Concept by Neelima Alam & Sanjay Bajpai

Department of
Science & Technology
Ministry of Science & Technology
Government of India

Department of Science & Technology
Technology Bhavan, New Mehrauli Road
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NERC NATURAL ENVIRONMENT RESEARCH COUNCIL
SCIENCE OF THE ENVIRONMENT

EPSRC Engineering and Physical Sciences Research Council

Newton-Bhabha Fund

Joint India-UK Projects on

Water Quality Research

DST's
Water Technology Initiative

NERC's
India-UK Water Quality Programme

India and UK are priority countries for each other for increasing research collaboration with the objective of pairing their best researchers with the best overseas.

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About

Department of Science & Technology(DST) was established in May 1971, with the objective of promoting new areas of Science & Technology and to play the role of a nodal department for organising, coordinating and promoting S&T activities in the country. DST plays a pivotal role in Promotion of Science & Technology in the country.

The funding call align closely with DST's
Water Technology Initiative

Natural Environment Research Council
Polaris House, North Star Avenue
Swindon, SN2 1EU
United Kingdom
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Fax 01793 411501

About

NERC (Natural Environment Research Council) is the UK's leading public funder of environmental science, invest in cutting-edge research, postgraduate training and innovation in universities and research centres.

Programme Background:

Innovative, Collaborative, Interdisiplinary

India and UK are priority countries for each other for increasing research collaborations with the objective of jointly supporting research projects focussing to improve water quality by providing a better understanding of the sources and fate of different pollutants and by supporting the development of management strategies and technologies to reduce pollution levels.

Improving water quality by providing better understanding of the transport, transformation, interactions and fate of natural and man-made pollutants (pharmaceuticals, personal care products, metals, organic particles and plastics) in water

The funding aims to bring together the UK and Indian scientific research and innovation sectors to find joint solutions to the water challenges facing India in economic development and social welfare

DST and NERC & EPSRC approved projects for Water Quality Research

Project 1
Innovative low-cost optical sensor platform for water quality monitoring

Project 2
Fate & Management of Emerging Contaminants (FAME)

Project 3
Impact of rainwater harvesting in India on groundwater quality with specific reference to fluoride & micropollutants.

Project 4
Rehabilitation of Vibrio Infested waters of VembanAd Lake: pollution and solution (REVIVAL)

Project 5
Future Secular Changes & Remediation of Groundwater Arsenic in the Ganga River Basin

Project 6
The development & implementation of sensors & treatment technologies for freshwater systems in India

Project 7
PATHWAYS and evolution of pollutants: Interactions between physical controlling effects, microbial community composition and pollutant biodegradation

Project 8
Antimicrobial resistance and pollutants: interactive studies and novel sensor technologies

Our Projects

Innovative low-cost optical sensor platform for water quality monitoring

Project 1

Vision statement:

To Create A Positive Impact Through Innovative Advanced Water Quality Monitoring Systems

Academic Partners

Investigators

Prof. S. Asokan
Prof. Sanjiv Sambandan

Prof. B.M.A. Rahman
Prof. K. T.V. Grattan

Methodology

Innovation of optical fibre-based sensors, by incorporating Fibre Bragg Gratings (FBG) and long period gratings (LPG) for chemical and physical sensing to specific biomaterials and heavy-metal sensing.

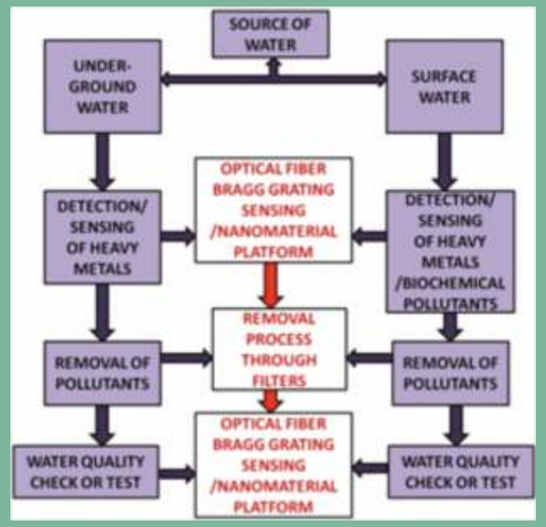


Figure 1: Flow Diagram Depicting the Principle of Optical Fiber Based Innovative Advanced Water Quality Monitoring System to Be Developed

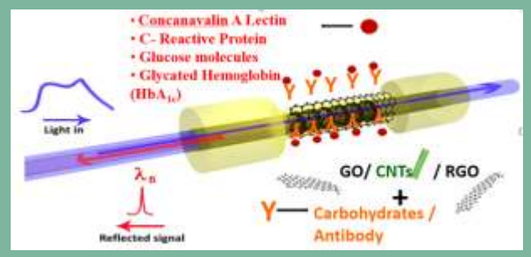
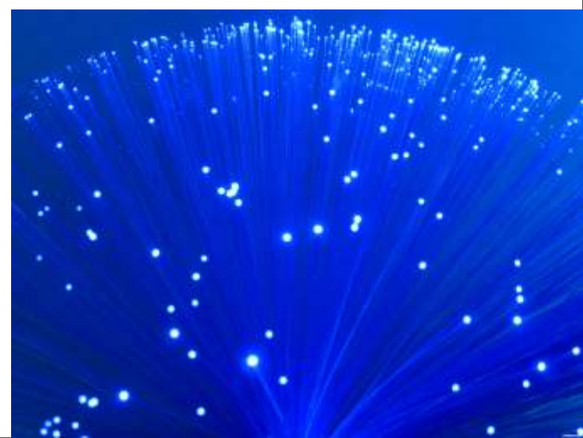


Figure 2: Schematic of Highly Sensitive and Selective Etched Fiber Bragg Grating Platform for Biosensing

Outcome

- Development of highly selective and sensitive bio-sensing functional layer for grating based optical sensors and Sis compact sensors
- Advanced signal processing for multi-parameter sensing with reduced cross-sensitivity
- Development of a novel platform technology involving functionalized fiber bragg grating, etched fiber bragg grating, long period grating and concatenated gratings based optical fiber sensors for sensing bio-pathogens and heavy metals
- Development of field deployable, low cost interrogation systems for grating based optical fiber sensor platform



Fate and Management of Emerging Contaminants (FAME)

Project 2

Vision statement:

Support the Clean Ganga Mission in India and water pollution control in the UK through the investigation of emerging contaminants fate and the development of novel solutions for their sustainable management.

Academic Partners

UCL

EXETER

Investigators

Prof. Ligy Philip

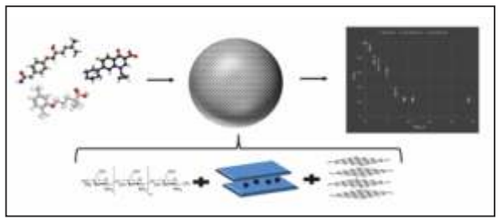
Prof. Absar Kazmi
Dr. Banu Prakash

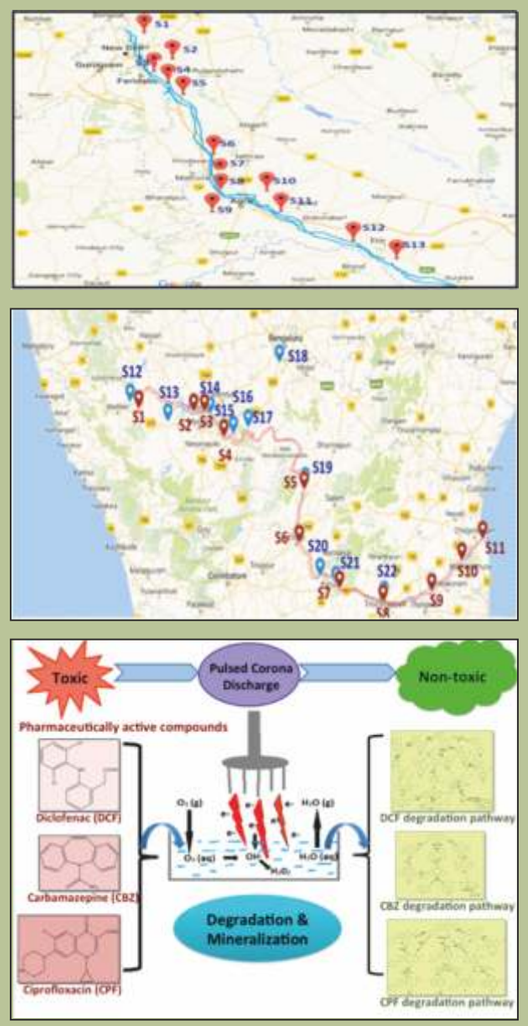
Dr. Sarah Bell

Dr Fayyaz Memon
Prof. David Butler
Prof. Shaowei Zhang

Methodology

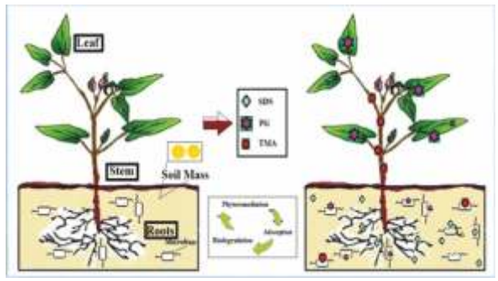
Monitoring of the fate and interaction of emerging contaminants (ECs) in surface water and development of an "open access" novel decision support system capable of automatically generating and identifying optimal sustainable water management strategies meeting end users needs and contexts.





Outcome

- Operation and design guidelines for energy efficient natural treatment systems for ECs management in rural communities and decentralised treatments for urban areas.
- An evidence based study for improved understanding of fate of emerging contaminants in: surface water, wastewater, groundwater and bio-solids bio-pathogens and heavy metals.



Impact of rainwater harvesting in India on groundwater quality with specific reference to fluoride and micropollutants.

Project 3

Vision statement:

To assess the impact of rainwater used for MAR on groundwater quality and more specifically understand how dissolved organic matter present in harvested rainwater affects fluoride and other pollutant levels, thereby improving MAR structure design and management practices.

Academic Partners

Other Partner

Ground Water Department
Govt. of Rajasthan

Investigators

Dr. Anupma Sharma

Dr. L. Vijay Anand

Dr. Rakesh K. Sharma

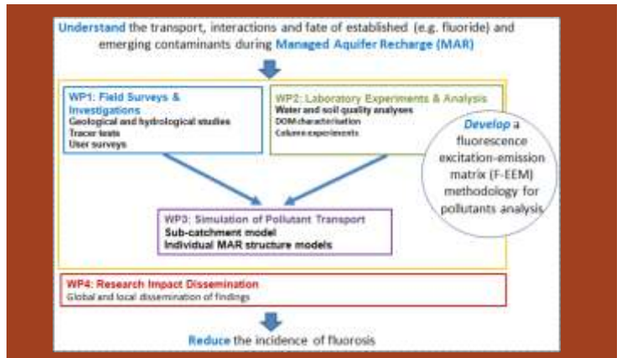
Dr. Alison Parker

Dr. Pablo C. Moreno

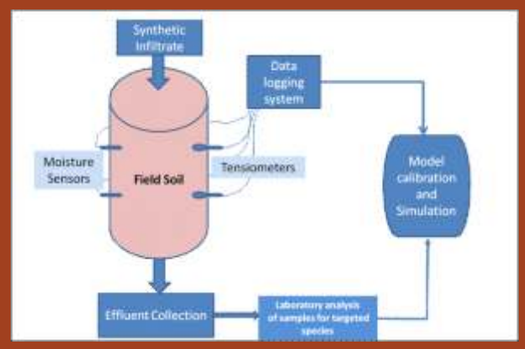
Methodology

- Field Surveys & Investigations to gain an understanding of fundamental geological and hydrogeological parameters and water quality;
- Laboratory Experiments to analyse water and soil samples from the field sites and characterisation of dissolved organic matter; (3), Simulation of Pollutant Transport to predict groundwater quality under variable forcing factors such as rainfall rates and land use patterns.

Chouka system (set of small-scale interlinked percolation ponds)



Schematic of Project Structure

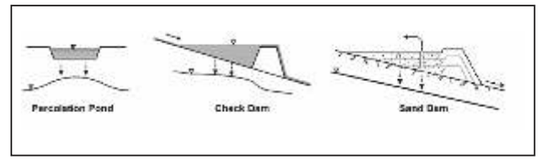


Transport of Pollutants through Variably Saturated Media

Location of proposed MAR sites in Rajasthan

Outcome

- To address the priority area “public health and well-being” as it has the potential to reduce the incidence of fluorosis in India and globally.
- To provide a better understanding of the transport, interactions and fate of established (e.g. fluoride) and emerging contaminants during MAR.



Rehabilitation of Vibrio Infested waters of VembanAd Lake: pollution and solution (REVIVAL)

Project 4

Vision statement:

Healthy environment, healthy population. Sustainable development, sustained economic benefits.

Academic Partners

Investigators

Anas Abdulaziz
Abdul Jaleel

Grinson George

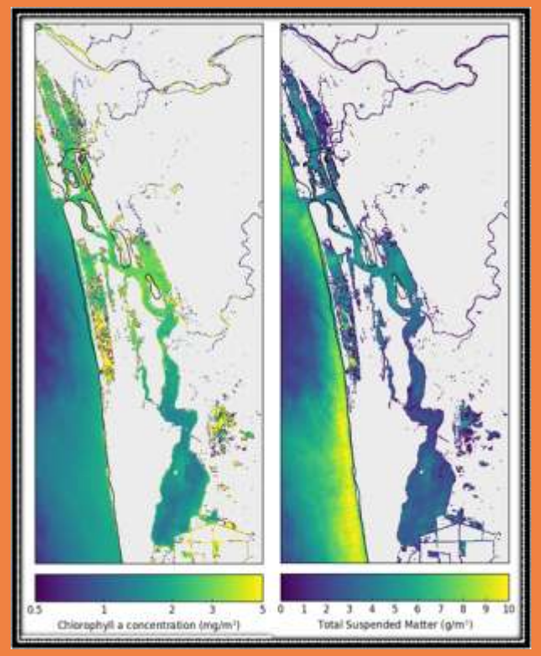
Amir Kumar Samal

Shubha Sathyendranath
Trevor Platt
Marie Fanny Racault
Robert Brewin

Methodology

- The proposed work deals with Vembanad Lake (popularly known as the Backwaters), the largest water body in the State of Kerala, a Ramsar site.
- Work plan is designed to observe the system at a variety of scales, ranging from in situ point observations and transects, to remote sensing that will serve to scale up the observations to the level of the entire lake.

A secchi disk with temperature sensors to be distributed to public as part of citizen science



Remote sensing image showing the distribution of chlorophyl and suspended matter in Vembanad lake

Outcome

- Will provide an information base to be used by policy makers and regulators reconciling the competing interests in the water body; through providing solutions to clean up, improve, monitor and maintain water quality in the lake; and restore its ecosystem.
- Will contribute to welfare through improvement of public health, maintenance of a secure income and provision of a cleaner environment.

Future Secular Changes & Remediation of Groundwater Arsenic in the Ganga River Basin

Project 5

Vision statement:

Researching the unique Natural Laboratory, the Ganga River Basin, develop global understanding of complex aquifers' vulnerability to secular changes in arsenic, and provide a strong basis for India & UK scientists/organisations to more effectively transfer knowledge, services & products to manage groundwater arsenic hazard for improved public health and wellbeing.

Academic Partners

Investigators

Narayan Ghosh

Himanshu Joshi

Ashok Ghosh

Abhijit Mukherjee

Academic Partners

Investigators

David Polya
Laura Richards

Debapriya Mondal

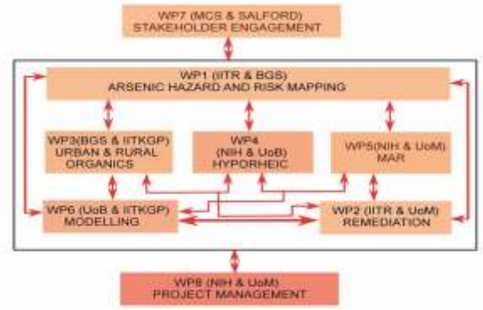
Darren Goody

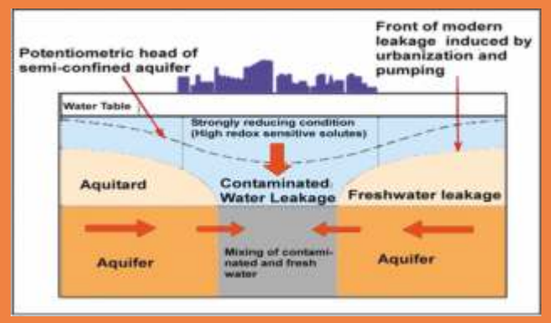
Stefan Krause

Methodology

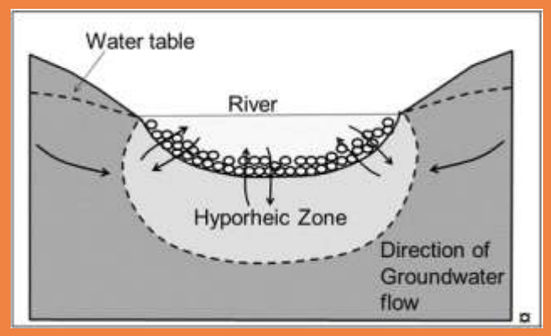
The project comprises 7 work packages:

- Hazard & Risk Modelling;
- Remediation Strategy – Present and Future;
- Urban & Rural Organics;
- Hyporheic Zone Contaminant Transport;
- MAR systems
- Reactive Contaminant Transport Modelling.
- Outreach, Impact and Stakeholder Engagement.





Schematic diagram of groundwater evolution beneath a developing city.



Schematic of hyporheic zone.

Outcome

- Mapping of current arsenic hazard and risks;
- Improved understanding of natural and anthropogenic controls on groundwater arsenic;
- Prediction of future arsenic hazard, including under rapidly growing urban areas and in MAR systems;
- Recommendations for groundwater management practices and strategic selection of water remediation technologies and publications.

The development and implementation of sensors and treatment technologies for freshwater systems in India

Project 6

Vision statement:

The improvement of measuring emerging pollutants and biological contamination in Indian freshwaters, to provide access to sustainable and safe drinking water for all through effective and affordable detection and treatment technologies.

Academic Partners

Bose Institute Kolkata

Institute of Life Science Bhubaneswar

IISER KOLKATA

Investigators

Prof. T. K. Dutta

Prof. K. Pakshirajan

Dr. S. K. Das

Prof. T. K. Sengupta

Academic Partners

BRISTOL University of the West of England

centrego

ctg

Portsmouth Aviation

FRANK WATER

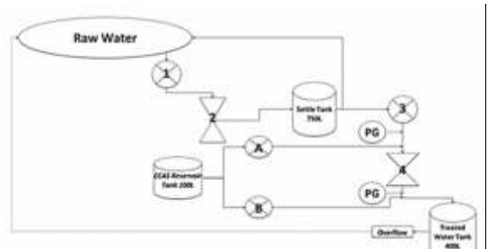
Investigators

Prof. D. N. Reynolds

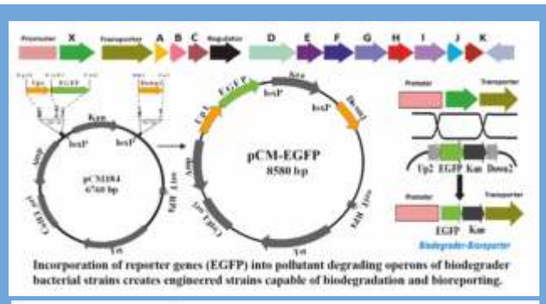
Dr. R. Thron

Methodology

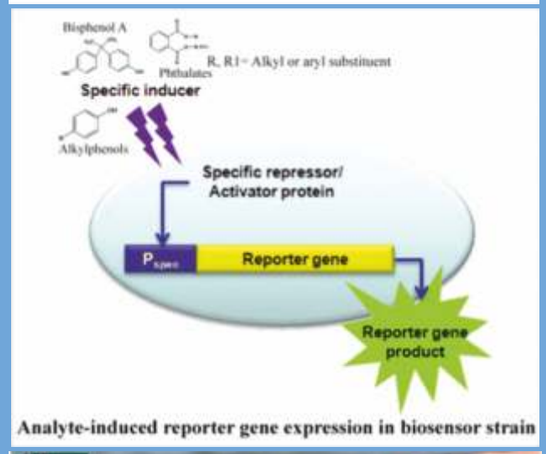
- In-situ fluorescence sensors for rapid detection of microbial contamination of freshwater sources
- Develop a novel biosensor for the detection of endocrine disrupting chemicals, using bio-reporter strains for detection of emerging chemical pollutants in freshwater systems.
- An “off-grid” water treatment technology will be deployed for both the removal of bacterial contaminants in freshwater systems and the production of potable drinking water.



Technical schematic of the off-grid drinking water production system. Direction of arrows refer to water flow direction. (1) Submersible filter pump (115 µm); (2) Reverse flushing filter (100 µm); (3) Peristaltic pump; (4) UF membrane columns (0.02 µm); ECAS reservoir tank 100L for ECAS generated outside of the DWPS; (A) & (B) ECAS peristaltic dosing pumps for delivering ECAS into the bulk treated water stream; (PG) Pressure gauges. Taken from Clayton *et al.* 2017, https://doi.org/10.1016/j.jwpe.2017.08.018



Incorporation of reporter genes (EGFP) into pollutant degrading operons of biodegrader bacterial strains creates engineered strains capable of biodegradation and bioreporting.



Analyte-induced reporter gene expression in biosensor strain

In-situ fluorescence sensor for rapid detection of microbial contamination

Outcome

- To develop and implement sensing technologies that improve the ability to determine the presence of emerging chemical pollutants and biological contamination in freshwaters.
- Project involves the exchange and development of ideas, skills, innovation, technology and knowledge to focus on delivering societal and economic impact in both the short and medium term.
- To provide robust proven technologies that can deliver tools for improving the quality of freshwater catchments in India, and beyond..

PATHWAYS and evolution of pollutants: Interactions between physical controlling effects, microbial community composition and pollutant biodegradation

Project 7

Vision statement:

The main scientific vision is to develop validated algorithms describing mixing and biodegradation processes in complex flow domains (rivers, ponds & wetlands, lakes) subject to a variety of controlling effects (shape, boundary, free surface, light, degradation, sorption) through in-situ field studies, and controllable purpose built laboratory flumes using state-of-the-art novel measurement technologies.

Academic Partners

Investigators

Prof. Kapil Gupta

Dr. Jonathan Pearson
Prof. Hendrik Schafer
Prof. Gary Bending

Methodology

The research will be progressed principally by a combination of mathematical modelling, experimental flume studies, and environmental experimental field sampling campaigns.

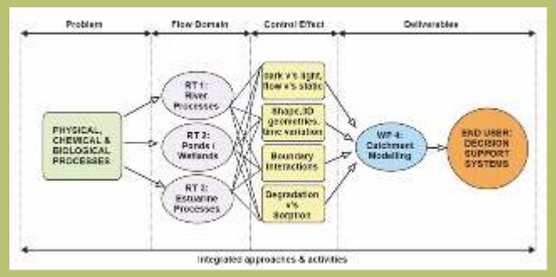


Figure 1: Integrated approaches for the controlling physical and microbial effects

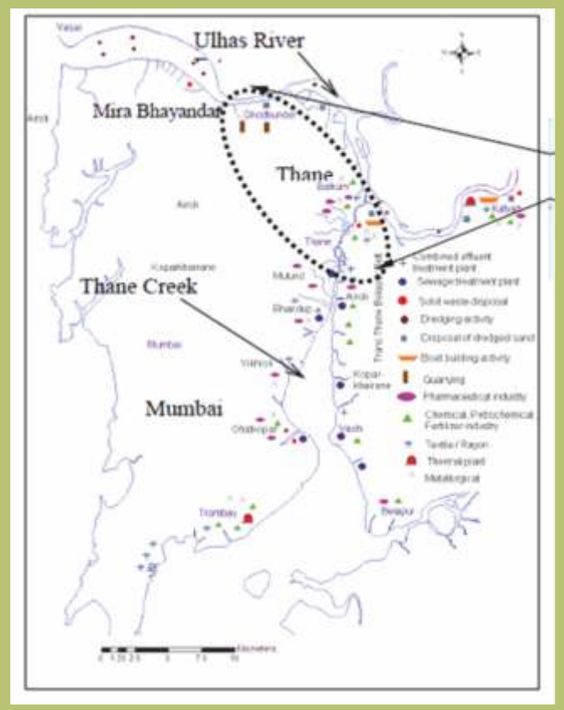


Figure 2: Our study, Ulhas River and Thane Creek

Outcome

- Study will employ a range of novel fundamental research approaches, including laboratory and field tracer studies, data interpretation and simulations, to ascertain the pathways and evolution of pollutants within a range of flow domains.
- The characteristics of the microbial communities in river water and sediments (microbial diversity) and their pollutant-degrading potential will be assessed and how they are affected by physical and chemical controls in four flow domains: rivers, lakes and wetlands and near-shore in the Ulhas River/Thane Creek Catchment (Mumbai Metropolitan Region, India).

Antimicrobial resistance and pollutants: interactive studies and novel sensor technologies

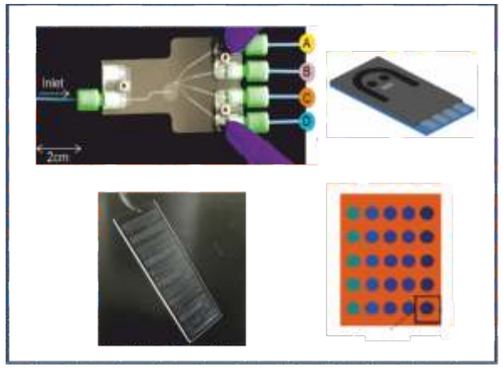
Project 8

Vision statement:

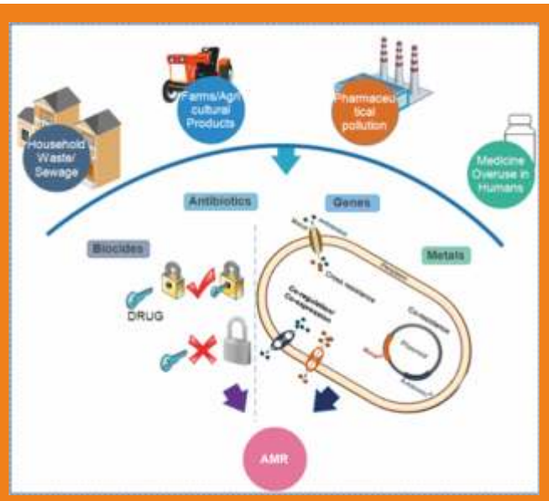
The over-arching focus of this proposal is to develop novel sensors to measure the concentration of antimicrobials, heavy metals and AMR genes to explore the relationship between the pollutants and AMR

Methodology

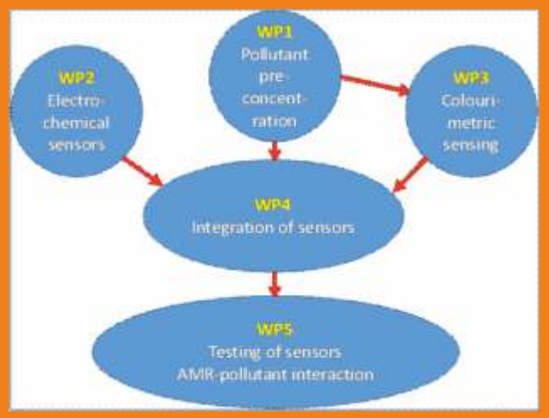
- Identification of the most effective polymers showing strong binding with heavy metals and targeted pollutants for pre-concentration or potential removal at the source and integration into sensors.
- Development of rapid, low-cost carbon based electrochemical sensors to detect and monitor heavy metals, antimicrobials and AMR genes
- Fabrication and characterization of user friendly, robust, low-cost paper-microfluidic sensors



Sample pre-processing and electrochemical/microfluidic sensors



Role of pollutants in anti-microbial resistance



Project methodology

Outcome

- The primary outcome of this project, would be to provide a better understanding of the prevalence of different pollutants in water and their impact on AMR.
- Another main output of the project would also be a benchmark system against traditional testing procedure with added benefit of field studies contributing to the evidence base regarding the transport and interaction of heavy metals, antimicrobials and AMR in the environment.
- Will improve water quality in India by delivering novel sensor technology for ongoing water quality monitoring and improved understanding of the role of pollutants in increasing levels of AMR.

Academic Partners

Investigators

T. Renganathan
S. Pushpavanam
R. Ravikrishna
Indhumathi M. Nambi
V. V. Raghavendra Sai

Gargi Singh

Academic Partners

Investigators

Helen Bridle
Marc Desmulliez

Lisa Avery
Zulin Zhang
Eulyn Pagaling

Mark Bradley
Seshasailam
Logan Mackay