Assessment of the performance of the International Training Centre for Operational Oceanography (ITCOocean) established as a Category 2 Centre (C2C) under the auspices of UNESCO on 15th June 2018 at the Indian National Centre for Ocean Information Services (INCOIS) in Hyderabad India

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REVIEW REPORT

(Final)

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Contents

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1 Executive Summary

An assessment was made on the performance of the International Centre for Operational Oceanography (ITCOocean) established as a Category 2 Centre (C2C) under the auspices of UNESCO, towards the potential renewal of its Agreement which came into force on 15 June 2018.

The Centre is based at the Indian National Centre for Ocean Information Services (INCOIS) in Hyderabad, India. Through a desk review of the relevant available documents and then questioning the staff and stakeholders, the performance of the Category 2 Centre (C2C) centre was evaluated and came out with recommendations on renewal of the Category 2 status of the Centre. A retrospective and prospective approach was adopted for the evaluation which resulted in local evidence based analysis, guided by the questions refined by me (the Individual Specialist/Consultant) and also by conducting a personal visit to the Centre.

Based on the ground-truth information to complement the desk study, it was observed that the Centre has achieved 100% of its mandate with relevant contribution to the UNESCO's Approved Program and Budget (C/5). The quality of coordination and interactions with IOC-UNESCO both at Headquarters and the UNESCO Office in India, as well as with National Commission were found excellent. The Centre developed quality partnerships with government agencies, public and private partners, and local donors. The Centre's governance, organisational arrangements, management, availability of human resources and accountability was found satisfactory. Financial resources are available for its sustainable institutional capacity through Govt. of India funding (budget allocation) and for some training programmes funding drawn from established partnerships and local donors. The Centre has within its scope of work the autonomy necessary for the execution of its activities and legal capacity.

Based on the information collected, compiled and presented in the Annexes and from the opinion/suggestions provided in the feedback forms and from interviews conducted with the Heads of Institutions, professionals, researchers, trainees and students, it is concluded that the Centre activities are fully in alignment with those set out in the agreement signed by UNESCO and the Government of India. Given the relatively short period of the Centre's existence and the fact that operations of the Centre during the last few years were hampered by sanctions and pandemic, the reviewer concludes that the Centre's work is in conformity with the Integrated Comprehensive Strategy for Category 2 Institutes and Centres under the auspices of UNESCO (37 C/Resolution 93 and Document 37 C/18 Part 1 and its Annex), and the Centre was able to meet successfully the goals identified in the Agreement and contributed to achieving ocean related goals presented in SDG 14 through improved knowledge of the marine area and coasts under its terms of reference.

The participation of scientists/students from and outside the regions in training programmes, conferences/seminars and webinars conducted by the Centre brought an improved cooperation and proved to have a great potential for appropriate coordination among organisations and member counties in the region and an opportunity to advance knowledge in marine science and research.

The reviewer recommends that Indian National Centre for Ocean Information Services (INCOIS) of the Ministry of Earth Sciences as an International Training Centre for Operational Oceanography as a category 2 Centre under the auspices of UNESCO for IOC global member states (ITCOocean) **should continue to maintain the status of Category 2 Centre under the auspices of UNESCO** and the Agreement for the continued operation of Centre be renewed for a further period of eight years. Further, UNESCO – IOC may consider/recognise ITCOocean as a **"Centre of Excellence"** for imparting training on Operational Oceanography,

committed to serve the humanity with its incredible infrastructure, excellent collaborations and genuine expertise.

2 Purpose of Review

The independent Specialist/Consultant (Dr. B. Meenakumari), under the supervision of Ahanhanzo, Justin (UNESCO), within the framework of the IOC Programme and Budget 2024-2025 (42C/5), IOC Expected Result 1, Function 'F' - 'Capacity Development', shall implement activities related to the assessment of the performance of the International Centre for Operational Oceanography (ITCOocean) established as a Category 2 Centre (C2C) under the auspices of UNESCO towards the potential renewal of its Agreement and relevant actions supporting preparation of the required documentation for consideration by the UNESCO Executive Board in fall 2024. This will contribute to the information sought by UNESCO (as under 205 E X/13 dated 2nd October 2018) to consider renewal of ITCOocean as a C2C.

3 Scope of the Review

The scope of this review aligns with the specifications for C2C reviews detailed in UNESCO document 40 C/79 12 November 2019 titled *Strategy for Category 2 Institutes and Centres Under the Auspices of UNESCO (2019)*. It responds to the instructions given to the reviewer in respect to the framework of the task and review report by the UNESCO IOC Regional Liaison Officer and also provides ground-truth information to complement the desk study by the international independent Individual Specialist/Consultant. The review assesses the information gathered in respect to the C2C's performance and makes recommendations relevant to UNESCO's considerations for renewal.

4 Methodology

This review was undertaken by analysis and assessment of all available data and information provided by ITCOocean, relevant to its activities since inception in the context of its performance in meeting its mission as a C2C, but mainly focused on the period under review, with reference to the parameters (a) to (h) under Section 7.

Administrative documentation with metrics in respect to annual financial reports, lists of staff, the C2C management structure, lists of people trained by the C2C, and lists of partners were made available and studied as below.

- Reports of the C2C Governing Board, conclusions and recommendations of conferences, workshops, and training courses, implemented by the C2C.
- Information was collected through interviews and feedback with staff of INCOIS/ students / personnel associated with ITCOocean/ Head of Institutes (stakeholders) who are engaged in the C2C's training activities both as a participant and as a trainer.
- For personal interview, visited INCOIS and other stakeholder institutes and held personal interactions with Heads of Institutions and personnel who are involved in

research and imparting secondary training and who have undergone training, in and around Hyderabad and Cochin. Undertook travel to Chennai, Kolkata, and Mumbai to meet stakeholders/beneficiaries and interview them to get their feedback.

- Discussions were held with Dr Uday Bhaskar (Coordinator, ITCOocean), Dr Srinivasa Kumar T (Director, INCOIS), Dr Nimit Kumar (Project Scientist, ITCOocean) and other INCOIS scientists regularly serving as ITCOocean faculty. This included face to face meetings, e-correspondences, review of reports, meeting minutes *etc*., as well as the consultant's familiarity with the INCOIS and stakeholder institutes. The C2C and its host agency and related facilities, including site visits by the consultant to the C2C was conducted to undertake in-situ surveys across its facilities.
- A questionnaire was prepared and communicated to more than 200 prospective personnel with regular follow up to return the completed questionnaire.
- A close collaborative liaison was undertaken with the co-consultant Dr Nick D'Adamo (Adjunct Research Fellow, UWA Oceans Institute Australia), who is also engaged in this review phase, to discuss and exchange information/inputs complementary to each other's respective assessments.

5 Background

About host institute:

The Indian National Centre for Ocean Information Services (INCOIS) was established in 1999 under the Ministry of Earth Sciences (MoES) and is mandated to provide ocean data, information and advisory services to society, industry, the government and the scientific community through sustained ocean observations and constant improvements through systematic and focused research in information management and ocean modelling. The Institute is providing ocean data, information and advisory services to society, industry, the government and the scientific community through sustained ocean observations and constant improvements through systematic and focused research in information management and ocean modelling. INCOIS, since the last two and half decades, has been serving the nation and the community with various flagship programmes such as Tsunami Early Warnings (TEWS), Ocean State Forecast (OSF), Potential Fishing Zones (PFZ), and Ocean Data Services that have proven to have immense socio-economic benefits for a wide range of stakeholders, and enhance the lives and livelihoods of coastal communities.

About ITCOocean C2C:

INCOIS also provides several services to the international community through the UNESCO Category 2 Centre International Training Centre for Operational Oceanography (ITCOO) and as Tsunami Service Provider (TSP) for the Indian Ocean region. ITCOO is used as a strategic platform for academic research in support of INCOIS services, competency development of our own staff, and for capacity development in the whole Indian Ocean region. The International Training Centre for Operational Oceanography (ITCOocean) is aimed at promoting the development and optimization of scientific base, technology and information

systems for operational oceanography at national, regional and global scales. The facility can help in promoting excellence in integrated multidisciplinary oceanography on a global scale. It is also expected that the legacy of the training programme will endure far into the future as it will help build a future ocean system which directly serves the needs of mankind through improved marine monitoring and enhanced stewardship of the seas. The formation and association of the C2C was made possible by a letter of intent (Annexure 4) between MoES and UNESCO concerning cooperation for reducing disaster risks and capacity building in the Earth Sciences. The proposal by INCOIS under ESSO-MoES for upgradation of international Training Centre for operational oceanography as C2C under the auspicious of UNESCO is in Annexure 5. The management framework and agreement between UNESCO and Government of India concerning the establishment of INCOIS of the Ministry of Earth Sciences as an international training centre for operational oceanography under the auspicious of UNESCO (Category 2) is in Annexure 6 and 7.

Mission of C2C:

- To provide advanced training in operational oceanography for young scientists and technical (S&T) persons and decision makers/ officials from India (including industries on payment basis), Indian Ocean Rim (IOR) countries and other developing nations (on sponsorship basis) on a continuous regular basis, to enable to create a large pool of young trained manpower with core skills in the sub-continent.
- To provide training on generation of data from oceans using in situ and satellite platforms, transmission of data to operational centres, data reception, data processing in real-time, usage of data in models and generation of forecasts and dissemination of the same to end users within the shortest possible time.
- To provide ship-board experience and training in observational oceanography using state-of-the-art instrumentation from all available sources and interaction with national and international pool of faculties to so as to widen the S&T base.
- To promote excellence in integrated multidisciplinary oceanography on a global scale to improve understanding and management of natural resources.
- To help scientists to be in a state of preparedness for nowcasting and forecasting the behaviour of the oceans and also to address the role of ocean science and technology in delivering information critical to safety, commerce and environmental protection.

The trained manpower generated through the ITCOocean would help translating the results and findings in ocean science to real-time use by end users such as fishermen, shipping industries, ports and harbours, oil and natural gas industries, disaster management agencies *etc*., more efficiently and contribute to form valuable assets of manpower for induction in oceanography and earth science related institutions. The Intergovernmental Oceanographic Commission (IOC/UNESCO) will support ESSO-INCOIS for capacity building activities in the field of operational oceanography through ITCOocean.

Target Students/Trainees (Stakeholders):

- Students who would like to pursue their career in operational oceanography, with a special focus on the trainees from the IOR countries, Africa and other developing nations including SIDS and LDCs.
- Staff of maritime related institutions including fisheries.

- Staff of government departments involved in oceanographic services and others associated with maritime / environmental activities including teaching.
- Decision makers who need familiarization with oceanographic data management.
- Institutions and persons involved in ocean state forecasts, hazard related warnings, environmental protection, NGOs, coastal planners, those involved in disaster management activities and industries involved in coastal and offshore developmental activities.
- Staff of other operational oceanographic centres who need familiarization with operational oceanographic tools and products and to improve their qualification.

Courses offered:

- Short term courses are offered to professionals and decision makers who have chosen operational oceanography as their career, which will allow the professionals to acquire the essential training to carry out the activities related to operational oceanography and to advance their knowledge in operational techniques and methods. Topics covered are determined depending on the targeted trainees and requirements.
- Currently, ITCOocean offers short-term Certificate courses of duration up to four months. Further, long-term courses up to two years spread over four Semesters leading to a university Post-Graduate Degree/Diploma are also envisaged.

6 ITCOocean Infrastructure & Human Resource:

A) Infrastructure

To support direct on-site learning as part of the courses, INCOIS provides the Centre with direct access to all of its biogeochemical and physical oceanographic laboratories, Indian Tsunami Warning System and other ocean hazards facilities, classroom facilities, IT infrastructure and internet access, and virtual conference meeting facilities. On-site there is also capacity to cater for large classroom numbers – INCOIS provides ITCOocean with conference rooms (2x) seating up to 400 people per room, with computer terminals, audio-visual facilities and with breakout areas for tea breaks *etc*. ITCOocean also provides room for digital lectures, integration across remotely situated classrooms and hence facilitates remote attendance. This enables the Centre to cater for participants that would otherwise have no other means of attending lectures.

The modalities of training possible include: theoretical lecture type classes; instrument demonstrations and training in their use (hands on sessions); software training; one to one (trainer-trainee) individual focus learning; group project and discussion sessions; wet/dry physical and biogeochemical laboratory sessions; technical demonstrations.
A unique feature of this C2C, is the on-site guest-house accommodation for participants and faculty, offering single and double/suite rooms, at very low cost per night by international standards, with associated facilities for extended stays, including internal cafeteria and housekeeping facilities. A modern full-fledged health club and recreational facilities are an added attraction to this facility.

The accommodation is within a few minute walk to the learning and laboratory areas of ITCOocean within the INCOIS site. The ITCOocean (*i.e.* INCOIS) site is also within walking distance of conventional hotels (<1km) and shopping/food areas. The accommodation is within the gated security of the general INCOIS property and has

24/7 reception/security oversight. Photographs of these are made available at: https://drive.google.com/drive/folders/17DWtSlx1AAMEioNvZj78teTXOPNhjK-1.

B) Human Resource

While there are as many (Indian & foreign) experts from outside the host institute who served as faculty during the review period, the alphabetical list of those from INCOIS to support and assist the human resource available at ITCOocean is presented in Annexure 11.

Personal interviews conducted with the ITCOocean Manager and other Faculty showed their understanding of the subject as well as the work they are carrying out at the ITCOocean. All of them experienced the full satisfaction of the participants and said that the continued interaction with them and their desire to have advanced training, is an example of this. Photos/videos of these interactions are provided at:

https://drive.google.com/drive/folders/17bMV6N7lzBoGGc9neJpNSB_t9W78BlDD.

7 Findings

The eight functions/objectives set out in the Centre Agreement between UNESCO and the Government of India is in Fig.1. In essence, they focus on a number of key themes across the respective areas.

Fig.1. C2C Objectives (please see Annexure-1 for full titles)

The above objectives where one of the parameters for the assessment of the Centre's performance as listed in Fig. 2. The list of parameters is given as follows.

Fig. 2. C2C assessment parameters (please see Annex-2 for full titles)

a. The extent to which the centre's objectives as set out in the agreement signed with UNESCO were achieved

With respect to the Centre's performance for **Objective a:**

'**Provide advanced training in operational oceanography for young scientists, technical persons and decision makers/officials from Indian Ocean rim countries, south Asia, Africa on a regular basis'**, the results are substantive and meet more than reviewer's expectations.

Annex 3 provides a detailed chronological listing of ITCOocean C2C course titles conducted during 2018-2023, including associated participation metrics. The information contained in Annex 3 is, in complementary manner, also is highly relevant in detailing elements of the performance of the other seven key objectives (b-h, Fig.1 above),

Examining the Centre's '**advanced training'** performance in terms of courses that were run and their associated metrics, the result is underscored by the following metrics:

- The Centre ran 68 courses, of which 34 were international and 34 national, with notable course continuity achieved during 2020-21 despite these being especially challenging 'COVID-19' years:
    - 2018 - 5 Int. and 4 Nat. (total 9)
    - 2019 – 4 Int. and 9 Nat. (total 13)
    - 2020 – 4 Int. and 1 Nat. (total 5)
    - 2021 – 11 Int. and 2 Nat. (total 13)
    - 2022 – 3 Int. and 6 Nat. (total 9)
    - 2023 – 7 Int. and 12 Nat. (total 19)

- There was a total participation of 5637 trainees: 1745 being international and 3892 nationals. The Centre's excellent data on participation (made available to the reviewer and is on the website https://incois.gov.in/ITCOocean/Course_Analytics.jsp) shows that they are from young students, doctoral scholars/technical and decision making officials.
- Gender distribution constituted 2172 female and 3465 male.
- Participants derived from at least 45 countries: from Asia (spanning east to west and to north-east Asia), Africa, SIDS and regions beyond (Europe, Canada, and from South American countries).
- A number of courses are scheduled for 2024 covering short-term course (4-6 months) for officials from academia, policy makers educators, students (SNOM, Indian Navy) *etc*.; ITCOocean training programme on Fishery oceanography for the Ocean Decade; Ocean observations for coastal applications; and OTGA-INCOIS training course: discovery and use of operational ocean data products and services. These are being updated at https://incois.gov.in/ITCOocean/Forthcoming_Courses.jsp (for forthcoming) and when completed available at

  https://incois.gov.in/ITCOocean/Courses_Conducted.jsp.

Course methodology includes:

- ITCOocean staff preparing and disseminating invitations for pre-course surveys to ascertain preferable and high priority topics for prospective trainee groups;
- Participant selection based on applicants' motivation and qualifications including with the inputs from experts at the partner organization where applicable;
- Regular communication to offer assistance including but not limited to training subject, logistics *etc*.;
- Pre-course materials provided, with links;
- Github (https://github.com/) platform access;
- Group-wise mini projects and laboratory sessions;
- Facilitation of feedback, discussions and evaluations of courses;
- Sharing of presentations, video lectures and course materials at the respective course webpage given at the links above;
- After course services including facilitation of student visits and mentoring by faculty, feedback survey material was also provided for review. It was observed that a good overall level of response was received from trainees upon invitations to them to provide feedback which is a testament to the interest and continued engagement of the trainees. **For example, there was an overwhelming positive response in all the training programmes conducted so far, to the question of '*how much would you recommend ITCOocean to others?*'**

Objective b

With respect to '**defining regional and global problems and priorities…',** the Centre's collaborative international and national associations enabled planning and implementation of courses framed with reference to regional and global problems and priorities. This included support through various modes including but not limited to, monetary support, knowledge sharing, contributing as resource persons and mentors.

These associations included:

- OTGA: Ocean Teacher Global Academy (IOC UNESCO) https://classroom.oceanteacher.org/
- POGO: Partnership for Observation of the Global Ocean (a UK based charity organisation) https://pogo-ocean.org/
- IOTIC: Indian Ocean Tsunami Information Centre (IOTIC) (established in Jakarta by UNESCO IOC)
- RCOWA: Category 2 Regional Education and Research Centre on Oceanography for West Asia under the auspices of UNESCO https://rcowa-unesco.ir
- ISBA: International Sea-Bed Authority (an autonomous international organization established under UNCLOS) https://www.isa.org.jm/
- CSSTEAP: Centre for Space Science and Technology Education in Asia and the Pacific (established as a UN initiative) https://cssteapun.org/
- UNDOS: UN Decade of Ocean Science for Sustainable Development 2021-30
- UN-ESCAP: Economic and Social Commission for Asia and the Pacific (UN) https://www.unescap.org/
- IOCINDIO (then as the IOC Regional Committee for the Central Indian Ocean , and imminently to be known as the IOC Sub-Commission for the central Indian Ocean) https://www.ioc.unesco.org/
- IORA: Indian Ocean Rim Association https://www.iora.int/en
- WAGOOS: Western Australian Global Ocean Observing System
- UNESCO IOC Perth Programme Office (to 2021)
- BOBP: Bay of Bengal Programme
- NOAA: National Oceanic and Atmospheric Administration, USA
- IOCCG: International Ocean Colour Coordinating Group
- ITEC: Indian Technical and Economic Cooperation Programme (MEA- GoI)
- CEMACS: Centre for Marine and Coastal Studies, Universiti Sains Malaysia
- SUST: Shahjalal University of Science and Technology, Bangladesh
- SQU: Sultan Qaboos University, Sultanate of Oman
- CORDIO: Coastal Oceans Research and Development in the Indian Ocean, East Africa
- CSIRO: Commonwealth Scientific and Industrial Research Organisation, Australia
- DFFE: Department of Forestry, Fisheries and the Environment, South Africa
- MMF: Marine Megafauna Foundation, US
- NMU: Nelson Mandela University, South Africa
- ORI: Oceanographic Research Institute, South Africa
- UCT: University of Cape Town, South Africa

- UEM: Universidade Eduardo Mondlane, Mozambique
- UKZN: University of KwaZulu-Natal, South Africa
- UM: University Malaya, Malaysia
- University of Oxford, United Kingdom
- Universite de la Reunion, France
- UQ: University of Queensland, Australia
- USF: University of South Florida, USA
- UWA: University of Western Australia, Australia.
- Minderoo Foundation, Australia
- Oman Tsunami Warning Centre
- The IOGOOS (Indian Ocean Global Ocean Observing System) related network of bio-physical ocean observational, research and knowledge transfer related international alliances, making a significant contribution to the missions of UNESCO/IOC-GOOS, WCRP/CLIVAR, SCOR, IMBeR:
    - IIOE-2 (Second International Indian Ocean Expedition, under UNESCO IOC, SCOR and IOGOOS);
    - SIBER (Sustained Indian Ocean Biogeochemistry and Ecosystem Research, Under IMBER and IOGOOS);
    - IORP (Indian Ocean Region Panel under CLIVAR and IOC-GOOS);

Similarly, National partners include (but not limited to):

- INCOIS: Indian National Centre for Ocean Information Services (Ministry of Earth Sciences) https://incois.gov.in/
- CSBOB : Centre for Studies on Bay of Bengal, Andhra University
- NDMA : National Disaster Mitigation Authority, New Delhi
- MSSRF : M S Swaminathan Research Foundation, Chennai
- SNOM : School of Naval Oceanology and Meteorology, Cochin
- NPCIL: Nuclear Power Corporation of India Ltd.
- NIH : National Institute of Hydrography, India
- CRAI : Community Radio Association of India
- NCPOR : National Centre for Polar and Ocean Research, India
- Vidyasagar University, West Bengal, India
- NIOT: National Institute of Ocean Technology
- NCCR: National Centre for Coastal Research

Objective c

"Providing training on generation of data using in situ and satellite platforms, transmission of data to operational centres, usage of data in models, and generation of forecasts and dissemination of the same to end users".

With respect to Objective c, Annex 3 provides insight to the subject matters (through the titles) with regard to the range of courses that were conducted. Clearly, significant training more than the Centre's commitment was undertaken with respect to **(c)**.

Some of the courses relevant to these objectives were found as follows:

Discovery and use of operational ocean data products and service; Marine-met data visualization using FERRET; and Emerging trends in ocean observations and ocean data analysis; Fundamentals of Ocean Data Management; Ocean Observation System and Ocean Data Utilisation; and Sea glider instrumentation, testing, data acquisition, processing and analysis. This is in addition to a relevant initiative IIOE-2 Regional Coordination Unit for Data and Information Management that has been established through the IIOE-2 project Office hosted at INCOIS. Abiding the IIOE-2 Data and Information Management Policy, the data is available to all ITCOocean trainees, through INCOIS's data management group. The Policy was designed with input from IOC staff in the context of IODE aspirations and IOC data policy objectives. Hence, this is a service to the IIOE-2 international constituency that can facilitate capacity building and knowledge transfer in the 'data' realm to all IIOE-2 stakeholders, including its Early Career Scientists Network and IIOE-2 members from the Indian Ocean region, including SIDS (Small Island Developing States) and countries with lesser developed ocean science capabilities.

Objective d

With respect to **Objective d "Substantially contribute to the activities of numerous users and UNESCO/IOC programmes related to climate change, disasters mitigation, data and information exchange and others"**, the Centre's achievements in reaching users are evident by the wide geographical reach, gender balance and numerous number of trainees engaged in the many courses that were conducted (see links at Objective-a)**.** These courses involved (see Annex 3) climate change and disaster mitigation through three specifically directed courses for international trainees, and four for national trainees. With respect to data and information exchange, the Centre's strong performance in this area is highlighted in the narrative for Objective c. The association and relevancies with UNESCO/IOC programmes include IOC-OTGA, the UNESCO Tsunami programme (including with IOTIC and the IOTWMS), the Global Ocean Observing System, and Second International Indian Ocean Expedition.

Also, it is to be noted that the recently articulated intention of the Centre (at ITCOocean Board Meeting 2022, Annex-10) to include formulation of activities is in reference to priorities under the UN Ocean Decade. At the 2022 Board meeting, activities were submitted in its Annexure 6 of the minutes. Furthermore, now INCOIS is also the host of an UN Ocean Decade endorsed Decade Collaborative Centre for the Indian Ocean Region (DCC-IOR), which facilitates closer linkages between the ITCOocean C2C and DCC-IOR, facilities and integrated programming of priorities and training initiatives complementary to each other. On similar lines (having integrative complementarity with the C2C) was another note from the 2022 ITCOocean Board Meeting, which announced an intent (Annexure 4) for the Indian Government to pursue a proposal for ITCOocean to be recognised as an IORA Centre of Excellence.

Objective e

With respect to **Objective e, "Promote excellence in integrated multi-disciplinary oceanography understanding and management of natural resources"**, the Centre has delivered fittingly in this area. It is clear through the multidisciplinary nature of the range

of courses run at the Centre and the clear integrating nature of the themes across the course network, along with the links to multi-disciplinary and multi-national programs (e.g. IIOE-2 and related alliances, IOCINDIO, IOGOOS, OTGA, IORA, UNDOS), that integration and the multi-disciplinary approach are key underpinning motivations of the course framework. It is notable that the themes span the continuum from observations to characterisation of environmental processes, to modelling, to fundamental and applied applications and finally through to the use of knowledge and information for societal benefit.

Many of the multi-disciplinary trainings conducted provided trainees with a better understanding of natural resource management. Some of these trainings (with self-explanatory titles) were: Fishery oceanography for future professionals, Ocean colour remote sensing, Fishery stock assessment and ecosystem modelling, Coastal vulnerability and advances in operational oceanography, Biological observations in the Indian Ocean (from microbes to megafauna), Modelling for ocean forecasting and process studies, Remote sensing of Potential Fishing Zones and ocean state forecast.

Objective f

This objective is: "**Help scientists to be in a state of preparedness for nowcasting and forecasting the behaviour of the ocean and address the role of ocean science and technology in delivering information critical to safety, commerce and environmental protection"**.

Being hosted at an operational ocean information and service agency such as INCOIS, the ITCOocean C2C has understandably fulfilled this objective very well.

Modelling in the context of nowcasting and forecasting is explicitly addressed in a number of directly relevant courses that were run by the Centre, including: numerical modelling of the coastal circulation around India; fundamentals of ocean modelling; Indian Tsunami Warning System (involves modelling of tsunami events); fisheries stock assessment and ecosystem modelling; forecasting of Potential Fishing Zones (PFZ); modelling for ocean state forecasting and process studies; and fundamentals of ocean climate modelling at global and regional scales.

Objective g

The Centre meets its aim very well for **Objective g: "Promote activities of the Centre, of UNESCO and IOC role in marine and coastal matters, raise public awareness concerning the need for sustainable management of the sea and coastal areas, and introduce the benefits of national and regional cooperation approach".**

From the 2018-2023 period of assessment, and through forward looking elements as well, a comprehensive list of actions and initiatives that address objective g, include:

- ITCOocean reports regularly as required to the UNESCO IOC Assembly and Executive Council sessions, which by default then brings awareness with promotion of the Centre's activities relevant to UNESCO and IOC, through the attention of the large constituency of UNESCO IOC Member States (150) and Observers, including: IOC Sub-Commissions (e.g. AFRICA, WESTPAC, Central Indian Ocean); IORA; IODE (incl. therefore OTGA).

- ITCOocean website, being a vital and excellent modality in support of Objective g.
- ITCOocean's engagement with the international and stakeholders from community to science levels represented within the frameworks such as IOGOOS, IIOE-2, IORP, SIBER, IRF and KUDOS. This includes users and scientists, managers policy/decision makers at their annual meetings (under the auspices of the annual International Indian Ocean Science Conference gatherings: Perth 2017, Jakarta 2018, Port Elizabeth 2019, India 2020-22 (virtual due to COVID-19), and Perth 2023 and throughout the year through ITCOocean staff engagement in the respective operations and meetings of these alliances.
- Up to Sep 2021, liaising with the UNESCO IOC Perth Programme Office.
- Through the general collegiate engagement with the Centre's international partners (as listed for Objective a, above).
- The Centre's stated intended new relationships with international organisations such as IORA.
- Awareness and promotion by virtue of the links through experts in the Centre's 'visiting professorship' program.
- International awareness and promotion gained by the 'national' courses that have the eye of the global community through geopolitical alliances (e.g. SNOM).
- The co-located and thematically linked new Indian Ocean Region – Decade Collaborative Centre, under the auspices of UNESCO, provides a further avenue for promotion especially at the Indian Ocean regional and UNESCO IOC institutional levels, and further at the higher UN level in the context of the SDG14 imperative.
- By virtue of the very wide geographical reach of the Centre in terms of awareness to the international community, through the constituency of trainees engaged and to be engaged in the courses of the Centre (over 5000 trainees from over 45 countries).
- Through links *via* the membership of the Governing Board of the Centre – itself international in composition, involving UNESCO IOC and other regional stakeholders.

Objective h

The Centre played a vital societal role in achieving the aspirations of **Objective h**, to**: "Organise assistance to IOC/UNESCO in mobilising human, financial and material resources to respond to the needs of the coastal countries of the region in dealing with emergency situations triggered by marine natural hazards".**

Through the apt design and delivery of specific courses and encouragement and facilitation of engagement of regional stakeholders to participate in such courses, the Centre made and is projected to make valuable and significant contribution in this area of the Centre's mission. The Centre's creation and well framed governance and operational structure has led to significant resources (human, financial and material) being made available to support activities relevant to the objective, both from India and from international alliances.

In context, hazards related courses included:

- Coastal vulnerability and advances in operational oceanography science (hazards to humans and infrastructure relating to extreme sea level (relevant to acute and long-term), extreme waves, currents, erosion etc);
- An observing system simulation experiment for Indian Ocean surface pCO_2 measurements (relevant to climate change and acidification and threats to primary producers, including calcareous species in coastal habitats, such as corals and pelagic organisms);
- Indian Tsunami Early Warning System (ITEWS) training to naval officers and, in context, the Centre's thematic links to the IOTIC and broader tsunami programme, including IOTWMS which itself has a node at INCOIS Hyderabad, co-located collegiately with the Centre;
- Biological observations in the Indian Ocean (from microbes to megafauna) (as would be relevant to trophic structure analyses, algal bloom related threats in coastal environments etc.)
- Modelling for ocean forecasting and process studies (as would be relevant to engineering applications in siting and designing coastal outfalls, characterising land-based pollutants entering the coast, spills monitoring/prediction/risk assessment etc)
- Fundamentals of ocean climate modelling at regional and global scales (as would be relevant for vulnerability assessments of important coastal/shelf habits with respect to climate change threats (warming, acidification, changes in ocean dynamics and nutrient dynamics, species changes changing background / climatic conditions, natural hazards and disasters *etc*.)

b. The relevance of the contribution of the centre's programmes and activities to the achievement of UNESCO's prevailing Approved Programme and Budget (C/5) at the time in which it was designated, including global strategies and actions plans as well as sectoral programme priorities (IOC-UNESCO programmes and activities), as defined in the agreement.

- UNESCO C/5 specifies a number of guiding principles in the form of objectives, lines of action and priorities, to which the Centre committed to align within the framing of its portfolio of courses and in the manner in which it conducted its operations.
- This review finds that the Centre's contribution to UNESCO C/5 at both the global level and specific to the sectoral programme priorities of IOC-UNESCO has been germane and at a high level, with reference to the designated guiding foci outlined in C/5. This is evident both through the selection of the topics designated for the many courses that were initiated during the 2018-23 period, as well as the reach geographically (Ref: C/5 Global Priority Africa) and in terms of actively promoting gender balance in its participant constituency (Ref: C/5 Global Priority Gender Equality). The metrics referred to in Objective a, above, speak to this outcome. With respect to the C/5 high level aim of 'supporting Member States in the implementation of the 2030 Agenda and other ocean related policies' the Centre's effort and resulting focus on the UN Decade (as discussed above), which then links to SDG14 as one important element of Agenda 2030, refers very positively here.

- More specifically to IOC's Functions, which reflect its priority responses to UNESCO C/5, the Centre has aligned very well with those in the way by selecting and implementing the topics.
- A comparison between the full range of courses (Annex 3) shows clearly how the Centre is addressing IOC Function A (Ocean Research), B (Observing systems and data management, (C) Early warning systems, and (D) Assessment and information for policy (as also relevant to decision making), albeit perhaps to the lesser extent compared to A, B and C.
- Furthermore, in C/5, capacity development, as a designated priority that cuts across all of the elements in A, B, C, D above, is both implicitly and explicitly relevant to the Centre's mission and related course portfolio. The very nature of training early career and emerging ocean scientists, practitioners and decision makers in the range of subjects represented in the Centre's courses defines **capacity development** precisely.
- UNESCO's Category 2 Centres are championed by UNESCO as one of its key modalities of Member State engagement in support of UNESCO's societal aspirations. It is clear that there has been (and is projected to be) an invaluable contribution by the ITCOocean C2C to UNESCO's aspiration in this context.

The relevance of the contribution of the activities of the centre to global development agendas

- The Centre has formed itself to be highly relevant to global development agendas, with particular reference to UN Agenda 2030 (UN General Assembly reference A/RES/70/1 21 October 2015), and its SDG14 'Life below Water'. In this context, note the reporting above, on the Centre's activities in response to 7b. The Centre's actions and plans support the actions and priorities for IOC in UNESCO C/5, which in turn address the 2030 Agenda's SDG14.
- SDG14 lists ten target areas for Member States to focus on and listing them herewith highlights that the Centre's portfolio of course themes address those that a C2C ocean training centre can sensibly cover within its mandate. The Centre provides its **constituents with training in the underpinning science and related applications relevant to almost all of the SDG14 'targets'** ***viz,***

    1. Reduce marine pollution*
    2. Protect and restore ecosystems
    3. Reduce ocean acidification
    4. Sustainable fishing
    5. Conserve coastal and marine areas
    6. End subsidies contributing to overfishing
    7. Increase the economic benefits from the sustainable use of marine resources
    8. Increase scientific knowledge, research and technology for ocean health
    9. Support small scale fisheries
    10. Implement and enforce international sea law.

    *SDG14 further emphasizes 'plastic pollution' as a key issue to be addressed.

- The Centre addresses 1, 2, 3, 4, 5, 7, 8, 9 through a set of highly relevant and focussed training courses. Its courses either focus directly on these areas, or provide the essential underpinning base scientific understanding and training on applying the science with respect to supporting these targets for SDG14.

- This review notes that if in a position to take up new courses, the Centre could be guided by these 10 target areas, and also introduce plastic pollution as an adjunct theme to 1, above.
- In this regard, it is notable that the Centre recently introduced the 'Visiting Professorship' programme, and collaboration with other institutes, which could be used to bring expertise in any of the above areas into the Centre's portfolio, complementary to the significant expertise already at hand at a national level.
- Furthermore, it is notable that the Centre has already introduced a focus on the UN Decade, as one important avenue to guide any enhancement of the Centre's attention on Agenda 2030.

c. The quality of coordination and interaction with UNESCO, both at Headquarters and in the field, as well as National Commissions, other thematically-related category 1 and 2 institutes or centres with regard to planning and implementation of programmes.

- The Centre coordinates and interacts with UNESCO effectively and at appropriate levels. At the highest level, the Governing Board has UNESCO DG representation through the UNESCO IOC Executive Secretary (who also has the position of ADG UNESCO). THE UNESCO IOC is also represented on the Board by its Regional Liaison Officer. Board meetings have been held as required, with UNESCO IOC Members in attendance. At the national (Indian) level, the Board is represented at a high level by the Secretary to the Ministry of Earth Sciences (MoES), representing the Governmental host and national sponsor of the Centre (that is effected via the institutional host agency of the Centre – INCOIS, Hyderabad). The INCOIS Director is also a Board Member and participates as required in all Board meetings, along with the Secretary MoES.
- Centre leadership personnel (INCOIS Director) is closely involved with IOCINDIO (IOC Regional Committee for the central Indian Ocean). IOCINDIO is soon to be transformed to the IOC Sub-Commission for the central Indian Ocean, continuing and further strengthening the C2C's close interactions with countries of the Indian Ocean the IOCINDIO UNESCO-IOC Member State constituency.
- The Director of INCOIS (the Centre's host institution) is a regular Member of the Indian delegation to UNESCO IOC Assembly (biannual) and Executive Council (EC) (annual) Sessions, as is the Secretary MoES, enabling further opportunistic close and regular interaction between high level C2C leaders and UNESCO IOC representatives. Secretary MoES is the Board Chair. MoES also provides two other Members to the Board, being respectively the Joint Secretary MoES, and the Additional Secretary & Financial Advisor MoES. Furthermore, in this same context, INCOIS Director Dr Srinivasa Kumar is a Vice-Chair of the IOC and, by association, an Officer of the IOC and hence interacts with IOC formally inter-sessional to IOC's formal Assembly and EC meetings.

d. The partnerships developed and maintained with government agencies, public or private and donors

- The Centre has established a substantive list of partnerships across government, and public and private donors, including (Full names, are given in 7a, above): INCOIS/MoES; RCOWA; OTGA (IODE & UNESCO links); POGO; IOTIC; ESCAP; ISBA; CSSTEAP; SNOM; IOCINDIO; IORA; WAGOOS; IOC Perth Programme Office (to Sep 2021); IOGOOS and its related alliances of IIOE-2, IORP, SIBER and IRF).

e. The nature and efficiency of the centre' governance, including organizational arrangements, management, human resources and accountability mechanisms.

- The Centre's Governance is affected through the Governing Board, which met regularly as required, and operated efficiently and with the support it required by INCOIS as the ITCOocean host. The Board minutes for 2020, 2021 and 2022 respectively in **Annexures 8, 9 and 10.** The Board focussed on ensuring that the Centre adhered to its obligations as per the Agreement, and in facilitating maximal relevance of the Centre for its constituency. The composition of the Board is as specified in the Centre Agreement, having representation from the Indian Government (at the level of Secretary - Ministry of Earth Sciences), from UNESCO Member States (through heads of high-level institutions in ocean sciences relevant to the Centre's mandate) and from UNESCO at the DG level (through the IOC Executive Secretary/ADG). The Board is well supported administratively by INCOIS through the Director and senior staff. It has met three times, and the agendas, reporting and strategic and tactical levels of the discussions underpin the Centre's strong performance and focus on its mission as per the Agreement. The annual Board meeting minutes showed that the Board meetings involved both reviews of performance and forward-looking deliberations, and the live list of action items were examined and addressed at each. The Board is also provided clear and accurate information by INCOIS on the Centre's finances and activities thereof in terms of courses that were run and proposed and associated participation metrics. Of note is that the Centre's administrative underpinning (through INCOIS) enabled the Board to maintain an efficient and regular Governance function even during the challenging COVID-19 era, which is a testament to the sophistication and operability of the Centre's excellent modern virtual meeting facilities, being the same that are used for the courses.
- The Centre's organisational arrangements are excellent, having strong material support from a high government level (Indian Government, via the Ministry of Earth Science, as channelled through the Centre host, INCOIS in Hyderabad). The INCOIS Director oversees the designation of required staffing resources to support the Centre, at senior to administrative levels. This includes operational support in terms of finances, logistics and in providing staff experts in the course subject areas to act as trainers across the portfolio of courses.
- To support direct on-site learning as part of the courses, INCOIS provides the Centre with direct access to all of its biogeochemical and physical oceanographic laboratories, Indian Tsunami Warning System and other ocean hazards facilities, classroom facilities, IT infrastructure and internet access, and virtual conference meeting facilities. On-site there is also capacity to cater for large classroom numbers – INCOIS provides

ITCOocean with conference rooms (2x) seating up to 400 people per room, with audio-visual facilities and with breakout areas for tea breaks etc.

- ITCOocean also provides for digital lectures, integration across remotely situated classrooms and hence remote attendance. This enables the Centre to cater for participants that would otherwise have no other means of attending lectures.
- Overall, the modalities of training possible include: theoretical lecture type classes; instrument demonstrations and training in their use (hands on sessions); software training; one to one (trainer-trainee) individual focus learning; group project and discussion sessions; wet/dry physical and biogeochemical laboratory sessions; technical demonstrations. The field trips are also organised as and when required for hands on training of sample collection *etc*.
- There have been no course fees sought of applicants, further facilitating participation from lesser developed countries and SIDS. As a further somewhat unique feature of this C2C, this review notes that ITCOocean has on-site purpose built guest-house accommodation for participants and faculty, offering single and double/suite rooms, at very low cost per night by international standards, with associated facilities for extended stays, including internal cafeteria, recreational facilities and housekeeping facilities. The accommodation is within a few minute walk to the learning and laboratory areas of ITCOocean within the INCOIS site. The ITCOocean (*i.e*. INCOIS) site is within walking distance of conventional hotels (<1km) and shopping/food areas. The accommodation is within the gated security of the general INCOIS property and has 24/7 reception / security oversight.

f. The financial resources available for ensuring sustainable institutional capacity and viability.

- The Agreement specifies the Indian Government's committed obligation in regard to financial resources for the Centre (Annex 7) copies the Agreement, and Article 9 refers, specifying the Government's obligation. Essentially the Government has to provide '*…all the resources, with financial or in kind, needed for the administration and proper functioning of the Centre'*. This has been achieved and exceeded. Financial information in this context was provided to the reviewer and is also reported on through the minutes of the Board (ref: 2020, 2021 and 2022 Board Minutes).
- As budgetary data submitted formally through Board Meeting documents, the ITCOocean C2C received funding from the Indian Government amounting to approx. (exact figures at INCOIS):

2017 - 18 (as a startup figure pre-Agreement date of June 2018)	$2.370M USD
2018 - 19	$1.931M USD
2019 - 20	$1.176M USD
2020 - 21	$0.600M USD
2021 - 22	$1.020M USD
2022 - 23	$0.811M USD
2023 - 24 (projected)	$0.949M USD
2025 – 26 (projected)	$0.719M USD

Summary of Interactions and Inputs from Managers/Policy makers and Stakeholders

**Note:* Photographs and videos of these interactions are provided at

Observations of Managers:
https://drive.google.com/drive/folders/1cNAZl2P3EM_eCcZDuard_qCSq0wvJ8AS

Interactions with Stakeholders: https://drive.google.com/drive/folders/1Rv-2F8cRdsPONJEawjjUzh-KSSOR-JAV

Excerpts and inputs of personal discussions are given in Annexure 13.

Summary of feedback and inputs from the questionnaire received is attached in Annexure 14. The original feedback forms (unedited) received from students, researcher and managers (Annexure 15) are given in the link:

https://drive.google.com/drive/folders/18RcBOKbRpbCjPkjNGgU0Y9tgKpMDm2QB

The review took about eight weeks and positive response was received across the participants. The list of institutions contacted in the process is given in the Annexure 16.

Article 9 – Contribution by the Government

1. The Government shall provide all the resources, either financial or in kind, needed for the administration and proper functioning of the Centre.

2. The Government undertakes to:

   (a) make available to the Centre necessary facilities and staff needed for the successful operations;

   (b) entirely assume [the maintenance of the Centre premises, salary of the staff, operating expenses, and the like;

   (c) contribute to the Centre a total amount of USD 600,000 per year for at least a period of 6 years;

   (d) make available to the Centre the administrative staff necessary for the performance of its functions, which shall comprise of at most 6 staff members of INCOIS including the Director of INCOIS.

g. The extent to which the centre enjoys within its territory the autonomy necessary for the execution of its activities and legal capacity to contract, centre legal proceedings, and to acquire and dispose of movable and immovable property.

- The Centre enjoys autonomy to execute its function, as granted to it by virtue of the Centre's Agreement and as intrinsically embedded in the autonomy and legal framework underpinning the Centre's host agency INCOIS under the Ministry of Earth Sciences of Government of India.

- It is therefore sanctioned formally, by virtue of the Agreement co-signed at the Government of India level, to have all that requires at operational and institutional levels in order to undertake its mission as 'agreed' with UNESCO.
- Underpinning establishment documents signed by the Government of India commit the Government to providing the required financial inputs annually, and the host agency for the Centre (INCOIS) is a fully operational, legally framed and legally protected entity within the Ministry of Earth Sciences of the Government of India.
- The Governing Board includes as a standing requirement Membership of the representatives of the Government of India (through the Ministry of Earth Sciences and INCOIS) to provide continual formal oversight that the Centre functions as per the Agreement.

This review concludes that the status and underpinning Governance framework should provide UNESCO with the confidence needed to ensure that the "centre enjoys within its territory the autonomy necessary for the execution of its activities and legal capacity to contract, centre legal proceedings, and to acquire and dispose of movable and immovable property".

8 Conclusion

Based on the information collected, compiled and presented in the Annexes and in the feedback provided by feedback forms and interviews by the Heads of Institutions, professionals, researchers, trainees and students it is concluded that the Centre activities are fully in alignment with those set out in the agreement signed by UNESCO and the Government of India.

It is further confirmed that the Centre is well established, financially supported by the country and its activities and outputs consistent with the objectives and functions of the Agreement. Given the relatively short period of the Centre existence (2018-2023) and the fact that operations of the Centre in between was slowed down during the COVID-19 period, the reviewer conclude that the Centres' work was in conformity with the Integrated Comprehensive Strategy for Category 2 Institutes and Centres under the auspices of UNESCO and the Centre was able to meet successfully the goals identified in the Agreement and contributed to achieving ocean dimension presented in SDG 14 through improved knowledge of the marine area and coasts under its terms of reference. Many activities of the Centre are relevant to on-going UNESCO initiatives, particularly those related to the mandate of the Intergovernmental Oceanographic Commission of UNESCO. ITCOocean is assisting Member States to meet new challenges facing UNESCO/ IOC: the UN Ocean Science Decade with the vision to create "Science we need for the Ocean we want" where the IOC plays a key role.

The Centre and the host institution is contributing to the research efforts of the region by bringing out trained manpower. They have established effective and reliable tsunami warning system and thus preventing and reducing the impacts of natural hazards, mitigating the impacts of and adaptation to climate change and variability. By fostering cooperation in the region among governmental and non-governmental organisations working in the areas of marine/coastal research the Centre could attract participation of brilliant young minds and middle level managers and this participation of the trainees/students from within and outside the country revitalised improved cooperation in the region and proved to have a great potential for ways of cooperation, coordination, collaboration and partnership in the marine research. The training programmes are shaped in such a way that clearly demonstrate the state of art marine research in the region and facilitate its application, show leading strategic objectives

and reflect the relevance to ITCOocean objectives and mandate and the needs of the Member States of the region and wider.

IOC Member States consider ITCOocean training programmes and Seminars/ Webinars/Conferences conducted by INCOIS as another opportunity to express their concerns of the future state of regional marine and coastal environment and an opportunity to discuss and find the ways for improved cooperation, and workshops and training courses as an opportunity to advance knowledge in marine science and research. The scientific scope of the workshops and training courses covers a wide range of issues of high regional interest from coral reefs protection, acidification and its effects and oil pollution to ocean data collection, satellite oceanography and tsunami warning, and fisheries forecasting and modelling. They help in expanding collective knowledge of marine area conditions and support sustainable development of the regional economy.

Taking into consideration of all these, the reviewer concludes that the **ITCOocean should maintain the status of Category 2 Centre under the auspices of UNESCO and the Agreement for the continued operation of Centre be renewed for a further period of six years.**

The auspices of UNESCO can consider **ITCOocean as a "Centre of Excellence"** for imparting training on Operational Oceanography committed to serve the humanity with its incredible infrastructure, excellent collaborations and genuine expertise.

9 Recommendations

The Centre is having excellent facilities and state of art technologies.

1. To further enhance its coordination and collaboration with other relevant organizations and initiatives, such as the UN Decade of Ocean Science for Sustainable Development, the Global Ocean Observing System, and the Intergovernmental Panel on Climate Change, can take the training centre way forward in capacity development in ocean studies and operational oceanography.
2. Increasing its funding and resources will support its core activities and programs, as well as to respond to emerging needs and priorities in the ocean domain.
3. The centre can prioritise hands-on training according to the syllabus, along with the project component, which would improve the overall effectiveness of the course.
4. Furthermore, providing individual computer workstations at the centre, rather than relying on participants' personal laptops, would ensure consistency in performance and prevent any issues arising from differences in operating systems.
5. This necessitates additional infrastructure development/fund support in the coming years.
6. In future, further focus may be given research on ocean dynamics and predictive modelling of coastline changes, climate change, sea level rise, species distribution, harmful algal bloom occurrence and those which are critical for mitigating environmental impacts and promoting ecosystem resilience.
7. The centre has to continue to pursue its vision and mission with passion and excellence in the coming years with affiliation of UNESCO.
8. For senior level managers very short-term courses (spanning 2-3 days) may be planned.
9. Training programmes may also be tailor made to other level of participants particularly for the coastal communities and their leaders through their regional partners.

10. This review also noted that if in a position to add to its thematic areas for new courses, the Centre could be guided by these 10 target areas, and also introduce plastic pollution as an adjunct theme.
11. It is strongly recommended that this state of art facility now functioning under INCOIS may be affiliated and taken forward as a next level independent training institute as a **"Centre of Excellence"** in operational Oceanography with autonomy and permanent staff.

10 Acknowledgements

I am deeply grateful to UNESCO for entrusting me with the challenging task of reviewing the C2C centre (ITCOocean) established at INCOIS, Hyderabad. The experience was both enriching and enjoyable, as I had the opportunity to interact with the enthusiastic and talented students trained at the facility and the positive and ambitious management team.

I would like to express my sincere appreciation to Dr. Srinivasa Kumar, Director, Dr. Udaya Bhaskar, Scientist and Manager, and Dr. Nimit Kumar, Project Scientist, ITCOocean, for their invaluable support throughout the review process and their crucial role in enabling this report. I am also grateful to Dr. Nicolino D'Adamo, co-consultant, for his insightful discussions and contributions to the report preparation.

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