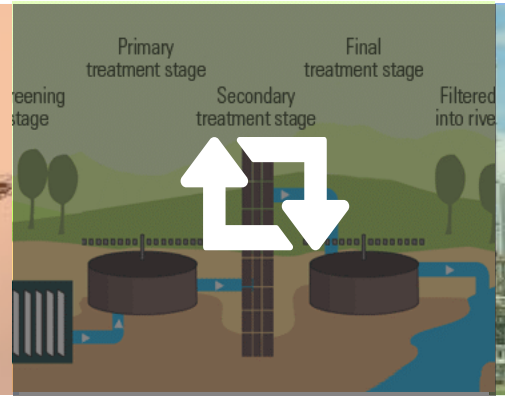
Water Technology Centre

SUTRAM for EASY WATER

Sustainable **T**reatment, **R**euse **a**nd **M**anagement for
Efficient, **A**ffordable and **Sy**nergistic Solutions for
Water

Surface water runoff

Water Purification

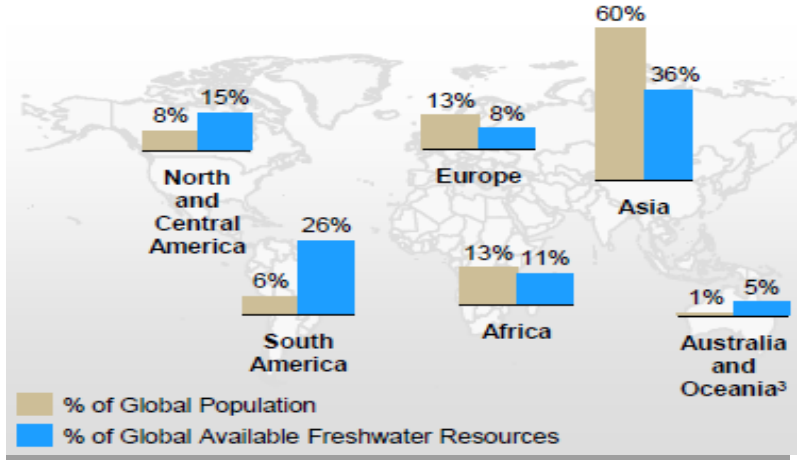


Wastewater treatment

Industrial water

Principal Investigators - Ligy Philip & T. Pradeep

Lead institute - IIT Madras



Fresh water constitutes 2.5 % of the total water on the earth. Half of the fresh water reserves support 86 % of the population

Introduction

Water is a precious resource

Water scarcity is one of the main problems faced by most of the countries

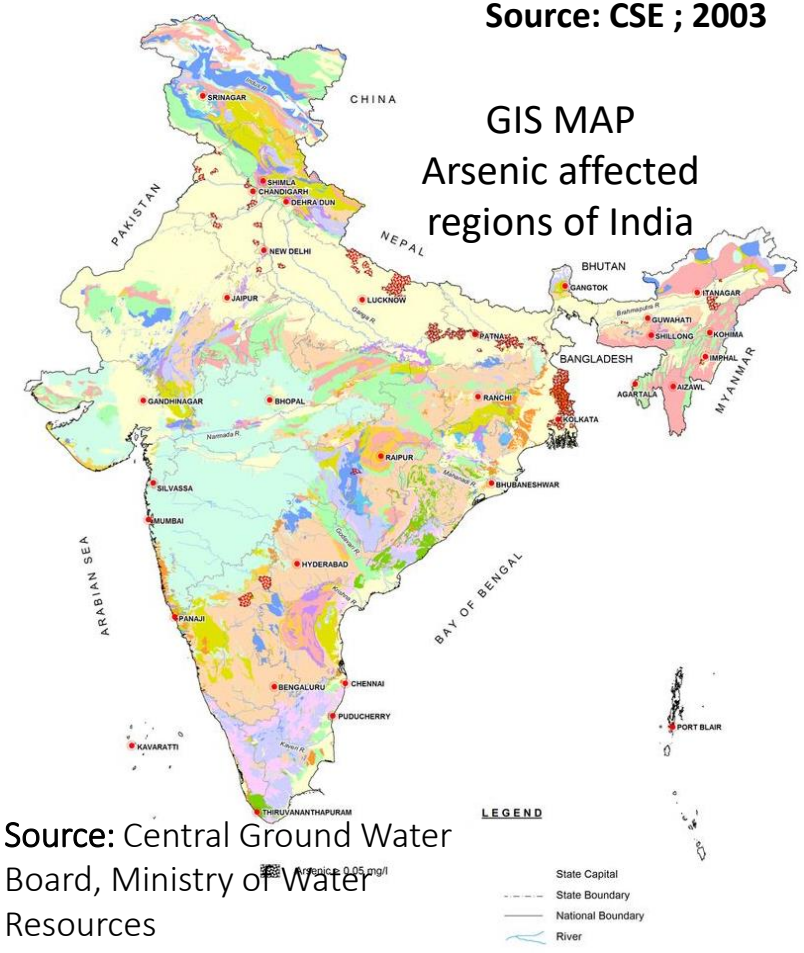
Water resources are contaminated: indiscriminate discharge of wastewater from domestic & industrial sectors

Ground water contamination by pollutants of natural and anthropogenic origin

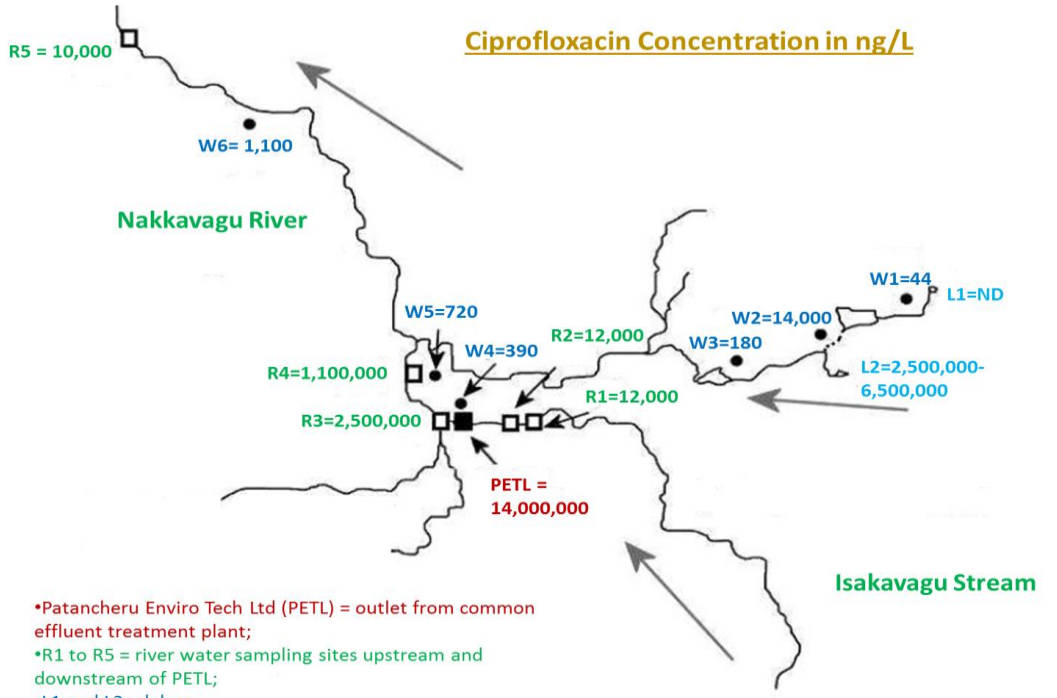
ECs like personnel care products, pharma, pesticides & other complex chemicals: Partially treated / untreated wastewater.

Source: CSE ; 2003

GIS MAP
Arsenic affected regions of India



Source: Central Ground Water Board, Ministry of Water Resources



Source: Arya et.al, IITM

Fluoride

- ~28,000 habitations across 18 states are affected by fluorosis

Arsenic

- ~10,000 habitations are routinely exposed to arsenic

Ref: Format E29- Contaminated habitations, National Rural Drinking Water Program, Ministry of drinking water and sanitation

** Data Shown here is as per laboratory testing results entry done on regular basis hence may change*

Rural and peri-urban India: Unprotected surface or groundwater for drinking purpose. Most of these sources are contaminated by multiple pollutants

There is significant loss of water in distribution systems.

Flood and drought frequencies are increasing due to the climate change effects. Appropriate management strategies for storm water to augment water sources are lacking.

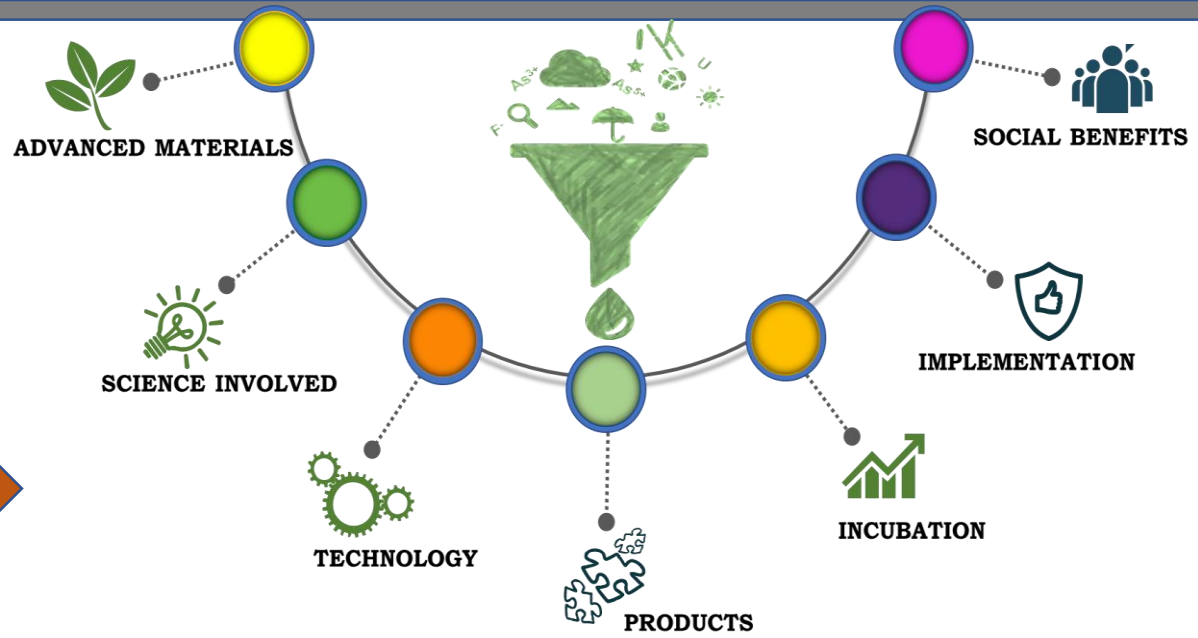
Water intensive industries like textile and tanneries : problems with respect to water availability and treatment of complex wastewaters

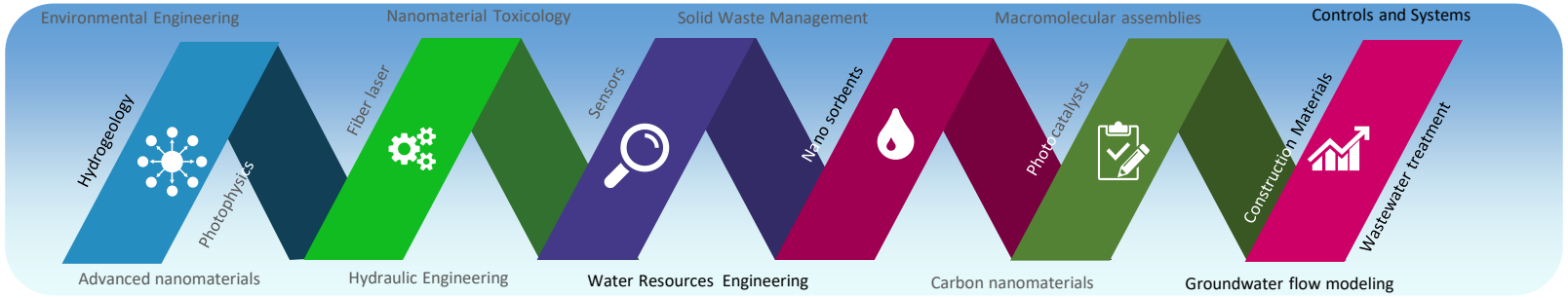
Hydrogeology of the location plays an important role

There is an urgent need for sustainable management of the water resources to provide adequate quantity of good quality water for all

Introduction

Project Expertise





SUTRAM for EASY WATER

@ IIT MADRAS

01 IIT MADRAS

02 IITR LUCKNOW

03 ANNA UNIVERSITY

04 VIT CHENNAI

05 CLRI CHENNAI

06 IIT TIRUPATHI

07 IISER BHOPAL

08 KUMAUN, UTTARAKHAND

09 PRIST UNIVERSITY, TANJORE

10 INDUSTRIAL PARTNERS

Aims and Objectives

Aims

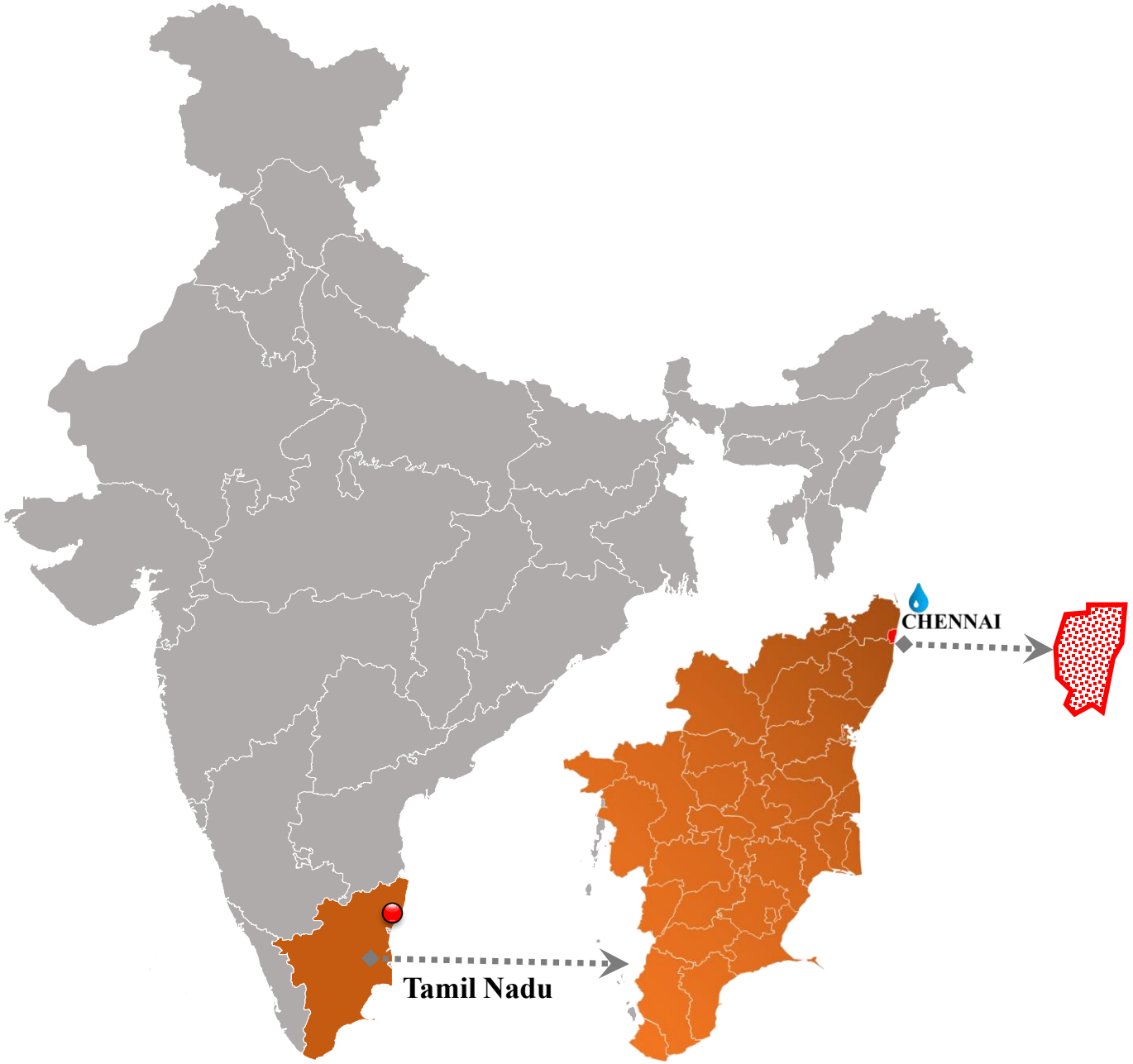
- The overall goal is to ensure adequate, safe, reliable and sustainable sources of drinking water for rural and urban India.
- Process water for highly polluting and water intensive industries through research, technology development and capacity building.

Objectives

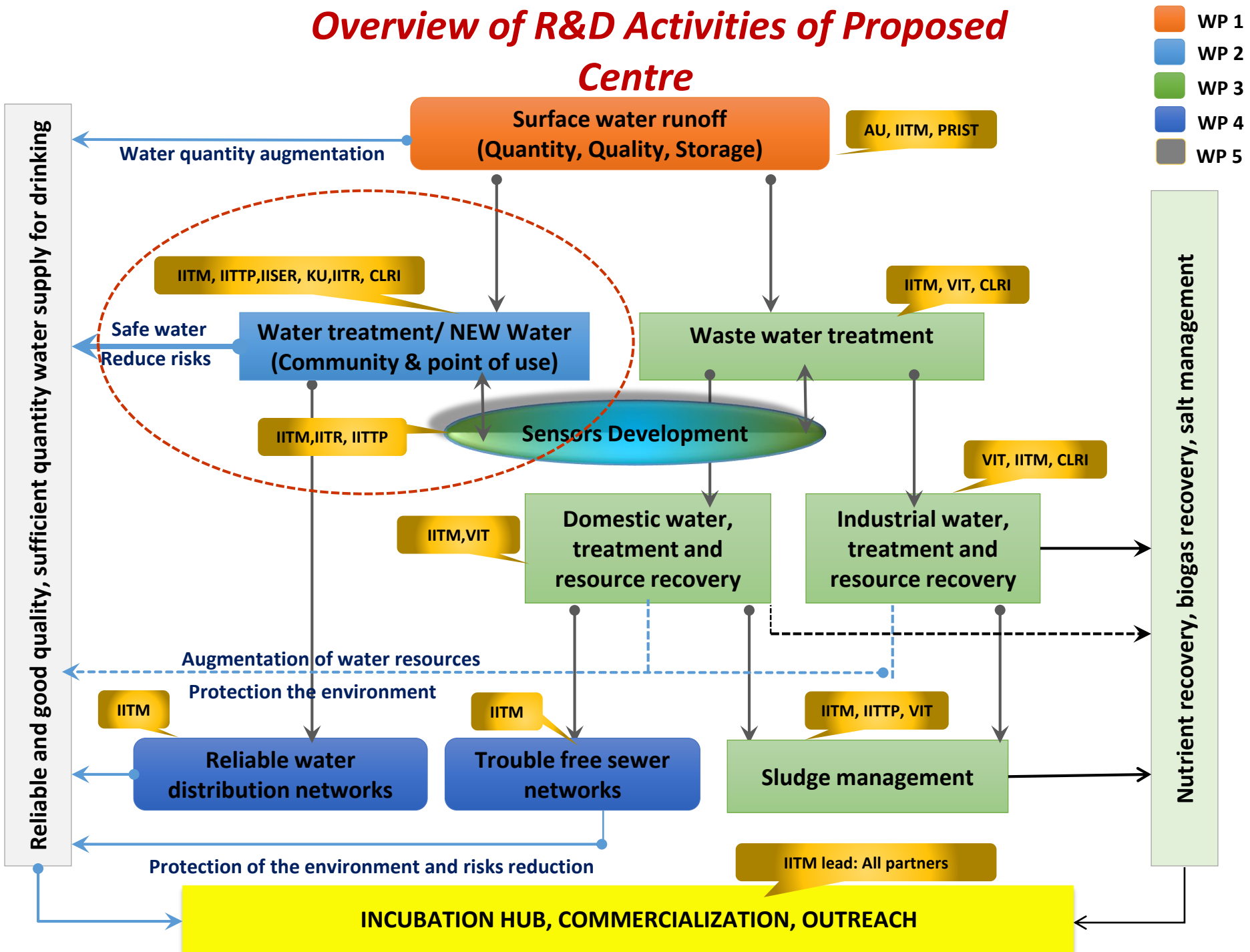
- To develop strategies and technologies for sustainable treatment, reuse and management of water.
- To translate the water technologies using the resources, mechanisms and knowledge acquired and close the innovation loop.
- To have active engagement with researchers and the innovators across the country and abroad
- Incubation and commercialization of developed technologies and products

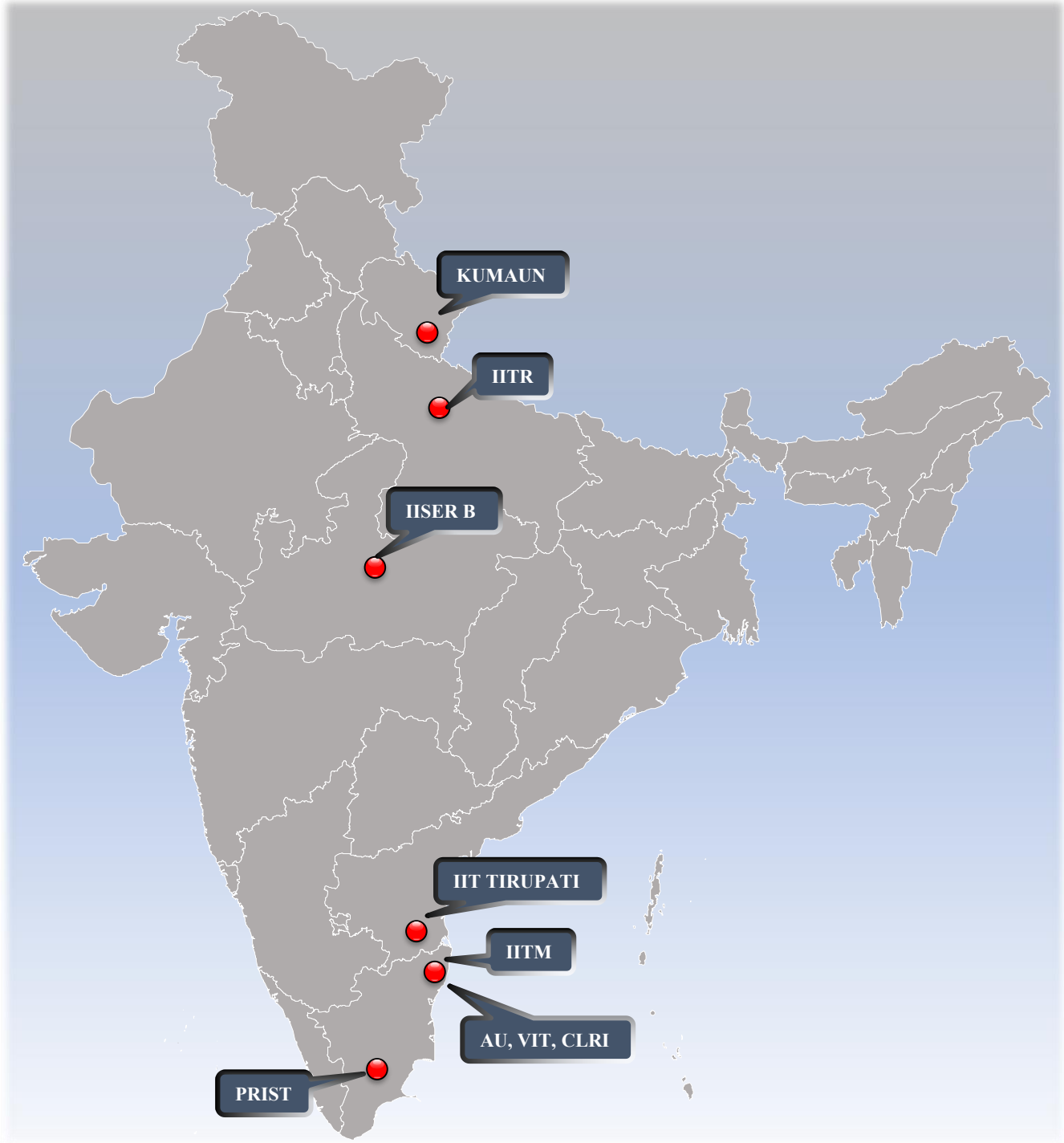
Study Area

Chennai



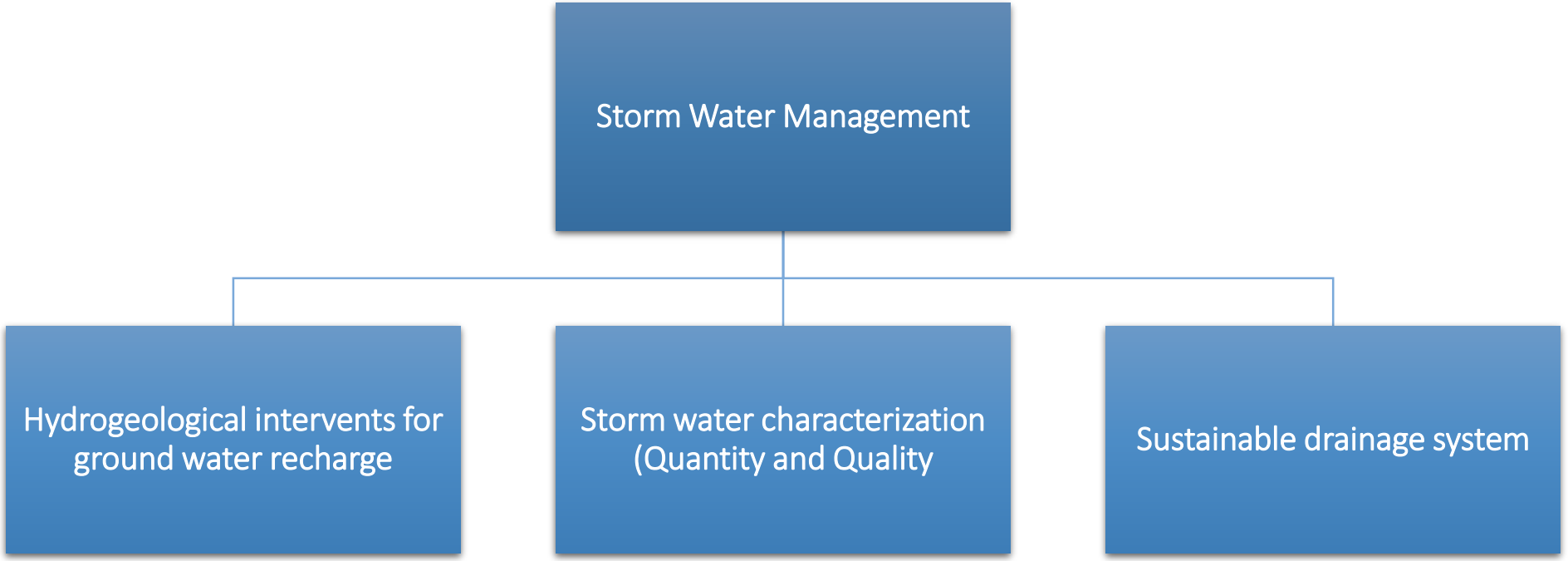
Overview of R&D Activities of Proposed Centre



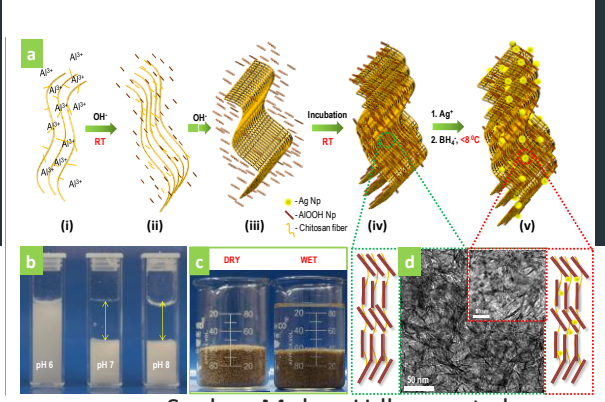

KUMAUN
IITR
IISER B
IIT TIRUPATI
IITM
AU, VIT, CLRI
PRIST

Methodology

WP – 1: Storm Water Management



WP – 2 : Water Treatment



Sankar, Mohan Udhaya, et al.
PNAS 110.21 (2013): 8459-8464

Contaminated Water

(Pathogens, Turbidity, ECs, F, As, Heavy Metals)

Low Cost, Easy to use, No power - Traditional

Advanced technologies

Nano, CDI, AOP and beyond

Evaluation of existing point of use water treatment system using local materials. Filters for various contaminants

Development of new absorbents, materials and treatment technology, new water

Field evaluation of tailor-made low cost filters in rural areas & underprivileged communities

Development of treatment systems and performance evaluation, sludge management

Sensors and kits for quality analysis

Optical, fibre, cluster, molecular

Guidelines and manuals for operation of developed systems

WP – 3: Wastewater Management

Salt management @ Tirupur, TN

Wastewater
(Pathogens, Turbidity, ECs, Nutrients)

Maximize Reuse

Abatement of Emerging Contaminants

Recovery of C,N,P, Biogas from WW

Integrated Treatment for Tannery & Textile WW

Sustainable / Socially acceptable tech for ZLD household

New Materials & Technology Development

New Technology Development

New Technology Development , Solving existing problems

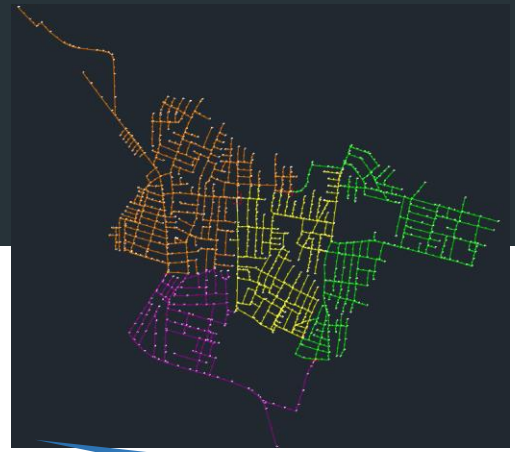
Performance Evaluation

Sludge management (Organic), Composting, Biomethanation

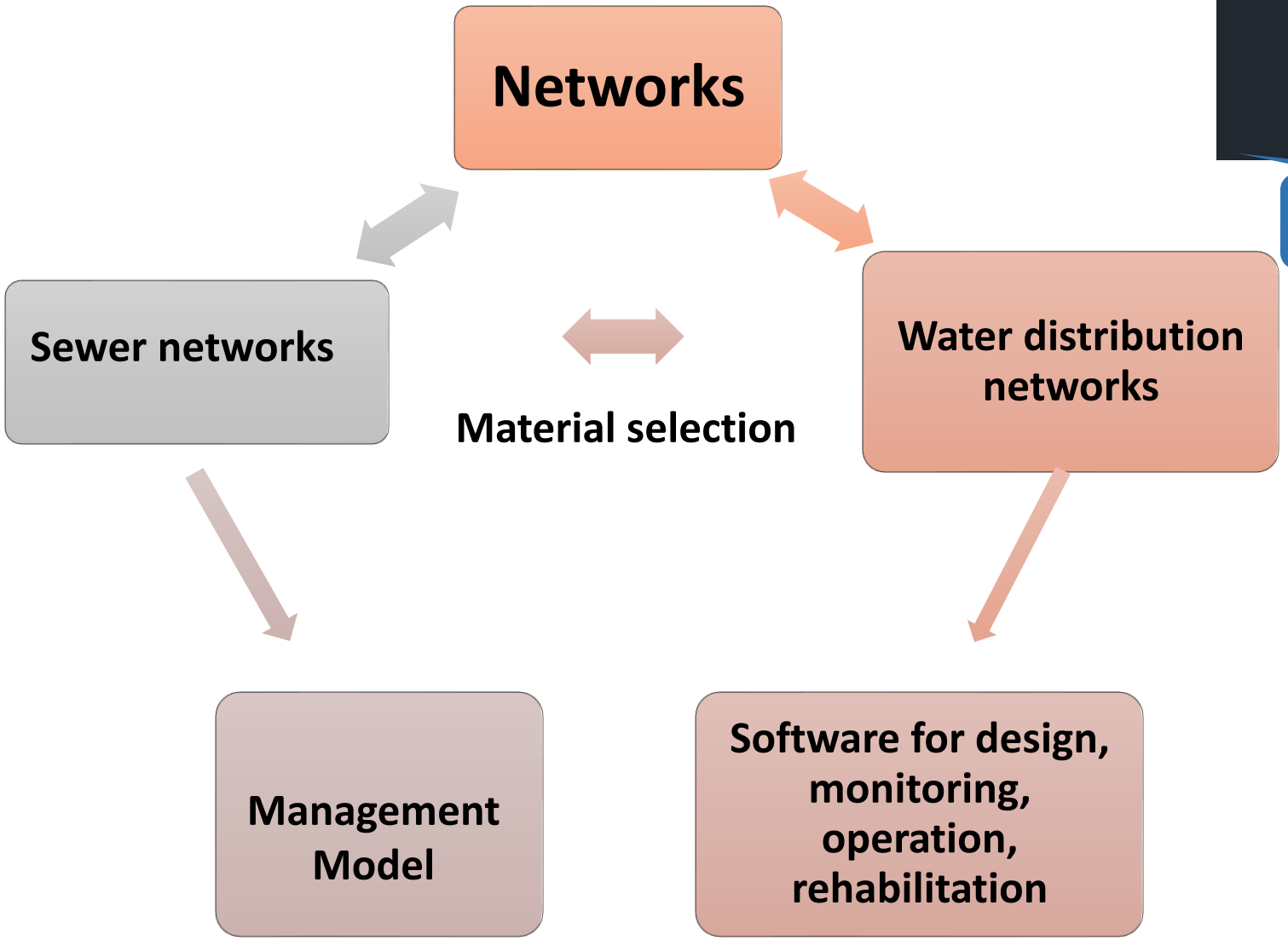
Salt management (Inorganic)

Guidelines for Design, Operation and Maintenance

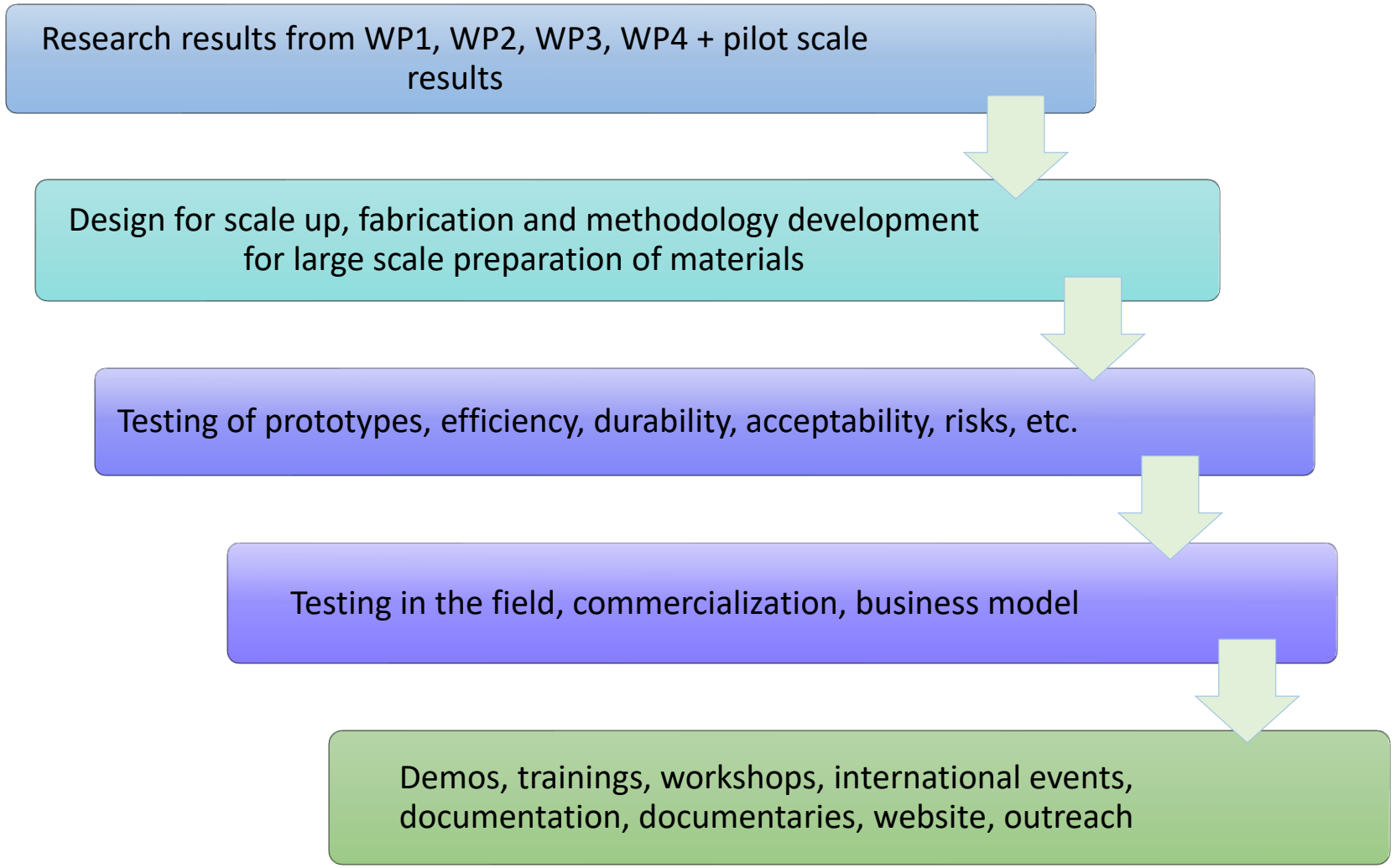
WP – 4: Collection and distribution



Pipeline map of IITM



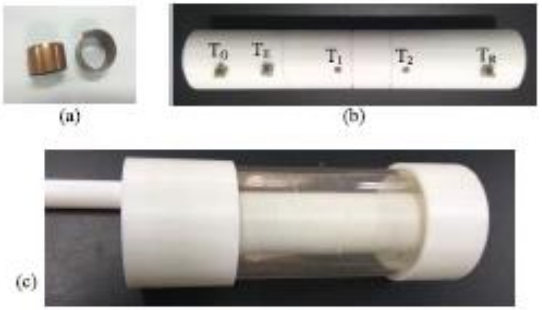
WP-5: Incubation HUB – Commercialization Outreach



Work done

- Developed a new level sensor that can measure level and conductivity of water simultaneously. A prototype has been developed and tested in the laboratory, and conducted one test in the filed. A patent is filed.
- Develop a new water quality sensor for online monitoring of recycled water. Sensor has been tested in the laboratory and in the field. Its cost is less than 5000 INR. A patent is filed along with the complete system. This work is partially funded.
- Develop a news non-contact conductivity sensor for continuous monitoring of conductivity of the liquid (water), in a pipe or in a tank or lake. Laboratory tests are conducted. There is a journal publication from this work. This work is partially funded.

Monitoring-final unit with casing



(Water-IC for SUTRAM for EASY WATER)

Prof. T. Pradeep's research group

Targeted Objectives

Activity	Achievement/Milestone	Responsible Organisation
Fluoride free drinking water	Synthesis and lab scale performance evaluation completed	IITM
Low-cost microfluidic platform for multi-analyte assessment of water quality	Optimization for the detection unit is completed	IITM
Atmospheric Water Capture	Performance evaluation towards water capture completed	IITM
CDI Prototype	Large scale preparation of carbon based materials completed	IITM
Incubation Hub	Facility Building: Continuation and completion	IITM

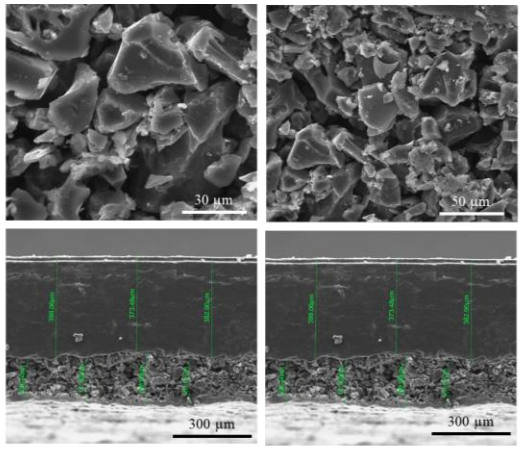
Vis-à-vis achievements in coordinated research

Milestone	Target Month	Progress
2.1.1. Synthesis and characterization of advanced materials	March, 2019	Complete
2.1.2. Lab-scale performance evaluation	May, 2019	Complete
2.5.1 Fabrication of hierarchically structured surfaces for atmospheric water capture	July, 2019	Complete
2.5.2. Performance evaluation of above surfaces for water capture	December, 2019	Complete
2.4.3.1. Optimization of microfluidic chip	June, 2019	Complete
2.4.3.2. Optimization for the detection unit	November, 2019	Complete
2.6.1. Large scale preparation of carbon based materials	December, 2019	Complete
Incubation Hub	Facility Building	Complete

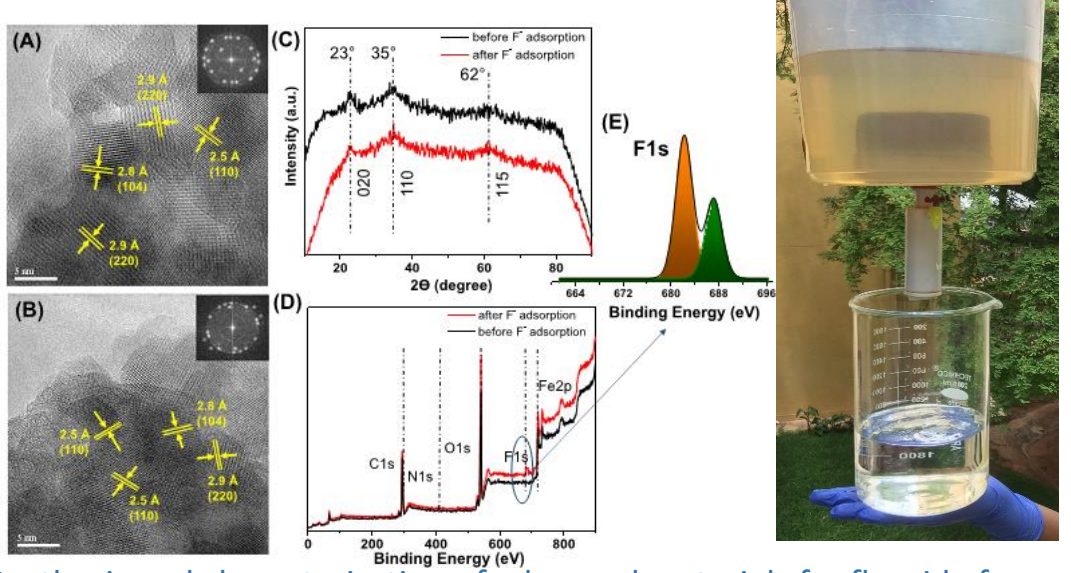
- GC-MS - Agilent
- AAS and accessories – Thermo Fisher Scientific
- **Gas cylinders – Indo gas**
- **Ion selective electrode and water analysis kit**

(Purchased and installed)

Technological outcomes



Large scale preparation of carbon based materials for CDI Prototype



Synthesis and characterization of advanced materials for fluoride free drinking water

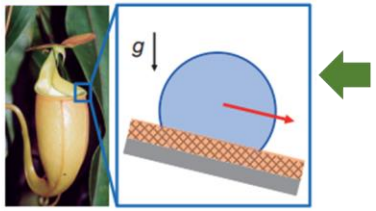
Hierarchical condensation

Beetle's bumps + Cactus spine's asymmetry = Hierarchical micro-nanostructures

Lab-scale testing

193.03 L/m²/day (23.6°C, 50% RH)

Pitcher plant-inspired molecular-level smoothness over hierarchical structures



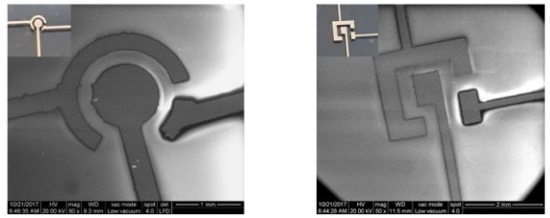
Surface type	Water Collected (L/ m²/ day)
Planar	84.00
Planar-superhydrophobic*	25.68
Hierarchical	**193.03**
Hierarchical-superhydrophobic*	49.28

*superhydrophobicity achieved by silane functionalization using dip coating

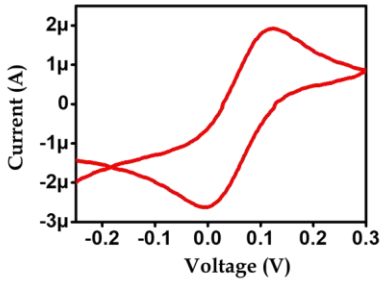
Fabrication of hierarchically structured surfaces for atmospheric water capture

Electrodes on Glass fabricated using Photolithography

Metallization Method : E-beam Deposition, Chrome Height – 5 nm, Gold Height – 75 nm



SEM of the fabricated electrodes.



Cyclic voltammetry of 2 mM ferro/ferricyanide complex using the fabricated Au electrode.

Low-cost microfluidic platform for multi-analyte assessment of water quality

Publications/Patents

Sl no.	Title of the paper	Journal, Issue, Year etc.	Authors
1	Geologically-inspired monoliths for sustainable release of essential minerals into drinking water	ACS Sustain. Chem. Eng., 7 (2019) 11735-11744 (DOI: 10.1021/acssuschemeng.9b01902)	Swathy Jakka Ravindran, Ananthu Mahendranath, Srikrishnarka Pillalamarri, Anil Kumar Avula, Md Rabiul Islam, Sritama Mukherjee, Ligy Philip, and Thalappil Pradeep
2	Nanocellulose reinforced organo-inorganic nanocomposite for synergistic and affordable defluoridation of water and an evaluation of its sustainability metrics	ACS Sustainable Chem. Eng. 2020, 8, 1, 139-147 (doi: 10.1021/acssuschemeng.9b04822)	Sritama Mukherjee, Haritha Ramireddy, Avijit Baidya, A. K. Amala, Chennu Sudhakar, Biswajit Mondal, Ligy Philip, and Thalappil Pradeep

Sl no.	Title	Inventors	Filed on	Granted on
1	A green method for preparing robust and sustainable cellulose polyaniline based nanocomposite for effective removal of fluoride from water and a purifier thereof, 201941046691	Thalappil Pradeep; Sritama Mukherjee; Haritha Ramireddy	November 15, 2019	
2	A modified surface for condensation PCT/IN2019/50078	T Pradeep, Ankit Nagar, Ramesh Kumar	February 2, 2019.	

SUTRAM for Water

WP – 1: Stormwater Management

WP -1.2 : Sustainable drainage system (SUDS) components:

Design and development Methodology

Progress Report

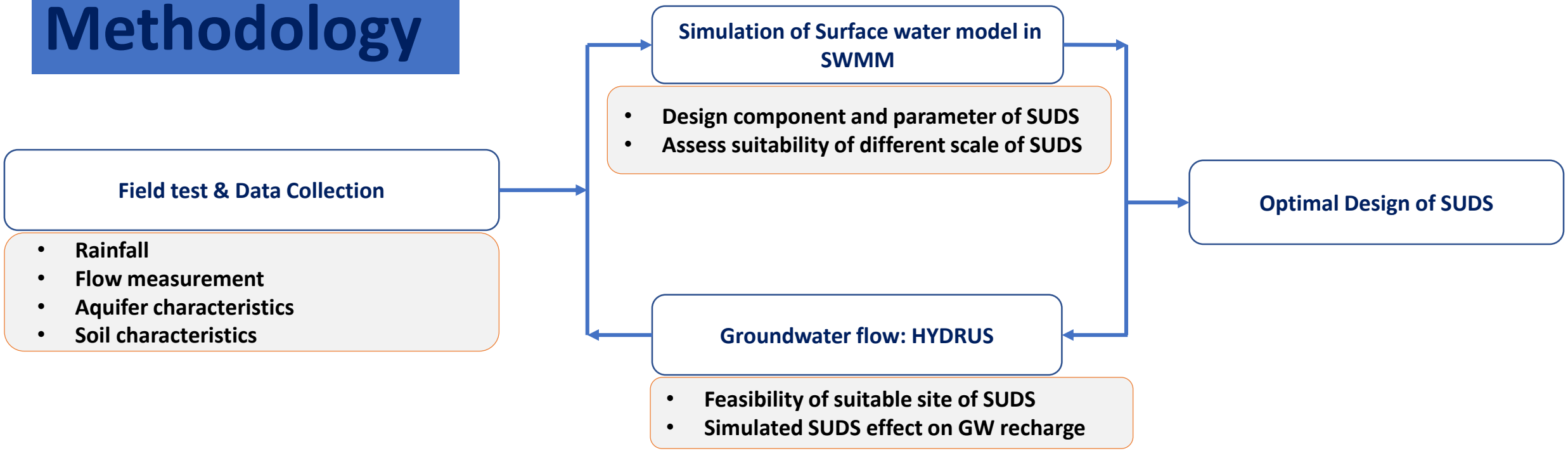
Balaji Narasimhan

B.S. Murty

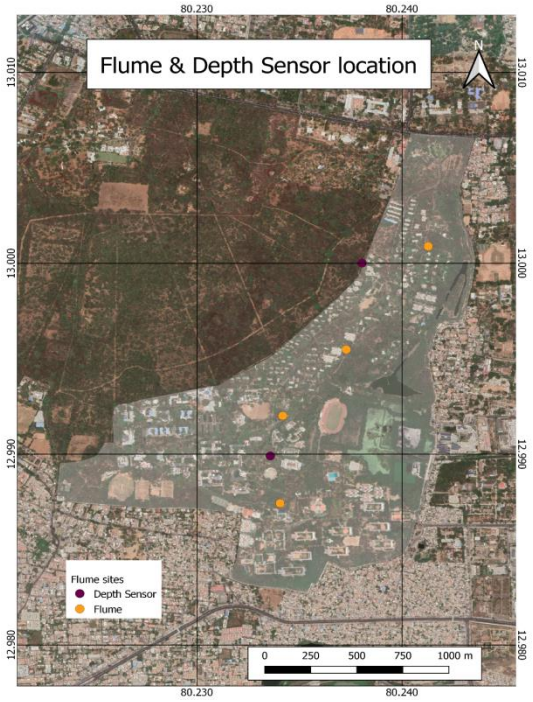
Deliverables

- Appropriate SuDS for Indian conditions, typical performance and design protocols /standards / manuals
- SuDS numerical tool box: For planning & Designing
- Experimental observatory of various SuDS

Methodology

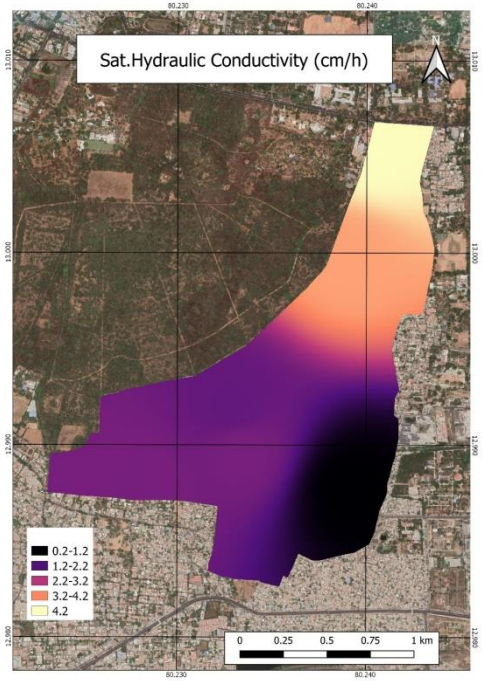


Flow Measurement

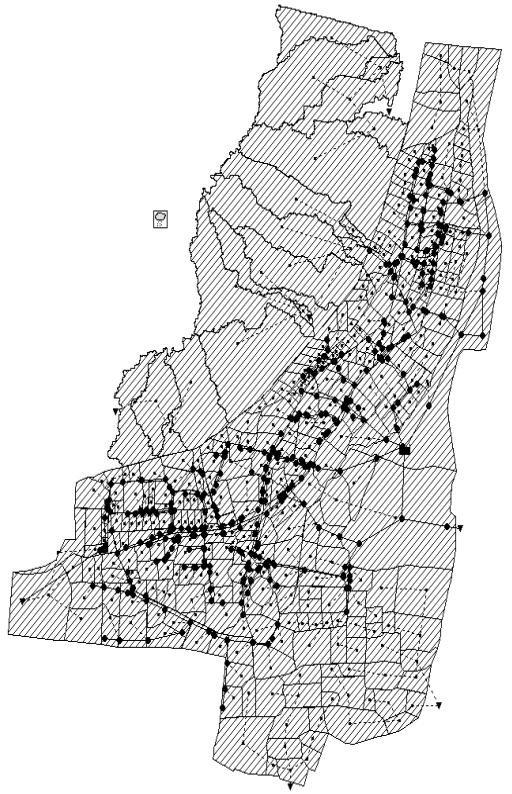


Groundwater level

Field Experiment

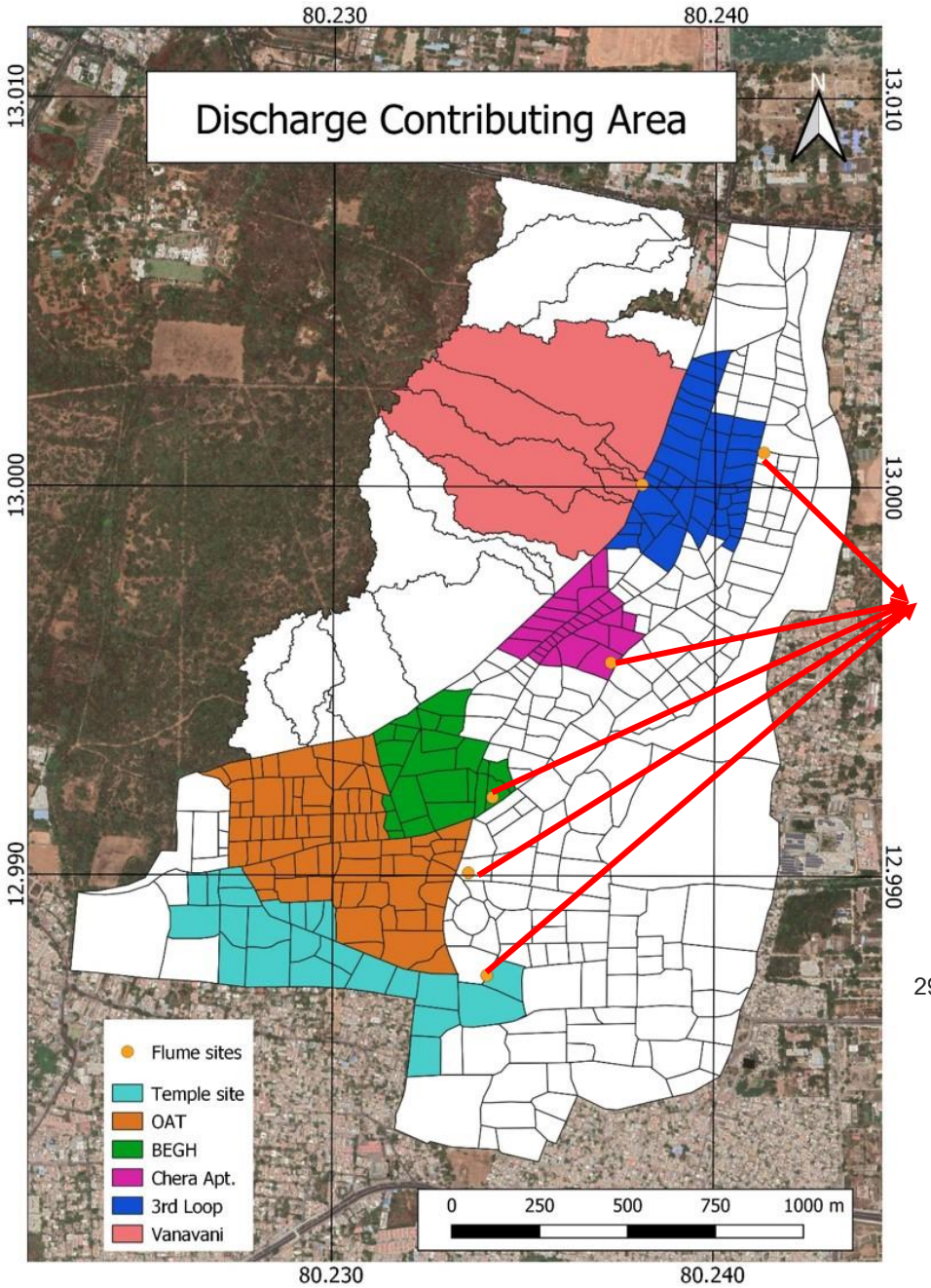


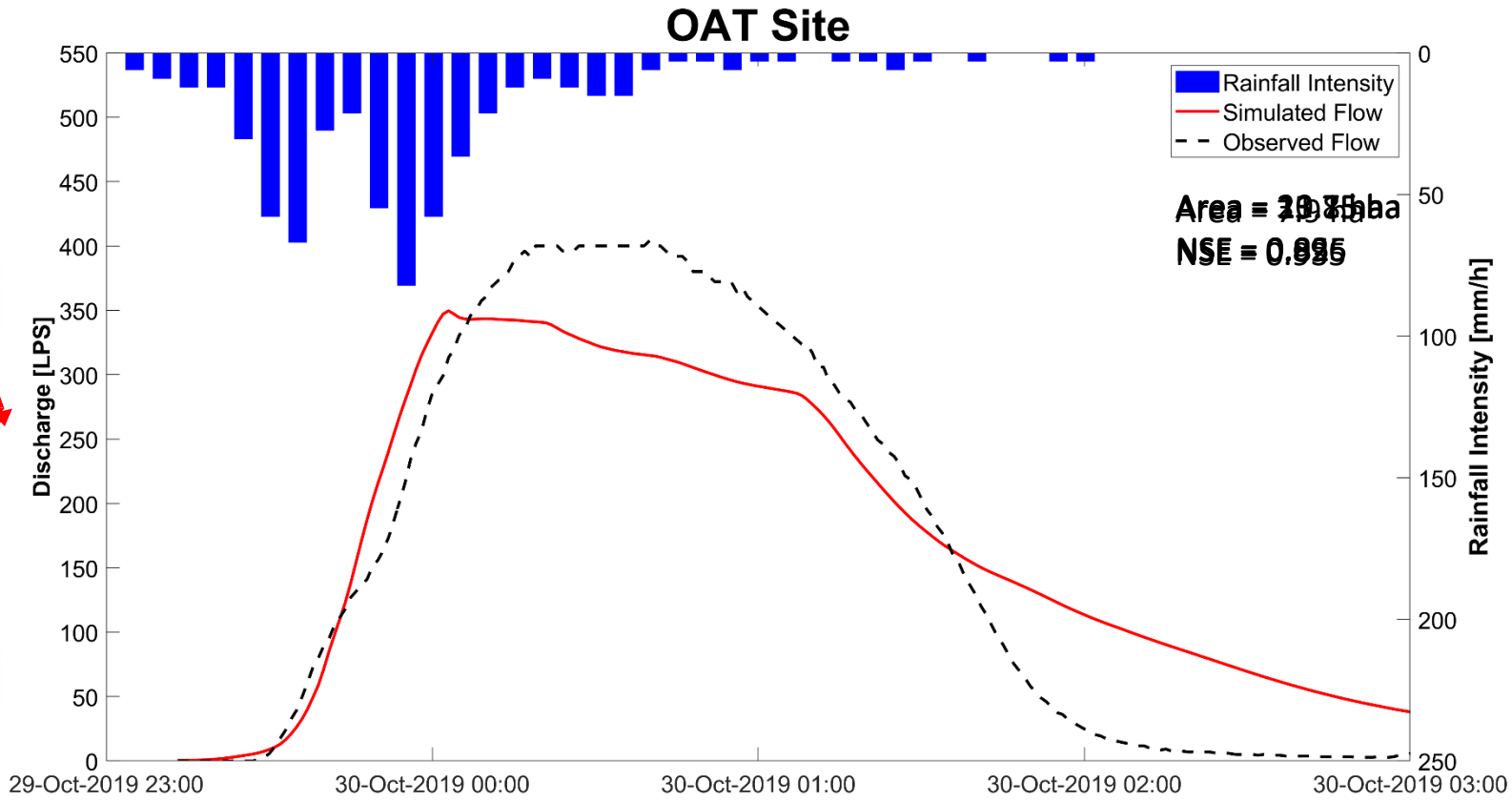
Model Setup (SWMM)



- Sat. Hydraulic Conductivity
- Particle size distribution at different soil depth
- Dry bulk density, Porosity,
- Soil water retention relation parameter

Calibrated Model





Publications

Title of the paper	Journal, Issue, Year	Authors
Evaluation of augmented infiltration based LIDs for low lying urbanizing coastal catchments using a numerical modeling approach: A case study of Chennai city, India	Under Review	Bagya Lakshmi & Narasimhan, B.
An analysis of challenges and opportunities for Low Impact Development (LID) techniques in urbanizing catchments of coastal city of Chennai, India – A case study	Under review	Bagya Lakshmi & Narasimhan,B.

Work to be Done

Ongoing:

- Review of SuDS practices worldwide
- Modyfying and adapting SuDS practices to suit Indian conditions
- Development of a SUDS numerical tool-box

To be Done:

- Piloting of SuDS in two or three selected academic campuses
- Preparation of Design Manual

Integrated Methodology & Software for Water Network Design, Monitoring and Rehabilitation

Work Package 4

Prof. Sridharakumar Narasimhan, Prof. Shankar Narasimhan

Prof. B. S. Murty, Prof. Ravindra Gettu

IIT Madras

Objectives:

- Develop systematic methodologies for rehabilitation, operation and monitoring of water distribution networks
- Demonstrate the methodologies using simulations and experiments on the IIT Madras laboratory water network facility
- Develop state-of-art software and decision support system for water network design, monitoring, operation and rehabilitation

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- **Date of commencement of project:**

  23-Oct-2018

- **Reporting Period**: Oct 2019- Jan 2020

- **Approved date of Completion:**

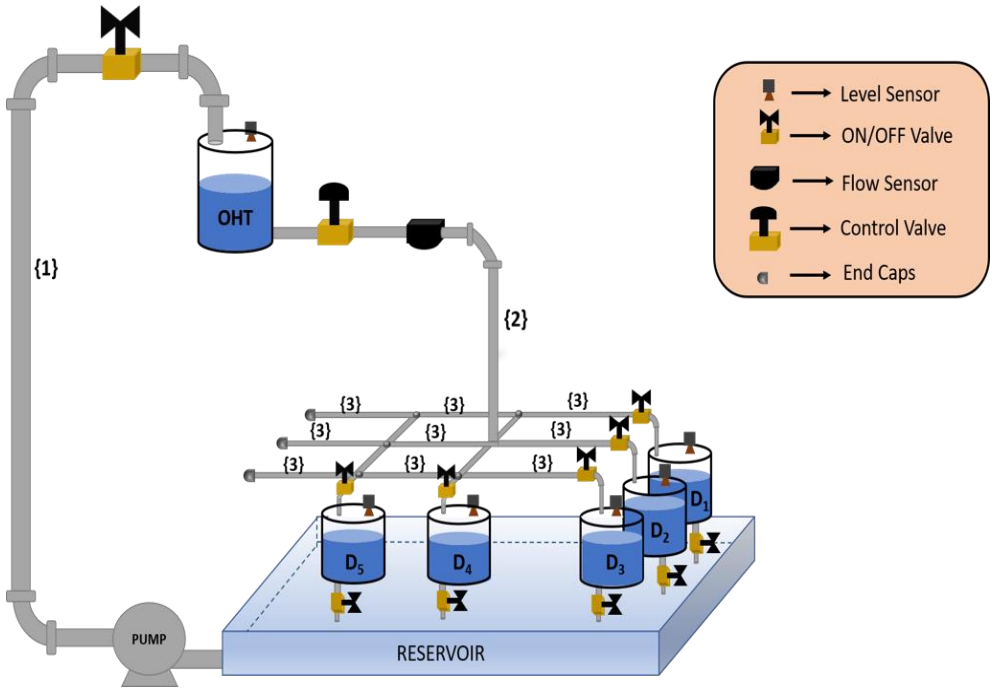
  22-Oct-2023

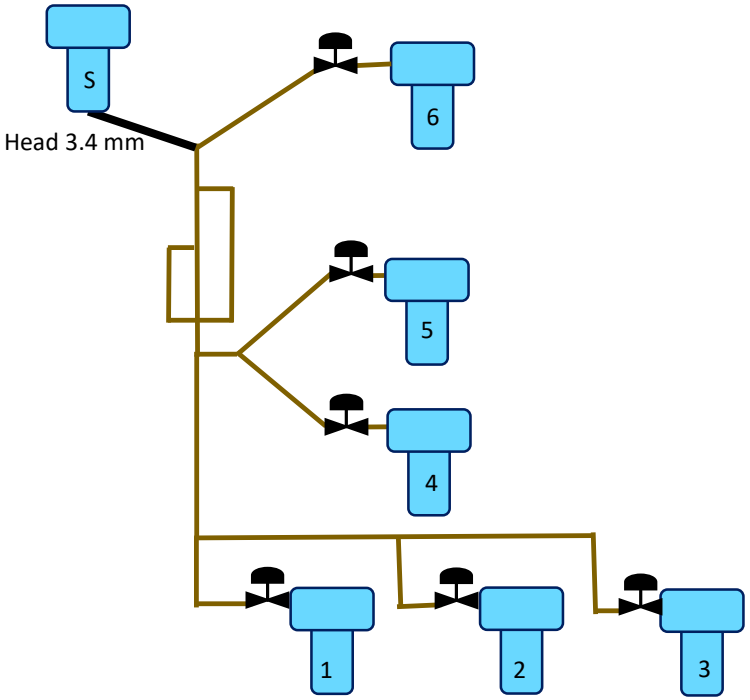
Presentation in Five International Conferences

NETWORK CALIBRATION

Experiments

- Experiments are conducted on existing IIT Madras laboratory facility.



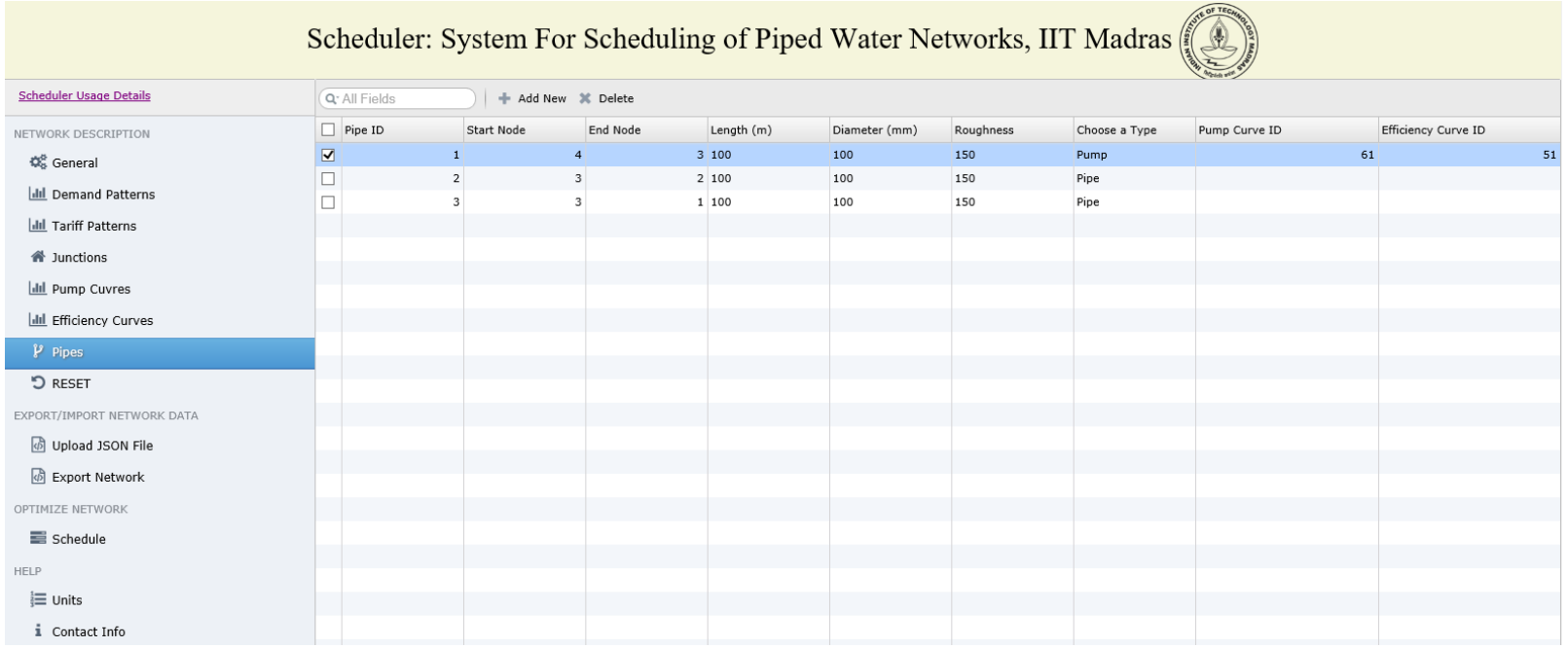


- A test network consisting of six tanks with provisions for on/off valve operations and data acquisition is used for study.

NETWORK OPERATIONS

Software

- Software for scheduling of WDNs operated with On/Off valves is completed.

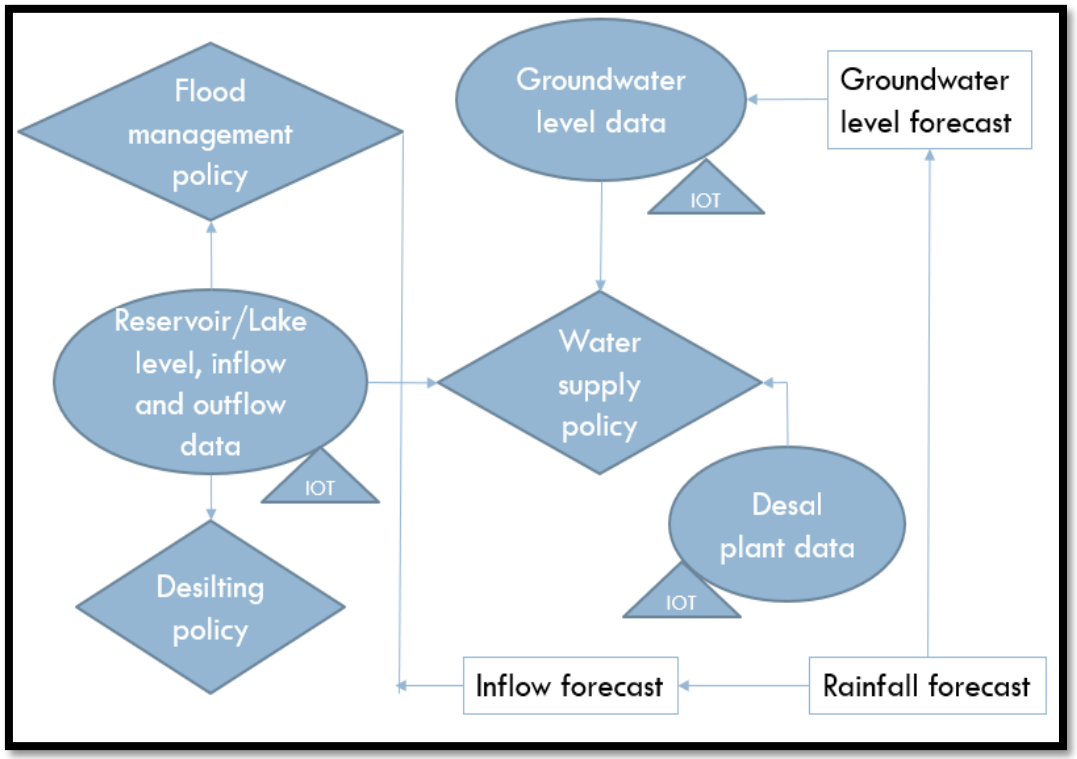


- Scheduling software is hosted in Robert-Bosch Centre for Data Science & Artificial Intelligence (RBCDSAI) website http://10.21.184.209:8080/scheduler/.
- Software for scheduling of WDNs operated with Continuous valves is ongoing.

DSS SYSTEM

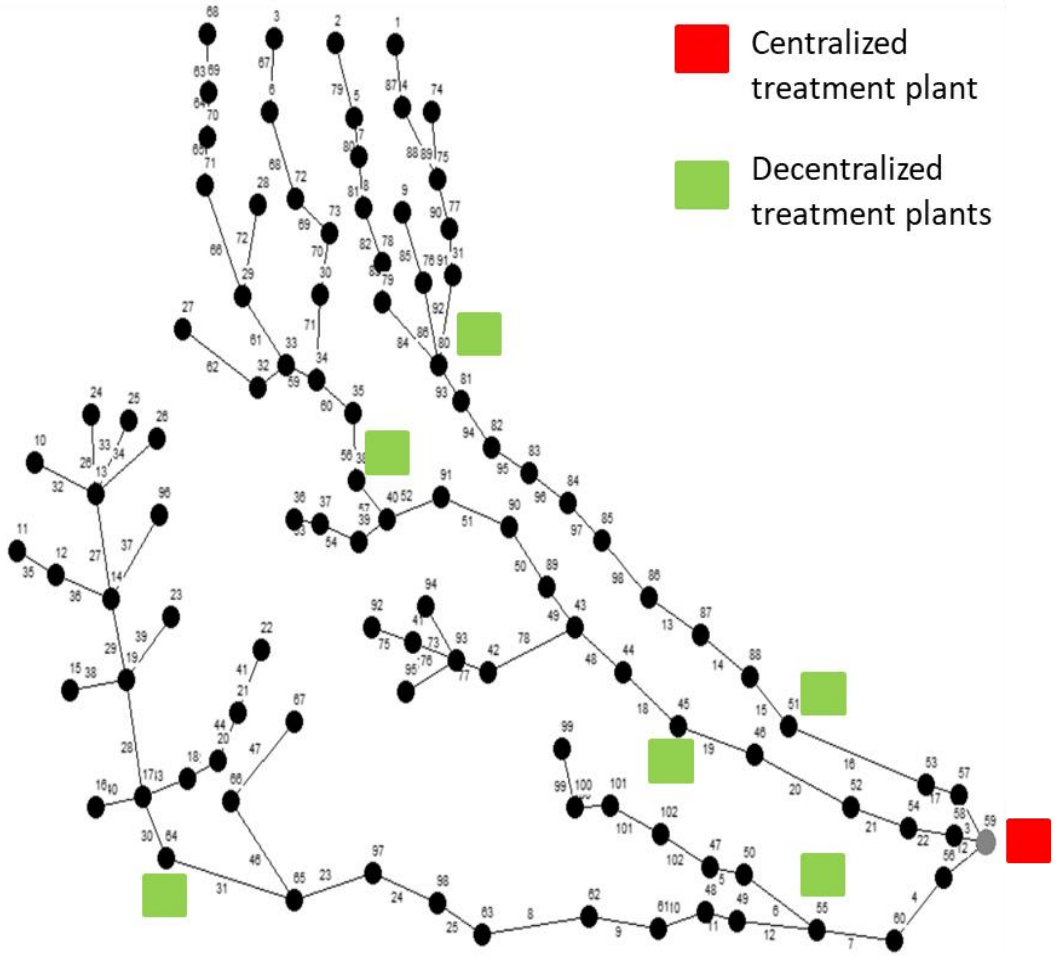
Methodology

- Building DSS System to monitor water availability and demand; and use it to take key policy decisions like
  - Amount of water to be supplied to different areas
  - Method of water transport



An Analytical Hierarchical Process Method for Pipe Material Selection

Optimal Implementation of DWWM



WP1.3. Hydrogeological interventions for flood mitigation and augmentation of groundwater recharge

DST/TM/WTI/WIC/2K17/82(G) Date: 23.10.2018

L. Elango

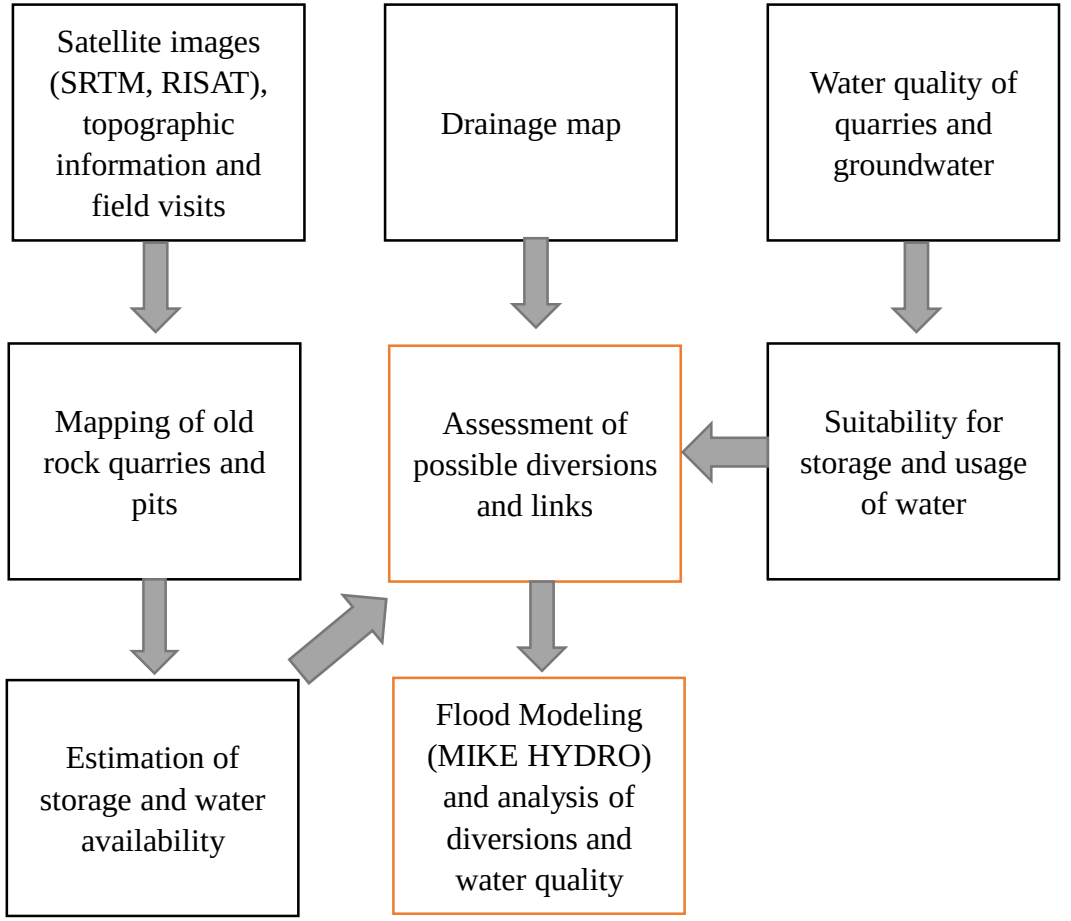
Department of Geology

Anna University

Chennai

Objectives and Methodology

- To identify the existing pits/quarries to use them as storage reservoir to conserve storm water and augment groundwater recharge
- To identify measures to divert flood water to improve water storage and reduce flood inundation through modelling
- To come up with a methodology for effective balancing of surface and groundwater for water sustainability



Accomplishment in Terms of Milestone for the Review Period

Milestones	Target month	Progress
Collection of existing data (Lithologs, Rainfall, Soil, Water level)	March, 2019	Completed
Topographic survey	July, 2019	Completed
Identification of pits/ quarries/ tanks	August, 2019	Completed
Assessment of quarry water, surface water and groundwater quality	periodical up to June, 2023	Completed for the samples collected during 2019. Have to do it periodically

Conference

Title of the paper	Conference	Date of the conference	Authors
Significance of reservoir operation during extreme rainfall event in flood mitigation and water demand management in a metropolitan city of India: a case study	EGU general Assembly 2020	4 – 8 May, 2020	Anahdharuban Panchanathan, Michele La Rocca, Elango Lakshmanan
Groundwater quality assessment in the urbanized city, Chennai, Tamilnadu, India	Indian National Groundwater Conference (INGWC-2020) at CWRDM, Kozhikode, Kerala.	18 -20 February, 2020	Merin Sackaria and Elango. L
Role of a domestic water supply reservoir during hydrologic extreme events in the coastal city of Chennai, India	Asia-Pacific Coastal Aquifer Management Meeting	11 – 14 December, 2019	Anandharuban P. and Elango. L
Impact of rainfall distribution in flood modelling of an ungauged river basin using HEC-HMS - A case study	8th International Groundwater Conference on sustainable management of Soil-Water at IIT Roorkee	21-24, October, 2019	Anandharuban P. and Elango. L

Publications

Title of the paper	Journal / Issue / Year	Authors
A box model approach for reservoir operation during extreme rainfall events: A case study	Journal of Earth System Science	Anandharuban P., Michele La Rocca, Elango L.
Organic micropollutants in groundwater of India – A Review	Water Environment Federation	Merin Sackaria, Lakshmanan Elango

Centre for Sustainable Treatment, Reuse and Management for Efficient, Affordable and Synergistic Solutions for Water

(WATER-IC for SUTRAM of EASY WATER)

WP: A Point of Use Single Probe Multi-analyte Sensor

Prof. Ligy Philip
Prof. T. Pradeep
IIT Madras

J. Raghava Rao
S. Easwaramoorthi
CSIR-CLRI

Objective

- A point of use single probe multi-analyte sensor for Cr(III & VI), As(III & V), Hg(II) and other metal ions in industrial waste water

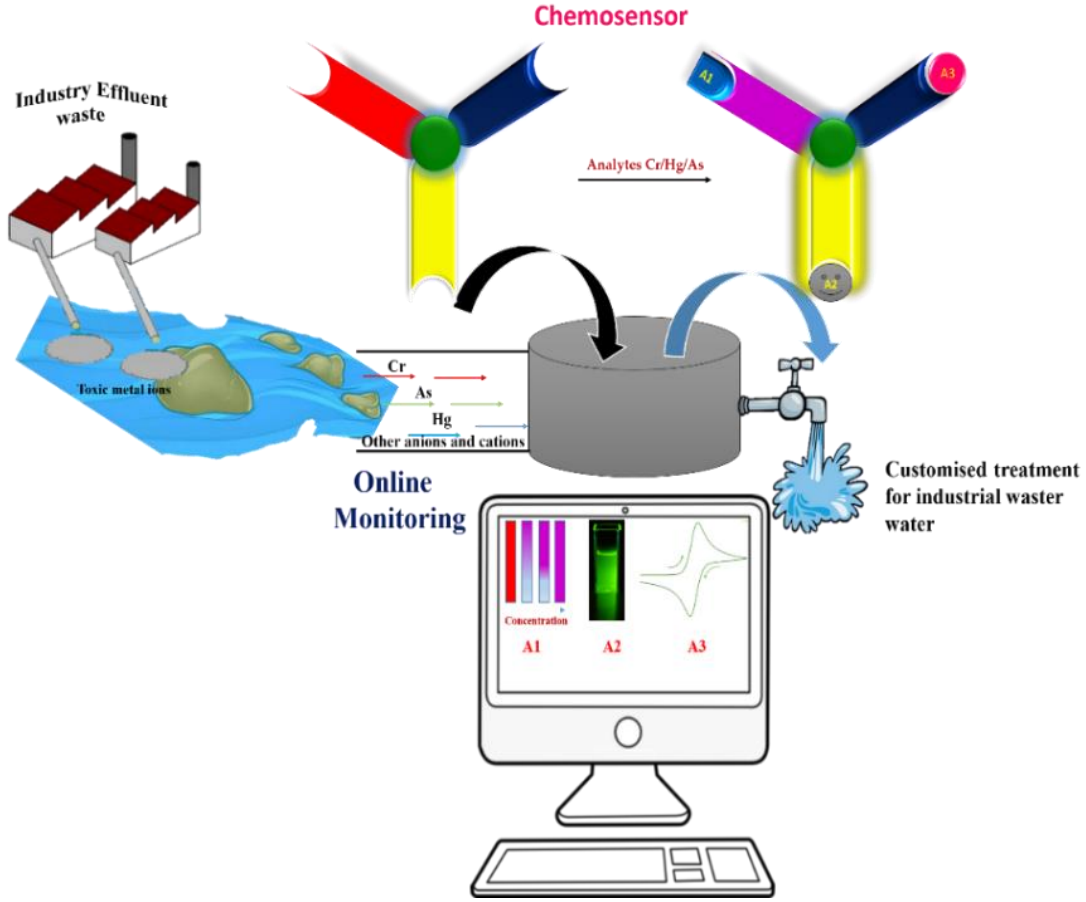
- Stakeholders
  - ✓ Small scale industries without an analytical lab for testing
  - ✓ Assists in planning the effluent treatment methods

Deliverables & Milestones

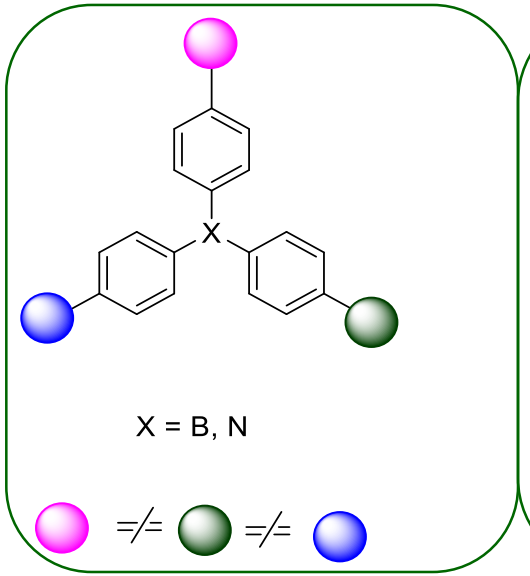
S.No.	Milestones	Time Period	Deliverables
1	Project initiation, identifying the structural motif's , synthesis of intermediate compounds	Year 1	Identification of signaling units & receptors combinations
2	Evaluation, identifying the lead sensor molecules and incorporation of multiple receptors to one signaling unit	Year 2	Optical, fluorescent and electrochemical sensing studies for different analytes in ppm level (Cr, Hg, As) Patent/publication
3	Fine tuning the receptor structural motif to improve the sensitivity and selectivity	Year 3	Two sensor molecules Patent/publication
4	Testing the workability of the sensor in industrial waste water and protocol optimization	Year 4	Optimizing the workability in tannery and other industrial waste water Patent/publication
5	Exploring and proposing the possible standardized test protocol for identifying toxic analytes using the sensors.	Year 5	Sensor strips with ppm level detection limit, standardized protocols for naked eye detection, consolidation of the work report Patent/publication

Sensor Design Principles

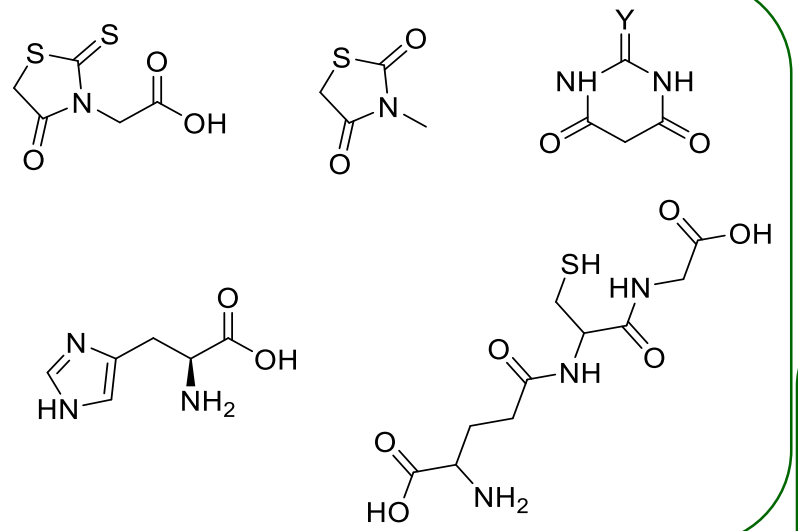
- ✓ Single probe multianalyte sensors
- ✓ Non-interfering orthogonal signal mechanism
- ✓ Water solubility



Signaling motif's



Receptors



Interactions

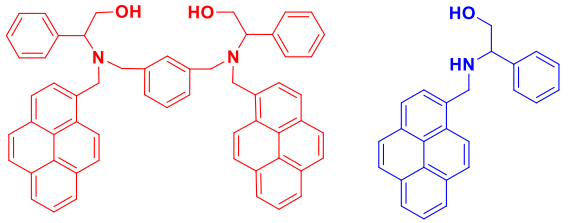
- ➢ Electrostatic Interactions
- ➢ Chemical reactions
- ➢ Complexation induced changes

Signals

- ➢ Optical
- ➢ Fluorescent
- ➢ Electrochemical
- ➢ Changes in solubility

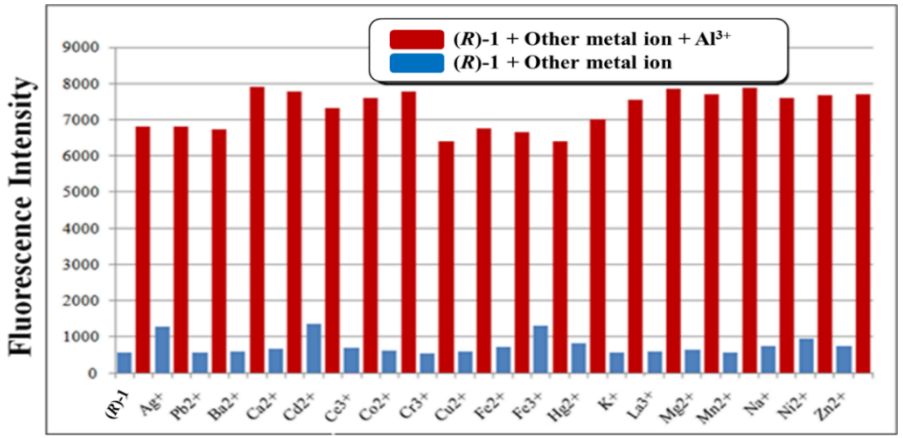
Pyrene-Phenylglycinol chemosensor

Sensor

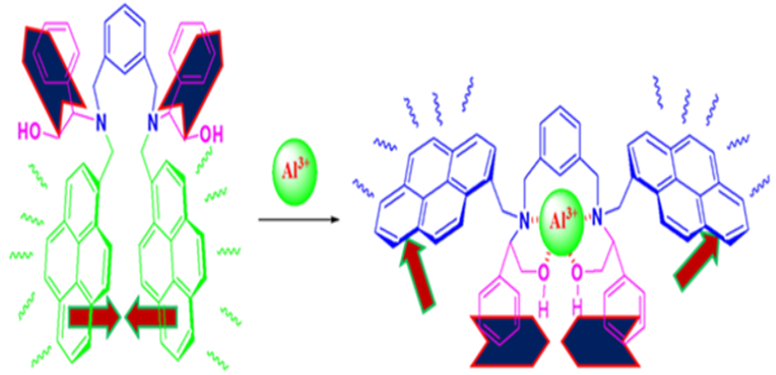


(*R*)-1 (*R*)-2

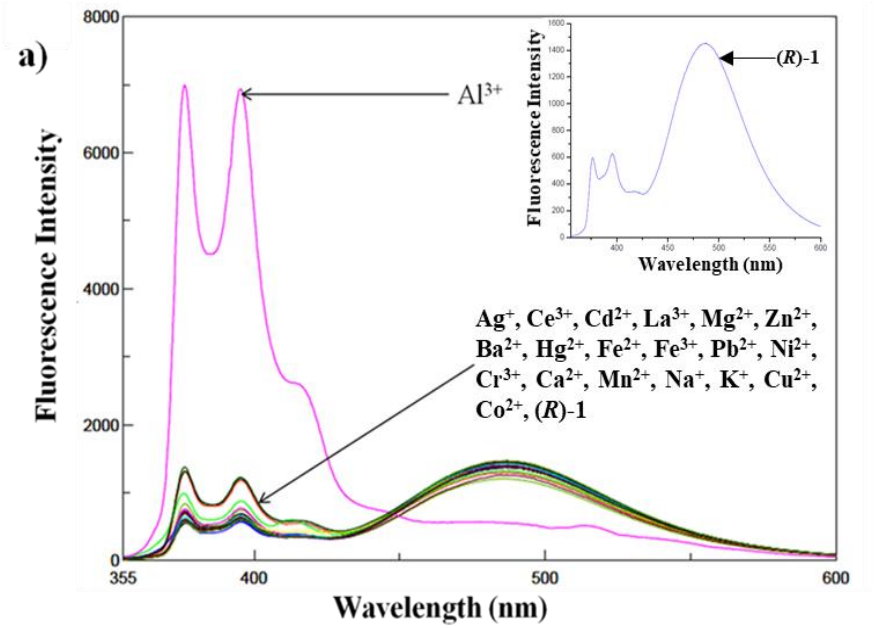
Selectivity

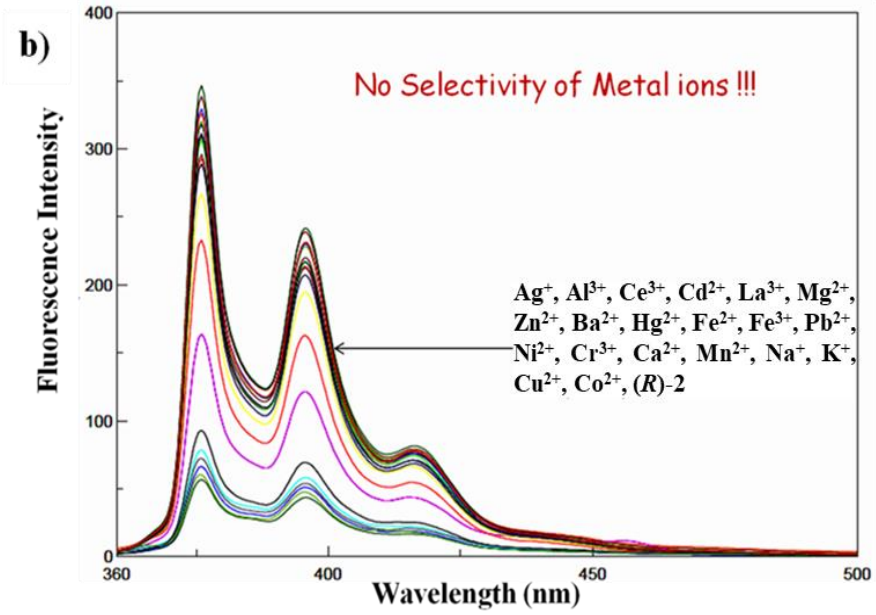


Mechanism



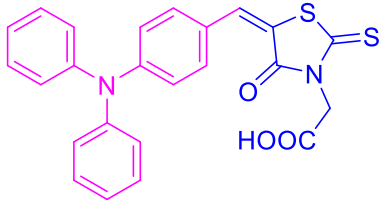
Pull (Fluorophore)-Push (Ionophore) Push (Fluorophore)-Pull (Ionophore)



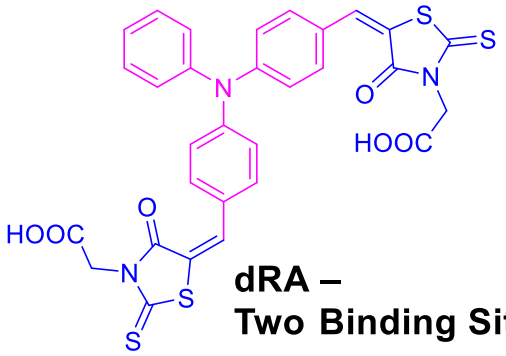


Analytica Chimica Acta, 2019, 1090, 114

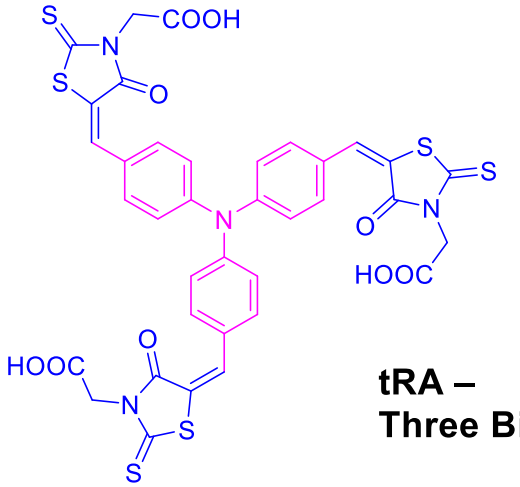
Multipolar Sensor – Multiple binding sites



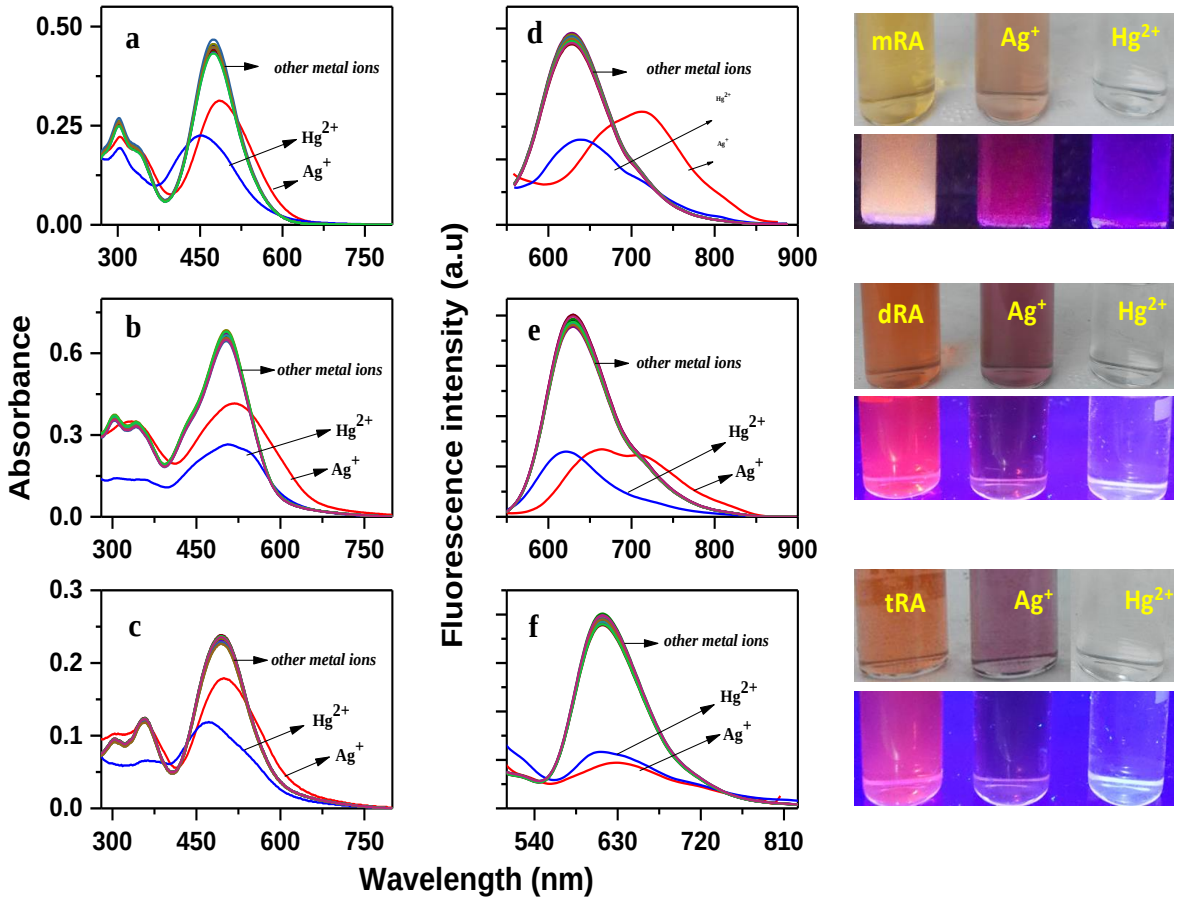
mRA –
Single Binding Site



dRA –
Two Binding Sites



tRA –
Three Binding Sites



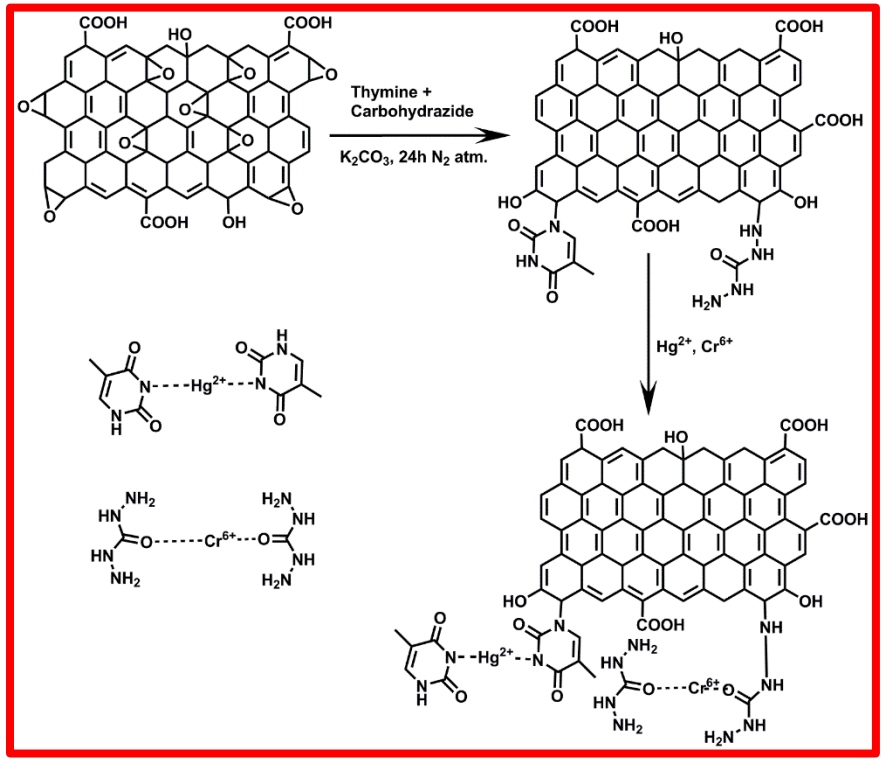
Detection limit (ppm)

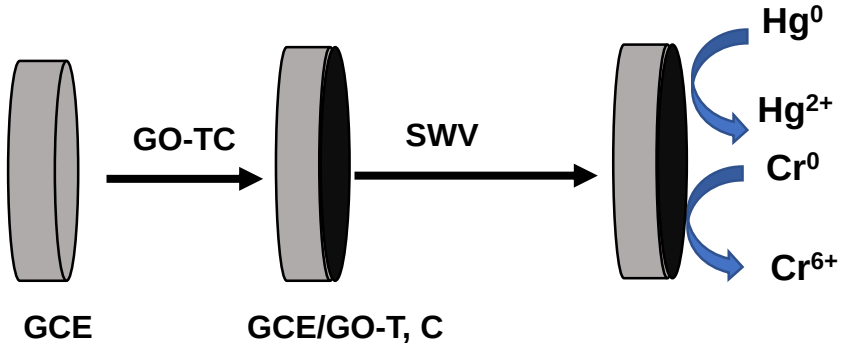
Cmpd.	Ag^{+}	Hg^{2+}
mRA	1.58	0.14
dRA	1.06	0.99
tRA	0.56	0.79

- Second and third binding site doesn't involve in binding – Negative cooperativity in binding

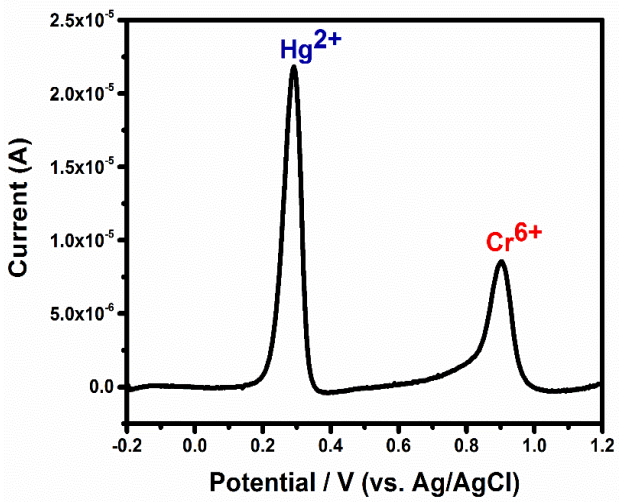
ACS Sustainable Chemistry & Engineering 7,2019, 9865-9874

Thymine, Carbohydrozide-Covalently Functionalized Graphene oxide sheets





GCE - Glassy carbon electrode
GO - Graphene oxide
T - Thymine
C - Carbohydrazide
SWV - Square wave voltammetry



Typical Square wave voltammetric of the sensor for different (Hg^{2+}) and (Cr^{6+})

Low level - 156 ppb

Maximum -100 ppm

Optimization in using low cost screen printed electrodes and exploration of possible point of care device setup in collaboration with other partners (IITM) is in progress

Summary

- Several target compounds were synthesised and the evaluation of sensing properties are in progress

- Reporter having more than one receptor was synthesized and it responds to Ag^{+} and Hg^{2+} with different signals

- An electrochemical sensor to detect Cr^{6+} and Hg^{2+} with different signals with the LOD of ppb was developed and further work is in progress in optimization of performance and device development

Centre for Sustainable Treatment, Reuse and Management for Efficient, Affordable and Synergistic solutions for Water (WATER-IC for SUTRAM of EASY WATER)

WORK PACKAGE NO : 3.5
Tannery wastewater treatment

WP Lead : Dr.S.V.Srinivasan, Principal Scientist
Environmental Science and Engineering Division,
Central Leather Research Institute (CSIR-CLRI),
Chennai , India

CLRI Central Leather Research Institute
Council of Scientific and Industrial Research

WP 3.5 – Targeted objectives and Timelines

CLRI Central Leather Research Institute
Council of Scientific and Industrial Research

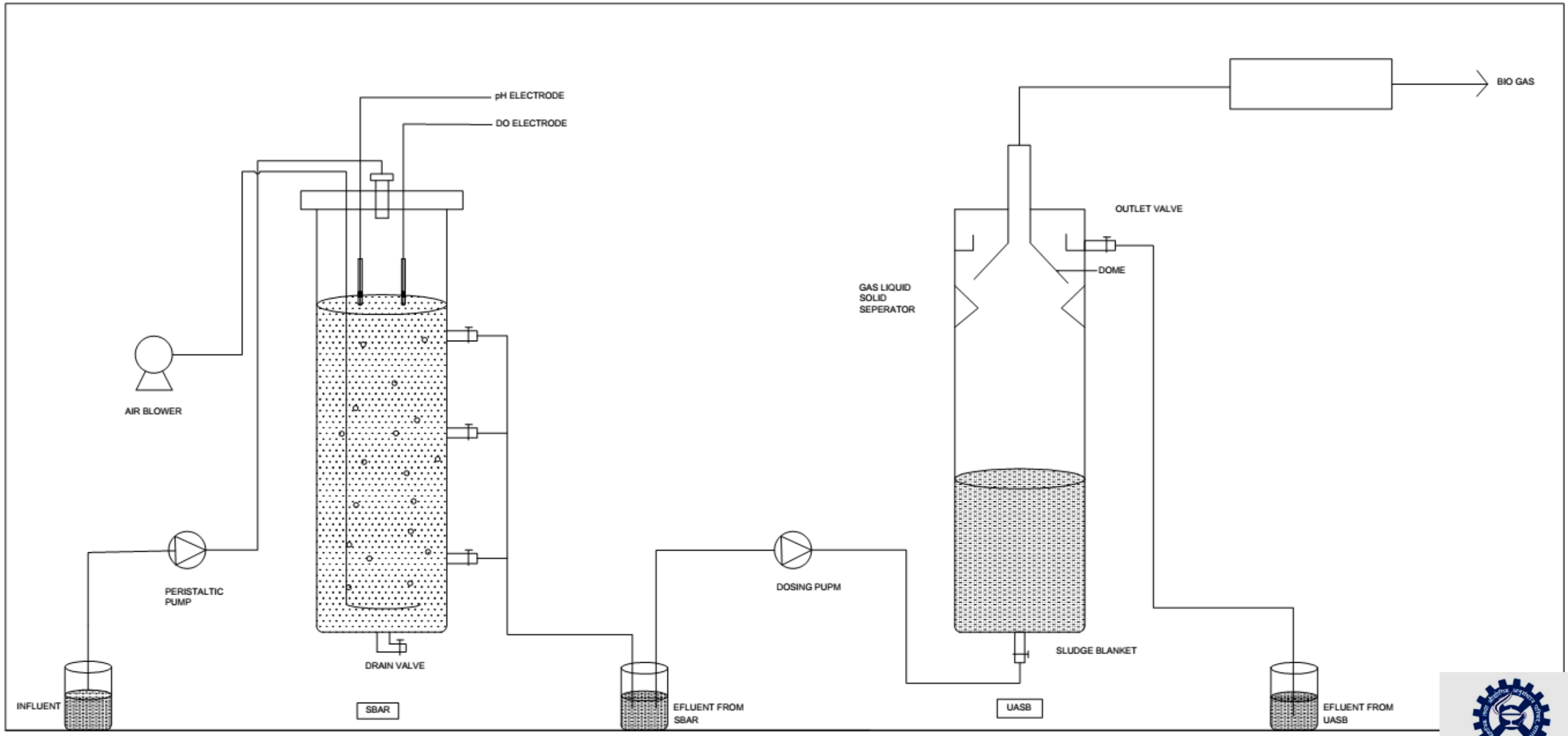
Milestones

- Proposed process flow scheme and design parameters for assesment
- Developed bacterial consortium for lab scale bioreactor study
- performance of bacterial consortia on CNS removal in batch scale study (Synthetic wastewater)
- performance of bacterial consortia on CNS removal in batch scale study
- Quantitative real time RT-PCR data analysis of nitrifiers, denitrifiers and sulfur reducers
- CNS removal in SBR under different COD loading rates
- CNS removal in SBR under different Nitrogen loading rates
- CNS removal in SBR under different sulphur loading rates
- Microbial community structure and diversity in SBR system
- Final project report with the results obtained

Deliverables

- Review of literatures and detailed charcterization of tannerywastewater
- Acclimatization of bacterial consortia and design of lab scale bioreactor for CNS removal
- Batch study in lab scale bioreactor with synthetic wastewater
- Sequential Batch reactor (SBR) study with synthetic wastewater
- Gene expression/abundance studies on nitrifiers, denitrifiers and sulfur reducing organisms.
- Effect of COD loading rates in real tannery watewater with SBR
- Effect of nitrogen loading rates in real tannery watewater with SBR
- Effect of sulfur loading rates in real tannery watewater with SBR
- Metagenomic sequencing studies of the developed microbial consortia
- Evaluvation of Techno-economic aspect

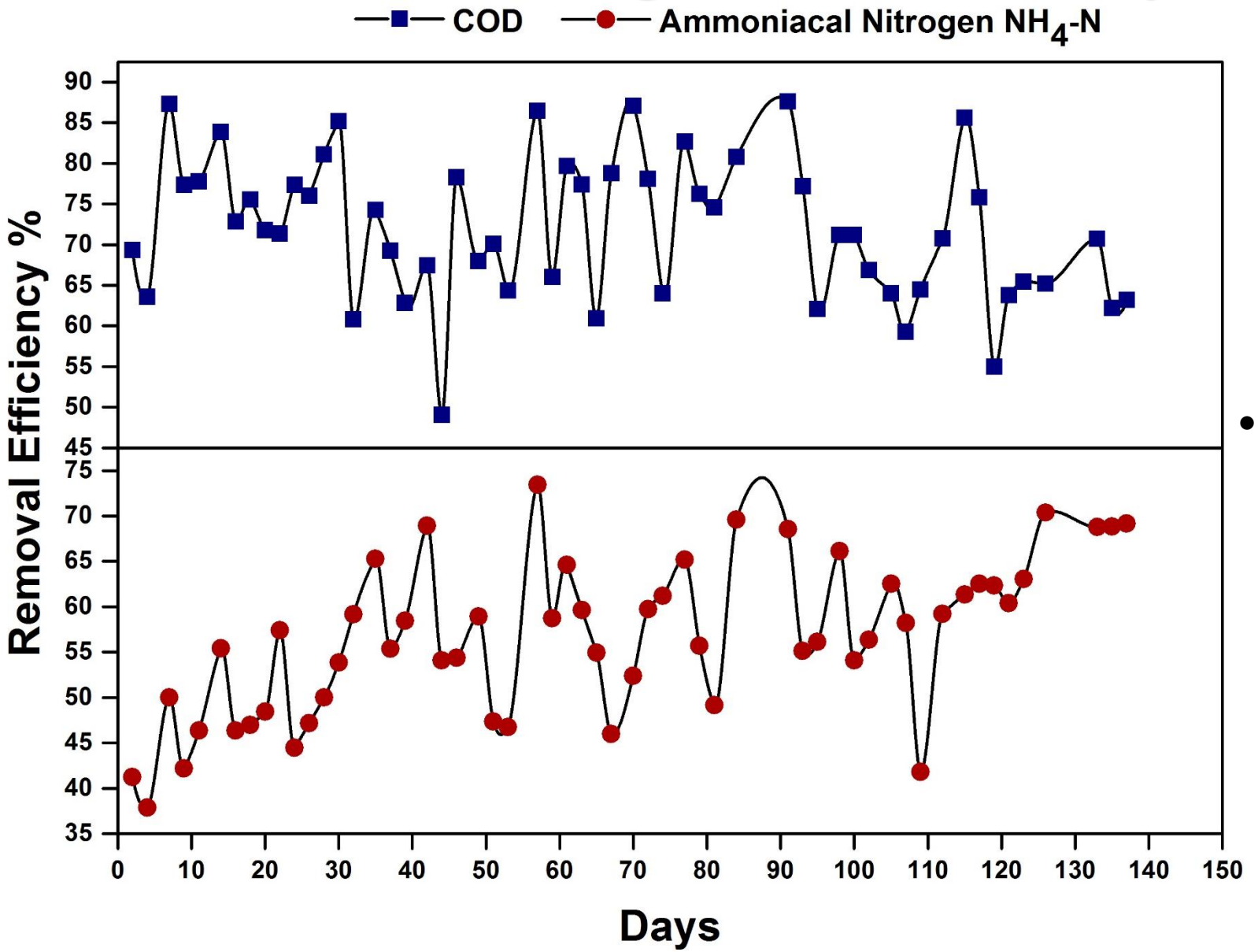
Current Status of the project - Summary



The process flow scheme

CLRI Central Leather Research Institute
Council of Scientific and Industrial Research

Removal efficiency of COD and Ammoniacal nitrogen in SBAR during the treatment period



- Maximum removal efficiency of COD was found to 85% and Ammoniacal nitrogen was found to be 75 %

CLRI Central Leather Research Institute
Council of Scientific and Industrial Research

Technological achievements during December 2018 – March 2020

- Background study on treatment methods for tannery wastewater and Current state of art technologies for removal carbon, nitrogen and Sulphur has been carried out.
- Seed inoculum for the treatment of Synthetic tannery wastewater was developed from the Aerobic sludge of CETP, aerobic sludge from STP and nitrifiers rich soil using enrichment medium for nitrifiers.
- Inoculum development i.e., Cultivation and enrichment of sulfur reducing bacteria (SRB) using three different medium based on the literatures and the seed culture was obtained from existing biogas plant in Central Leather Research Institute (CLRI)
- Acclimatization of bacterial consortium for the removal of Sulphur and Nitrate and residual COD from the synthetic tannery wastewater has been initiated.
- Sequential batch process was performed to study the efficiency of inoculum for the aerobic process (C & N removal) with the cycle time of 36 hrs was evaluated over a period of 150 days.
- Removal of COD with more than 87% and Ammoniacal nitrogen with the maximum removal of 75 %. Over 50 % conversion of Ammonical nitrogen into nitrate was observed

WATER TECHNOLOGY CENTRE: SUTRAM FOR EASY WATER

Review Meeting

Centre for Sustainable Treatment, Reuse and Management of Water (WATER-IC for SUTRAM of Water)

IIT Tirupati

भारतीय प्रौद्योगिकी संस्थान तिरुपति

TIRUPATI

WP 2: Objectives

- Development of affordable nanoscale materials for the removal of the pathogenic organism and heavy metals in water
- Develop a sustainable waste management protocol for handling spent materials.

Achievements in terms of Lab scale study

1. Developed a point-of-use disinfection system with enhanced antibacterial efficacy in presence bicarbonate ions
2. Developed an affordable and granular binary metal nanocomposite nanocomposite

1

2

Publications

Title of the paper	Journal, Issue, Year etc.	Authors
Book Chapter: Measurement, Analysis, and Remediation of Biological pollutants in the water	Measurement, analysis, and remediation of environmental pollutants. Springer Nature, 211-242, 2020. https://doi.org/10.1007/978-981-15-0540-9_11.	U. Kannan, S. K. Prashanth, and S.M. Maliyekkal
Occurrence, contamination, speciation, and analysis of selenium in the environment	Measurement, analysis, and remediation of environmental pollutants. Springer Nature, 245-269, 2020. https://doi.org/10.1007/978-981-15-0540-9_12.	M.S.V.N. Jyothi, B.J. Ramaiah, and S.M. Maliyekkal
Development of an eco-friendly and reusable point-of-use disinfection system	Journal of Cleaner Production (Communicated)	U. Kannan, P.C. Sabumon, and S.M. Maliyekkal

Publications

Title of the Talk/paper	Symposium/ Conference	Dates of the Symp/Conf.	Presenter /Authors
An affordable and eco-friendly methodology towards the clean water	Water Future conference, Indian Institute of Science, Bengaluru	24-27, September 2019	U. Kannan and S.M. Maliyekkal (2019)

WP2.7. Environmental impact

Satyakam Patnaik, Ph.D
Water Analysis Lab
Nanomaterial Toxicology Group
CSIR-Indian Institute of Toxicology Research (IITR)

- **Targeted Objectives and timelines:**
  - Environmental impact (19-26 months)
- **Publications/Patents:**
  - Journal of Hazardous Materials, 385, 121525, 2019 (IF-7.650)
- **Financial and Manpower Status:**
  - Procurement of proposed equipment is completed with installation and demonstration. Manpower hiring is in the process.

Development of Cost Effective Nano Composite Based Water Filtration Units for the Efficient Removal of Hazardous Impurities Found in the Lakes of Nainital, Uttarakhand

By

Prof. Nanda Gopal Sahoo

Professor Rajendra Singh Nanoscience and Nanotechnology Centre
Department of Chemistry
DSB Campus, Kumaun University, Nainital

DELIVERABLES

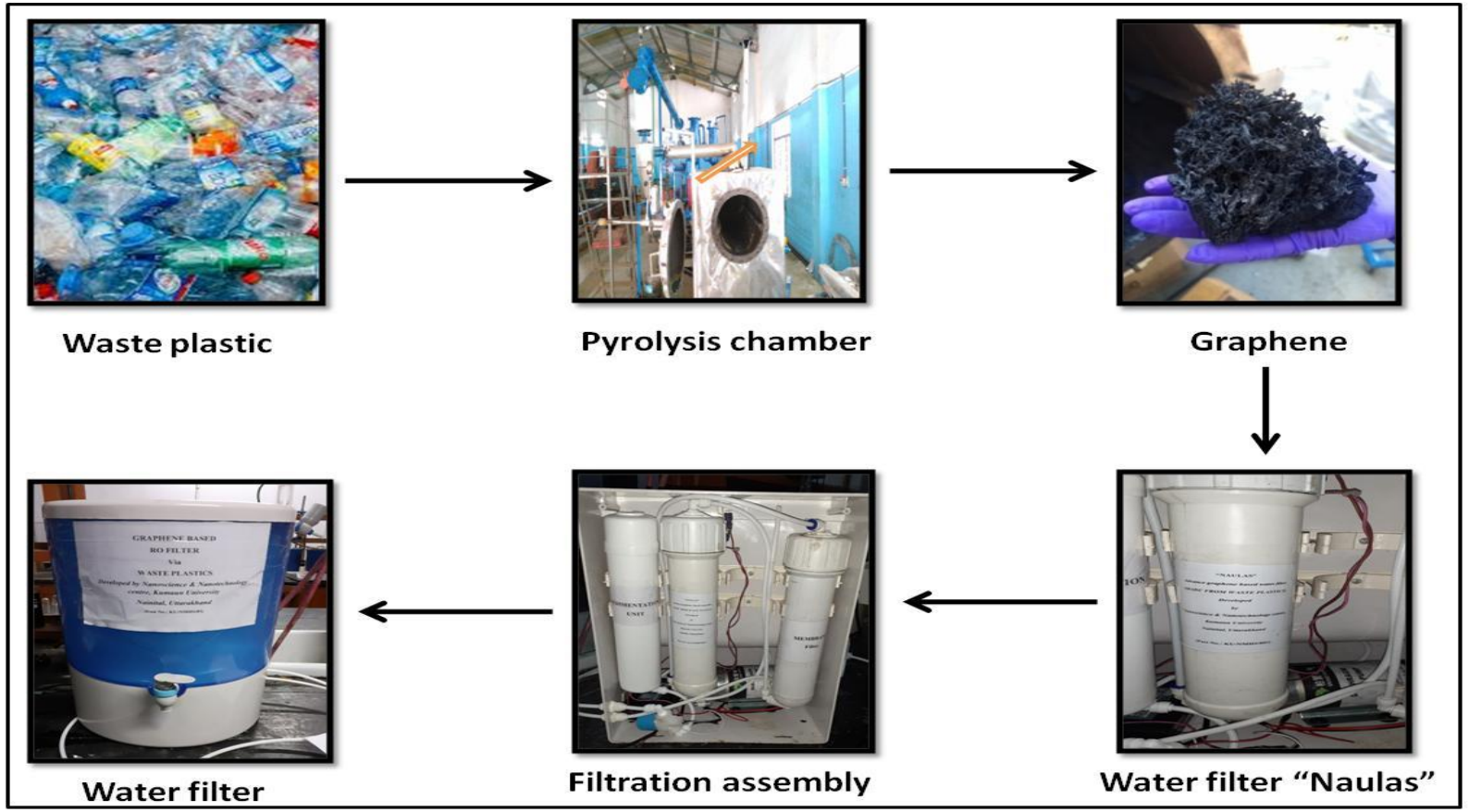
Time period (in months)	Deliverables
0-6	• Water samples collection from the lakes of Nainital region
6-12	• Examination and Identification of the collected samples
12-18	• Synthesis of porous carbon nanomaterials/activated carbon black by using traditional precursors and waste plastic. • Research Paper
18-24	
24-30	• Carbon nanomaterials /activated carbon black/nano-zeolite based polymer nano composites as filter membranes for water filtration unit. • Research Papers and patent
30-36	
36-42	• Highly advanced water filters using by nanocomposite materials for the removal of all kind hazardous impurities (biological/non- biological). • Research Papers and patent
42-48	
48-54	• Optimization and development of cheaper and efficient water filters
54-60	• Final Technical Report

ACHIEVEMENTS

- In this frame of time, we successfully collected the water samples from the lake of Nainital region, and done the examination and identification of the samples.
- In this frame of time, we successfully synthesized the 2D nanomaterial i.e. graphene oxide using different precursor i.e. waste plastic, agricultural waste (Quercus ilex fruits), and paper waste.
- We studied the removal efficiency of dyes (brilliant green dye and methylene blue) using waste plastic generated graphene oxide.
- One step synthesis of self potassium doped graphene oxide from Quercus ilex fruits has been done and found its application in field of metal sensors for selective detection of iron (III) ions present in water samples. Fluorescence quenching effect of the K-doped GO in the presence of Fe^{3+} ion provided a platform for detecting Fe^{3+} ion from aqueous solution with detection limit 0.345X 10^{-7} M.
- In this frame of time, we successfully published one research paper, four conference papers, two patents, one book chapter (under review).
- In this frame of time, our research scholar Chetna Tewari got two awards (best poster award and young scientist) in conferences.

PROTOTYPE

Development of graphene based RO water filter "Naulas"



PUBLICATION DURING THE PERIOD

Research Paper:

Title of the paper	Journal, Issue, Year etc.	Authors
A simple, eco-friendly and green approach to synthesis of blue photoluminescent potassium-doped graphene oxide from agriculture waste for bio-imaging applications	Materials Science & Engineering C, 104 (2019) 109970	ChetnaTewari, Gaurav Tatrari, Manoj Karakoti, Sandeep Pandey, Mintu Pal, Sravendra Rana, BoddepalliSanthiBhushan, AnandBallabhMelkani, Anurag Srivastava, Nanda Gopal Sahoo

Book Chapter:

Title of the book chapter	Publisher	Authors
Introduction, past and present scenario of plastic degradation	Materials Research Forum LLC	Neema Pandey, Bhashkar Singh Bohra, ChetnaTewari, S. P. S. Mehta, Nanda Gopal Sahoo

Conference Papers:

Title of the Talk/paper	Symposium/ Conference	Presenter/Authors
A Green and cost-effective approach to synthesis of potassium doped graphene oxide from agriculture waste for Biomedical application.	International Conference on Advances in Nanomaterials and Devices for Energy and Environment (ICAN-2019), 27-29 Jan, 2019, M. P., India	ChetnaTewari, Nanda Gopal Sahoo;
A Novel and Green cost-effective approach for synthesis of graphene oxide.	13thUttarakhand State Science & Technology Congress 2018-19,26-28 Feb, Dehradun, India	Chetna Tewari, Nanda Gopal Sahoo
Synthesis of graphene oxide for water purification	International conference on energy and functional materials & sustainable environment management , 24-26 May, 2019	Chetna Tewari, Nanda Gopal Sahoo

Patents:

Title	Inventors	Filed on
Hydro-solvo-thermal graphene oxide synthesis method	Chetna Tewari, Sandeep Pandey Manoj Karakoti, Gaurav Tatrari, Sunil Dhali, Himani Tiwari, A.B. Melkani, N.G. Sahoo	17/03/2020
Process of preparation of naturally doped silicon, magnesium and calcium graphene nanosheets from paper waste for energy application	Sandeep Pandey Manoj Karakoti, Sunil Dhali,.Chetna Tewari, N. G. Sahoo	27/04/2020

WP-1.3. Storm water characterization (both, qualitative & quantitative), surveillance, modelling and forecasting

LEAD : Dr. Ashutosh Das/PRIST

Target Objectives & Timelines:

Months →	0-6	7-12	13-18
Milestone-I	Secondary Data-Collection (hydro-geol, morpho-climatic, etc), Image Procurement	Primary Data-Collection (storm-water & runoff quantity)	Basic Geospatial Analysis & querying
Milestone-II	Field-visit & Questionnaire Survey	Digitization, Georeferencing & Generation of Thematic Layers	Field validation & Surveillance
Milestone-III	Base Map-Preparation	Development of DEM models & zonation of Storm-water Regimes	Development of optimized Models, diagnostics & predictability

Achievements *

Months →	0 to 18
Achievements in coordinated research	Secondary Data-Collection, Image Procurement, Questionnaire Survey, Base map preparation; Primary Data-Collection, development of DEM model & Zonation of storm-water regimes, Basic Geospatial Analysis & querying, Field validation & surveillance; Development of optimized models, diagnostics & predictability

* **NOTE : ALL TARGET OBJECTIVES HAVE BEEN ACHIEVED, HENCE, THERE IS NO SHORTFALL IN ACHIEVEMENT**

Technological outcomes

Months →	0-6	7-12	13-18
DATABASE FOR MODELING	Secondary Data-base (incl. imageries) for all the three study areas*	Primary water *quantity* data-base (storm-water & runoff)	Primary water *quality* data-base (storm-water & runoff)
MODEL DEVELOPMENT	Base Map-Preparation	Development of DEM models & zonation of Storm-water Regimes	Development of optimized Models (integrated with water quality variation)
MODEL VALIDATION, DIAGNOSTICS & PREDICTABILITY	Base-map : Ground Truth Validation (GPS - aided)	Storm-water prediction Model Calibration (with updated rainfall data of 2019-20)	Validation of Water quality-integrated model through representative primary field data of 2019-20

* Study Areas : Thanjavur, Nagapattinam & Chennai of Tamil Nadu

PUBLICATIONS

Title of the paper	Journal, Issue, etc.	Authors
Development of digital elevation Model for storm -water modeling for deltaic regions of Thanjavur Suburbs of southern India	International Journal of Civil Engineering and Technology, Volume-10, Issue-4, April 2019, pp. 193-201	Sivasamandy. R, Jose Ravindra Raj. B, Aravind. S, Nithin. S, Niraj prabhu. R, Sivabalan. S, Sakthi dharmadurai. S, Ashutosh Das
Development of digital elevation model for storm -water modeling for coastal region in Nagapattinam using geospatial studies	International Journal of Civil Engineering and Technology, Volume-10, Issue-4, May 2019, pp. 108-117	Mahesh R, Jose Ravindra Raj B., Gokilan M, Arul Anban, Milan M, Nongmaithem Deepak Singh, Abdul Rahman J and Ashutosh Das
Spatio-Temporal Variability of Gamma Radiation Profile Along the Southern-Indian Coastline (Poompuhar To Nagapattinam Strech)	International Journal on Emerging Technologies (in press)	Mahesh, R., Parthiban, P., Sivasamandy, R. and Das, A.,
Study on effect of Monsoonal Transition of wind flow pattern in Cauvery delta zone of Thanjavur, Southern Tamilnadu, India	International Journal on Emerging Technologies (in press)	Sivasamandy, R. , Parthiban, P. , Mahesh, R., and Das, A.,

PATENTS FILED…

Title	Inventors	Filing Date & Appln. No.
Method of Preparation of Pigmented Particle Board Using Spent Biosorbents (Rice Husk and Baggase) Generated From Adsorptive Treatment of Dye Wastewater	: Dr. Ashutosh Das, Dr. Mukesh Goel, P. Parthiban and R.Mahesh	**09.09.19 (Appln.no. 201941036259)**
RO Reject Pressurized Water Jet Nano Grinding Machine	**Dr. Ashutosh Das and Dr. TTM. Kannan**	**10.09.19 (Appln.no. 321472-001)**

Work Package Objectives (VIT, Chennai)

WP3.4.1:

Process Know-how for Removal/Recovery of Nutrients from Wastewater

W.P.3.6.2:

Decolorization of azodyes from textile wastewater

Research Accomplishments

- A nano-biotechnological Process for ammonia removal was developed in batch SBR and the effect of pH, temperature and potential inhibitors were studied (VIT and IIT T)

- Screening of 5 azodyes (Methyl Orange, Methy Red, Orange G, Chrysoidine Y, and Tartrazine) for decolourization using denitrification and/or sulphidogenesis using batch rector studies and optimization of pH, dye concentration and biomass concentration effects were completed.

- An upflow lab scale anoxic continous packed bed reactor studies for Methyl Orange decolourzation (500 mg/L) was completed after operated around 1 year with varying HRT, COD/NO_3-N ratios.

Research Accomplishments ……

- Thermal pre-treatment of food waste and sewage was done for decentralized waste management involving co-digestion with enhanced recovery of biogas and nutrients.

- A low cost decentralized wastewater treatment system was developed and reuse potential of the treated effluent was investigated and the results are published in Water Science & Technology (International Water Association Publication).

- A laboratory scale SBR (3 L) with process control was started to develop SND process and to achieve simultaneous removal of C, N and P. The reactor was operated for 180 days till date and the optimum removals obtained were 90.49% of NH_4^+-N, 82.8% of TN, 79% of P and 86.6% of COD.

Research output

Publications:

International Journals: 2

International Conferences: 14