Revised Implementation Strategy for the Second International Indian Ocean Expedition 2015-30

17 October 2024

(For final check by IIOE-2 PO)

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Preamble and context

This document is the Revised Implementation Strategy for the Second International Indian Ocean Expedition 2015-30. It was prepared in response to the IIOE-2 International Steering Committee's decision at its seventh major meeting (4-5 March 2024, Lombok, Indonesia) (IIOE-2 SC7) to extend the tenure of IIOE-2 by another five years out to 2030. The IIOE-2 was launched on 4 December 2015, originally as a five-year initiative, guided by the original Implementation Strategy (IPC, 2015a) and original Science Plan (Hood *et al*, 2015). In 2019 at IIOE-2 SC3 in Port Elizabeth, South Africa, the IIOE-2 was extended to 2025. This was in response to IIOE-2's growing constituency and significant level of completed and planned science activities, including major cruise expeditions, and related scientific reporting extending beyond 2020. The COVID-19 period resulted in an effective hiatus in operational activities during 2020-22 but the interest in IIOE-2, associated rate at which project proposals were being submitted and receiving IIOE-2 endorsement, strong rate of publication, and re-programing of cruises otherwise delayed by COVID-19, continued in earnest. In February 2023, at the IIOE-2 SC6 in Perth, Western Australia, that interest along with noting of the high level of tangible commitments beyond 2025 resulted in the IIOE-2's constituency resolving to develop plans for IIOE-2 to realize its further potential out to 2030.

There has also been a IIOE-2 Science Plan Addendum produced (Hood *et al*, 2024), to help guide IIOE-2's extended tenure into the 2015-30 period. That addendum was sought by the IIOE-2 International Steering Committee at IIOE-2 SC7. This revised IIOE-2 Implementation Strategy complements the IIOE-2 Science Plan Addendum and provides practical guidance in implementing IIOE-2. The flow and contents of this Revised Implementation Strategy follow very closely the original Implementation Strategy of 4 December 2015 (IPC, 2015a) that was written by the UNESCO IOC IIOE-2 Interim Planning Committee (Group of Experts) (Chair Dr Satheesh Shenoi) and produced with the support of a writing group (Ed. Dr Nick D'Adamo). The following page is a reminder and acknowledgement of the writing and editing groups that were responsible for the original Implementation Strategy of 4 December 2015, as a reference and to provide historical context to this Revised Implementation Strategy.

This revision reflects the pragmatic modifications made by the Steering Committee to the governance and operational structures of IIOE-2 during 2015 to 2023, and those made at IIOE-2 SC7 proactively in respect to the IIOE-2's new tenure out to 2030.

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A look back to the beginning of IIOE-2 launched on the 4th of December 2015

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Contents

1 Executive Summary
2 Introduction
3 Governance
4 Science and Research
5 Data and Information Management
6 Operational Coordination
7 Early Career Scientists Network
8 Project Office
9 References
10 Acknowledgments
Appendices 1 and 2

1 Executive Summary

Prepared by Nick D'Adamo 29 July 2024.

This Revised Implementation Strategy for IIOE-2 2015-30 supports the IIOE-2's mission: *to advance our understanding of the Indian Ocean and its role in the Earth System in order to enable informed decisions in support of sustainable development and the well-being of humankind*.

It not only builds on the four formative years of consultations, planning and institutional advocacy that were undertaken during 2012-2015 for the IIOE-2 involving the Indian Ocean's regional constituency as well as complementary global stakeholders, but also takes account of the developments in the scientific outputs, revised scientific foci, and operational running of the IIOE-2 since its launch on 4 December 2015. It was produced to align with the IIOE-2 International Steering Committee's decision at its 7th major meeting during 4-5 March 2024 (IIOE-2 SC7) to extend the IIOE-2's tenure out to 2030. It complements, as a guiding document designed to help run the IIOE-2, the IIOE-2 Science Plan Addendum (Hood et al, 2024). It is noteworthy to recall that the original Implementation Strategy of 4 December 2015 was underpinned by materials that derived from a series of planning workshops, meetings and institutional deliberations by the co-sponsors IOC, IOGOOS and SCOR during 2012-15 and which are available through the IIOE-2 Project Office at ESSO-INCOIS, Hyderabad, India or through the IIOE-2 website https://iioe-2.incois.gov.in/ (see Hood and D'Adamo 2012, 2013 & 2014; D'Adamo 2014).

As with the original Implementation Strategy, this revision document is designed to provide a guiding *strategy* rather than a detailed operational procedure for the Expedition. Operational details will continue to be developed and arranged through the Steering Committee in conjunction with the IIOE-2 Project Office, and through its associated elements including the science theme leaders and the three Working Groups. This Revised Implementation Strategy therefore continues the original focus of providing motivations and related objectives with associated recommended actions (in some cases committed actions) in response to the major elements of the IIOE-2 portfolio. It thereby again suggests and recommends ways in which the Steering Committee's and its Working Groups' aspirational frameworks can be best achieved whilst acknowledging that as for all major initiatives of this nature, resource limitations and operational constraints can limit the attainment of the ideal operational framework in terms of executing the IIOE-2.

The major sections cover the structure of the IIOE-2 Steering Committee, its associated Governance, its elemental membership, and the functions of the six science themes, the three Working Groups and the IIOE-2 Early Career Scientists Network. The Steering Committee's framework remains practically very close to what it was, albeit with some minor structural changes in representation. For example, originally IIOE-2 had seven Working Groups, whereas those seven now consolidate into three, being WG1, WG2, WG3 (below). In addition, attention is also given to improving the engagement and integration of the ECSN into the Science Theme and Working Group networks.

- **WG1 Science and Research** *(as it was and remains).*
- **WG2 Data and Information Management** *(as it was and remains).*
- **WG3 Operational Coordination** *(being a consolidation of the former WGs 3-7: ie former WG3 Capacity Development + former WG4 Operational Coordination + former WG5 Outreach and Communication + former WG6 Translating Science for Society + former WG7 Sponsorship and Resources).*

The Project Office, which since October 2021 exists as a sole Node in India, is addressed in terms of its structure and functions.

A strong emphasis is again placed on ensuring that the IIOE-2 is efficiently and professionally run, administered and resourced. Another key emphasis is to guide the underpinning operational support needed for the IIOE-2 to achieve science of contemporary relevance, of a high standard and integrated within the thematic elements of the revised Science Plan. Working Group 1 focuses on this aspect of IIOE-2. Priority is also given to ensuring that

the data and information management thereof supports the optimal utilisation of the science effort that will continue to be assigned to IIOE-2, as reflected through the aims of Working Group 2.

Another key aspiration is that the Revised Implementation Strategy again supports an aim of IIOE-2 to leave a legacy throughout the Indian Ocean region, as did the original IIOE of 1959-65, by establishing the basis for improved scientific knowledge transfer to wider segments of society and regional governments. The importance of these objectives is reflected in the maintenance of the foci of Capacity Development and Translating Science for Society within Working Group 3. Furthermore, it aims to support IIOE-2's educational and capacity development opportunities in support of regional and early career scientists, as reflected in the enhanced explicit engagement of ECSN members within the respective Science Theme and Working Group networks.

This Revised Implementation Strategy is designed such that it may be reviewed and updated if and as required on an annual basis, with the review process to be informed by input through the Steering Committee.

2 Introduction

The IIOE-2's mission is: *to advance our understanding of the Indian Ocean and its role in the Earth System in order to enable informed decisions in support of sustainable development and the well-being of humankind*.

In support of this mission, this Revised Implementation Strategy draws on the original Implementation Strategy (IPC, 2015a) and aligns with a number of other key preceding IIOE-2 documents, including: the SCOR Science Plan Development Committee's (SPDC) *IIOE-2 Science Plan* (Hood *et al*, 2015) which has been updated through the IIOE-2 Science Plan Addendum (Hood *et al*, 2024) and which provides the underpinning framework for the science of IIOE-2; and the *Strategic Framework for the Implementation of IIOE-2* (IPC, 2015b) which is an Info Doc of the UNESCO IOC 28th Assembly meeting in 2015.

It is written to act as a succinct guide for the implementation of IIOE-2, with the specification and implementation of further detail to be overseen by the IIOE-2 Steering Committee.

This Revised Implementation Strategy has been structured to include specific chapters for Governance, the three respective IIOE-2 Working Groups of Science and Research, Data and Information Management, Operational Coordination, and for the Early Career Scientists Network and Project Office respectively.

For many of the key issues there are specific objectives and associated actions which provide descriptors that can be used to guide 'what is to be done' in an implementation context and have been so designed to facilitate the IIOE-2 achieve its mission.

3 Governance

Introduction

The IIOE-2 governance structure provides the strategy, leadership and stakeholder relationships that underpin the delivery of IIOE-2. The guiding principles of governance are based on fairness, consistency, transparency, cohesiveness and ensuring 'fitness-for-purpose' in the structures, strategies and delivery of IIOE-2. Effective governance is also required to ensure proper oversight and accountability for public resources. IIOE-2 structures and delivery mechanisms are intended to be science-driven and outcome-focused.

The principles underlying the structure and representativeness of the IIOE-2 Steering Committee were first specified in Strategic Framework for the Implementation of IIOE-2 (IPC, 2015b), endorsed by IOC and published as IOC/INF-1324 of the UNESCO IOC 28th Assembly meeting in 2015. The original IIOE-2 Implementation Strategy (IPC, 2015a) provided IIOE-2 with operational guidance and specified its Steering Committee framework. That framework remains practically the same in this Revised Implementation Strategy, but with minor changes, as detailed below.

Sponsors

Major Sponsors: As at IIOE-2 SC7, the Major Sponsors of IIOE-2 remained as IOGOOS, SCOR and UNESCO IOC, with:

- SCOR as the major cash sponsor;

- IOGOOS providing the Project Office along with significant underpinning resources (secretariat premises, personnel, logistics etc), including the IIOE-2 Regional Coordination Unit for Data and Information Management; and
- The 150 Member State UNESCO IOC providing the high-level imprimatur for the IIOE-2 including links to the newly established IOC Sub-Commission for the Central Indian Ocean (IOCINDIO).

Collectively these autonomous international bodies, each involved in science in the Indian Ocean, take responsibility for facilitating the IIOE-2 across its required operational and institutional facets.

Partner Sponsors: The Steering Committee also provides for 'Partner Sponsors'.

- Partner Sponsors are complementary to the Major Sponsors. Partner Sponsors are recognised as providing resources on an occasional basis and their importance in supporting the IIOE-2 is reflected in their right to have a standing Membership in the Steering committee.

Steering Committee

Role: The over-arching role of the IIOE-2 Steering Committee (SC) is to set the high-level policies and take responsibility for the delivery of the project for the 2015-30 period.

Structure: The IIOE-2 SC framework, as modified to be fit-for-purpose for the IIOE-2's tenure out to 2030, is described below.

Chairing: The IIOE-2 SC will be chaired by the founding Major Sponsors: IOGOOS, SCOR and UNESCO IOC. The three sponsors may co-chair or the chairing may rotate among the three sponsors, with a Chair and two Vice-Chairs. Irrespective of the chairing procedure, the sponsors have equal rights and share responsibilities in appointing the Science Theme leaders and the Working Group leaders.

<table>
<tr><td rowspan="2">Core Group</td><td>Co-Chairs (IOGOOS, SCOR, UNESCO IOC)

(representing the three Major Sponsors)</td><td rowspan="4">Project Office

(PO)

Leading PO personnel represented on Steering Committee as ex-officio</td></tr>
<tr><td>Strategic Executive Level
One representative (leader) per each of the six science themes
+
One representative (leader) per each of the three IIOE-2 Working Groups
+
One representative per each major IOC regional body/committee wishing to be a Member of the Steering Committee
(e.g. IOC AFRICA, IOCINDIO, IOC WESTPAC)
+
One representative per each Partner Sponsor wishing to be a Member the Steering Committee
(eg IMAREST WA Branch)</td></tr>
<tr><td rowspan="2">Stakeholder Group</td><td>Regional Coordination Level
One representative per each IIOE-2 'National Committee'</td></tr>
<tr><td>Science Delivery Level
One representative (i.e. Principal Investigator) per each endorsed IIOE-2 scientific research initiative
+
One representative (leader) from the IIOE-2 Early Career Scientists Network</td></tr>
</table>

Figure 1: The IIOE-2 Steering Committee structure (as revised 2024)

Main groupings within SC: As shown in Figure 1, the SC comprises (non-hierarchically) a **'core group'**, being the Strategic Executive Level (the 'Executive') and a broader more operationally orientated **'stakeholder group'** including the respective Regional Coordination and Science Delivery levels.

Core Group

The Core Group refers to the 'Executive', including the SC Co-Chairs, and one representative for each of the six over-arching science themes specified in the Revised IIOE-2 Science Plan. The six themes are: 1) Human benefits and impacts; 2) Boundary current dynamics, upwelling variability and ecosystem impacts; 3) Monsoon variability and ecosystem response; 4) Circulation, climate variability and change; 5) Extreme events and their impacts on ecosystems and human populations; and 6) Unique geological, physical, biogeochemical, and ecological features of the Indian Ocean. These over-arching themes provide scientific areas for interested parties to engage in IIOE-2 and to identify and select scientific relevancies for their respective interests. The Executive will also include one member from each of the three Working Groups, namely: Science and Research; Data and Information Management; and Operational Coordination.

The Executive will also comprise *ex-officio* members from the PO, and representatives of key Indian Ocean related IOC regional bodies and committees. It is expected that the regional bodies and committees will be represented by their Chairs or nominated alternates with decision making authority.

Each of the three IIOE-2 Working Groups are formed and operate under the oversight of the SC. IIOE-2's steerage 'community' of Science Themes, Working Groups and others as described by this structure, will work collaboratively and through annual IIOE-2 wide symposia that will constitute essential sessions at which assessment, exchange of information, review and forward planning take place. The Science Themes and Working Groups could also allow for their own inter-sessional gatherings to address issues specific to individual Science Themes or Working Groups or that cut across two or more Science Themes and/or Working Groups, as might be required and as feasible.

Stakeholder Group

Membership of the 'Stakeholder Group' of the SC will derive from three supporting groups of IIOE-2 namely: (i) representatives (typically the Chairs) of IIOE-2 'National Committees', noting that each country that has an effective IIOE-2 National Committee involved in the delivery of IIOE-2 may provide a single member to the SC; (ii) a leading scientist (typically the Chair or Principal Investigator) from each respective major science initiative established, approved and implemented under the IIOE-2's science framework; and (iii) a representative (Chair or Co-Chair) of the IIOE-2 Early Career Scientists Network. Since these stakeholder groups are self-contained and will choose their own Chairs/Leaders, representation at the SC will evolve naturally within each group. The PO will communicate with and advise these groups as necessary.

SC membership and renewal

The leaders of the Science Themes and the Working Groups in the Executive will continue to be chosen and appointed by the SC Co-Chairs to balance nationalities, gender, and experience in international science activity.

The aspiration will be for SC members to rotate once every 5-years using a process to be defined by the Co-Chairs. However, the IIOE-2 Co-Chairs will reserve the right to pragmatically allow continuity of membership if members are clearly seen to be both delivering with high value to the IIOE-2 and committed to continue such contribution.

On rotation, Science Theme and Working Group leaders will be chosen by the members of their own Science Theme or Working Group.

It is also expected that representatives of regional bodies and committees will rotate during the lifetime of IIOE-2. Such rotation would be in accordance with their own body/committee processes.

The Co-Chairs will oversee: (i) a membership selection, appointment, and rotation policy; and (ii) the implementation of that policy.

Meeting frequency: The SC will meet at least once annually (face to face) and also inter-sessionally by electronic communication if and as required. It will take a view of IIOE-2 over the long-term period. The Executive will be in frequent contact by electronic communication.

Core Group: The Core Group, for members wishing to participate, may act as a practical mechanism to support the wider SC through meeting more frequently than the annual SC meetings, thereby providing a means to deal with SC level issues (including making decisions where practicable) inter-sessionally to

annual SC meetings. The PO will continue to provide the necessary secretariat and administrative support to the Core Group meetings.

Annual symposia: The programme of annual IIOE-2 symposia will continue to comprise complementary science and planning streams. Each symposium will involve a general IIOE-2 related science programme along with a SC led annual planning meeting that cuts across the entire SC constituency. The annual symposia will be developed under the auspices of the SC in close working with the PO. Advocacy to secure hosts and sponsors, resourcing in general and logistical underpinning for the annual meetings will be coordinated through liaison between the SC, IIOE-2 sponsors and the PO.

Reporting to Sponsor organisations: It will be the responsibility of the individual sponsors' representatives (ie the SC Co-Chairs representing IOGOOS, SCOR and IOC, respectively; and Partner Sponsor representatives) to report back to their own organisations as and when required.

IIOE-2 Project Office (PO)

The 'Project Office' (PO) is the key facilitator for IIOE-2 delivery and will have day-to-day responsibility for the co-ordination and implementation of IIOE-2. The IIOE-2 PO is hosted by INCOIS, Hyderabad, India.

The PO focuses on Steering Committee support, outreach/communication (including the website https://iioe-2.incois.gov.in/), data and information management and operational coordination, whilst also supporting sponsorship facilitation, knowledge transfer for societal benefit and capacity building.

The PO will continue to draw collaborative support from established IOC Member State institutions in respect to providing infrastructure and resources, consistent with the IOC's 28th Assembly Resolution on IIOE-2 (IOC-XXVIII/DR (5.3) Rev 2). The respective 'Resources and Sponsorship' and the 'PO' sections, below, refer to a list of key functions required for overall IIOE-2 project management.

The aspiration (notwithstanding resource limitations) is that the PO will be supported by at least one salaried full-time staff person with required administrative and hosting resources, and that this person will be line-managed by their parent employing host, but with responsibilities in terms of their IIOE-2 support function to the Co-Chairs of the SC under an agreed job description and associated terms of reference between the host and SC (i.e. through the Co-Chairs). Any complementary additional IIOE-2 support staff, either under sponsorship or secondment to the PO or operating as national employees within supporting Member States, will have their normal institutional line-management respected, with due notice taken of input from the SC Co-Chairs over staff tasking and performance. If a host institute requires, then there may be a formal agreement (such as a MoU) between the host institute and the sponsors and, if necessary, with the normal institute of the staff member.

The working model for the PO may be reviewed by the Steering Committee from time to time.

Research Initiatives and their endorsement under IIOE-2

The IIOE-2's research initiatives are the Endorsed Projects, of which there were over 50 at the date of this Revised Implementation Strategy. They form the heart of the science delivery and so this constitutes the major element of IIOE-2. Each major research initiative will have its own coordinating or governing mechanism that would involve the main scientists involved in the initiative. Members of each coordinating or governing mechanism are most likely to be volunteers as they are fuelled by self-interest. Each initiative will have a representative focal point as a member of the SC (ie the 'PI', as per the Science Delivery Level of the SC structure in Figure 1). Each initiative will work and meet through modalities that its own resourcing allows but should at least communicate regularly by cost effective modes such as web-based meetings and email. There will be a strong link between each research initiative and the PO.

Free standing sub-projects outside research initiatives will be represented on the SC through their national committees.

PIs seeking endorsement of their projects as part of IIOE-2 should contact the PO for guidance. The SC has overseen the process of developing the IIOE-2 protocol for assessing and endorsing proposals under IIOE-2, focused on ensuring that IIOE-2 activities adequately refer to and align with IIOE-2's integrated objectives. The endorsement is via an Endorsement Form process, administered by the PO (see the website https://iioe-2.incois.gov.in/).

IIOE-2 National Committees

As the funding for IIOE-2 activities is principally generated within each country, each country should have an IIOE-2 'National Committee' with a Chair who is the point of contact for the SC and the PO. It is recommended that each participating country have an IIOE-2 National Committee representing their IOGOOS, SCOR and IOC communities. It is noted that in most countries there are already national committees or focal point groupings

relating to IOGOOS, SCOR and IOC programmes and so there should be useful existing available infrastructure to facilitate the IIOE-2 National Committee objective. How National Committees are run will depend on the respective national need. Guidelines on this will be available from the PO. These committees would be self-sustaining but would need to adhere to principles of the SC and their own respective local sponsoring organisations. As at the date of this report National Committees had been formed by Australia, China, France, Germany, India, Indonesia, Japan, Republic of Korea, South Africa, UK and USA.

IOC regional bodies, committees and related entities

Involvement of IOC regional organizations and programmes within the IIOE-2 (e.g. IOC AFRICA, IOC INDIO, IOC WESTPAC, UNESCO Category II Centres) continues to be encouraged and facilitated. There are explicit membership positions allowed for in the Strategic Executive Level of the SC for IOC regional organizations and programmes. These positions will provide an efficient and formal entry point option for their respective constituents to be represented and to engage in IIOE-2 in a regionally coherent and coordinated manner and may provide conduits for IIOE-2 advocacy at higher institutional and national levels.

Partners in support of IIOE-2

Other relevant complementary organisations will be welcome to participate in the IIOE-2 and are encouraged to form alliances with the various elemental levels of the SC.

4 Science and Research

4.1 Introduction

The IIOE-2 Science Plan (Hood et al, 2015), now supported by the IIOE-2 Science Plan Addendum (Hood et al, 2024), articulates the overarching goals and the core research themes of the Expedition, as follows.

> *The overarching goal of IIOE-2 is to advance our understanding of interactions between geologic, oceanic and atmospheric processes that give rise to the complex physical dynamics of the Indian Ocean region, and determine how those dynamics affect climate, extreme events, marine biogeochemical cycles, ecosystems and human populations. This understanding is required to predict the impacts of climate change, pollution, and increased fish harvesting on the Indian Ocean and its surrounding nations, as well as the influence of the Indian Ocean on other components of the Earth System. New understanding is also fundamental to policy makers for the development of sustainable coastal zone, ecosystem, and fisheries management strategies for the Indian Ocean. Other goals of IIOE-2 include helping to build research capacity and improving availability and accessibility of oceanographic data from the region.*

The IIOE-2 Science Plan is structured around six scientific themes. Each of these include a set of questions that need to be addressed to improve our understanding of the physical forcing that drives variability in marine biogeochemical cycles, ecosystems and fisheries in the Indian Ocean and to develop the capacity to predict how this variability will impact human populations in the future. It is also important to emphasize that most of these questions are relevant to open-ocean, coastal and marginal sea environments.

- **Theme 1: Human benefits and impacts** (*How are human-induced ocean stressors impacting the biogeochemistry and ecology of the Indian Ocean? How, in turn, are these impacts affecting human populations?)*
- **Theme 2: Boundary current dynamics, upwelling variability and ecosystem impacts** *(How are marine biogeochemical cycles, ecosystem processes and fisheries in the Indian Ocean influenced by boundary currents, eddies and upwelling? How does the interaction between local and remote forcing influence these currents and upwelling variability in the Indian Ocean? How have these processes and their influence on local weather and climate changed in the past and how will they change in the future?)*
- **Theme 3: Monsoon variability and ecosystem response** *(What factors control present, past and future monsoon variability? How does this variability impact ocean physics, chemistry and biogeochemistry in the Indian Ocean? What are the effects on ecosystems, fisheries and human populations?)*
- **Theme 4: Circulation, climate variability and change** *(How has the atmospheric and oceanic circulation of the Indian Ocean changed in the past and how will it change in the future? How do these changes relate to topography and connectivity with the Pacific, Atlantic and Southern oceans? What impact does this have on biological productivity and fisheries?)*

- **Theme 5: Extreme events and their impacts on ecosystems and human populations** *(How do extreme events in the Indian Ocean impact coastal and open-ocean ecosystems? How will climate change impact the frequency and/or severity of extreme weather and oceanic events, such as tropical cyclones and tsunamis in the Indian Ocean? What are the threats of extreme weather events, volcanic eruptions, tsunamis, combined with sea level rise, to human populations in low-lying coastal zones and small island nations of the Indian Ocean region?)*
- **Theme 6: Unique geological, physical, biogeochemical, and ecological features of the Indian Ocean** *(What processes control the present, past, and future carbon and oxygen dynamics of the Indian Ocean and how do they impact biogeochemical cycles and ecosystem dynamics? How do the physical characteristics of the southern Indian Ocean gyre system influence the biogeochemistry and ecology of the Indian Ocean? How do the complex tectonic and geologic processes, and topography of the Indian Ocean influence circulation, mixing and chemistry and therefore also biogeochemical and ecological processes?)*

To deliver on its goals and objectives, IIOE-2 focusses on three major areas of science activity: 1) remote sensing studies; 2) modelling and assimilation studies; and 3) in situ observation and potential for leveraging existing infrastructure. All of these will require close collaboration and multidisciplinary integration of knowledge obtained by teams of researchers operating throughout the Indian Ocean.

4.2 Science and Research – Objectives and Actions

Objective 4.2.1: Ensure continued development, integration and promotion of the IIOE-2 science themes to assure effective delivery of IIOE-2 science.

Each of the IIOE-2 science themes includes a set of questions that need to be addressed to improve our understanding of the atmospheric, oceanic and geologic dynamics of the Indian Ocean. Addressing these questions will ensure the development of the understanding that is needed to predict how variability in these dynamics will impact human populations in the future.

> Action 4.2.1.1: The Science and Research Working Group should continue to facilitate the chaired subcommittees for each of the respective IIOE-2 Science Themes to oversee their delivery.
>
> Action 4.2.1.2: The Science and Research Working Group should ensure that there is communication and effective linkages with and between these Science Theme subcommittees.

Objective 4.2.2: Translate the research questions identified in the IIOE-2 Science Plan (and in the Science Plans of other relevant programs complementary to IIOE-2) into specific studies that should be motivated in IIOE-2.

The research themes and questions identified by the IIOE-2 Science Plan (and considering its 2024 Addendum) provide the motivation for a wide range of targeted IIOE-2 studies. In addition, since the finalization of the Science Plan, additional research priorities will continue to have been identified, such as in the International Ocean Discovery Programme Science Plan, that should be pursued under IIOE-2.

> Action 4.2.2.1: The Science and Research Working Group should continue to identify and advocate for specific targeted oceanographic, atmospheric, geologic and human impact studies that need to be pursued as part of IIOE-2 derived from the Science Plan and other relevant programs complementary to IIOE-2.

Objective 4.2.3: Promote and incorporate new research initiatives that align with the IIOE-2 Science Plan.

In addition to coordinating ongoing research, the IIOE-2 is working to initiate new research projects and programmes that are designed to address the core IIOE-2 research themes. These will include both national and international efforts, across planned and prospective initiatives.

> Action 4.2.3.1: The Science and Research Working Group should promote the development and implementation of:
>
> - The Eastern Indian Ocean Upwelling Research Initiative (EIOURI);
> - The Western Indian Ocean Upwelling Research Initiative (WIOURI);

- The Year of the Maritime Continent; and
- Any other existing or planned initiatives that align with the IIOE-2 Science Plan.

It is important to emphasize that these are just examples of research initiatives that are already emerging under IIOE-2. Indeed, the scope of the Expedition is much broader than these initiatives and embraces many other aspects of physical, chemical and biological oceanography and also geology and atmospheric science. Efforts should be undertaken to promote additional interdisciplinary research initiatives under IIOE-2. These could include initiatives dedicated to any of the six core themes articulated above.

Objective 4.2.4: Effectively integrate the IIOE-2 with the remote sensing research community to maximize use of remote sensing data in the Expedition.

IIOE-2 studies in the Indian Ocean should continue to take full advantage of remote sensing to support their scientific objectives. The IIOE-2 framework requires a coordinated approach to address this issue and therefore a dedicated task team is recommended.

Action 4.2.4.1: The Science and Research Working Group should establish an IIOE-2 Remote Sensing Task Team. This Task Team should work to establish strong ties with scientists and agencies that are actively involved in remote sensing-oriented research, motivate the use of available remote sensing tools, information and related studies as required, and thereby maximise the benefits that remote sensing can bring to the science and research objectives of IIOE-2.

Objective 4.2.5: Promote modelling and data assimilation studies in IIOE-2.

IIOE-2 studies in the Indian Ocean should continue to take full advantage of advanced scientific modelling and related data assimilation methods to study and understand oceanic, atmospheric and geologic variability.

Action 4.2.5.1: The Science and Research Working Group should continue to develop effective engagement mechanisms between the IIOE-2 and the modelling research community and promote studies of:

- Ocean and atmosphere circulation, variability and change;
- Biogeochemical processes and variability;
- Tectonic processes;
- Impacts of riverine and atmospheric inputs;
- Bio-physical dynamics between the Indian Ocean and its marginal seas;
- Higher trophic level modelling; and
- Data assimilation for modelling.

Objective 4.2.6: Leverage existing research infrastructure in the Indian Ocean.

Long-term in situ observing and monitoring efforts are ongoing in several coastal and open ocean locations in the Indian Ocean. Studies motivated as a part of IIOE-2 should target, leverage and build upon this existing research infrastructure.

Action 4.2.6.1: The Science and Research Working Group should continue to promote and facilitate leveraging of:

- Coastal monitoring and observation programs;
- Open ocean monitoring and observation programs;
- Ocean monitoring and observation programs of the marginal seas of the Indian Ocean;
- National marine and related observing systems;
- GO-SHIP;
- Ships of Opportunity programs;
- Citizen science initiatives;
- The International Ocean Discovery Programme (IODP);
- InterRidge (International Cooperation in Ridge-Crest Studies);

- The EAF-Nansen Project;
- Large Marine Ecosystem Programs; and
- Any other identified existing or emerging programmes that align with this objective.

Objective 4.2.7: Review, if and as may be deemed necessary, the scientific criteria for determining whether a research initiative or project qualifies as IIOE-2 research.

The IIOE-2 Steering Committee has developed criteria for determining whether a particular research initiative or project qualifies as IIOE-2 research (ie the IIOE-2 Endorsement Form process). The Science and Research Working Group should continue to facilitate the SC's work in this regard.

Action 4.2.7.1: The Science and Research Working Group should continue to provide input to the SC Executive in respect to the IIOE-2 Research Project endorsement criteria.

Objective 4.2.8: Ensure that data collected by different research groups and countries that are participating in IIOE-2 adopt common methods and standards so that ultimately, these data can be compared and combined into larger scale data sets.

The IIOE-2 should continue to identify and/or review the variables that will or are being measured basin-wide and inter-calibration activities for these measurements should be conducted, manuals of standard methods should be compiled, and training thereof should be carried out. Refer also to Chapter 5, below.

Action 4.2.8.1: The Science and Research Working Group should review the need to establish a Task Team on Inter-calibration to insure:

- Consultation of manuals and experts on best practices, inter-calibration and the use of standards and reference materials to underpin the development of inter-calibration guidelines (or best practices) for the IIOE-2 (perhaps a manual);
- Integration with IIOE-2 Data and Information Management Policy; and
- That the guidelines that are developed include recommendations for carrying out training to ensure that the guidelines are understood and followed.

Objective 4.2.9: Facilitate collegial collaboration and cooperation among IIOE-2 scientists and with other relevant programs.

Collegial collaboration and cooperation among IIOE-2 scientists and communication with other relevant programmes continues to be vital to the success of IIOE-2.

Action 4.2.9.1: The Science and Research Working Group should continue to:

- Facilitate collegial collaboration and communication among IIOE-2 scientists;
- Work with the PO on the development of scientific agenda for annual IIOE-2 Symposia to maximize opportunities for information exchange and for the embracing of an ever-broadening scientific constituency into IIOE-2; and
- Facilitate communication between the IIOE-2 and other complementary programmes by promoting placement of scientists on IIOE-2 Working Groups that are also involved in these other programs.

Objective 4.2.10: Help scientists understand how they can participate in IIOE-2.

In addition to defining research priorities and motivating research and collaboration on topics that have been identified in the IIOE-2 Science Plan, scientific leaders in IIOE-2 should continue to help scientists understand how they can participate in IIOE-2.

Action 4.2.10.1: The Science and Research Working Group should:

- Develop guidelines that explain how scientists can participate in IIOE-2;

- Ensure that the IIOE-2 website that is established enables the effective dissemination of these guidelines;
- Ensure that the PO is facilitated as a reference point for this information; and
- Ensure that Working Group chairs are facilitated as reference points for this information.

Objective 4.2.11: Increase public awareness of IIOE-2 and ensure that managers and policy makers are informed about the scientific activities and outcomes in a timely manner.

Communication of IIOE-2 scientific objectives, outcomes and benefits to the public, to resource managers, to policy makers and to the IIOE-2's institutional and governmental stakeholders continues as an important goal of the Expedition, both as a public responsibility per se and also as a vehicle to growing as broad a constituency as possible for IIOE-2.

Action 4.2.11.1: The Science and Research Working Group should continue to identify opportunities for scientists to participate in IIOE-2 outreach and communication activities targeting both the public and management communities.

Action 4.2.11.2: The Science and Research Working Group should continue to encourage IIOE-2 scientists to participate in these outreach and science communication activities.

5 Data and Information Management

5.1 Introduction

The IIOE-2 research effort involves the full range of marine data acquisition modes, including: remote sensing; mooring deployments; research vessels; modelling; and laboratory experiments. Basic scientific research requires sound data management practices. In programs of the breadth, depth and scale of IIOE-2, even greater attention must be paid to data management efforts when diverse and distributed teams of researchers expect to undertake data integration and synthesis efforts. The Data and Information Management Working Group (ie Working Group 2 of the iIOE-2) has developed a IIOE-2 Data and Information Policy document to guide this element of IIOE-2. The Policy addresses many of the aspirational actions recommended in the original Implementation Strategy of 4 December 2015. Accordingly, this Revised Implementation Strategy has not repeated those actions those herewith. The current Policy is presented herewith (in italics).

IIOE-2 Data and Information Policy (copy without editing as at was on 11 January 2023)

Introduction

Basic scientific research requires sound data management practices and one of the overarching objectives of IIOE-2 is to support the collection and curation of all data to encourage data sharing using internationally agreed rules of data exchange, and to facilitate data discovery and use in the long term. Timely and unrestricted sharing of data and other research outcomes is critical for the success of ocean research programs that aspire to inform the decision-making process.

Scientists participating in research activities, projects and programs endorsed by IIOE-2 (https://iioe-2.incois.gov.in/IIOE-2/EndorsementForm.jsp) are expected to comply with this data policy. The IIOE-2 Data Policy is consistent with the IOC Oceanographic Data Exchange Policy (https://www.iode.org/index.php?Itemid=100040) and informed by data sharing policies of similar, contemporary global research programs. Exceptions can be arranged in cases where this policy is in conflict with policies associated with an IOC Member State's national data access policies. In those cases, it is recognized that IOC Member State's policies must supersede the IIOE-2 data policy, and the project lead should contact the head of the IIOE-2 Project Office (PO) located at the Indian National Centre for Ocean Information Services (INCOIS) in Hyderabad, India.

The intent of this policy is to promote practices that support the FAIR data principles

(https://www.force11.org/group/fairgroup/fairprinciples and https://www.go- fair.org/) that research data be Findable, Accessible, Interoperable and Reproducible (FAIR). That objective is compatible with common practices of collaborative, scientific research programs wherein researchers require access to a broad range of trans-disciplinary research outcomes to achieve the scientific outcomes of the research plan. IIOE-2 research outcomes should: be made available on a free and unrestricted basis ensuring open exchange of data and metadata; be compatible with the FAIR data principles; and be archived in recognized data centres to be preserved for future use.

IIOE-2 strives to be inclusive of all national programs and therefore the data policy is intended to encourage open data sharing in an effort to facilitate the scientific goals of IIOE-2, while respecting national data and information exchange policies. The IIOE-2 Data Policy is written to support scholarly exchange, but not be a deterrent to participation.

General Data Submission Guidelines

For the purposes of this data policy, 'data' includes all types of digital data generated during the course of the IIOE-2 endorsed research project. Some examples include: raw and processed data files, in situ observations and measurements, remote sensing and experimental data, model results and synthesis data products.

Researchers associated with IIOE-2 endorsed projects are encouraged to contact their local project office, national data centre (e.g., NODC), IODE recognized Associate Data Unit (ADU) or other accredited data centre. If local or regional data management support is not available, then researchers should submit data and metadata directly to the IIOE-2 Regional Coordination Unit for Data and Information Management (https://iioe-2.incois.gov.in/IIOE-2/login.jsp) at INCOIS in Hyderabad, India. This distributed approach means that it is imperative that a Digital Object Identifier (DOI) be assigned to each data set.

All IIOE-2 researchers are encouraged to have an ORCiD (persistent digital identifier for persons). To get or retrieve your ORCiD visit: https://orcid.org/

Cruise Data and Metadata Submission Guidelines

As early as possible: pre-cruise metadata (https://iioe-2.incois.gov.in/IIOE- 2/metadata.jsp) should be submitted to the IIOE-2 Regional Coordination Unit for Data and Information Management in addition to the relevant national data centre.

- *Within two weeks of the end of a cruise the Chief Scientist should submit acompleted cruise report (https://iioe-2.incois.gov.in/IIOE-2/login.jsp)*
- *Within 6 months of the end of a cruise the Chief Scientist should submit the following to the relevant national data centre and/or INCOIS:*
    - *a final copy of the cruise report;*
    - *data and metadata for standard shipboard observations and measurements (e.g., underway data, basic hydrography);*
    - *CTD profile and underway data (both raw and processed files, including sensor metadata and calibration history).*
- *As soon as possible, and no more than 2 years after data generation:*
    - *all data sets (processed) along with initial quality flags and accompanying metadata (including any additional relevant documentation) should be submitted to the relevant national data centre and/or INCOIS.*

Data Release Policy

- *Soon after submission, pre-cruise metadata for cruises and datasets will be made publicly available from the IIOE-2 Data Portal hosted at INCOIS.*
- *Science party members are encouraged to make all metadata and data generated during a cruise available to cruise participants in preliminary form during the cruise.*
- *Any data generated from a cruise and submitted to INCOIS will be password protected and available at the Chief Scientist's discretion (e.g., recognized data originators and approved*

collaborators) until the public release date.

- *Prior to public release, all data will be considered preliminary and clearly designated as such. Data should be shared with other cruise participants as soon as they become available during or after a cruise, to enable data synthesis to proceed rapidly, and to facilitate early quality assessment of the data. It is understood that the data are the proprietary material of the originating scientist and should not be used without their permission.*

Data Access and Citation Guidelines

- *Data and metadata generated by IIOE-2 endorsed projects will be accessible from the IIOE-2 Metadata Portal (https://iioe-2.incois.gov.in/IIOE-2/data.jsp).*
- *All datasets will be assigned a Digital Object Identifier (DOI) such that they may be uniquely identified and will be freely available with a CC BY 4 license.*
- *It is expected that data will be properly cited in any subsequent reuse to ensure that proper credit is afforded the original investigator.*

Data Embargo Periods

Most nations have data release conditions imposed by funding sources. IIOE-2 acknowledges and respects these conditions. However, in the interest of advancing collaborative scientific efforts the IIOE-2 program expects that all data will be released as soon as possible and within two years of data generation, or at the time of publication, whichever is sooner. Exemptions can be arranged with the IIOE-2 Steering Committee in cases where this is in conflict with Member State policies or for data associated with a student's thesis work.

Data Management Plans

IIOE-2 investigators are encouraged to write a data management plan for their respective research programs and cruises. A data management plan includes plans for stewardship of data, samples, physical collections, software, curriculum materials, and other materials to be produced during the course of the research project. The plan should reference community-accepted content standards to be used for data files and metadata records. Plans for data access and sharing including provisions for appropriate protection of personal privacy, confidentiality, security, or other requirements should be clearly specified as required. The plan should also specify mechanisms for archiving data, samples, software code and other research products.

For guidance on writing data management plans, see:

UNESCO IOC (2016) "Guidelines for a Data Management Plan". Paris. Intergovernmental Oceanographic Commission of UNESCO, 16pp. 2016. IOC Manuals and Guides No. 73. English. IOC/2016/MG/73. © UNESCO 2016. Also, an online, interactive data management planning tool is available that uses templates to guide the creation of data management plans appropriate for a range of funding sources and data types, see DMPTool at URL: https://dmptool.org/.

Additional Information

DOI: Digital Object Identifier (https://dx.doi.org)
ORCiD: Open Researcher and Contributor ID (https://orcid.org/)

General Guidelines

A User Guide is available from INCOIS.
https://iioe-2.incois.gov.in/IIOE-2/pdfviewer.jsp?docname=UserGuide.pdf

IOC Manuals and Guides:
Cookbook

IOC Manuals and Guides No. 73 Guidelines for a Data Management Plan
IOC Manuals and Guides No. 77 IOC Strategic Plan for Data and Information Management

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The guidelines described in this section are intended to support individual science plans as well as the overall IIOE-2 program goals, by encouraging early sharing of data using internationally agreed rules of data exchange.

It is highly recommended that all IIOE-2 PIs and other research/technical staff plan and implement data and information management tasks in close consultation with their respective IODE National Oceanographic Data

Centre (NODC) or IODE Associate Data Unit (ADU), if existing, and with their marine librarian, if existing. Some of the tasks could also be implemented directly by the NODCs/ADUs.

However, as one over-arching objective, IPC (2015b) noted that the IIOE-2 science plan requires data beyond purely 'oceanographic' (eg climatic).

Objective 5.1.1: In respect to data other than oceanographic (eg climatic) in IIOE-2, engage other relevant organizations in the Data and Information Management framework of IIOE-2.

> Action 5.1.1.1: It is recommended that other relevant organizations be invited to engage in IIOE-2, including consideration of the relevancy of them being formally linked to IIOE-2, as may be pursued say in liaison with the SC and/or through association with IIOE-2 Working Groups. Such organizations would include (but not be limited to) the World Meteorological Organization (WMO), International Hydrographic Organization and the International Council for Science (ICSU) World Data System.

5.2 Data and Information Management – Objectives and Actions

Several objectives (and associated actions) that were recommended in the original Implementation Strategy of 2015 have, in effect, been addressed through the development of the IIOE-2 Data and Information Policy. Hence, they have not been duplicated herewith, but rather only those actions not explicitly given in the Policy are revisited herewith.

Objective 5.2.1: Agree on a list of core measurements (and associated data types and units) for IIOE-2 scientific activities.

> Action 5.2.1.1: A list of core measurements (and associated data types) is to be developed based on the IIOE-2 research themes and arrived at by consensus among community members and updated at least annually at workshops. This list will be made available to the IIOE-2 community.
>
> Action 5.2.1.2: Investigators are to be encouraged to use internationally agreed core measurement names and units of measurement when sharing data. Such names and units should be documented in published guidelines.

Objective 5.2.2: Agree on sampling and analytical protocols and metadata structure.

Documentation describing sampling and analytical protocols is essential to enable accurate interpretation by colleagues wishing to collaborate with the original providers of the data.

> Action 5.2.2.1: Develop and publish documentation on sampling and analytical protocols.
>
> Action 5.2.2.2: Develop and publish metadata structures that capture the basic documentation required to interpret the resultant data. For a cruise, this includes generation of a cruise report (e.g. ROSCOP form) and a sampling event log recording all instrument activities and deployments. Mooring deployments should be documented by detailed configuration reports including sensor and instrument components. Similar documentation should be provided for other research modes (models and experimental research). Established protocols should be followed when possible, and the appropriate references cited.

Objective 5.2.3: Agree on quality control/quality assurance procedures for all data types.

An important task in the data management chain is processing of data. This includes verifying the quality of the sampled data. Depending on the data type (and instrument), methodologies exist for this purpose. To some extent, the quality control can be carried out automatically (by computerized methods) but in several cases this needs to be done manually.

> Action 5.2.3.1: For all agreed upon data types, the associated quality control protocols to check errors need to be designated and made available. A recommended source and repository for this information would be the OceanDataPractices document repository website (http://www.oceandatapractices.net), relating to information available from the IOC's International Oceanographic Data and Information Exchange (IODE).

Action 5.2.3.2: The results of quality control procedures should be reported with the data set in the metadata, and as quality flags within the data set. IOC Manuals and Guides No. 54 - Volume 3 Ocean Data Standards: Recommendation for a Quality Flag Scheme for the Exchange of Oceanographic and Marine Meteorological Data (http://www.iode.org/mg54_3) is a flexible scheme that would be appropriate for this purpose.

Objective 5.2.4: Publication of research results.

This objective describes actions related to making available scientific publications as IIOE-2 outputs as well as the related data sets used to prepare such publications. Formal publication of final data sets is strongly recommended to facilitate proper citation by authors of scientific publications that make use of those data sets. Data sets can be published separately from the paper and assigned a persistent identifier (e.g. a Digital Object Identifier or DOI). As such, these data sets can be referred to in a unique and persistent manner. This is also important to support reproducibility of results when data sets are used from large data bases that may change over the course of the research program (e.g. yearly updates as additional field expeditions are completed). DOI identifier systems are recommended because the major publishers will accept a data set with a DOI as a citable reference.

Action 5.2.4.1: Develop and publish a metadata structure and methodology for data publishing/data citation for use by the IIOE-2 research community.

Action 5.2.4.2: Make data sets available together with scientific publications using the methodology for data citation/data publishing.

Action 5.2.4.3: Make available all publications (including grey literature) related to IIOE-2 research (and support) activities.

Action 5.2.4.4: For its "grey literature", the IIOE-2 may consider the use of the OceanDocs (http://www.oceandocs.org) as a suitable repository.

Action 5.2.4.5: IIOE-2 should consider developing an agreement with selected journals to make "collected reprints" of publications published on IIOE-2 activities available.

Objective 5.2.5: Develop ancillary information systems associated with IIOE-2 research.

The IIOE-2 will create a constituency of many (likely hundreds) marine researchers deriving from countries bordering the Indian Ocean and beyond and involved in undertaking research cruises, other observations and associated research. It is important that this community be identifiable as both specific research initiative alliances and as individuals. Hence, relevant contact information should be documented and available so that researchers may be easily identified and contacted by not only the IIOE-2 community but also by other researchers at any time.

Action 5.2.5.1: Develop and maintain an updated regional directorate of research professionals (and ancillary staff) relating to IIOE-2. This could be achieved using the IOC's OceanExpert directory (http://www.oceanexpert.net).

Objective 5.2.6: Develop and update data and information management capacity.

Data/information management requires specialized expertise that is generally not always available across the whole of the research community. In many countries, specialized facilities have been established for the management of oceanographic data and information. Within the IOC community, these include National Oceanographic Data Centres (NODCs), IODE Associate Data Units (ADUs) and OBIS Nodes. In addition, several marine libraries already exist in the region.

It is important that IIOE-2 leverage these existing facilities in support of the IIOE-2 program.

If such facilities do not exist in any country/institution participating in the IIOE-2, then the following actions are recommended:

Action 5.2.6.1: Establish ADUs/NODCs where they are not yet established as feasible and as required.

Action 5.2.6.2: Provide specialized training and education on data and information management as required and through the IIOE-2 framework of working groups.

6 Operational coordination

6.1 Introduction, background and update

The IIOE-2 began in 2015 with seven dedicated working groups, of which five were: Capacity Development as WG3 (within which the ECSN objective was included); Operational Coordination as WG4; Outreach and Communication as WG5; Translating Science for Society as WG6; and Sponsorship and Resources as WG7. The Steering Committee Co-Chairs then rationalised that these five WGs be consolidated into one called Operational Coordination as WG3, via a paper and proposed restructure presented and adopted at IIOE-2 SC3, Port Elizabeth 2019. The salient paper to which this decision was made is reproduced in Appendix 1 for reference and context. Note that the same paper (and inherent adopted decision) included a specification of a 'Core Group' that had been and continued to meet virtually a few times per year, in between major annual SC meetings, addressing and deciding on high priority issues as they arose on behalf of the full SC. In today's terms (with IIOE-2 having only a singular Project Office), that Core Group should be comprised of at least the following Steering Committee members:

IIOE-2 Core Group:

a) *IIOE-2 Co-Chairs (nominated by the three Major Sponsors)*
b) *WG 1 Chair(s): Science & Research (nominated by the Co-Chairs)*
c) *WG 2 Chair(s): Data & Information Management (nominated by the Co-Chairs)*
d) *WG 3 Chair(s): Operational Co-ordination (nominated by the Co-Chairs)*
e) *Head of the IIOE-2 PO in Hyderabad, India*

6.2 Capacity Development - Objectives and Actions

The Capacity Development (CD) component in WG3 of IIOE-2 is designed to stimulate research and create associated expertise in the international community, especially among developing Indian Ocean Rim nations. The objective is to contribute to their ongoing capacity development efforts by enabling them to effectively participate and benefit from IIOE-2. The objectives for CD through IIOE-2 do not change, and even if not all of them have been actioned due to obvious limitations in IIOE-2 resources, they are retained and re-visited here to represent important guiding aspirations, resources notwithstanding.

Objective 6.2.1: Review current capacity development initiatives in the region and how they can contribute to IIOE-2.

Action 6.2.1.1: Convene a meeting of the major international and regional organizations that conduct capacity development, including IOC, SCOR, Partnership for Observation of the Global Oceans (POGO), Western Indian Ocean Marine Science Association (WIOMSA), Indian Ocean Rim Association (IORA) etc; determine what each organization could/would contribute; and develop a detailed capacity development plan for their potential engagement in IIOE-2, including how related resourcing/funding could be prospectively developed to support the plan.

Objective 6.2.2: Understand current capacity development needs of Indian Ocean countries and align these needs with the 2015 IIOE 2 Science Plan and its 2024 Addendum.

In the recent past, numerous CD needs assessments have been carried out by projects and programmes to guide CD activities for the Indian Ocean region and beyond. For IIOE-2, it will be important to access and use the latest relevant assessments for the IIOE-2 region. In this context, the priorities of developing countries for CD within IIOE-2, as articulated by representatives of developing countries in the Indian Ocean region at IIOE-2 planning meetings, are to be also considered. Hence, there is the essential need to have a contemporary understanding of Indian Ocean constituents' key needs in capacity development. These are to be aligned with the 2015 IIOE-2

Science Plan and its 2024 Addendum (herewith referred as the Science Plan) including specifically where achieving CD objectives will benefit from or require participation on expeditions at sea.

Action 6.2.2.1: Continue a review of existing capacity development needs assessments; ascertain their relevance to CD actions within IIOE-2.

Action 6.2.2.2: Consider designing and implementing a questionnaire type survey to identify specific CD needs of Indian Ocean countries to close gaps in related knowledge and infrastructure and to align the needs with the IIOE-2 Science Plan.

Action 6.2.2.3: Consider developing an inventory of ongoing national CD efforts related to IIOE-2 CD objectives.

Action 6.2.2.4: Align to the extent possible CD activities under IIOE-2 with other national, inter-governmental and not-for-profit organisations operating in the Indian Ocean region.

Objective 6.2.3: Develop human resources in the context of IIOE-2 Capacity Development.

Human resources (eg academic and other research organisation staff, researchers, technicians, managers, students) are the foundation required for any research and management activities. It is to be noted here that UNESCO has endorsed two formal Category II Centres focussed on ocean science related training for the Indian Ocean (eg RCOWA Iran; ITCOocean India) and that can play a role here. In addition, there are also other training related initiatives aligned with UNESCO IOC in the region (eg Regional Training Centres; IOC's IODE, IOC's OceanTeacher Global Academy etc) and of course opportunities exist through academic and other science based national institutions throughout the region. This foundation must be examined, built upon, and maintained. In this regard, and in the context of CD objectives for IIOE-2:

Action 6.2.3.1: Organize short-term training courses in response to requests formulated by Indian Ocean rim countries.

Action 6.2.3.2: Support requests from young developing country scientists to participate in CD actions, eg for conference attendance and mentoring.

Action 6.2.3.3: Empower constituents to not only participate through collaborations in research and observations, but also in the analysis of data and related publication of results (eg as can be achieved via IODE Training Programs).

Action 6.2.3.4: Promote collaboration among universities (and associated research institutions) in the IO region; align cooperation between UNESCO Chairs and IOC programs, and SCOR to this end.

Action 6.2.3.5: Promote ocean-related faculty development by assisting with the organization of training courses, workshops and "summer schools" based on the IIOE-2 needs.

Action 6.2.3.6: Encourage and promote the engagement of early career researchers in the IIOE-2 through the implementation and resourcing of the IIOE-2 Early Career Scientists Network.

Action 6.2.3.7: Create and distribute promotional products targeted to early career researchers (such as an IIOE-2 Early Career Scientists Network brochure).

Objective 6.2.4: Increase access to existing online training courses, resources and learning materials.

Several programmes have made their training materials available online. Partnering with these facilities and adding content to existing online infrastructure increases access to verified training materials and resources for classroom-based as well as distance learning.

Action 6.2.4.1: Review online learning materials relevant to the priority training areas of IIOE-2 (see above) and explore the creation of new ones, making resources available online, where possible.

Action 6.2.4.2: Use the experience of the IOC's OceanTeacher Global Academy (OTGA) in enabling the sharing the course material, in promoting student and teacher mobility and in promoting regional and inter-regional collaboration through community building.

- The OceanTeacher Learning Management System (LMS), which is a tool of the OceanTeacher Global Academy, is offered for use by all regional training centres for the storage, management and sharing of training contents.

Objective 6.2.5: Increase access to research infrastructure including on-board opportunities.

On-site and on-board experience is essential for the career of an ocean researcher. Many Indian Ocean countries do not have ocean-going research vessels, and the IIOE-2 provides a unique opportunity to facilitate on-board training. Strategies for expanding capacity and opportunities for CD beyond scheduled science cruises include broader access to ships of opportunity and the use of science-mobilized commercial vessels. Scientists from the region must be given opportunities to participate in research cruises financially supported through bilateral and/or international arrangements. To this end, the following recommendations are made.

Action 6.2.5.1: Establish a register of infrastructure and centres of expertise for marine science studies in all the Indian Ocean countries.

Action 6.2.5.2: Enable a link and access to the register of IIOE-2 cruises and associated activities to identify training opportunities.

Action 6.2.5.3: Develop an inventory of CD opportunities, activities and plans related to IIOE-2 and make this inventory a dynamic (continuously updated) document that is widely available to the community for planning purposes.

Action 6.2.5.4: Periodically assess alignment between available resources and CD objectives to identify and share with the community specific resource gaps where additional capacity will have a significant impact on achieving CD goals.

Objective 6.2.6: Increase awareness of capacity development opportunities.

The proposed CD actions need to be brought to the awareness of the IIOE-2 constituency and advertised widely to effectively to meet the CD objectives. To this end, the following recommendations are made.

Action 6.2.6.1: Use currently available portals and capacities within the IIOE-2 constituency for capacity development, for example as could be used to promote and implement actions such as summer schools, participation in research cruises, analyses, observational and related processing techniques, modelling, publication etc.

Action 6.2.6.2: Regularly disseminate information on CD opportunities.

Action 6.2.6.3: Develop eligibility criteria for CD opportunities.

6.3 Operational Coordination – Objectives and Actions

The objective of the specific Operational Coordination component in WG3 of IIOE-2 is to develop and integrate web-based tools, databases and partnerships to enable a sufficient level of cooperation, resource-sharing, scientific collaboration and capacity alignment. WG3 will work collaboratively with other IIOE-2 Working Groups, committees and other stakeholders to achieve this goal.

Objective 6.3.1: Maintain a central web-based expedition planning utility for operational coordination and cruise archiving, linked to the IIOE-2 website.

Action 6.3.1.1:

- Maintain an updated IIOE-2 research activity spreadsheet and link to the IIOE-2 website.
- Link the JCOMMOPS cruise database and portal with the IIOE-2 website.
- Develop or adapt available web-based platforms that can aggregate planned IIOE-2 research activities, facilitate communication and collaboration among IIOE-2 participants, and archive completed cruises and other activities.

- Establish processes and support through the PO for assessing emerging infrastructure gaps, aligning available capacity and resources with research needs, and assisting with mobilizing and coordinating additional capacity where needed.

Objective 6.3.2: Establish an opportunity/volunteer vessel database of commercial-sector ships and fixed platforms available for research and observations.

Action 6.3.2.1:

- Work with JCOMMOPS, and others (eg the World Ocean Council (WOC)) to aggregate transit data from commercial shipping firms who agree to provide routine access to their commercial vessels as ships of opportunity platforms.
- Develop an opportunity/volunteer vessel database that aggregates and presents cruise routes, schedules and contact information.
- Integrate the database with expedition planning tools to enable integration with IIOE-2 project planning.
- Provide coordination assistance for project liaison between PIs and commercial operators, as needed and through the PO.

Objective 6.3.3: Establish a database of "in-kind" resource support from institutions, national fleets, and funding agencies, including from both planned deployments and resources available through an application process.

Action 6.3.3.1:

- Aggregate committed resources and opportunities to apply for assistance through a proactive, community-wide assessment and request process.
- Develop a database of resources and links to applications, presented on the IIOE-2 website.
- Ensure sufficient detail within a template format and continuous updating to facilitate effective research planning and access to resource/funding opportunities.

Objective 6.3.4: Establish a review process to ensure complete and usable data inputs from the research community into integrated IIOE-2 expedition planning tools.

Action 6.3.4.1:

- Establish an appropriate level of detail for planning data required for effective research support, operational coordination and collaboration.
- PO to review, evaluate and facilitate improvement in user effectiveness in populating and using the planning tools for resource-sharing, collaboration and communication.

Objective 6.3.5: Utilize existing JCOMMOPS operations that support maintenance of observation systems in the Indian Ocean for shared use by IIOE-2 PIs.

This objective is motivated by the opportunities to leverage existing observation systems operations to support IIOE-2 research.

Action 6.3.5.1:

- Seek JCOMMOPS sharing of cruise track files and scheduling data from planned JCOMMOPS cruises for upload to the GOCEPT expedition planning tool.
- Solicit proposals from PIs on the IIOE-2 website to join planned JCOMMOPS cruises.
- Seek JCOMMOPS facilitation in respect to proposals to modify and extend planned JCOMMOPS cruise tracks and days-at-sea to facilitate IIOE-2 research.

Objective 6.3.6: Evaluate current consensus on use of certified reference materials and standard analytical methods where consistent use of such methods will likely impact the quality of inter-study data comparison and integration across IIOE-2 research.

This objective is in respect to supporting inter-calibrated sampling & standard methods as appropriate across IIOE-2 studies.

Action 6.3.6.1:

- The IIOE-2 Steering Committee to regularly assess the current general use and availability of certified reference materials (chemical, physical and biological) and standardized methods of analysis.
- Regularly review methods manuals from programmes such as GO-SHIP and GEOTRACES, and availability of commercial preparations (e.g. IAPSO Standard Seawater, etc.).
- Regularly update the identification of parameters for which reference materials and/or standard analytical methods should be recommended for use across IIOE-2 studies.

Objective 6.3.7: Provide access to references on recommended methods and sources for acquiring calibration materials.

Action 6.3.7.1:

- Develop and host technical documents, or link to existing documents hosted elsewhere, that describe recommended reference materials and methods, accessible from the IIOE-2 website.
- Identify sources for recommended certified reference materials, linked from the IIOE-2 website, which can be ordered from commercial suppliers.

Objective 6.3.8: Establish a process for reviewing planned and developing research projects toward discovering, communicating and enabling opportunities for collaboration among PIs.

This objective is in respect to advocating and facilitating opportunities for collaborative, multidisciplinary and trans-disciplinary IIOE-2 research.

Action 6.3.8.1:

- Solicit input from relevant members of the IIOE-2 Steering Committee (e.g. members at Regional Coordination and Science Delivery Levels) to help identify opportunities for collaboration and cooperation within their regions and disciplines.
- Publicise opportunities on the IIOE-2 website where collaborative research would be facilitated by available instrumentation for shared-use, available ship time, etc.
- Encourage new proposals from the science community that complement active IIOE-2 studies and would contribute to more fully addressing multidisciplinary questions identified by the Science Plan.

Objective 6.3.9: Provide operational support to capacity development efforts identified and prioritized by the IIOE-2 Operational Coordination Working Group and IIOE-2 Steering Committee.

This objective is in respect to organizing and managing operational resources needed to support the capacity development goals of IIOE-2.

Action 6.3.9.1:

- Examine planned expedition activities for opportunities to coordinate resources, ship time and project scientists identified and prioritized for support by the Capacity Development objectives of IIOE-2.

- Develop specialized expeditions: to support planned capacity development-focused programs; to support scientists from developing nations working in collaborative science teams with colleagues in developed nations; and to focus on supporting early career scientists, women scientists, students and other priorities.

6.4 Outreach and Communication - Objectives and Actions

Well-organized, professional and efficient outreach, communication and associated promotional campaigns are important in initiatives such as the IIOE-2. This should continue to be a priority for IIOE-2, to:

- create and maintain an understanding and appreciation amongst its constituency of the fundamental and applied importance and value of IIOE-2 to society, emphasising the paramount role that the Indian Ocean plays in the everyday life of the coastal communities of the Indian Ocean;

- bring scientists in closer association with concerned stakeholders and the public and assist in bridging the gap between scientifically derived knowledge and everyday life;
- help grow a constituency for the IIOE-2, across the spheres of communities, institutions, scientists, government (through their leaders, policy makers and advisors) and organisations including representative global and regional bodies and NGOs etc;
- capture the world's attention and garner its interest in the IIOE-2; and
- encourage world-wide action and engagement at a multitude of levels in support of IIOE-2 and empower people to concrete actions.

It is important to make IIOE-2 highly visible and its aims, objectives and activities clearly understood amongst both the scientific community and decision-makers in countries both within the Indian Ocean domain and beyond, as well as in related inter-governmental organisations and entities.

Outreach and communication help underpin the search and acquisition of support and resources for IIOE-2.

Objective 6.4.1: Develop an updated IIOE-2 Communication Strategy and related Implementation Plan to ensure that the IIOE-2 is effectively communicated and that its brand is consistently applied and highly visible to all potential stakeholders.

Action 6.4.1.1: The PO should seek input from expert science communicators for a strategic review of the IIOE-2 communication framework, forming the basis of a revised outreach and communications strategy and implementation program. Objectives in this section may form the basis of the review.

Objective 6.4.2: Maintain the IIOE-2 website.

Action 6.4.2.1: In collaboration particularly with SC's Executive and Working Groups, the PO will be responsible for the maintenance of the IIOE-2 website and will coordinate and manage inputs/outputs of materials for it. This will cater for the website needs of all facets of the IIOE-2, including external constituents such as the public, and technically connected spheres (eg governmental, institutional, scientists (established and early career), funding agencies and organisations (including philanthropic).

Objective 6.4.3: Capture and build interest in IIOE-2 amongst the general public through public events and promotional materials campaigns.

Action 6.4.3.1: The PO to coordinate the development and implementation of public events for IIOE-2, including aspects such as public outreach events and promotional materials (eg products as IIOE-2 badged items).

Action 6.4.3.2: PO to update the IIOE-2 logo for the new period 2015-30.

Action 6.4.3.3: The PO in conjunction with the SC should ensure the logo is used as widely as possible on appropriate IIOE-2 related products (electronic and hard form, such as publications, notices, presentations, posters, conference/workshop banners, cruise flags etc).

Objective 6.4.4: Showcase and promote the relevancies of the IIOE-2 research being undertaken and its impacts and benefits across the scientific, cultural, social and economic spheres and directly link IIOE-2 research activities to related communication initiatives.

Action 6.4.4.1: PO to directly draw on the IIOE-2 research activities to identify and link appropriate information to general communication initiatives of the outreach and communications objectives within the IIOE-2 WGs.

Objective 6.4.5: Maintain a regular and current dissemination mode of cross-cutting information and general news and specific announcements for IIOE-2.

Actions 6.4.5.1: PO to maintain and manage the Indian Ocean Bubble 2 newsletter.

Action 6.4.5.2: PO to facilitate, coordinate and encourage principle IIOE-2 stakeholders (from the SC, WGs, National Committees Chairs, PIs, JPO personnel etc) to deliver regular briefings (notes, PPTs, papers etc) to their own institutional focal points and others as required, and to this end the PO should:

- Make available generic IIOE-2 presentations that may be convenient and suitable for general use in this context; and
- In harmony with the website's function, produce brochures, posters, electronic notices etc for general dissemination on both over-arching aspects and specific aspects of IIOE-2 as these evolve (eg major scientific breakthroughs, events etc).

Objective 6.4.6: Promotion of IIOE-2 via presentations and contributions at local, national scientific and institutional forums.

Action 6.4.6.1: PO to facilitate the presentation of IIOE-2 information at relevant forums (eg conferences, workshops, meetings) and via relevant publication modes, such as through UNESCO IOC, SCOR and IOGOOS related media, international journals, etc.

Objective 6.4.7: Provide the full IIOE-2 constituency with an avenue for information, general communication and queries on all aspects of IIOE-2.

Action 6.4.7.1: The PO will be, for the full IIOE-2 constituency, an efficient avenue for general communication on IIOE-2, thereby providing readily accessible and direct personal and e-communication modes of contact for the general IIOE-2 community (across all spheres) to be able to seek information, make queries and obtain outputs and advice on all aspects of IIOE-2.

Action 6.4.7.2: The head of the PO will be the principal point of contact for general communications (public included) on IIOE-2, doing so by effectively linking, keeping informed and working collegially and closely with the other focal points of the administrative network of IIOE-2, including SC elements (particularly theme leaders, WG leaders, the sponsors and Executive elements), IOC HQ and regional programs and offices etc.

6.5 Translating Science for Society – Objectives and Actions

Approach and Benefits

The IIOE-2 Science Plan Addendum refers to capacity development activities relevant to the IIOE-2's six science themes. Capacity Development represents a critical component for the delivery of societal benefit in the context of IIOE-2 and is discussed above. Increasing the understanding of the Indian Ocean and its coastal systems among the people and communities living in this region will empower better-informed public stewardship of ocean resources for emerging Blue Economy imperatives. Insight gained from scientific research, advances in observations, and innovative technologies will further enable evaluation of trade-offs between alternative management scenarios, enhance the ability to balance competing demands on ecosystems, and strengthen economic and scientific competitiveness of Indian Ocean rim countries.

Policy Requirements and Evidence

Good policy for sustainable usage of the oceans requires good information. It should be founded on solid evidence, be well implemented, and receive broad support across Indian Ocean societies. But limiting progress regarding this aspiration is the fact that large swathes of the Indian Ocean marine estate remain insufficiently uncharacterised, leaving Indian Ocean rim countries with major gaps in understanding of its marine systems, and an inability to measure their resilience to change or use. There continue to be large gaps in our understanding of social, cultural and economic drivers, and how they affect decisions. Importantly, many of the changes needed for long-term food security require multidisciplinary research planning and implementation, to support the implementation of key strategies to prepare for critical and emerging issues.

The Science

To meet these challenges and opportunities, our science must continue to be collaborative, integrated, and internationally engaged. We must develop better tools for managers, better decision-making systems and new supporting technologies. Our research must further quantitative modelling and address methods to better integrate coupled socioeconomic and biophysical approaches to resource assessment, including cumulative impacts.

By continuing to take a more integrated approach to the design, implementation and delivery of experimental marine science, we will be able to test system-level hypotheses for the drivers of changes of our coasts and oceans, including direct comparisons of anthropogenic impacts versus natural variability in order to be able to discern and decouple their respective influences.

IIOE-2 research initiatives and relevancies for societal benefit

The IIOE-2 Science Plan is structured around six scientific themes. Each of these include a set of scientific questions that need to be addressed to improve our understanding of the physical forcing that drives variability in marine biogeochemical cycles, ecosystems and fisheries in the Indian Ocean and develop the capacity to predict how this variability will impact human populations in the future. It is also important to emphasize that most of these questions are relevant to open ocean, coastal and marginal sea environments.

Objective 6.5.1: In the context of facilitating the translation of the IIOE-2 science for societal benefit, at a minimum all IIOE-2 endorsed projects should identify links with national and/or international benefits in the following categories.

Action 6.5.1.1:

In respect to the scientific relevancies:

- Enhancing basic scientific knowledge and understanding;
- Associated activities to communicate progress to peers (e.g. presentations and peer-reviewed publications) and public (e.g. media releases, public seminars); and
- Identifying the alignment of the science objectives (referring to themes 1-6) with societal benefits and then facilitating the transfer of the science for those benefits.

Action 6.5.1.2:

In respect to environmental relevancies:

- Identifying how the research activity will directly or indirectly contribute to sustainable environments and environmental management (global, basin-scale, regional, coastal); and
- Facilitating the transfer of those activities and outputs for environmental sustainability imperatives.

Action 6.5.1.3:

In respect to social relevancies:

- Identifying how the research activity will directly or indirectly increase or at least support the social well-being of humanity, e.g. through:
    - Capacity development;
    - Communication of research results to the public;
    - Policy development, including relating to the issue of 'social license to operate'; and
    - Facilitating the transfer of those activities and outputs for societal benefit imperatives.

Action 6.5.1.4

In respect to economic relevancies:

- Identifying how the research activity will directly or indirectly contribute to sustained economic growth and/or poverty eradication in the Indian Ocean region while maintaining a healthy ecosystem, as articulated in emerging 'Blue Economy' frameworks, and as relates to:
    - Improved disaster preparedness and risk management;
    - Sustainable exploitation of living and non-living marine resources;
    - Regional and coastal management etc; and
    - Facilitating the transfer of those activities and outputs for economic benefit imperatives.

To estimate the quantitative socio-economic value and impact of new scientific knowledge generated by the IIOE-2 initiative, the following objectives and complementary actions are recommended for Science Theme 1.

Objective 6.5.2: To estimate the societal and economic value of proposed IIOE-2 research, through conducting a socio-economic assessment study that references, and is complementary to, the IIOE-2 Science Plan.

Action 6.5.2.1:

- Undertake a literature review of generically informative examples of societal and economic value assessments undertaken for programs with elements similar to IIOE-2;
- Solicit and review one or more proposals from relevant academic, inter-governmental and other communities to conduct an economic impact assessment of the societal application of new scientific knowledge derived from IIOE-2;
- Ensure that the assessment links to widely recognized socio-economic challenges and concerns, and to specific impacts identified in the IIOE-2 Science Plan; and
- Publish a position paper or report on study conclusions, including a non-technical summary of key results and implications.

Objective 6.5.3: Widely disseminate the results of the IIOE-2 socio-economic assessment to global public, governmental and other stakeholder communities.

Action 6.5.3.1:

- Publish and communicate the socio-economic assessment study conclusions through the public media, in scientific conferences, publications and other venues and modes (including through the PO, Science Themes, WGs and annual IIOE-2 symposia;
- Develop an integrated analysis comparing the estimated value of resources needed to support IIOE-2 activities with the economic and societal return from new knowledge, as estimated by the economic assessment study; and
- Integrate study conclusions into presentations for funding and other support, to member states, funding agencies and the private sector.

6.6 Sponsorship and Resources – Objectives and Actions

The objective of the Sponsorship and Resources component of WG3 of IIOE-2 is to provide:

- The basic resourcing for the operational administrative and day-to-day practical functions of the IIOE-2 (eg of the PO; SC; Working groups; public interaction; communications etc); and
- The more strategic overarching effort required to seek larger scale IIOE-2 wide resources support. This relates to establishing a strategy and the resources to proactively seek financial and other material support for IIOE-2, both through and beyond the resources that have been and will be committed from traditional funding and institutional sources for the day-to-day operations.

This relates to the basic day-to-day practicalities under the auspices of WG3 which will be overseen by the PO.

Objective 6.6.1: Provide the day-to-day underpinning resources to administer and run the IIOE-2 through the functions of the PO.

Action 6.6.1.1:

- The Sponsorship and Resources element of WG3 will service the immediate and sustained practicalities for the general underpinning of the IIOE-2. This will refer to functions supported by (but not limited to) the following set of actions:
    - Maintaining PO node resourcing;
    - Supporting the SC;
    - Facilitating and supporting annual symposia and complementary inter-sessional meetings (eg of the Working Groups, SC Executive etc);
    - Resourcing the PO focal point role for general public engagement in IIOE-2;
    - Providing the conduit and linkages for IOC's interests and engagement;
    - Through the PO, resourcing, leading and managing key functions including the IIOE-2 website and IIOE-2 Regional Coordination Unit for Data and Information Management at INCOIS, Hyderabad, India;
    - Resourcing the needs of the PO in facilitating outreach and communication through leadership and facilitation of the Outreach and Communications objective;
    - Leadership and facilitation of the Translating Science for Society objective.

6.7 Facilitation of the acquisition of larger scale over-arching strategic support to IIOE-2

In the original Implementation Strategy a detailed rationale was included for this section, written by Jim Costopulos, CEO, Global Oceans. For brevity in this section of the Revised Implementation Strategy, that rationale is copied in full, as originally written, into Appendix 2 for reference and context herewith.

The proposed Objectives and Actions below reflect the strategies outlined in Jim Costopulos's original rationale and refer to developing an effective capacity for engaging with regional and global stakeholder communities to support IIOE-2 with needed financial, technical, physical and personnel resources through 2020.

This Revised Implementation Strategy has retained this 'larger-scale' aspiration for sponsorship and resources for IIOE-2 considering the fundamental case and merit for funding what has grown to be a successful initiative with the capacity still to align with major funding should it become available.

Objective 6.7.1: Identify distinct public- and private-sector stakeholder communities that can be strategically engaged to support IIOE-2 with direct funding, infrastructure, personnel and technical resources.

Action 6.7.1.1:

- Consult with the IIOE-2 Steering Committee and other resources to identify a wide range of global funding and stakeholder communities that have a potential interest and stake in the outcomes of IIOE-2 objectives and goals; and
- Identify a global base of potential corporate sponsors capable of supporting IIOE-2 with funding and other resources of value to the IIOE-2 community.

Objective 6.7.2: Develop a strategic plan for uniquely engaging within each funding and stakeholder community to commit resources that are most feasible and appropriate.

Action 6.7.2.1

- Assess each community, and individual entities within each community, for unique needs, interests and potential for supporting IIOE-2;
- Develop a plan for approaching individual organizations, agencies, foundations, corporations and others with appropriate requests for support; and
- Utilize the planned IIOE-2 socio-economic impact and "return on investment" assessment to inform potential supporters of relevant societal outcomes from IIOE-2.

Objective 6.7.3: Develop within the IIOE-2 governance structure a process for managing and making decisions pertaining to fundraising and acquiring sufficient resources for IIOE-2.

Action 6.7.3.1:

- Provide a feedback mechanism from IIOE-2 Working Groups and others to help guide and prioritize funding and solicitation activities; and

- Ensure that continuing efforts to marshal resources and commitments for the IIOE-2 Science Plan are aligned with critical resource gaps and meeting strategic objectives (e.g. capacity development, etc.).

Objective 6.7.4: Provide sufficient internal (IIOE-2) resources to support the effort of soliciting and obtaining complete and sustained financial and other support for IIOE-2.

Action 6.7.4.1:

- Develop and allocate resources needed (personnel, travel funds, communication materials, etc.) to individually engage with potentially supportive stakeholders, on a priority basis.

7 Early Career Scientists Network

Introduction

Established on 2nd December 2015, at the National Institute of Oceanography (NIO) in Goa, India, the Early Career Scientists Network (ECSN) stands as a critical component of the Second International Indian Ocean Expedition (IIOE-2). Originating from a dedicated session, "Recent Results from Early-Career Scientists in Indian Ocean Research," during the IO-50 conference in Goa, India, ECSN endeavours to unite young scientists from Indian Ocean rim countries, fostering collaboration to unravel the intricacies of the less-explored Indian Ocean in response to the IIOE-2 Science Plan.

The IIOE-2 ECSN is represented (through the Chair or Co-Chairs) within the Science Delivery Level of the the IIOE-2 Steering Committee (Figure 1). Furthermore, the ECSN is encouraged to support the Science Theme and Working Group framework through facilitating nominations of ECSN members direct to respective Science Theme and Working Group leaders.

Mission and objectives

ECSN's primary objective is to catalyse ocean research and related fields for early career scientists within the IIOE-2 framework. By championing scientific collaboration among emerging researchers, ECSN creates a dynamic environment for knowledge exchange, idea-sharing, and collaborative research initiatives. Regional and international meetings, workshops, and training courses organized by ECSN encourage interdisciplinary interactions within the ocean science community. The network is committed to fostering collaboration, actively seeking partnerships with groups sharing complementary objectives to promote joint initiatives and facilitate information exchange.

Connections and mentorship

ECSN endeavours to establish meaningful connections between early career scientists and senior researchers, including through engagement in Science Themes and Working Groups under the IIOE-2 framework. Through mentorship programs and active participation, ECSN bridges the gap between emerging and established professionals, contributing to the overall advancement of ocean science. These collective efforts underscore ECSN's commitment to creating a supportive ecosystem for the next generation of scientists, empowering them to shape the future of ocean exploration and research.

Leadership structure

ECSN operates under the guidance of a dedicated ECSN Core Committee. There is also an ECSN ‘Advisory Committee’. The current core committee comprises nine active members (3 females and 6 males across oceanography disciplines from 8 different institutions) to ensure a balanced representation in terms of gender and geographical diversity. The ECSN Advisory Committee members derive from former founding ECSN members, underscoring the network's commitment to continuity of its mission, sustaining effective leadership and promoting diverse perspectives within the IIOE-2 ECSN framework.

The way in which ECSN’s respective the various memberships are formed is as follows:

1. **General membership:** Membership in ECSN is open to anyone who is interested in helping the group achieve its aim and willing to abide by the rules of the group. Early Career Scientists (ECS) are individuals within ten years of receiving their highest qualification of Masters or PhD degree in relevant sciences. Every member, regardless of category, shall have one vote at general meetings.

2. **Core Committee membership:** The Core Committee consists of members elected at the network's Annual General Meeting. The Core Committee should comprise not less than three (3) and not more than fifteen (15) members, who are at least 18 years old. The selection process considers expertise, dedication, geographic representation, and gender diversity. Among the leadership roles, there is a Chair, Co-Chair/Secretary and Joint Secretary positions along with other appointed officers that the group shall deem necessary at the meeting.

3. **Advisory Committee membership:** Members of the Advisory Committee are drawn from former Core Committee memberships and appointed based on past involvement and contributions. The Advisory Committee ensures continuity, effective leadership, and diverse perspectives within the IIOE-2 ECSN framework.

The ECSN's membership structure is designed to promote inclusivity, offering opportunities for both early career scientists and experienced mentors to contribute. The respective Core and Advisory Committees play distinct roles in providing leadership and guidance, ensuring the network's effective operation

Contextual background on ECSN's research contributions and educational initiatives :

ECSN within IIOE-2 has significantly advanced ocean science. Members have co-authored synthesis papers presented at European Geosciences Union (EGU) meetings, demonstrating their strong commitment to contributing valuable insights in response to IIOE-2's science mission. ECSN members have led IIOE-2 sponsored cruises, received hands-on research experience, and actively contributed to IIOE-2 newsletters, the Indian Ocean Bubble and several book chapters focused on Indian Ocean research. In contribution to the missions of IPCC and the UN Decade of Ocean Science for Sustainable Development 2021-30 (Ocean Decade), ECSN members conducted a comprehensive IPCC and Ocean Decade review. Notably, ECSN members have played a pivotal role in an Indo-French collaborative project, funded by DST, India, and endorsed by IIOE-2, exploring the intricacies of the Northern Indian Ocean's near-surface warming and its linkages to monsoon anomalies. See https://www.clivar.org/sites/default/files/documents/Exchanges_IndianOcean_No68.pdf. The network's dedication was acknowledged by EGU, awarding them the Best Blog of the Year in 2021. There are several peer-reviewed publications by ECSNs which contribute to the scientific understanding of the Indian Ocean. Currently, ECSN members are actively authoring a publication for a special issue of Oceanography on "Building Diversity, Equity, and Inclusion in the Ocean Sciences." ECSN members are also co-authoring a publication for the special edition of Oceanography on "A Vision for Capacity Sharing in the Ocean Sciences," particularly in the topic area "Capacity Building and Capacity Sharing Programs: Examples and Best Practices".

ECSN's impact goes beyond traditional research avenues. It initiated the Indian Ocean Insights seminar series, fostering knowledge dissemination and research discussions. Embracing educational initiatives, ECSN organized a highly successful online course on Fishery Oceanography for Future Professionals (https://incois.gov.in/ITCOocean/itcoo1120.jsp), attracting 1400 registrations from 70 countries. This underscores ECSN's commitment to capacity building and global knowledge sharing.

ECSNs hosted a virtual workshop for early career researchers during IIOSC 2022. The IIOSC 2022 ECSN Workshop ran over three days with Day 1 offering an overview of ECSN and introducing new members and fostering community spirit. Day 2 was centred around interactive sessions among members, discussing expectations and contributions. On Day 3, ECSN expanded horizons by introducing participants to other key groups which included NANO (NF-POGO Alumni Network for the Oceans) (https://nf-pogo-alumni.org/), UN Decade ECOPs (https://oceandecade.org/actions/early-career-ocean-professionals-ecops/), PORSEC (Pan-Ocean Remote Sensing Conference) (https://porsec.nwra.com/), and WIO-ECSN (Western Indian Ocean ECSN) (https://wio-ecsn.wiomsa.org/), thus promoting collaborative opportunities and strengthening inter-group cooperation within the scientific community.

These multifaceted contributions highlight ECSN's dynamic role in helping to shape the landscape of ocean research within the IIOE-2 framework.

Contextual background on ECSN's outreach and networking:

The ECSN is actively engaged in outreach activities, recognizing the power of effective communication and networking. ECSN leverages social media platforms like Facebook (https://www.facebook.com/IOearlycareer/) and Twitter (@iioe_ecsn) and YouTube (https://www.youtube.com/@ECSN-IIOE). ECSN's Facebook and Twitter platforms help it to disseminate job information and fieldwork opportunities relevant to early careers. With a follower base exceeding 1200, these pages have garnered increasing participation over time, successfully connecting with young researchers worldwide. A recent initiative launched in July 2023 by the ECSN is the webinar series titled 'Ocean Insights - Indian Ocean Seminar Series feat. Held on the first Friday of each month, this series invites early career professionals working on the Indian Ocean to share their research and challenges. The seminar information is disseminated in advance through ECSN social media platforms, ECSN mailing lists and IIOE-2 monthly newsletters. The sessions are recorded and regularly uploaded to ECSN's YouTube channel (https://www.youtube.com/@ECSN-IIOE . Additionally, ECSN members contribute consistently to IIOE2 Newsletters and the Indian Ocean Bubble. This helps update members and the broader community on ECSN activities.

The ECSN actively fosters connections with other Early Career Researcher (ECR) groups, promoting collaboration on a global scale. Successful collaborations have been established with prominent networks such as WIOMSA, PORSEC, NANO, UN Decade ECOPs, and IAPSO ECS. Moreover, the ECSN is dedicated to the development and dissemination of outreach materials aimed at engaging a wider audience, furthering the network's mission to enhance communication and collaboration within the global early career scientist community.

Contextual background on ECSN's UN Ocean Decade Involvement:

Under the Ocean Decade framework, the IIOE-2 ECSN spearheads a significant initiative known as Early-Career Ocean Professionals (ECOPs). As perhaps the broadest basin-scale Indian Ocean multidisciplinary network for early-career professionals globally, ECSN holds a pivotal role. The Decade Action CFDA 03/2022 – Capacity Building Initiative: "Devising Early-Career Capacity Development in the Indian Ocean Region" (DECCaD-IO) received endorsement under the Ocean Decade, effective from March 2023. Collaborating with partners like ITCOocean (https://incois.gov.in/ITCOocean/), WIOMSA, PORSEC, NANO, UN Decade ECOPs, this initiative is proposed to run from 2023 to 2027. The primary objective is to position early-career professionals as trainers and mentors, thereby fostering skills development and knowledge exchange across the network. This initiative aims to empower early-career scientists, providing them with opportunities for active participation in ocean-related endeavours. The inaugural DECCaD-IO event was successfully conducted in September 2023 at the INCOIS ITCOocean UNESCO Category 2 centre in Hyderabad, India.

uture endeavours

ECSN plans to foster a vibrant and inclusive community within the IIOE-2 framework. The focus includes improving visibility through various channels such as social media and academic platforms, establishing a regional representative system for diverse perspectives, and actively recruiting members from diverse backgrounds to enrich the ECSN community. Addressing the unique legacy of challenges relating to the recent COVID-19 pandemic, ECSN engages in white paper discussions to navigate specific challenges faced by members. These activities collectively contribute to building a robust and supportive ecosystem for early-career scientists.

Looking ahead, ECSN members aim to intensify engagement through social media for deeper connections, and through continuous development of the website and newsletter to ensure effective communication. Collaboration with other networks remains crucial for knowledge exchange and multicultural teamwork. Additionally, establishing engagement within the Working Groups and the Science Themes of IIOE-2 will serve to mor effectively align ECSN initiatives with the broader IIOE-2 program goals. Efforts will be directed towards initiating and advancing capacity-building, fostering a vibrant and interconnected community of early-career scientists.

8 Project Office

IIOE-2's secretariat support will be provided via the Project Office, having gone from two Nodes (respectively based in India, and until 31 September 2021 in Australia) to a sole node hosted by ESSO-INCOIS, Hyderabad, India underpinned by the Ministry of Earth Sciences (Government of India) with funding, in-kind resourcing and links with other relevant Indian agency centres and programs.

The general governance related aspects and over-arching functions and lines of management specifications relating to the PO were given in Chapter 3.

The PO will include the full-time salaried head of office along with support staff and underpinning operational budget and resources, as available. That person will provide the principal public focal point for IIOE-2, in close collegiate and collaborative alignment and operability with leaders of the Science Themes, WGs, sponsors and other elements of the SC.

The general roles and functions of the PO are as would be typical and expected for such major collaborative ocean science undertakings, with key responsibilities including:

- Liaison and linkages with IOC, SCOR and IOGOOS (as the Major Sponsors of IIOE-2) and their associated global and regional offices and programmes;
- Liaison and linkages with Partner Sponsors of IIOE-2;
- Oversight and facilitation of the Sponsorship and Coordination objective, including a priority on facilitation of sponsorship and resources to underpin the PO;
- Oversight and facilitation of the Translating Science for Society objective;
- Support of specific elements of Operational Coordination;
- Facilitation of the IIOE-2 project endorsement process, with the SC;
- Principal point of reference and contact point for general IIOE-2 communications, enquiries etc;
- Strategic facilitation of annual symposia (eg brokerage of symposia hosts), including elements of symposia sponsorship acquisition, conference coordination and event facilitation;
- Coordination and implementation of selected Capacity Development projects under IIOE-2, including through the ITCOocean UNESCO Category 2 Centre in Hyderabad;
- Strategic and operational support role to the IIOE-2 Steering Committee and Working Groups;
- Provision of over-arching integrating operational support across operational elements of the SC (eg Working Groups, National Committees, PIs etc);
- Facilitation of IOC Co-Chair reporting requirements to IOC Executive Council and Assembly meetings, with similar support to the other two co-Chairs.
- Establish, host and maintain the IIOE-2 Regional Coordination Unit for Data and Information Management;
- Establish, host and maintain (including editorial functions) the IIOE-2 website across all aspects;
- Manage specific communication products (eg provide promotional materials; host and maintain the Indian Ocean Bubble 2 and monthly newsletters);
- Operational facilitation of annual symposia, including logistical coordination, and required administration;

9 References

These references can be obtained via the IIOE-2 project office, at INCOIS, Hyderabad, India and via the IIOE-2 website https://iioe-2.incois.gov.in/.

D'Adamo N (2014). Report of the Western Indian Ocean Regional Focus Group Meeting to help plan the International Indian Ocean Expedition 50th Anniversary Initiative (IIOE-2), Quatre Bornes, Mauritius, 6 and 7

March 2014. Perth Programme Office in support of UNESCO IOC, Perth, Western Australia, www.iocperth.org.

Hood *et al* (2015). The Second International Indian Ocean Expedition (IIOE-2) Science Plan. Scientific Committee on Ocean Research.

Hood *et al* (2024). Second International Indian Ocean Expedition (IIOE-2) Science Plan Addendum. Scientific Committee on Ocean Research.

Hood R and N D'Adamo N (2012). The 50th Anniversary of the International Indian Ocean Expedition. A Prospectus and Charge for an Organizing Committee. 19 December 2012.

Hood R and D'Adamo N (Eds) (2013), Report from the IIOE-2 Reference Group Meeting No. 1, Hyderabad, India, 14-15 May 2013. IMBER Report #8; IOGOOS:PR:08:IIOE-2/RG-01; SIBER Report #5.

Hood R and D'Adamo N (2014). Meeting Notes from the IIOE-2 Reference Group Meeting No 2, Qingdao, China, 20-21 November 2013. Perth Programme Office in support of UNESCO IOC, Perth, Western Australia.

IPC (2015a). Implementation Strategy for the Second International Indian Ocean Expedition 2015-20. (Ed. N D'Adamo). Written by: UNESCO IOC IIOE-2 Interim Planning Committee (Group of Experts) (Chair Sateesh Shenoi). UNESCO Intergovernmental Oceanographic Commission (IOC), Paris, France

IPC (2015b). Strategic Framework for the Implementation of IIOE-2. UNESCO Intergovernmental Oceanographic Commission. Paris, France. IOC/INF-1324, 28th Assembly of UNESCO IOC, 2015.

10 Acknowledgements

The majority of this document draws from the original IIOE-2 Implementation Strategy of 2015 (IPC, 2015a). Dr Aditi Modi (Co-Chair IIOE-2 Early Career Scientists Network) provided the formative input for Chapter 7. Chapter 5 contains a reproduction of the Data and Information Policy prepared under the leadership of the former Co-Chair IODE, Dr Cyndy Chandler. The Briefing Note in copy in Appendix 1 was produced under the leadership of the then Co-Chair of IIOE-2, Professor Peter Burkill. Appendix 2 was originally prepared by Global Oceans CEO Dr Jim Costopulos.

Appendix 1

A copy of a Briefing Note titled '*A new structure for delivering IIOE-2'* presented to and adopted by the IIOE-2 Steering Committee at its 3rd meeting, Port Elizabeth, South Africa, March 2019)

A new structure for delivering IIOE-2

P Burkill, S Shenoi, V Ryabinin, H W Bange, R Hood, S Nayak, N D'Adamo, S Prakash and E Urban

At the 2018 Steering Committee (SC) meeting in Jakarta, we discussed the IIOE-2's governance structure. Our main conclusion was that it was too complex, requiring too much of people's time. It was also too costly to run because sponsors were paying for a large number of participants to attend the meetings. Hence, there was a suggestion to develop a more cost-effective governance structure for IIOE-2, to enable the Core Group to best facilitate high level issues in support of the Steering Committee as a whole. We outline here a slimmed down governance structure to be discussed further at the next SC in March 2019. We present this to allow you to consider it in advance of the meeting.

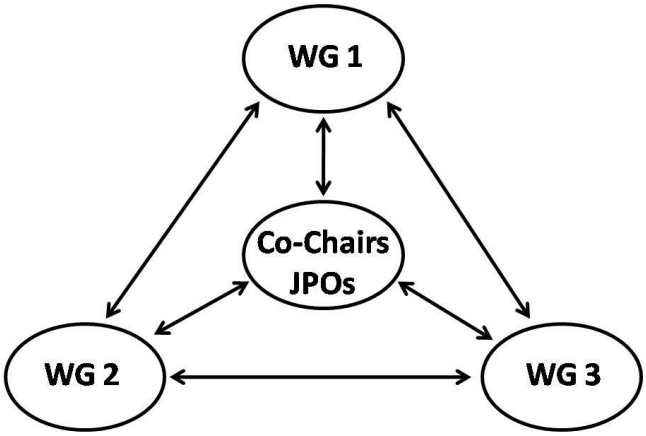
What are the three sponsor's positions? SCOR is the sponsor that provides the most direct support to get people to meetings. While there is a general agreement that SCOR will pay $25k each year to facilitate IIOE-2 until 2020, we need to be mindful of SCOR's return on this investment. SCOR's main strength is funding SCOR Working Groups and it funds two new ones each year costing $30k each per year. The WGs are the heart of SCOR and they have been hugely successful at opening up new

research topics through publishing findings in peer-reviewed papers. SCOR also oversees large-scale programmes, but the funding of these is generally pass-through funds from NSF, while SCOR's international programme offices are normally funded by host nations. For SCOR, IIOE-2 is unusual in being a large-scale programme that requires funds derived from SCOR dues, competing with funding for SCOR working groups. What will happen after 2020? That will be for the SCOR Executive Committee to decide, but there has already been discussions leading to the feeling that if IIOE-2 is continued to be supported, it has to deliver more scientific output for SCOR's investment. Although this will be challenging, it is a major motivator for reducing the complexity of our governance structure.

IOGOOS is an association of marine science institutes in the Indian Ocean region and aims at promoting, planning and executing collaborative projects in the region. Through the sponsorship of IIOE-2, IOGOOS is looking at the scientific outcomes of the project as well as the benefits to its members. IOGOOS has committed to support IIOE-2 to an extent of $10k each year utilising the budgetary support that it receives from IOC for functions in the Indian Ocean region. That funding is mainly used for the travel of its members to attend the meetings of IIOE-2 Steering Committee, IIOE-2 WGs and the annual meeting of IOGOOS.

Through the sponsorship of IIOE-2, the Intergovernmental Oceanographic Commission of UNESCO, or IOC, is looking at creating new knowledge that would be highly relevant for sustainable development of Indian Ocean riparian states. One pillar of this work is capacity development in marine research. IOC also would like to enhance communication between researchers and managers to enable informed policy decisions by member states as well as international bodies for effective ocean management and preservation. The cash contribution of IOC for SC member travel to meetings is currently limited, but it provides the much-needed platform for IIOE-2 functioning including the Joint Project Office (JPO) node in Perth, Australia, which works in concert with the other JPO node in Hyderabad, India, supported by the Indian Government.

As an outline for the new Core Group, we propose to simplify the current structure for the delivery of IIOE-2 as follows:



The Core Group will comprise:

a) *IIOE-2 Co-Chairs (nominated by the three main sponsors).*
b) *WG 1 Chair(s): Science & Research (nominated by the Co-Chairs).*
c) *WG 2 Chair(s): Data & Information Management (nominated by the Co-Chairs)*
d) *WG 3 Chair(s): Operational Co-ordination (nominated by the Co-Chairs).*
e) *Heads of the IIOE-2 JPOs in Hyderabad, India, and Perth, Australia*

The SCOR office in Delaware, USA (not shown above), will administer SCOR funds it contributes to IIOE-2.

The Core Group will continue to meet by teleconference approximately every 6 weeks and will continue to deal with high level strategic issues.

Within WG1, the formal Science Theme Committee structure (currently comprising six Science Theme (ST) teams) is consolidated into one, reducing expenses and streamlining the overall functioning. This flattens the structure with the research into a single entity, while noting that the Chair(s) of WG1will need to decide how they will interact with the former chairs of ST 1-6.

WG2 Data & Information Management will continue its work without change.

WG3 would consolidate into one that would include former specific WG functions of Outreach & Communication, Sponsorship & Resources, Capacity Development and Translating Science for Society, respectively. A new sub-group will be tasked with Ocean Remote Sensing within WG3, perhaps as a 'task team' within WG3.

It will be for each of the chairs of WG 1, 2 and 3 to decide how they can best deliver their responsibilities. The next step will be to spell out the Terms of Reference for each component of the Core Group and that will be discussed and finalised at the March meeting in Port Elizabeth.

If you have any comments, please get in touch with one of the Co-Chairs (peter.burkill@plymouth.ac.uk; shenoi@incois.gov.in; v.ryabinin@unesco.org) and note that we aim to finalise the new Structure at the Port Elizabeth meeting in March 2019

Appendix 2

A rationale for the facilitation of the acquisition of larger scale over-arching strategic support to IIOE-2

This is an unedited copy of the text prepared originally for the first version of the IIOE-2 Implementation Strategy (IPC, 2015a) by Jim Costopulos CEO of Global Oceans, a US-based 501(c)(3) non-profit organisation https://www.global-oceans.org. Note that referencing to Section numbering etc pertains to the original Implementation Strategy, and not to this current Revised Implementation Strategy.

"The Implementation Strategy herewith goes into a relatively greater degree of motivational and guiding detail, in light of the critical and ambitious need to try to create a resourcing landscape for IIOE-2 that helps it reach its optimum potential. This is in terms of science and its delivery for societal benefit, through leveraging the vast amount of general interest, and governmental, institutional and personal engagements that IIOE-2 has already harnessed for its mission.

This task will seek to acquire the larger scale over-arching sustained and complete support for the execution of the IIOE-2 Science Plan and complementary activities for IIOE-2 out to 2030, and perhaps beyond.

It will also seek to address resource gaps, new opportunities for significant work, and unforeseen resource needs as identified by IIOE-2 Working Groups, the Steering Committee and the IIOE-2 community in general.

It will seek to establish a strategy and the resources to proactively garner financial and other material support for IIOE-2, both through and beyond the resources that have been and will be committed from traditional funding and institutional sources.

It will benefit from the actions and outputs outlined above.

A number of fundamental factors should be considered when designing such a strategy aimed at funding and supporting the resource needs of IIOE-2, including through sponsorships. The presumption is that there is and will continue to be a baseline level of committed resources, including scheduled scientific cruises, along with related research and capacity development initiatives from traditional intergovernmental and national programs, supported by agency science funding budgets. This sponsorship and resources effort should include a strong focus toward increasing share-of-support from these 'budget-driven' programmes over the five-year programme period. It should also be substantially directed toward gaining new and additional IIOE-2-specific commitments, including from non-traditional private-sector sources (foundations, corporations, global companies with an interest in the ocean), directly from UN member states (including from those without strong science funding mechanisms), NGOs/non-profits, and others. These latter sources may have great potential to significantly increase the total value of support - and potentially with funding that is more discretionary.

There are complex interrelationships between existing programmes and funding agencies globally, and therefore there is a need for a dedicated and strategic approach to an appeal for more support, including for dealing with non-traditional funding sources.

When considering how the IIOE-2 should think about funding activities and garnering participation, financial, in-kind and other support from existing programmes and agencies, two of the key factors that should be recognized are:

- *That the number of potential sources and partnerships for funding and other support is large; and*
- *Informational, funding and other supporting relationships among ocean-, atmosphere- and space-focused scientific organizations, agencies and programmes is complex (as per a 2006 study by the consulting firm of Douglas-Westwood on Global Markets for Ocean Observing Systems, conducted for Industry Canada and other sponsors and which refers to the "byzantine complexity" of the network of funding and organization relationships).*

The large number of stakeholders with potential interest in IIOE-2 activities therefore represents both significant potential for support and a significant logistical challenge - suggesting that a formulated, strategic approach is warranted. The governance structure established for IIOE-2, embodied by the three sponsoring organizations and the larger Steering Committee, provides an ideal platform with an appropriate stature and hence should be fully engaged in this process to ensure that a productive approach to mobilizing global support for IIOE-2 is developed and executed.

One conceptual way of thinking about this in more detail is suggested as follows. Funding, infrastructure, personnel and material support for IIOE-2 activities in general could be divided into the following proposed components:

1. *PI-driven 'projects' proposed and funded through traditional governmental funding agency and private-sector (e.g. foundation) sources, qualifying as IIOE-2 activities;*
2. *Government, institutional, and intergovernmental agency funded and scheduled research and observation activities in the IO, including cruises, as contributions to IIOE-2 (which support funded PIs);*
3. *New, IIOE-2-focused resources contributed by all of the above in support of IIOE-2 sub-initiatives (e.g. EIOURI, WIOURI etc.), other IIOE-2 Science Plan-focused cruises, regional capacity development programs, and other activities defined by the IIOE-2 Science Plan and its implementation strategy; and*
4. *Undefined support, i.e. all support (direct funding, infrastructure, in-kind, etc.) that will be needed to fully enable the IIOE-2 Science Plan and related elements of both its own complementary Implementation Strategy and that of the wider IIOE-2 portfolio – which is not currently committed, or even perhaps yet defined.*

Mobilizing activity within all of these components will benefit from proactive engagement and promotion by IIOE-2 governing bodies and the community at large, but points 3 and especially 4 represent areas where active, strategic engagement to develop support will be most necessary and potentially productive. The need for resources not committed initially, for IIOE-2 projects and activities not yet defined, would also ideally be met at some level with discretionary funding (i.e. from committed discretionary organizational budgets and/or a dedicated reserve fund). An IIOE-2 discretionary reserve fund would be the most effective option and could be made up of restricted and unrestricted funds (e.g. allocated for capacity development activities, etc.).

An effort to request discretionary funding for IIOE-2 from major stakeholders would not be unlike many major public and private fundraising efforts in that it needs to be strategically planned and executed.

Taking a direct appeal to member states for funding and/or other support as an example, a normal 'development' (i.e. fundraising) strategy, unique for each member state, would first involve an individual assessment along the lines of:

- *What is the member state's history of participating in and funding marine science projects and initiatives, and at what level of support?*
- *What is the overall economic outlook and strength of their scientific funding community?*
- *What influential scientists are located in those states who could get behind, and benefit from, IIOE-2 by helping to make the case for IIOE-2 support to their nation's decision makers?*

- *What are the specific and pressing issues within each nation that align with the IIOE-2 Science Plan, capacity development goals, and other objectives?*
- *What regional socio-economic factors, as quantified by the planned IIOE-2 economic impact study, are vital to the member state?*
- *What is the resulting value of IIOE-2 science to the member state?*
- *What is the best method for requesting support for each state (i.e., direct contribution to a discretionary IIOE-2 fund, an annually budgeted contribution, facility and infrastructure mobilization, specific project or expedition funding, etc.)?*
- *What is an appropriate level of funding to request?*
- *What are the right channels and processes to use in approaching each member state for funding?*

This represents a strategic, concerted effort that will itself require some resources and a management process directed by the IIOE-2 Steering Committee – but would likely be the most effective approach for a large-scale effort like IIOE-2. The IIOE-2 socio-economic impact study that is planned (Section 9.2.2/9.2.3, above) will be vital for presenting an economic value-based context and rationale for generating large-scale support from these activities.

Similar strategies could be developed for more traditional governmental and intergovernmental funding agencies (e.g. GEF), private foundations, and even corporate sponsorships. Regarding corporate sponsorships, the broad-based, international nature of IIOE-2 is likely to create an enhanced attraction for corporate participation including for example subsidized infrastructure, programme funding, technical support, etc. Likely drivers for corporate support are public visibility and public relations – e.g. to be seen as supporting an effort that will have a positive impact on issues of sustainability, understanding climate change, capacity development, education, mitigating human environmental impact, etc., and possibly also as a technology testbed opportunity.

In terms of developing a potential 'discretionary plus restricted' funding account or pool, to be allocated by the IIOE-2 Steering Committee through some consensus-based process, a question emerges as to how much should be targeted for a capital raise for IIOE-2. One approach would be to conduct a high-level estimate of the total value of resources needed to execute the entire Science Plan, then to allocate the estimated value of each major component above. The 'residual' value in the form of a gap analysis would provide an estimate for this pool. If we assume that the main purpose of a discretionary pool would be to fill resource gaps; ensure support for all portions of the Science Plan, such as capacity development programming; enable emergent and unplanned opportunities for new research that might be otherwise difficult to fund quickly, etc. – then a 'proforma budget' exercise as described above could roughly constrain the bounds of such a fund used for this purpose.

The Sponsorship and Resources Working Group, working with other WGs, could then allocate a rational level of requested support among potential funders and stakeholders, to arrive at the additive total."