



collection, storage, and transport. Creation of a national infrastructure development strategy for organising biomass supply will trigger a positive chain reaction in establishment of production plants.

Furthermore, establishing a biomass trading platform that makes the commodity a tradable financial security can bring in the necessary capital to finance the growth of the sector.

### 5. Capacity leasing model for decentralised infrastructure segments

It is a generally well accepted notion that decentralised/distributed infrastructure should co-exist with large grid scale infrastructure simply because there will always be nooks and corners in any country which will be prohibitively expensive to bring under the coverage of national grid. Furthermore, there are a lot of unorganised regions which will be brought under grid coverage soon but remain dark at the moment. These segments are apt for decentralised infrastructure.

However, given the average size of projects, this segment is mostly delivered by small-medium size enterprises and their financial constraints limit them from taking on many concurrent projects. Innovative financial structures, such as “Capacity Leasing”, can help in rapid expansion of the decentralised infrastructure asset class.

The structure is best applicable to standardised technology solutions that are either new to market and/or have high capital costs. For instance, “electrolyzers” for production of green hydrogen. Rapid advancement in the technology also introduces decision inertia amongst project developers as they are unable to commit to the solution for the fear of obsoletion. Additionally, the banks are reluctant to lend as they need a few years of operating data to commit finance to the solution. This situation is ideal for using a “capacity leasing” model, where the electrolyzer OEM (original equipment manufacturer) may offer the solution on either a lease finance (akin to dry leasing of aircraft) or offer a fully operational lease (akin to wet leasing of aircraft).

# Investing in Energy


This financing model will help accelerate commercialisation of new technologies and should become the norm.

### 6. Carbon Credits

As India moves to establishing its compliance carbon-credit markets, the most significant challenge the government will face is how to create the demand, and who pays for it. Set a floor price too low, and the very purpose of establishing a market is defeated, set it too high and the market becomes ineffective as there would be limited participants. This roaring debate is not just India centric but a global one, as to what is the universally accepted price of carbon. If the world accepts a price, then would there be a separate regime for developing countries?

With many major carbon offset projects being challenged globally such as forestry driven credits or cook-stove related credits, there is a major trust and integrity issue creeping in the markets. Robust technologies and transparent approaches can address the integrity related issues, but the underlying science must be robust when assessing the efficacy of a proposed solution.

### 7. Role of a Market-Maker in the green-hydrogen sector

Market-makers are entities that are established to act as an intermediary between energy producers and wholesale consumers. Examples include SECI and NTPC that play a critical role as market-makers. The role of market-maker cannot be underestimated particularly in the case of green-hydrogen and its derivates such as ammonia and methanol. The market-maker's function in this sector will be to offer long-term, typically more than 10 years, offtake agreements to green hydrogen producers and down-sell the produced molecules to willing buyers who will only offer short duration contracts.

The market-maker assumes three different risks:

- The price differential risk
- The contract term risk
- The volume differential risk

The absolute financial value of the risks can be bridged through a Contracts-for-Difference (CFD) style structure. The market-maker will have to fill the financing gap through long-term borrowings using green bonds, selling carbon-credits or use government grants.

### 8. Technology in the energy sector

The following are the unique technology related challenges in the energy sector:

- **Inverted structure on solar panels**

  Despite the local content requirement in projects, Indian developers end up importing their panels from China, while Indian panel manufacturers end up exporting majority of their production to US and EU.

# THE ABSOLUTE

**financial value of the risks can be bridged through a Contracts-for-Difference (CFD) style structure. The market-maker will have to fill the financing gap through long-term borrowings using green bonds, selling carbon-credits or use government grants**


- **Access to metals and minerals for battery**
  India is very much dependent on imports for lithium, nickel, cobalt, vanadium, niobium, germanium, rhenium, beryllium, tantalum, and strontium. These minerals are critical for the manufacturing of electronics and EV batteries.

- **EV charging infrastructure**
  India has inadequate charging infrastructure for electric vehicles which leads to range-anxiety amongst potential buyers dissuading them from purchasing EVs. Most of the current demand is coming from corporate buyers and fleet owners, but the industry will require significant investment in nationwide rollout of charging infrastructure if it wants the consumer demand to pick up.

- **Battery Energy Storage Systems**
  The success of storage systems will be critical for India to provide 24x7 renewable power. Although, battery storage systems, despite the possibility, may not scale up to giga-watt scale, they will play a crucial role in decentralised infrastructure. Testing the technical competency of these systems must be accelerated.

- **Carbon capture, utilisation and storage**
  With no compliance markets, lack of revenue from carbon credits becomes an impediment to deployment of CCUS systems. However, a commercial pathway to use of CO2 in methanol production can spur development of CCUS projects in India.

CITIS 6

November 23, 2023

# Investing in Waste and Circular Economy

**DAY 2:**
Thursday, November 23, 2023
16:00 – 17:30 hrs

**MODERATOR:**
Sanmit Ahuja [Expert Member, cGanga]
Sundeep Chauhan [Expert Member, cGanga]

**PANELLIST:**
Aditya sharma [Director of Strategy, Boson Energy]
Ashish Mathur [MD, Imperium Energy]
Gurudas Nulkar [Professor & Director, Gokhale Institute of Politics and Economics, Pune]
Hirander Misra [CEO, GMEX Group]
Meeta Narsinghani [Associate Partner, Circulate Capita]
Rajan Varshney [Deputy General Manager, NTPC]
Ravneet Mann [Head of Strategy & Policy, Stride Ventures]
Rob Sampson [CEO, Ceres Biosystems]
Suvarna Bhat [Jt. Managing Director, HNB Engineers Pvt Ltd]
Uday Kelkar [Managing Director and CEO, NJS Engineers India Pvt Ltd]


## SESSION BRIEF

Investing in waste management and fostering a circular economy is not just a local or regional concern; it has evolved into a pressing global issue with far-reaching consequences. Municipal solid waste has grown into a formidable challenge that transcends geographical boundaries, bringing forth escalating public health, environmental, social, and economic costs that reverberate worldwide. Moreover, it is crucial to recognize that inadequate solid waste management significantly exacerbates climate change, contributing to approximately 5% of global carbon emissions. This sobering statistic underscores the urgent need for comprehensive solutions. Furthermore, it is disheartening to note that poorly functioning Municipal Solid Waste Management (MSWM) systems are responsible for a staggering 80% of ocean plastic pollution. By strategically investing in advanced waste management practices and embracing circular economy principles, we can mitigate these challenges, reduce carbon emissions, and work collectively toward a more sustainable and cleaner future for our planet.

# INADEQUATE SOLID

**waste management significantly exacerbates climate change, contributing to approximately 5% of global carbon emissions**


## GRAND CHALLENGES PRESENTED IN THE PANEL

1. End of life-tyres – turning hazard into an opportunity
2. Municipal waste – still far away from being sorted
3. Enabling a structured commodity market for waste

## KEY POINTS DISCUSSED

### 1. Organising the waste as a commodity

To bring circularity principles into the entire value chain of the waste management sector, the stakeholders must enable two very important facets: (1) embedding an intrinsic monetary value to the commodity and (2) to segregating the mixed waste into separate homogenous waste streams.

Although the ragpickers (kabaadiwaala) network is the most organised/un-organised sector, the market remains very disaggregated and highly unorganised. Furthermore, monetising the commodity can happen within a particular radius, or else the long-distance transportation cost will make any downstream processes very expensive therefore rendering the processing economically

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# Investing in Waste and Circular Economy


unviable proposition. Thus, if organised, the market will mostly remain mostly local.

The recyclables segment of the waste market is quite organised already as there is a clear market-value for recycling PET and other soft plastics. As a result,several aggregator companies are emerging that are attracting the necessary growth capital. As the sector matures, technology will play an important role to enable processing larger volumes and increasing daily throughput.

For other segments such as biodegradable waste, which has a limited shelf-life, farm-waste, construction & debris waste, and other waste from industrial processes, a separate waste commoditisation strategy will be required.

### 2. Municipal waste management remains challenging but there are positives throughout the nation

Two critical issues regarding managing of municipal waste remain in the country:

(a) The level of operational expenditure committed to various projects is inadequate in a lot of the cases. No national benchmarks exist on what the aggregate per-tonne cost for collection, transport and processing should be. Contractors do aggressive low-ball bidding to win concessions thereby creating an unsustainable economic model. Municipalities are only happy (on surface) to have given the concessions but are aware of the sub-optimal operations. Therefore, there needs to be a national assessment on what the true cost of municipal waste management in the country should be.

**NO NATIONAL**

**benchmarks exist on what the aggregate per-tonne cost for collection, transport and processing should be. Contractors do aggressive low-ball bidding to win concessions thereby creating an unsustainable economic model**


(b) Substantial portion of the waste being generated is coming from unorganised segments of the population, making it difficult for municipalities to manage the operations without being able to collect any service fee from this segment.The true-cost assessment can only be done if there is proper data on how much waste each city is generating.

Many cities such as Indore, Nasik, Pune, Jamshedpur, and others have already been running transformative initiatives and these models must be studied and propagated across the nation.

### 3. Sorting waste as a service

The characteristic of waste generated in Indian cities is very different to that of what is generated in developed countries. Given the high proportion of wet food waste, the waste management process must be designed to recycle and reuse as much of it that is possible. This will be hugely supportive to bio-energy industry as feedstock will be assured, whilst the recyclable industry segment will find more efficiency. As more and more downstream use-cases are established, the waste-management industry will find a much necessary fillip.

Sorting municipal waste at industrial scale can become an industry. The centres can be funded by private sector using PPP models such as BOOT and Hybrid Annuity Models (HAMs). This new investment asset class can energise the waste-management industry.

# Investing in Waste and Circular Economy


**4. Organic and biodegradable waste**

The organic and biodegradable waste, which is a significant part of the municipal waste composition can be used as a feedstock for multiple bio-energy forms such as compressed biogas (CBG) and bio-ethanol amongst others. But the biggest utilisation of bio-degradable waste is the trapping the methane emissions in case this waste goes to land-fill sites. Therefore, a concerted effort needs to be made to enable the efficient segregation and supply of biodegradable waste to processing facilities.

**5. Sludges from sewage treatment plants**

Another large source of bio-degradable waste generation is the sewage generation plants that produce sludges post treatment of wastewater. An optimum use of the sludge, once it is dewatered, is to utilise the dried, hygenised, stabilised and homogenised material for agricultural land-application. This is the most prolific use case of STP sludges as it converts what is a liability for one department (municipalities) into an asset for another (agriculture). This process also returns carbon back to the soil which is necessary for its

**THERE IS NO**
**shortage of use cases for use of this biomass to produce different bio-energy forms, the challenge is more of collection and storage as nearly 2.5 million tonnes of waste is produced just in a couple of states north of Delhi**

good health. India's topsoil is eroding at a massive rate, and its rejuvenation must be of national importance.

### 6. Crop burning of farm-waste

Burning of paddy-waste at the end of the harvest season has become an annual national event that massively degenerates environmental health, reduces air-quality to dangerous levels and harms all forms of life. Whilst there is no shortage of use cases for use of this biomass to produce different bio-energy forms, the challenge is more of collection and storage as nearly 2.5 million tonnes of waste is produced just in a couple of states north of Delhi. Akin to developing waste-sorting centres, if collection and storage hubs are created in farm areas, then the risk of feedstock non-availability reduces thereby enabling processing capacity to come in the vicinity of the storage hubs. The cutting, bailing and transporting equipment can be part of the asset-base of the storage hubs which can be financed using long-term annuity models. Farmers will also get adequate payment for supplying the biomass which would boost their incomes.

### 7. End-of-life-tyres

India produces over 2MMT of end-of-life tyres every year. These end up going to landfill or used to produce oil using the banned dirty pyrolysis process. Although there are shredding procedures utilised for recovering rubber and/or steel from the tyres, the process is not very efficient both in its energy consumption and recovery of materials from the tyre. A process called ultra-high-pressure-water jet uses high pressure and velocity water jets to pulverise tyres. This allows recovery of 100% rubber and steel separated so that the materials can be used for the appropriate processes and industries.

The tyre manufacturing industry has already been brought under the Extended Producer Responsibility (EPR) framework to which it must comply. This solution offers the industry to comply

# Investing in Waste and Circular Economy



with the EPR notification but in a manner that is both environmentally friendly and economically viable.

8. **Waste trading platform and a market-maker**

As several waste-segments move towards using circular economy principle, the need for a transparent and robust trading platform becomes more acute. It is only through platforms that the sector can enable scale in the sector. However, transitioning a value chain that is a hybrid of organised and un-organised segments to a fully organised and a structured model will not be easy. The platform needs to be beneficial to all parties involved in the value chain. The obvious benefits are listed below:

- For waste producers, it must help them in complying with their waste-disposal obligations and where possible reduce the cost by recovering economic value from the materials.
- For traders, it must help in ability to increase their trading volumes with synchronous settlements and help with price discovery.
- For processors, it must enable them with continuous supply of their feedstock material at best possible prices.
- For municipal administrations, it must lower their waste management burden and help increase compliance levels.
- For citizens, the platform must visibly demonstrate its effectiveness in improving the hygiene conditions of the city they live in.

The trading platform itself can be supplemented with a layer of a "commodity fund" which will act as a market-maker. This functional can iron out the market-distortions where the traders are unable to take holding positions because of lack of financial resources. A market-makers role can be to bring

# A MARKET-MAKERS

**role can be to bring "risk-capital" to support the traders who will remove the waste-commodity from the cities or farms and store them at locations from where processors can purchase over a period**




"risk-capital" to support the traders who will remove the waste-commodity from the cities or farms and store them at locations from where processors can purchase over a period.

## 9. Technology in the waste-sector

Several additional interesting technologies are emerging in the waste sector:

### *i. Municipal waste to hydrogen to EV fast charging*

In many a case where waste processing is difficult to aggregate to a single site, decentralised solutions are emerging. One such solution is using gasification solution to produce hydrogen from waste in a thermos-chemical recycling process. This produces carbon-negative hydrogen which can be used directly in $H_2$ refuelling stations or $H_2$-powered fast charging stations. By producing hydrogen near the point of consumption can avoid transportation and storage challenges. It is estimated that 100 tonnes of sorted MSW (with 2500 kcal/kg calorific value), can produce 4000-5000 kg of hydrogen per day that can deliver 80-100 MWhe for DC/DC charging.

### *ii. Battery recycling – major shortage of lithium over the next decade*

India's hugely ambitious EV programme also requires access to sufficient input raw materials such as lithium. With scant domestic reserves, the country is almost entirely dependent on importing the batteries and/or the minerals. Recycling can not only help build up the mineral security but also make India a major recycling hub in the world.

### *iii. Sorting technologies*

Advanced solutions are emerging that are AI powered and use industrial automation processes to sort all types of wastes. These will not only increase the throughput capacity of waste sorting centres but also have a huge social impact by bringing the unorganised sector (ragpickers) into formal workforce through adequate training.

CITIS 7

November 24, 2023

# Investing in Food and Agriculture

**DAY 3:**
Friday, November 23, 2023
09:30-11:00 hrs

**MODERATOR:**
Sanmit Ahuja [Expert Member, cGanga]
Sundeep Chauhan [Expert Member, cGanga]

**PANELLIST:**
Dheeraj Mutreja [Consultant, Rabo Foundation]
Ganesh Kulkarni [Managing Director, Hindustan Agri Business Pvt Ltd]
Girish Aivalli [CEO, Impact Investors Council]
Shivi Sheoraan [Business Development Manager, IKEA]
Tomaž Rodič [Director, Slovenian Centre of Excellence for Space Sciences and Technologies, Slovenia]


## SESSION BRIEF

Investing in food and agriculture is a multifaceted endeavor with far-reaching benefits. One promising avenue of investment is in regenerative agriculture, a holistic approach that not only enhances soil health and biodiversity but also reduces the environmental footprint of farming practices. Additionally, investing in innovative agricultural technologies and practices holds the potential to increase farm yields and uplift farmer income, thereby fostering economic growth in rural communities. Furthermore, it is crucial to allocate resources towards agricultural practices and technologies that help reduce agriculture emissions, as this plays a pivotal role in addressing climate change. By channeling investments into these key areas, we can not only ensure food security but also promote sustainable farming practices that benefit both farmers and the planet.

# IT IS CRUCIAL TO

**allocate resources towards agricultural practices and technologies that help reduce agriculture emissions, as this plays a pivotal role in addressing climate change**


## GRAND CHALLENGES PRESENTED

1. Top-soil continues to erode at a dangerous rate – how to regenerate
2. Advanced farming can massively increase yields and farmer incomes
3. Farm-waste burning continues to wreak a havoc

## KEY POINTS DISCUSSED

### 1. Top-Soil rejuvenation

The top-soil of India's agricultural lands is depleting at an alarming rate. Rejuvenating these will require both encouraging regenerative agriculture as well as external interventions such as applying soil-conditioners to the lands. According to a recent cGanga report, bio-degradable and organic wastes from cities and farms can be converted into a stabilised and consistent product that can be used to enhance top-soil quality. Biosolids such as hygienised and stabilised sludges from sewage treatment plants, biodegradable city waste and other farm wastes can be used as feedstock to develop a "top-soil-conditioner" product.

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# Investing in Food and Agriculture


The challenge however is developing an economic model in a scenario where the waste, which is a liability for one government department (municipal administrations), when processed can become an asset for another government department (agriculture). So, establishing an economic model can be tricky which requires not just policy integration but also establishment of underlying value chains.

Cross departmental and sectoral integration is key to the success of enabling this segment. To initiate the process, the most critical requirement is establishing the value-determinants of the new product class that the farmers will appreciate. The definition of the soil-conditioner product must clearly articulate the benefits, the safety and the value to the farmer. Once a monetary value is established that the farmer is willing to pay, then a detailed cost-analysis of the backward integration all the way up to the point of production will determine what is the level of subsidy, if any, that the government needs to pay to make the process chain economically viable.

Select pilot projects will help establish the market and the production chain. Over the years the farmers should visibly appreciate the improvement in soil-quality and therefore the farm yields, at which point the product can become a mass-market solution.

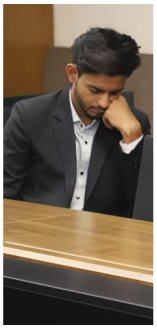
## 2. Farmer resilience

Given the very small landholdings of the Indian farmer, increases their vulnerability to systemic shocks such as soil-erosion, floods or droughts. Helping farmers build climate resilience is critical

# HELPING FARMERS

**build climate resilience is critical not just for preserving the agricultural economy but also for food security of a nation and the world**





# Investing in Food and Agriculture

not just for preserving the agricultural economy but also for food security of a nation and the world as such
- Further exacerbated by issues of irrigation (or lack of), low farm yields, inability to market products
- Have to help them move towards sustainable farming practices
- Farmers are not very literate and generally quite resistant to change particularly when it involves advanced technologies
- Part of the reason is their inability to afford new solutions


### 3. Advanced farming techniques

- Quality and nutrition haven't yet been monetised
- Advanced farming can massively increase yields and with them farmer incomes
- Not everything can be grown using green-houses but it can be a huge income generator and pathway to economic prosperity
- Natural farming takes 4-5 years
- Climate greenhouses
- Remote sensing from space – must also be socially relevant and acceptable

### 4. Building greenhouse infrastructure as a service

- Downward spiral on new technological adoption

### 5. Crop burning of farm-waste

Burning of paddy-waste at the end of the harvest season has become an annual national event that massively degenerates environmental health, reduces air-quality to dangerous levels and harms all forms of life. Whilst there is no shortage of use cases for use of this biomass to produce different bio-energy forms, the challenge is more of collection and storage as nearly 2.5 million tonnes of waste is produced just in a couple of states north of Delhi. Akin to developing waste-sorting centres, if collection and storage hubs are created in farm areas, then the risk of feedstock non-availability reduces thereby enabling processing capacity to come in the vicinity of the storage hubs. The cutting, bailing and transporting equipment can be part of the asset-base of the storage hubs which can be financed using long-term annuity models. Farmers will also get adequate payment for supplying the biomass which would boost their incomes.

**AKIN TO DEVELOPING**
waste-sorting centres, if collection and storage hubs are created in farm areas, then the risk of feedstock non-availability reduces thereby enabling processing capacity to come in the vicinity of the storage hubs

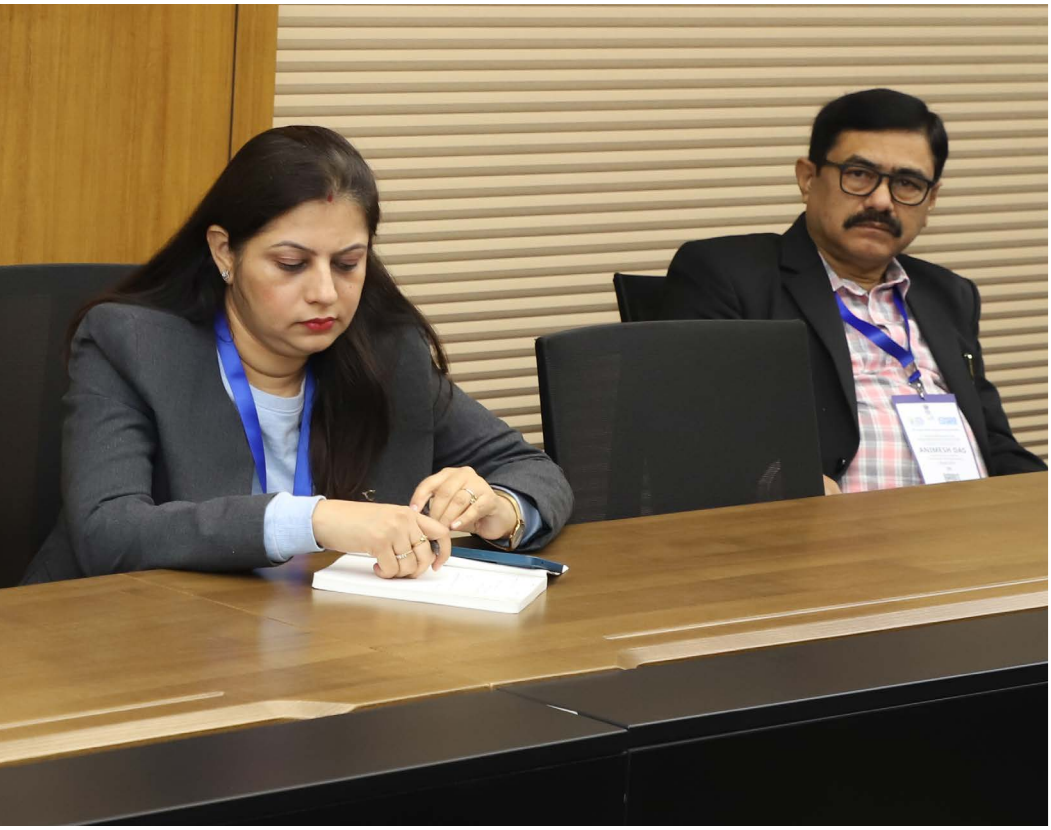
CITIS 7

November 24, 2023

# Investing in Food and Agriculture

# AN OPTIMUM USE

**of the sludge, once it is dewatered, is to utilise the dried, hygenised, stabilised and homogenised material for agricultural land application**




## 6. Market Maker

- Bringing more money directly in the hands of the farmer
- Reduce inefficiencies
- Can work with all government programmes
- Forward market linkages to ensure quality of supply and guarantee of production

## 7. Technologies

i. Remote sensing
ii. Nutrition and protein content of food
iii. Keeping food fresh

## 8. Sludges from sewage treatment plants

Another large source of bio-degradable waste generation is the sewage generation plants that produce sludges post treatment of wastewater. An optimum use of the sludge, once it is dewatered, is to utilise the dried, hygenised, stabilised and homogenised material for agricultural land-application. This is the most prolific use case of STP sludges as it converts what is a liability for one department (municipalities) into an asset for another (agriculture). This process also returns carbon back to the soil which is necessary for its good health. India's topsoil is eroding at a massive rate, and its rejuvenation must be of national importance.

# Investing in Transport

**DAY 3:**
Friday, November 24, 2023
11:30-13:00 hrs

**MODERATOR:**
Sanmit Ahuja [Expert Member, cGanga]
Sundeep Chauhan [Expert Member, cGanga]

**PANELLIST:**
Dheeraj Mutreja [Consultant, Rabo Foundation]
Ganesh Kulkarni [Managing Director, Hindustan Agri Business Pvt Ltd]
Jayeis B Sonill [Founder & CEO, AUM Capital]
Rajiv P Kapahi [Strategic Advisor, Confederation of Empowerment Initiatives (CEI)]
Rakesh Mehrotra [Associate Professor, Delhi Technological University]
Riya Saxena [Senior Associate, RMI India]
Rob Sampson [Ceres Biosystems, Toronto]
Shivi Sheoraan [Business Development Manager, IKEA]
Sujit Jena [Policy Advisor, G20 Secretariat]
Tomaž Rodič [Director, Slovenian Centre of Excellence for Space Sciences and Technologies, Slovenia]

## SESSION BRIEF

Investing in the transport sector is paramount as we navigate the transformative shifts in mobility and sustainability. A crucial aspect of this investment is accelerating the pace of electric vehicle (EV) charging network expansion. This infrastructure development not only encourages the adoption of EVs but also addresses range anxiety, making electric vehicles a more attractive option for consumers. Furthermore, investments in a dynamic electric vehicle supply chain are essential to support the growing demand for EVs and to ensure a steady and efficient flow of electric vehicles from manufacturing to market. Additionally, the emergence of electric vertical takeoff and landing (eVTOL) vehicles represents a disruptive force in the transport industry. These innovative aircraft have the potential to revolutionize urban transportation, reduce congestion, and lower carbon emissions. By strategically directing investments into these areas, we can propel the transport sector towards a sustainable and technologically advanced future.

# INFRASTRUCTURE

**development not only encourages the adoption of EVs but also addresses range anxiety, making electric vehicles a more attractive option for consumers**

## GRAND CHALLENGES PRESENTED

1. Accelerating pace of EV charging network
2. Establishing a dynamic electric vehicle supply chain
3. Enabling the EVTOL industry in India

## KEY POINTS DISCUSSED

### 1. EV charging infrastructure

The expansion of the EV market in India is highly coupled and correlated to the expansion of the charging infrastructure. Whilst, some may say that it is the lack of availability of finance that is stopping the rolling out of charging infrastructure, however it is lack of the appropriate economic model that is a bigger challenge. This is further exacerbated by inadequate planning at municipal administration level. The proliferation thins out even more as one move to tier 2/3 cities and towns in the country.

There needs to be market support for EV-charging infrastructure as otherwise range-anxiety will hamper growth. There is a subsidy allocation under the FAME-II scheme, but take-up on that is still limited and for this reason

# Investing in Transport


the deployment of charging infrastructure capacity remains behind the requirement.

Charging density both in cities as well as on highways is another concern, as drivers find it impractical to charge vehicles at charging points far-away from their primary residence of place of work. Teething problems with the availability of functioning chargers also causes concerns amongst potential buyers.

Those investing in the development of the charging infrastructure need to be compensated through long-term financing schemes and mechanisms. These market-support mechanism should have a fixed minimum "capacity charge" that should be made available to the operator. This capacity charge should be able to cover the debt/interest payments to the lenders, whilst the equity investors can take exposure to implementation risks. For the government it is critical to back the roll-out of infrastructure that will only accelerate the growth of EV market segment.

The take-up of EVs remains promising in the two-three wheeler segments which have adopted the battery swapping models.

## 2. Costs of electric vehicles

A number of concerns remain around the overall economics of EVs. Whilst the government's FAME policy does offer subsidy in the hand of the end buyer, the fact that EVs are generally more expensive to purchase than ICE vehicles is a barrier for most.

# THE MAIN ECONOMIC

**benefit of EV is its low cost of running and potential generation of carbon credits that can be monetised**


Furthermore, the prospective buyer also evaluates additional issues such as range, availability of charging network at or in their vicinity of home or work, market for used cars, life and cost of battery replacement and availability of insurance cover for repairs.

Since the main economic benefit of EV is its low cost of running and potential generation of carbon credits that can be monetised. In both the cases, the owner will accrue the benefits over a long-run, making the incentive proposition rather weak.

The industry should develop flexible financing models such as leasing or hire-purchase models that don't require the customer to make a capital payment up-front. If more such asset platforms emerge, then the take up of EVs will get accelerated in the market. The platform owners insulate the customer from issues related to price of second-hand market but would not be able to allay the range-anxiety fears.

## 3. Electric buses

The government is also very keen that there is a big EV take-up by city administrations in replacing public transport buses with electric buses. Such a commitment to a large aggregate fleet of electric buses across the country would send a strong signal to the industry of India's commitment to decarbonise the transport sector.

Many cities are planning bringing out tenders for a "lease" supply model of buses, but operators remain concerned about payment

# Investing in Transport


security issues as the credit risk of a large number of municipalities remains poor.

Although the vehicle leasing model allows municipalities to ramp up their plying capacity, the contract with the supplier/operator must be underpinned by a credit-worth payment guarantee mechanism to build financial confidence in the contract value-chain.

## 4. Electric Vertical Take-Off and Landing (EVTOL) aircrafts

Advanced electric mobility segments are also extending rapidly to air-transport. The onset of Electric Vertical Take-Off and Landing (EVTOL) aircraft is ushering a whole new dimension in the short-haul air travel market segments. EVTOLs are already able to cover 50 – 250 kms distances and can massively increase mobility and accessibility to places not easily connected.

Although regulations around plying of EVTOL within India are still under development, the industry must be supported so that supply chain can develop rapidly around manufacturing and assembly of the aircraft in India.

## 5. Market-making platforms

Three market-making platforms will be critical to India's EV industry's success:

### *a. Charging infrastructure as a service*

This platform would be offered to cities that wish to expand the density of charging infrastructure. This would help cities deploy their infrastructure so as to encourage more EVs on the roads.

### *b. Vehicle leasing platforms*

These platforms should mostly sit alongside the automobile manufacturers who can offer the vehicles on a leasing bases to bulk buying

# MANY CITIES ARE

**planning bringing out tenders for a "lease" supply model of buses, but operators remain concerned about payment security issues as the credit risk of a large number of municipalities remains poor**

customers. The facility could also be designed for direct individual customer who wishes to drive an EV but are not able to afford.

### c. *Critical materials and components procurement platform*

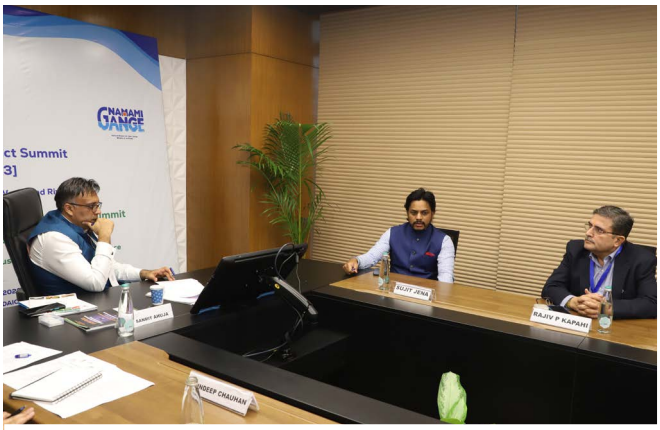
The platform would be a centralised alliance that offers collective buying and procurement of critical materials and components to all supply-chain actors. This would massively increase both India's capacity as well as resilience in its EV supply chain.

## 6. Technologies

- ***Battery technology remains both an opportunity and a challenge***

  The production linked-incentive scheme has spurred the battery related manufacturing activity in the country, but that remains largely in the Lithium-Ion space with heavy reliance on Lithium which is rarely found in India. The industry needs to invest in further development of other battery technologies as well such as Solid-State batteries, Sodium-Ion batteries, Aluminium-air batteries and others.

# Investing in Transport




# THE ONSET OF

**Electric Vertical Take-Off and Landing (EVTOL) aircraft is ushering a whole new dimension in the short-haul air travel market segments**


The extension of this industry is the battery recycling segment which will become provider of the critical components to the cell manufacturers.

- ***Battery performance and usage data***
  Collection and analysis of large amounts of data from passenger vehicles, through which manufacturers are able to analyse vehicle performance in a range of operating conditions, would be hugely beneficial. The advance analytical tools would help all actors such as OEMs, battery manufacturers and fleet operators on how to improve efficiency and optimise usage.

- ***Fleet management***
  Fleet operators are the ones who are proactive in buying EVs, and would therefore need a comprehensive and sophisticated fleet management system. A fleet-management platform that can be adapted to the needs of the fleet operators would be in huge demand.

- ***EVTOLs and related value chain***
  India has a great opportunity to become an EVTOL manufacturing hub for the world particularly since it has the potential of a large domestic market as well. If the industry is yet to become mainstream globally, by establishing both a market and a domestic supply chain, the country can become a leader in this space.

CLOSING SESSION

November 24, 2023

# Valedictory Session of CITIS 2023

**DAY 3:**
Friday, November 23, 2023
14:00-15:30 hrs

**MODERATOR:**
Sanmit Ahuja [Expert Member, cGanga]
Vinod Tare [Founding Head, cGanga]

**DIGNITARIES ON DIAS:**
Guneet Banga [Executive Director, Caravel Group]
Michael Bucki [Head of Department, European External Action Service]
Sameer Rastogi [Managing Partner, India Juris]


## SESSION BRIEF

India extends an invitation to the global community to collaborate and endorse the AAA Declaration. Through this collaborative effort, we aim to expedite the commercialization of technology-led solutions that are vital for both "life" and "mission" critical purposes. Our overarching objective is to ensure that these technologies align with the following principles:

## GRAND CHALLENGES PRESENTED

1. Making technologies Accessible to all nations
2. Making technologies Affordable for all socioeconomic segments
3. Making technologies Available to all communities

## KEY POINTS DISCUSSED

### 1. Making technologies Accessible, Affordable and Available

The developing world alone needs over USD 6 trillion by 2030 to meet its nationally determined contribution (NDC) targets for greenhouse gas

**THE DEVELOPING**
**world alone needs over USD 6 trillion by 2030 to meet its nationally determined contribution (NDC) targets for greenhouse gas emissions and a further USD 4 trillion a year for clean energy technologies to meet the overall decarbonisation goals**


emissions and a further USD 4 trillion a year for clean energy technologies to meet the overall decarbonisation goals. It is going to be extremely difficult if not impossible to get this level of funding even committed let alone unlocked from the developed world, for a simple reason that there is no agreement yet as to who will pay to decarbonise the world GDP.

The anomaly in the above scenario is that if the global south continues to rely on the developed nations to provide this capital, then all it will end up doing is kicking the can further down the road. Furthermore, even if the funding was available for capital deployment, this won't necessarily come in as a grant, but commercial investments or loans, and will unravel the glaring inability of the global south to absorb the expensive technologiesor take on the debt obligations without creating a commercially viable model for projects.

The one major trick that is yet to be fully utilised is making the technologies affordable at the outset. Both the moral and business case exist in its support. Firstly, if technologies are expensive then the developing world will not be able to afford those in the first place.

CLOSING SESSION

November 24, 2023

# Valedictory Session of CITIS 2023

But if those solutions were made affordable by localising the supply chain regionally, then the solution will come within the spectrum of affordability without any compromise in quality or efficiency. Yes, this does require the IP owner to work closely with the licensee or supply chain actors in the developing markets, but the end result will be a win-win situation for everyone. And there is nothing new in this process, as it has and is being done for decades. The only difference here is that the companies bringing disruptive innovation to market tend to be small with limited resources, and therefore find it difficult to localise the supply chain.

Once this indigenisation process is completed, the resultant technology not only becomes more affordable but additional operational and engineering capacity also gets developed, thereby opening up and creating a large market for the particular solution. The level of deployment of the technology in high growth markets will far outstrip the ones in their home country, thus supporting the second argument of the "business-case" to make technologies more affordable.

If the technology is demonstrated in both developed and developing world context,




finding capital to scale it up will not be a challenge. Investors are already backing decarbonisation projects globally and would also do so in the case of new disruptive solutions as they will have been de-risked. This enables the rolling out of the solution and make ubiquitous, ticking the "making it available" box.

## 2. India to become a global demonstration and acceleration hub

To make solutions affordable in any particular country by indigenising the supply chain, the country must have depth of talent, large and diverse manufacturing base, strong engineering capabilities, experience of deploying large scale infrastructure projects, good governance, open and fair business environment and protection of intellectual property rights.

India offers all of the above and additionally it has also a large domestic market which is backed by an ambitious policy of the government to rapidly decarbonise by adding more and more renewable energy capacity as well as promote development of new energy solutions such as green hydrogen.

India can add great value by helping create a supply chain that makes solutions affordable, which would provide a huge fillip to the developing world. There is no reason why even companies from developed world can't develop their supply chain out of India, which would give more profits to them when they implement the solutions in their home economy.

The coupling role that India can play in upstreaming technologies from developed nations, localise the supply chain and then

**INVESTORS ARE**

**already backing decarbonisation projects globally and would also do so in the case of new disruptive solutions as they will have been de-risked. This enables the rolling out of the solution and make ubiquitous, ticking the "making it available" box**

CLOSING SESSION

November 24, 2023

# Valedictory Session of CITIS 2023



# THE COUPLING ROLE

**that India can play in upstreaming technologies from developed nations, localise the supply chain and then downstream the solutions to developing countries, can be hugely transformative in the world's collective batter to fight climate change**

downstream the solutions to developing countries, can be hugely transformative in the world's collective batter to fight climate change.

### 3. A new asset class is needed – FOAK

Most innovators dread the valley of death, which is a point when the technology has been developed in a "lab" setting but there is no commercial scale demonstration project out there. At this point, the Government grants, which are for the research and development purposes, disappear, and private sector doesn't yet have the confidence to invest as the solution has not been proven or scaled up in the real world.

The situation is quite severe for those in the infrastructure technologies space as the ticket sizes of their expenditure is much larger than those innovating in the software or digital world.

To solve this problem, a new investment asset class is needed that funds the first-of-a-kind (FOAK) commercial demonstration project. The asset class would perhaps be created by bringing the Governments, academia, development finance institutions, impact investors and more progressive industrial customers closer to each other so that the investors can see market traction, and prospective buyers can visibly see derisking of the technology.

### 4. Financing continuum is critical to take FOAK to NOAK

The journey from FOAK to NOAK is somewhat easier but finding adequate capital to scale-up rapidly can be daunting and frustrating. Like creating a new asset-class such as the FOAK, to support the scale-up to NOAK, there needs to be a financing continuum that can unlock capital for the project proponents.

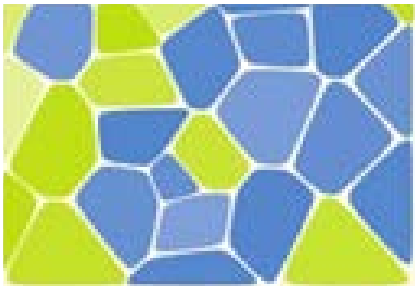
The financing continuum must be fully established between the three main stages of technology commercialisation – the introduction stage (FOAK), the expansion phase (construction capital), and steady stage operations phase (long-term institutional yield-seeking capital).

If there is adequate depth in the financing continuum, then capital can be unlocked by faster churning. Lenders can down-sell their debt whilst equity investors can exit to institutional investors. The more assets that get into O&M phase, and are able to release equity & debt, the more the availability of capital for previous phases.

MoC

November 23, 2023

# Global Coalition for River Science and Management



cGanga is pleased to announce the inauguration of the Global Coalition for River Science and Management (CRSM), which represents a collaborative assembly comprising river basin organizations, centers of excellence, and distinguished experts specializing in river systems and catchment areas.

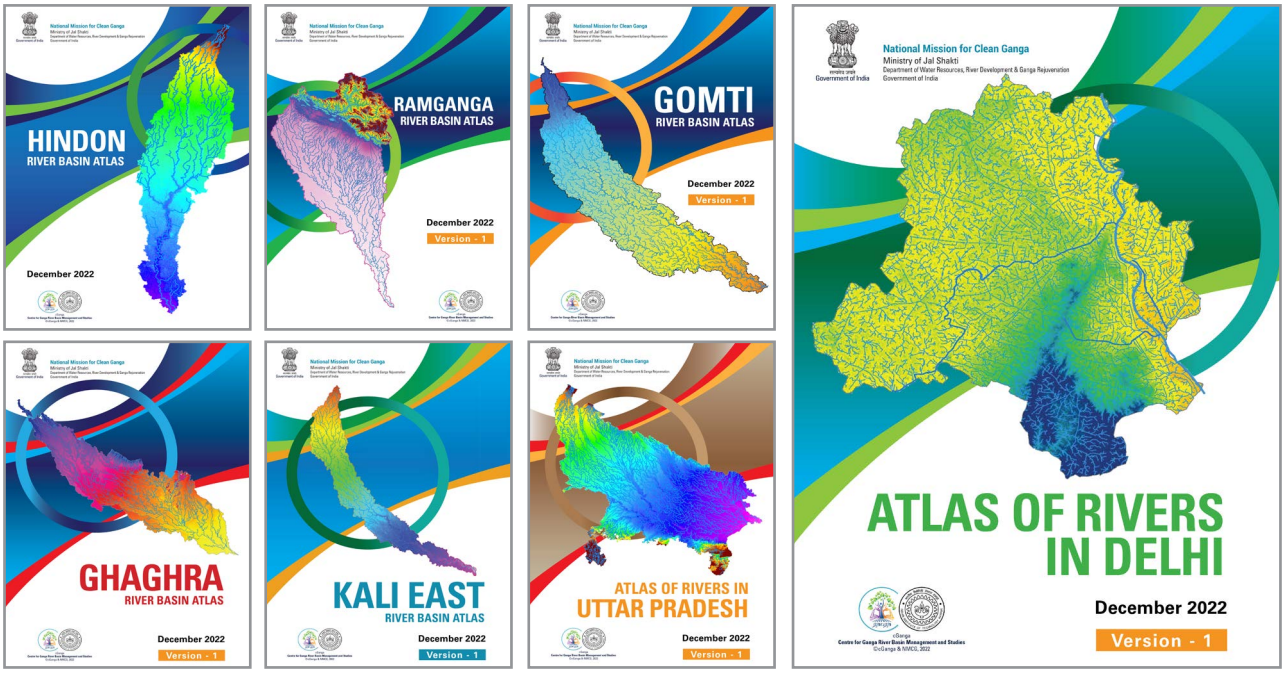
The Coalition aims to consolidate expertise, tools, technologies, solutions, and methodologies pertaining to river basin and catchment management, with the primary objective of disseminating this knowledge to nations worldwide. This endeavor is anticipated to contribute significantly to the overall improvement of river systems' quality on a global scale.

A worldwide digital data center is currently in the process of establishment at the Indian Institute of Technology Kanpur, encompassing approximately 30,000 square feet of dedicated space designed to serve as a comprehensive repository for river basin data, encompassing river systems both within India and across the globe.

cGanga extends an invitation to interested parties to:

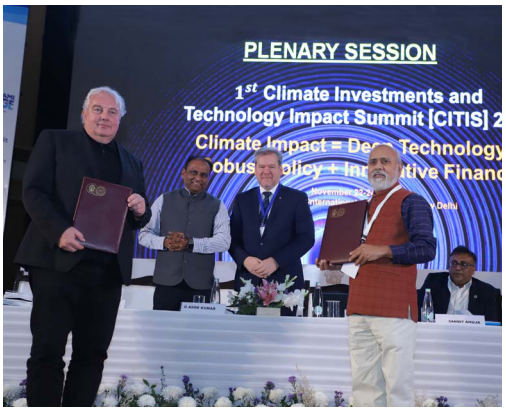
- Participate in the advancement of the repository and the establishment of a knowledge hub dedicated to exemplar practices.
- Facilitate the dissemination of digital solutions and knowledge to regions within the Global South.
- Engage in training and capacity-building initiatives tailored for river basin managers.

## SAMPLES OF RIVER ATLASES DEVELOPED BY cGANGA FOR RIVER SYSTEMS IN INDIA




PREM SINGH RANA
ANSHUMAN
ASHOK KUMAR SINGH


PLENARY SESSION


PLENARY SESSION

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

सत्यमेव जयते
Government of India
Ministry of Jal Shakti

G20 भारत 2023 INDIA

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

# Memorandum of Collaboration

This MOC is signed between cGanga (set upat Indian Institute of Technology Kanpur (IITK) as a Centre of Excellence to further the development of Ganga River Basin. It acts in the capacity of a comprehensive think-tank for the National Mission for Clean Ganga and the Ministry of Jal Shakti, Government of India, in its stated goals and objectives vis-a-vis the Ganga River Basin and wider river systems in India.

And Space-SI,which is a Slovenian Centre of Excellence for Space Sciences and Technologies, at the India Water Impact Summit and Climate Investments and Technology Impact Summit 22-24 November 2023, New Delhi.

## Global Coalition for River Basin Science and Management

**Objective of Collaboration**

cGanga is pleased to announce the inauguration of the Global Coalition for River Basin Science and Management, which represents a collaborative assembly comprising river basin organizations,centers of excellence, and distinguished experts specializing in river systems and catchment areas.

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Engage in training and capacity-building initiatives tailored for river basin managers.

cGanga/IITK and Space.SI act as independent contractors in the performance of this MOC and neither Party shall act as an agent for or partner of the other Party without consent of the other Party. Nothing in this MOC shall be deemed to constitute, create, give effect to or otherwise recognize a joint venture, partnership, or formal business entity of any kind, and the rights and obligations of the Parties shall be limited to those expressly set forth herein. The terms and conditions of the collaboration are to be agreed upon between the Parties in a separate MOU specifying the terms and conditions governing such collaboration (e.g. financial,intellectual property, licenses). The parties shall aim to complete the separate MOU and subscribe to the charter of the Coalition within 90 days of signing this Memorandum of Collaboration.

**Signatures**

In witness whereof the Parties hereto have caused this understanding in duplicate to be executed hereunto set their respective hands the day month and year first hereinabove written.

**Party: 1**

Signed

Prof. Vinod Tare, Founding Head - cGanga
Indian Institute of Technology Kanpur
KANPUR - 208016, INDIA

23 November 2023

**Party: 2**

Signed

Name: Mr. Tomaz Rodie
Organisation: Space-SI

23 November 2023

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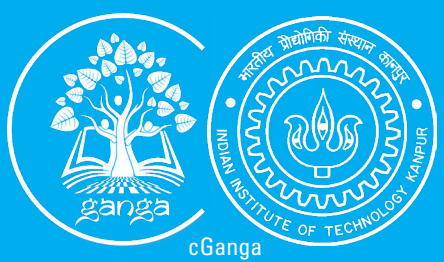


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**Centre for Ganga River Basin Management and Studies**