

# Unlocking Wastewater Treatment, Water Re-use and Resource Recovery Opportunities for Urban and Peri-urban Areas in India

## OVERVIEW OF PROJECT ACHIEVEMENTS

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**Anshuman** | TERI, New Delhi, India

# Project goal and approach



**Unlock environmental and economic potential** for wastewater treatment, water reuse and resource recovery

**Wastewater treatment & resource recovery**

**Water Governance**

**Smart Water Management**

Capacity building, business development, dissemination



**Reduce pollution, by improving treatment**, particularly for organic micropollutants

Promote **wastewater reuse for irrigation**, to free up water resources for drinking



# Pavitra Ganga in brief

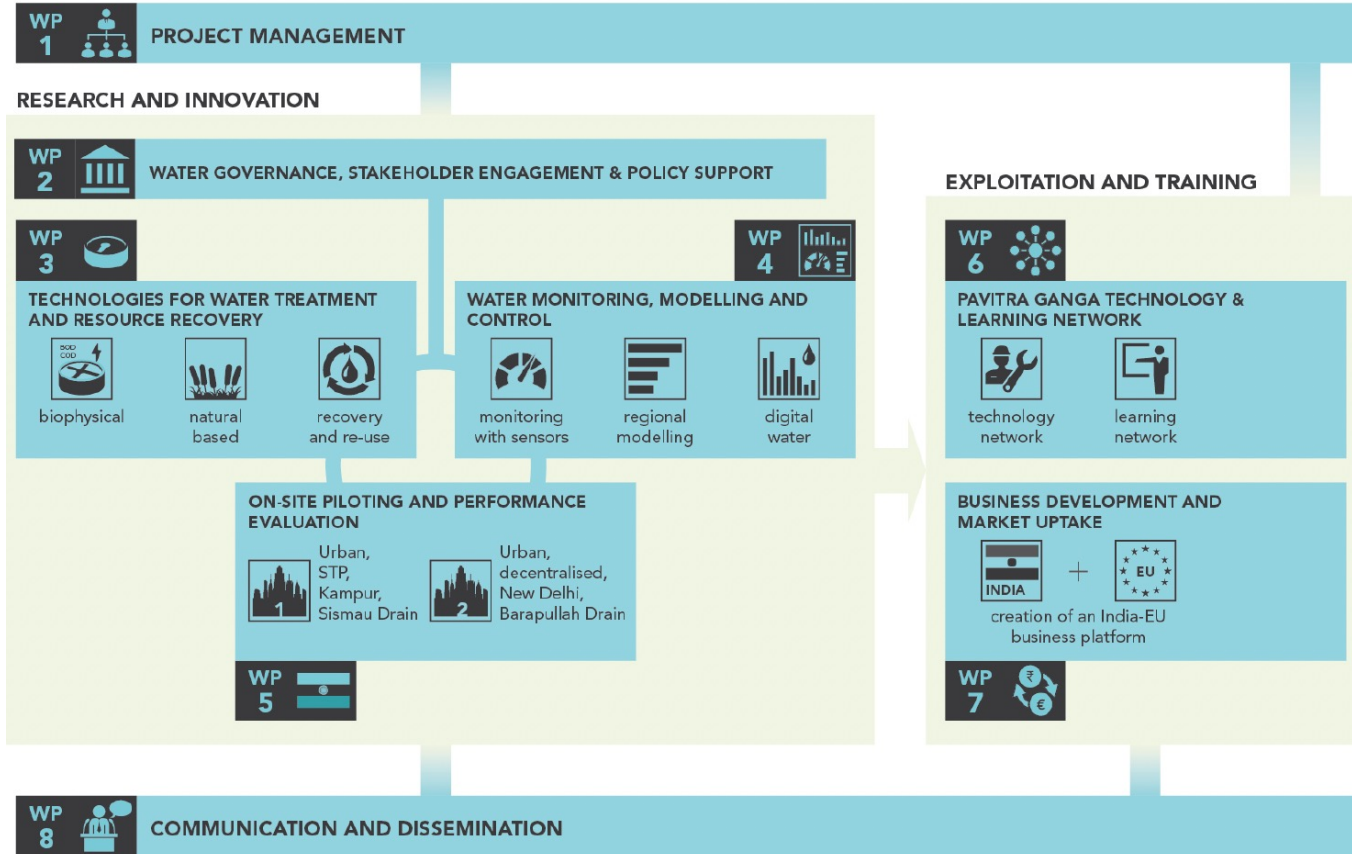


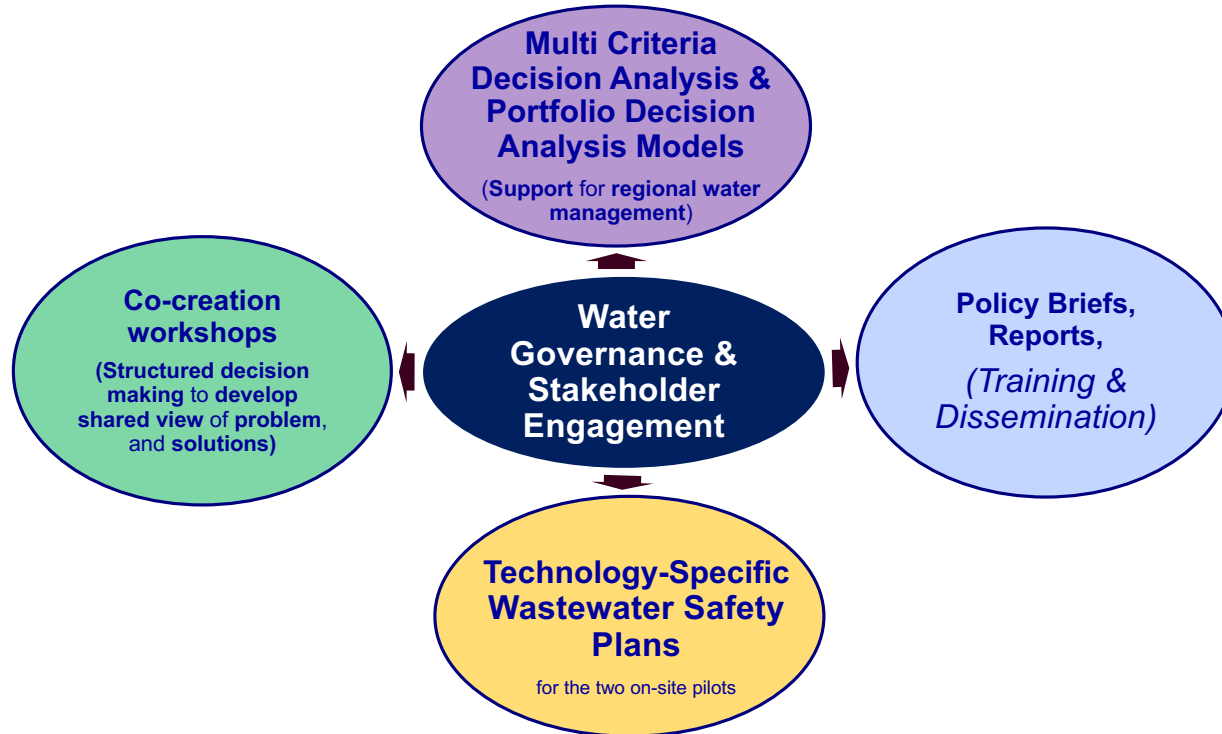
- A **research and innovation action** project funded in the H2020 EU-India Cooperation (**EC / GoI – DBT**)
- **14 project partners** from academia, research centres, industry and SMEs (**9 EU and 5 Indian partners**)
- Total budget **€ 4.11 M** (EC € 3.07 M – GoI € 1.03 M)
- **01/02/2019 – 31/01/2024**
- [www.pavitra-ganga.eu](http://www.pavitra-ganga.eu)



# The PAVITRA GANGA Consortium







Analyse water governance systems

Co-creation Workshops

MCDA and portfolio analysis

Wastewater safety plans

- **Stakeholder workshops** (N. Delhi & Kanpur)
- Assessed cases & **Identified barriers and factors for good governance.**
- **Policy Brief**
- Stakeholder analysis; engagements.
- **Co-creation workshops done** 1- (Problem structuring), 2- (WW management alternatives), 3- (Portfolio outcomes)
- **Project Brief/Fact Sheets** (on WW management in two pilot sites)
- MCDA & portfolio models, and performance assessment of technologies
- **MCDA & Portfolio Models**
- Development of **wastewater safety planning**
- **Citizen Science** and **capacity building: WQ monitoring and testing**

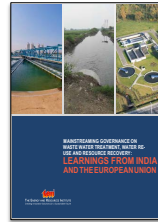
## Stakeholder Consultation Workshops



New Delhi (Feb'20)



Kanpur (March'20)



Policy Brief



Fact Sheet

### Delhi Co-Creation Workshop



### Kanpur Co-Creation Workshop



MCDA Model



WW Safety Plan



Publications



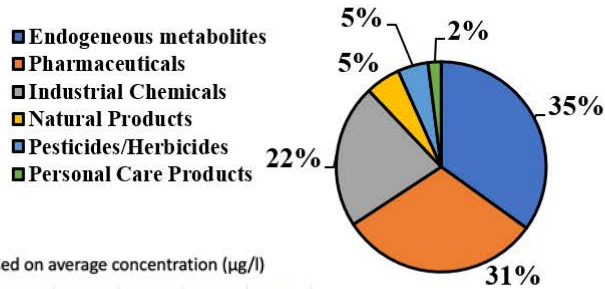
## For 2 Pavitra Ganga test sites: Delhi and Kanpur



- **WWSP** adapted and successfully applied
- **PG technologies** minimize health risks for farmers and operators
- **Citizen Science**



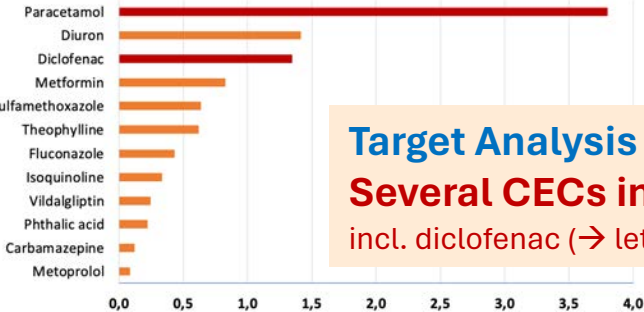
## Non-targeted Screening > 140 CECs detected



Ranked compounds based on average concentration (µg/l)

### Target Analysis

Several CECs in µg/L range!  
incl. diclofenac (→ lethal for vultures)

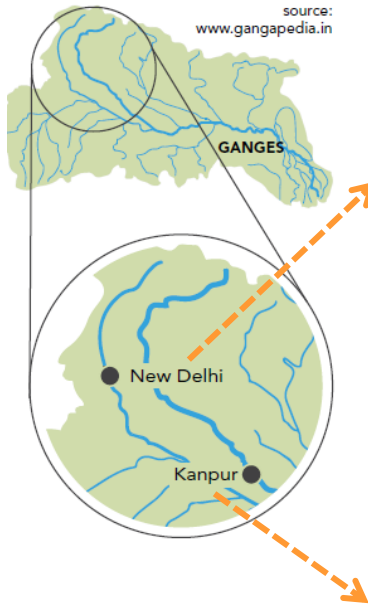


## PFAS detected across the whole water cycle mainly 2<sup>nd</sup> Generation compounds

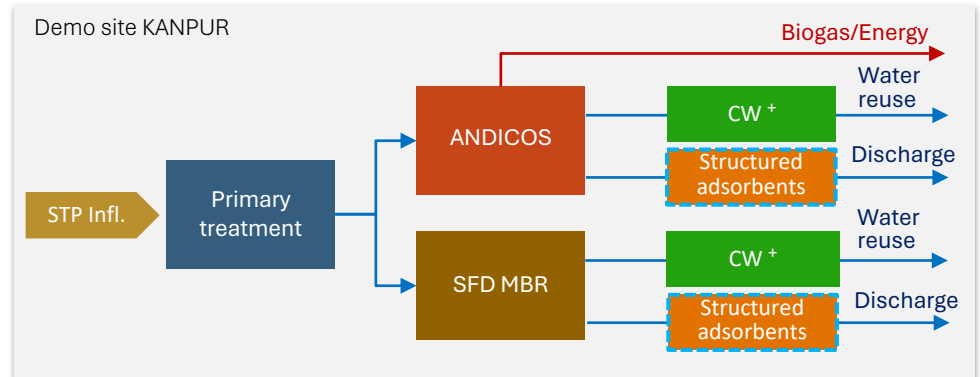
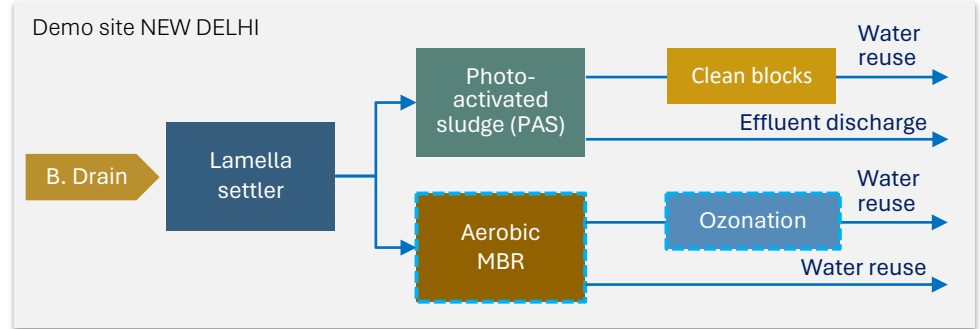
| Sampling event | Total PFASs ng/L | EFSA PFAS ng/L | T-PFHxS ng/L | PFOA ng/L | PFNA ng/L | PFOS ng/L | 6:2FTS ng/L | 8:2FTS ng/L |
|----------------|------------------|----------------|--------------|-----------|-----------|-----------|-------------|-------------|
| 06/03/2023     | 40               | 14             |              | 3,2       | 11        |           | <20         | <2          |
| 20/11/2023     | 3,7              | < 2            | <2           | <2        |           | <50       | NA          | <2          |
| 06/03/2023     | 166              | 31             |              | 8,6       | 22        |           | 100         | 2,1         |
| 20/11/2023     | 11               | < 2            | <2           | <2        |           | <40       | NA          | <2          |
| 2022           | 13               | 5,2            | < 2          | < 2       |           | < 2       | < 2         | < 2         |
| 20/11/2023     | 132              | 12             | 10           | 2,6       |           | <40       | NA          | 95          |
| 2022           | 400              | 4              |              | 4         |           | < 2       | 59          | 330         |
| 06/03/2023     | 257              | 17             |              | 6,6       | 10        |           | 120         | 100         |
| 2022           | 275              | 3,5            |              | 3,5       |           | < 2       | 49          | 220         |
| 20/11/2023     | 12               | 2,6            | <2           | 2,6       |           | <40       | NA          | <2          |
| 2022           | 6                | < 2            | < 2          | < 2       |           | < 2       | 2,5         | < 2         |
| 20/11/2023     | 32               | 0              | <2           | <2        |           | <40       | NA          | 24          |
| 2022           | 11               | 5,1            | <2           | <2        |           | 5,1       | <2          | <2          |
| 20/11/2023     | 83               | 0              | <2           | <2        |           | <40       | NA          | 48          |
| 2022           | 16               | 6,4            | < 2          | < 2       |           | 6,4       | < 2         | < 2         |

In cooperation with PERISCOPE (a Flemish - Indian Research Project)





STP Jajmau 130 MLD



KANPUR



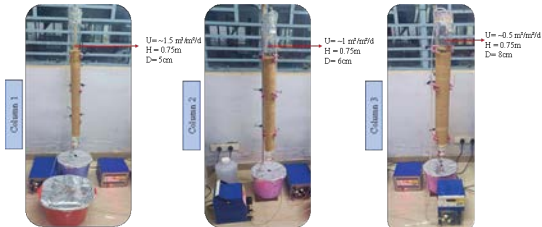
ANDICOS



Constructed Wetlands +



Self Forming Dynamic-MBR



Structured Adsorbents

NEW DELHI



PAS



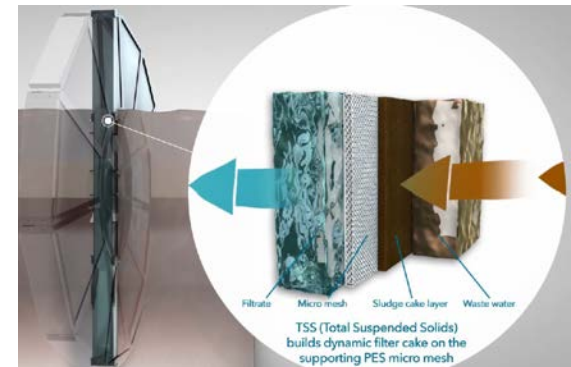
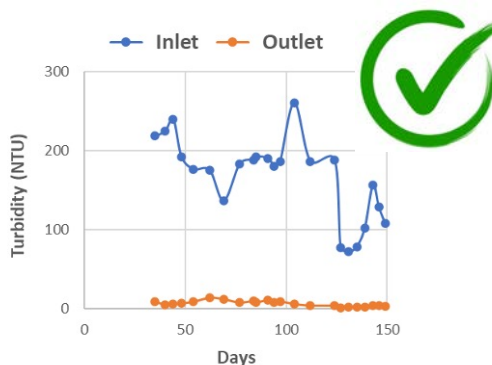
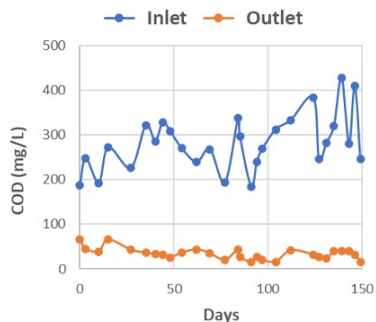
Clean Blocks



Aqua Track + Ozonation

## SFD-MBR demonstrated in Kanpur

- MBR-like behaviour by **filtration thru cake layer**
  - **10% of energy consumption** of conventional MBR
  - **Lower pressure gradient** compared to conventional MBR, suitable to gravity-driven operation
  - **Very low turbidity** effluent suitable for direct UV disinfection
- **Filtrate quality: COD < 50 mg/L | turb. < 10 NTU**

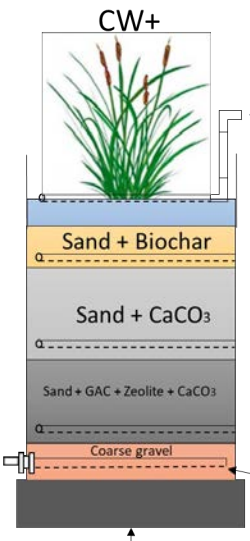




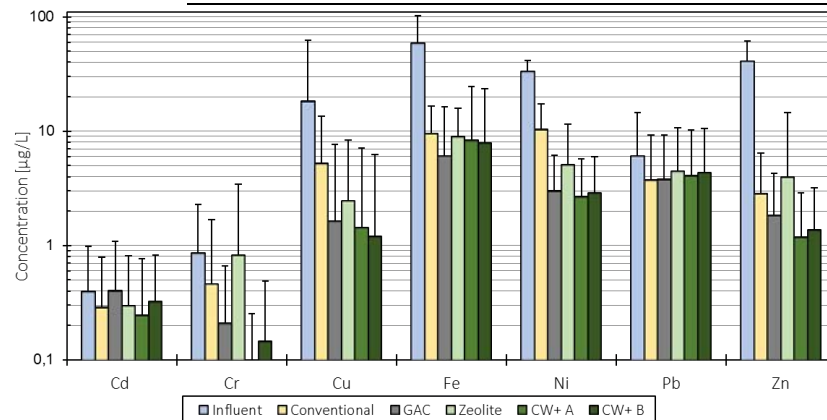
## Vertical flow pilot wetlands in EU & India

- Conventional substrate plus...
  - **Modifications in several layers**
  - **Zeolite**
  - for advanced heavy metal removal
  - **Granular activated carbon**
  - for CEC removal

- **Removal of target pollutants (CEC incl. PFAS) to below Limit of Detection**
- **Excellent removal of HMs**
- **Very stable operation**



| Compound              | LOQ [ng/L] | STP Effluent [ng/L] | Conventional | GAC   | Zeolite | CW+ A | CW+ B |
|-----------------------|------------|---------------------|--------------|-------|---------|-------|-------|
| 1H-Benzotriazole      | 30         | 308 ± 98            | -4%          | > 89% | 88%     | > 89% | > 89% |
| Candesartan           | 30         | 1245 ± 265          | -16%         | > 97% | 80%     | > 97% | > 97% |
| Carbamazepine         | 30         | 163 ± 36            | -19%         | > 80% | > 80%   | > 80% | > 80% |
| Clarithromycin        | 30         | 101 ± 60            | 52%          | > 53% | > 53%   | > 53% | > 53% |
| Diclofenac            | 10         | 1,095 ± 281         | -40%         | > 99% | 93%     | > 99% | > 99% |
| ∑ Methylbenzotriazole | 250        | 420 ± 250           | > 40%        | > 40% | > 40%   | > 40% | > 40% |
| Metoprolol            | 30         | 775 ± 207           | 84%          | > 96% | > 96%   | > 96% | > 96% |
| Sulfamethoxazole      | 30         | 223 ± 132           | 18%          | > 80% | 65%     | > 80% | > 80% |
| Amisulpride           | 30         | 42 ± 9              | 16%          | > 19% | > 19%   | > 19% | > 19% |
| Citalopram            | 30         | 35 ± 4              | > 12%        | > 12% | > 12%   | > 12% | > 12% |
| Venlafaxine           | 30         | 110 ± 16            | 18%          | > 72% | > 72%   | > 72% | > 72% |
| Irbesartan            | 30         | 135 ± 49            | 1%           | > 74% | > 74%   | > 74% | > 74% |
| Hydrochlorothiazide   | 30         | 145 ± 41            | -22%         | > 77% | > 77%   | > 77% | > 77% |
| PFBA                  | 10         | 16 ± 3              | -31%         | > 97% | -51%    | > 97% | > 97% |
| PFOA                  | 0.2        | 11 ± 1.4            | 20%          | > 98% | 56%     | > 98% | > 98% |
| PFBS                  | 1          | 9 ± 2               | -30%         | > 91% | -34%    | > 91% | > 91% |
| PFOS                  | 0.2        | 5 ± 1               | 64%          | > 96% | 89%     | > 96% | > 96% |



## Outcomes: **Several issues encountered!**

- **Good performance of IPC membranes** for direct sewage filtration
- Critical air pollution led to rapid corrosion of electrical and mechanical units
- Potential of **biogas production reduced** → negative impact on Andicos business model
  - Changed organic content of sewage
  - Loss of organics in membrane tank → optimized tank design
  - Mixing concentrated sewage with food waste **unsuitable** due to reluctance to mix fecal and non-fecal wastes → using septic waste instead



## Why is Andicos still relevant for India?

- Converting organics from sewage and solid waste into biogas → **Green Energy and GHGe reduction**
- Modular set up means that it's flexible for **new decentralized solutions**
- **Permeate from IPC Filtration is a safe wastewater for non potable reuse.**

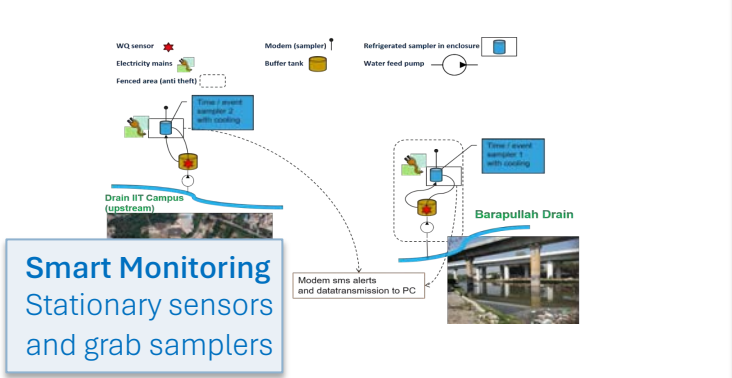


**Modelling**  
Regional water  
balance scenarios

**Citizen  
based  
monitoring**



**AQUA-track**



## Dashboard

**DASHBOARD**

**New Delhi water quality**

**Groundwater monitoring approach**

**Goal**

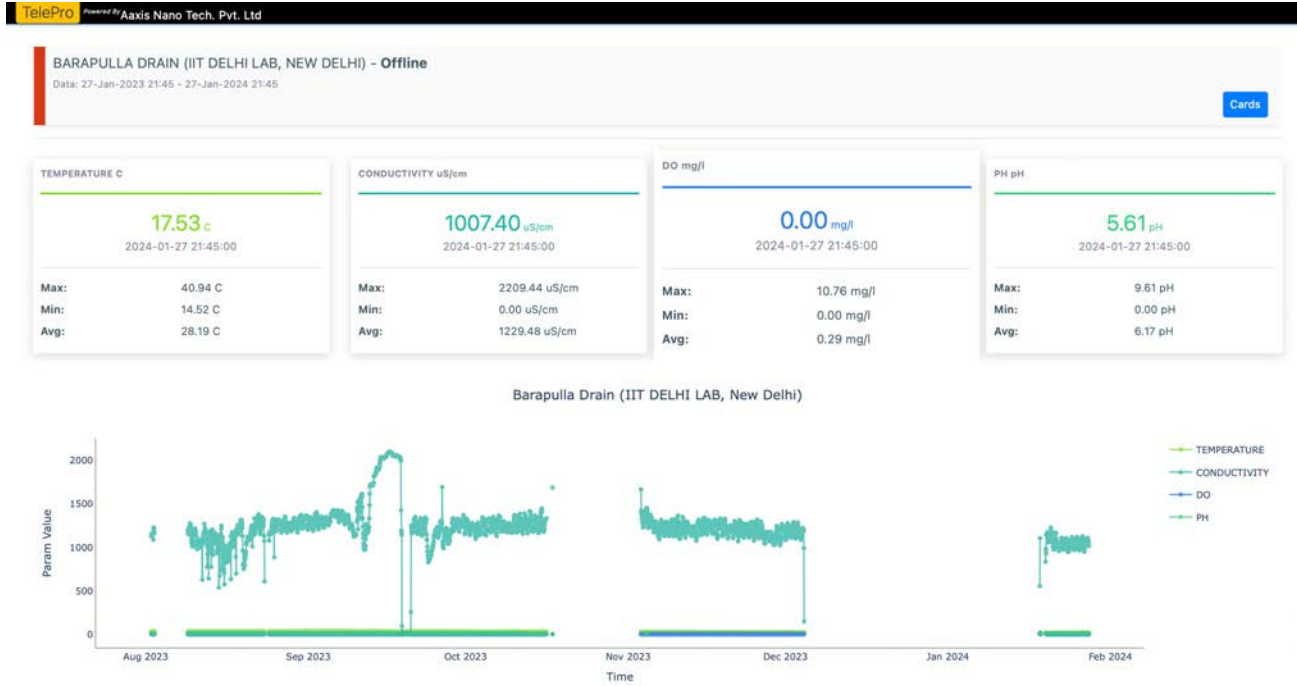
Generate information using Akvo Caddisfly as a mobile water quality monitoring tool to assess ambient water quality along with contextual information on water resource use. Flagging up potential water quality issues in the project location along the Barapullah Drain.

**Approach**

- Water quality screening tool, Akvo Caddisfly, using hand-held sensors to measure ambient water quality parameters;
- Scope of monitoring campaign is the screening of the ambient water quality of groundwater sources such as borewells, handpumps, submersible pumps, wells;
- Focus is to facilitate the capacity building of local NGOs (e.g. Solidarity) to test water quality and understand local water challenges;
- Demonstrate an easy-to-use portable water quality monitoring tool, with simplified design and user support, to enable individuals (from Solidarity) without extensive scientific backgrounds and technical knowledge to monitor and assess the quality of their local water resources effectively;
- Surveying with Caddisfly offers an opportunity to engage with the community to select sampling points, and share observations about quality, quantity and usage of water sources;
- Monitoring was conducted in two periods in 2023: pre and post monsoon. All the groundwater sources were mapped and monitored regularly status Electrical Conductivity, pH and

← BACK TO OVERVIEW







## Six workshops in Pavitra Ganga

Smart Water  
Management

1. Water management **decision support systems**
2. **Benchmarking** water quality and quantity and use of mobile monitoring solutions

Water  
Governance

3. **Safety planning** for wastewater reuse
4. **Multi-criteria Decision (MCD)** models to support regional water management

Wastewater  
treatment &  
resource  
recovery

5. **Innovative technologies** for wastewater treatment and reuse/recovery

Wastewater  
treatment &  
resource  
recovery

Water  
Governance

Smart Water  
Management

6. **Indian wastewater: challenges and solutions**





**BENCHMARKING WATER QUALITY AND QUANTITY AND USE OF MOBILE MONITORING SOLUTIONS**

A workshop on Akvo's data collection and monitoring tool will be given, which includes geo-tagged data collection, mobile monitoring solutions (low cost sensors, 1 smart phone) and a network of stationary real-time monitoring sensors, can quickly and accurately map situations and track changes.



**DECISION ANALYSIS PROCESSES TO SUPPORT WASTEWATER MANAGEMENT**

This course deals with processes to facilitate multi-criteria problem structuring and multi-criteria decision analysis for the development and appraisal of options to jointly address shared problems.



**WATER MANAGEMENT DECISION SUPPORT SYSTEMS**

The use and application of Senseviewd, a web-based water quality and water quantity dashboard (GIS viewer and time-series analysis) will be presented in a workshop to provide operational dashboards for water quality alerts and control protocols.



**INNOVATIVE TECHNOLOGIES FOR WASTEWATER TREATMENT AND REUSE/RECOVERY**

The innovative technologies can be used in stand-alone STP, or to upgrade existing STPs, with a focus on energy/water, heavy metal recovery. It will cover the different



**INDIAN WASTEWATER: CHALLENGES AND SOLUTIONS**

In this workshop we will create awareness among EU stakeholders (research, government and private) of the main



**MINIMIZING OCCUPATIONAL RISKS IN WASTEWATER TREATMENT: THE ROLE OF TECHNOLOGY-BASED WASTEWATER SAFETY PLANNING**

## Registration for Pavitra Ganga Open Course Network

<https://pavitra-ganga.eu/en/registration-pavitra-ganga-open-course-network>

To be launched soon!

- Active social media channels:  
X (Twitter), LinkedIn, YouTube
- 6 Newsletters
- **Final Conference in Jan 24 in New Delhi**
- Frequently updated website
- Scientific peer-reviewed journal publications still ongoing
- 2 + 3 PhDs theses to be completed ca. 2025
- **7 contributions to IWA Reuse 23 in Chennai**



## FINAL CONFERENCE

Wastewater treatment and reuse:  
challenges and solutions in India



24<sup>th</sup> January 2024  
India Habitat Centre  
New Delhi

**Anshuman**  
Director, Water Resources  
The Energy and Resources Institute (TERI)



# Key Policy Messages



MAINSTREAMING GOVERNANCE ON  
WASTE WATER TREATMENT, WATER RE-  
USE AND RESOURCE RECOVERY:  
**LEARNINGS FROM INDIA  
AND THE EUROPEAN UNION**



*Mainstreaming Governance on  
Wastewater treatment, water  
reuse and Resource Recovery:  
Learnings from India and the EU*

- **Need for target-based regulations, defined national reuse standards** for treated wastewater and sewage sludge and **effective enforcement strategy**. (More **updated WW discharge norms including ECs**. **Monitoring** them as first step!)
- **Policy and guiding frameworks** need to **establish detailed guidance** on wastewater and sewage sludge treatment and **reuse technologies (fit-for purpose treatment)**.
- **Need of effective financing mechanisms** (funds, taxes, tariffs) that permit **sufficient cost- recovery** for long-term **operation and maintenance** of wastewater and sewage sludge treatment infrastructure.
- **Appropriate pricing of treated WW (TUU)** aiming recovery of all including **additional O&M costs for intended reuse WWQ** as well **full cost recovery** for TUU treated domestic sewage.



# Key Policy Messages



- **Treated WW need to be priced lower than the existing freshwater** and therefore **rational pricing of freshwater/drinking water** as well is **critical to success of WW reuse policy**. Differential pricing (**IBT**) to be practiced
- **Incentives/Disincentives Mechanisms**: rebates on GST, exemption in custom duty etc.
- **Enhanced government support and investments into research and development** for innovative technologies for wastewater treatment and **RRR. National Funding Mechanism** for financing WW reuse projects (AMRUT, etc.)
- **State Governments** must provide **policies / laws** for wastewater management and **reuse**.
- A **robust implementation framework** involving **last mile connectivity of solutions** will help in better **upscaling** and **optimization**.
- **Strengthening of institutional & monitoring capacity**. **Engagement** of key **stakeholders in policy formulations** and **implementation**. **Community mobilization, awareness and capacity building** important for **collaborative action**.

# Thank you for your attention !



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Photo: Lindner / Pixabay



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