International Indian Ocean Expedition:
How it Came About and What we Learned about International Projects

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As the ocean science community is about to launch the Second International Indian Ocean Expedition (IIOE-2), it is worthwhile to look back to the original IIOE to determine why and how it developed, and what lessons were learned from the IIOE that might be applied to the IIOE-2.[1]

The original idea for the IIOE arose during the first meeting of the Special Committee on Oceanic Research (renamed "Scientific Committee on Oceanic Research" some years later). SCOR was formed by the International Council of Scientific Unions (ICSU, now the International Council for Science) as its first interdisciplinary committee in 1957.

The first SCOR meeting was held in Woods Hole, Massachusetts (USA), chaired by Columbus Iselin, director of the Woods Hole Oceanographic Institution. The participants, all men, are shown in Figure 1.

Figure 1: Participants in first annual SCOR meeting in 1957 in Woods Hole, where the idea for the IIOE was developed. Participants are identified in Wolff (2010).

[1] Information about the IIOE is available online at http://scor-int.org/IIOE-1/History.htm.

The first annual SCOR meeting handled all the usual business for an organization meeting for the first time, but participants also discussed what kind of issues SCOR would tackle first. The concept of SCOR working groups (WGs) was also developed. The global science community was in the midst of the 1957-1958 International Geophysical Year and the benefits of an intensive multinational focus on geoscience for a limited period was the context for the SCOR discussions. Participants identified the Indian Ocean as the ocean basin that was least known and which would most benefit from a concerted international research effort (Deacon, 1957). The IIOE was originally envisioned as a relatively short and intensive program, but began officially on 1 September 1959 and lasted until 31 December 1965; synthesis and reporting continued for several years beyond 1965. Besides the usual creation of peer-reviewed research papers, 6 atlases and various books (e.g., Zeitschzel, 1971) were produced, along with an 8-volume compilation of 656 peer-reviewed publications from the IIOE (see http://scor-int.org/IIOE-1/Reprints.htm).

The Woods Hole meeting set up the first four SCOR working groups, which were later combined into SCOR WG 5 on the International Indian Ocean Expedition; WG 5 was chaired by Columbus Iselin. SCOR WGs 6-11 were also formed during the lifetime of the IIOE to address issues specific to the IIOE. The IIOE was to become the main focus of SCOR for the first 8 years of its existence.

In 1959, SCOR hired an IIOE Project Coordinator, Mr. Robert G. Snider, who had worked with Roger Revelle previously on U.S. Navy issues. (Behrman, 1981 provides a very readable history of the IIOE, including Snider's involvement in it.) Snider was employed by the U.S. National Academy of Sciences Committee on Oceanography and paid with funding from the U.S. National Science Foundation. Snider worked out of an office in New York City, assisted by a secretary. During his term of about three years, Snider was instrumental in laying the foundation for the IIOE by making 5 trips to the Indian Ocean region to meet with scientists, agency heads, politicians, foundation staff, and others to raise the profile of the IIOE in the region and to determine what resources existed in the Indian Ocean region to carry out the IIOE. Snider also worked to develop support for the IIOE in nations of Europe, Asia, Oceania, and North America to encourage involvement of these nations in sending ships to the Indian Ocean during the IIOE period. Snider's papers and reports are available at http://scor-int.org/IIOE-1/Snider_Papers.htm. Ships were sent from 23 nations; the cruise reports from some of these cruises are available at http://scor-int.org/IIOE-1/Cruise_Reports.htm. More than 570 scientists from 29 nations participated on cruises and in the land-based research camps.[2] Female scientists participated on several cruises, particularly on cruises from the United States (at least 14) and the United Kingdom (at least 1); female participation was a rarity on research cruises in the early 1960s.

The IIOE was multidisciplinary, including water sampling for hydrographic parameters, phytoplankton and zooplankton sampling, characterization of the Indian Ocean seafloor,

[2] I have compiled this information from cruise reports and other documents. The actual number is undoubtedly much higher because I only have access to cruise reports from about one-third of the 180 cruises.

aircraft measurements to study meteorology, and land-based marine biological investigations (at Mandapam Camp in India and the island of Nosy Bé in Madagascar).

The IIOE was one of the first multi-national ocean research projects, so the project planners and managers did not have much previous experience to build on. The following section will discuss some of the important features of the IIOE and some lessons learned.

Intercalibration

Intercalibration, standard methods, and reference materials are obvious requirements for any project that includes more than one analyst, measuring device, measuring time, etc., when it is intended to compare observations collected at different times and places. Any project that intends to compile data into single database (CLIVAR, GO-SHIP, GEOTRACES) must devote a great deal of effort to the issue of intercalibration. I have not been able to find records of the intercalibrations for measurements of physical parameters in the IIOE, although the reference stations developed early in the project were probably one attempt to intercalibrate (Figure 2). However, Australian scientists found that hydrographic measurements at Reference Station #1 were too variable for this site to serve as a good reference station, and speculated that a similar problem might exist at other reference station (Rochford, 1965).

An effort was made aboard the Australian *Gascoyne* and the USSR's *Vityaz* in September 1960 to intercalibrate oxygen and phosphate measurements. Scientists from 8 countries worked on these two ships and on-shore at the University of Hawaii. The results obtained were more variable than expected. Further intercalibration activities for oxygen were carried out in August 1961, also with disappointing results.

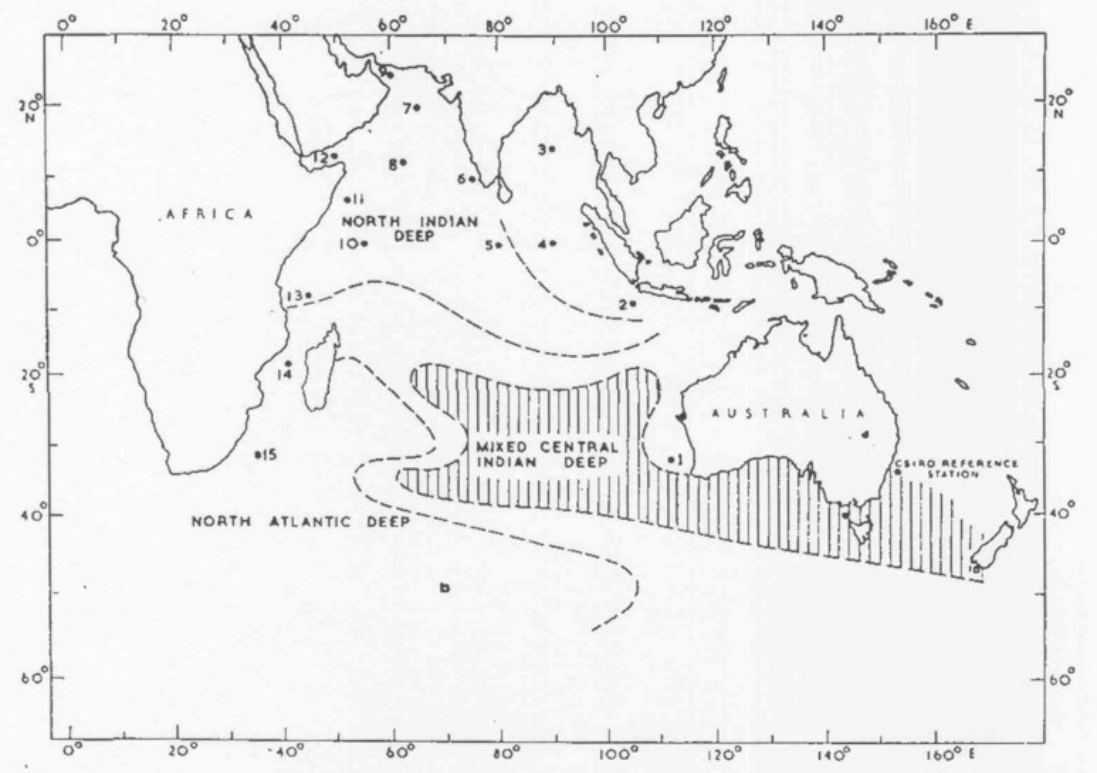

Figure 2. Position of SCOR-Unesco Reference Stations (adapted from Rochford, 1965). Considerable effort was devoted to intercalibration of sampling for chlorophyll and phytoplankton, with onboard intercalibration activities in Hawaii (1961) and Australia (1962). Some nations (e.g., Japan) carried out national intercalibrations among their ships involved in the IIOE.

SCOR WG 3 on Measurements of the Productivity of the Sea and of the Standing Crops of Phytoplankton and Zooplankton (renamed Biological Production of the Sea) was set up at the first SCOR meeting in 1957, to help develop standard methods for plankton measurements. The work of WG 3 led to the development and adoption of the Indian Ocean Standard Net (IOSN), which was deployed in a standard manner (a vertical haul from 200 m to the surface at 22:00 hours). The IOSN is still used today and is available for purchase through oceanographic equipment suppliers. Zooplankton nets were compared in August 1962 at SCOR-UNESCO Reference Station #1 (32°S, 111°50'E) aboard the USSR ship *Vityaz* (Tranter, 1963a,b) as the basis for recommendations that led to the use of the IOSN (see http://scor-int.org/Historical%20Documents/IIOE/Foxton.pdf). Samples collected with the IOSN and other nets were analyzed by scientific technicians at the Indian Ocean Biological Centre (IOBC) established in 1963 in Ernakulam, India (Hansen, 1966). This center was recommended by SCOR and supported by UNESCO and the Indian government. By February 1966, 2,068 IOSN samples were received by the IOBC, from 10 countries (Highley, 1968).

Implications for the IIOE-2: Fortunately, much progress has been made in developing standard methods for many parameters and manuals are available for hydrographic measurements, nutrients, oxygen, trace elements and isotopes, etc. (see http://www.go-ship.org/HydroMan.html and http://www.geotraces.org/libraries/documents/Intercalibration/Cookbook.pdf). Better reference materials are now available for many more parameters than was the case during the IIOE. An early task for IIOE-2 implementation should be the adoption of existing manuals to guide project scientists and identification of any parameters for which intercalibration should be pursued. Recommendations should be made about which certified reference materials are available and should be used. Training on standard methods can contribute to both intercalibration and capacity building.

Top-down versus Bottom-up Planning

It is important to find the right balance of top-down and bottom-up approaches to planning and coordination of international research projects. Most projects today are generated by ideas from the scientific community, whose members convince national funding agencies of the merits of the projects, rather than by international organizations brainstorming and developing project ideas. The IIOE started as a top-down creation of SCOR. Over time, the IIOE became more bottom-up in the sense of being more driven by the interests of individual scientists and national interests, rather than by the SCOR or IOC. The systematic sampling plan proposed by Wüst (1959) was discussed at length by project scientists and supporting organizations, but was not adopted. By 1961, the map of planned cruises (Snider, 1961) looked much like the eventual map (see Hood et al. article, this newsletter), where cruise transects were designed to answer scientific questions of interest to individual scientists from different nations (Figure 3). Some scientific questions require sampling along regular transects, as demonstrated by the global hydrography programs of WOCE, CLIVAR, and now GO-SHIP, and this is what Wüst had envisioned. Other questions require sampling that is focused on specific processes and areas of interest, and the IIOE mostly evolved as a project looking at processes, particularly related to the reversing monsoons in the Indian Ocean region and how that drives physics (oceanic and atmospheric), chemistry, and biology.

Implications for the IIOE-2: Like the first IIOE, the IIOE-2 has resulted largely through the initiative of organizations like SCOR, IOC, IO-GOOS, and others. It will be important for the IIOE-2 to build a strong base of interest in the international community and identification of "heroes" who will make the IIOE-2 a significant focus of their careers.

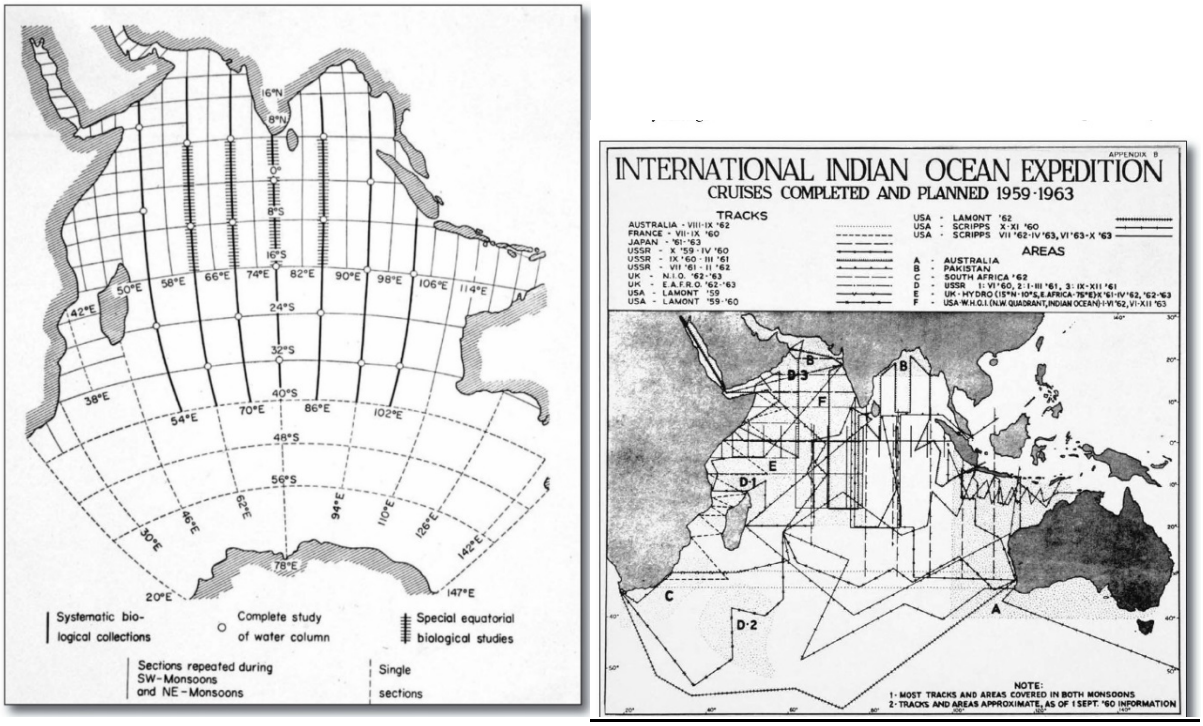

Figure 3: Proposal for IIOE sampling plan from Wust (1959) versus sampling plan presented in 1961 (Snider, 1961).

Research Projects as "Start-ups"

Research projects, particularly those with a bottom-up origin, resemble commercial start-ups in some ways. Project founders are often "scientific entrepreneurs" who develop the vision for the project, convince their colleagues that it is an activity worth investing their time and effort in, and create a "business plan" (the project science plan) to convince potential financial sponsors (usually national science agencies) to invest in the project. Oftentimes, the founder(s) serve as the first project chair(s) and these individuals invest years of their careers getting a project started. As a top-down project, the vision for the IIOE was provided by SCOR. There was not a specific scientist who could be identified as the project founder or "hero". Instead, SCOR took the approach of hiring Robert G. Snider as the Project Coordinator for IIOE because he was known as a person who was able to succeed at complex jobs and had a good working relationship with Roger Revelle, the first SCOR President. Snider was largely responsible for laying a foundation for the IIOE, although his key role is not often recognized. Snider's extensive travel, development, and early coordination of the program was a key to its success.

For many maturing start-ups, the founder does not have the set of skills necessary to take organizations or projects into a stable organizational phase. In the case of the IIOE, by mid-1962, both the U.S. National Academy of Sciences and IOC were ready to move to a different

mode of operation for the IIOE, which would require more intergovernmental action and coordination (Wooster, 1984). The NAS and IOC engineered a transition of management to IOC earlier than the end of 1962 timeframe that was originally planned. IOC was responsible for the IIOE from mid-1962 until 31 December 1965, and provided the resources needed to ensure that cruises were coordinated, information about the project was communicated to project scientists, special arrangements were made among governments for cooperation, and that the results of the project were synthesized in forms that would be useful for both the scientific community and national agencies.

Implications for the IIOE-2: Success of the IIOE-2 will depend on the sponsors of the project nurturing a good balance between the entrepreneurship of individual scientists and the stability and resources that can be provided by large international organizations.

Capacity Building

Capacity building can magnify the achievements and legacy of a project. The IIOE had capacity building as a major focus of its activities. Two major approaches were used: (1) establishment of regional centers for biology and meteorology; and (2) participation of scientists from the region on cruises of ships from outside the region. At least 77 scientists from developing countries (Brazil, Egypt, India, Indonesia, Madagascar, Malaysia, New Caledonia, Pakistan, South Africa, Tanzania, Thailand, United Arab Republic) participated in cruises of other nations (Australia, Japan, USSR, United States). A large percentage of these scientists were Indian scientists hosted on the U.S. *Anton Bruun*.[3] The IIOE helped build significant capacity in the Indian Ocean region for ocean science, particularly within India, where the Indian Ocean Biological Centre (IOBC) evolved into the National Institute of Oceanography in Goa, India (see the paper by Naqvi et al. in the same issue). In addition to IOBC, the IIOE resulted in the establishment of the International Meteorology Centre in Bombay, funded by the World Meteorological Organisation, the UN Special Fund, and the Indian government.

Implications for the IIOE-2: Capacity building in ocean science is still needed in the Indian Ocean region. The regional research infrastructure has improved greatly since 1960 due to the influence of the IIOE and later by national and international investments in capacity building. Still, human population has increased significantly in the region, placing greater pressures on the ocean environment and resources. The IIOE-2 can bring renewed attention to research needs in the region and stimulate education and training of the next generation of ocean scientists around the Indian Ocean rim and on the basin's island nations. Both training of individual scientists and building up of existing institutions is needed. Morrison et al. (2013) gives ideas about how international research projects like the IIOE-2 can be used to build ocean science capacity. The IIOE-2 can help develop ocean science capacity in the region by increasing the cooperation of regional scientists with scientists from outside the region (for an example of this, see the Indo-French collaboration on oceanography described by Vialard et al. in this

[3] A film about the Anton Bruun's participation in the IIOE was produced by the U.S. National Science Foundation and is available at http://scor-int.org/IIOE-1/Film.htm.

issue), as the IIOE did. SCOR, IOC, the Partnership for Observation of the Global Oceans (POGO), the Western Indian Ocean Marine Science Association (WIOMSA), and other organizations can contribute significant experience and resources to capacity-building elements of the IIOE-2. Hopefully, the IIOE-2 will involve on-board training of students and scientists from the region and the building up of institutions in the region, as was the result of the IIOE.

Combining the Strengths of Non-governmental and Intergovernmental Organizations

Projects that are co-sponsored by non-governmental and intergovernmental organizations can reap the benefits of each, if they can avoid the weaknesses of each and if the organizations can overcome challenges to cooperation. Wooster (1984) gives a good description of the complementary roles of SCOR and IOC in the IIOE, whose combined capabilities and resources helped make the IIOE a success. The top oceanographers of the era were participating in SCOR and were responsible for identifying the Indian Ocean as needing intensive investigation. As a non-governmental organization, SCOR was able to agree to scientific priorities without influence from governments. SCOR's founders were well connected to their national funding structures, but independent from national agencies and so national political considerations did not drive the development of the IIOE. However, SCOR was not set up to manage the kind of intergovernmental interactions that were needed for success of the IIOE. IOC's assumption of IIOE management in mid-1962 allowed the project to mature. SCOR continued to provide scientific advice to the project.

Implications for the IIOE-2: The IIOE-2 already involves non-governmental (SCOR) and Intergovernmental (IOC and IO-GOOS) organizations. The challenge will be to create a project that appeals both to individual scientists and national governments. Individual scientists are the driving force for research, contributing their ideas and efforts. In exchange, they seek a minimum of bureaucracy and direction of their research by government agencies. National governments and the research institutions and universities they fund seek to fulfill national research priorities and protect national interests. The situations for research access and data sharing are more complicated than in the IIOE era, but the need for cooperation is more urgent. A larger area of the Indian Ocean is under national jurisdiction through the UN Convention on the Law of the Sea and the establishment of exclusive economic zones than in the early 1960s. IOC influence is absolutely crucial for the IIOE-2 to operate within the more complicated political context for ocean research, while SCOR will provide advice on the scientific direction of the IIOE-2 and help address specific technical issues.

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