IGSTC

INDO-GERMAN SCIENCE AND TECHNOLOGY CENTRE

INTEGRATED WATER RESOURCE MANAGEMENT

Indo-German Pathways to Sustainable Futures

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Catalysing Indo-German Research & Technology Partnership

Feb 2026

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About IGSTC

The Indo-German Science & Technology Centre (IGSTC) has been established to facilitate Indo-German R&D projects and networking through substantive interactions among Government, academia/research systems and industry to foster innovation for the overall economic and societal developments of both the countries.

IGSTC Aims to:

- Play a proactive role in facilitating participation of industry in joint R&D+I projects.
- Provide/assist in mobilizing resources to carry out industrial R&D+I projects.
- Promote electronic exchange and dissemination of information on opportunities in bilateral science & technology cooperation. The Centre will also prepare/compile state-of-the-art reports on topics of interest with the help of highly qualified scientists and technologists from both the countries.
- Provide advice to institutes and industries from both the countries on the possibilities of Indo-German cooperation and help identify suitable partners.
- Facilitate and promote Indo-German collaboration in Science and Technology through substantive interaction among Government, academia and industry.
- Encourage Public-Private Partnerships (PPP) to foster elements of innovation and industrial application and cultivate a culture of cooperation between science and industry.
- Nurture networking between young and mid-career scientists and technologists to develop a sense of mutual trust, leadership and entrepreneurship.
- Develop cooperation through the identification of scientists and scientific institutions of the two countries.
- Organize workshops, seminars, training programmes and other types of events on topics of mutual interest.

Preface

For more than a decade and a half, IGSTC has developed a strong portfolio of Indo-German collaborative research through its 2+2 Projects, Bilateral Workshops, and specialised fellowship programmes, including WISER, PECFAR, and the Industrial Fellowships (PDIF and PIEF). These initiatives have advanced innovative approaches in water science and Integrated Water Resource Management, ranging from smart monitoring and predictive modelling to nature-based and engineered solutions. By nurturing interdisciplinary collaboration and linking scientific innovation with practical application, IGSTC-supported research is contributing to improved water security, enhanced environmental protection, and greater climate resilience across multiple sectors. Collectively, these efforts demonstrate IGSTC's sustained commitment to promoting resilient and sustainable water systems for the future.

Researchers in India and Germany have come together to prioritize exploration of key areas like:

1. **Water and Wastewater Management:** Advancing technologies and strategies for efficient treatment, reuse, and protection of water resources.
2. **Water Infrastructure Integration and Planning for Smart Cities:** Integrating water systems with urban planning, data platforms, and resilient infrastructure for smart, sustainable livelihood.
3. **Climate, Water & Environmental Risks:** Understanding climate-driven hazards and developing predictive tools to reduce water-related risks.
4. **Aquatic & Ecosystem Sustainability:** Preserving aquatic biodiversity and ecosystem functions under growing environmental pressures.
5. **Hydrogeology, Geomechanics & Resource Systems:** Unlocking insights into subsurface waters and geosystems for sustainable resource management.

Taken together, these projects and fellowship outcomes illustrate the dynamic ecosystem created by IGSTC to advance integrated and sustainable water resource management through bilateral excellence.

WATER AND WASTEWATER MANAGEMENT

The project EfectroH2O: Effect-based Monitoring Demonstrates the Efficiency of Electrically-driven Water Treatment Processes to Remove Salts and Micropollutants from Process Water implemented through a partnership between IIT Madras, Tamilnadu Water Investment Company (TWIC), RWTH Aachen University, Goethe University Frankfurt, and Ibacon GmbH, demonstrates a clear value addition over conventional textile wastewater treatment technologies by introducing a novel, chlorine-free electrochemical ozone oxidation process (ECOOP) combined with capacitive deionization (CDI). Existing solutions in textile effluent treatment largely depend on chemical oxidation, chlorination, and energy-intensive reverse osmosis systems, which generate toxic by-products, suffer from membrane fouling, and incur high operating and maintenance costs. In contrast, the ECOOP system achieves high removal efficiencies for color and organic pollutants (up to 96% color and 53% COD removal under real industrial conditions) without producing harmful chlorinated residues, thereby offering a safer and more environmentally sustainable alternative.

A further key advancement lies in the project's differentiated treatment strategy, which recognizes that only a small fraction of textile effluent contains high pollutant loads while the majority consists of lower-strength wash water. By treating dye-bath effluents with ECOOP followed by RO, and wash water with biological treatment followed by CDI, the system significantly reduces dependence on RO units, extends membrane life, lowers sludge generation, and cuts overall treatment costs. The successful pilot-scale demonstration at a CETP under real operating conditions confirms the robustness and industrial relevance of the technology. Compared to existing ZLD-based systems, this integrated electrochemical and effect-based monitoring approach delivers superior pollutant removal, reduced environmental impact, and improved techno-economic feasibility, marking a substantial step forward in sustainable wastewater management for the textile industry.

Tamilnadu Water Investment Company (TWIC)

"Driving sustainable textile wastewater treatment from pilot innovation to industrial reality."

Ibacon GmbH

"Advancing effect-based monitoring for safer and smarter water quality assessment."

Electrochemical Ozone Oxidation Process (ECOOP) installed at CETP, Tiruppur

Capacitive Deionization (CDI) at CETP

Another project Cleanwater: Modular lightweight wastewater treatment units made with Textile Reinforced Concrete (TRC) for rural and peri-urban dwellings was implemented jointly by IIT Madras, CSIR-SERC, Raina Industries from Indian side and RWTH Aachen University & Betonwerk Hentzschel GmbH from German side.

Conventional decentralized wastewater treatment solutions in rural and peri-urban regions mainly rely on reinforced cement concrete (RCC) septic tanks or small prefabricated plastic units. RCC systems are generally bulky and heavy, require large quantities of construction material, and are difficult to transport and install in remote or inaccessible locations. Over time, they are also vulnerable to cracking, corrosion of steel reinforcement, and leakage, which can lead to groundwater contamination and higher maintenance costs. Plastic units, although lighter and easier to handle, often suffer from limited structural strength and susceptibility to ultraviolet radiation and mechanical damage. Their long-term durability under field conditions is therefore uncertain, particularly when exposed to fluctuating temperatures and

chemically aggressive wastewater. As a result, both conventional options present challenges in terms of service life, operational reliability and overall sustainability.

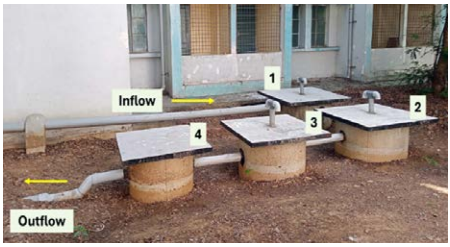
The CleanWater project delivers a clear value addition by introducing TRC-based modular treatment units that combine high structural strength with very low material usage. Compared to RCC tanks, the TRC units are significantly lighter and thinner, reducing raw material consumption, transport cost and installation time. Unlike steel-reinforced concrete, they are non-corrosive and more resistant to biogenic and chemical attack, improving service life in aggressive wastewater environments. The modular design allows factory production with consistent quality and rapid on-site assembly, making the system scalable for small communities. By integrating an anaerobic baffled reactor and filter within compact TRC tanks, the system achieves better treatment efficiency than conventional septic tanks while remaining energy-free and low-maintenance. Overall, the project outcome offers a technically robust, environmentally sustainable and economically viable alternative to existing decentralized wastewater treatment solutions.

Raina Industries Ltd.

"Driving sustainable sanitation through lightweight, modular concrete innovations for rural and peri-urban communities."

Betonwerk Hentzschel GmbH

"Engineering durable TRC solutions for next-generation decentralized wastewater treatment."



Prototype TRC STP at IIT Madras

TRC STP installed at Samatha Vidyalaya, Pune

The Sustainable Handling of Innovative Membrane Technologies for Environmental Protections (SHINE 2025) workshop took place from September 22–25, 2025, at the University of Hamburg's Institute of Pharmacy in Germany. Funded by the Indo-German Science and Technology Centre (IGSTC), the event addressed emerging threats to water resources, such as pharmaceuticals, dye waste, and polyfluoroalkyl substances (PFAS), which are often resistant to conventional treatment methods.

Technical Scope and Objectives

The workshop provided a platform for experts from India and Germany to discuss the transfer of knowledge and establishment of collaborations in membrane science. Discussions were organized into several technical pillars:

- Membrane Distillation: Focusing on fouling mechanisms in pharmaceutical wastewater and the use of advanced polymers of intrinsic microporosity.
- Novel and Hybrid Materials: Development of polymeric N-oxide brushes, metal-organic frameworks (MOFs), and hydrogen-bonded organic frameworks (HOFs) for selective separation and antifouling performance.
- Micropollutant Removal: Utilizing functionalized polymer membranes and electrospun nanofibres for removing heavy metals, trace organic contaminants, and antibiotic-resistant bacteria.
- Sustainable Materials and Processes: Showcasing energy-efficient desalination, scale control without chemical antiscalants, and the use of recycled polymers for membrane fabrication.

Key Participating Institutions

The event featured 29 lead resource persons and participants from leading scientific, academic, and industrial organizations in both nations.

India

IIT Roorkee, IIT Dhanbad, Gauhati University, IIT Patna, CSIR-Indian Institute of Petroleum, VIT-AP University, IISc Bangalore, IIT Bombay, NIT Nagaland, CSIR-CSMCRI Bhavnagar, Advanced Membrane Horizon Pvt. Ltd., Tata Steel Ltd.

Germany

University of Hamburg, Helmholtz-Zentrum Hereon, Solventum (former 3M), Leibniz-Institute of Surface Engineering (IOM), IUTA Duisburg, Evonik Industries AG, University of Duisburg-Essen, TH Köln, Max-Delbrück-Center Berlin, Hamburg Wasser, TU Hamburg.

Major Outcomes and Future Roadmap

The workshop concluded with several strategic recommendations and milestones for continued Indo-German engagement:

- Academic and Industrial Linkages: Establishing strong ties between researchers to identify common priorities like PFAS mitigation and resource recovery from industrial brines.
- National Hub Proposal: Participants collectively emphasized the urgent need to establish a dedicated academic and research Centre for Sustainable Membrane Technology at IIT Roorkee to reduce reliance on imported technologies and foster indigenous innovation.
- Future Collaboration: Preliminary discussions were held regarding joint publications, co-supervision of doctoral research, and student and researcher exchange programs.
- Technical Excursions: The program included site visits to the Hereon-Institute of Membrane Research and the Hamburg Wasser municipal treatment plant to observe operational urban water infrastructure.

SHINE workshop group photo

The Indo-German bilateral workshop, titled "Securing sustainable treatment for drinking water production and water recycling with focus on anionic contaminants (SuWaRec)," was held from July 20 to July 22, 2022, at the Technishe Universität Hamburg (TUHH) in Germany. Organized by the Indo-German Science & Technology Centre (IGSTC), the event was led by Dr. Bhaskar Jyoti Deka of IIT Roorkee and Prof. Dr.-Ing. Mathias Ernst of TUHH.

Core Objectives & Themes

The workshop provided a platform for 14 Indian and 20 German participants from academia and industry to address the threat of anionic contaminants in water bodies.

Key focus areas included:

- Advanced Remediation: Discussing hybrid and membrane-based technologies beyond conventional adsorption.
- Research and Detection: Sharing in-depth findings on the quantification and detection of contaminants.
- Sustainable Recycling: Achieving goals for sustainable water recycling through low-cost remediation techniques.
- Academic-Industry Collaboration: Connecting scientific communities with relevant industries from both countries to facilitate knowledge exchange.

Participating Institutions

The event involved a collaborative network of several prominent academic and industrial organizations:

India

Indian Institute of Technology (IIT) Roorkee, IIT Indore, Indian Institute of Science (IISc) Bangalore, Manipur University, National Institute of Technology (NIT) Durgapur, Doon University, Aligarh Muslim University (AMU), Mizoram University, University of Petroleum and Energy Studies, Omkrown Pharmachem Pvt Ltd.

Germany

Technishe Universitat Hamburg (TUHH), DVGW-Research Center TUHH, Helmholtz-Zentrum Hereon, CERAFILTEC GmbH, Hamburg Wasser, GEH Wasserchemie GmbH & Co. KG, Berliner Wasserbetriebe.

Scientific Highlights & Innovation

- Advanced Membrane Fabrication: Research on electrospun superhydrophobic and omniphobic membranes for contaminant removal using membrane distillation.
- Innovative Treatment Processes: Introduction of advanced reduction processes (ARPs) for degrading oxidized contaminants like perchlorate and nitrate.
- Resource Recovery: Exploring the recovery of high-value metals like lithium and caesium from low-concentrated wastewater using metal-organic frameworks.
- Emerging Tech Integration: Utilizing machine learning, artificial intelligence, and GIS techniques for optimized water management and recycling.

Strategic Outcomes

- Technical Advancements: Exchange of expertise on fabricating affordable, low-energy adsorptive membranes to remove anionic pollutants.

- Industrial Insights: Presentations from industrial partners like GEH Wasserchemie and CERAFILTEC GmbH provided critical understanding of commercial adsorbents and ceramic membrane applications.
- Future Collaboration: The workshop successfully established new chapters of academic and industrial cooperation between the two nations.
- Socio-Economic Impact: Participants highlighted that these research developments could uplift both the scientific output and the socio-economic aspects of India and Germany.

SuWaRec workshop group photo

The Indo-German Joint Scientific Workshop, titled "Membranes for Water and Energy" (IGWMWE-2019), was held from February 18 to February 20, 2019, at the CSIR-Central Salt and Marine Chemicals Research Institute (CSIR-CSMCRI) in Bhavnagar, Gujarat, India. Supported by the Indo-German Science and Technology Centre (IGSTC), the event was coordinated by Dr. Vinod K. Shahi of CSIR-CSMCRI and Prof. Mathias Ulbricht of the University of Duisburg-Essen.

Core Objectives & Themes

The workshop aimed to create a synergy between Indian and German researchers to tackle the global scarcity of clean water and sustainable energy. Key thematic areas included:

- Advanced Membrane Materials: Developing high-performance membranes with improved life-time, efficiency, and productivity.

- Water Desalination and Purification: Addressing water scarcity through reverse osmosis, nanofiltration, and ultrafiltration.
- Sustainable Energy Generation: Exploring membrane roles in fuel cells, redox flow batteries, and hydrogen production by water electrolysis.
- Industrial Synergy: Reinforcing engagement between researchers and industrial end-users to provide affordable and adaptable green technologies.

Participating Institutions

The workshop hosted approximately 150 delegates, including 10 German, 2 Russian, and 20 Indian professors and scientists, alongside a large cohort of young researchers.

India

CSIR-CSMCRI (Bhavnagar), various IITs (Kharagpur, Hyderabad, Guwahati, Madras, Roorkee, Delhi, BHU, Tirupati), BARC (Mumbai), CSIR-IICT (Hyderabad), CSIR-CGCRI (Kolkata), CSIR-CECRI (Karaikudi), CSIR-NEIST (Jorhat), CSIR-CLRI (Chennai), BITS Pilani (Goa), ONGC Energy Centre, Tata Consultancy Services (TCS), Reliance Industries.

Germany

University of Duisburg-Essen, Helmholtz-Zentrum Geesthacht, Karlsruhe Institute of Technology, Technical University of Munich, Technical University Berlin, University of Stuttgart, IGB Stuttgart, ZBT GmbH, inge GmbH / BASF SE.

Scientific Highlights & Innovation

- Block Copolymers: Research on the self-assembly of block copolymers in isoporous hollow fiber membranes for advanced purification.
- Hybrid Membrane Processes: Transferring synergy effects of hybrid processes into technical scale for improved fouling mitigation.
- Energy Storage & Conversion: Development of polymer electrolyte membranes (PEM) for fuel cells and modifications

of graphite felt electrodes for vanadium redox flow batteries.

- Industrial Waste Treatment: Utilizing membrane distillation-crystallization for the recovery of pure water and crystalline products from industrial waste.
- Sustainable Solutions: Introduction of low-cost mixed matrix hollow fibers and ceramic membrane-based plants for decontaminating arsenic and iron from groundwater.

Strategic Outcomes

- Collaborative Networking: Ten round-table sessions were held to formulate future research groups and establish active synergy between Indian and German researchers.
- Early-Career Support: Providing a platform for young researchers and students to establish contacts and share research accomplishments.
- Industrial Relevance: Strengthening partnership between academia and leading Indian industries like Reliance, ONGC, and TCS to commercialize membrane technologies under "Make in India".
- Knowledge Dissemination: Setting a footing for long-term collaboration in addressing unmet challenges in energy consumption and cost-affordability of membrane processes.

The Indo-German Bilateral Workshop, titled "Decentralized Approach for wastewater management & septic tank management reality - Solutions and innovation in the Indian water sector," was held from February 22nd to 24th, 2016. Organized by the Indo-German Science & Technology Centre (IGSTC), the event took place in Karlsruhe and Witten/Herdecke, Germany. It was led by Indian Coordinator Prof. Sreekrishnan Trichur Ramaswamy from IIT Delhi and German Coordinator Prof. Erhard Hoffmann from KIT. The workshop brought together 14 participants—8 from India and 6 from Germany—to engage in field trips, technical presentations, and discussions aimed at addressing wastewater challenges in the Indian water sector.

Technical Focus and Innovations

The event emphasized the urgent need for compact decentralized wastewater treatment units in India, particularly for unplanned urban localities where centralized sewerage is geographically or economically impossible.

- A primary technological focus was the Rotating Biological Contactor (RBC), valued for its low land requirement and ease of operation.
- Experts discussed modifying RBC designs for anaerobic treatment to transform these systems into energy-neutral or energy-positive solutions.
- Field trips provided participants with hands-on exposure to operating RBC systems and fabrication facilities in Germany.
- The workshop highlighted that India will remain a global leader in septic management volume for decades due to the limitations of centralized collection systems.
- Discussions moved beyond technical design to address the bottleneck of sustainable operations and maintenance.
- New strategies were proposed, including franchising in the septic tank sector and realizing synergies between biogas production and septic management.
- Academic presentations covered economic perspectives and specific design improvements for the Indian context.

Participating Institutions

India
IIT Delhi, Delhi Jal Board, Anna University.
Germany
Karlsruhe Institute of Technology (KIT), System S&P GmbH, IEEM gGmbH.

Strategic Outcomes and Future Plans

- Research Collaboration: A strong potential for fruitful collaboration was identified between KIT, IIT Delhi, and IEEM gGmbH regarding RBC applications.
- Stakeholder Commitment: The Delhi Jal Board agreed to provide infrastructural support to the consortium to test RBC technology at a pilot scale within one of its existing plants.
- Policy Integration: Participants concluded that research must integrate socio-cultural conditions and business models to ensure long-term success.

The Indo-German Joint Scientific Workshop on "Water and Wastewater Management for Sustainable Development" was held at IIT Delhi on January 30–31, 2014. Organized by the Department of Civil Engineering at IIT Delhi and Institute IWAR at TU Darmstadt, the event addressed the increasing complexity of water pollution and the shrinking of freshwater resources in both nations. The workshop provided a platform for over 60 experts and researchers to share technical know-how and identify challenges that can be tackled through mutual cooperation.

Technical Highlights and New Developments

The workshop deliberated on sustainable technologies through 35 research presentations across six technical sessions.

- Aquifer Recharge: New developments included managed aquifer recharge, innovative urban rainwater harvesting, and snow harvesting in mountainous regions.
- Resource Management: Presentations focused on integrated water resources management using decision-making techniques, simulation-optimization models, and the Schwartz method for basin-scale management.

- Wastewater Treatment: Highlights featured the use of macrophytes, anaerobic hybrid reactors, zero liquid discharge (ZLD) systems, water pinch analysis, and bioenergy generation via algae.
- Industry-Specific Solutions: Discussions covered water pollution in mining, sugar, and distillery plants, as well as sewer rehabilitation technologies and anaerobic biodegradation of organic waste.
- Irrigation Systems: Deliberations included optimization models for border strip and basin irrigation, and strategies for enhancing water productivity in saline environments.

Participating Institutions

The event drew participants from leading academic institutions, research laboratories, and diverse industries.

India

IIT Delhi, IIT Roorkee, IIT Kanpur, JNU New Delhi, NIT Patna, CSSRI Karnal, SASE Chandigarh, NIH Kakinada, PAU Ludhiana, Delhi University, Central Ground Water Board (CGWB), L & T, TCE, Ministry of Earth Sciences

Germany

TU Darmstadt (TUD), Institute for Social-Ecological Research, KompetenzZentrum Wasser Berlin, TZW: DVGW-Technologiezentrum Wasser, Terrawater, GIZ, Gesellschaft für Wasserwirtschaft und Informationssysteme

Major Recommendations and Outcomes

- Collaborative Research: Proposals should be initiated for improved technologies in aquifer recharge, wastewater management, and irrigation systems.
- Pilot Implementation: Future projects should include pilot-scale demonstration plants to test sustainable technologies in real-world conditions.

- Academic Exchange: The event recommended short-term student and faculty exchange visits to strengthen networking and collaborative research.
- Ongoing Dialogue: Experts suggested conducting joint workshops alternately in India and Germany to maintain progress in identified areas of collaboration.
- Industrial Engagement: The workshop emphasized formulating collaborative projects involving industrial participants to bridge the gap between research and field application.

Solar-Driven Photocatalysis for PFAS Removal from Water

Dr. Shilpi Verma

Assistant Professor, Thapar Institute of Engineering and Technology, Patiala, India

Host: Prof. Harald Horn

Karlsruhe Institute of Technology (KIT), Germany

Dr. Shilpi Verma is investigating solar-driven photocatalytic strategies to address contamination of water by poly- and per-fluoroalkyl substances (PFAS), which are known for their chemical stability and resistance to conventional treatment processes. The research centres on the synthesis of lanthanide-doped, upconversion-based photocatalytic materials that can harness low-energy solar radiation and convert it into reactive energy capable of initiating PFAS degradation. Initial progress includes the successful preparation of $NaYF_4$-based host materials, with phase purity and optical behaviour verified using X-ray diffraction and UV–visible diffuse reflectance spectroscopy. During her research stay at KIT, catalyst testing was initiated under controlled solar-simulator conditions, enabling assessment of photocatalytic performance in water matrices that reflect real treatment challenges. Ongoing work focuses on tracking degradation pathways, identifying transformation by-products, and evaluating the toxicity of treated water, with the aim of informing scalable, solar-assisted solutions for persistent contaminant removal.

Phytoremediation and Constructed Wetlands for Industrial Wastewater Treatment

Prof. Jutta Papenbrock

Leibniz University Hannover, Germany

Host: Prof. Deepak Swami

Indian Institute of Technology Mandi, India

Prof. Jutta Papenbrock is leading the project RemCW, which develops plant-based solutions for treating industrial wastewater contaminated with heavy metals, salts, and emerging pollutants. The research integrates hydroponic systems and constructed wetlands using halophytes and macrophytes adapted to saline and polluted environments. Laboratory- and pilot-scale prototypes are designed to evaluate pollutant removal efficiency under controlled conditions, with chemical analyses conducted using techniques such as LC–MS and ICP–OES. Treatment performance is assessed through parameters including COD, BOD, toxicity, and nutrient balance to determine suitability for agricultural water reuse. The project also examines the potential valorisation of plant biomass and secondary metabolites, linking remediation with resource recovery. By combining ecological engineering with process monitoring and modelling, the work advances nature-based treatment systems tailored to industrial regions of Himachal Pradesh, contributing to cost-effective and environmentally sustainable water management strategies.

Ashish Sengar, IIT Delhi

Host: Fraunhofer IGB, Stuttgart

Area of Work: Wastewater treatment: Remediation of micro pollutants present in wastewater. He intends to assess different innovative techniques for the remediation of trace pollutants present in effluent of wastewater treatment plants.

Yamini Mittal, CSIR-IMMT Bhubaneswar

Host: Janisch & Schulz mbH, Münzenberg-Gambach

Area of Work: Field scale planning, building and operation of Constructed Wetlands (CWs) for municipal wastewater treatment. She intends to learn the planning and construction of CWs at field scale from renowned Janisch and Schulz, Germany in order to augment her skills towards development of CWs in India.

Dr. Sarita Devi, CSIR-Central Scientific Instruments Organisation (CSIO), Chandigarh

Host: Federal Institute for Materials Research and Testing (BAM)

Area of Work: Tailored metal-organic framework-integrated microfluidic device for immunosensing of waterborne pathogen.

Angel Joseph, IIT Delhi

Host: Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB

Area of Work: Wastewater Treatment – CO2 reduction in oxidation of micro pollutants: energy intensive vs. novel solar based processes

Ms Kolli Venkata Supraja, IIT Delhi

Host: HZDR Innovation GmbH

Area of Work: RePhoAs: Recovery of arsenic and phosphate from wafer production wastewater

WATER INFRASTRUCTURE INTEGRATION AND PLANNING FOR SMART CITIES

The project ECOWET: Efficient Coupling of Water and Energy Technologies for Smart Sustainable Cities pursued by the consortium consisting of scientists from IIT Gandhinagar, MMM University of Technology Gorakhpur, GIFT City Ltd Gandhinagar, Fortiss GmbH Munich and Sonnen GmbH Wildpoldsried.

Conventional urban infrastructure treats water and energy systems as largely independent entities, with limited coordination between treatment plants, pumping stations and power supply networks. Existing solutions typically rely on fixed-rule control strategies and manual scheduling, which do not account for real-time variations in electricity prices, renewable energy generation or water demand. As a result, wastewater treatment plants and water pumping systems often operate inefficiently, leading to higher energy consumption, increased operating costs and underutilization of renewable energy sources and battery storage systems.

The ECOWET project provides a significant value addition by introducing an integrated hardware–software platform that enables intelligent coupling of water and energy infrastructures. Unlike traditional systems, ECOWET applies real-time monitoring, forecasting and optimization algorithms to coordinate solar PV generation, battery energy storage and water treatment operations. This allows energy-intensive processes to be shifted to periods of high renewable generation or low electricity prices, thereby reducing operating costs and carbon emissions. The modular architecture and distributed control approach make the solution adaptable to different urban use cases, such as sewage treatment plants and water treatment facilities. By embedding intelligence directly at the device and system level, ECOWET moves beyond isolated automation towards a truly cyber-physical infrastructure for smart cities. In a line, the project outcome represents a scalable, data-driven and energy-efficient alternative to existing water–energy management practices, offering tangible benefits in sustainability, operational efficiency and long-term urban resilience.

GIFT City

"Advancing smart urban infrastructure through the seamless integration of water and energy systems."

Sonnen GmbH

"Enabling the water–energy nexus with intelligent battery storage and advanced control solutions."

Atmospheric Water Generation at WTP, GIFT City

Installed Sonnen batteries at STP, GIFT City

The project SMART&WISE: Smart and reliable water and wastewater infrastructure systems for our future cities in India and Germany executed by a team consists of researchers from IIT Madras, Tamilnadu Water Investment Company (TWIC), TU Kaiserslautern, Ingenieurbuero Scheer Oberstdorf & tandler.com GmbH.

Conventional urban water infrastructure solutions are typically planned in silos, where water supply, sewerage, and stormwater systems are designed independently using static design standards and a narrow set of performance indicators. Most existing commercial planning tools focus primarily on simulation or isolated network optimisation. While these tools are useful for checking technical feasibility, they offer limited support for integrated system design, long-term sustainability assessment, or the evaluation of reuse and decentralised treatment options. As a result, planners often rely on experience-based judgement rather than structured, multi-criteria decision-making when selecting infrastructure solutions.

The SMART&WISE project delivers a significant value addition by introducing an integrated and "smart" planning framework that links water supply, wastewater, and stormwater management into a single, coherent decision-support approach. In

contrast to existing solutions, it combines flowchart-based planning logic with advanced optimisation tools for network routing, pipe dimensioning, district metered area (DMA) design, and on-site retention and reuse systems. This allows planners to systematically compare alternative solutions based on sustainability, resilience, and resource efficiency, rather than focusing only on capital cost or hydraulic performance.

A further key advancement is the project's capability to retrofit existing systems for decentralised greywater reuse and pressure-managed distribution, features that are largely absent from conventional planning tools. By embedding these methods within the software environment and validating them through real pilot cases in India and Germany, SMART&WISE converts fragmented engineering practices into a unified, smart-city-ready planning methodology. The outcome extends beyond technically sound networks to adaptive, data-driven infrastructure systems that support long-term urban sustainability and climate resilience.

Tamil Nadu Water Investment Company (TWIC):

"Translating smart water innovation into sustainable urban infrastructure solutions."

tandler.com GmbH:

"Transforming integrated water planning into intelligent, automated software tools."

Project site at University of Kaiserslautern

Project pilot area at Coimbatore, India

The Digital Public Goods for Water Sensitive Planning and Urban Flood Resilience (DPG-WaSPUR) workshop took place from September 24–25, 2025, at HafenCity University (HCU) in Hamburg, Germany. Funded by the Indo-German Science and Technology Centre (IGSTC), the event focused on leveraging open-source tools and international collaboration to enhance urban climate resilience.

Core Objectives and Thematic Focus

The workshop aimed to create a collaborative framework for developing Digital Public Goods (DPGs) to address water-related urban challenges. Discussions were organized into four technical pillars:

- Spatial Planning & Frameworks: Integrating blue-green infrastructure and nature-based solutions into urban design.
- Spatial Data Infrastructures (SDI): Applying FAIR principles (Findable, Accessible, Interoperable, Reusable) to urban water data.
- Planning Policy & Regulations: Evaluating administrative strategies, such as Ahmedabad's 2041 Water Management Plan, and the risks of platform governance.
- Tools & Techniques: Showcasing innovations like Urban Digital Twins, AI-driven geospatial agents (Robot Kruti), and cloud computing for real-time monitoring.

Key Participating Institutions

The event featured 28 participants from leading scientific and governmental organizations across both nations.

India

CEPT University, GIFT City, ISRO (NRSC & Space Application Centre), SPA New Delhi, IIRS Dehradun, IIT Bombay, IIT Roorkee, NIUA, AUDA, BORDA South Asia

Germany

HafenCity Universität Hamburg, IOER, Technical University Hamburg, Technical University Köln, Universität Tübingen, IZES gGmbH, BUKEA Hamburg, TU Dresden, HAW Hamburg, Stadt Wuppertal

Major Outcomes and Future Roadmap

The workshop concluded with several strategic milestones for Indo-German S&T engagement:

- Signing of the MoU: A formal Memorandum of Understanding was exchanged between HCU Hamburg and CEPT University, committing to long-term research cooperation in urban flood resilience.
- 2+2 Project Proposal: Participants utilized sandpit sessions to ideate a future IGSTC 2+2 proposal, bridging engineering precision with community-centric adaptation.
- Ongoing Collaboration: A shared Miro board was established to synthesize insights and refine project application structures.
- Pusch Funding: HCU received follow-up funding to send a delegation to CEPT University in Ahmedabad to finalize the collaborative proposal and participate in state-level water sensitivity roundtables.

DPG-WASPUR workshop group photo

CLIMATE, WATER & ENVIRONMENTAL RISKS

The Unconventional Perspectives on Flood Risk: Opportunities and Motivating Narratives (UPFLOO) workshop was held from May 5–7, 2025, at the GFZ Helmholtz Centre for Geosciences in Potsdam, Germany. Supported by the Indo-German Science and Technology Centre (IGSTC), this bilateral event explored innovative and often overlooked approaches to flood risk research and management.

Technical Agenda and Themes

The workshop's technical program was structured around several key pillars of flood research:

- Systemic Risk and Interactions: Evaluating how human and natural systems interact, including land-atmosphere feedback and the impact of vegetation on water distribution during climate extremes.
- Technological Innovations: Showcasing data-driven computing, AI, and cloud computing for flood severity insights, as well as satellite-based precipitation products for predicting extreme events.
- Complex Flood Risk Systems: Using integrated hydrologic-hydraulic modeling and weather generators to understand deltaic risks and future flood scenarios.
- Risk Communication: Discussing participatory scenario planning and the integration of art into flood risk science to improve community engagement.

Key Scientific and Academic Highlights

The workshop featured high-quality contributions from both Indian and German experts:

- Stress Testing: Researchers introduced an alternative to traditional modeling by stress testing the global river network to identify floodplains most sensitive to increasing flood magnitudes under climate change.
- Mental Health Impacts: A significant study explored the long-term mental health effects of the 2021 German floods, revealing high rates of PTSD (17-24%) among affected populations years later.

- Forensic Flood Analysis: Experts emphasized forensic studies—multidisciplinary, rapid investigations of extreme events to unravel physical and social disaster mechanisms.
- Climate-Informed Frequency Analysis: This approach links flood probabilities directly to large-scale climate indicators to better project future risks.

Participating Institutions

The workshop brought together 12 Indian and 21 German participants, along with several guests.

India

Indian Institute of Technology Delhi, IIT Gandhi Nagar, IIT Roorkee, IIT Kharagpur, IIT (BHU) Varanasi, Government College of Engineering Ratnagiri, Indian Institute of Remote Sensing (ISRO), CSMRS (Ministry of Jal Shakti), DGRE (DRDO)

Germany

GFZ Helmholtz Centre for Geosciences, University Potsdam, Berlin Technical University, RWTH Aachen, University Osnabrück, UFZ Helmholtz Centre for Environmental Research, CDM Smith, Research Institute for Sustainability Potsdam, University of Applied Sciences for Media, Communication, and Business Berlin

Outcomes and Shared Insights

The workshop identified several areas of complementary expertise between the two nations:

- India's Strengths: Significant experience in combined flood-drought management, pre-monsoon groundwater drawdown, and community-based response mechanisms.
- Germany's Strengths: Advanced methodologies for socio-economic damage assessment, standardized risk mapping, and insurance-based mitigation strategies.
- Joint Roadmap: It was agreed to map regulatory frameworks and institutional capacities in both countries as a foundation for future innovative, transferable solutions.

UPFLOO Workshop group photo

The Inter-Disciplinary Approach to Sustainable Habitats using AI-ML Tools workshop took place from February 24–26, 2025, at the Indian Institute of Science (IISc) in Bengaluru, India. Supported by the Indo-German Science and Technology Centre (IGSTC), the event focused on integrating artificial intelligence and machine learning to solve complex urban and environmental challenges.

Technical Scope and Objectives

- The workshop aimed to create a cross-disciplinary dialogue between engineers, scientists, and policymakers on using digital tools for sustainable development. The technical sessions were organized around several core themes:
- Water and Wastewater Management: Leveraging AI for predictive maintenance of water infrastructure and optimizing treatment processes.
- Air Quality and Energy Systems: Monitoring urban pollutants and enhancing the efficiency of renewable energy integration in buildings.
- Material Selection and Agricultural Practices: Using data-driven approaches to identify sustainable building materials and precision farming techniques.
- Law and Policy: Discussing the regulatory frameworks needed to govern AI applications in public infrastructure and environmental protection.

Key Participating Institutions

The workshop brought together 29 participants, including 15 from India and 14 from Germany, representing a mix of academic and industrial expertise.

India

Indian Institute of Science (IISc) Bengaluru, IIT Madras, IIT Delhi, National Institute of Advanced Studies (NIAS), and various clean-tech startups.

Germany

University of Cologne, TU Berlin, RWTH Aachen, and representatives from German small and medium-sized enterprises (SMEs).

Major Outcomes and Future Roadmap

- The event resulted in concrete plans for long-term bilateral engagement in the field of sustainable habitats:
- Indo-German Research Cluster: Participants agreed to form a dedicated research cluster focused on Sustainable Habitat and Climate Action.
- Student and Researcher Exchange: Preliminary agreements were reached for PhD cotutelle models, short-term exchange programs, and summer internships between IISc and German universities like TU Berlin and RWTH Aachen.
- Industry-Academia Linkages: German SMEs and startups expressed interest in piloting clean-tech solutions in India, facilitating technology localization and co-commercialization.
- Knowledge Platform: The development of a shared digital knowledge platform was proposed to track joint projects and facilitate continuous networking.
- Training Schools: Plans were outlined for future Indo-German training schools focusing on emerging technologies like AI-ML for the water-energy nexus.

Inter-Disciplinary Approach to Sustainable Habitats using AI-ML Tools workshop group photo

The IGSTC Indo-German Workshop on "New Generation Sensors for Unsaturated Soils and Water Technology" was held at Ruhr-Universität Bochum, Germany, on February 24–25, 2016. Coordinated by experts from IIT Bombay, TERI University, Ruhr-Universität Bochum, and the Helmholtz Centre for Environmental Research (UFZ), the event facilitated knowledge transfer and research development between scientists and industrial partners from both nations.

Technical Highlights and New Developments

The workshop featured parallel tracks focused on specialized environmental monitoring and geotechnical engineering.

Unsaturated Soils and Geotechnical Monitoring

- A major focus was placed on sensors capable of measuring parameters related to the thermo-hydraulic-mechanical-chemical (THMC) behavior of soils, such as water content, suction, and temperature.
- New technology presented included the MPS-6 porous ceramic disc sensor, which covers a high suction range from 9 to 100,000 kPa.
- Numerical optimization tools were introduced to improve monitoring strategies by determining the ideal type, amount, and location of sensors for geotechnical applications.

- A custom laboratory device for measuring thermal flux and electrical impedance was showcased to assess soil moisture, density, and thermal properties.

Water Technology and Biosensors

- Presentations covered advanced water quality monitoring, including ARSOlux, a biosensor for arsenic detection, and Aquacheck, a comprehensive multi-parameter test kit.
- German partners presented the WaterBox, a transportable and compact system for water treatment.
- Indian contributions highlighted energy-independent compact sanitation systems and web-based water quality database concepts.

Key Participating Institutions

India
Indian Institute of Technology Bombay, TERI University New Delhi
Germany
Ruhr-Universität Bochum, Helmholtz Centre for Environmental Research (UFZ) Leipzig

Major Recommendations and Outcomes

- Monitoring air, soil, and water for hazardous pollutants is essential for protecting public health and the environment.
- Ideal sensors for environmental and geotechnical purposes must prioritize robustness, specificity for target pollutants, fast response times, and the ability to operate in harsh field conditions.
- Participants emphasized that German water technologies must be adapted to suit Indian environmental extremes, such as monsoon floods and high temperatures, as well as socio-economic factors like power shortages and the need for low-cost manufacturing through "Make in India".

- A key proposal emerged for establishing a "Centre for Geoenvironmental Research and Innovation" to transform India into a technology demonstration hub.

The Indo-German Bilateral Workshop on "Near Real Time Forecasting of Soil Moisture for Water Resources Management" was held in Bangalore from March 24th to 28th, 2014. Jointly organized by Prof. M. Sekhar of the Indian Institute of Science and Prof. Harry Vereecken of Forschungszentrum Jülich, the event was funded by the Indo-German Science and Technology Centre (IGSTC) to bring together geoscientists to develop new approaches for increasing water use efficiency in irrigated agriculture. The workshop combined scientific deliberations with a two-day field visit to the Kabini Observatory and AMBHAS observatory to account for local soil, crop, and power characteristics.

Technical Highlights and New Developments

The workshop focused on combining field measurements with satellite data and hydrological prediction models.

- The German TERENO long-term observatory network was presented as a test bed for algorithms on water cycling, land-atmosphere coupling, and data assimilation.
- New sensor technologies were discussed, including COSMOS sensors and soil moisture measurement using cosmic ray probes.
- Advanced modeling tools were introduced, specifically the use of Bayesian frameworks and particle smoothers for soil hydraulic parameter estimation.
- Integration strategies were showcased for retrieving soil moisture and crop variables from SAR remote sensing for use in environmental models.
- Indian researchers presented on the use of the Risat-1 microwave satellite for mapping soil moisture for applications in agriculture, floods, and droughts.

Key Participating Institutions

India

Indian Institute of Science (IISc), ISRO, IIT Roorkee, IIT Kharagpur, NRSC, SAC, CDAC, CMMACS, ATREE, KSNDMC, PRL, NITK Surathkal

Germany

Forschungszentrum Jülich, Max-Planck-Institute for Meteorology, University of Bonn, Ludwig-Maximilians University (Munich), University of Cologne, Kiel University, VISTA Remote Sensing in Geosciences

Major Recommendations and Outcomes

- It was recommended to develop models using plants as sensors to improve the understanding of soil behavior.
- Participants proposed developing a super site in semi-arid climatic environments for controlled experiments with soil moisture and remote sensing.
- A recommendation was made to establish a broad umbrella program involving ISRO, DLR, and academic institutes for the operational retrieval of soil moisture from satellite data.
- The workshop facilitated an agreement to share algorithms for soil moisture retrieval developed in both countries.
- Future plans include a joint research project on upcoming satellite products and student exchange visits to the TERENO observatory network in Germany.

Compound Heat–Rainfall Extremes and Urban Flood Risk in a Warming Climate

Dr. Poulomi Ganguli

Assistant Professor, Indian Institute of Technology Kharagpur, India

Host: Prof. Dr. Bruno Merz

GFZ German Research Centre for Geosciences, Potsdam, Germany

Dr. Poulomi Ganguli led the project CRA Floods: *Compound Risk Assessment of Heat-Stress Induced Pluvial Floods*, which investigates how episodes of humid heat can set the stage for subsequent extreme rainfall and urban flooding. Rather than treating heatwaves and floods as isolated hazards, the research focused on their sequential interaction, developing multivariate, climate-informed risk frameworks that capture processes overlooked in conventional flood assessments. The study combined long-term station observations, high-resolution precipitation datasets, probabilistic copula approaches, and two-dimensional hydrodynamic modelling to map hotspots of hot–wet compound events across India and globally. Detailed analyses of coastal and metropolitan regions, including Chennai, revealed that heatwave-preconditioned rainfall can substantially amplify flood extent, exposure, and damage. Together, the findings provide a scientifically robust basis for rethinking urban flood risk, supporting water managers and planners in designing drainage systems and adaptation strategies that remain effective under intensifying climate extremes.

Glacier Hydrology, Cryosphere Water Linkages & Data-Driven Water Forecasting

Dr. Bramha Dutt Vishwakarma

IISc Bengaluru, India

Mr. Codruț-Andrei Diaconu

German Aerospace Center (DLR), Germany

Glaciers act as natural buffers in mountain water systems, storing precipitation as snow and ice and releasing it as meltwater during dry seasons. Under the PECFAR programme, the Indo–German team advanced the science of glacier mass balance estimation by combining in-situ measurements, satellite observations, reanalysis climate data, and physics-informed deep learning models to overcome severe data scarcity in the Indian Himalayas. By improving estimates of snow water equivalent, seasonal melt contribution, and long-term ice loss, the work strengthens scientific understanding of how climate variability alters glacier-fed river flows, providing critical inputs for integrated water resource management, downstream water security, and climate-resilient basin planning.

Data-Driven Flood and Water Quality Risk Assessment

Ms. Nadja Veigel

TU Berlin, Germany

Dr. Abhijith Gopinathan NRD

IIT Kanpur, India

During her PECFAR research visit to IIT Kanpur, Ms. Nadja Veigel investigated data-driven methods for water quality assessment and flood risk analysis, with a focus on handling fragmented, heterogeneous, and non-traditional data sources. Scientifically, her work explored the application of natural language processing (NLP) to extract hydrologically relevant information from textual records such as reports, historical documents, policy notes, and case studies, which are typically excluded from quantitative water models. By examining how such unstructured information can be combined with conventional hydrological and water-quality datasets, the work contributes to improving situational awareness, event reconstruction, and risk assessment in data-limited river basins—an important challenge in integrated water resource management.

Monsoon Storm Dynamics, Extreme Rainfall & Water Risk

Mr. Vishnu S. Nair

IISER Thiruvananthapuram, India

Dr. Antonio Sánchez Benítez

Helmholtz Centre for Polar and Marine Research, Germany

Under the PECFAR programme, Mr. Vishnu S. Nair visited the Alfred Wegener Institute and worked with Dr. Antonio Sánchez Benítez to investigate tropical monsoonal storms and extreme rainfall

over India under pre-industrial and future warming scenarios (2K, 3K, and 4K). Scientifically, the work involved tracking monsoonal storm systems in high-resolution climate model experiments, analysing their vortex structure, thermodynamic properties, and rainfall characteristics, and separating dynamic versus thermodynamic drivers of extreme precipitation. The analysis revealed that future increases in monsoon rainfall are primarily driven by thermodynamic intensification (sub Clausius Clapeyron scaling) rather than stronger storm circulation, providing critical insight for flood risk assessment, basin-scale water planning, and climate-resilient integrated water resource management, especially for vulnerable regions such as the Western Ghats and flood-prone river basins.

Landslide Detection, Slope Hydrology & Catchment Risk

Dr. Naveen Chandra

Wadia Institute of Himalayan Geology, India

Dr. Mahmud Haghshenas Haghighi

Leibniz Universität Hannover, Germany

Under the PECFAR programme, the Indo German team worked on detecting and monitoring landslides in the Himalayas, where slope failures can block rivers, increase sediment loads, and trigger downstream flooding. Using satellite radar data from Sentinel-1, the researchers measured subtle ground movements and surface changes over time, allowing them to identify unstable slopes before visible failure occurs. By connecting these ground-movement signals with rainfall and terrain conditions, the work improves understanding of how landslides interact with river systems, providing practical knowledge to support integrated water resource management, early warning, and safer planning in mountain river basins.

AQUATIC & ECOSYSTEM SUSTAINABILITY

The Indo-German workshop, titled "AQUASMART: Water conserved organic food production through climate smart carbon neutral aquaculture," took place from March 2 to March 4, 2023, in Kochi, Kerala. Organized under the Indo-German Science & Technology Centre (IGSTC), the event was led by Prof. (Dr.) Dinesh Kaippilly of KUFOS and Prof. (Dr.) Dušan Palić of LMU Munich.

Core Objectives & Themes

The workshop aimed to facilitate open dialogue between Indian and German stakeholders—spanning academia, government, and private industry—on the future of sustainable aquaculture. Key focus areas included:

- Net-Zero Production: Transitioning to carbon-neutral and energy-independent models.
- Resource Efficiency: Reducing water footprints and managing waste to minimize environmental impact.
- Food Safety & One Health: Combatting antibiotic resistance and implementing robust biosecurity to ensure public health and seafood safety.
- Blue Transformation: Utilizing coastal and open oceans for low-trophic species like seaweed and bivalves.

Scientific Highlights

- BioRas-Shrimp: An AI-based, bio-secure recirculating aquaculture system for shrimp with innovative effluent treatment.
- Sustainable Aquafeed: Development of specialty proteins from shrimp waste and the exploration of insect meal as a fishmeal alternative.
- Integrated Systems: Research into Integrated Multi-Trophic Aquaculture (IMTA) and climate-smart Agri-Aqua systems (IAAS).

Key Participating Institutions

The event featured a collaborative network of academic, research, and industrial organizations:

India

Kerala University of Fisheries and Ocean Studies (KUFOS), ICAR - Central Marine Fisheries Research Institute (CMFRI), ICAR - Central Institute of Fisheries Education (CIFE), ICAR - National Bureau of Fish Genetic Resources (NBFGR), ICAR - Central Coastal Agricultural Research Institute (CCARI), College of Fisheries Mangalore, Tamil Nadu Dr. J. Jayalalitha Fisheries University, Banaras Hindu University, Agency for Aquaculture Development Kerala (ADAK), Mayank Aquaculture, Avitech Nutrition Pvt. Ltd., Keystone Trades, Kemin Industries, Smart Green Aquaculture

Germany

Ludwig-Maximilians University Munich (LMU), Fraunhofer Research Institution for Individualized and Cell-Based Medical Engineering (IMTE), Bavarian State Research Center for Agriculture (LfL), Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research, Leibniz Center for Tropical Marine Research (ZMT), Technical University of Munich (TUM), German Inland Fisheries and Aquaculture Association (VDBA/VDBI), Rheingarnelen GmbH

Strategic Outcomes

- Academic Cooperation: A formal intent for cooperation was established between LMU Munich and KUFOS, including student/faculty exchanges and twinning programs.
- Future Planning: A follow-up workshop is planned for Bavaria, Germany, focusing on practical biosecurity auditing and net-zero facility training.
- Conclusion: The participants emphasized that "Net Zero" must become a global market standard, supported by nature-based solutions and rigorous biosecurity measures.

Aquasmart workshop photo

The Indo-German bilateral workshop, titled "MariSustain: Marine Farming - opportunity towards entrepreneurship, self-employment, and sustainable rural development," took place from August 23 to August 25, 2022, in Bremen, Germany. Hosted by the Leibniz-Centre for Tropical Marine Research (ZMT) and supported by the IGSTC, the event was coordinated by Dr. Lata Gawade of Goa University and Dr. Andreas Kunzmann of Leibniz-ZMT

Core Objectives & Themes

The workshop brought together 13 Indian and 10 German participants from academic institutions and the private sector to explore marine farming as a catalyst for rural development. Key focus areas included:

- Sustainable Cultivation: Advancing techniques for green mussel, oyster, and seaweed cultivation at a commercial scale.
- Integrated Systems: Exploring the potential for Integrated Multi-Trophic Aquaculture (IMTA) and co-culture models.
- Socio-Economic Growth: Evaluating marine farming as a model for community entrepreneurship and self-employment.
- Knowledge Exchange: Facilitating mutual learning between scientific institutes and the aquaculture industries of both nations.

Key Participating Institutions

The event featured a collaborative network of academic, research, and industrial organizations:

India

Goa University, National Centre for Polar and Ocean Research (NCPOR), CSIR-Central Salt and Marine Chemicals Research Institute (CSMCRI), Marine Products Export Development Authority (MPEDA), ICAR-Central Marine Fisheries Research Institute (CMFRI), CSIR-National Institute of Oceanography (NIO), The Energy and Resources Institute (TERI), Gyaneswari Hatcheries, Mack Fisheries

Germany

Leibniz-Centre for Tropical Marine Research (ZMT), GMA/IMTE Büsum, von Thünen Institute, Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research, IGB Berlin, Förde Garnelen GmbH, Aquapurna GmbH

Scientific Highlights & Innovation

- Innovative Feed: Development of low-cost aquaculture fish feed using de-oiled algae.
- Advanced Aquaculture: Research into tropical shrimp aquaculture in Germany and RAS (Recirculating Aquaculture Systems) cultured Cassiopea andromeda.
- Technology Integration: Use of microbial activity studies and bioeconomy-focused microalgae research to enhance production.
- Field Visits: Participants visited the ZAF (Zentrum für Aquakulturforschung) facilities at AWI and fish processing installations in Bremerhaven.

Strategic Outcomes

- Subject Groupings: Participants organized into specialized groups to tackle subjects such as hatchery-related research (natural feed, bivalve

cultivation) and seaweed research (intensive systems, microbial activities).

- White Paper Preparation: Guiding texts developed during networking sessions will be used to prepare a "white paper" with key input for the next IGSTC 2+2 call.
- Bilateral Project Development: Mixed teams were appointed to develop short texts on how to tackle specific subjects within a bilateral project.

AI-Based Plankton Imaging and Ocean Monitoring

Dr. Sadaf Ansari

Senior Scientist, CSIR–National Institute of Oceanography, Goa, India

Host: Prof. Dr. Rainer Kiko

GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany

Dr. Sadaf Ansari is developing AI-driven methods for automated plankton image analysis, addressing a major bottleneck in large-scale ocean monitoring. The project focuses on designing smart image-segmentation algorithms capable of accurately separating individual plankton organisms, even in dense or overlapping scenes, where conventional image processing fails. Using deep-learning and attention-based segmentation techniques, supported by a dedicated image pre-processing pipeline, the work improves the reliability of plankton identification and enumeration from high-throughput imaging systems. During her research visit to GEOMAR, Dr. Ansari worked with ZooScan and in-situ imaging platforms and studied annotation workflows and the MorphoCluster tool, gaining critical insights for developing cross-platform, multi-user analysis pipelines. The project strengthens the scientific foundation for consistent, data-driven monitoring of plankton dynamics in the Indian Ocean, which is essential for understanding marine ecosystems and climate-driven ocean change.

Microplastic–Heavy Metal Mixtures and Aquatic Ecotoxicology

Dr. Jayanthi Ganapathi

Gujarat Institute of Desert Ecology (GUIDE), India

Dr. Wibke Busch

Helmholtz Centre for Environmental Research (UFZ), Germany

This WISER paired project investigates how microplastics and heavy metals interact in coastal, riverine, and inland aquatic ecosystems of Gujarat, and how these combined contaminants affect aquatic life across trophic levels. Field campaigns across three seasons generate water, sediment, and biota samples to characterise microplastic–metal complexes using spectroscopic techniques and to quantify their spatial and temporal variability. In parallel, controlled mixture experiments are conducted using Daphnia magna, zebrafish embryos, and Azolla to assess acute and chronic toxicity, bioaccumulation, and combined effects under defined exposure scenarios. The project integrates multivariate statistics, geostatistical hotspot mapping, and mixture risk modelling based on concentration addition approaches to improve ecological risk assessment frameworks. By linking field observations with mechanistic ecotoxicology, the collaboration advances scientifically grounded strategies for managing plastic and metal pollution in aquatic environments.

Decoding the Biodiversity–Blue Carbon Nexus in Inland and Coastal Mangroves

Dr. Kripa M. K.

Ashoka Trust for Research in Ecology and the Environment (ATREE), India

Dr. Véronique Helfer

Leibniz Centre for Tropical Marine Research (ZMT), Germany

Mangrove forests are widely recognised as blue carbon ecosystems, yet the processes that regulate how biodiversity influences carbon storage remain poorly resolved. This paired WISER project investigates contrasting mangrove systems in Gujarat, including the inland mangroves of Guneri and Shravan-Kavadiya, and coastal old-growth and replanted forests of the Gulf of Kachchh. The study integrates remote-sensing-based time-series mapping, field-based biomass estimation, and seasonal litterfall measurements with high-resolution characterisation of sedimentary organic matter using pyrolysis GC/MS and stepwise-muffling approaches. Biodiversity is assessed across floral, faunal, and microbial components through eDNA metabarcoding and ddRAD sequencing to evaluate functional and genetic diversity. By combining spatial modelling, molecular tools, and biogeochemical analyses, the project aims to clarify how biotic and abiotic drivers interact to shape carbon quantity, quality, and origin, generating robust data to inform blue carbon accounting and conservation planning in rare inland mangrove ecosystems.

Floating Solar Systems and Reservoir–Ecosystem Interactions

Dr. Manish Kumar

Himachal Pradesh University, Shimla, India

Mr. Alexander Graef

Fraunhofer Institute for Solar Energy Systems (ISE), Freiburg, Germany

Under the PECFAR programme, Dr. Manish Kumar collaborated with Mr. Alexander Graef within the Floating Photovoltaics (FPV) research group at Fraunhofer ISE to investigate how floating solar installations physically interact with surface water bodies. The scientific work involved environmental monitoring beneath FPV arrays, including assessment of shading patterns, surface temperature modification, wind–wave attenuation, and wave-induced electrical mismatch losses, alongside evaluation of meteorological drivers and soiling effects. By analysing how these factors influence reservoir surface dynamics, light penetration, and near-surface ecological conditions, the study provides process-level evidence to guide integrated water resource management, particularly for multi-use reservoirs where energy production must be balanced with water quality, evaporation control, and ecosystem integrity.

HYDROGEOLOGY, GEOMECHANICS & RESOURCE SYSTEMS

The Indo-German bilateral workshop, titled "Innovative technologies for assessment and mitigation of groundwater contamination (TEC4WATER)," was held from September 16 to September 18, 2019, at Anna University in Chennai, India. Organized by the Indo-German Science & Technology Centre (IGSTC), the event was led by Dr. L. Elango of Anna University and Dr. Michael Schneider of Freie Universitaet, Berlin.

Core Objectives & Themes

The workshop brought together 17 Indian and 11 German participants to identify causes of groundwater contamination and propose mitigation mechanisms. Key thematic areas included:

- Geogenic Contamination: Assessing naturally occurring pollutants like fluoride in southern India and arsenic in the Indo-Ganges plains.
- Anthropogenic Impact: Evaluating human-induced contamination, specifically heavy metals and organic pollutants (PAH) from tanneries and textile industries.
- Modelling and Monitoring: Using numerical, geochemical, and isotope techniques to track the fate and transport of contaminants.
- Strategic Networking: Formulating research groups for future collaborative projects, student exchanges, and joint degree supervision.

Participating Institutions

The event featured experts from a variety of academic, governmental, and industrial organizations:

India

Anna University (Chennai), IISc (Bangalore), JNU (New Delhi), CSIR-NGRI (Hyderabad), ISRO-NRSC (Hyderabad), VIT (Vellore), BARC (Mumbai), IIT Madras, CSIR-CLRI (Chennai), CGWB (Chennai), Greenvironment Innovation & Marketing India (P) Ltd +3

Germany

Freie Universitaet (Berlin), Leibniz Centre for Agricultural Landscape Research (ZALF), BGR (Hannover), Humboldt University of Berlin, Claas Rain - Hydrogeologists and Agricultural Consultants, Deutsche Bahn (Munich), BfU GmbH (Munich), Umweltcluster Bayern (Munich) +2

Scientific Highlights & Innovation

- Advanced Mapping: Introduction of Heliborne Surveys for aquifer mapping at the micro-watershed level.
- Coastal Solutions: Discussion of SUBSOL (Subsurface Water Solutions) technologies, such as freshmakers and freshkeepers, to mitigate seawater intrusion.
- Smart Management: Implementation of IoT-enabled, cloud-based systems for real-time monitoring of water and wastewater in buildings.
- Remediation Techniques: Deliberations on permeable bio-barriers for chromium treatment and mechanized sprinklers to reduce nitrate leaching in agriculture.

Strategic Outcomes

- Research Group Formulation: Established specialized teams to focus on geogenic/anthropogenic contamination, industrial wastewater, and innovative agricultural water-saving methods.
- Funding Strategy: Delegates decided to target future IGSTC (2+2), DST-DAAD, and EU Horizon 2020 calls for collaborative proposals.
- Practical Insights: Field visits were conducted to northern Chennai to study seawater intrusion and traditional temple tanks as rainwater harvesting methods.
- Sustainable Recommendations: Suggested induced recharge of rainwater via existing dug wells to remediate geogenic fluoride contamination.

The Indo-German bilateral workshop, titled "Recent advancement in online/remote water quality monitoring and management technologies," was held from February 2 to February 4, 2016, at Anna University in Chennai, India. Funded by the Indo-German Science & Technology Centre (IGSTC), the event was coordinated by Dr. D. Karunanidhi and Dr. T. Subramani from the Indian side, and Prof. Dr. h.c. Rafig Azzam and Prof. Dr. Franziska Steinbruch from the German side.

Core Objectives & Themes

The workshop brought together 39 Indian and 7 German participants to address the rising demand for safe drinking water through advanced monitoring technologies. Key thematic areas included:

- Remote Monitoring Technologies: Keynote addresses and sessions focused on online and remote water quality monitoring for both waste and drinking water.
- Hydrological Cycle Integration: Combining water quality monitoring with hydrological cycle data and water budgets.
- Contaminant Load Monitoring: Utilizing remote sensing to track spatial and temporal variations in contaminant loads.
- Global Monitoring Systems: Discussing global portals and platforms for data sharing and information dissemination.

Key Participating Institutions

The workshop featured experts from a variety of academic and governmental organizations:

India

Anna University (Chennai), IIT Madras, IIT Bombay, Indian Institute of Science (IISc Bangalore), Jawaharlal Nehru University (JNU), Pondicherry University, Central Ground Water Board (CGWB), National Geophysical Research Institute (NGRI), CWRDM (Kerala), Department of Science & Technology (DST)

Germany

RWTH Aachen University, Kiel University, Martin-Luther-Universität Halle-Wittenberg, Helmholtz Institute Freiberg, Helmholtz-Zentrum für Umweltforschung (UFZ), German Remote Sensing Data Center (DLR)

Scientific Highlights & Innovation

- EnMAP Hyperspectral Mission: Germany presented the Environmental Mapping and Analysis Program, a satellite mission designed to model dynamic Earth ecosystem processes by extracting biochemical and biophysical parameters.
- HOLM System: Presentation of first experiences with a newly developed hygiene online monitoring system for assessing raw and drinking water quality.
- Advanced Mapping & Modeling: Indian researchers discussed aquifer mapping using advanced techniques, electrical resistivity modeling, and isotope hydrogeochemistry.
- Field Visits: Participants visited coastal aquifers from Thiruvanmiyur to Mahabalipuram and a desalination plant to observe local water management infrastructure.

Strategic Outcomes & Recommendations

- Joint Working Group: A core joint working group was proposed to evolve a collaborative plan for online and remote water quality monitoring.
- Technology Exchange: The event emphasized the need for multifaceted online monitoring mechanisms combining in-situ, spaceborne, and airborne (drone-based) sensors.
- Identifying Gaps: The workshop noted that while Germany implements the EU Water Framework Directive, India currently focuses more on water exploration and abstraction.
- Future Funding: Participants discussed future collaborations for joint projects and identified potential funding sources to sustain the engagement.

Social Communication, Movement Strategies and Collective Tracking of Ephemeral Resources

Dr. Akanksha Rathore

Birla Institute of Technology & Science (BITS) Pilani, Hyderabad, India

Dr. Ariana Strandburg-Peshkin

Max Planck Institute of Animal Behaviour, Germany

In arid and highly variable environments, water and other critical resources can appear and disappear unpredictably. This paired WISER project examines how social animals successfully track such ephemeral resources by integrating computational modelling with behavioural ecology. Dr. Rathore's project develops an agent-based simulation framework in which virtual agents follow bio-inspired movement rules and adapt search strategies using reinforcement learning, calibrated with high-resolution seasonal satellite imagery. In parallel, Dr. Strandburg-Peshkin's complementary project investigates how social cohesion, communication range, fission–fusion dynamics, and signalling strategies shape collective tracking performance in dynamic landscapes. By systematically varying communication rules, movement patterns, and resource distributions, the collaboration aims to identify adaptive strategies that enhance detection efficiency under ecological uncertainty. Together, the projects bridge theory and application, advancing quantitative understanding of collective intelligence in resource-scarce ecosystems and informing bio-inspired monitoring approaches.

Geothermal Hydrogeology & Subsurface Water Systems

Dr. Pankaj Khanna

IIT Gandhinagar, India

Dr. Samuel Thiele

Helmholtz Institute Freiberg (HIF–HZDR), Germany

Under the PECFAR 2022 Call, the Indo–German team conducted integrated field and digital investigations of geothermal water systems, focusing on exposed geothermal reservoirs in Ladakh (Chumathang and Puga hot springs). Using hyperspectral imaging, UAV-based 3D outcrop modelling, geological mapping, and water sampling, the project mapped fluid flow pathways, alteration minerals, and temperature indicators that control groundwater–geothermal circulation. These insights improve understanding of subsurface water movement, heat–water interactions, and reservoir behaviour, providing a scientific basis for sustainable management of geothermal waters, groundwater protection, and long-term water–energy planning in sensitive Himalayan regions.

Tailings Hydromechanics, Water Risk & Mining System Safety

Dr. Surabhi Jain

Indian Institute of Technology (ISM) Dhanbad, India

Ms. Ana Paula Ribera

Technical University of Munich (TUM), Germany

The PECFAR 2022 team carried out an in-depth investigation of mine tailings behaviour before and after bio-chemical stabilisation, combining engineering characterisation, microstructural analysis, and advanced numerical modelling. Laboratory studies assessed permeability, consolidation, shear strength, and liquefaction potential of tailings under drained and undrained conditions, while constitutive models (Mohr–Coulomb, Hypoplasticity, NorSand) were calibrated and validated against physical experiments. By improving the scientific understanding of tailings–water interactions and failure mechanisms, the work directly supports integrated water resource management through risk reduction of tailings dam failures, prevention of groundwater contamination, and protection of downstream surface-water systems in mining-impacted basins.

Ms Stuti Srivastava, Amrita Vishwa Vidyapeetham

Host: DHI WASY GmbH

Area of Work: Dynamic hydro-modelling: Integrating land surface phenology (LSP) and climate projectionsfor groundwater resilience

Publications arising out of IGSTC supported projects (select few)

1. Optimal Implementation of Wastewater Reuse in Existing Sewerage Systems to Improve Resilience and Sustainability in Water Supply Systems – Aakash Dev, Timo C Dilly, Amin E Bakhshipour, Ulrich Dittmer,S Murty Bhallamudi. Water, 13(15), 2021. DOI: 10.3390/w13152004

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For more information:
https://scholar.google.com/citations?user=_uQDQUYAAAAJ&hl=en

2+2 PROJECTS

IGSTC 2+2 PROJECTS

The Indo-German Science & Technology Centre (IGSTC), a joint initiative by the Department of Science and Technology (DST), Government of India and the Federal Ministry of Research, Technology and Space (BMFTR), Government of Germany aims to support joint R&D+I projects of industrial relevance by means of "2+2 Mode of Partnership" with the participation of research/academic institution and industry from both India and Germany. Project proposal is expected to produce insight and exploitable research results leading to new technologies, products and/or services.

Salient Features

Partners

- India: one academic/research institute + one industry
- Germany: one academic/research institute + one industry
- Minimum 4 and Maximum 6

Funding

- Indian side: ₹ 350 lakhs (includes ₹ 150 lakhs for industry)
- German side: € 500000 (includes funding for industry according to De-Minimis or AGVO)

Duration

- 3 years
- Selected projects may be considered for extension phase up to 2 years

Phase II of 2+2

It is an opportunity to selected 2+ 2 projects with promising results to apply for an extension up to two years with additional financial support to cover the gap between the validation in relevant environment and system qualification.

Partners

- One partner from both India and Germany
- Minimum one industry

Duration: • 2 Years

Expected Starting Level

- Technology Readiness Level (TRL) 6

Funding

- Indian side: ₹ 230 lakhs (includes ₹ 100 lakhs for industry)
- German side: € 30000 (includes funding for industry as per AVGO norms)

WORKSHOPS

IGSTC Bilateral Workshops

Platform for substantive interactions between researchers, academicians and industry

The Indo-German Science & Technology Centre (IGSTC), a joint initiative by the Department of Science and Technology (DST), Government of India and the Federal Ministry of Research, Technology and Space (BMFTR), Government of Germany supports proposals for organising Indo-German workshops (in India or Germany) on areas designed around a specific research topic out of thematic areas relevant to both DST and BMFTR.

- Create platform for cross fertilization of ideas
- Establish joint knowledge pools to address global challenges
- Develop knowledge networks for industrial sectors to enhance competitiveness
- Advance industrial research partnership with mutuality of interest and respect

Salient Features

Who can apply?
Workshop proposals may be submitted by a researcher in academia or in an industry from India and Germany to deliberate on the experiences and expertise of an identified research issue pertaining to an industrial problem. Proposals should be submitted jointly by one Indian and one German Coordinator.

Funding
Approximately € 30000 / ₹ 25 lakhs

Nature of Support
Funding is supplementary and is intended to cover

- International and Domestic Travel (Economy Class).
- Accommodation and Hospitality (Workshop lunches and official dinner).
- Organizational Costs (Venue, AV support, Logistics, etc).

WOMEN INVOLVEMENT IN SCIENCE AND ENGINEERING RESEARCH (WISER)

Women Involvement in Science and Engineering Research (WISER)

The Indo-German Science & Technology Centre (IGSTC), a joint initiative by the Department of Science and Technology (DST), Government of India and the Federal Ministry of Research, Technology and Space (BMFTR), Government of Germany supports proposals in paired mode from women researchers in India and Germany to foster innovation in the field of STEM.

- Facilitating bilateral exchange among women researchers
- Create avenues for long-term Indo-German research collaboration
- Capacity building and networking
- Open to all areas of STEM

Salient Features

Eligibility
Women holding a regular/long-term research position in academia or research institutes/industries

Tenure: 3 years

Age limit: No Age Limit

Research stays: 1-month/year research stay in the host country

Mode
In paired mode (Proposals from Indian and German women researchers)

Financial Assistance

Indian Awardee

- Up to ₹ 39 lakhs
- Grant includes support for research staff, consumables, contingency, travel and per diem (€ 2300/month) in Germany

German Awardee

- Up to € 48000
- Grant includes support for research staff, consumables, contingency, travel and per diem (€ 2300/month) in India

PAIRED EARLY CAREER FELLOWSHIP IN APPLIED RESEARCH (PECFAR)

Paired Early Career Fellowship in Applied Research (PECFAR)

The Indo-German Science & Technology Centre (IGSTC), a joint initiative by the Department of Science and Technology (DST), Government of India and the Federal Ministry of Research, Technology and Space (BMFTR), Government of Germany offers Paired Early Career Fellowship in Applied Research (PECFAR) to facilitate exchange of early career Indian and German researchers. The Programme supports short duration visit to explore, connect and network for research collaboration in Science, Technology, Engineering and Mathematics (STEM).

- Create avenues for two-way exchange of young researchers in pairs
- Support for research stay in India/ Germany
- Explore the Indo-German research landscape on entrepreneurship, joint research and innovation
- Build future partnerships with complementary expertise

Salient Features

Eligibility

- Early career researchers holding regular positions in academic/ research institutions/industries or long-term nationally recognized fellowship
- Minimum Qualification: Master's in Science/Bachelor's in Engineering
- Applications are to be submitted jointly by the pair of Indian and German researchers

Age limit: 40 years

Tenure: Minimum -1 month, Maximum -2 months

Financial Assistance

- Fellowship: € 2300 per month/awardee
- Single round trip economy class airfare including visa fees and medical/travel insurance up to € 1500

IGSTC INDUSTRIAL FELLOWSHIPS

IGSTC Industrial Fellowships (IF)

Industrial Exposure in Germany for Young Indian Researchers

The Indo-German Science & Technology Centre (IGSTC), a joint initiative by the Department of Science and Technology (DST), Government of India, and the Federal Ministry of Research, Technology and Space (BMFTR), Government of Germany offers Industrial Fellowships to encourage young Indian researchers towards applied research at an industrial setup in Germany.

- Motivate and facilitate young researchers towards applied research
- Expose researchers to German industrial ecosystem
- Capacity Building
- Encourage innovation & technology development

Fellowship Details

PhD Industrial Exposure Fellowship (PIEF)

Eligibility Criteria

- Pursuing and completed one year of PhD in Science/Engineering
- Age limit: 28 years

Duration: 3 to 6 months

Funding: Stipend of € 1500 per month + travel, visa and medical insurance

Post Doctoral Industrial Fellowship (PDIF)

Eligibility Criteria

- PhD awarded within the last 2 years in Science/ Engineering
- Age limit: 35 years

Duration: 6 to 12 months

Funding: Stipend of € 2500 per month + travel, visa and medical insurance

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