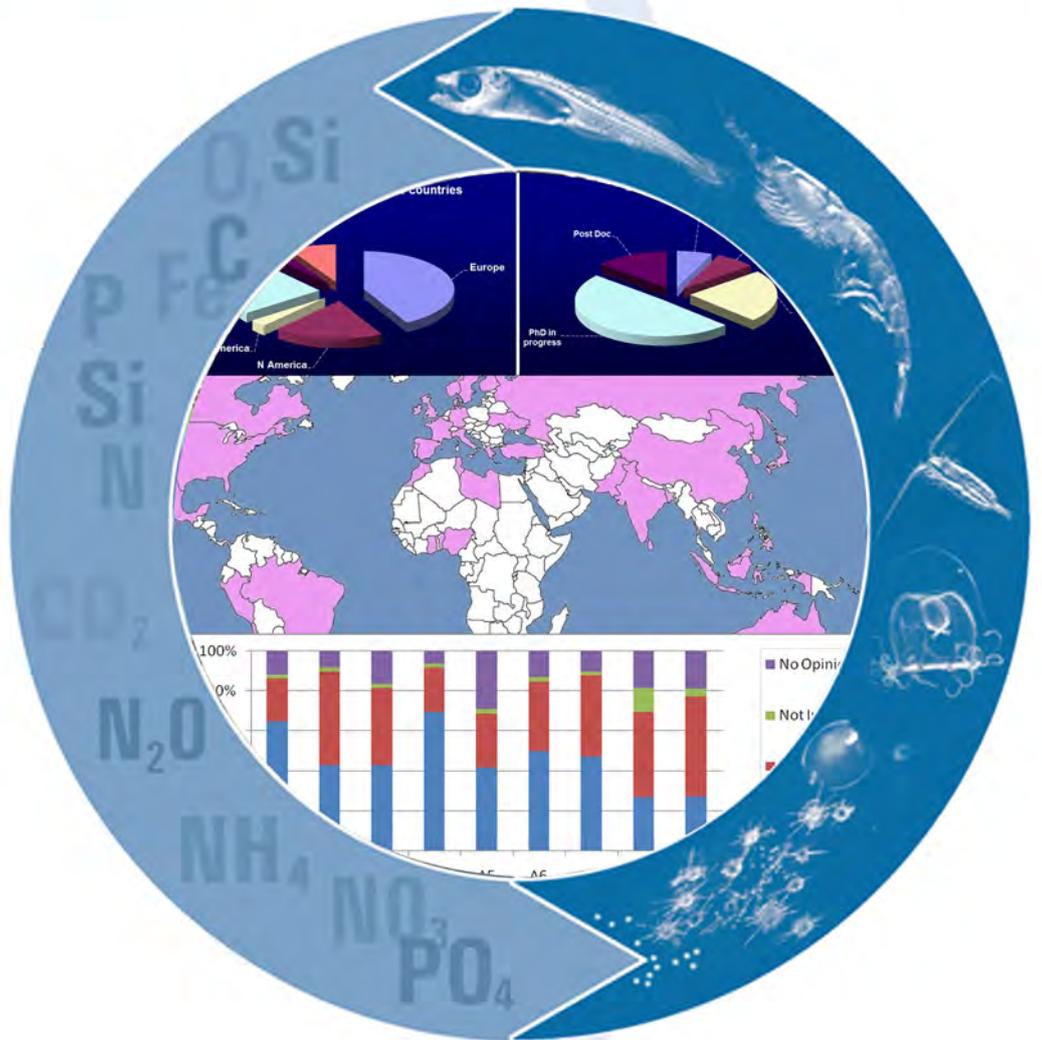


IMBER

Capacity Building

Legacy and Perspectives



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Integrated Marine Biogeochemistry and Ecosystem Research

IMBER Report No. 9

IMBER
Capacity Building
Legacy and
Perspectives

Note: This document of IMBER Capacity Building is prepared based on the output of a APN and IMBER workshop: “Needs assessment for capacity development for integrated marine biogeochemistry and ecosystem research in the Asia-Pacific region (31 July - 4 August 2012, Shanghai, China)” and a follow up meeting (25-27 March 2013, Shanghai, China). Participants of these two workshops in Appendix C and IMBER CBTT members in Appendix D contribute collectively to the vision of this document.

Preface

The development of a community of scientists focused on advancing particular areas of research is perhaps the true lasting legacy of any research programme. The Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project, co-sponsored by the Integrated Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR), recognized from the outset that addressing its overall goal of providing *a comprehensive understanding of, and accurate predictive capacity for, ocean responses to accelerating global change and the consequent effects on the Earth system and human society* required a community of researchers that could integrate marine food webs, biogeochemical cycles and human interactions. Consequently, from its inception in 2005, IMBER has proactively worked to build and strengthen the scientific capacity of early to mid-career researchers and scientists, with particular attention given to those in developing countries. The Capacity Building Task Team (CBTT) was one of the first groups established by IMBER and it provided programmatic focus on capacity building.

The CBTT developed a strategy to build and strengthen scientific capacity. An important focus of this strategy was capacity building in new research initiatives needed to advance IMBER science in less developed and other coastal countries, as detailed in this report. The IMBER summer schools have been particularly effective training and capacity building activities. Most IMBER meetings, workshops and conferences include capacity building components that range from financial support for participants, to dedicated writing and publication workshops for early career scientists, to individual mentoring of attendees, as well as opportunities for discussion and networking. Capacity building is now an integral part of IMBER regional programmes, working groups and affiliated projects.

Addressing questions at the intersections of natural and social science, humanities, and governance is a priority for the research agenda that will guide IMBER for the next decade. The activities of the CBTT provide a strong foundation from which IMBER can advance this research agenda. Capacity building is and will continue to be a priority as IMBER moves into its next phase of research.

Eileen Hofmann

Former Chair, IMBER Scientific Steering Committee

December 2015

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Scope and Overview

Rationale

Integrated Marine Biogeochemistry and Ecosystem Research (IMBER, www.imber.info) is an international project focused on the impacts of global change on marine biogeochemical cycles and ecosystems. IMBER aims to provide a comprehensive understanding of, and predictive capacity for, ocean responses to accelerating global change and the consequent effects on the Earth System and human society (IMBER, 2005a and 2010).

Capacity Building (CB) is an integral part of IMBER, and from the project's inception it was recognised that involving researchers from around the world, from different scientific disciplines pertaining to the marine environment, and at different stages of their careers, was critical to its success. To facilitate this, mechanisms to promote interaction and communication amongst researchers and to enable the two-way transfer of knowledge and skills between scientists and those tasked with management and policy protocols for marine resources are needed (IMBER, 2005). Through various activities and events, IMBER has contributed to CB at international and regional levels. This document aims to assess these activities, and outline a way forward for sustainable capacity development within the IMBER research community as it prepares for the next 10 years of marine biogeochemistry and ecosystem research.

The IMBER Capacity Building Task Team

The original IMBER Science Plan and Implementation Strategy (IMBER SPIS, 2005) prioritised capacity development. Consequently, one of the first IMBER groups to be formed was the Capacity Building Task Team (CBTT), to enhance research capacity in less developed countries, and to develop the capabilities of the next generation of researchers through education, training, scientist and student exchanges, networking, and other activities.

The goals and activities of the CBTT outlined in the IMBER SPIS are:

- To initiate, promote and oversee CB activities within IMBER where possible;
- To ensure synergy between CB activities implemented within and across the IMBER regional programmes and working groups;
- To promote collaboration between IMBER CB activities and those of other relevant international projects and initiatives;
- To identify and build on existing training and capacity development opportunities (fellowships, workshops, summer schools, etc.) and potential funding sources;
- To ensure that relevant opportunities for CB are used in IMBER activities; and,
- To ensure that CB remains an integral component within IMBER, by identifying and enhancing a specific research theme that will develop capacity not currently existing in some regions.

CBTT Terms of Reference and Implementation Strategy

The Terms of Reference (TOR) for the CBTT (www.imber.info/index.php/content/download/2066/11385/file/ToR_IMBER_Capacity_Building.pdf) are:

- To enhance research capabilities in less developed countries especially those geographically close to regions of interesting biogeochemical/ecosystem provinces for optimal implementation of the IMBER science plan;
- To enhance research capabilities globally in those IMBER activities that have few practitioners but are crucial for optimal implementation of the IMBER science plan; and,
- To strengthen graduate education in ocean sciences.

It is noteworthy that the TOR include both IMBER-specific and more general marine science goals.

The CBTT developed a strategy to implement the TOR that highlights the need for IMBER to foster development of capacity building in new research initiatives and establish or improve the infrastructure needed for IMBER research in less developed and other coastal countries. However, this undertaking is far beyond the remit or capability of the CBTT. The infrastructure needed for oceanographic research is very expensive, especially sea-going vessels and facilities, and many less-developed countries simply cannot afford them (see, for example, NRC, 2008). Consequently, marine researchers in these countries are hampered by the lack of equipment, and research and travel funding, which isolates them from the global scientific community. Networking and collaboration, both regionally and globally, are essential to overcome these constraints.

The IMBER CBTT (www.imber.info/index.php/Science/Working-Groups/Capacity-Building/Who-is-involved) includes representatives from both developed and developing countries (**Appendix D**) and aims to facilitate the development of enabling environments to promote capacity development measures within the scope of IMBER. Because of limited CB resources, regional networking and coordination should target:

- Countries that already have some CB-related financial and/or human resources, and where modest help can yield quick and substantial returns (e.g., countries in the Middle East, Southeast Asia, northeast and southwest Africa, South America), and
- Regions of special interest for IMBER science (e.g., surrounding the Indian Ocean).

Capacity Building in IMBER

IMBER capacity building activities to date

Summer Schools

IMBER CB activities have focused primarily on summer schools for students and early-career researchers (less than 10 years post PhD). There have been five IMBER summer schools since 2008, with one held every second year:

1. ClimEco - Climate Driving of Marine Ecosystem Changes (21-24 April 2008, Brest, France)
2. E2E Eco-model - Analysis of End to End Food Webs and Biogeochemical Cycles (11-16 August 2008, Ankara, Turkey)
3. ClimEco2 - Oceans, Marine Ecosystems, and Society Facing Climate Change: A Multi-disciplinary Approach (23-27 August 2010, Brest, France)
4. ClimEco3 - A View Towards Integrated Earth System Models: Human-Nature Interactions in the Marine World (23-28 July 2012, Ankara, Turkey), and

TABLE 1. Summary of IMBER summer schools and CB contributions to IMBER’s science themes. Summer school details are available at: www.imber.info/index.php/Science/Working-Groups/Capacity-Building/Summer-schools/.

CB Activity	Location and Date	Main themes covered	Relevant IMBER Themes
ClimEco	Brest, France 21-24 April 2008	<ul style="list-style-type: none"> • Impacts of climate variability on the marine environment • Physical climate variability changes and their impact on the marine environment • Modelling aspects of the ocean and climate • Statistical analysis techniques and the link from climate to marine ecosystems 	<p>Theme 1: Key Interactions</p> <p>Theme 2: Sensitivity to Global Change</p>
E2E Modelling	Ankara, Turkey 11-16 August 2008	<ul style="list-style-type: none"> • Main processes controlling marine food webs • Advances in end-to-end food web modelling 	<p>Theme 1: Key Interactions</p> <p>Theme 2: Sensitivity to Global Change</p> <p>Theme 4: Responses of Society</p>
ClimEco2	Brest, France 23-27 August 2010	<ul style="list-style-type: none"> • Climate, ocean circulation, biogeochemistry and marine ecosystems • Climate-driven changes in marine biodiversity and interactions among species • Impact of global change on marine resources and uses • Vulnerability and adaptation to climate change in the coastal zone • Communicating climate change: from information to action 	<p>Theme 1: Key Interactions</p> <p>Theme 2: Sensitivity to Global Change</p> <p>Theme 3: Feedbacks to the Earth System</p> <p>Theme 4: Responses of Society</p>
ClimEco3	Ankara, Turkey 23-28 July 2012	<ul style="list-style-type: none"> • Overview of Earth System and socio-economic models • Modelling low trophic level processes and human interactions 	<p>Theme 1: Key Interactions</p> <p>Theme 4: Responses of Society</p>
ClimEco4	Shanghai, China 4-9 August 2014	<ul style="list-style-type: none"> • Overviews of climate change • General information on data bases • Data analysis methods for indicators • Criteria and use of indicators for informing management and policy 	<p>Theme 2: Sensitivity to global change</p> <p>Theme 3: Feedbacks to the Earth System</p> <p>Theme 4: Responses of society</p>

The topics of the IMBER summer schools have evolved over the past 10 years. Originally the emphasis was on physical and climate driving forces, but in recent years, issues combining natural and social sciences, of relevance to the human dimensions of marine global change, have been addressed. The practical teaching has also increased significantly. Since ClimEco3, there has been a strong focus on hands-on, practical applications of the techniques and methods discussed in lectures.

ClimEco: Climate Driving of Marine Ecosystem Changes (21-24 April 2008, Brest, France)

The first ClimEco summer school was co-convened with CLIVAR and GLOBEC and focused on the physical climate variability changes and their impacts on the marine environment. This aligned with the IMBER scientific themes 1 and 2 (TABLE 1). Early-career marine scientists were introduced to climate processes and climate data sets that can be used to analyse the coupling between the marine environment and climate. Thirty Ph.D. students and postdoctoral scholars were selected from 190 applicants to attend. About 74% of the attendees were from Europe and North America; Ph.D. students accounted for about 60% of the total attendees (FIG. 2). A web-conference tool provided by Eur-Oceans, allowed those who were unable to attend to follow the lectures on live the internet. The system had a “Question & Answer” facility, which enabled online participants to post questions for the lecturers to answer. Over the course of the summer school, an average of 40 external participants followed the lectures.

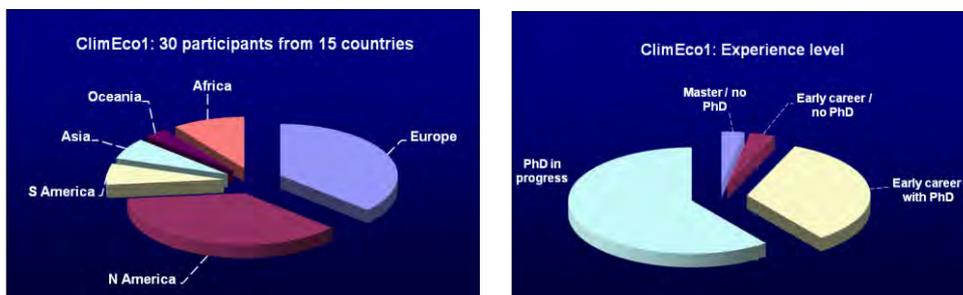


FIGURE 2. Regional distribution (left) and experience level (right) of the ClimEco summer school attendees.

E2E Eco-model: Analysis of End-to-End (E2E) Food Webs and Biogeochemical Cycles (11-16 August 2008, Ankara, Turkey)

The aim of the E2E Eco-model training course was to provide participants with the knowledge and skills to increase their understanding of global change and its impacts on marine biogeochemical cycles and end-to-end food webs. It also introduced them to new methods, techniques and models available for understanding the combined effects of physical and biological forcings on marine biogeochemical cycles and ecosystems. It addressed the IMBER scientific themes 1, 2 & 4 (TABLE 1). An inter-disciplinary group of 22 early-career scientists from 11 countries, within the European Union, as well as from Turkey, China, Ukraine, USA and Russia attended.

ClimEco2: Oceans, Marine Ecosystems, and Society Facing Climate Change: A Multi-disciplinary Approach (23-27 August 2010, Brest, France)

ClimEco2 was co-organized by IMBER, the Institut Universitaire Européen de la Mer (IUEM) and GIS Europole Mer. Participants were provided with an overview of current knowledge and methods, models and approaches for analyzing the impact of climate change on marine ecosystems and the consequences for society. This dealt with all four IMBER science themes (TABLE 1). An inter-disciplinary group of 70 early-career scientists from 26 countries attended (FIG. 3). The French Research Institute for Development (IRD) and PICES provided support for the participation of 14 early-career researchers and students, including five from developing countries (China, Ghana, Mozambique, Nigeria, and Tanzania). The programme ensured that these young scientists were acquainted with a much broader knowledge and understanding of the demands of the multi-disciplinary tasks required to understand and model ecosystems facing climate change.

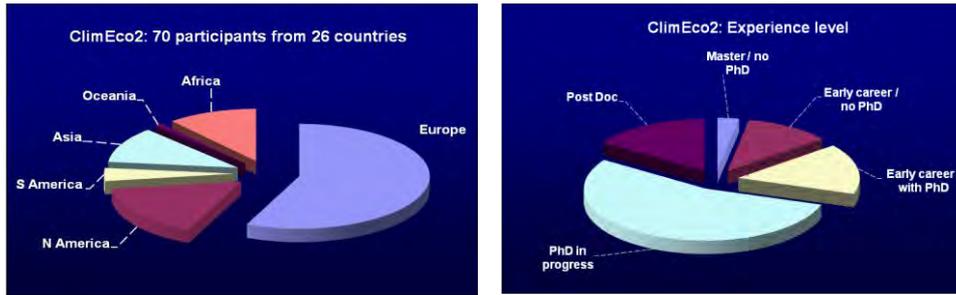


FIGURE 3. Regional distribution (left) and experience level (right) of the ClimECO₂ summer school attendees.

ClimEco3: A View Towards Integrated Earth System Models: Human-Nature Interactions in the Marine World (23-28 July 2012, Ankara, Turkey)

Forty-eight participants, from 26 countries and an array of social and natural science backgrounds, attended ClimEco3 (FIG. 4). The programme focused on the interface between marine ecosystems and biogeochemistry, physical driving forces, food webs and socio-economic systems; with lectures on modelling all of these system processes, as well as model coupling and Earth System models. IMBER Theme 4: Responses of Society, was the main focus of this summer school (TABLE 1).

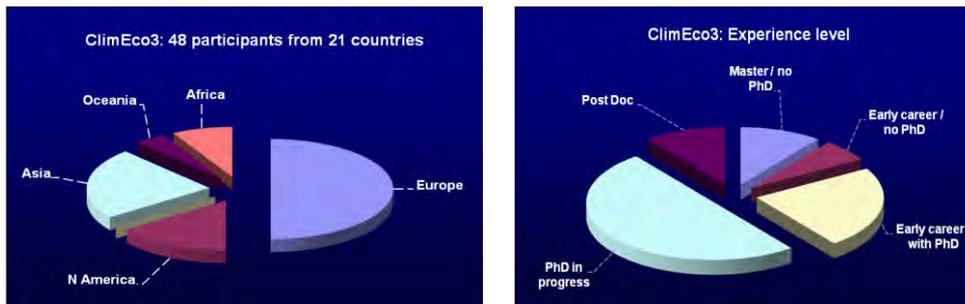


FIGURE 4. Regional distribution (left) and experience level (right) of the ClimEco3 summer school attendees.

ClimEco4: Delineating the Issues of Climate Change and Impacts to Marine Ecosystems: Bridging the Gap between Research, Assessment, Policy and Management (4-9 August 2014, Shanghai, China)

The main focus of ClimEco4 was the interface of natural and human systems, and it was designed around IMBER scientific themes 2, 3 and 4, (TABLE 1). The lectures and practical exercises focused on indices of climate change, climate impacts, and ecosystem services, and how these are linked to indices for socio-economic and policy information in relation to climate-ecosystem interactions. Topics covered included overviews of climate change impacts on marine ecosystems from biological, physical and human perspectives. Information about what indicators are and how to use them, models, data analysis, linking indicators to a regulatory or management perspective, and bridging the gap between research and information that is practically useful for management. Fifty students and early-career scientists from 22 countries attended. Following the suggestion of the IMBER 2012 CB workshop, ClimEco4 was held in China, to make it more accessible to participants from the Asia-Pacific region. This had the desired effect, and there were more participants from Asia than at any previous IMBER summer school (FIG. 5).

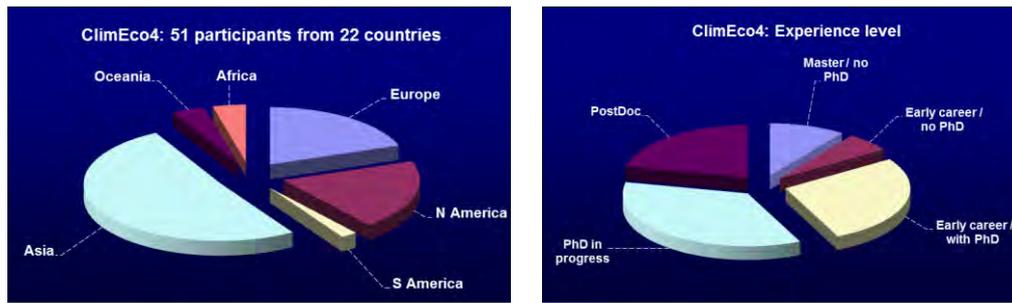


FIGURE 5. Regional distribution (left) and experience level (right) of the ClimEco 4 summer school attendees.

Other CB Events

Data management workshops

At all IMBER events, for example the IMBIZOs and the Open Science Conference (OSC), there have been efforts to facilitate the participation of students and early-career researchers, and researchers from developing countries. About 15% to 20% of the IMBIZO I, II and III participants were from one of these categories. Data management workshops (including “dry cruise” workshops) held in conjunction with each IMBIZO provided data management training for students and researchers at all career levels. The focus is often on sea-going activities, highlighting best practices using actual datasets as training-support materials. Workshops on scientific writing and publishing were also held in conjunction with both IMBIZO III and the OSC.

Mentoring programmes

Mentoring programmes at the IMBIZOs and the OSC also contributed to IMBER CB. For example, a mentoring programme was organised during the OSC, to assist students and early-career researchers about scientific and career path questions. About 85 established researchers indicated their willingness to be a mentor when registering for the OSC. About 50 mentees signed up for the programme and provided a short note on their research interests, which was used to match them with appropriate mentors. After “virtual” introductions, the mentors and their mentees decided on their individual interactions prior to, during and after the OSC. Some had online discussions, others provided guidance on poster or oral presentation preparation, or suggested ways to get the most out of the meeting. All arranged to meet at the conference itself, and the mentors helped to include their mentees in the formal and informal discussions, and to meet other researchers in their field. At the IMBIZOs, about on average around 20-30 mentees were matched with mentors. In addition, at all these events, “lunch with scientists” was arranged, to enable students and early-career researchers to meet other more established scientists.

Capacity building in the Asia-Pacific region

The IMBER China-Japan-Korea (CJK) regional symposium series (initially established as the CJK GLOBEC symposium in 2002) also includes a training component for students, based on “hot” research topics, or “hot spots” in the region. The establishment of the IMBER Regional Project Office (RPO) in Shanghai in 2010 also demonstrates IMBER’s dedication to promoting IMBER science in the Asia-Pacific region. Since its inception, the RPO has taken the lead in developing several CB activities in this region.

In addition to the above-mentioned CB activities, IMBER encourages its working groups, regional programmes, and endorsed projects to include CB as a component in their research activities. A CB plan and activities is one criteria considered for IMBER endorsement of a project. This approach helps to promote CB within the wider IMBER community.

Evaluation of IMBER Capacity Building

Marine research requires integration of multi-disciplinary skills, advanced observational techniques, and state-of-the-art infrastructure and facilities. Inadequate infrastructure for sea-going observations, limited funding, and a “brain-drain” of scientists, particularly from developing countries, are major factors constraining marine research (NRC, 2008). The initial focus of the CBTT efforts was to develop a network in less developed countries in geographic areas of special interest to IMBER, and to encourage undergraduate and graduate students to participate in IMBER science through CB activities (IMBER, 2005a). The following strategies, were proposed by the CBTT to develop such activities:

- Encourage new research initiatives and establish or improve infrastructure needed for IMBER-related research in less developed and other coastal countries;
- Human resource development;
- Seek special funding for CB-related activities.

In this regard, about 200 students and early-career researchers from 43 countries have attended the IMBER summer schools (2008-2014). Among these countries, 42 were from coastal regions and 23 from developing countries (FIG. 6a). Masters students made up 6% of the participants; Ph.D. students - 49%; early-career with Masters - 7%; early-career, with Ph.D. -24%; and Post-Doc researchers - 14% (FIG. 6b).

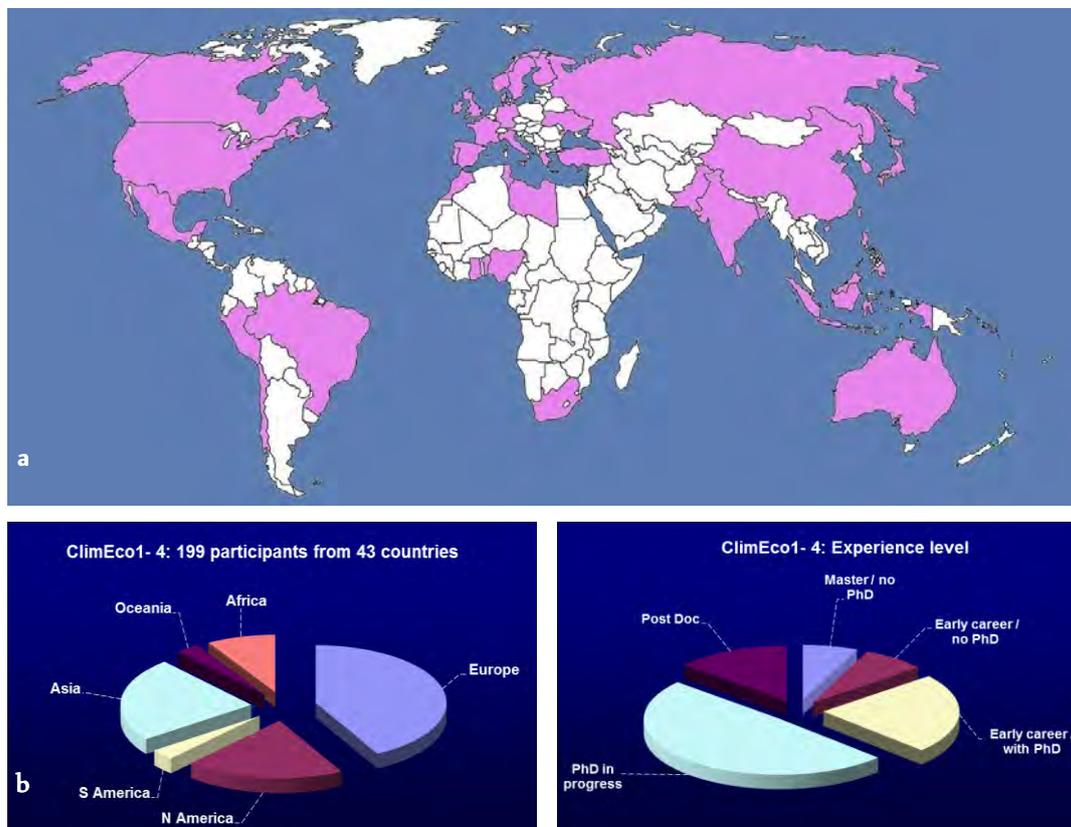


FIGURE 6. Countries represented at the five IMBER summer schools (pink shading) (a), regional distribution (b, left), and experience level (b, right) of the summer school attendees.

The few participants from Africa and South America (FIG. 6a) may be a result of limited funding, inadequate communication, limited involvement in IMBER science, or summer school themes that are not consistent with training and needs in these regions. Perhaps more likely, however, is limited funding. With this in mind, the next IMBER summer school, ClimEco5, will be held in Brazil. It is hoped that this will enable more involvement of current and future researchers in this region. The interactions between IMBER and research funding agencies at the regional level needs to be strengthened, particularly in those areas where summer school participation has thus far been limited.

IMBER CB has benefited from collaboration and partnerships with several international organisations. For example, the Scientific Committee on Oceanic Research (SCOR) has provided numerous travel grants for IMBER scientists and students from developing countries to participate international marine science meetings and short-term training programmes, thus enabling networking, knowledge transfer and mentoring (Urban and Boscolo, 2013). The IOC WESTPAC Regional Network of Training and Research Centers on Marine Science also provides opportunities for skills and network development for early-career scientists. The IMBER summer schools, IMBIZOs, and other IMBER-related workshops have been co-sponsored by many international organisations, such as CLIVAR, GLOBEC, ICES (International Council for the Exploration of the Sea), PICES (North Pacific Marine Science Organization), PAGES (Past Global Changes) project, the Euro-Basin project, the US Ocean Carbon & Biogeochemistry (OCB) program, the Asia-Pacific Network for Global Change Research (APN), the World Academy of Sciences (TWAS), the EUR-OCEANS Consortium, Intergovernmental Oceanographic Commission (IOC), as well as many national research funding agencies. Reciprocally, IMBER often provides travel grants to students and early-career researchers to attend IMBER-sponsored events, e.g., the PICES Annual Meeting and summer schools, and the Austral Summer Institute (ASI) training programmes. These collaborations engage a larger research community, beyond the IMBER community.

International research projects like IMBER have an important role to play in building research capacity, not only by organising and enabling CB activities in specific regions, but also through the mid- to long-term results of the project itself (Zhang et al., 2013b).

The relevance of IMBER capacity building

IMBER CB activities rely on voluntary contributions of established researchers as organisers, lecturers or mentors, IPO and RPO staff time, in-kind contributions from local hosts, and externally-sourced funding. Relevance to IMBER science is therefore, essential. International projects like IMBER can facilitate development of regional research communities by:

- Creating global CB activities that provide some benefits to all regions;
- Identifying activities that would benefit specific regions that are particularly important to the scientific goals of the project;
- Supporting links to other IMBER-relevant CB activities;
- Accessing resources of other organisations that specialise in CB, for example, SCOR, POGO, IOC, APN, Inter-American Institute for Global Change Research (IAI), Global Change System for Analysis, Research, and Training (START), and securing dedicated support from national and international funding agencies;
- Establishing a network of research initiatives and organisations that is relevant to the capacity development of IMBER and have the potential to continue beyond the lifetime of the project.

Education and training of researchers from less-developed countries in emerging, multi-disciplinary and integrative approaches is a critical component of CB in global environmental change science. The goal is to promote scientific activities beyond the “critical mass” needed to address IMBER research questions. IMBER CB activities (e.g., summer schools) have consequently been designed with close links to the four IMBER scientific themes (TABLE 1).

An assessment of IMBER capacity building activities

To enhance IMBER science, particularly in the Asia-Pacific region, an international workshop entitled “Needs assessment for capacity development for integrated marine biogeochemistry and ecosystem research in the Asia-Pacific region” (CB Assessment workshop) was convened at the East China Normal University (ECNU) in Shanghai, China from 31 July to 4 August 2012. Twenty marine researchers, science managers and CB experts gathered to consider existing CB initiatives and case studies from the region, and to assess CB needs and potential collaboration for future capacity development (FIG. 7). The workshop was sponsored by IMBER, the Asia-Pacific Network for Global Change Research (APN) and ECNU, through support from the State Oceanographic Administration of China (SOA). A follow-up meeting was held from 25 to 27 March 2013. (Zuo et al., 2014)



FIGURE 7. Capacity building needs assessment workshop participants (**Appendix C**): (left to right) back row: Xiaojun Deng, John Morrison, Chamroeun Pen, John Machiwa, Francis Gerald Plumley, Bernard Avril, Wenxi Zhu, Temel Oguz, Mingyuan Zhu, and Jing Zhang; front row: Fang Zuo, Liuming Hu, Thamasak Yeemin, Samina Kidwai, Maria Lourdes San Diego-McGlone, Julie Hall, Edward Urban and Yunxuan Zhou.

Another IMBER CB workshop was held just prior to the IMBER OSC in Bergen, Norway on 22 June 2014. This provided a forum for researchers, managers and representatives of the IMBER regional programmes and other initiatives, to discuss and assess IMBER’s current and future CB activities with members of the IMBER CBTT and others who had participated in

the Shanghai workshop. This gave them the opportunity to identify which activities would be most useful towards achieving their goals. These were found to include: workshops and meetings, summer schools, cooperative research and cruises, and explicit integration of CB into all IMBER initiatives.

To get more extensive input on the usefulness of IMBER CB activities and future CB needs, an online community survey (Appendix A) was conducted.

Synthesis of the capacity building online community survey

52 people from 20 countries completed the online community survey to evaluate the efficacy IMBER CB activities (summary in TABLE 2). Most (87%) of the respondents had not previously been involved in IMBER CB activities. The respondents identified and prioritised several major CB needs for IMBER, including training through summer schools and workshops, and involvement in national and regional projects. The respondents acknowledged that IMBER has promoted CB through the scientific activities of its working groups and regional programmes, the endorsement of regional research projects and by providing support for international meetings and publications (e.g. special issues of science journals).

The responses showed that travel grants to attend IMBER-related meetings, and a variety of CB activities within the IMBER regional programmes and working groups are the most effective ways to build the capacity of the marine research community. The importance of IMBER CB activities were ranked by the respondents as follows:

1. Travel grants to attend IMBER-related meetings
2. IMBER ClimEco summer schools
3. On-board ship experience and visiting professorships
4. Alumni network
5. Data management sessions at IMBER meetings and conferences
6. Distance learning.

TABLE 2. Summary of responses to the IMBER CB questionnaire. Respondents were asked for their opinion of focus areas for future IMBER CB activities. The high response rates for the first two categories (“very+somewhat important”, more than 80% of respondents) demonstrate the strong value attached to the IMBER activities by the research community.

CB Activities	Very Important	Somewhat Important	Not Important	No Opinion	Total
ClimEco Summer Schools	33 (65%)	11 (22%)	1 (2%)	6 (12%)	51
Data Management sessions at IMBER IMBIZOs and OSC	21 (43%)	23 (47%)	1 (2%)	4 (8%)	49
Mentoring at IMBIZOs and OSCs	21 (43)	19 (39%)	1 (2%)	8 (16%)	49
Grants to attend IMBER-related meetings	34 (69%)	11 (23%)	1 (2%)	3 (6%)	49
CB activities of IMBER regional programme and working groups	20 (42%)	13 (27%)	1 (2%)	14 (29%)	48
Ship-board experience	23 (50%)	16 (35%)	1 (2%)	6 (13%)	46
Visiting professorships	23 (47%)	20 (41%)	1 (2%)	5 (10%)	49
Distance learning	13 (27%)	21 (43%)	6 (12%)	9 (18%)	49
Alumni network	13 (27%)	24 (50%)	2 (4%)	9 (19%)	48

Respondents were asked to rate the importance of specific CB approaches for the next phase of IMBER (FIG. 7). The ClimEco summer schools, grants to attend IMBER-related meetings, ship-board experience, and visiting professorships were ranked as very important CB activities. The development of an alumni network, data management training sessions, and distance learning were ranked as “Somewhat Important” (TABLE 2). Other CB activities mentioned were: awards (e.g. best student presentations), interaction with IMBER-endorsed projects, dedicated early-career scientists workshops dealing with scientific writing and publishing, and proposal writing in conjunction with IMBER meetings, encouraging IMBER regional programmes and endorsed projects to provide opportunities for scientists from developing countries, engaging science leaders in project planning, providing an open source model and data library with content validation and technical support, tutorials, and creating Massive Open Online Courses (MOOCs).

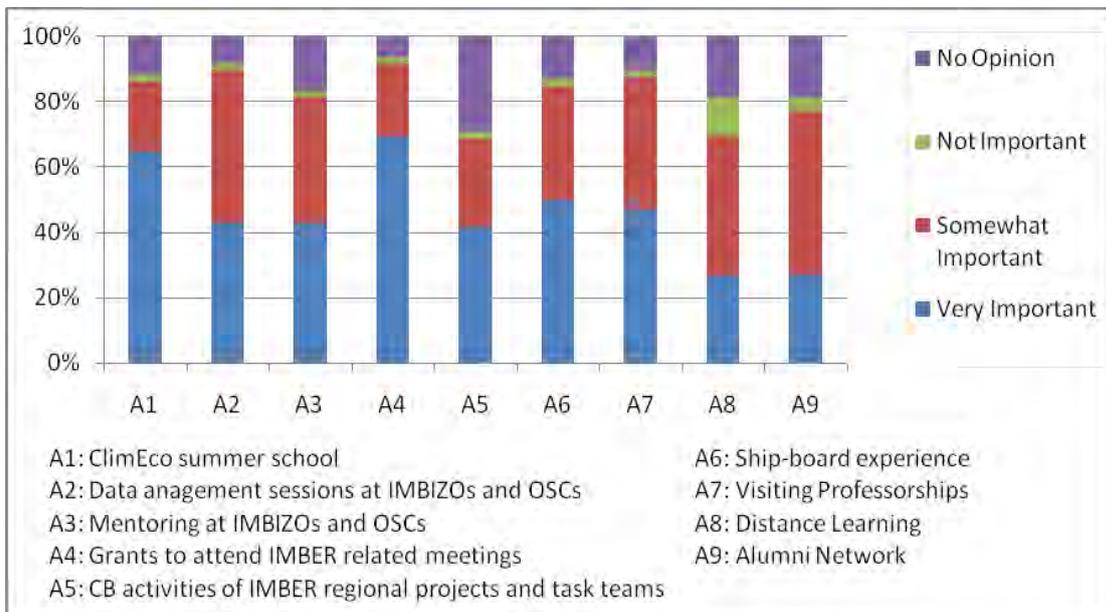


FIGURE 7. Relative importance rankings for future IMBER CB activities (%) provided by the survey respondents.

To ensure that IMBER CB activities are effective and integrated into other IMBER activities, the survey results suggest:

- Facilitating follow-up activities of IMBER-related projects and alumni (former students);
- Evaluating the effectiveness of CB activities and the response of participants;
- Involve more IMBER-people with CB skills, and who are likely to continue for some time;
- Linking CB directly to scientific outputs;
- Creating training/collaborative activities, such as intercomparison exercises, similar to those conducted for the Arctic and the Antarctic by ESSAS and ICED communities, that result in community publications;
- Sharing information and creating a network of scientists interested in CB, and
- Linking IMBER CB activities to national research contributions and relevant CB activities, which will co-invest and provide ongoing support for those who undergo training.
- Using the IMBER “Data Management Cook Book” as a model for other IMBER protocols, e.g. for setting-up and running CB activities;
- Develop a platform to collect the all IMBER CB contributions, including those from on-going projects at regional and national levels;

- Extend the mentoring process beyond IMBER meetings. Mentees could select potential mentors from the IMBER science community;
- Selection of trainees for summer schools needs to seek input from national contacts and from IMBER endorsed projects;
- Combining summer school lectures with field work where feasible, to enable the trainees to benefit from the experience and learn various techniques via the summer schools;
- Encouraging IMBER endorsed projects to contribute to CB by making cruise berths available;
- CB should be available at all career levels, including mid-career scientists, with a sliding scale for funding for participation in the activities.

Challenges and Recommendations for IMBER Capacity Building

Capacity building challenges at different levels

The challenges for IMBER CB activities can be considered in terms of “Human Capacity Building” (involving individuals or groups), “Organisational Capacity Building” (dealing with research infrastructure for observations, monitoring and other organisational capabilities) and “Institutional Capacity Building” (that refers to responsibility, planning, accountability, transparency, conflict resolution, etc.). These three levels are discussed in the following sections.

Human Capacity Building (Individual level)

Capacity building at the individual level refers to the development of conditions that allow participants to engage in the process of learning and adapting to change (United Nations Committee of Experts on Public Administration, 2006). An important aspect of achieving individual capacity building is the availability of a critical mass of people, particularly early-career scientists, involved in marine research. One of the big challenges for IMBER, and for the ocean research community as a whole, is to attract postgraduate students and early-career scientists into marine science-related careers and to provide opportunities for their professional development. However, the challenge to achieving this is the availability of multi-disciplinary research with sufficient funding, facilities for undertaking research, and opportunities for collaboration with oceanographic research institutes.

Bridges between traditional university marine science education and multi-disciplinary and/or cross-disciplinary research approaches are needed. Undergraduate marine education tends to be discipline-specific to meet the requirements of specific majors, but marine science research programmes often need practitioners with a broad knowledge and ability to conduct multi-disciplinary experiments and observations.

Capacity development at the individual level can be achieved through a variety of approaches including, training courses, summer schools, workshops, web-based training, collaborative cruises, scientific exchange programmes, and joint efforts

between non-governmental organisations (NGOs) and research institutions. Mechanisms are needed to facilitate the exchange of students and early-career researchers between research institutions, such as the IMBER-SCOR fellowship scheme, that particularly support travel and/or accommodation costs.

Development of a project-wide mentoring programme to facilitate networking would enhance capacity building at the individual level. Identification of established scientists who are good educators/tutors who will act as mentors would provide the basis for a long-term mentoring system. An IMBER alumni network of IMBER-related students and early-career researchers and mentors should also be established. It is important that there is “buy-in” from the institutions that employ early-career scientists so that they include studying and training as part of their job descriptions.

Organisational and Institutional Capacity Building (Organisational/ Institutional level)

Capacity building at an institutional/organisational level refers to the process of enhancing an organisation's abilities to better fulfill its defined mission (Eade, 2005). Maintaining and where possible, strengthening the capacity of the marine science community, globally and also in specific countries or regions should be a priority for IMBER because of the limited personnel and funding resources that are available to build capacity. In developing countries, ensuring that trained people return to and remain in the country is essential for building a critical mass of trained researchers, who could potentially attract both human and financial resources and infrastructure, to further develop capacity for marine science.

Promotion of capacity building requires selection of techniques and methodologies appropriate for the sustainable development of a particular region. To limit the “brain-drain” from research institutions, universities, and national governments, job opportunities in marine sciences need to be maximized to enable recipients of CB to find relevant positions and pursue research careers in their home countries. National and/or regional scholarships that support academic studies and also provide support for a period of time after graduation would promote this. Research projects, like IMBER, can assist with development of alumni networks that provide support and promote interaction between early-career scientists. This has been done successfully by the Analysis, Integration and Modelling of the Earth System (AIMES - <http://www.aimes.ucar.edu/ysn>) project, via the Young Scholars Network, and POGO through its Nippon Foundation – POGO Alumni Network for Oceans (NANO) initiative. Often, newly-trained marine researchers advance rapidly into scientific leadership or management positions, with very little basic CB.

Projects such as IMBER face the challenge of using limited resources to provide in-depth training to specific individuals or less extensive training to a larger group. The approach chosen requires balancing the needs of the project, those of the individuals, country and/or institution involved, as well as the requirements of the agency or organisation supporting the capacity building effort. The approach taken by research projects often depends on the type of capacity building required, and the focus and timing of an activity or event in the project.

In-depth training could assist a country in training individuals in a specific topic, providing the skills to take on scientific leadership, and thereby helping to maintain the critical mass needed for marine research. This approach has the potential to increase scientific capacity in a step-by-step manner and target talented individuals who could then undertake the more extensive training. Follow-up after the training to determine its effectiveness and relevance should be part of the overall approach so that long-term sustainability can be achieved, which in turn provides encouragement for continued support.

Innovative marine research requires the integration of multi-disciplinary knowledge and skills, which is a priority for IMBER research. Many researchers tend to remain within specific research domains because of recognition by their disciplinary peers, potentially more consistent research results, and access to funding sources. For early-career researchers, maximizing research output is critical for continued employment and promotion; moving into a new discipline can slow research outputs. In developing countries, researchers may have fewer opportunities to explore new research domains because of limited funding sources and/or research facilities. This is compounded by the typically higher cost of multi-disciplinary studies, especially in marine science (e.g., in terms of infrastructure and expertise). In addition to the individual challenges of undertaking multi-disciplinary research, there are also structural barriers within the education and training systems in many countries. University curricula are typically developed around traditional disciplines, which are not integrated in a cross-disciplinary way. This is particularly true in oceanographic studies in developing countries where teaching is often limited to one or two disciplines.

Synthesizing and integrating scientific information from a wide variety of disciplines is challenging and requires unique skills. In the marine research context, integration of biological, chemical, physical and geological information with process understanding is needed to determine the functioning of marine ecosystems that provide humans with sustainable food and other services. Researchers undertaking such work must be able to work across disciplines and utilise concepts and information from fields as diverse as physical oceanography, fisheries science, ecology, biogeochemistry, genetics, bioeconomics and sociology. The ability to think widely in terms of scale (10s–1000s of km) and time (seconds to hundreds or even up to millions of years) are also important. There are very few marine science educational programmes that prioritise the development of such capacity. In fact, there appears to be a trend towards ‘reductionist’ approaches, with many marine scientists narrowing their disciplinary focus. Development of skills to work across disciplines is difficult to achieve under the best of circumstances.

Regional/international level

Many CB activities are designed by donor countries, without identification of the specific needs of recipient nations, institutions or individuals. This can result in duplication and/or gaps in CB activities and failure to use locally available knowledge and expertise. Capacity building activities undertaken by international research projects like IMBER are often interdisciplinary and aimed at developing a community of early-career scientists working across traditional disciplinary boundaries, which can complement and build on university education in the development of scientific careers. Key issues identified by a multi-disciplinary and international research project are unlikely to overlap completely with the scientific needs of any specific country, but efforts can be made to align the project scientific directions with specific country needs, thereby enhancing the capacity development at national and/or regional levels. Thus, CB discussions and milestones must be ongoing throughout the project lifetime. International projects can complement the educational system of a country by providing alternative integrated research-based training opportunities and education across disciplinary barriers (TABLE 3). Several types of collaboration are possible between international research projects and countries, for example:

- Training activities and summer schools can be used to develop the scientific and technical capacity within a country’s marine science community;
- Affiliations between universities and research institutions and NGOs can be established to reduce the barriers of traditional education;
- Regional scale trans-boundary recognition of university courses and degrees can be promoted, overcoming

political and administrative obstacles to such recognition;

- Mechanisms to facilitate the exchange of students and early-career researchers between institutions can be identified, such as an IMBER-SCOR fellowship;
- Global coordination to transfer knowledge across the various regions can be developed to integrate as many of the existing national and international CB activities as possible.

The infrastructure and training required by marine research necessitates regional collaboration. Sustainable funding for CB programmes is a major challenge. Developing new collaborations between universities, government and research institutions could lessen the challenge regionally.

Collaboration between projects to ensure that CB activities are complementary and productive will prevent duplication of effort. Different projects have similar capacity development needs and attempts should be made to jointly fund relevant activities. National and international funding agencies should enable this. Good collaboration requires communication between the relevant international project offices and the Scientific Steering Committees of the projects. Capacity building activities are sometimes arranged by national research projects through collaboration with international projects. In such cases, those involved in CB should establish cooperation with external scientists early on. Lessons learned from collaborative activities on the Mekong River Delta (<http://www.unesco-ihe.org>) and in studying the Benguela Current System (<http://www.dlist.org>), show that CB activities must adapt to the culture of the country and individuals who are being targeted, and that training and infrastructure development should be embedded in the collaborations from project design through to achieving the research goals. In multi-country CB projects such as the Benguela Current Large Marine Ecosystem (BCLME) and the Agulhas and the Somali Current Large Marine Ecosystems (ASCLME), language is a challenge. Using translators is costly and conducting activities in English means that many students do not realise the maximum benefit.

Projects should consider approaches for integrating existing CB activities in regions, such as the Asia-Pacific region, and ensure, coordination of knowledge transfer across the regions, where possible. Globally, IMBER should explore mechanisms to participate in CB discussion or coordination forums in regions of particular relevance for IMBER. IMBER could facilitate and contribute to the creation of a virtual forum for coordinating CB activities for mutual benefit.

TABLE 3. Examples of capacity building activities undertaken by selected international organisations (Source: Zhang et al., 2013b) that could be used by IMBER CB activities and in development of new activities.

CB Activity	IAEA	IFS	IOC	POGO	SCOR
Grants to attend meetings	X	X	X		X
Grants for short-term training in ocean observations	X		X	X	X
Summer schools			X	X	X
Training for professionals	X	X			
Training through research	X	X	X		
Bursaries for developing country institutions				X	
Ship-board experience			X	X	
Visiting professorships				X	X
Centres of Excellence in oceanography training				X	X
Leadership training			X		
Internships in international secretariats			X		

The International Atomic Energy Agency (IAEA) Marine Environment Studies Laboratory sponsors a variety of training programmes (TABLE 3). Training can be arranged in a particular region if several IAEA member states request it. Laboratory training is also available within a technical cooperation programme at the country level.

The International Foundation for Science (IFS) helps individual scientists with small-scale research funding and travel support to present research results at international meetings. IFS funding is not specific to marine science, but marine researchers can benefit from IFS programmes.

IOC-UNESCO represents marine science, observations, services and capacity building within the United Nations system. It offers a number of training and research opportunities through a variety of programmes at international and regional levels, e.g., IOC/WESTPAC. Global CB activities include: ocean data and information training by the International Oceanographic Data and Information Exchange (IODE), harmful algae, tsunami preparedness and response, and observations and services through the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) and WMO. WESTPAC is the regional arm of IOC in the Asia-Pacific region. It endeavours to develop and enhance capacity for marine science research in the region through the IOC Regional Network of Training and Research Centers on Marine Science initiative. This IOC initiative aims to improve regional capacity in a sustainable and systematic manner by establishing a series of IOC Regional Training and Research Centers (RTCs), offering training and research opportunities on specific topics to early-career scientists mainly from developing countries within and outside the region. The first is the RTC on Ocean Dynamics and Climate at the First Institute of Oceanography at Qingdao, China, that offers training annually on ocean and climate models. WESTPAC's other training programmes currently focus on harmful algal blooms, marine toxins, coral reef conservation and restoration, monsoon science and air-sea observations.

POGO is an international consortium of oceanographic institutions, whose objectives are to promote global oceanography and the implementation of a global ocean observing system and to stimulate capacity for ocean science and observations in developing countries. POGO has a database of cruises with available berths (Urban et al., 2009). Lack of trained personnel is a major obstacle for the development of a global ocean observing system. Therefore, CB is a central element of POGO, and it has developed an extensive array of education and training activities, primarily for scientists from developing

countries and those with economies in transition.

SCOR promotes the enhancement of scientific capacity in developing countries and those with economies in transition by ensuring that every SCOR activity includes students and marine scientists from such countries. A Committee on Capacity Building was established in 2007 to coordinate SCOR CB, develop new activities, and help secure fundings for these activities. The primary ongoing SCOR CB activities are:

- Travel Grants – offered to marine scientists from developing countries and those with economies in transition, including support for IMBER IMBIZOs, Open Science Conference and summer schools;
- POGO-SCOR Visiting Fellowships for Oceanographic Observations;
- SCOR Visiting Scholarship – supported ocean scientists to go to developing countries to teach and mentor for two weeks or more;
- Ocean Summer Schools Portal –jointly hosted by SCOR, IODE, and POGO for ocean-related summer schools;
- Regional Graduate Education Networks for Ocean Sciences - fosters the establishment of regional centers of excellence in Southern and Southeast Asia, South America and Africa;
- SCOR web portal of CB activities of many different international organisations that are relevant to CB for ocean science and observations.

Potential scientific partners to assist with IMBER CB should be identified, for example, SCOR, Future Earth, IOC, POGO, and the European Marine Board (EMB). IMBER should also explore relevant CB resources of other organisations and advertise those opportunities to the IMBER community to stimulate applications (e.g., SCOR Visiting Scholarship and POGO Visiting Professorship).

Suggestions and Way Forward

The research areas identified as priorities for future IMBER CB efforts include climate change impacts, ecosystem health, and food security. Addressing climate change impacts requires individuals trained in data collection, interpretation, calibration, and modelling. Issues of ecosystem health need capacity in basic information such as mapping of habitats and potential resources, as well as understanding, identification and management of sources of nutrients, pollution and other human activities that could impact these habitats. Food security issues require training in monitoring, collection and interpretation of data, development of knowledge and technology on such as integrated multi-trophic aquaculture, as well as early warning systems and decision tools. Addressing these issues will also require community and stakeholder involvement, and translating the scientific knowledge into policy and legislation.

Successful CB in international projects requires that initiatives undertaken support national capacity development, be embedded in the projects from the start, and be of interest to regional and international agencies. Obviously, international initiatives can only partially meet the enormous need for capacity development in individual countries. Regular and on-going CB efforts are essential.

To advance CB in a coordinated and effective manner, IMBER should develop a CB strategy consistent with the scientific

objectives outlined in its Science Plan and Implementation Strategy, which is sufficiently robust to encompass new activities. These activities should be aligned with IMBER's scientific themes and grand challenges, while meeting the specific needs of the IMBER regional programmes and working groups and, where possible, endorsed projects. In implementing its CB strategy, IMBER needs to consider the following actions:

- Undertaking an analysis of the scientific areas and geographically-relevant regions where different levels of CB are required, including the future needs of each IMBER regional programme, working group and, where possible, endorsed projects;
- Evolving IMBER's portfolio of CB activities for both short and longer terms, taking into account the evolving needs of the project by creating a schedule of CB activities and establishing metrics for evaluation of each activity;
- Identifying potential scientific partners for involvement and collaboration in IMBER CB, and potential funders for these activities to maximize the CB resources;
- Identifying mechanisms to facilitate the exchange of students and early-career researchers between institutions and establishing a mentoring programme for project-wide networking activities;
- Promoting CB activities through web-based networking tools and social networking to increase effectiveness.

The next phase of IMBER research will include a focus on science at the interface of human and natural systems, and recognition that not all countries have the same level of research capacity (i.e., infrastructure and trained personnel) in this area is needed. Thus, more advanced countries will be looked to help raise the level of human and resource capacity needed for IMBER-related science. The related CB issues are especially critical because the IMBER science themes for the next decade of research will require a different level and type of training than is currently available. The growing importance and need to address questions at the interface of natural and social science will require a community of researchers that is only starting to be developed. Development of this community will require different educational models, integration of efforts by a variety of agencies, greater involvement of the scientific communities of developing countries, and resources to support medium- to long-term studies in different ecosystems (IMBER CBTT, 2014).

On-going and new IMBER capacity building activities

IMBER is beginning its second 10-year phase of research, which coincides with large-scale changes in the organisation of international science coordination and networking efforts, with particular implications for the marine, global environmental change community. Coincident with this new phase, the IGBP, the International Human Dimensions Programme (IHDP), the International Programme of Biodiversity Science (DIVERSITAS), and the Earth Systems Science Partnership (ESSP) have been replaced by a single programme, Future Earth. This is a 10-year international research initiative designed to *“develop the knowledge for responding effectively to the risks and opportunities of global environmental change and for supporting transformation towards global sustainability in the coming decades”*. Future Earth aims to provide critical knowledge required for societies to understand and address challenges posed by global environmental change and to seize opportunities for transition to global sustainability.

Many of the global environmental change core projects previously sponsored by the IGBP, including IMBER, will transition

to Future Earth. IMBER has requested a 10-year extension from its other co-sponsor, SCOR. IMBER's new science plan and implementation strategy outlines a research agenda that integrates capacity building activities into all activities. The IMBER SSC and chairs of working groups and regional programmes are tasked with ensuring that this is realised.

Priorities and Recommendations

Capacity building for marine scientific research is addressed by many international organisations and agencies, through specific individual activities and in partnerships. These activities contribute to enhancing the awareness of marine science issues among nations and broadening the reach and scope of participating countries in international marine research projects. Experience gained from these activities, as well as from the IMBER assessment of capacity building needs for the Asia-Pacific region (Zhang et al., 2013b) provide the basis for the following priorities and recommendations:

1. Global, regional and national capacity building activities are undertaken by many organisations and institutions. Better communication and improvement of linkages between these entities will reduce overlaps and duplications, and more effectively use of resources.
2. National components of global projects like IMBER often involve bilateral cooperation between developing countries that contribute to CB in partner nations. This could be further developed and refined through the designation of a member of the IMBER SSC to oversee CB activities and liaise with other national, regional and international organisations and initiatives.
3. Capacity building activities should involve on-board training to familiarise trainees with working at sea. In addition to continuing the current mechanisms offered by SCOR, IOC and POGO, efforts should be made to gain access to ships of opportunity for CB activities.
4. Countries need to create an enabling environment so that the CB activities are fully utilised. This requires investment at the national level in education, and in creating opportunities to retain trained personnel.
5. Capacity building activities should strive to recruit and involve active early-career researchers. This will require implementation of, for example, more active performance evaluation.
6. Capacity building should be an important component of all international programmes and projects. It should be considered early in programme development and involve representatives of countries in need of CB. This will help to set realistic goals and align national and international missions.
7. Adequate consideration should be given to the differences in culture and language of the participants, as well as the stakeholders of CB activities.

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Appendix A: Online Community Survey for the CB Workshop during the IMBER Open Science Conference (Bergen, 21-27 June 2014)

INTRODUCTION

The IMBER Capacity Building Task Team (CBTT) organised a joint workshop with the Asia-Pacific Network for Global Change Research (APN) in Shanghai in August 2012. Based on the presentations and discussions at the workshop, a summary paper was published in *Marine Pollution Bulletin* in 2013, and a report submitted to the APN (Hu et al., 2013; Morrison et al., 2013). To build on this, CBTT held a workshop (22/06/2014) in conjunction with the IMBER Open Science Conference in Bergen, Norway. At the workshop there was an evaluation of the progress that IMBER has made in building capacity for IMBER-related science based on information from the IMBER Working Groups (WG), Regional Programmes and IMBER scientists, and using this input to develop new ideas and a plan for Capacity Building (CB) during the next 10 years.

ON LINE SURVEY

(<https://www.surveymonkey.com/s/CKJGFNP>)

Have you been involved in IMBER CB activities?

If YES, please try and mark the boxes in questions 1 and 2, as well as consideration of the questions. If NO, please consider the questions below the boxes in Questions 2 and 3 and the other questions for provision of your input.

1. How would you rate the effectiveness of the following activities since the beginning of IMBER, in terms of contributing to the success of IMBER and/or building the community of scientists involved in IMBER?

CB Activities	Very Effective	Somewhat Effective	Not Effective	No Opinion
CLIMECO Summer Schools				
Data Management Sessions at IMBER IMBIZOs				
Mentoring at IMBIZOs				
Grants to attend IMBER-related meetings				
CB activities of IMBER regional projects and task teams				

Related issues:

- What do people think the IMBER has accomplished on CB in recent years?
- How can we best measure the effectiveness of IMBER CB activities?
- Do you have suggestions for improving any of these activities?
- Other Comments and suggestions

2. How important could the following capacity building approaches be for the next phase of IMBER?

CB Activities	Very Important	Somewhat Important	Not Important	No Opinion
CLIMECO Summer Schools				
Data Management Sessions at IMBER IMBIZOs and OSCs				
Mentoring at IMBIZOs and OSCs				
Grants to attend IMBER-related meetings				
CB activities of IMBER regional projects and task teams				
Ship-board experience				
Visiting Professorships				
Distance Learning				
Alumni Network				
Other (please specify):				

Related issues:

- What major CB activities are needed to support IMBER in the next phase of its development?
- How can IMBER CB activities be achieved by collaborating with other programs/agencies?
- How can we ensure that IMBER CB activities are effective and the skills developed are utilised in IMBER projects?
- What CB activities not mentioned in the above table could be used by IMBER in the future?
- Other Comments and suggestions

3. How would you rate the balance of IMBER capacity building activities on regional versus global levels (select one)?

- The balance is about right_____
- There should be more activities on the regional level_____
- There should be more activities on the global level_____

4. Can you provide examples of global-level CB activities scaled down to regional levels and/or regional activities scaled up to global levels, which could serve as a model for IMBER?

5. What should be the CB legacy of IMBER?

6. How can effectiveness of IMBER CB be evaluated?

7. Are there any gaps in IMBER CB in terms of previous activities?
8. What is your vision of the strategy of CB of IMBER for next 10 years?

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Appendix B: Acronym index

- AIMES:** Analysis, Integration and Modeling of the Earth System (<http://www.aimes.ucar.edu>)
- APN:** Asia-Pacific Network for Global Change Research (<http://www.apn-gcr.org>)
- ASCLME:** Agulhas and Somali Current Large Marine Ecosystems (<http://www.asclme.org>)
- ASEAN:** Asian Development Bank, Association of Southeast Asian Nations
- BCLME:** Benguela Current Large Marine Ecosystem
- CB:** Capacity Building
- CBTT:** Capacity Building Task Team (<http://www.imber.info/index.php/Science/Working-Groups/Capacity-Building>)
- CIDA:** Canadian International Development Agency
- C-J-K:** China-Japan-Korea
- ClimEco:** Climate and Ecosystems
- CLIVAR:** Climate and Ocean – Variability, Predictability, and Change Project (<http://www.clivar.org>)
- COPAS:** Center for Oceanographic Research in the eastern South-Pacific (<http://copas.udec.cl>)
- DAAD:** German Academic Exchange Service (<https://www.daad.de/en>)
- DIVERSITAS:** International Programme of Biodiversity Science (<http://www.diversitas-international.org>)
- ECNU:** East China Normal University (<http://english.ecnu.edu.cn>)
- ESSP:** Earth Systems Science Partnership (<http://www.diversitas-international.org/activities/essp-1>)
- GEC:** Global Environmental Change
- GLOBEC:** Global Ocean Ecosystem Dynamics (<http://www.globec.org>)
- IAEA:** International Atomic Energy Agency (<http://www.iaea.org>)
- IAI:** Inter American Institute for Global Change Research (<http://www.iai.int>)
- ICSU:** International Council for Science (<http://www.icsu.org>)
- IFS:** International Foundation for Science (<http://www.ifs.se>)
- IGBP:** International Geosphere-Biosphere Programme (<http://www.igbp.net>)
- IHDP:** International Human Dimensions Programme (<http://www.ihdp.org>)
- IMBER:** Integrated Marine Biogeochemistry and Ecosystem Research (<http://www.imber.info>)
- IMBER OSC:** IMBER Open Science Conference (<http://www.imber.info/index.php/Meetings/IMBER-OSC-2014>)
- IMBER SPIS:** IMBER Science Plan and Implementation Strategy (<http://www.imber.info/index.php/Science/Science-Plan>)
- IOC:** Intergovernmental Oceanographic Commission (<http://www.unesco.org/new/en/natural-sciences/ioc-oceans/>)

IOC/WESTPAC: Intergovernmental Oceanographic Commission, Sub-commission for the Western Pacific (<http://iocwestpac.org>)

IODE: International Oceanographic Data and Information Exchange (<http://www.iode.org>)

IPO: IMBER International Project Office

IRD: French Research Institute for Development (<https://en.ird.fr>)

IRD LMI: French Research Institute for Development - International Mixed Laboratories Program

IUEM: Institut Universitaire Européen de la Mer (http://www-iuem.univ-brest.fr/en?set_language=en)

JCOMM: Joint Technical Commission for Oceanography and Marine Meteorology (<http://www.jcomm.info>)

MB-ESF: Marine Board – European Science Foundation (<http://www.marineboard.eu>)

MOOCs: Massive Open Online Courses

NANO: Nippon Foundation – POGO Alumni Network for Oceans (<http://www.nf-pogo-alumni.org>)

NGOs: Non-Governmental Organisations

NORAD: Norwegian Agency for Development Cooperation (<http://www.norad.no/en/front-page>)

NRC: United States National Research Council (<http://www.nationalacademies.org/nrc/index.html>)

PICES: The North Pacific Marine Science Organization (<https://www.pices.int>)

POGO: Partnership for Observation of the Global Oceans (<http://www.ocean-partners.org>)

RPO: IMBER Regional Project Office

RTCs: Regional Training and Research Centers

SCOR: Scientific Committee on Oceanic Research (<http://www.scor-int.org>)

SIDA: Swedish International Development Agency (<http://www.sida.se/english>)

SOA: State Oceanic Administration, the People's Republic of China (<http://www.soa.gov.cn/english>)

SSC: Scientific Steering Committee

START: Global Change System for Analysis, Research, and Training (<http://start.org>)

ToRs: Term of References

TTR: Train Through Research

TWAS: Academy of Sciences for the Developing World (<http://twas.org>)

UN: United Nations (<http://www.un.org>)

WBCSD: World Business Council for Sustainable Development (<http://www.wbcsd.org/home.aspx>)

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