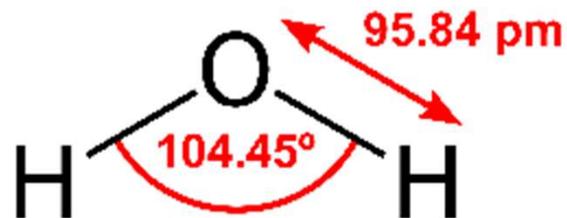




Since 1959



Water Technology Particularly for Drinking Water and Atmanirbharata

Co-founder

InnoNano Research Pvt. Ltd.
InnoDI Water Technologies Pvt. Ltd.
VayuJAL Technologies Pvt. Ltd.
Aqueasy Innovations Pvt. Ltd.
Hydromaterials Pvt. Ltd.
EyeNetAqua Solutions Pvt. Ltd.
DeepSpectrum Innovations Pvt. Ltd.



Associate Editor

ACS
Sustainable
Chemistry & Engineering

T. Pradeep

Institute Professor, IIT Madras

pradeep@iitm.ac.in

<https://pradeepresearch.org>

Professor-in-charge



International Centre for Clean Water



Dept. of
Science and Technology
Govt. of India
&
Tamilnadu State Council for
Science and Technology
Govt. of Tamilnadu



Celebrates
VIGYAN UTSAV
(Science Festival)
Theme
**ATMANIRBARATHA
& INDUSTRY**
29 July 2022
11 a.m. to 1:00 p.m.

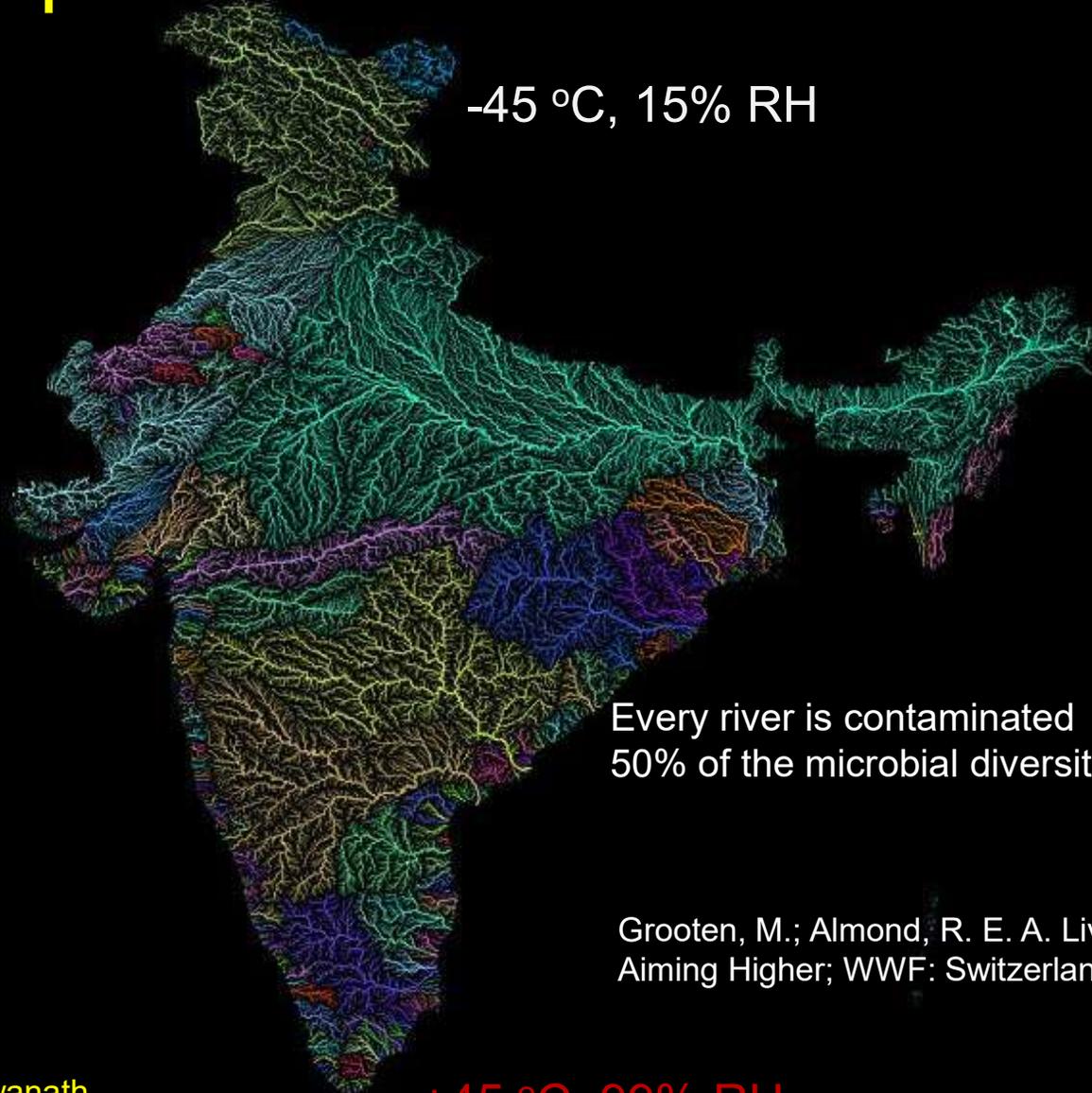


Atmanirbarata & Industry, Tamilnadu State Council for Science & Technology, July 29, 2022

Challenges

Every possible need

Arsenic
Fluoride
Uranium
Mercury
Chromium
Perchlorate
Nitrate
Pesticides
Antibiotics
Plastics
Detergents
.....



-45 °C, 15% RH

Every river is contaminated
50% of the microbial diversity is lost for ever

Grooten, M.; Almond, R. E. A. Living Planet Report - 2018:
Aiming Higher; WWF: Switzerland, 2018.

+45 °C, 99% RH

From S. Vishwanath

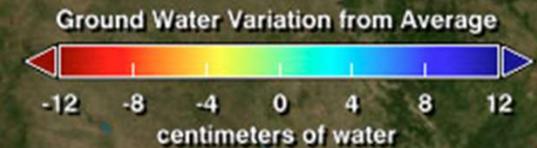
Indian agriculture

67% of agriculture run on GW

Total districts 742
Water stressed >300
256 with critical or overexploited ground water levels
'India is suffering from its worst water crisis in its history.'

November 2002

November 2008



Data from NASA

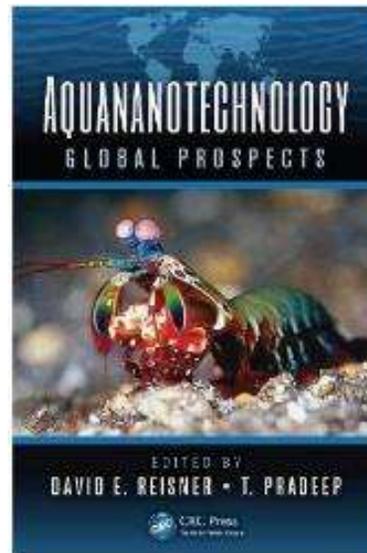
Water purification, history

Important milestones in the history of water purification (1800–2007) from the perspective of noble metal nanoparticles in water treatment (compiled from multiple sources on the World Wide Web).

Year	Milestone
1804	Setup of world's first city-wide municipal water treatment plant (Scotland, sand-filter technology)
1810	Discovery of chlorine as a disinfectant (H. Davy)
1852	Formulation of Metropolis Water Act (England)
1879	Formulation of Germ Theory (L. Pasteur)
1902	Use of chlorine as a disinfectant in drinking water supply (calcium hypochlorite, Belgium)
1906	Use of ozone as a disinfectant (France)
1908	Use of chlorine as a disinfectant in municipal supply, New Jersey
1914	Federal regulation of drinking water quality (USPHS)
1916	Use of UV treatment in municipal supplies
1935	Discovery of synthetic ion exchange resin (B. A. Adams, E. L. Holmes)
1948	Nobel Prize to Paul Hermann Muller (insecticidal properties of DDT)
1959	Discovery of synthetic reverse osmosis membrane (S. Yuster, S. Loeb, S. Sourirajan)
1962	<i>Silent Spring</i> published, first report on harmful effects of DDT (R. Carson)
1965	World's first commercial RO plant launched
1974	Reports on carcinogenic by-products of disinfection with chlorine Formulation of Safe Drinking Water Act (USEPA)
1975	Development of carbon block for drinking water purification
1994	Report on use of zerovalent iron for degradation of halogenated organics (R. W. Gillham, S. F. O'Hannesin)
1997	Report on use of zerovalent iron nanoparticles for degradation of halogenated organics (C-B. Wang, W.-X. Zhang)
1998	Drinking Water Directive applied in EU
2000	Adoption of Millennium Declaration during the UN Millennium Summit (UN Millennium Development Goals)
2003	Report on use of noble metal nanoparticles for the degradation of pesticides (A.S. Nair, R. T. Tom, T. Pradeep)
2004	Stockholm Convention, banning the use of persistent organic pollutants
2007	Launch of noble metal nanoparticle-based domestic water purifier (T. Pradeep, A. S. Nair, Eureka Forbes Limited)

Affordable clean water is a problem of advanced materials

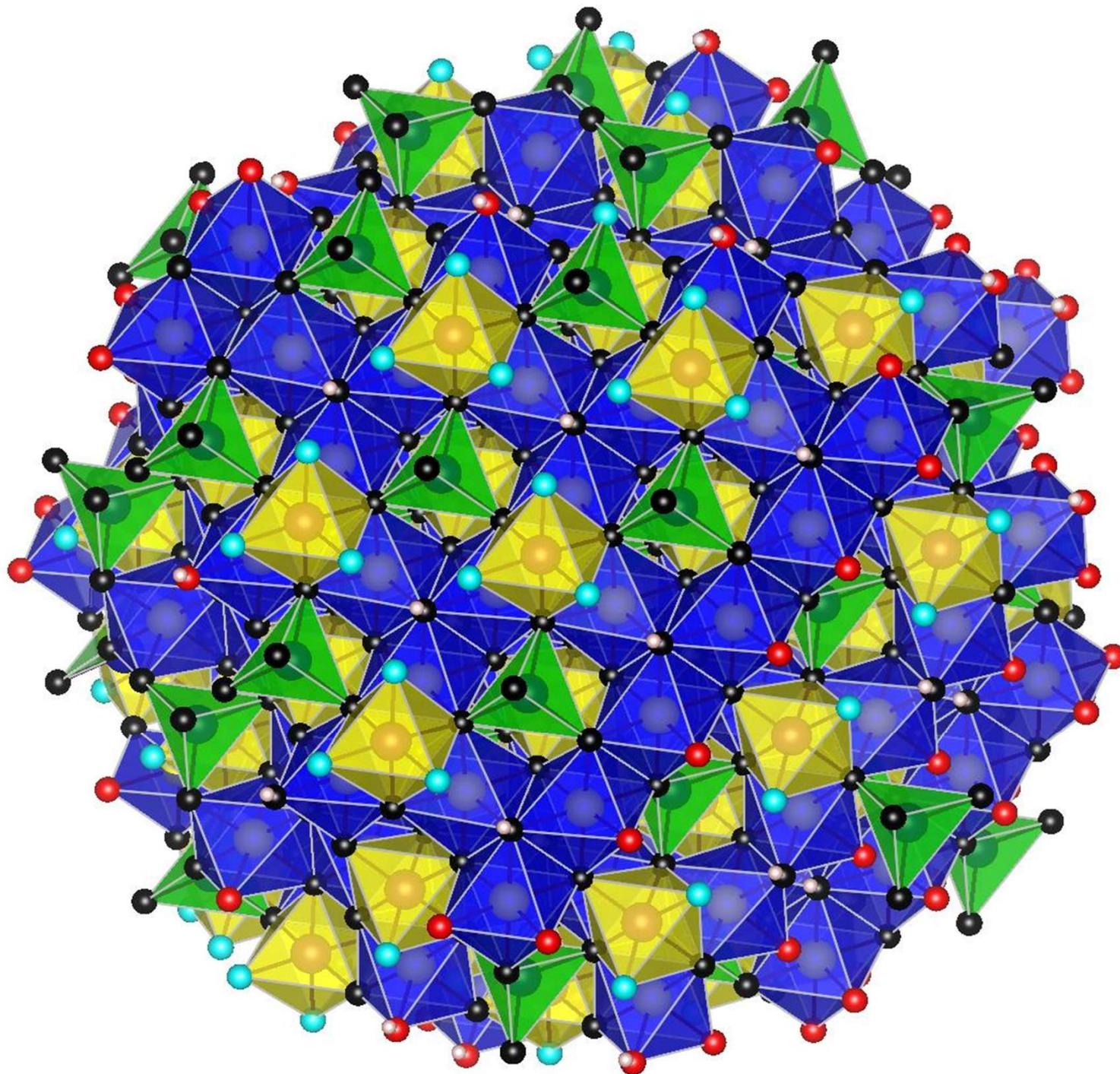
- New adsorbents
- New sensors
- New catalysts
- Novel phenomena
- New devices

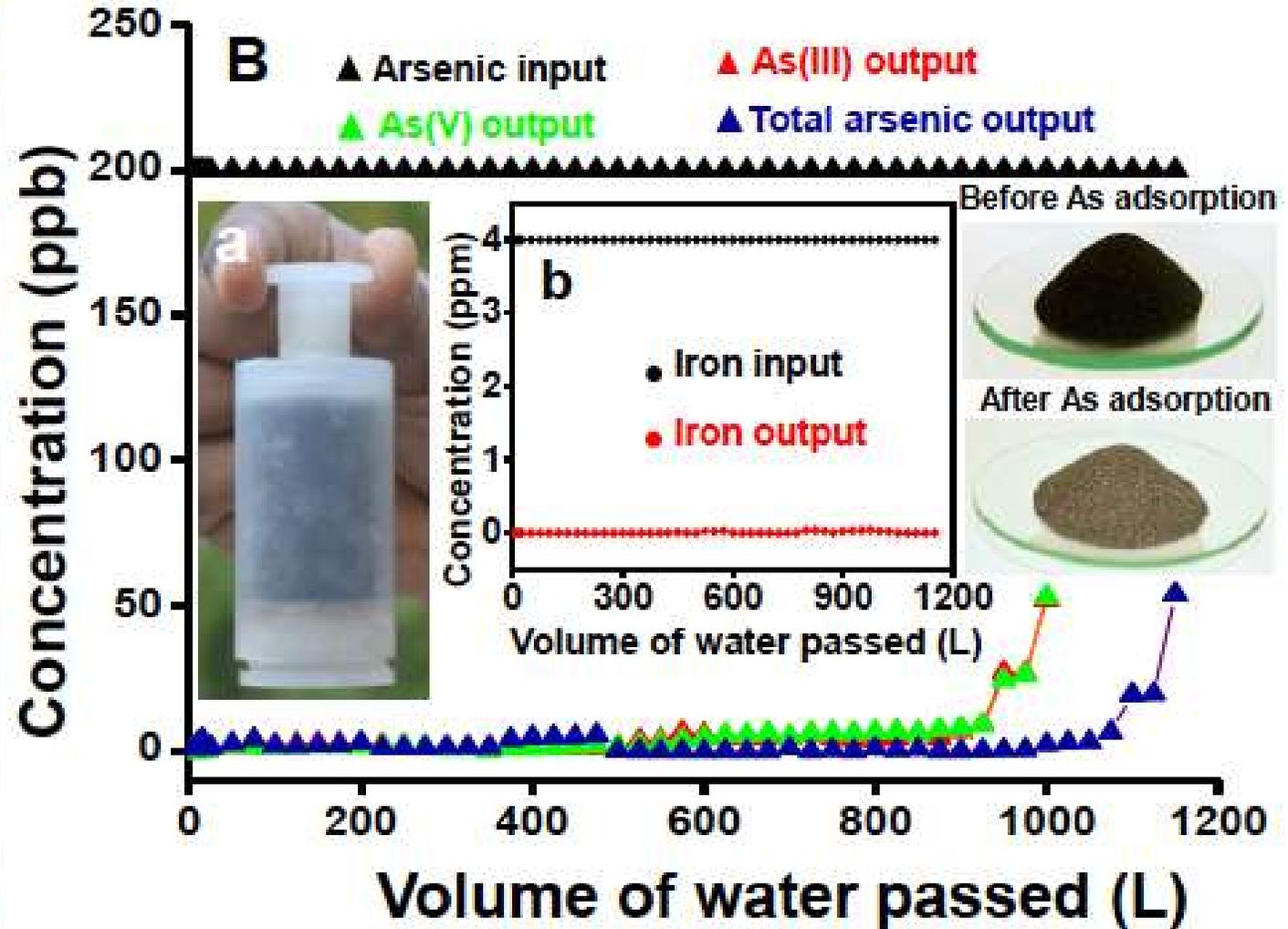


Nanomaterials can solve real problems



ACS Sustainable Chemistry & Engineering Editorial, December 2016







Population Map Of India-2001



Changing the dynamics in the field



Existing plant in 40 cents

- Existing unit for iron and arsenic removal – 20 m³/h
- Uses activated alumina and iron oxide (old generation of adsorbents)



New plant in 3 cents

- Existing unit for iron and arsenic removal – 18 m³/h
- Uses iron oxyhydroxide (new generation of adsorbents)
- Input arsenic concentration: 168 ppb
- Output arsenic concentration: 2 ppb



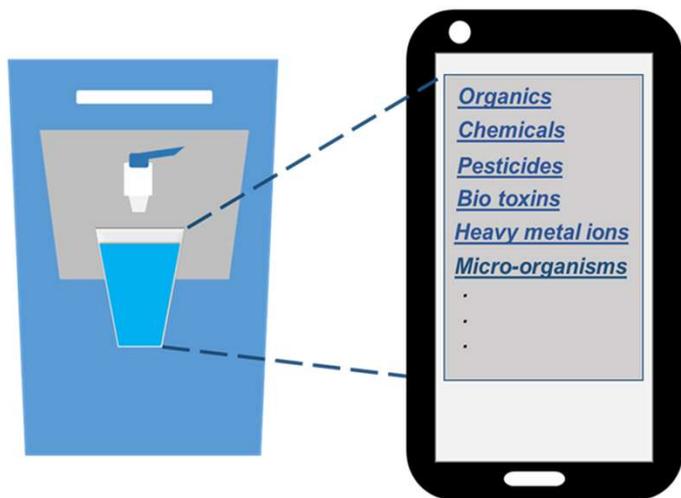
Cleanwater at 2.1 paise per litre!

Calculation for the Tariff to be collected for treated water (Revision if Required)

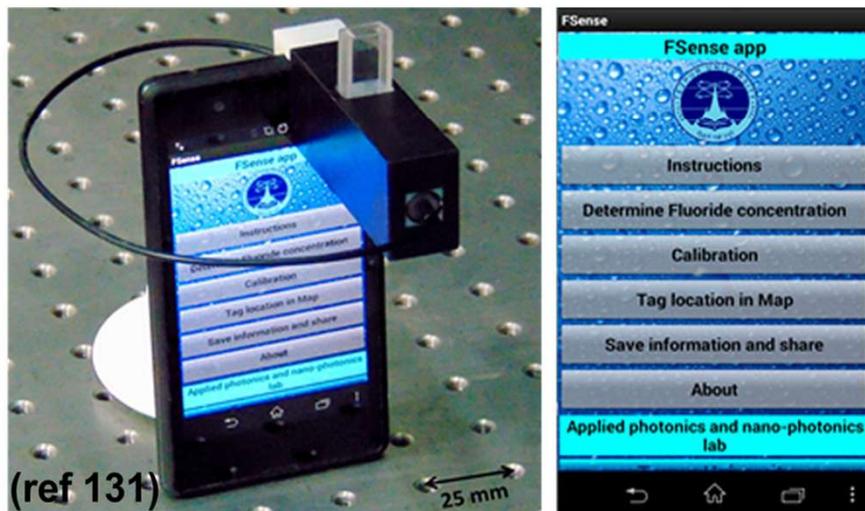
Sr.No	Design population	1,071	Plant capacity/70 LPCD
	Item/Description	Cost / Quantity	Remarks
1	Cost of Replacement of Iron removal media	56400	After minimum two years if Iron concentration is more than 5 ppm. But iron concentration is more than 5 ppm at only two to three places. Therefore media may work for 3 years also.
2	Cost of Replacement of Arsenic removal media	978660	After minimum two years if Arsenic concentration is more than 100 ppb. But arsenic concentration is more than 100 ppb at only two to three places. Therefore media may work for 3 years also.
3	Cost of replacement of Activated Carbon	28560	
4	Total cost of Replacement of media	1063620	After minimum two years.
5	Total cost of Replacement of media for one year	531810	
6	Plant capacity	75000	ltr per day
7	Design population	1,071	Plant capacity/70 LPCD
8	Cost per liter of water	2.1 Paise per ltr	
9	Cost of replacement of media	1.36	Rs. per head per day =Media replacement cost per year/365/Design population
		<u>40.80</u>	per head per month for 70 LPCD water

Smart water purifiers and big data

Smart Water Purifiers linked to IoT

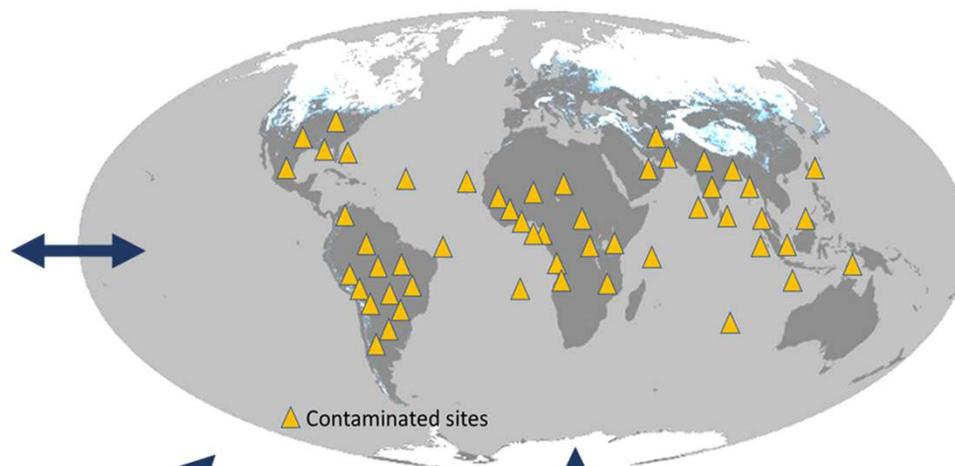


Cost-effective sensor accessory for point-of-use applications

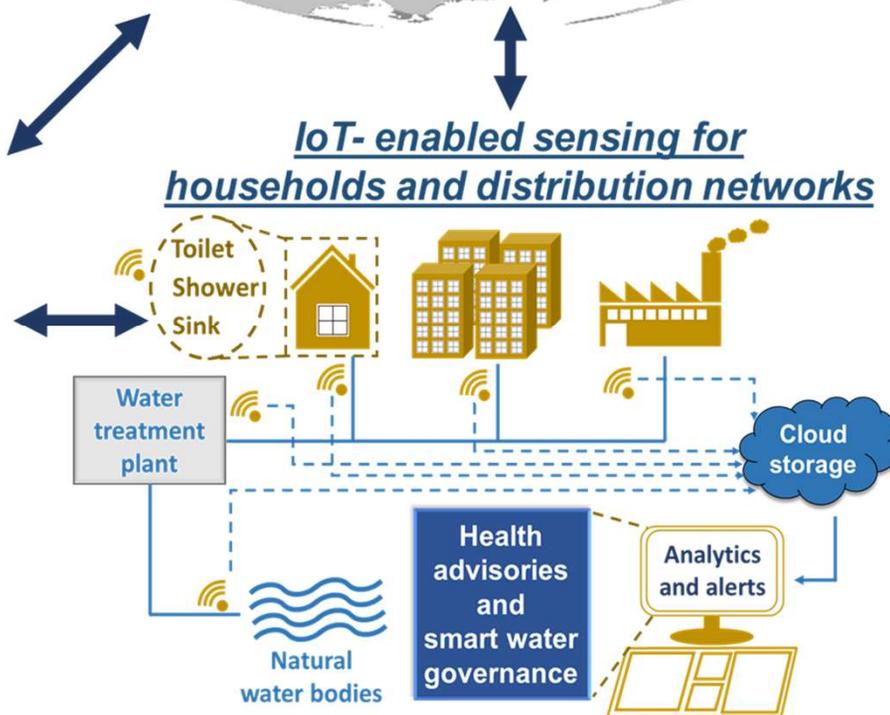


(ref 131)

Global Map of Water Health



IoT-enabled sensing for households and distribution networks



Waste management

Adsorbents conform to toxicity characteristic leaching procedure

Elemental waste goes back to local environment

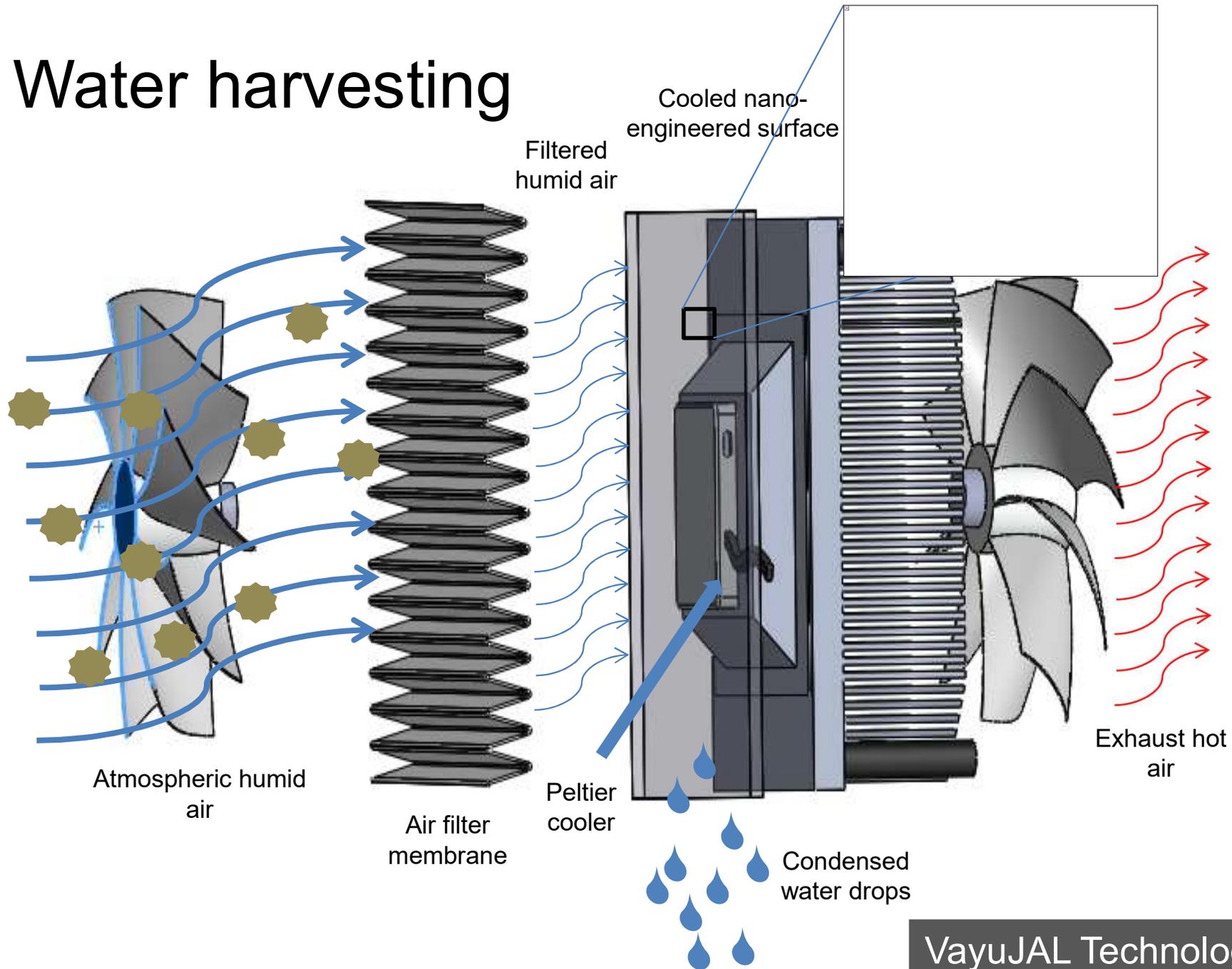
Safe disposal of arsenic (or any other) laden waste

Additional protection could be considered, if necessary

Exploring viable uses



Water harvesting



VayuJAL Technologies Pvt. Ltd.
Ramesh Kumar Soni and Ankit Nagar

Products in the field



35 LPD 120 LPD

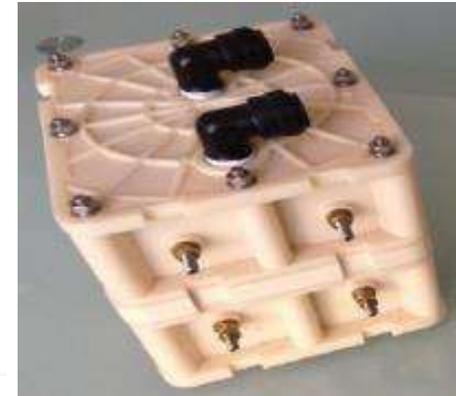
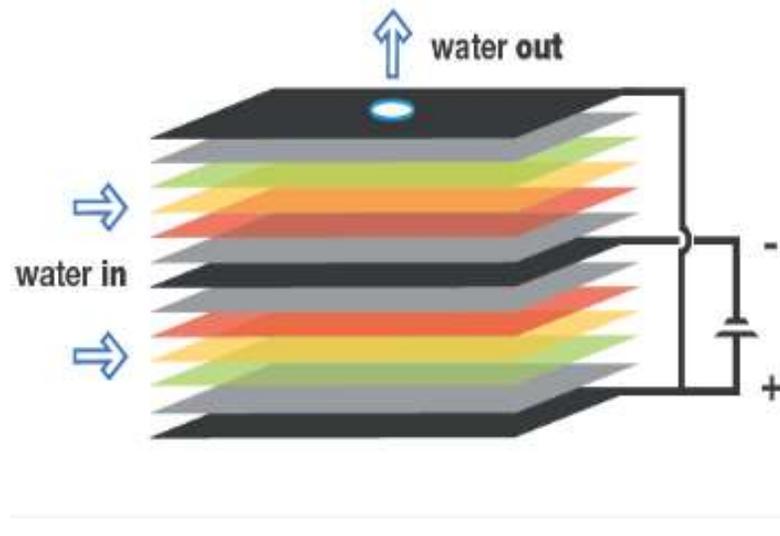
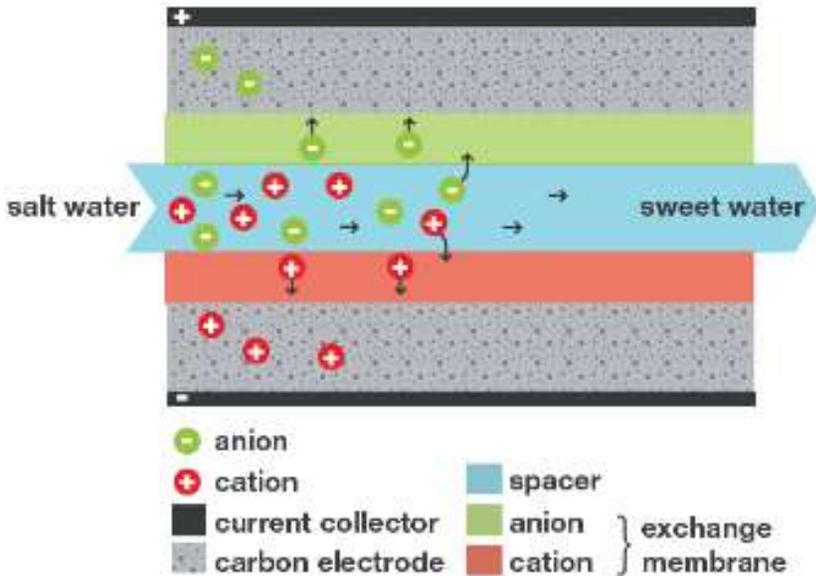
400 LPD

1000 LPD

2000 LPD

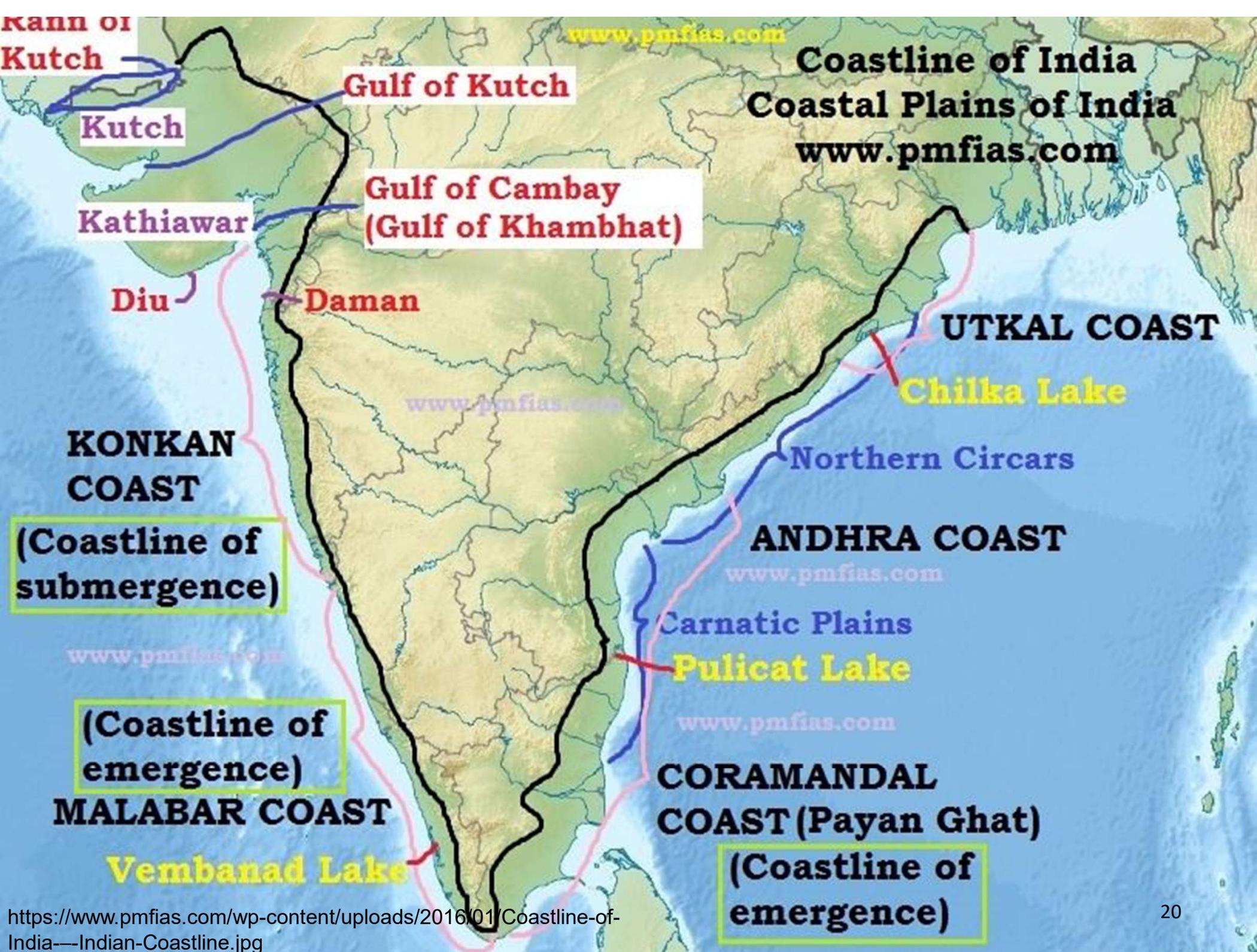
(LPD: Litres per day)

Capacitive Desalination (CDI)



Our new company

Soujit Sengupta, Rabiul Islam and others



Kutch

Gulf of Kutch

Kutch

Coastline of India
Coastal Plains of India
www.pmfias.com

Kathiawar

**Gulf of Cambay
(Gulf of Khambhat)**

Diu

Daman

UTKAL COAST

Chilka Lake

**KONKAN
COAST**

Northern Circars

**(Coastline of
submergence)**

ANDHRA COAST

www.pmfias.com

www.pmfias.com

Carnatic Plains

**(Coastline of
emergence)**

Pulicat Lake

www.pmfias.com

MALABAR COAST

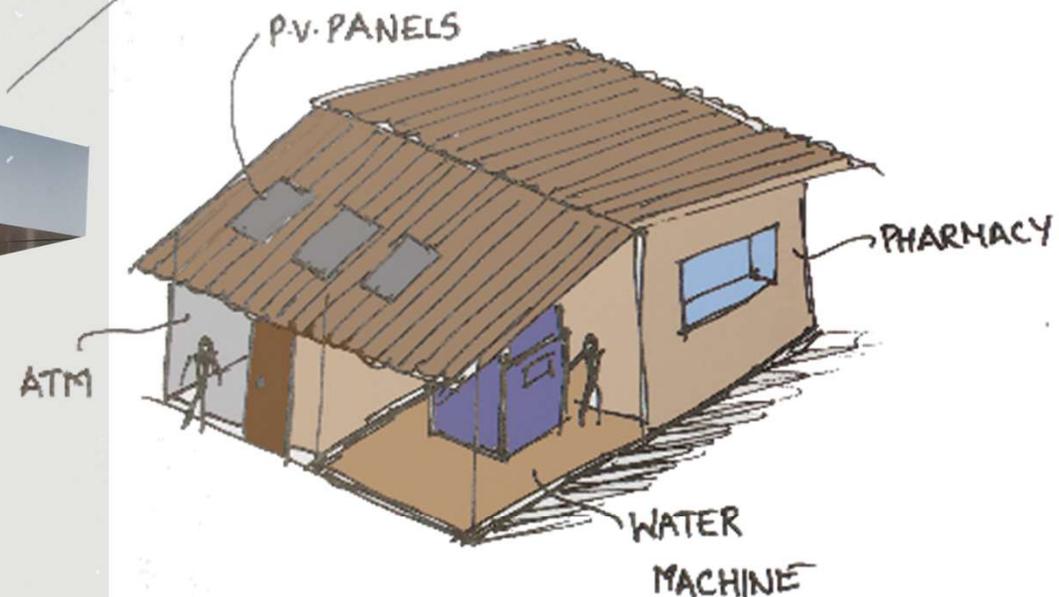
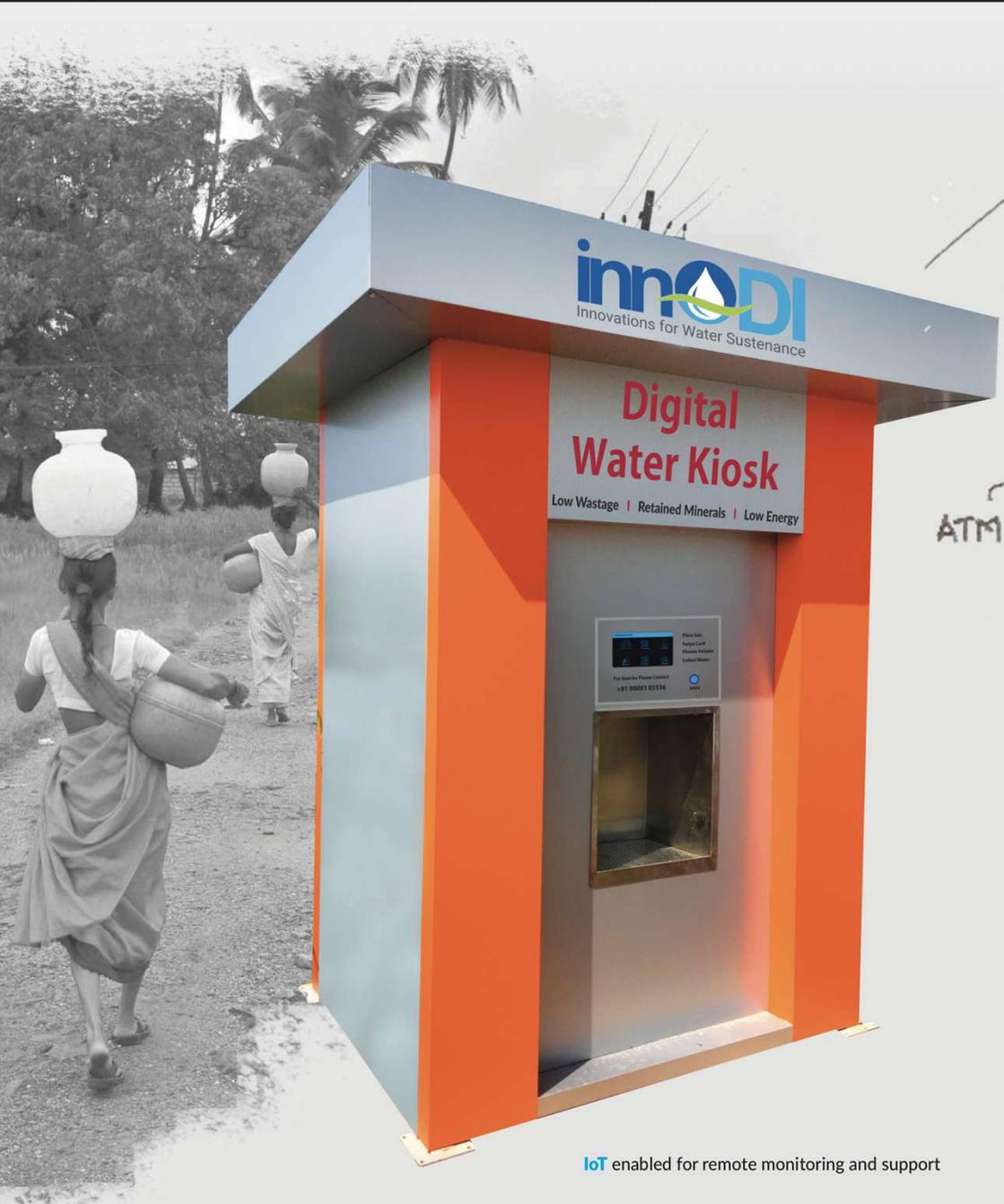
**CORAMANDAL
COAST (Payan Ghat)**

**(Coastline of
emergence)**

Vembanad Lake

DIGITAL WATER KIOSK

for community drinking using CDI Technology



Products under implementation

Vijay Sampath and Tullio Servida

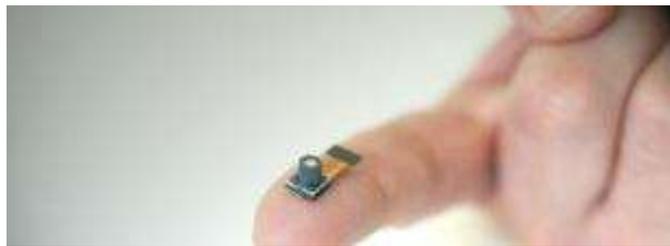
Sensors and new opportunities



Analog/Grating
Equipment
\$ 5~6 Billion (2017)
a few **100k units (2017)**



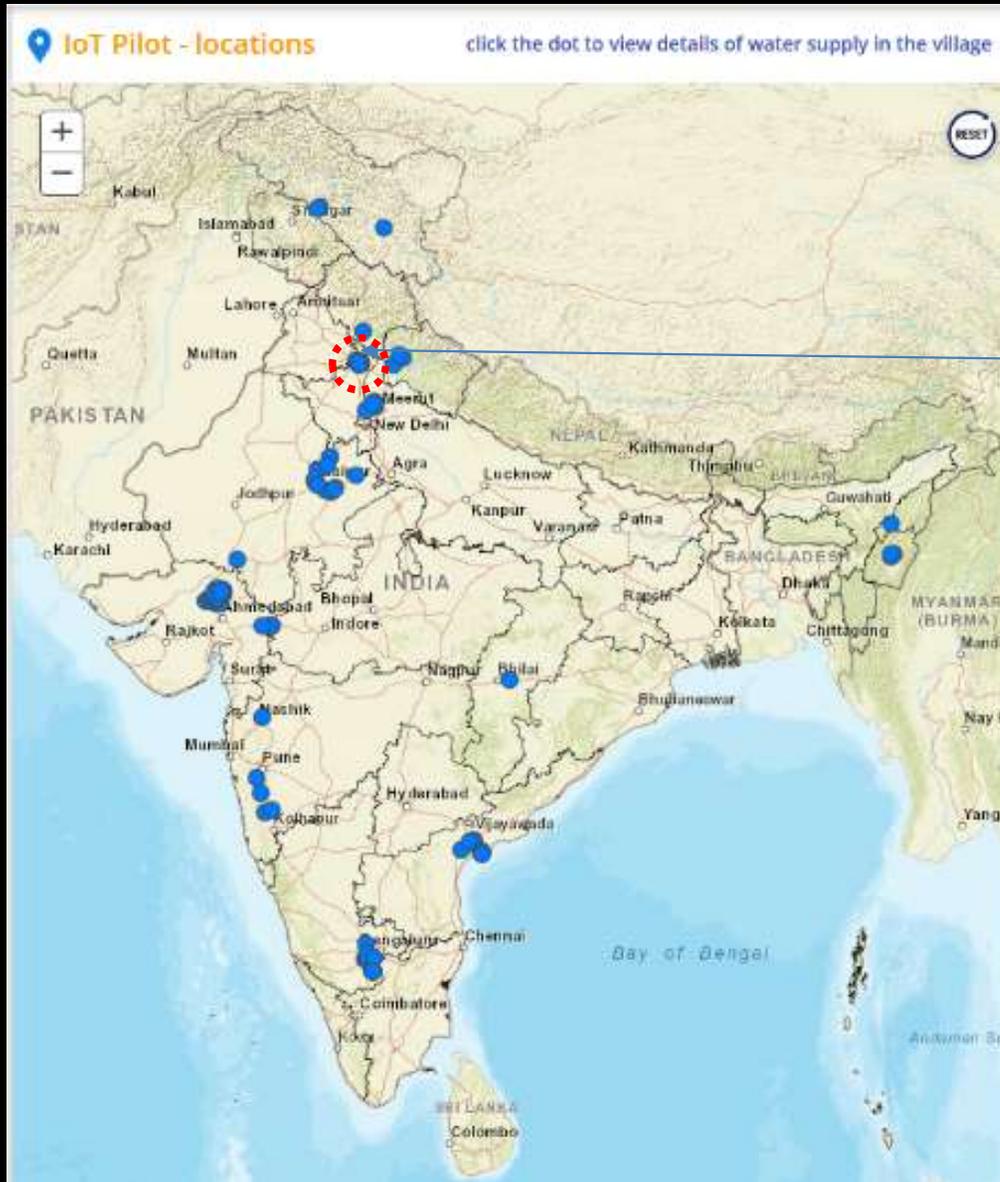
**Ultra compact Low Cost
Spectral Sensor Module**
~ **Billions units (? 2027)**



Water quality measurement – In the pipeline

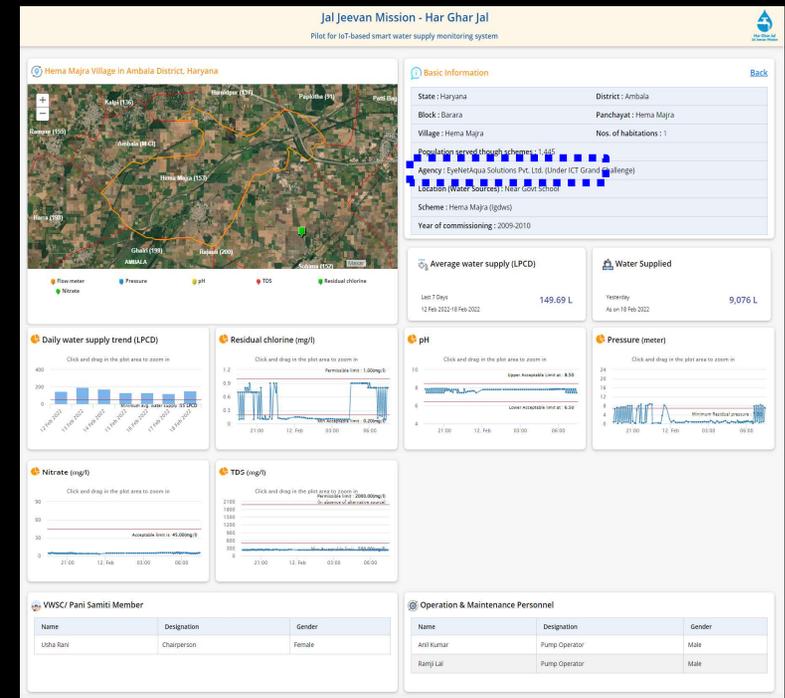
nano λ

India's water is being monitored



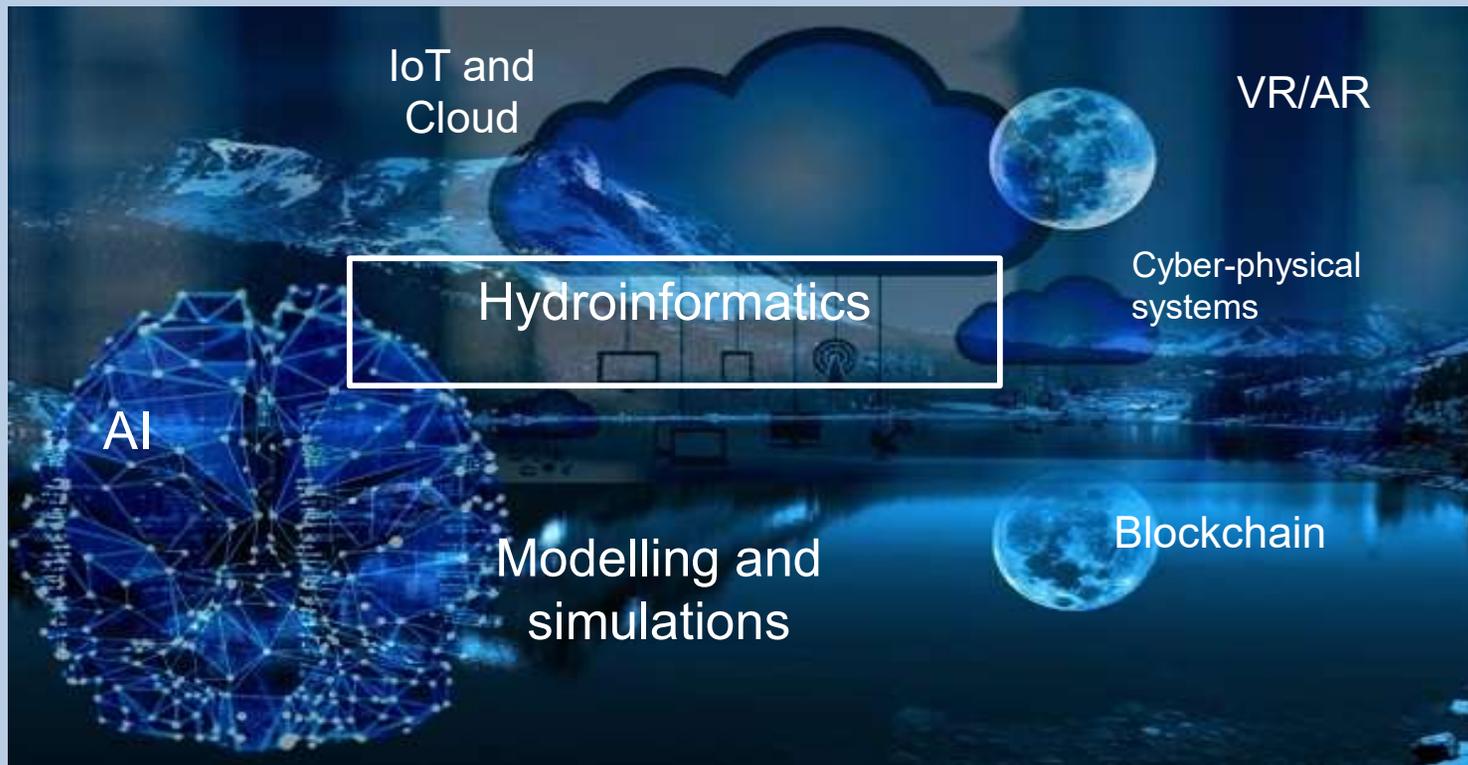
IITM/IISc

Installations made by four companies



Hydroinformatics

Application of computing technologies for efficient, sustainable and equitable water management.



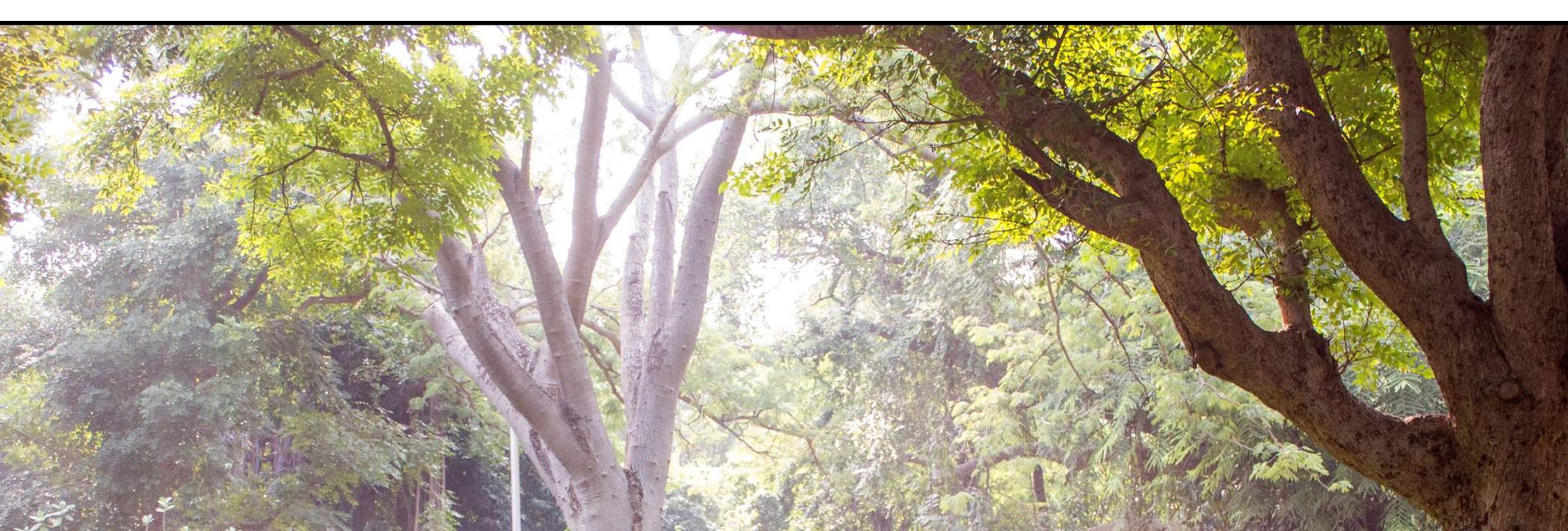
Digital water or water 4.0 will revolutionize water management.



International Centre for Clean Water



IIT Madras Research Park



The AMRIT Team, 2013



Group during 2018, along with Prof. Graham Cooks



Thank you all

People: A. Sreekumaran Nair, Anshup, M. Udhaya Sankar, Amrita Chaudhary, Renjis T. Tom, T. S. Sreeprasad, Udayabhaskararao Thumu, M. S. Bootharaju, K. R. Krishnadas, Kalamesh Chaudhari, Soujit Sengupta, Depanjan Sarkar, Avijit Baidya, Swathy Jakka Ravindran, Abhijit Nag, S. Vidhya, Biswajit Mondal, Krishnan Swaminathan, Azhardin Gnayee, Sudhakar Chennu, A. Suganya, Rabiul Islam, Sritama Mukherjee, Tanvi Gupte, Jenifer Shantha Kumar, A. Anil Kumar, Ankit Nagar, Ramesh Kumar Soni, Tanmayaa Nayak, Shihabudheen M. Maliyekkal, G. Velmurugan, Wakeel Ahmed Dar, Ganapati Natarajan, N. Pugazhenthiran, A. Leelavathi, Sahaja Aigal, S.Gayathri, Bibhuti Bhusan Rath, Ananthu Mahendranath, Harsh Dave, Erik Mobegi, Egor Moses, Hemanta R. Naik

Funding: Department of Science and Technology, Government of India

Start-ups and partners:

