Annual Report on the Collaborative Research Activities between the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany and Goa University (GU), India

Reporting Period: March 2025 – June 2026

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Overview

The Memorandum of Understanding (MoU) between the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany, and Goa University (GU), India, continues to strengthen scientific cooperation in the fields of oceanography, coastal and estuarine processes, ocean optics, biogeochemical modelling, and marine environmental research. During the reporting period (March 2025 - June 2026), the collaboration facilitated scientific exchanges, joint research activities, proposal development, and capacity building, further enhancing the international partnership between the two institutions.

Key Activities and Achievements

1. Goa University Delegation Visit to IOW (August 2025)

A high-level delegation from Goa University, led by the Hon'ble Vice-Chancellor, Prof. Dr. Harilal B. Menon, visited the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany, from 18-20 August 2025 as part of ongoing efforts to strengthen the institutional partnership established under the Memorandum of Understanding between the two institutions. The delegation comprised Prof. Jivan S. Parab (School of Physical and Applied Sciences), Dr. Siddhi K. Jalmi (School of Biological Sciences and Biotechnology), and Dr. Sheryl O. Fernandes (School of Earth, Ocean and Atmospheric Sciences), and was coordinated jointly by Prof. Dr. Joanna J. Waniek (IOW), Dr. Bronwyn E. Cahill (IOW), and Dr. Arjun Adhikari (GU). The visit provided a strategic platform for reviewing ongoing collaborative activities, identifying new areas of scientific cooperation, and developing a roadmap for future Indo-German research partnerships.

The programme commenced with an official welcome at IOW by Prof. Dr. Oliver Zielinski, Director of IOW, and a ministerial address by Mrs. Bettina Martin, Minister for Science, Culture, Federal and European

Affairs of the State of Mecklenburg-Vorpommern. During the opening session, the Hon'ble Vice-Chancellor of Goa University delivered a presentation entitled “Partnering for Global Scientific Excellence”, highlighting Goa University's academic strengths, internationalisation strategy, emerging research priorities, and long-term vision for marine and environmental sciences. Particular emphasis was placed on opportunities for collaborative research in ocean observations, climate change studies, coastal ecosystem services, marine technology development, and long-term environmental monitoring programmes.

The delegation was introduced to several major scientific programmes at IOW, including the Baltic Sea Long-Term Observation Programme and the Shore-to-Basin (S2B) initiative. Faculty members participated in scientific exchanges aboard the research vessel “Elisabeth Mann Borgese” and visited specialised research infrastructure, including the Marienehe Lager instrument and sample storage facility. These interactions provided valuable insights into IOW's integrated observational and research capabilities and highlighted opportunities for collaboration in marine observations, ocean monitoring technologies, and environmental data management.

A major component of the visit was dedicated to scientific exchange and interdisciplinary discussions between researchers from both institutions. Faculty members from Goa University delivered presentations showcasing ongoing research activities and identifying potential areas for collaboration. Discussions covered a broad spectrum of topics, including coastal and estuarine ecosystem functioning, microbial ecology, marine biotechnology, pollution monitoring, ocean optics, climate change impacts, sensor development, artificial intelligence applications in environmental monitoring, and advanced observational technologies. These interactions facilitated the identification of complementary expertise and laid the foundation for future collaborative research projects and externally funded proposals.

One-to-one meetings between researchers from Goa University and IOW proved particularly productive, enabling detailed discussions on prospective joint projects, student and faculty exchanges, co-supervision opportunities, and international funding mechanisms. These meetings directly contributed to the development of collaborative research concepts that subsequently evolved into proposals addressing microplastic pollution, biodiversity monitoring, estuarine processes, and coastal environmental change. The visit also strengthened links between Goa University researchers and IOW research groups specialising in Integrated Optical Remote Sensing, Bio-Physical Interactions, Biogeochemistry, Physical Oceanography, and Estuarine and Coastal Ocean Processes.

As part of the programme, the delegation visited the University of Rostock and met with Rector Prof. Dr. Elisabeth Prommer to explore opportunities for expanding academic cooperation beyond the existing IOW partnership. Discussions focused on faculty and student mobility, doctoral and post-doctoral exchanges, and participation in international fellowship programmes such as the “Mare Balticum Fellowship”. The delegation also visited the Federal Maritime and Hydrographic Agency (BSH) offices in Rostock, where interactions centred on hydrographic surveying, nautical chart production, marine environmental monitoring, forecasting services, and marine technology applications. These visits broadened the scope of potential collaborations and strengthened Goa University's engagement with Germany's marine science and higher education ecosystem.

Overall, the visit significantly strengthened institutional relationships between Goa University and IOW and resulted in the identification of several priority areas for future collaboration. These include ocean optics and remote sensing, coastal and estuarine ecosystem research, marine pollution monitoring, climate change impacts on coastal systems, artificial intelligence and sensor technologies for environmental

observations, long-term marine monitoring programmes, and coupled physical-biogeochemical modelling. The visit also laid the groundwork for subsequent joint publications, researcher exchanges, and international funding proposals, thereby substantially advancing the objectives of the Goa University-IOW Memorandum of Understanding.

2. Joint Scientific Publications

The Goa University-IOW collaboration has resulted in significant progress towards the development of high-quality scientific publications addressing critical questions in coastal and marine environmental research. One major outcome of the partnership during the reporting period has been the preparation of a collaborative manuscript, "Climate-driven shifts in optical signatures and radiative heating in coastal waters" by Dr. Arjun Adhikari (Goa University), Dr. Bronwyn Cahill (IOW), and Prof. Dr. Harilal B. Menon (Goa University). The paper focuses on the role of optical processes in coastal climate and investigates climate-driven changes in the optical properties of the coastal waters in the eastern Arabian Sea and their implications for radiative energy transfer, water-column heating, and ecosystem functioning. The study integrates long-term satellite ocean-colour observations, extensive in situ optical measurements, and radiative transfer modelling to examine how variations in optically active constituents influence light propagation and heat distribution within coastal and estuarine environments. By linking changes in water optical properties to physical and ecological processes, the research provides new insights into the mechanisms through which coastal ecosystems respond to environmental variability and climate change. The work draws upon the complementary expertise of researchers from Goa University and IOW in ocean optics, remote sensing, radiative transfer, and coastal oceanography. It further demonstrates the value of combining observational and modelling approaches to address complex interdisciplinary scientific questions. The manuscript represents a significant scientific output of the Goa University-IOW partnership and serves as an important example of the collaborative research being undertaken under the framework of the Memorandum of Understanding. The paper has been submitted to Scientific Reports with first authorship shared between Dr. Adhikari and Dr. Cahill.

3. Joint International Research Proposal Development

The collaboration has successfully expanded into joint international funding initiatives.

a. Microplastic Pollution and Species Diversity in Climate-Stressed Urban Seas

   Status: Submitted to DFG, currently under revision

   Principal Investigators:

   - Prof. Dr. Joanna Waniek (IOW)
   - Dr. Arjun Adhikari (Goa University)

   The MUSE II proposal addresses the interactions between microplastic pollution, biodiversity, and climate-related stressors in urban coastal marine environments. The project aims to integrate observational, ecological, and modelling approaches to understand the impacts of multiple environmental pressures on coastal ecosystems.

b. Salt Intrusion into Tidal EstuarieS (SITES)

   Status: The proposal was submitted to the German Research Foundation in April 2026.

Principal Investigators:

- M.Sc. Karoline Rummel (IOW), proposal for an own Postdoc position at IOW

The SITES initiative focuses on understanding saltwater intrusion dynamics in tidal estuaries under changing climatic and hydrological conditions. The proposed research combines field observations, numerical modelling, and process studies to improve scientific understanding of estuarine circulation, salinity transport, and ecosystem impacts. The Zuari and Mandovi estuaries in Goa are included into the study as typical monsoonal estuaries. Dr. Arjun Adhikari (Goa University) is a key collaborator for this proposal.

c. Eastern coast of Arabian Sea - natural laboratory under human induced stress (Urban Seas)

Status: SONNE cruise proposal, submission approved by DFG and due in July 2026

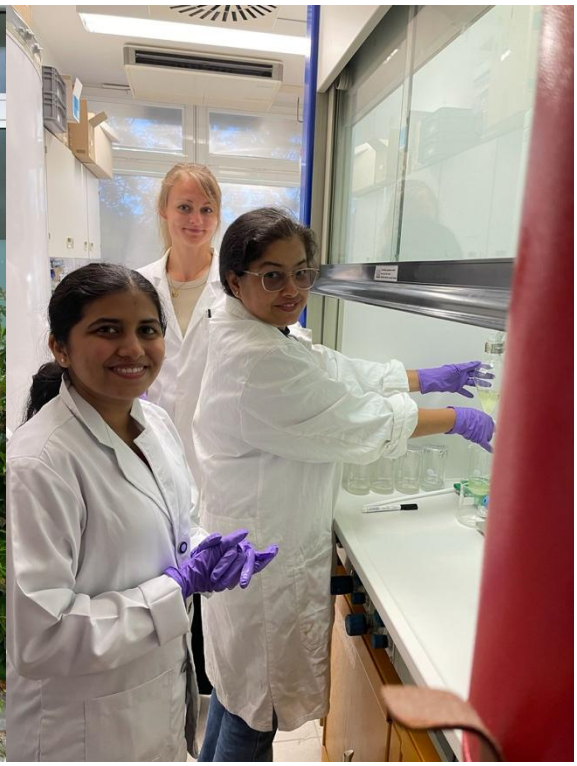
Principal Investigator:

Prof. Dr. Joanna Waniek

The cruise is aiming to investigate human impacts along the coastal-ocean-shelf-open ocean continuum using various parameters in the atmosphere, water column, and sediments. The Indian coast in the eastern Arabian Sea is an ideal model system for tropical marine marginal seas, which are subject to a sharp increase in nutrient inputs, drastic oxygen changes, organic pollutants, and microplastics resulting from rapidly expanding industrialization. As part of the expedition, we will conduct detailed investigations into (i) the significance of transport processes across the shelf for the distribution of natural and anthropogenic substances in the atmosphere, the water column and sediments; (ii) the role of sediments in the removal or neutralization of pollutants; and (iii) the interaction between anthropogenic nutrient and substance inputs and oxygen depletion in the deep water column. The focus of these investigations is detailed sampling of carbon, nutrients, their stable isotopes, new pollutants, and microplastics during the northeast monsoon, to understand the distribution of these substances along the coastal ocean–shelf–open ocean continuum. The cruise is led by IOW in cooperation with University of Hamburg, Institute of Geology, Hereon and TROPOS and the Goa University.

4. Guest Scientist Exchange Programme (Summer 2026)

The MoU facilitated reciprocal scientific visits and research exchanges during Summer 2026.



a. Dr. Arjun Adhikari (Goa University), hosted by Dr. Bronwyn Cahill and Prof. Dr. Hans Burchard

   Dr. Adhikari undertook a one-month research visit to IOW (May - June 2026) focusing on coupled physical-biogeochemical-optical modelling of coastal and estuarine systems. Activities included collaborative work on ocean optics, radiative transfer modelling, estuarine dynamics, and development of integrated modelling frameworks for coastal environmental applications.

b. Dr. Priya D'Costa (Goa University), hosted by Prof. Dr. Joanna Waniek

   Dr. D'Costa is participating in the IOW Guest Scientist exchange programme at IOW under the guidance of Prof. Dr. Waniek. Dr. D'Costa arrived on mid May for a 2 month visit and is training with the Biophysical Interactions Working Group on high-resolution analytical workflows to characterise composition, chemical alteration and surface weathering of microplastics using µFTIR spectrometry. She is analyzing samples taken during the Indian Ocean SONNE 305/2 cruise. Dr. D'Costa gave a special colloquium at IOW on 29 June 2026 entitled "Phytoplankton and bacterial communities on plastics: Insights from a tropical, monsoon-influenced environment".

c. Dr. Aditi V. Naik (Goa University), hosted by Prof. Dr. Joanna Waniek
   Dr. Naik is currently undertaking research in the Biophysical Interactions Working Group under the competitive Mare Balticum Fellowship program. Her three month research stay focuses on developing an understanding of microplastic interactions, biofilm formation, and environmental processes in Baltic Sea ecosystems, including exposure to analytical approaches such as micro-FTIR. The fellowship also aims to support future studies in microplastics in Indian coastal and wetland ecosystems. Dr. Naik presented her work on "Plastisphere Dynamics: Concepts and Biogeochemical Context" at the IOW colloquium on 19 June 2026.

5. Outlook

- Ongoing joint development of integrated modelling frameworks for coastal environmental applications (Adhikari, Cahill, Burchard, Rummel, Li).
- Further activities planned in 2026/2027 are pending proposal reviews, described in section 3.
- Next reporting period: July 2026 to June 2027.