

Meeting on Capacity Building and Development for the Southern Africa Region
5-6 November 2012
Henties Bay, Namibia

Executive Summary

A group representing both international organizations, and national and regional organizations, from Namibia and South Africa was hosted by the University of Namibia to discuss the possibilities for cooperation within the southern Africa region for ocean science education. Meeting participants developed the following findings and recommendations, which are presented in greater detail later in the report:

1. Status of Marine Science in the Region

- a. **Finding:** There is a need for more outreach in the region to recruit students to marine science and technology careers (based on needs assessment).
- a. **Recommendation:** Governments should assess their need for more ocean scientists and increase jobs at universities and government agencies, as needed. National institutions should consider conducting more activities to recruit high school and early undergraduate students to marine science careers.
- b. **Recommendation:** National universities and agencies should work together to identify needs for technical staff and ways to fill these needs. Technical training might be best done on a regional basis since the need for staff in any single country is small. The idea of a regional marine instrumentation center should be explored, as a place to train, calibrate equipment, etc.

2. Regional Approach to Ocean Science Education and Facilities

- a. **Finding:** A regional approach to graduate and technical education could improve marine science in the region. Sharing of ocean science facilities in the region could benefit all participating institutions.
- a. **Recommendation:** (1) An assessment of training needs should be conducted for the region by institutions in the region (based on discussions at the regional meeting recommended below). (2) Interested institutions should meet to create a needs assessment (based in part on the IOC needs assessment for Africa) and to discuss a series of steps and a timetable to implement an RGNO. Contacts should be made with additional institutions in the region, besides the ones represented at the meeting

3. Role of International Organizations in Regional CB&D

- a. **Finding:** CB&D activities of SCOR, POGO, IOC, and development agencies of several countries have been important in southern Africa.

- a. **Recommendations:** SCOR, POGO, and IOC should maintain funding for CB&D activities in southern Africa, and should consider whether more funding could be directed to this region for a limited period, for example, five years. . SCOR, POGO, and IOC should consider new funding proposals to help regional institutions implement their CB&D plan.
- b. **Finding:** UNESCO Chairs could be more effective in regional CB&D.
- b. **Recommendation:** IOC should consider working to increase the UNESCO Chair mandate for CB&D and/or nations in the region should request appointment of an additional UNESCO Chair within southern Africa. The local institutions in which the chair is located should consider providing additional support for the CB&D mission of the chair.
- c. **Finding:** International, multilateral, and bilateral research projects working with scientists in the region have the potential to contribute to capacity building.
- c. **Recommendation:** Future national research projects from outside the region should be more proactive about partnerships with scientists within the region and to contribute to the regional graduate network of oceanography.
- d. **Finding:** Opportunities for CB&D could be enhanced when research vessels from outside the region visit the area. International research vessels use harbors in the region on a regular basis, especially Walvis Bay and Cape Town, for refueling and/or crew changes. On most occasions of ship visits, information on these visits does not reach the scientific community in the region early enough to take advantage of the visits. Valuable CB&D opportunities to local and regional scientists and students are therefore lost.
- d. **Recommendation:** SCOR and POGO should encourage their members to take opportunities to provide ship-board training and on-shore lectures when ships are in the region. Information obtained about ship visits should be made available through the [South African Network for Coastal and Oceanic Research](#) (SANCOR).

4. Funding for Regional CB&D

- a. **Finding:** Increasing CB&D activities in the southern Africa region will require increased funding.
- a. **Recommendations:** International, regional, and local organizations should seek new funding from local, regional, and international agencies and foundations. National aid agencies should be approached. Joint projects between EU and African countries are one option.

5. The Role of Visiting Scientists

- a. **Finding:** Sabbatical visits by scientists from within and outside the region are highly beneficial.

- a. **Recommendation:** SCOR and POGO should determine interest among institutes in the region (and within countries) to host sabbatical visits and provide a portal for access by potential visitors, and more proactive communication of this information. Return visits are considered to be especially beneficial as the visiting scientists are then familiar with the working conditions and needs of the African countries.

6. Components of a Regional Graduate Network for Oceanography

- a. **Finding:** Internships are valuable opportunities for undergraduates to explore career options, gain practical work experience, make contacts, etc.

- a. **Recommendation:** Institutions and agencies in the region should explore opportunities to expand internship programs.

- b. **Finding:** Libraries in the region need more hard copies of books and reports from international organizations.

- b. **Recommendations:** Distribute publications from international and regional organizations to libraries in the region. Libraries in the region should join IAMSLIC and work through ODINAFRICA.

- c. **Finding:** Electronic communications (bandwidth program) and reception of satellite data can be difficult in the region, both costly and inefficient.

- c. **Recommendation:** [GEONETCAST](#) satellite communication systems should be expanded in the region; institutions in the region should push for greater access.

- d. **Finding:** Short courses/summer schools/refresher courses/continuing education/research camps can provide experience complementary to graduate programs.

- d. **Recommendation:** Short courses/summer schools/refresher courses/continuing education/research camps should be made integral components of the regional graduate network for oceanography. National IODE focal points should be encouraged to disseminate information about the availability of courses. IODE should send information to SANCOR for posting on their Web site.

- e. **Finding:** CB&D activities would be more effective if more ship time were available for training. The research vessels belong to the national agencies and are maintained and run from their national budgets. Budgetary constraints involved in running the vessels for non-line function work by the Ministry of Fisheries and Marine Resources in Namibia has been a reason for unavailability of the vessels for some proposed research cruises that would potentially involve capacity building. Ship time requests cannot be made at the last

minute because of various safety and health requirements that require some time to complete.

- e. **Recommendation:** The necessary ship time should be defined well in advance of the time needed and communicated to the ship managers. Institutions requesting ship time on a regular basis should appoint a designated person to handle the logistics of ship time requests and required certifications/exemptions.

We hope that these ideas will be helpful in better using the existing capacity for ocean science in southern Africa and creating new cooperation among universities, government agencies, inter-governmental bodies, and non-profit organizations in the region. The opinions expressed in the report are the opinions of the individuals involved in the meeting and may not reflect the policies of their organizations.

Introduction

Capacity building and development (CB&D) is needed in marine science in many developing regions of the world. Marine science and marine technology expertise are needed to address many societal issues in developing regions, as well as to advance basic scientific understanding. The Scientific Committee on Oceanic Research (SCOR) has been involved in CB&D since soon after its formation in 1957. In 1998, SCOR held a meeting on CB&D at the Bellagio Center of the Rockefeller Foundation. The [conclusion of the meeting participants](#) was that SCOR should pursue the idea of regional graduate education, in which the complementary assets of various marine science institutions within a developing region are brought together to strengthen the capacity for marine science throughout the region. SCOR has been partnering on this issue with two other major international organizations that focus on marine science: the Partnership for Observation of the Global Oceans (POGO) and the Intergovernmental Oceanographic Commission (IOC).

On 5-6 November 2012, SCOR convened a meeting to focus on CB&D in the southern Africa region at the Sam Nujoma Marine and Coastal Resource Research Centre (SANUMARC) of the University of Namibia in Henties Bay, Namibia (see participants in Appendix I and agenda in Appendix II). The meeting brought together representatives of SCOR, POGO, IOC, and universities, government and intergovernmental agencies, and non-profit organizations from Namibia and South Africa to develop recommendations regarding the next steps that could be taken to develop a regional graduate network for oceanography (RGNO) in the region. This report makes recommendations to the international organizations involved, as well as to institutions in the region. Many complementary CB&D activities already exist in the region that could be linked more closely to benefit students, scientists, universities, and agencies in the region.

Venu Ittekkot and Ed Urban presented the goals for the meeting:

- Share information about the marine science education needs and capabilities of institutions and organizations in southern Africa
- Acquaint participants with the current mid- to long-term goals and strategies of the institutions in the region for marine science education (level, themes or disciplines)
- Explore existing cooperation in marine science education among institutions/nations (bilateral, multilateral) in the region
- Share information about the capacity-building opportunities offered by international marine science organizations working in southern Africa
- Discuss the concept of a regional graduate network for oceanography in southern Africa, and how regional institutions and international organizations could cooperate in developing such a network
- Develop recommendations to regional institutions and international organizations about what should be done next
- Identify funding opportunities and other ideas

Context

Activities and Needs in the Southern Africa Region for Education in Marine Science

The meeting included participants from three universities in southern Africa, a governmental agency, a regional intergovernmental organization, and a non-profit organization. Each can offer different capabilities and cooperation among these organizations to provide a foundation for additional of other institutions.

University of Cape Town (South Africa)—The University of Cape Town (UCT) is the premier ocean science institution in the region and trains students from throughout Africa. UCT created the Marine Research (Ma-Re) Institute in 2006 to cover a range of ocean science topics. This institute offers a Master's degree in Applied Marine Science. The Ma-Re Institute includes several different departments at the university, including the Department of Oceanography. UCT provides an opportunity to train scientists and teachers within the region on regionally relevant scientific topics. UCT has access to a new research vessel belonging to the South African Department of Agriculture, Forestry and Fisheries (DAFF) (the *RV Agulhas II*) that could serve as a regional resource.

University of Namibia (UNAM)—UNAM is the major educational institution in Namibia and provides education in all fisheries and aquatic sciences at its main campus in Windhoek, to the doctorate level. UNAM's [Sam Nujoma Marine & Coastal Resources Research Centre](#) (SANUMARC) in Henties Bay, Namibia could serve as a regional resource in terms of providing easy access to an interesting research environment, the necessary laboratory facilities for study of the local ecosystems, and housing for visiting scientists and students from the Windhoek campus, the region, and beyond. The center is still developing its capabilities, including Internet

access. Plans are under development for summer “research camps” funded by the Agouron Institute, and developed on experience gained by SCOR Visiting Scholar Kurt Hanselmann. (see Appendix III). SANUMARC, in collaboration with some institutions in Germany and South Africa, is actively involved in the Science Partnerships for the Assessment of Complex Earth System Processes (SPACES) program being funded by the government of Germany.

[National Marine Information and Research Centre](#) (NatMIRC)—NatMIRC, together with its sister research institute at Lüderitz, is the national agency in Namibia responsible for the regulation of the fisheries and mariculture sector under the Ministry of Fisheries and Marine Resources. These government agencies have laboratories, two research vessels (*RV Mirabilis* and *RV Welwitschia*), and human resources that could contribute to regional education. The major limitations to contributions from the Ministry of Fisheries and Marine Resources are that its agencies have a full slate of regulatory and scientific responsibilities and little spare time for working with interns and training new students.

[Applied Centre for Climate and Earth System Science](#) (ACCESS)—ACCESS is a South African consortium focused on global change, including components on research, education/training, and service. It includes most of the major universities in South Africa, as well as some of the national agencies.

Benguela Current Commission (BCC)— The Benguela Current Commission (BCC) is a multi-sectorial intergovernmental Large Marine Ecosystem (LME) commission concerned with the sustainable and optimal use and management of the living and non-living marine resources through an integrated approach to ocean governance. The BCC, through the implementation of its Strategic Action Programme (SAP) since 2008, has advanced greatly to integrate non-fisheries sectors into its work programme and policy framework. The BCC includes three coastal states: Angola, Namibia and South Africa. The BCC offers short courses that could contribute to an RGNO

As stated above, these institutions working together could provide a foundation for an extended network in the region. As of yet, these focus primarily on Namibia and South Africa, but such an RGNO should extend beyond these two countries. At the same time, it may be wise to add new institutions gradually as the system gains experience and success. Angola is an obvious next country to bring into discussions of an RGNO because Angola participated with South Africa and Namibia in the Benguela Current Large Marine Ecosystem (BCLME) project, which has been succeeded by the BCC. Regional cooperation in ocean management (with some science) has already achieved a good start on the Atlantic coast of southern Africa, with additional activity on the Indian Ocean coasts through the [Agulhas and Somali Current Large Marine Ecosystems](#) (ASCLME) project. The Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania have been involved in ASCLME. Individuals from Angola and Mozambique were invited to the meeting, but were not able to attend. Our previous experience has demonstrated that networks must grow “organically” as new partners learn of the advantage of participating and that the benefits to participating in the network and sharing resources outweigh the costs.

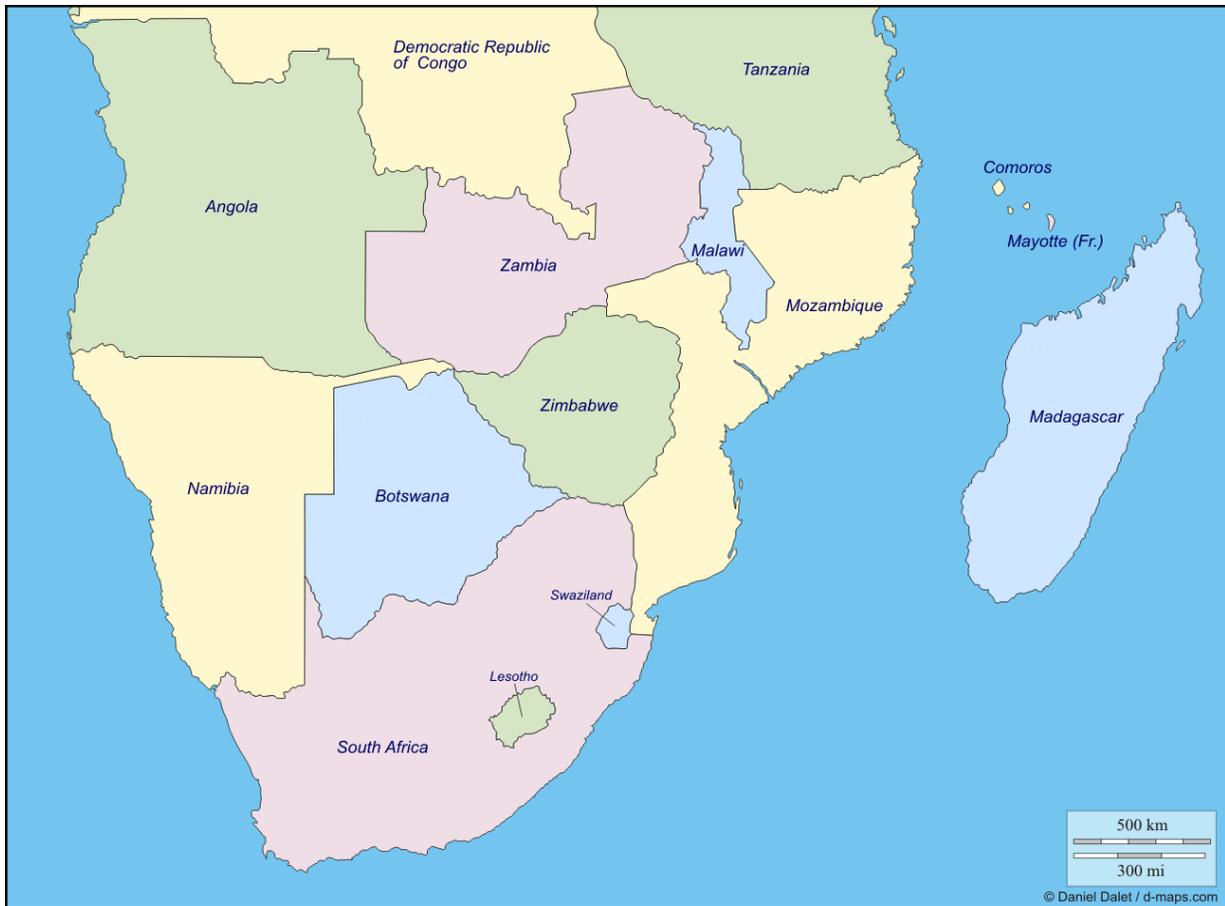


Figure 1. Map of southern Africa (used with permission from d-maps.com: http://d-maps.com/carte.php?lib=southern_africa_map&num_car=25648&lang=en).

Activities of International Organizations

Regional scientific and education activities must be driven from within the region and be self-sustaining from regional resources, yet international organizations can provide resources that may be helpful. International organizations can provide extra resources from outside the region, resources of the international ocean science community. They can catalyze interactions that might not otherwise happen, through connections they have with different people in the region.

Scientific Committee on Oceanic Research (SCOR)—SCOR is an international non-governmental organization and has global responsibilities in all its activities, including capacity building, but SCOR has conducted several capacity building activities in southern Africa in recent years. SCOR has sponsored many southern African students to attend scientific meetings, has co-sponsored several meetings in southern Africa, has sent reports to libraries in the region, and has sent four SCOR Visiting Scholars to the region from 2010 to 2013. SCOR CB&D activities are conducted primarily through funding from the U.S. National Science Foundation.

SCOR's capacity building resources that could be focused on the region include the following:

- Travel grants—In the period of 2008 to 2012, SCOR awarded 194 travel grants. Thirty-five of these were awarded to Africans, from 13 different countries. All of the southern Africans funded were from South Africa. This outcome must result from not enough individuals from the region being aware of and/or applying to meeting organizers for travel support. (SCOR does not accept applications directly from individuals.) SCOR could work more effectively with networks in the region to disseminate information about travel grants.
- Meetings held in southern Africa—SCOR has supported four scientific meetings in southern Africa in the past few years: (1) AGU Chapman Conference on The Agulhas System and its Role in Changing Ocean Circulation, Climate, and Marine Ecosystems (8-12 Oct. 2012, South Africa); (2) 2nd DBCP Africa/Western Indian Ocean Capacity Building Workshop and SCOR/WCRP/IAPSO WG 136 Meeting (2-6 May 2011, Mauritius); (3) 5th EGU Alexander von Humboldt International Conference (12-16 Jan. 2009, South Africa); and (4) SCOR/IAPSO Workshop on Deep Ocean Exchange with the Shelf (6-8 Oct. 2008, South Africa).
- SCOR Visiting Scholars—Two SCOR Visiting Scholars have worked in Namibia and South Africa in the past few years, and another will serve in South Africa in early 2013 and another in Namibia later in 2013. The SCOR Committee on Capacity Building decides on Scholar placements based on applications received and could direct more Scholars to the region. It would be helpful to have more requests for Scholar placements from institutions in the region. For example, there have been no requests from Angola, Mozambique, or Madagascar to host a Scholar and no one asking for a Scholarship has specifically requested any of these three countries.
- POGO-SCOR Fellowships for Operational Oceanography—SCOR and POGO could perhaps make efforts to distribute information about this program more effectively in southern Africa, beyond current members of SCOR and POGO.
- SCOR Committee on Capacity Building—This committee could continue to convene planning meetings in southern Africa to extend the progress made at the Henties Bay meeting. Much work needs to be done to expand the organization's contacts in additional countries in the region.

Partnership for Observation of the Global Oceans (POGO)—Like SCOR, POGO conducts several different kinds of activities CB&D in southern Africa. In addition to the POGO-SCOR Fellowships for Operational Oceanography mentioned above, POGO has funded the following CB&D efforts in southern Africa:

- POGO Visiting Professors—POGO has sent two Visiting Professors to South Africa and Namibia (see Appendix V), with another to be sent this year.
- NF-POGO Centre of Excellence in Observational Oceanography (2008-2012)—This program hosted 10 students for a 10-month program each year to “promote excellence in integrated, multidisciplinary oceanography on a global scale.” Individuals from South Africa and Namibia participated in this program.

- POGO supports a [bursary program](#) for students from other countries in Africa to pursue a master's degree at UCT. Since inception of the program, three bursaries have been funded, with one student from another country in the region, Mozambique.

Intergovernmental Oceanographic Commission (IOC)—IOC's main CB&D outreach in the southern Africa region has been through the International Ocean Data and Information Exchange (IODE), IODE has trained students and other individuals trained at the IODE Project Office in Belgium, as well as providing courses taking place in different African countries under the framework of ODINAFRICA. Altogether, 89 participants from the Maritime South African Development Community (SADC) countries have attended [OceanTeacher](#) training activities so far, from Angola, Democratic Republic of Congo, Madagascar, Mauritius, Mozambique, Namibia, Seychelles, South Africa, and Tanzania..

A variety of other international organizations whose mandate covers global change science or science more broadly could contribute to an RGNO in southern Africa. The Global Change System for Analysis, Research and Training (START) is an organization of the International Council for Science (ICSU). ICSU also has a regional office for Africa, located in Johannesburg, that might be interested in future participation in the RGNO.

Findings and Recommendations

1. Status of Marine Science in the Region

- b. Finding:** There is a need for more outreach in the region to recruit students to marine science and technology careers (based on needs assessment).

The southern Africa region has a relatively undeveloped infrastructure for ocean science. Many of the coastal environments in the region are still relatively pristine, with low coastal populations. However, increased urbanization, pressures from commercial fishing, and more proposals for mining of continental shelf areas, together with increasing marine pollution from coastal activities, mean that there will be a need for a better understanding of coastal ecosystems, how human activities will affect these ecosystems, and how human activities in one nation's coastal waters will affect the environment in down-current areas.

Increased recruitment of students to marine science and technology must be tempered by the fact that demand for trained ocean scientists and technologists depends on decisions made by national governments. Without government commitments to employ ocean scientists in academia and government agencies, these areas of study will not be as attractive as work in the commercial sector. Anecdotal evidence suggests that the most talented undergraduate students do not pursue graduate careers in the region because they can obtain more lucrative jobs in industry or by working in institutions in developed countries. It is important not to train people for jobs that will not be available.

- b. Recommendation:** Governments should assess their need for more ocean scientists and increase jobs at universities and government agencies, as needed. National institutions

should consider conducting more activities to recruit high school and early undergraduate students to marine science careers.

More attention needs to be devoted at governmental levels to creating sustainable university and agency jobs, to meet the need for more individuals training on ocean science and technology.

In developed countries, training is available for individuals to learn how to work as specialized laboratory and ship-board technicians, equipment design and maintenance experts, and data analysis experts with different, but complementary, training from research scientists. This type of specialization can make ocean research and observations more efficient and allow individuals to follow their interests and talents. Such training is less common in developing countries. However, the [Cape Peninsula University of Technology](#) offers diplomas, bachelors and masters degrees in marine and oceanographic technology, but so far all their students have been in-service trainees from South African government departments. There is scope to expand the student body to individuals who would work in universities. The South African Department of Environmental Affairs (DEA), which includes Oceans and Coasts, is establishing a new technical center for maintaining, testing, and calibrating Antarctic and oceanographic equipment. This should be explored as a potential regional facility.

- c. Recommendation:** National universities and agencies should work together to identify needs for technical staff and ways to fill these needs. Technical training might be best done on a regional basis since the need for staff in any single country is small. The idea of a regional marine instrumentation center should be explored, as a place to train, calibrate equipment, etc.

2. Regional Approach to Ocean Science Education and Facilities

- b. Finding:** A regional approach to graduate and technical education could improve marine science in the region. Sharing of ocean science facilities in the region could benefit all participating institutions.

Even before the current global economic downturn, it was obvious that it was not economically feasible for each country in southern Africa to have its own complete ocean research infrastructure. Not enough funding is available to support jobs in the government and academic sectors, or to equip laboratories with the latest equipment, deploy ocean observing systems, or purchase and maintain research vessels. Fortunately, there are models on both national and international levels for standardization of degree programs and sharing of major facilities. The [Bologna Process](#) has been adopted by several European nations to harmonize coursework in higher education among European institutions and to ensure a uniform level of quality. In terms of facilities, developed nations have learned the value of sharing expensive facilities on national and international levels. National examples in the United States include the [National Ocean Sciences Accelerator Mass Spectrometry facility](#) funded by the U.S. National Science Foundation at the Woods Hole Oceanographic Institution for analysis of carbon-14 in small samples and the [UNOLS research fleet](#). Internationally, examples include the [EuroFleets](#) initiative, and efforts outside the marine sciences, such as the CERN facility and the International

Space Station. International and even national coordination and shared use of facilities can be complicated, but the examples mentioned above could provide models for successful development on new cooperation in southern Africa and other regions.

The coastal nations in southern Africa share a long coastline and include two Large Marine Ecosystems (LMEs): the Agulhas and Somali Current LME in the Indian Ocean, and the Benguela Current LME in the South Atlantic Ocean. Both of these rich and complex LMEs are shared by at least three nations. Experience by the two LMEs has demonstrated the need for integrated regional research and management. Integrated research and management will be best supported by a regional approach to CB&D, including a Regional Graduate Network for Oceanography, which will benefit from the uniqueness of these LMEs and their common strategic needs. These countries have in common the fact that they became independent only a few decades ago, partially explaining their relatively recent start in marine-related sciences compared to other countries in the world. The countries also share several common needs and issues in marine sciences. Since two languages (English and Portuguese) are used by most of the scientists working in these countries, there may be opportunities for development of written materials that could be shared among the countries.

- b. Recommendation:** (1) An assessment of training needs should be conducted for the region by institutions in the region (based on discussions at the regional meeting recommended below). (2) Interested institutions should meet to create a needs assessment (based in part on the IOC needs assessment for Africa) and to discuss a series of steps and a timetable to implement an RGNO. Contacts should be made with additional institutions in the region, besides the ones represented at the meeting

Development of plans for increased regional cooperation in ocean science education must ultimately be developed by interested institutions in the region, although international organizations can help catalyze regional developments by convening meetings and applying their resources to strengthen regional efforts. Universities and national agencies should consider whether they can accomplish more working together than working alone. Developing systems should start at a modest level and with “pilot projects”, developing a stable foundation of achievements before expanding.

3. Role of International Organizations in Regional CB&D

- b. Finding:** CB&D activities of SCOR, POGO, IOC, and development agencies of several countries have been important in southern Africa.

SCOR, POGO, and IOC are global organizations, but have made modest investments in southern Africa. Greater progress in CB&D in ocean sciences could be achieved if the three organizations worked together in a more coordinated manner. SCOR and POGO has sent several different visiting scientists to the region. Repeat visits by visiting scientists can be beneficial, as they and their hosts can adapt their approaches based on experience from their first visits. The normal approach of most organizations is to not fund the same person repeatedly to go to the same area, but this approach should be reconsidered.

- c. **Recommendations:** SCOR, POGO, and IOC should maintain funding for CB&D activities in southern Africa, and should consider whether more funding could be directed to this region for a limited period, for example, five years. . SCOR, POGO, and IOC should consider new funding proposals to help regional institutions implement their CB&D plan.

SCOR, POGO, and IOC should consider how they could work together to seek new funding to expand their existing activities in the region. (Some financial sponsors prefer larger coordinated proposals asking for a larger amount of funding.)

- d. **Finding:** UNESCO Chairs could be more effective in regional CB&D.

UNESCO appoints [UNITWIN/UNESCO Chairs](#) whose mission is to build capacity in higher education and research institutions. Of the UNITWIN/UNESCO chairs focused on ocean science, only one is based in southern Africa, the UNESCO Chair in Marine Sciences and Oceanographic Issues, based at Eduardo Mondlane University, Maputo, Mozambique. UNESCO chairs, working with the IOC Africa Region office, could be effective regional resources for CB&D.

- d. **Recommendation:** IOC should consider working to increase the UNESCO Chair mandate for CB&D and/or nations in the region should request appointment of an additional UNESCO Chair within southern Africa. The local institutions in which the chair is located should consider providing additional support for the CB&D mission of the chair.
- e. **Finding:** International, multilateral, and bilateral research projects working with scientists in the region have the potential to contribute to capacity building.

Scientists from outside the region (notably from Norway, Iceland, Germany, and France) have helped build ocean science capacity in the region by planning research cruises in the region, and involving regional scientists. Ideally, regional scientists would also be involved in preparing publications from the research that is conducted on cruises. An excellent recent example of how this can work is the writing workshop sponsored by NANSCLIM (Nansen Climate research project). The workshop brought together scientists from Norway, other European countries, Namibia, and South Africa to meet in an isolated location for several days to write up research for a special volume of a peer-reviewed journal. It was important that participants were able to get away from their routine jobs to concentrate on discussing and writing. Participants, particularly from the region, felt this was a highly beneficial and empowering experience. Many research projects do not budget time and funding for project participants to meet to analyze data and write up research results.

- e. **Recommendation:** Future national research projects from outside the region should be more proactive about partnerships with scientists within the region and to contribute to the regional graduate network of oceanography.

Research projects should involve regional participants for data analysis and writing up of results after data collection. Samples collected on a research cruise should not be analyzed by only one party, but exchange visits to jointly analyze samples and data should be an integral part of the projects. Writing workshops, where project partners retreat to an isolated place and focus on data analysis and writing up of results for publication should be included in the project budget. The Science Partnerships for the Assessment of Complex Earth System Processes (SPACES) **and** **GENUS** (**G**eochemistry and **E**cology of the **N**amibian **U**pwelling **S**ystem) programs from Germany, EAF-Nansen (Ecosystem Approach to Fisheries) project (Norway) , International Centre for Education, Marine and Atmospheric Sciences over Africa (ICEMASA) project (France), and other projects should use and expand the NANSCLIM model.

- f. Finding:** Opportunities for CB&D could be enhanced when research vessels from outside the region visit the area. International research vessels use harbors in the region on a regular basis, especially Walvis Bay and Cape Town, for refueling and/or crew changes. On most occasions of ship visits, information on these visits does not reach the scientific community in the region early enough to take advantage of the visits. Valuable CB&D opportunities to local and regional scientists and students are therefore lost.

There are several good examples of the benefits to scientists in the region of CB&D related to visits of research vessels. A prime example is the [GENUS program](#), in which scholarships for MSc and Ph.D. programs are offered to students from southern Africa to study in German universities and participant in GENUS cruises. Eight individuals from Namibia have been selected for the study program.

- e. Recommendation:** SCOR and POGO should encourage their members to take opportunities to provide ship-board training and on-shore lectures when ships are in the region. Information obtained about ship visits should be made available through the [South African Network for Coastal and Oceanic Research](#) (SANCOR).

Efforts should be made to compile and spread information on the activities of international research vessels in the region. If these vessels have transit legs, the possibility of using these legs for ship-board training should be explored. During the stay of research vessels in the harbor towns, scientists from the vessels should be invited to local institutions to give guest lectures to staff members and students. SCOR and POGO should request the international ocean research community to offer their services when visiting a developing country port. A good example is the visit of the Japanese vessel *Yokosuka* to Cape Town in [April 2013](#).

Similarly, participation of international specialist scientists on local research cruises with follow-up analyses in the regional home research institutions should be encouraged and facilitated. Experience has shown that training on home vessels using local facilities is the most valuable, if continuity of skills and real in-house scientific competency (with eventual independence from foreign aid) is to be expected from the scientists in the region. Funding for these expert trainer visits as well as contributions towards ship-time for specific training cruises on the local vessels would greatly empower students and scientists to tackle research projects in their own regions, using the available facilities.

4. Funding for Regional CB&D

- b. Finding:** Increasing CB&D activities in the southern Africa region will require increased funding.

Investments by SCOR, POGO, and IOC in the southern Africa region have been very modest to date, but have provided a “proof of concept” for the approaches used by these organizations. Scaling up the activities, even in a minimal way, will require more funding.

- b. Recommendations:** International, regional, and local organizations should seek new funding from local, regional, and international agencies and foundations. National aid agencies should be approached. Joint projects between EU and African countries are one option.

It should now be possible for SCOR, POGO, IOC, and other organizations to create written descriptions of their successful CB&D approaches that will highlight their value as pilot projects to serve as examples for scaled-up activities.

5. The Role of Visiting Scientists

- b. Finding:** Sabbatical visits by scientists from within and outside the region are highly beneficial.

Both long-term and short-term visits have been useful in the region. POGO offers Visiting Professorship opportunities that are intended to be 3-6 month commitments, most likely taken during sabbaticals. Profs. David Checkley and Lisa Levin served as POGO Visiting Professors in Swakopmund and Cape Town. Their visit was very beneficial and encouraging to young scientists in the region. Checkley and Levin found the experience stimulating and beneficial and the visit resulted in new collaborations (see Appendix V and http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2011_08_26/career.a1100088).

SCOR’s Visiting Scholars program is intended for shorter term visits than the POGO program, with the goal of getting as many people into mentoring situations as funding will allow. At the same time, it is hoped that the visits will be long enough to establish mentoring and training relationships that will continue beyond the visits. Several SCOR Visiting Scholars have continuing work in the region. The best example so far has been Kurt Hanselmann, who made two visits to the SANUMARC facility at Henties Bay as a SCOR Visiting Scholar and has continued his relationship by collecting and arranging for shipment of used laboratory equipment and has developed plans for a 4-year program of research camps at Henties Bay with funding from the Agouron Institute (Appendix III).

- b. Recommendation:** SCOR and POGO should determine interest among institutes in the region (and within countries) to host sabbatical visits and provide a portal for access by potential visitors, and more proactive communication of this information. Return visits are considered to be especially beneficial as the visiting scientists are then familiar with the working conditions and needs of the African countries.

The need for mentors and trainers is so significant that there are opportunities for many different types of individuals who should be encouraged to visit the region. Academics who have sabbaticals should be encouraged to spend 3-6 month periods at institutions in the region to embark on research projects with young scientists and graduate students and act as mentors to them. At the same time, there are opportunities for young-to-retired faculty, technicians, and others to make shorter visits outside of typical sabbatical programs. The POGO Visiting Professorships and SCOR Visiting Scholarships can be well utilized for this purpose.

6. Components of a Regional Graduate Network for Oceanography

- b. Finding:** Internships are valuable opportunities for undergraduates to explore career options, gain practical work experience, make contacts, etc.
- c. Recommendation:** Institutions and agencies in the region should explore opportunities to expand internship programs.

Tertiary institutions in each country need to work to create more internships in agencies, institutions, and companies, including casual employment/volunteering over summer holidays. There is tremendous scope for temporary vacation employment and volunteers during school and university holidays. The Two Ocean Aquarium in Cape Town has volunteer “young biologist” school pupils who get trained and act as guides, but also become very keen conservationists and potential marine scientists. This is scope for more such schemes, taking into account the reality that many students cannot afford to donate their time.

- d. Finding:** Libraries in the region need more hard copies of books and reports from international organizations.

Because of the limitations imposed by the expense of electronic communications and access to ocean science information through the Internet, there is still a need for hard copy publications in the region.

- d. Recommendations:** Distribute publications from international and regional organizations to libraries in the region. Libraries in the region should join IAMSLIC and work through ODINAFRICA.

SCOR, POGO, and IOC should compile a list of marine libraries in the region to which their printed publications could be distributed.

- e. **Finding:** Electronic communications (bandwidth program) and reception of satellite data can be difficult in the region, both costly and inefficient.
- e. **Recommendation:** [GEONETCAST](#) satellite communication systems should be expanded in the region; institutions in the region should push for greater access.
- f. **Finding:** Short courses/summer schools/refresher courses/continuing education/research camps can provide experience complementary to graduate programs.

The Ma-Re Institute at UCT runs an Applied Marine Science Masters course that is divided into 3-week modules that can be taken individually by young scientists to improve specifically needed skills (see Appendix IV). These courses have been most used by government employees from South Africa so far, but they could be extended to government and university employees from throughout the region. The [Applied Center for Climate & Earth Systems Science](#) (ACCESS) runs “[Habitable Planet](#)” workshops in different parts of the region to foster the interest of young people in global change and Earth system science.

Kurt Hanselmann is working with University of Namibia staff to plan a four-year program of research camps at SANUMARC, funded by the Agouron Institute (see Appendix III).

IODE OceanTeacher courses are underutilized in this region.

- f. **Recommendation:** Short courses/summer schools/refresher courses/continuing education/research camps should be made integral components of the regional graduate network for oceanography. National IODE focal points should be encouraged to disseminate information about the availability of courses. IODE should send information to SANCOR for posting on their Web site.

Institutions in the region should make efforts to use the online resources available through OceanTeacher, send individuals to the OceanTeacher courses in Belgium, and request through their national IOC committees that OceanTeacher courses be taught in the region.

- g. **Finding:** CB&D activities would be more effective if more ship time were available for training. The research vessels belong to the national agencies and are maintained and run from their national budgets. Budgetary constraints involved in running the vessels for non-line function work by the Ministry of Fisheries and Marine Resources in Namibia has been a reason for unavailability of the vessels for some proposed research cruises that would potentially involve capacity building. Ship time requests cannot be made at the last minute because of various safety and health requirements that require some time to complete.

The region has several very good research vessels that offer the possibility for training of students and young scientists, but training opportunities on these vessels are currently underutilized. In part, this situation has resulted because requests for ship time for training purposes are not submitted with enough advance notice and/or do not follow official procedures

and can therefore not be accommodated. Safety and health requirements for participants have to be followed and require time and money to be obtained. A new MOU between NatMIRC and SANUMARC may help improve the situation in Namibia.

- f. Recommendation:** The necessary ship time should be defined well in advance of the time needed and communicated to the ship managers. Institutions requesting ship time on a regular basis should appoint a designated person to handle the logistics of ship time requests and required certifications/exemptions.

Training institutions should request vessel time well in advance through official channels so that these can be incorporated into the annual ship's schedule. Training institutions must be informed of health and safety requirements and make sure these are addressed in time so that the necessary exemptions can be obtained from the relevant authorities. Regular planning meetings between training institutions and ship-time managers could help make better use of shipboard training opportunities. Such meetings should define when the ship time is available, when the training time is needed, how the training would fit into the academic program(s) of the training institution, how the training could contribute to the goals of the ship operator, etc.

Conclusions

Participants in the meeting at Henties Bay, Namibia were enthusiastic about the opportunities for developing a regional graduate network of oceanography in southern Africa. A variety of challenges exist to establishing such a network, but the potential benefits are substantial. Participants hope that this document will provide some ideas for a regional network and that accumulating experience with these ideas will be used to update this document in the future.

Appendix I - Participants

Gisela Cramer, Mayor, Henties Bay
Bronwen Currie (MFMR, Namibia)
Claudia Delgado (Training Coordinator, UNESCO/IOC Project Office for IODE)
Simon Elwen (South Africa)
John Field (South Africa and POGO)
Tess Gridley (Namibia)
Kurt Hanselmann (Switzerland)
Venu Ittekkot (Chair, SCOR CB Committee, Germany)
Ekkehard Klingelhoefter (BCC, Namibia)
Anja Kreiner (MFMR, Namibia)
Cleophas Mutjavikua, the Regional Governor of Erongo Region
Mika Odido (IOC Africa region)
Edosa Omoregie (SANUMARC, Namibia)
Diina Shuuluka (SANUMARC, Namibia)
Ed Urban (SCOR)

Appendix II -Agenda

Capacity Building Regional Meeting for Southern Africa

5-6 November 2012
Henties Bay, NAMIBIA

Hosted by the University of Namibia

List of Participants

International: Claudia Delgado (Training Coordinator, UNESCO/IOC Project Office for IODE), Kurt Hanselmann (Switzerland), Venu Ittekkot (Chair, SCOR CB Committee, Germany), Mika Odido (IOC Africa region), Ed Urban (SCOR)

Regional: Bronwen Currie (Namibia), Simon Elwen (South Africa), John Field (South Africa and POGO), Tess Gridley (Namibia), Ekkehard Klingelhoefter (Namibia), Gisela Cramer (Namibia), Anja Kreiner (Namibia), Edosa Omoregie (Namibia), Diina Shuuluka (Namibia),

Agenda

November 5 (Monday)

8:45 a.m. Arrival of Participants

9:00 a.m. Welcome ceremonies

Namibian and AU Anthems
Welcome to meeting – *Edosa Omoregie*

Welcoming Remark by Honourable *Cleophas Mutjavikua*, the Regional Governor of Erongo Region

Remark by Her Worship, Hon. Cllr. *Gisela Cramer*, the Mayor Henties Bay

Remark by Prof. *Lazarus Hangula*, the Vice Chancellor, University of Namibia

Welcome from SCOR – *Ed Urban*
Orientation to Henties Bay Center - *Edosa Omoregie*

9:30 a.m. Goals for meeting – *Venu Ittekkot* and *Ed Urban*
Development of a Regional Graduate Network for Oceanography:
The Concept

- 10:00 a.m. A brief review of SCOR, POGO, and IOC/IODE activities and possible implementation of specific joint actions among international organizations in the region – *Ed Urban, John Field, and Claudia Delgado* (Appendixes IV and VII)
- 11:00 p.m. Potential contributions of Namibia to a southern African RGNO – *Edosa Omoregie* and *Kurt Hanselmann* (Appendix III)
- 11:30 a.m. Break
- 12:00 p.m. Report on SCOR Visiting Scholar Activities in Namibia and Future plans – *Kurt Hanselmann*
- 12:30 p.m. Lunch
- 2:00 p.m. Report on work of SCOR Visiting Scholar René Swift – *Simon Elwen* and *Tess Gridley*
- 2:30 p.m. Report on POGO Visiting Professors' (Lisa Levin and David Checkley) Activities in Namibia and South Africa – *John Field, Bronwen Currie, and Anja Kreiner* (Appendix V)
- 3:00 p.m. IOC Africa Activities – *Mika Odido* (Appendix VI)
- 4:00 p.m. Break
- 4:30 p.m. Current national efforts, capabilities, and needs for ocean science education in Namibia – *Edosa Omoregie*
- 5:00 p.m. Current national efforts, capabilities, and needs for ocean science education in South Africa – *John Field* (Appendix IV)
- 6:00 p.m. Adjourn for the day
- 7:00 p.m. Group Dinner

November 6 (Tuesday)

- 9:00 a.m. Capacity-building activities and interests of the Benguela Current Commission – *Ekkehard Klingelhoefter* (Appendix VIII)
- 10:00 a.m. Capacity-building activities and interests of new German research projects – *Venu Ittekkot*
- 10:15 a.m. Continued discussion of a regional graduate network of oceanography
Review and discuss Design Principles for a Regional Graduate Network of Oceanography (RGNO)
What are planned activities of international organizations in southern Africa that could contribute to a regional network?
What national/regional assets could be brought together into a regional network?
What are the challenges?
Develop recommendations to institutions and international organizations
- 11:00 a.m. Break
- 12:00 p.m. Continued discussion of a regional graduate network of oceanography
- 1:00 p.m. Lunch
- 2:00 p.m. Experience and perspectives of UNAM students
- 3:00 p.m. Develop Writing Assignments and Begin Drafting Report
- 4:00 p.m. Break
- 4:30 p.m. Continued discussion of a regional graduate network of oceanography
- 6:00 p.m. Adjourn Meeting

Appendix III – Research Camps at SANUMARC (summary from presentation by Kurt Hanselmann)

Students from the University of Namibia (UNAM) have the opportunity to gain laboratory and field experience in marine research at SANUMARC. They are willing to learn, but hampered by the lack of equipment. It is unfortunate that active participation in research is limited for groups of students by the numbers and kind of equipment. Thanks to the generosity of individual scientists, inexpensive shipping on German research vessels, and significant work by Kurt Hanselmann, a large amount of used research equipment, from glassware to an analytical balance, the laboratories at SANUMARC are becoming equipped for basic research. The students need more practical experience in the lab and field, more exposure to published science, more opportunities to ask research questions, and more help in integrating all their basic knowledge from years 1 and 2 of their university courses. The learning process should involve investigating, analysing, presenting, and reporting, skills that every scientist needs to master, whether working in a university, the government, industry, or the non-profit sector. Marine science students in Namibia do not need more lectures. Research training can best be done by

- inspiring people to identify new research areas and ask imaginative questions,
- introducing classical and state-of-the-art methodologies to answer them,
- opening access to tools and research facilities,
- networking in research collaborations, and
- producing research results in cooperation.

The BSc program at UNAM needs to become more intellectually demanding and lead to motivated and well-educated students, from which the best students can be selected for advanced graduate research studies.

The laboratories at SANUMARC now have the capabilities for basic chemical and biological research, as well as mariculture experiments. Living quarters are available for visiting researchers, instructors, and students.

Hanselmann's experience in mentoring and teaching at UNAM has resulted in some lessons that could guide future CB&D there. Research-guided CB&D is needed and must focus on two aspects simultaneously: (1) the training of qualified individuals and (2) technical support. Neither instrumentation without skilled personnel to use it, nor trained people without the equipment necessary to make use of their skills, nor good research questions, will ever make CB&D worthwhile. There should be more emphasis on sharing and maintaining research equipment in southern Africa. CB&D in Namibia should take advantage of the uniqueness of Namibia's coastal and upwelling systems and the access to these systems through facilities at Henties Bay, Swakomund, and elsewhere. (The uniqueness of the systems could also draw visiting scientists to work in Namibia and contribute to CB&D.)

The most unique aspects of this location in the South Atlantic are the interactions between the arid lands that border directly at the ocean and the south-north flowing Benguela Current. The latter keeps the Benguela upwelling system one of the most productive regions in the world's oceans.

One would expect that having such unique research sites at the doorstep and attracting scientists from the world's leading research institutions to investigate them would also have led to the development of a strong marine research capacity in Namibia. Unfortunately, little of this expectation has materialized and there are a number of reasons why this has not happened yet: (1) UNAM is only 20 years old and research priorities are still being defined. (2) The research infrastructure for interdisciplinary oceanography at the university is minimal; actual research work by PhD candidates is done at institutions outside the university and even outside the country. (3) Research carried out by foreign investigators in the country has not been used sufficiently to develop national competencies. South Africa is doing this much more effectively through collaborative research programs. (4) A discovery and innovation-driven research culture and the recognition of research as an economic driving force are only slowly developing at the university. (5) Not many of those who are trained researchers are involved in doing oceanographic research, enliven it with conviction or teach it with the patience that transmits excitement to the students. RGNO courses could contribute to both, creating more excitement for scientific research and showing how it can be done.

SANUMARC could make an important contribution to a Regional Graduate Network of Oceanography (RGNO). An RGNO should

- have an international outlook,
- be research-driven,
- integrate and combine scientific fields,
- invite different departments/faculties to contribute to interdisciplinary research,
- be in the interest of the researchers from the host institution and also of the guests,
- lead to research collaboration between regional laboratories and institutions in other countries,
- create research networks between local students and those from abroad,
- inspire partnership with other regional and international CB&D efforts,
- put responsibilities into regional hands,
- involve researchers as instructors who are doing part of their research in the region,
- select participants competitively, and
- choose instructors who are inspiring, whose work links to Namibian research themes, and who have a record of excellency in teaching, and can commit enough time.

An RGNO should not be a scholarship program, an exchange program for lecturers, an independent research project, a research funding vehicle, a short course summer school or a curricular course at a single university. All these needs are fulfilled by other organizations already.

An RGNO can offer training to do independent research, extend skills by comparing with those of others, facilitate access to the appropriate research technologies and create collaborations in research teams. An RGNO site at SANUMARC could help develop it into a major center for ocean research, and a highly recognized place for training, the creation and exchange of ideas, and the start of collaborations.

Resources available for CB&D in Namibia and potentially contributing to an RGNO include

- NatMIRC (Ministry of Fisheries and Marine Resources), through its research arm (research and data compilation mandate, qualified personnel, specific infrastructure, experience, vessels capable of accessing different sites, long-term datasets, historical knowledge, potential sponsoring)
- Namibian Standards Institute (NSI) (specialized laboratories, well trained personnel),
- Namibian Geological Survey (core repository, rock analysis laboratory, permits)
- Benguela Current Commission (links to and between ongoing research and monitoring),
- Mining and fishing industries (specialized analysis equipment, sponsoring)

National and international organizations could also become important contributors to an RGNO, including

- University of Cape Town (Nansen-Tutu Center); University of Bergen, University of Bremen (MARUM, ZMT, MPI), University of Kiel (Geomar), University of Tokyo, CNRS, Station Biologique Roscoff (F) Roscoff (F)
- POGO, SCOR, IODE of IOC/UNESCO
- SAERI (South Atlantic Environmental Research Institute, Falkland Islands)
- EU framework research program
- SPACES (research advisors, shiptime for students and investigators from the region, scholarships for MSc and PhD studies abroad and in the home country)
- IODP (International Ocean Discovery Program 2013 – 2023)
- ISATEC (International Studies in Aquatic Tropical Ecology)
- IAEA (International Atomic Energy Agency),
- IMBER (Integrated Marine Biogeochemistry and Ecosystem Research project),
- SOLAS (Surface Ocean-Lower Atmosphere Study)
- ECORD (European Consortium for Ocean Research Drilling)

Suggestions for oceanographic topics to be covered by the RGNO:

- Research applied to fisheries economics and stock sustainability: NatMIRC and Lüderitz Research Institute
 - topics relating to the food web that leads to harvestable yields of fish for human consumption
 - toxic algal blooms
 - Biogeochemical oceanography and microbial diversity in oxic–anoxic transition zones off the coast of Namibia.

- Isolation and characterization of microalgae and prokaryotes from coastal waters and sediments.

This research should be collaborative between UNAM and NatMIRC because

1. Collaborative projects with NatMIRC must have highest priority, because that is where UNAM graduates find research opportunities and jobs later.
 2. We need to train Namibians on their marine systems so that their research is useful and can be justified to the ministries.
 3. RGNO projects can best make use of the international interest, if RGNO-based research is interesting to the international researchers.
 4. What's interesting for international research groups should also be interesting enough for the researchers from the region to work on.
 5. Projects close to or even overlapping with foreign ones are not a disadvantage; they stimulate innovation.
 6. GENUS and SPACES are glad to have researchers at the sites at all times and are willing to support them. If we want to make use of these offers, we have to train UNAM students to become competitive.
 7. Good Master's degree students have a better chance of receiving scholarships for studies abroad, if they can link the training, which they receive there, to a needed skill at home.
 8. RGNO projects should have a good chance to compete for funding in international programs.
 9. RGNO students should reduce their expectations of foreign aid and compete proactively with their own innovative research ideas.
 10. There remains enough to be done in the world's most active ocean upwelling system.
- Topics of interest to numerous foreign research missions
 - Geochemical cycling of nutrients in upwelling zones
 - Food chains: nutrient and energy flows
 - Biogeochemical oceanography and microbial diversity in oxic–anoxic transition zones off the coast of Namibia.
 - Isolation and characterization of microalgae and prokaryotes from coastal waters and sediments.
 - Benthos off Namibia
 - Earth systems processes: Role of oceans in regulating C-cycling
 - Topics of interest to FAS/SANUMARC
 - Biogeochemical oceanography and microbial diversity in oxic–anoxic transition zones off the coast of Namibia.
 - Isolation and characterization of microalgae and prokaryotes from coastal waters and sediments.
 - Coupling of C cycling to the availability of N and trace nutrients.
 - Consequences of high-rate S-cycling and the formation of CH₄: microbial loops

- Consequences for changes in ocean currents on regional upwelling ecosystems

Some recommendations recently made to UNAM by the Europe-Africa Quality Connect Team can relate to an RGNO

([http://www.unam.na/centres/quality/documents/Quality Assurance External Audit Report.pdf](http://www.unam.na/centres/quality/documents/Quality_Assurance_External_Audit_Report.pdf)):

- Institutional links should be built among African universities of different countries.
- Three out of five strategic priority areas for the University can be applied to an RGNO: (1) developments in learning and teaching; (2) research, and (3) knowledge transfer.

A research camp at SANUMARC aims at being accepted to the international league of summer research camps by drawing from experiences gained in similar initiatives, such as

- the University of Southern California **Geobiology Camp**
<http://dornsife.usc.edu/wrigley/geobiology/> on Catalina Island, California, USA;
- the University of Hawaii training cruises on **Marine Microbial Ecology**
<http://cmore.soest.hawaii.edu/agouron/>,
- the Bermuda Institute of Ocean Sciences training on the **Biogeochemistry, Ecology and Genomics of Oceanic Microbial Ecosystems**
http://www.bios.edu/education/summer_courses/
- the Marine Biological Laboratory, Woods Hole, summer schools on **Microbial Diversity**
http://www.mbl.edu/education/courses/summer/course_micro_div.html,
- the ECODIM RGNO on the **Ecology and Diversity of marine Microorganisms**
<http://www.microeco.uzh.ch/chile/chile.html>) at the Universidad de Concepción (UdeC),
- the Hopkins Microbiology Course of Stanford University on **Integrating Concepts in microbial Physiology, Ecology, and Evolution**
<http://www.stanford.edu/class/cee274s/index.html>

A grant from the Agouron Institute will allow us to establish a research camp at SANUMARC that can become a contribution to an RGNO. The proposal asked for international research capacity building at the graduate/postgraduate level to start an RGNO in Namibia. The activity supported by the grant must have a significant impact on the student's education, training, and career; develop research capabilities; and involve the completion of small research projects during the research camp time. The grant is time limited. The Agouron Institute's goal is that we offer excellent research and training opportunities; we are able to select the best students, those who have a chance to succeed in research; and that each research and training activity produces discoveries that are reported as a poster or an oral paper at a scientific meeting. The conditions are the following:

- Is there a need for advanced research training in oceanography in this region of the world?
- Can these research and training activities be made effective?
- What research and the training activities will have an impact on the students?
- Are the students prepared well enough?

- Is appropriate technology being used?
- Who are the beneficiaries of the CB&D?
- Can the research be adapted to contexts in the Benguela Current system?
- What kind of research partnerships are envisioned?
- How is the impact of knowledge transfer and knowledge sharing being evaluated?
- What is the commitment on the part of the hosting institutions?
- Is there a possibility to link the research and training activities with other SANUMARC, UNAM, Polytechnic, NatMIRC, and/or SPACES activities?
- Is the organizing/hosting institution in a position to offer proper facilities and research instrumentation?

The benefits of a research camp at SANUMARC must include the following:

- making scientific discoveries with motivated students from different backgrounds;
- investigating different geobiochemically active oceanic systems;
- benefiting from the strength of various research institutions by sharing skills, instructors, instrumentation and infrastructure;
- obtaining good results for well-prepared projects with an interdisciplinary group;
- following up certain analyses “at home” and contributing them to the course product;
- establishing networks and exchanges that last beyond the duration of an RGNO;
- accessing unusual natural sites and environmental conditions; and
- producing scientific posters and papers.

Evaluation criteria for the research camp could include the following:

1. Satisfaction: Did the participants learn what they expected to learn?
2. Motivation: Does the research camp stimulate to continue and to collaborate?
3. Recognition: Are the research camp achievements accepted for credits by universities?
4. Usefulness: Does the research camp fulfill a need?
5. Relevance: Are the contents scientifically, socially or economically important?
6. Creativity: Does the research camp initiate innovation and discovery?
7. Originality: Are the topics unique for the field?
8. Inspiration: Does the research camp strengthen understanding and knowledge?
9. Scholarliness: Does the research camp address state-of-the-art topics?
10. Quality: Are the contents taught didactically clear and logic?
11. Integration: Does the research camp link disciplines which are not normally combined?
12. Continuity: Is the research camp recommended further by alumni?

Appendix IV- University of Cape Town and ACCESS (Summary of Presentation by John Field)

Marine Research (Ma-Re) Institute, University of Cape Town

What is Ma-Re? It is a University of Cape Town (UCT) Signature Theme. Ma-RE consists of its members and Research Associates. It is an umbrella institute promoting all marine research at UCT and stimulating inter-departmental and inter-faculty activities, particularly between the Oceanography and Biological Science departments. Ma-RE provides a window into UCT's marine activities from the outside world. The Ma-RE Web page and outreach activities are handled by Pavs Pillay. Ma-RE has links to UCT's affiliated institutions and promotes academic exchanges of staff and students and links with sister institutes and universities.

Ma-RE's theme is global change research related to the sea and to marine activities. It is part of the UCT vision to be a leader in Africa on these topics. It provides a springboard for ACCESS and establishing Earth System Science at UCT. Ma-Re is part of Vice-Chancellor's Climate Change and Climate Variability initiative.

Ma-RE co-ordinates the UCT Applied Marine Studies Masters Course, which is a degree that include coursework and a dissertation. Coleen Moloney heads the program. Compulsory modules include statistics, marine law, Earth system science, project management, and ocean tools. There are a large number of elective modules for classroom and laboratory time. Any module can be done independently as in-service training for a 3-week period, making the program well-suited for individuals working full time. Between 2002 and 2011, there have been 76 graduates, 7 of which earned degrees with distinction. 53% of the graduates have been from South Africa, 32% from other countries in Africa, and the remaining graduates are from Europe, North America, and Asia.

UCT is developing a marine curriculum, including a BSc major in Marine Biology and Oceanography (Chair: John Bolton), with the possibility of establishing Hons B.Sc. and Masters degrees. Ma-RE provides post-graduate bursaries. It arranges and coordinates research contracts. It hosts Monday seminars (with SANCOR). In the future, Ma-RE will continue to develop new marine research initiatives at UCT.

UCT Department of Physical Oceanography

The department offers an undergraduate major in Ocean & Atmosphere Science, which includes an honours year. It also offers a taught Masters in Ocean & Climate Dynamics together with contributions to Applied Marine Science and Climate Change & Sustainable Development. The research foci of faculty in the department include the Southern Ocean, Benguela system, Agulhas system, and southern African climate. The department currently includes 5 full-time faculty, 3 support staff, researchers from France (IRD), the Nansen Tutu Centre, CSIR, MRSU, one Chief Research Officer, four post-doctoral fellows, 24 PhD students, 15 MSc students, and 10 Honours BSc students.

Africa Centre For Climate And Earth System Science (ACCESS)

The Acting Director and Manager of ACCESS is Dr. Neville Sweijd. The goals of ACCESS include

- Research—development of tools to predict changing climatic conditions on time scales from seasons to decades. ACCESS research includes coastal oceanography (observations and modeling) and ocean-atmosphere-land interactions, concentrating on understanding seasonal cycles. Research also includes long-term climate changes, regional climate changes, the fate of anthropogenic carbon, and past climate changes.
- Knowledge Transfer—involves the use of research results to establish and continually improve an operational capability, the routine prediction of the changing conditions in the oceans and on land.
- Career Development—includes efforts to make the public at large, students in high schools, and undergraduates at universities aware of exciting developments and opportunities in the Earth system sciences through “Habitable Planet” workshops.

South African marine science needs including the following:

- Limited supervisor numbers
- Limited range of expertise
- Need funds to hire post-doctoral fellows to help both research and teaching capacity
- Need to interact in research and training
- Exchange modules of courses with other institutes (co-badged degrees?)
- Re-establish joint research programs in the region (similar to BCLME)

Appendix V –POGO Visiting Professor in Namibia and South Africa (Lisa Levin & David Checkley, January-June 2011)

Profs. Lisa Levin and David Checkley of the Scripps Institution of Oceanography were appointed as POGO Visiting Professors and provided various forms of CB&D during their 6 months in Namibia and South Africa:

- Assistance to National Marine Information Research Centre (NatMIRC) [Swakopmund] in terms of Scientist/Staff Mentoring (sardine dynamics and climate, ship design, benthic ecosystem assessment, rocky shore biodiversity monitoring, and land-sea energy exchange)
- Lecture Series (9 talks): oxygen and pH dynamics, anchovy and sardine dynamics, upwelling ecosystem comparisons, stable isotopes, and larval connectivity. At the University of Namibia (UNAM) in Windhoek, they worked with Biology & Fisheries Students on the topics of benthic and plankton ecology, bioinvasions, climate change, and fisheries. They also conducted field exercises at SANUMARC. At the University of Cape Town, they taught a short course on Topics in Benthic and Pelagic Ecology and gave guest lectures in the Oceanography Dept.
- Student Mentoring: UNAM students; NatMIRC Staff
- Field Work: Namibian OMZ & mud belt, Skeleton Coast
- Guest public lectures—At Swakopmund Museum for World Ocean Day, secondary school lectures. interactions with business community (aquaculture, recreational fishermen, phosphate industry representatives, consultants and NGOs), Community hearings on offshore and coastal development
- Participation in cruises and field trips
- Contact information shared with regional scientists on initiatives regarding benthic and deep-sea ecology
- Guidance and provision of scientific literature to local scientists
- Interactive participation and input to meetings discussing controversial and potentially damaging exploitation of benthic and deep-sea resources in the region

Visiting Scientist Challenges (observations from Lisa and Dave)

- Communications and Internet access—slow, expensive, unreliable
- Logistical: Equipment limited, expensive
- Ship time: Money and personnel limited, unreliable
- Visas: Difficult to impossible to negotiate from within Namibia: this resulted in cancelling visits to scientific institutions in Angola
- Economic difficulties translate to high theft rate

Challenges for Namibian Science Development

- Lack of federal funding sources for research (No NSF funding equivalent)
- Limited research training of existing faculty
- Few appropriate researcher role models

- Government staff not given incentive or dedicated time to do research – either lead or train

Benefits to Visiting Professors

- Appreciation for global science and conservation challenges
- Appreciation of the challenges facing (Namibia) developing countries
- Ability to make a difference

Appendix VI - IOC Activities in Africa (Mika Odido, IOC Sub-Commission for Africa & the Adjacent Island State)

IOC welcomed 6 African Member States (Congo, Cote d'Ivoire, Ghana, Mauritania, Morocco & Tunisia) within its first year of existence. IOCWIO was established in 1979 and had 10 Member States. IOCEA was established in 1984 and had more than 17 Member States. These two Regional Committees were dissolved in 2012 to establish the IOC Sub-Commission for Africa and the Adjacent Island States. The purpose of the Sub-Commission is the Promotion of regional and international cooperation, and the development and coordination of the IOC's

- marine scientific and research programmes
- ocean services
- ocean observing systems
- capacity development and related activities

taking account of the specific interests and priorities of African Member States.

IOC's four High-Level Objectives for 2008-2013 are the following:

1. Prevention and reduction of the impacts of *Natural Marine Hazards* such as tsunamis. IOC (with ISDR and UNDP) is assisting Western Indian Ocean Member States (Mozambique, Tanzania, Comoros, Kenya, South Africa and Mauritius) in strengthening national warning systems for coastal inundation by providing instrumentation (seismic and sea-level stations), providing capacity building for emergency personnel, and assisting with production of educational material.
2. Mitigation of the impacts of and adaptation to *Climate change and variability*. Through its Integrated Coastal Area Management programme, IOC developed a regional approach to assist Member States to cope with climate change impacts in coastal areas and specifically related effects such as coastal erosion, which is a major issue in western Africa. This effort was implemented through a regional project called ACCC (Adaptation to Climate and Coastal Change in West Africa) that is funded by the Global Environment Facility (GEF) at a level of US\$4 Million, and regionally coordinated by IOC. This project is a component of the NEPAD Plan on Environment and is focusing on coastal sites located in Mauritania, Senegal, Gambia, Guinea Bissau, and Cape Verde. This West African coastal zone is a highly productive ecosystem of significant marine biological diversity and hosts a number of protected areas containing globally significant biodiversity, such as the Banc d'Arguin, Djoudj, Diawling, Saloum, and The Bijagos Archipelago. It also underpins a significant portion of livelihood opportunities for coastal communities. ACCC project priorities are
 - Identification of pilot protection and adaptation actions in hot spots
 - Mainstreaming adaptation strategy (national level)
 - Formulation of national and regional strategies of coastal adaptation

ACCC pilot activities include

- Stabilizing coastal erosion through rehabilitating indigenous vegetative cover;
- Implementing soil conservation measures to reduce runoff;
- Planting of local species for the stabilization of sand dunes;
- Developing alternative livelihoods;
- Ecotourism and forest management;
- Mangrove reforestation; and
- Disseminating new technologies to release the pressure of degradation of ecologically important mangrove resources.

IOC co-sponsored the 32nd Climate Outlook Forum (COF) for the Greater Horn of Africa (in collaboration with ICPAC and WIOMSA), on 29–31 August 2012, in Zanzibar, Tanzania. The theme of the forum was “Enhancing the use of information from the Indian Ocean systems for improved climate prediction and early warning of climate extremes over the Greater Horn of Africa”. Contributions to COF33 and COF34 in 2013 will be made in the framework of UNESCO Intersectoral project. GOOS-Africa will be re-launched in January 2013.

3. Safeguarding the *Health of ocean ecosystems*. IOC is supporting the African Register of Marine Species. The African Marine Atlas, developed by institutions from Africa with support from IOC, ASCLME and UNEP is a continental-scale online resource of public-domain geospatial data for the support of coastal and marine research and management in Africa. The Atlas contains more than 800 downloadable spatial data products in the fields of marine geosphere, hydrosphere, atmosphere, biosphere, and the human environment. The institutions in the region are now working on national coastal and marine atlases, which will be more detailed and thus useful for coastal management.
4. Promoting management procedures and policies leading to the *Sustainability of coastal and ocean resources*. IOC is helping develop decision support tools, such for Sea Level Rise & Flooding (Malindi, Kenya), Fisheries habitats (Shimoni, Kenya), Water Quality (Bon Sinais, Mozambique), Dredging & Sediments (Beira, Mozambique), Fisheries Habitats (Seychelles), Shoreline Change (Zanzibar, Tanzania), and Hydrodynamics (Zanzibar Channel, Tanzania).

IOC helps strengthen institutions by

- Sea level training (introduction to tidal theory; analysis of tide gauge data; introduction to harmonic analysis; introduction to tidal analysis software package; use of data within local and regional ‘operational oceanography’; tide predictions.
- Access to Literature & Other Information: Library catalogues and links to global networks [IAMS LIC], literature repository [www.oceandocs.net], access and contribution to bibliographic databases; projects database, and experts and institutions databases
- Access to Data, and Skills for Analysis and Interpretation: Repatriation of data from international centres, development of national data collections, development of marine species databases, sea level data facility [<http://www.ioc-sealevelmonitoring.org>], tidal predictions

- Enhancing oceanography capacities on Western Africa countries (2013-2014): Data mining, recovery and rescue; data analyzed and converted into compatible forms and meaningful data products at regional scale; publication of available West Africa (CECAF) research cruises and data sets; publication of Report on Oceanographic features and trends in the Canary Current LME/CECAF region.

Elements of IOC's Draft Strategy: 2014-2021

1. Maintain, strengthen and integrate a *Global Ocean Observing System* for monitoring, assessment and forecasting of the state of the ocean
2. Ensure national strategies for *Adapting to Climate Change* include coastal and ocean components
3. Strengthen capabilities of vulnerable coastal States to prepare for and respond to *Natural Coastal Hazards*
4. Strengthen *ocean knowledge and foster regional cooperation* in marine science with scientific institutions and governments
5. Enhance the global ocean governance framework through *shared knowledge base and capacity development*

Modalities for implementation of this strategy in the region include the following:

1. Knowledge Generation - Research & Monitoring
2. Capacity Development
3. Partnerships
4. Communication/Advocacy
5. Resource Mobilization

IOC's CB&D Strategy will begin with a comprehensive review of available capacity (including chapter on expertise in diaspora). It will focus on training of young generation of scientists and will strengthen institutions to engage in observations, monitoring and applications. It will also strengthen UNESCO Chairs (and establishment of centres of excellence). IOC's Rio+20 commitment: IOC will carry out a Baseline Study for an Assessment of National Capacities and Needs in Marine Research, Observation and Data/Information Management.

Appendix VII - IODE and Capacity Development (summary of presentation from Claudia Delgado)

Capacity development has been a cornerstone of the IODE since the programme's start in 1961. The objective is to assist Member States to acquire the necessary capacity to manage marine data and information and become partners in the IODE network. Capacity development activities teach the principles of data and information management and also promote the use of "standards" among all IODE centres and thus achieve interoperability amongst centres. From 1961 to 1997, the IODE capacity building programme was based upon four types of activities:

1. expert missions to Member States to advise on the establishment of national oceanographic data centres (NODCs). The number of NODCs has increased from two in 1961 to 80 in 2011. The IODE network also includes marine libraries and national coordinators for data management and information management.
2. Organization of group training courses: There are no formal academic degrees or even curricula in oceanographic data management and library management, so data managers start as either (ocean) researchers or IT specialists. Data and information managers still need to acquire the knowledge, expertise, and experience on the job. IODE thus provides training, in the form of visiting experts and internships. From 1980 onward, IODE provided technical training courses and set up Ocean Data and Information Network (ODINs). Participating countries identify national priorities and develop work plans that aim to address them. They add value in terms of sharing of expertise, data, and information within a region. An ODIN is based upon four elements:
 1. providing equipment
 2. providing training
 3. providing seed funding for operational activities for newly created data centres and marine libraries
 4. work in a regional context, addressing common as well as national goals

The following ODIN regional networks have been developed:

- ODINAFRICA: 25 African countries
- ODINCARSA: Latin America and Caribbean
- ODINCINDIO: Central Indian Ocean
- ODINWESTPAC: Western Pacific region
- ODINBlackSea: Black Sea region
- ODINECET: European Countries in Economic Transition
- ODIN-PIMRIS: Small Island Pacific States

OceanTeacher

In the late 1990s this concept was expanded and the IODE Resource Kit was developed, as a comprehensive self-training and resource tool, to assist managers and staff members to acquire the skills to set up and run new IODE centers. Later it evolved into Ocean Teacher – a Web-based educational tool based upon an encyclopedic resource module and training curricula.

Further development has been done under the name of “Ocean Teacher Academy”, which will each year survey training requirements globally and organize courses based upon the surveyed priorities. OceanTeacher is a training resource/tool to support IODE capacity development activities. It provides training tools for oceanographic data and information management. It provides a comprehensive resource tool for newly established NODCs and underpins the education and training requirements of the ODINs. The audience for OceanTeacher includes

- Data and information managers
- NODC staff (newly established and established centres)
- Marine library staff (newly established and established libraries)
- University students and researchers who need training in data and information management
- Staff of facilities working in related disciplines who need familiarization with oceanographic data management techniques

The Ocean Teacher Academy has the following objectives:

- Building high-quality and up-to-date expertise in oceanographic data and information management and exchange in new national oceanographic data centres (NODCs) and related facilities;
- Keeping staff in existing national oceanographic data centres (NODCs), marine information centres and related facilities up to date with the latest methodological and technical developments (continuous professional development);
- Creating awareness for the importance of oceanographic data management and marine information management with university students (marine environmental studies) to ensure that they will contribute quality data to data centres during their future career;
- Creating awareness for the importance of oceanographic data management with experts in oceanography and related disciplines.

Ocean Teacher components include

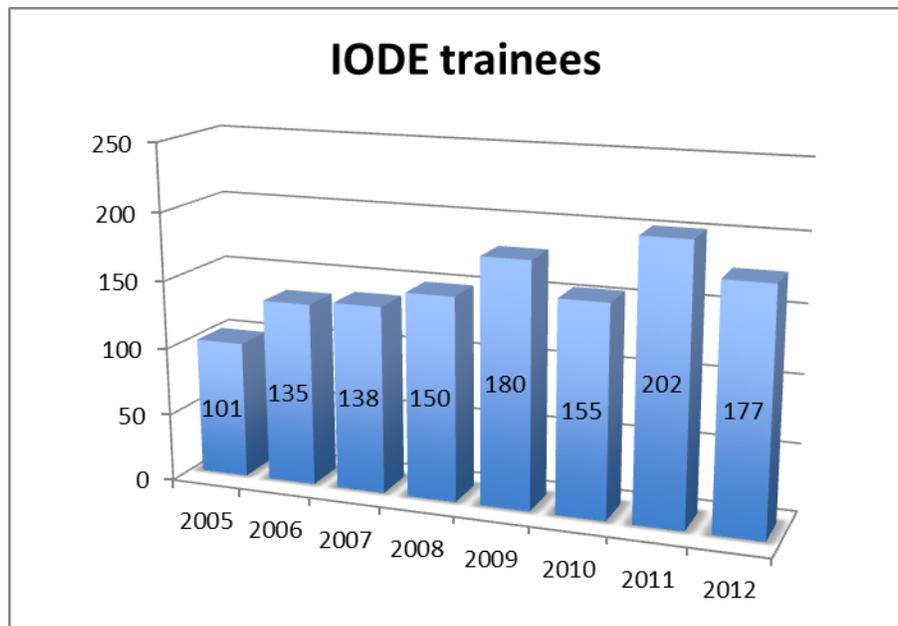
- OceanTeacher is a comprehensive Web-based training system that supports Classroom training (face-to-face), Blended training (combining classroom and distance learning), online tutoring and online self-learning.
- OceanTeacher has been developed as a training system for ocean data managers (working in ocean data centres), marine information managers (marine librarians) as well as for marine researchers who wish to acquire knowledge on data and/or information management. In addition, OceanTeacher is being used for training in other related disciplines.
- When the Digital Library and OpenCourseWare are used together for a training event this is called an **OceanTeacher Classroom**. The collection of all training instances constitutes the **OceanTeacher Academy**.
- **OceanTeacher Classroom** features courses on oceanographic data and information management. It is based upon Moodle software and contains a collection of outlines, notes and links to miscellaneous documents in the Digital Library. Registration enables

assistance by lecturers as well as communication with other students before, during and after the course.

- **OceanTeacher Digital Library** contains data and information management materials, including software (open source), quality control and analysis strategies, and reference documents.

OceanTeacher content is freely and openly available and access does not require registration. Access to contents is available during and after a participant takes a course. OceanTeacher content is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.

The IOC Project Office for IODE is based in Ostende, Belgium. The IODE Secretariat hosts an International Training Centre and International Conference Centre, as well as the IOC/IODE data and information services (Data/information services hub) and an Expert Centre. From 2005 to 2012, training courses at the IODE office have included about 1238 participants from 120 countries. About 6-8 courses are held each year. The IODE Secretariat receives support from Flanders Government (FUST) and works in close cooperation with Flanders Marine Institute (VLIZ).



IODE has put in place standardization procedures to improve its provision of capacity building services:

- Courses taught in Oostende can be taught anywhere else in the world using OTA platform resources [complete courses are available online, including videos];
- New, standardised application form;
- Funding Policy: one student accepted for full sponsorship/per country; other students from the same country co-sponsored only;

- Endorsement from national/Member State representatives compulsory;
- Survey to Member States in order to assess training needs
- Accreditation process: One course accredited by UGent: University Curriculum in Marine Data Management

Thoughts about the future of OceanTeacher and other IODE CB&D activities:

- Become a course provider on ocean data and information management fields;
- Need for a regular cycle of standardized courses, relevant for all regions
- Standard curriculum of annually organized courses
- Trainee selection
- Distance learning/blended learning;
- More interactive training (e.g. [online] pre-course assignments);
- Establish evaluation processes: [not only providing attendance certificates];
- Further explore online tools: broadcast to and/or from other training centres;
- New partnerships (reinforce already established + expand);
- Include OTA courses in partnering training programmes (other ocean-related organisations, Universities, projects);
- Course accreditation;
- Regional training centres: “Centres of Excellence” Hyderabad, Mombasa, Argentina, China...
- Greater emphasis on biological data and marine biodiversity (OBIS)
- Training & Education (including CPD – Continuous Professional Development)
- Translations - currently only English
- OT GlobalClassroom

IODE is working toward a distributed training network comprised of ODINs and regional training centres (Hyderabad, Mombasa, Argentina, China). The training network will also be cooperative with organizations/projects (e.g., POGO/SCOR, EUMETSAT, JCOMM, WMO, NOAA, EU, IOI (International Ocean Institute), SeaDataNet, CPPS-SPINCAM project, UGent/UHasselt, Rutgers University (OBIS))

Appendix VIII – Benguela Current Commission (from presentation by Ekkehard Klingelhoefter)

The Benguela Current is one of the most productive upwelling systems in the world. Commercial fisheries are an important contributor to food security, income, GDP and employment to countries in the region, especially Angola and Namibia. Cooperation in the region was initiated in the early 1990s and supported by the UN Development Programme/Global Environment Facility and other donors. The region developed a TDA and regional Strategic Action Program; completed in the late 1990s and endorsed in 2001. The governments of Angola, Namibia and South Africa endorsed an Interim Agreement for establishment of the Benguela Current Commission (BCC) in August 2006. The BCC Secretariat is located in Swakopmund, Namibia. The BCC Convention is to be signed by all three country Ministers on 18 March 2013. The focus of the BCC to date has been on the Fishery Sector – to understand the dynamics and functioning of the BCLME. In the future, the BCC will evolve to be multi-sectorial, to include fisheries; environment; mining; energy and transport; taking an ecosystem Approach to ocean/coastal governance.

The BCC has several purposes:

- To ensure responsible and sustainable management of the BCLME.
- To promote regional cooperation among the three countries that border the Benguela Current: Angola, Namibia, and South Africa.
- To provide *economic, environmental and social benefits* to people of the BCLME region *namely*: “to promote the *sustainable management and protection* of the BCLME using an ecosystem approach to ocean/coastal governance” to “improve *knowledge and skills* of managers, scientists and technical staff from National Institutions of Angola, Namibia, and South Africa, to allow for successful implementation of an Ecosystem Approach to Fisheries (EAF) management.”

The BCC consists of two major cornerstone programmes:

1. *Science Programme* –trans-boundary fish stock issues. The stocks of several commercially important fish species—Hake, Sardinella and Sardine, Horse Mackerel, Tuna, and Crab—straddle the borders of the three countries in the region. The BCC Science Programme has been funded by Norway and has an overall goal of ensuring optimal and sustainable utilization, as well as prudent management of the resources of the BCLME, while restoring, maintaining, and conserving the ecological integrity of the system. A specific purpose of the Science Program is to provide BCC Member States with the best available scientific advice for the management of the BCLME. Science projects have included the following: regional surveys, spatial biodiversity assessment, environmental links to pelagic fish life cycle, acoustic survey methods, Continuous Plankton Recorder surveys, acoustic methodology for zooplankton, studies of demersal fish stocks in Angola, fish stock dynamics, study of life history of horse mackerel, study of the effects of harmful algal blooms on inshore marine species, study of the effects of H₂S and low O₂ on marine species, feasibility of a

Histology Unit, development of data policy, development of SEIS–Database, and seal surveys.

2. *Training and Capacity Building* (TCB) for managers, scientists, and technicians. The region is in need of highly qualified individuals, so the BCC has focused on short courses as a means to encourage M.Sc. and Ph.D. students to take a holistic approach to ocean governance. Short courses have included GISS Training, Implementation of EAF on the Ground, Nansen Survey Data Analysis, Fisheries management course for managers, Stock Assessment Training Workshop, Data Analysis, Multivariate Analysis, and Hydro-acoustics. Iceland has been a major contributor of funding for TCB through ICEIDA, over the period 2008-2012. The final draft of the TCB Policy has been completed and the TCB Strategic Plan is being developed. Part of the BCC strategy is to establish strategic relationships with academic and research institutions, establishing new partnerships and strengthening existing ones. Examples of existing partnerships include

- a partnership between IOC and BCC
- BCC and the Danish Technical University (DTU) are involved together in the EU-funded ECOFISH project aimed at improving stock assessment of major commercially important species (hake, horse mackerel, sardines).
- **GENUS Project:** A German-funded project aimed at assessing the effects of climate change on biodiversity in the central BCLME
- **NEPAD:** On fisheries- and aquaculture-related projects
- **African LMEs** (Canary, Guinea and Agulhas and Somali) on enhancing synergies in areas of mutual interests
- **African LME Caucus:** On LME issues at continental and global level. BCC is the founding member of the Caucus and the current Chair.
- **ODINAFRICA (Ocean Data and Information Network for Africa (ODINAFRICA):** On data management, data policy and protocols. An MoU on data-related matters with ODINAFRICA was developed and will be signed in due course.
- **African Marine Atlas:** on data and information sharing. BCC is a member of the African Marine Atlas Steering Committee.
- BCC is finalizing MOUs with the University of Namibia, Anghosthino Neto University in Angola, and the University of the Western Cape in South Africa.

In summary, resource management within the BC-LME is about generating awareness, sharing information, involving and empowering people to understand the impacts of their interaction on the environment and to participate in *planning and decision making*.