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Abstract
This report presents a summary of the topics discussed at the fourth session of the Panel, whose broad objectives is to develop the coastal element of the Global Ocean Observing System. Elements of the C-GOOS Strategic Design Plan were discussed. Background information was provided regarding the following: A Vietnamese Typhoon Forecasting System; The Baltic Oceanographic Observing System; The International Atomic Energy Agency's Marine Monitoring Program; The U.S. GOOS Initiative. A report of a 1-day Stakeholders' workshop held in connection with the panel meeting is also provided.

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ANNEXES

1. OPENING

The fourth meeting of the Coastal GOOS (C-GOOS) Panel was opened at 0830 on 3 November, 1999 by Tom Malone, Chairman of the C-GOOS Panel. He welcomed the new participants and asked the participants to introduce themselves. The panel members and invited participants are listed in Annex I. He thanked everyone for taking time out of their busy schedules to attend this important meeting. He thanked the Local Organizing Committee for their hard work and excellent planning. Wang Hong, Chairman of the Local Organizing Committee (LOC), welcomed the participants to the National Marine Data and Information Center (NMDIS) and expressed his wishes for a successful meeting. He stressed the importance of GOOS and how it was likely to benefit all participants. Thorkild Aarup welcomed participants on behalf of the Executive Secretary of the Intergovernmental Oceanographic Commission (IOC) and on behalf of the sponsors of GOOS: Intergovernmental Oceanographic Commission, World Meteorological Organization (WMO), United Nations Environmental Program (UNEP), and International Council of Scientific Unions (ICSU). He also thanked the National Oceanic and Atmospheric Administration (NOAA) of the USA, and the Government of Holland for their generous financial support.

2. ADMINISTRATIVE ARRANGEMENTS

B.R. Subramanian was elected Rapporteur for the meeting. Wang Hong and Xucai Zhao went over the logistics for the meeting.

3. TOWARD A C-GOOS DESIGN PLAN

3.1 OVERVIEW

Tom Malone reviewed the agenda for the session (Annex II) and went over the remaining time line for C-GOOS as it was agreed to at the GOOS Steering Committee Meeting II, Beijing, 26-29 April, 1999:

- April, 2000: Develop plans for the panel merger of C-GOOS, Health of the Oceans (HOTO) and Living Marine Resources (LMR)
- April/May, 2000: C-GOOS V meeting to complete the Strategic Design Plan
- May, 2000: GOOS Steering Committee meeting to discuss merger plans
- October, 2000: First meeting of GOOS Integrated Panel for the Coastal Ocean (GIPCO)

Tom Malone reviewed the agenda for the C-GOOS IV meeting and stressed that the primary goal was to work on the C-GOOS Strategic Design Plan. He then summarized his activities as related to the promotion of C-GOOS since the C-GOOS III meeting (12-15 April, 1999):

(i) In 1998 a U.S. Congressional request was put forward to the National Ocean Research Leadership Council (NORLC) of the National Oceanographic Partnership Program (NOPP) to "*propose a plan to achieve a truly integrated ocean observing system*". A final report was submitted to the Congress on 26 April 1999. This report was prepared by a working group of experts chaired by Worth Nowlin and Tom Malone, and it reflected on contributions by both private and public sectors. (The US GOOS Plan: Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System is available at:

(http://core.ssc.erc.msstate.edu/NOPPobsplan.html).

(ii) A U.S. C-GOOS workshop was convened (23-26 May, 1999), the goals of which were to (1) begin the design of the coastal component of Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System; (2) acquaint coastal managers with the potential of *in situ* and remote sensing as a source of data and information upon which to base management policies, plans and decisions; and (3) acquaint scientists with the needs and perspectives of coastal managers. The workshop report "Challenges and Promise of Designing and Implementing an Ocean Observing System for U.S. Coastal Waters" is available at http://www.hpl.umces.edu/projects/wrkrpt.pdf

(iii) Talks were delivered on C-GOOS at the conferences Coastal Zone 99; the 15th Biennial International Conference which had a special C-GOOS session on remote and *in situ* sensing and the 3rd International Conference on Shellfish Restoration.

(iv) Served on the Steering Committee for a workshop in Rovinj, Croatia (18-22 October, 1999) to formulate recommendations for the design and implementation of the Coordinated Adriatic Observing System (CAOS).

(v) Organized a regional U.S. C-GOOS workshop in Maryland, U.S.A. ("E^3 – Environment, Education and Economics: Applications for a regional ocean observing system") on Technology & Eastern Shore Future Workshop, 28-29 October, 1999, Easton, Maryland).

He stressed that the work of the C-GOOS panel provided the basis and guidance for these and other development relating to the design and implementation of C-GOOS in the U.S.

Tom Malone then reviewed the emerging C-GOOS design plan (Annex III) and stressed the importance of the communications network and data management sections. The CAOS workshop had clearly demonstrated that these elements of the observing system should be a high priority for implementation. Without a functional system from data dissemination and management, investment in the measurement end of the system would be pointless.

3.2 STAKEHOLDERS' MEETING

The Stakeholders' workshop was opened by Dr. Li Jingguang (Director-General of the Department of International Cooperation of the State Oceanic Administration of China). Dr. Li Jingguang stressed the importance of C-GOOS for China in areas such as coastal zone management, resources conservation and environmental protection. He also pledged strong support from the State Oceanic Administration to the development of GOOS projects.

Activities and Requirement of Stakeholders:

(i) Marine environmental forecasting - Dr. Wang Xinian presented a preliminary marine environmental forecasting system for Chinese waters. He explained that two-dimensional numerical model and empirical-statistical schemes were used for the prediction of waves and storm surge. The system has played a very important role in ensuring the safety of offshore operations and in reduction of marine disasters.

(ii) Tide prediction and disaster mitigation - Mr. Song Lianxin expressed strong needs for real-time sea-level observation data for storm surge warnings and disaster mitigation. Tidal stations have been set up with the help of NMDIS and National Marine Data and Information Centre (NMEFC) of State Oceanic Administration (SOA). He hoped that the C-GOOS would provide them with timely and accurate data to enable storm surge warnings at least 5 hours in advance although 24 hours warnings would be desirable.

(iii) Sea Area Use and Coastal Zone Management - Mr. Wang Juncheng and Mr. Liu Lihua expressed needs of C-GOOS data and information for improving management of sea area use, environmental protection and zoning for the sustainable use of marine resources.

(iv) Oil and Gas exploration - Mr. Li Tongkui described the observation activities, which were conducted for the purpose of oil field design and production. He mentioned that sea ice data and typhoon data were very important for the planning of the offshore oil and gas industries.

(v) Seashore Engineering Design - Mr. Zhuo Yusheng expressed the needs for C-GOOS to provide high quality data and information for the offshore engineering design. He also mentioned that the C-GOOS data should be accessible on the web or in the GIS format.

(vi) Education and Research - Mr. Guoping Gao stressed that universities could get involved in the implementation of C-GOOS, and students could be trained to do observation and research according to the principles of C-GOOS. He also emphasized the importance of showing students the “real” state of the ocean with on-line access to the data of C-GOOS. C-GOOS could have impacts in education and the education could also accelerate the development of C-GOOS.

(vii) Marine fisheries and C-GOOS - The Chinese marine fisheries service share many of the same goals of C-GOOS. Advice is often based on local ecosystem modeling which makes it difficult to assess whether changes reflect the spatial scale of observation or time-dependent changes *in situ*. This problem is especially acute in coastal ecosystems. Lack of real-time data telemetry is also a problem. Assimilation and visualization are the major barriers to now-casting environmental conditions and forecasting environmental changes.

In his closing remarks Dr. Li Jingguang summarized the Stakeholders’ meeting into the following recommendations:

- C-GOOS data should be well managed to meet the requirements of the end-users;
- Design of C-GOOS should rest on a sound scientific foundation;
- Data and information management systems should be user friendly;
- All data should be shared.

Finally Dr. Li Jingguang stressed that capacity building is badly needed to ensure the implementation of C-GOOS and to make full use of data and information.

3.3 THE INITIAL GLOBAL NETWORK

3.3.1 Conceptual design

The conceptual design of the C-GOOS Global Network was presented at the C-GOOS III. At the core of it would be an evolving global system of infrastructure (the global network) supporting a core measurement suite. Observing, communication & data management, modeling, and product development are the core elements of the observing system. The global network would be regionally enhanced to meet local and regional needs. In addition to incorporating existing observing systems as appropriate, pilot projects will be required both to demonstrate the utility and cost-effectiveness of the GOOS approach and to transition research and development into an operational mode. Key elements of the initial global network will be (i) satellite remote sensing, (ii) an enhanced global network of tide gauges (GLOSS+), (iii) enhanced arrays of instrumented moorings and fixed platforms, (iv) voluntary observing ships (e.g. ferries), and (v) a network of coastal observatories (index sites) and laboratories. A more complete description of the Global Network can be found in Annex VI of C-GOOS-III Summary Report (GOOS Report No. 76).

3.3.2 Benefits of C-GOOS

The benefits of C-GOOS will been seen in both the commercial and public good sector as the products of C-GOOS are used to increase the efficiency and effectiveness with which our coastal resources are both utilized and managed. These benefits will be derived from using C-GOOS products which draw on our scientific understanding of the coastal zone and the observational data collected in C-GOOS. A recent survey of end-users of EuroGOOS showed that every marine activity surveyed had a demand for improved operational data suggesting that there is certainly a perceived economic benefit from GOOS and C-GOOS.

Full cost benefit analyses (CBA) are difficult to conduct in the case of GOOS and C-GOOS. However, it has been suggested in the GOOS Prospectus 98 that ex-post CBA should be carried out. The pilot projects within C-GOOS are an excellent opportunity for this to occur and for a full analysis of the cost and benefits of C-GOOS to be evaluated. This approach can be used to build a track record for C-GOOS and show that it is an approach that has proven benefits. These analyses can also be used to provide useful insights for future development of C-GOOS. However to give some indication of the potential economic benefits of GOOS an analysis for GOOS was conducted and indicated that benefits are likely to exceed by a comfortable margin the costs of creating and distributing the GOOS services. Optimistic figures suggest the ratio is 10 to 1 and pessimistic figures suggest 4 to 1 with an error of 2 (GOOS Prospectus 98). This suggests that the vision of GOOS is well founded and investment in specific elements of the end-to-end system is a sensible strategy.

The implementation of C-GOOS globally will allow benefits to occur at all levels from the local, regional, national basin to the global scale. The future success of C-GOOS will lie in developing products that will provide benefits at the local, regional and national level as it is at this level that the funding for monitoring programs will have to be justified and provided. At a global level concerns such as the impact of global climate change and climate variability in the coastal area will be addressed using the data collected in at the local, regional and national level.

Benefits will also come from multiple approaches to ubiquitous issues that are of concern globally but that act at a local level. The monitoring of these locally, regionally and nationally will enable a greater understanding of these issues and will lead to the exchange of ideas, data and approaches between regions with similar issues. Ubiquitous issues have been identified in four key areas, they are:

- Preserving healthy coastal environments,
- Sustainable use of coastal resources,
- Mitigation of coastal hazards,
- Safe and efficient marine operations.

To achieve the maximum benefits of C-GOOS a number of key issues must be addressed in the design and implementation of C-GOOS; these include;

- Strong links with the end-users of C-GOOS products from design and implementation through to the subsequent evaluation and adaptation of the products;
- Communication between the data providers, product developers and the end-users are developed and maintained based on mutual respect and understanding of different perspectives and needs;

- There is an active education program to inform potential end-users of the potential benefits of C-GOOS. This will enable the end-users to become active participants in C-GOOS;
- C-GOOS is used to initiate the widespread application of best practice and enables the collection of consistent and compatible data sets;
- The design allows all interested countries to participate and gain from C-GOOS;
- C-GOOS provides linkages between current programs monitoring the coastal zone and facilitates the sharing of data between these programs and C-GOOS;
- There is widespread dissemination of the data collected in C-GOOS to allow the widespread use of data for different applications;
- C-GOOS provides the framework for the continuity of a scientifically designed observation system. A recent survey showed that 1 in 20 monitoring programs survives more than 10 years and that 1 in 80 monitoring programs survives more than 20 years. The design of C-GOOS must create a monitoring system that is sustainable in the long term.

3.3.3 Products of C-GOOS

The first design principle of GOOS states that GOOS "*is based on a plan designed to meet defined objectives on the basis of user need*". This means that the users, be they individual companies, industry sectors, governments or the public, need to be involved in the defining of the products of C-GOOS. This involvement must include identifying the issues to be addressed, what needs to be predicted, the level of detail of those predictions, and the lead-time of the predictions.

To achieve a productive interaction and to allow new products to be developed in a coordinated fashion it is critical that there is open and constructive communications with the end-user community of C-GOOS. This may initially require interaction with the end-user community to outline the aims of C-GOOS and the types of products that can be developed and the benefits that can be derived from these products. Mechanisms must be found that ensure that the exchange of information on needs and capabilities occur on an ongoing basis.

The products of C-GOOS will vary widely from the transfer of data and basic products between participating agencies to highly specific products developed for specific end-users. In a recent EuroGOOS survey most end-users indicated they would expect a product after data analysis, processing (e.g. gridding), and modeling. Only 20 % of users require raw observational data on average, although this varies with the topic. This indicates that there is a significant need for highly developed and integrated products.

Accompanying this wide range of products there will be a range of approaches to the funding of the development of these products. Those for the public good are likely to be funded by government agencies and made available to the end-users free of charge. At the other end of the spectrum, products targeted at specific commercial sectors or companies are likely to be paid for directly by the end-users.

Who will produce the C-GOOS products? An interesting division has been made by EuroGOOS between the expert-user of operational oceanographic data products (typically a scientific modeling group, or a value-added agency), and the final end-user who wants a problem solved, but has no interest or expertise in oceanography. The product for this type of end-user usually involves the inclusion of extra data sources on materials, engineering, legislation, prices, etc. Already there are many local commercial organizations able to provide the final analysis for niche customer products. It has been suggested that GOOS/EuroGOOS should concentrate on providing the larger scale regional products which are used by the value-added sector. This approach should also be taken with C-GOOS. This is similar also to the approach taken in the USA with weather forecasting. It is NOAA's responsibility to provide weather, climate and hydrological information for public use. The private sector then uses this and other information to provide value added products for specific clients.

The types of products developed by C-GOOS will be very varied and will change as scientific knowledge and technology change. It is envisaged that initially many of the products will be physical based as the technology for these observations is well advanced. In the future as technology advances the measurement of biological variables in an operationally way will allow the development of new products. A recent EuroGOOS survey showed that the current demand for products was dominated by the physical parameters of the coastal seas and upper ocean. However the biological variables such as phytoplankton, chlorophyll, nutrients, and oxygen concentrations all appeared as requirements in the top 40 ranking. In the conclusions of the survey it was noted that descriptions of the ecosystem, water quality, chemistry, and sediment characteristics were close behind the physical variables in terms of user demand. This indicates that when the technology is available there will be a significant demand for biologically based products.

The promotion of C-GOOS products is important and needs to be approached in a consistent and professional manner. There also needs to be a mechanism to allow feedback from the end-users regarding the product. Initially this should be focussed on the presentations at relevant industry-based conferences and meeting and on the use of the GOOS Products and Services Bulletin. This will be produced on a web site with monthly updates and will also be produced in hard copy on a bi-monthly basis.

3.3.4 Quality assurance

An overarching principle for all levels of the C-GOOS framework is the need to incorporate Quality Assurance and Quality Control (QAQC) procedures. Offshore related met-ocean services have developed rapidly during the last two decades, mostly due to critical demands from the marine industry itself. These developments have been strongly supported by the advent of new tools within ocean sensing, improved data communication and numerical computer models simulating the marine environment. Increasingly, customers are demanding that service providers document their QA systems and procedures in order to establish confidence in their services and products. However, few service providers can present such documentation today, and this is in itself a threat to the safety at sea. Forecast, nowcast and climatological information aimed to support safety at sea, should be subject to the same level of QA requirements as for example rescue equipment, communication services, maintenance, etc. Although there is a wide range of such products, there are commonalties in the way they are produced, giving reason to suggest that a basic skeleton of a QA template can be substantiated and applied for the specific services.

The International Standardization Organisation (ISO) had provided a few simple recommendations from the perspective of:

- Use the flowchart of the 'Process' as the basis for your QA documentation. Process means the chain of events leading to the final product delivery, and QA actions should follow chronologically this chain of events.
- Signify the concerns and feedback from the industry. This will be reflected both in the schematics of the 'production line', and in the QA template itself.

The met-ocean service production line is defined in 4 parts, reflecting the chronology of events in the production process. Step 1 will be the site specific field measurements, step 2 is the "data blending" which consists of data covering a much wider area, transmission and management of such data, boundary and forcing data as required, and numerical models. Step 3 is the "value adding" functions where still expert-based interventions may take place, and step 4 contains the interactive functions with the user communities. The concept of a ‘production line’ along these chronological steps is applicable to nowcast, forecast, hindcast products, and to physical met-ocean, chemical and biological oceanographical services and products.

NEAR FIELD measurements included contract dedicated data	**FAR FIELD measurement data BOUNDARY and FORCING data ASSIMILATION NUMERICAL MODEL SUITE with NESTING**	**CONTRACT MANAGEMENT EXPERT INTER-VENTION QA/Validation Formatting Distribution**	**USER COMMUNITIES Satisfaction Market defined product spectrum Cost/benefit Policy making Market trends**
Part 1	**Part 2**	**Part 3**	**Part 4**

The following list provides some keywords/reminders when considering the contents of the four parts of the process:

(i) Near field data:

- Overview of the near field data acquisition system, number and types of sensors, positioning, output parameters, resolutions, accuracies, modes of data transfer and storage, validation according to specification, regularity, maintenance.

Normally, this will have been organized in an appropriate fashion already, following the conventional procedures for selection and deployment of ocean sensors.

(ii) Far field data:

As soon as a service is provided beyond the scope of pure real-time monitoring, part 2 becomes increasingly important. The typical requirements should be:

- Overview of the suite of numerical and statistical models in the service provider’s possession and operation for the purpose of fulfilling the demands of the contract; references to publication or international cooperation in developments of the models, performance documentation, scientific expertise in charge of software maintenance and updating, and connections with research activities aiming for model improvements.
- Overview of the forcing data (such as prognostic wind fields required as input to a wave model), their quality/accuracy and resolution, their sources and modes of transfer into the domain of the service provider. Backup arrangements in case of data communication failures. Any boundary and/or initializing data required from external sources to run the models, their origin, quality and modes of transfer into the service provider.
- Regional/international mechanisms for data exchange supporting the functions of the service provider in the context of the contract.

- Brief description of data assimilation into the service provider's suite of numerical models, both the near field data and the data imported to the service provider from external sources.
- Functional diagram (Flowchart) showing the service provider's suite of models in routine operation, with backup arrangements and updating frequencies.

(iii) Contract management:

This concerns the service provider responsible for fulfilling the contract, value adding, amendments as appropriate to forecasts, distribution to the customer, responding to complaints and supplementary demands.

- Curriculum Vitae for personnel in management and operational routine work for the contract.
- Description of the value adding functions (if applicable), corrections of automatically computed data, formatting, dissemination of warnings, amendment procedures, urgency procedures.
- Readiness to receive auditors, reporting schedules, etc.

(iv) User communities:

Items to consider includes: Has the service provider a Public Relations setup? Are customers invited to exchange views, discuss improvements and or extensions to services? Is the provider aware of user satisfaction, policy making, etc.?

Auditing and reporting requirements

ISO standards should be applicable. Both Audits and progress reports should follow and emphasize the substance and coherence.

3.3.5 Data and Information Management for C-GOOS

Wang Hong and Stephen Walker presented a draft of the C-GOOS Data and Information Management Plan. Based on comments from Ron Wilson (Joint Data and Information Panel, JDIMP) and the panel, the plan would be revised in areas such as quality control/quality assurance, distributed database technology, and better incorporation of IODE in the organizational structure.

3.3.6 Capacity building

All too often, the coastal countries in the developing world with the lowest capacity for marine research and production of needed marine products are also the ones most vulnerable to potential effects of climate change such as rising sea levels, to the consequences of coastal disasters and marine pollution, etc. Sound advice from local experts is essential for policy-makers in such countries. To develop the local expertise requires a series of conditions, including well-developed science education, marine science training, a sound scientific research base, and well-equipped national oceanographic services that are fully integrated into a global network. Thus, marine capacity building is a challenging assignment.

In order to adjust the general principles of capacity building for the specific needs of the Coastal Module of GOOS, it is necessary to follow carefully its principles. C-GOOS will differ from most present observing systems in having modeling and forecasting as part of its mandate, as well as the collection of data; in being holistic, integrated and interdisciplinary, rather than narrow and sectorial; and in being designed to deliver useful products for both decision-makers and the scientific community. In due course it will be expanded to include national systems that meet the published *GOOS Principles*.

The purpose of capacity building is to make possible the continued involvement of nations in GOOS. Capacity building includes education and training; the building of appropriate institutional support structures; the creation of networks; infrastructure elements (e.g., platforms, sensors, and data centres); and providing access to communication networks for data telemetry and dissemination (e.g., the Internet, downloading and visualising satellite data). Capacity building will be an integral component of C-GOOS activities including the design of the global network and pilot projects. A final component will be a general education element with the aim of increasing the public awareness of C-GOOS and the anticipated social benefits of such a system.

Where infrastructure does not exist, strategies should be implemented to meet the following needs of nations:

- The need to develop and maintain minimum scientific capability to support and participate in GOOS-related activities, including among others coastal zone and fishery resource management.
- The need to raise understanding of the value of *in situ* and space-based observations of the ocean to solving socio-economic problems. Efforts must be made to educate the public and politicians regarding the benefits to be obtained from investing in developing, maintaining, and utilising ocean observation systems.
- The need for ocean data, including satellite measurements and *in situ* measurements necessary for their calibration, validation, and augmentation. (Special efforts should be made to create and sustain baseline networks in the coastal waters and the Exclusive Economic Zone (EEZ) of high quality surface-based stations or sections in a wide range of climates. Many of these are likely to be in countries requiring assistance.)
- The need to raise the ability of countries to contribute to and benefit from global observing systems. There must be a long-term investment in facilities for receiving, processing, and interpreting data from ocean and space-based sources to be accompanied by training in the use of such facilities and in the provision of services and products. (Services and products are likely to relate to seasonal predictions, drought and severe storm monitoring, sea level rise, regional climate change, coastal zone and fisheries management, coastal protection, coastal pollution, harmful algae blooms, coral reef disturbance and recovery, and the like.)

Given the importance of capacity building to the implementation of the global network, special actions are needed to maximise effort and minimise problems throughout an efficient system design. The challenges and scarcity of resources should induce a cooperative behaviour among scientists and nations, but this is not common behaviour. The flux of resources, sometimes in relatively large amounts, is sporadic and uneven producing a competitive environment. With such policies of confrontation, non-cooperative behaviour is the norm and the more fruitful approach of mutual strengthening and support is the goal. As mentioned, critical mass often does not exist in developing nations and can only be achieved through regional collaboration. **Networking** must be a high priority to promote data exchange and cooperative behaviour, enhance regional interaction, and make for effective use of the collective resources of many nations. Emphasis should be placed on the improving the so-called South-South and North-South flow of knowledge and resources. Links to advanced projects and programs like EuroGOOS, BOOS, etc., will be of great importance.

What is networking?

It is a way of maximising efforts within a region or a country by linking the marine sciences community in order to pursue the necessary critical mass to overtake marine sciences challenges. It is not only to put together human resources, but also laboratory facilities, data banks, modeling centres, instruments, ships, etc. To do that, a cooperative environment needs to be created, rather than a competitive one. A healthy competitive environment could only be achieved when the region has a "population" (of scientists and material resources) big enough to promote the "natural selection" of the best adapted ones. As in developing areas, the number of individual scientists is scarce; reaching just the border of the minimum critical mass, the promotion of a very competitive environment could reduce the "population" to extinction levels, producing the opposite result.

Mechanisms to enhance the cooperative behaviour need to be promoted, maintaining the classical capacity building policy that proved to be correct, especially those that avoid the brain-drain problem. As many countries have historical constraints with respect to their neighbours, international programs could serve to promote better neighbouring relationships, and Coastal GOOS could be an important project in this sense.

Recommendations

A number of overall conclusions can be drawn about marine capacity building. It is a long-term process. The involvement of the government is crucial. Approaches should be tailored to specific country or regional needs. For building an indigenous capacity, the active involvement of the community in the developing countries is necessary. Partners in these countries are the most effective and persistent advocates for marine science and technology. Capacity building activities can vary from a training course to the implementation of a complete environmental monitoring system. The best instruments for capacity building are activities in which scientists, technicians, and users work closely together (learning by doing, teaching the teachers) in the execution of projects, programs, and partnerships. Governments, scientific and international organisations, the private sector, and donors should join forces in capacity building. In this regard, substantial capacity building also is needed between the science foundations and donor organisations (even in industrialised countries) because most donor organisations are unsure of marine issues. Finally, all participants must recognise the need to maintain capacity once it has been built. Creation of awareness in the minds of the public and policy-makers is essential for raising national and international support.

(i) Short term

- To use existing capabilities, supporting, enhancing and improving them under the concepts of C-GOOS;
- To establish and maintain new infrastructure and trained personnel for observing systems, communication networks and data management, as well as to capacitate in ocean modeling;
- To get the message as quickly as possible to local people to increase public awareness, to create societal support and to have the general public acting as guardian of the infrastructure (material and human);
- To ensure the stakeholder involvement, administrators and managers need to be informed about the C-GOOS products and tools that may help in solving their problems. It is a general education problem, where the general public, the C-GOOS operators and the end-users need to be trained and prepared to obtain full benefit from C-GOOS.

(ii) Long term

- To re-enforce training in quality assurance and quality control on a continual basis;
- To increase the efficiency by networking facilities;
- To ensure the best practice in ocean prediction and forecast;
- To ensure that only validated data are exchanged and archived;
- To promote awareness of the benefits of measurements in the coastal marine environment and potential application of marine data at local, regional and global scales;
- To increase the public recognition and appreciation of marine science.

Implementation Mechanisms

Developing and strengthening marine research and observational capacity involves human resources, the necessary institutions, and environments that support and sustain observational activities. These components must be integrated to form a single observing system. Procedures for integrating these components are not clear-cut.

There are many capacity building programmes that C-GOOS can work with in achieving the goals of capacity building. These include the Training, Education and Mutual Assistance (TEMA) activities of IOC; the Global Change System for Analysis, Research and Training (START) ; Train-Sea-Coast (UN); Education & Training Program of the WMO which has regional training centres over the world; the training activities of the Global Sea Level Observing System (GLOSS), the Harmful Algal Bloom (HAB) program and North East Asian GOOS (NEAR-GOOS); the European Union (IOC-EU) South American oceanographic network; and regular training courses as the ones presented at the International Atomic Energy Agency (IAEA) Marine Environment Laboratory and the International Centre for Theoretical Physics. The collaboration with ongoing training activities, such as the ones managed by GLOSS, will be the first capacity building activity of C-GOOS. Other users who may be prepared to be partners in capacity building include government agencies responsible for the management of the environment and natural resources, universities, conservation groups and non-governmental organizations (NGOs), navy meteorology and oceanography departments, industry, and harbour authorities. The creation of national GOOS Coordinating Committees will help stimulate this process.

Specialised colleges, higher education institutes and universities may make significant contributions to achieving the goals of capacity building. There are many general training and education programmes in universities, technical colleges, fisheries institutes, and merchant and military naval colleges that C-GOOS could enlist. As a first step, these institutions could be enlisted to use GOOS information and materials in their courses.

C-GOOS could also develop its own courses and training programs. The Web should be used more effectively to disseminate information on C-GOOS activities, and information that is useful to user groups. The coordination of computer-assisted learning activities, such as the existing Coorporative Program for Operational Meteorology Education and Training (COMET), Australian BatMet, Meteorological Office of the United Kingdom etc., and widening/strengthening its marine and coastal components will be of high value.

Capacity building in relation to GOOS is carried out by three partners: (1) recipients or local, national or regional beneficiaries of the activities; (2) national or international donor agencies, the private sector or countries; and (3) the GOOS organisation with its sponsors.

Public and political awareness policies are some of the most critical priorities in order to convince developed nations that they need to invest in capacity building in developing nations, and to convince developing nations that more and better information on the marine environment is good for their national economies and the well-being of their citizens. The focus should be on the value of information about the marine environment and the value-added aspects of global and regional (i.e. multi-national) observing systems.

3.3.7 Implementation mechanisms

The implementation of GOOS will occur via national and regional GOOS programs. Regarding the implementation of the GOOS Ocean Observing System, for physical observations, the Ocean Observations Panel for Climate (OOPC) and its parent body, the GOOS Steering Committee (GSC), has been instrumental in the creation of a new international body for this purpose. Although all GOOS/C-GOOS planning documents (e.g. the *GOOS Strategic Plan*) have recognized the need to build GOOS implementation, as much as possible, on existing systems and mechanisms, it had not been explicitly stated as to how this was to be accomplished or the nature of the overall co-ordination mechanism that is obviously required. Serious consideration of the various options has led the WMO Congress and the IOC Assembly in the spring of 1999 to approve the formation of a new body, the joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) to oversee the implementation of the physical observations required by GOOS/GCOS and the Climate Variability and Predictability (CLIVAR) program. It has been established through the merger of the Commission on Marine Meteorology (CMM) and the integrated Global Ocean Services System (IGOSS), and is the reporting and coordinating mechanism for all other existing bodies of WMO and IOC concerned with ocean observations and data management. JCOMM will report primarily to the Executive Councils of the WMO and IOC but will also interact directly with the GOOS Steering Committee and the Intergovernmental Committee for GOOS (I-GOOS).

It is presently planned that JCOMM will have subsidiary working groups that will oversee the implementation of GOOS physical observations in three categories: namely,

(i) the surface ocean and its atmospheric and oceanic boundary layers;

(ii) the upper ocean; and

(iii) the sea surface elevation.

In the future it may be necessary to put in place additional mechanisms to deal with deep sea hydrography, perhaps using systems similar to those developed by the World Ocean Circulation Experiment (WOCE). An Action Plan for Global Physical Ocean Observations (see http://www.ioc.unesco.org/goos/act_pl.htm) has been prepared for JCOMM’s initial work. This Action Plan includes the latest detailed specification of the ocean observing system for climate as specified by the OOPC and the Upper Ocean panel of CLIVAR. When the requirement for physical observations for C-GOOS are clear and accepted by C-GOOS and the GSC, the JCOMM Action Plan will be modified to include them. Since the design of GOOS will involve with time there will be strong interaction between JCOMM and the OOPC and C-GOOS.

For the present, JCOMM has responsibility for the physical observations required by GOOS. Whether the biological and chemical observations required by C-GOOS, LMR, and HOTO should be coordinated by JCOMM remains unclear. Another option would be to constitute a parallel organization for this purpose. What is clear is that at the present there do not exist subsidiary operational mechanisms for coordinating and implementing biological and chemical observations that are equivalent to the Data Buoy Cooperation Panel (DBCP), GLOSS, etc. for physical observations.

Lastly, it should be remembered that there is an intergovernmental mechanism, I-GOOS, with the responsibility to oversee the development and implementation of GOOS. The Intergovernmental Committee for GOOS (I-GOOS) provides a mechanism for soliciting national contributions to GOOS and for nations to express their intentions in this regard. The first GOOS Commitments Meeting was held during the IOC Assembly in July 1999.

3.3.8 Mechanisms for Sustaining and Enhancing C-GOOS

Lack of sufficient resources is frequently cited as a prime issue for sustaining coastal observations over the long run. Observations are not free and the process entails many costs, particularly related to collecting and organizing data and diffusing information. While observing programs often secure short-term funding to plan and launch an initiative, lack of sufficient resources becomes an increasing problem as sources of funding expire. In order to sustain coastal observations, programs need to look beyond the span of their immediate financial support.

An examination of various options and opportunities for ensuring the sustainability of international, regional, national, and sub-national coastal observing activities and programs, quickly confirms that it is unlikely that any single mechanism or arrangement will meet the needs of all countries or all levels of government. While national governments, particularly in the more developed world (e.g., the USA, the European Union, and Japan), will continue to be the primary source of funding for coastal observing systems, they need not be the only source.

The widespread trend to reduce governmental spending means that little or no additional public funding may be available to address national and global observing programs in the near term. The declining trend in government spending highlights the growing importance of the private sector as a potential ally. The private sector provides nearly US$260 billion per year in investments and loans in developing countries, in comparison to US$50 billion per year in loans from development banks and less that US$1 billion per year from the Global Environmental Facility (GEF). However, since approximately 90 percent of private funding has been flowing to only 12 countries undergoing fast-paced economic development, even if they could be accessed, private sector funds alone are not sufficient. This increases the importance of efficiently using the financing that is available from the domestic budgets of all governments, overseas development assistance, and multilateral development funds.

In order to develop a coastal observing capacity, most governments will have to strengthen their institutional arrangements for monitoring and their human resource capabilities. It is here that national governments, NGOs, donor agencies, and international organizations can play a significant role.

Some time-honored rules for dealing with uncertainty apply to the choice of financing instruments for coastal observations. These include (1) "looking before you leap," i.e., obtaining information before making decisions, (2) "not putting all your eggs in one basket," i.e., diversifying financing options, (3) "playing for time," i.e., putting off fixed commitments such as technology, and (4) "securing political support," i.e., an investment in awareness may return as future funding.

Within the framework of the Coastal-GOOS strategic plan, and assuming that national governments would continue to support the large capital-intensive observing systems (e.g., remote sensing), various institutions could consider financing observation systems through the following actions:

National Governments and Non-State Entities

- Prepare plans of action that target coastal observing systems on a national and regional basis; use public funds to implement those plans;
- Find ways to build the costs of observations into statutory responsibilities and activities;
- Disseminate news of project achievements to potential funding sources;
- Develop national coastal observing systems aimed at providing local governments with the capabilities to manage local coastal areas by establishing new financial initiatives to support coastal observations on a long-term and self-reliant basis;
- Develop and support national and regional information infrastructures;
- Develop technical assistance and financial incentive programs for the establishment of a sustainable national and regional coastal observing capacity;
- Charge "user fees" for provision of "valued" services, i.e., monitoring, but realize that personnel and a system for collection of fees would be required; legislation or regulations would also usually be required; any system of fees must be set up to ensure that fees are returned to the "management agency," and not the general fund.

Local Governments

- Incorporate coastal observations and practices into local planning, economic development, land management, social and environmental services and fiscal policies;
- Develop partnerships with the private sector, both formal and informal, through contractual arrangements, joint ventures, or similar schemes, by generating proposals that are technically and financially sound, implementing competitive bidding procedures, clearly identifying procedures and requirements of government in project development and implementation, and serving as the focal point between project proponents and the public sector;
- Enhance observing capabilities in marine and coastal areas and strengthen regulatory and economic instruments at the local level by forming partnerships and voluntary agreements with the private sector, NGOs, and the general public.

The Global Environment Facility, Donor Agencies, and Multilateral Banking Institutions

- Provide financial support to national and local governments and the private sector, within the framework of national economic programs and policies, to establish, develop, and extend coastal observations programs to individual countries, and regionally, through capacity building initiatives, pre-investment studies, research, and case studies;
- Foundation grants are generally not available to governments and usually not flexible; requires preparation of and adherence to project document; limited duration.

The Private Sector

- Work at the local, national and international level, and develop and implement processes, practices, and management frameworks that combine good business with sound environmental management, including observations;
- Develop capabilities and capacities to provide hardware and related technical, scientific, and management services essential to the development and sustainability of coastal observing systems.

Non-Governmental Organizations

- Implement community-based action programs that protect and conserve coastal and marine resources, including coastal observations.

3.4 IDENTIFICATION AND SOLICITATION OF PILOT PROJECTS

An operational observing system for coastal environments requires that measurements are routine (no interruption in data streams), long term (sustained into the foreseeable future), systematic (made with sufficient precision and accuracy on time and space scales that are tuned to the issues addressed), and integrated (synoptic measurements of physical, chemical and biological properties; collation and synthesis of data from disparate sources; responsive to a diversity of user group needs). From this perspective an integrated coastal ocean observing system should have the following characteristics:

- Addresses issues that fall within one or more of the operational categories defined by the C-GOOS Panel (Protect and Restore Healthy Ecosystems, Sustain Living Resources, Mitigate Coastal Hazards, Safe and Efficient Marine Operations);
- Integrates remote sensing to capture the spatial and temporal dimensions of change in surface properties (aircraft, satellites) and *in situ* measurements to capture the temporal and vertical dimensions of change (moored instruments, drifters, Autonomous Underwater Vehicles (AUVs), ships);
- Coordinates measurement and data management programs among nations to minimize duplication, reduce costs, and maximize data availability (requires multinational collaboration and cooperation);
- Incorporates an integrated information management plan that ensures continuous data-streams, adequate quality assurance, and timely delivery of data and information in response to user needs;
- Defines a process for and insures periodic review of the observing system from measurements to data management and the delivery of data products; and
- Adapts to new and changing user requirements for ocean data and products.

It must be recognized that many of the observations required to address issues in coastal ecosystems are not operational and that capacity building in developing nations will be required to achieve the goals of C-GOOS. Thus, the coastal component of GOOS will evolve along two tracks: (1) the building of a global network that is operational (end-to-end, user-driven) and (2) the development of pre-operational pilot projects that serve at least one of the following purposes:

- demonstrate the utility and cost-effectiveness of the GOOS end-to-end, user-driven approach;
- develop regional building blocks of the global network;
- identify and address issues that are regionally relevant; and
- provide the scientific basis for the global network and/or regional enhancements (e.g., new sensor technologies and platforms, assimilation techniques, and mechanistic models that will improve the power of the observing system to detect and predict change).

To be endorsed as an official C-GOOS pilot project, proposed projects must follow the C-GOOS design process described in section 6 of the 2nd report of the C-GOOS Panel (GOOS Report No. 63). This does not mean that each stage in the process must be completed. It does mean that if a particular step is incomplete, an explanation must be provided along with a plan to develop each step to completion.

A cornerstone of the design and implementation of GOOS is that it must build on existing programs in order to minimize redundancy and optimize shared used opportunities. This underscores the importance of the global inventory of national marine operational observing systems that is currently being conducted by the IOC. The results of this survey will provide the basis for identifying programs that meet the criteria described above. Initial priorities will be to conduct retrospective analyses of existing data to address regional issues (e.g., identify historical trends and underlying causes relevant to C-GOOS operational categories; develop mechanistic models) on a regional basis (multi-nation collaboration), to select those programs that meet C-GOOS criteria and to link them to the global network, to work with developing nations to design and implement C-GOOS pilot projects, and to establish capacity building programs as needed.

It will also be necessary to merge the panels on C-GOOS, HOTO, and LMR into a single panel, the GOOS Integrated Panel for the Coastal Ocean (GIPCO). GIPCO should be charged with merging the design plans of the three panels into a single implementation plan for the coastal ocean (EEZ, territorial seas, bays, estuaries and fjords). Once this has been completed, a GIPCO should be responsible for promoting implementation and updating the design as new technologies, assets, and resources become available. The GIPCO panel should include representatives from regional and national GOOS programs as well as experts in key aspects of the observing system. High priorities for implementation include:

- Developing capacity building programs to insure the participation of developing countries in the global network;
- Developing regional communications networks and data management systems required to link end-users to observations;
- Establishing a mechanism to identify, solicit and approve pilot projects and projects that become incorporated into the global network;
- Customizing or enhancing the global network to address regional needs; and
- Promoting research and development to improve the observing system and its power to predict change in coastal ecosystems.

These priorities and criteria will be used to identify and solicit those projects and programs that will be required to build the coastal ocean observing system.

3.5 JOINT ACTIVITIES/COLLABORATIONS

3.5.1 Land-Ocean Interactions in the Coastal Zone (LOICZ)/C-GOOS

During the previous C-GOOS sessions a number of presentations have been made on the interactions and possible cooperation between LOICZ and GOOS, particularly C-GOOS. The following commentary and identification of potential actions build on discussion generated by these presentations.

In general, C-GOOS and LOICZ can be regarded as very complementary programs aiming at a similar overall goal of providing the scientific contributions in order to better understand the nature of interaction between the ocean, the atmosphere, and the terrestrial ecosystem. There are, however, various approaches of how to reach this goal and therefore cooperation between C-GOOS and LOICZ is needed. As already defined at the C-GOOS session in Curitiba, LOICZ focuses on time defined research projects studying/assessing local, regional, and global changes of material fluxes and their environmental effects in the coastal zone, while C-GOOS focuses on monitoring/measuring these changes over longer period of time.

Three major areas were identified for the cooperation between C-GOOS and LOICZ:

- The use of LOICZ database by C-GOOS scientists when planning C-GOOS pilot projects and implementing the recommendations of the C-GOOS Initial Global Network;
- Application of the monitoring results from the C-GOOS Initial Global Network and pilot projects for verification of LOICZ material flux modeling; and
- Applications of scaling tools, such as the coastal typology.

The purpose of this document is to propose how the above mentioned cooperation can be carried out.

A LOICZ researcher database can be accessible for C-GOOS upon individual needs and requests. Such requests can be defined when proposing new pilot projects within C-GOOS and establishing research consortia to carry out these projects.

More efforts will be needed to establish and maintain a common, LOICZ and C-GOOS, database and information transfer system. This task has been proposed during the discussions at the C-GOOS Session in Accra in April 1999. The common database would host the information on physical, chemical, hydrological, meteorological and biological parameters as well as environmental indicators of change monitored/assessed during the LOICZ and C-GOOS pilot projects. The aim of the database would be to monitor various processes occurring in the coastal zone.

The results from the common database could be used to:

- detect trends in the state of the coastal ecosystem;
- assess possible risks from short-term and long-term evolutions in the coastal zone; and
- assess the sustainability of the on-going development.

The elaboration of the common database would require human resources and financial support. It is proposed that an *ad hoc* Working group is organized with scientists from the C-GOOS and LOICZ to elaborate on:

- data needs,
- database structure,
- procedures for data collection and storage, and
- dissemination of the results from the database.

One potential source of financial support for the development of the above mentioned database could be through the application to the EU 5th Framework Program, under the Program on Energy, Environment and Sustainable Development, RTD Priority 3.3.4. on Coastal Processes Monitoring.

Application of the monitoring results from the C-GOOS Initial Global Network and pilot projects for verification of LOICZ material flux modeling is also a very important issue although it will take some time before C-GOOS results can be used directly to verify the LOICZ estimates. It should be mentioned that LOICZ aims at carrying out 200 to 250 bio-geo-chemical budgets by the end of the year 2000. Verification of these estimates through measurements of at least chemical parameters (e.g., concentrations of chemicals being a subject of budget estimates) is clearly needed for:

- validation purposes of the budget estimates, and
- further improvement of budget estimate methods.

It is proposed here that leaders of the LOICZ budget estimate projects are in contact with the leaders of C-GOOS pilot projects through a LOICZ/C-GOOS representative, who will be continuously updated with regard to the performance of new LOICZ and C-GOOS projects and the planning of new activities within these programs.

LOICZ and C-GOOS Collaboration

Within the IGBP, LOICZ has a mandate to develop scientific knowledge and tools that address global change in the coastal zone, focussing on material flux and human dimensions at regional and global scales. For LOICZ purposes, the coastal zone incorporates the domain extending from river catchments through the land-sea interface and coastal shelf, to the shelf margins. LOICZ and C-GOOS clearly are strongly complementary.

LOICZ has scientific activities and products that are expected to be of significant benefit to the design, planning and operation of the C-GOOS program. These include bio-geo-chemical and human dimension modeling, developments in coastal typology, and databases. In addition, LOICZ has an increasing regional focus for its global project activities and an expanding network of coastal researchers and agencies at national and regional scales.

Determination of local and regional bio-geo-chemical estuarine and coastal seas budgets models (for C, N, P) is a core activity for LOICZ. A joint Joint Global Ocean Flux Study (JGOFS) - LOICZ group is working on fluxes across shelf margins, and catchment models for horizontal flux of materials and the implications of human activities are being addressed. The issue of “critical loads” at the river-sea interface is a focus. Linked socio-economic models are being derived (including resource evaluation approaches), and the human dimension is being addressed through research within the Driving Force-Pressure-State-Impact-Response (DPSIR) framework.

A coastal typology approach is being taken to address up scaling of coastal flux and coastal use information to regional and global scales. Tools and methodologies are under development, and being applied in a coastal classification system.

Data and scientific information within LOICZ is public domain, and databases include: electronic (website) and hard-copy publication for coastal typology variables, river discharge, and bio-geo-chemical budgets in coastal seas and estuaries. A dynamic global database of contributing projects (about 250) and a network of coastal zone researchers (about 2400) is maintained.

Initial collaboration between the two programs, coordinated by IOC, is bringing together a global database of coastal projects. Good opportunity exists to extend this joint network development and information in order to further identify and engage policy, environmental management, industry and community end-users of coastal zone science – a key element of LOICZ efforts.

Globally LOICZ has established regional coastal projects addressing natural and socio-economic knowledge and tools development for material flux from river catchments to the coastal shelf. These projects may contribute to or stimulate ongoing operational/monitoring programs that could be part of C-GOOS.

LOICZ is a science program with a finite life; currently planning to provide a global “snap shot” of material flux by end 2002. Discussion with the C-GOOS panel has highlighted advantage from cooperation and collaboration between the two enterprises; an existing Memorandum of Understanding between IOC and LOICZ provides a mechanism for formal association. In the short-term, there is need to establish a consultative mechanism for relevant interactions.

3.5.2 Global Terrestrial Observing System (GTOS) links to C-GOOS

The need to include a perspective of terrestrial activities in organizing and implementing C-GOOS has been expressed throughout the development of the program. Humans live primarily on land and their actions there often effect change in the coastal waters. The impacts on coastal waters may be from the direct activities and physical structures of coastal inhabitants, laws created by society, or technology that alters the opportunities for the people. The section “Overview” of the report from the C-GOOS III session (Accra, Ghana, 12-15 April, 1999) begins with the following statement: “*As human populations and activities increase in the coastal zone, the combined effects of global climate change and human alterations of the environment are expected to be especially pronounced in coastal waters of the global ocean*.” Table 1 from the same report contains seven “Perturbations & Stresses,” all of which can be linked to human activities on land or in freshwater. A primary way of including this perspective is the explicit link to GTOS.

GTOS has 5 focus issues of global concern:

- changes in land quality,
- availability of freshwater resources,
- loss of biodiversity,
- climate change,
- impacts of pollution and toxicity.

All of these are issues that impinge upon the environmental health of the coast. Furthermore, it has established a sampling regime that includes parameters that would be directly applicable to the needs of C-GOOS and protocols that could be interfaced with those of C-GOOS.

Challenges

- Pilot project based network. Pilot projects are often opportunistic and what may be an opportunity for coastal observations may not be so for the terrestrial counterparts and *vice-versa*.
- Different sampling strategies and indices. There is a need to coordinate timing and indicators whenever possible.
- Different end-points/users. Product-users may actually have separate and even conflicting purposes and demands.
- Different funding and administrative units. Administration of programs is separate from the agencies in the UN and at the national or local levels. Cooperation for funding and implementation may be problematic.

Linkage Strategies

Mechanisms should be established to foster cooperation between C-GOOS and GTOS activities and provide results in a manner that allows synergism. Examples of how GTOS focus issues could impact the coast and be of consequence to C-GOOS are numerous. Here are a few:

- Eutrophication and sedimentation of coastal waters is directly a result of land use and land management (or lack there of) within watersheds.
- Salinity regimes and resultant community structure in estuaries and coastal waters is dependent upon how freshwater resources are appropriated.
- The effects of sea-level rise on the coastal landscape depend on the human activities and structures on that landscape and how that population of humans is managing the land-sea margin.
- Harmful algae blooms in coastal waters may be promoted by eutrophication resultant of land use and coupled to freshwater harmful algae blooms.
- The occupations and life styles of coastal inhabitants may depend on availability of opportunities and levels of technology for agriculture, industry, forestry, tourism, and fisheries. Alterations of activities and management practices in the former 4 may affect the last.
- The use and management of freshwater resources may affect stocks of migratory freshwater-dependent fish.

Pilot project based network. Proposals to C-GOOS or to GTOS involving coastal areas should include a section recognizing the importance of the linkage of the 2 programs. Specific linkages for the project should be identified and addressed in the research or monitoring plan, if appropriate. If formal action on these linkages cannot be taken under the proposed research, then a mechanism needs to be developed to allow the possibility of activities by others. This may require coordination between C-GOOS and GTOS at the administrative level.

Sampling strategies and indices. GTOS has a formal, hierarchical sampling program (GHOST). C-GOOS has many of the same components, but it has not been developed in such a formal way. Furthermore, sampling in open aquatic systems may require different strategies than those used for terrestrial systems. Coordination of protocol and data management is essential.

End points/users. Both programs are “user driven” in the development of observing plans. But users may be different even within the same region. Mechanisms are needed to promote the interaction of users as well as scientists in resolving potential conflicts.

Funding and administrative units. High-level coordination is necessary to take advantage of opportunities that may arise from one program in prompting response in the other.

It is clear that a mechanism is necessary to review these various aspects of linkage with a regular and ongoing procedure. A major challenge is to develop a sustainable mechanism with minimal bureaucracy.

Opportunities

One immediate way to link C-GOOS and GTOS is through individual projects, especially pilot projects. Cooperation between the C-GOOS and GTOS may be obtainable in 4 ways:

(i) coordination of projects that are separately being developed,

(ii) development of a GTOS project in support of an ongoing C-GOOS project,

(iii) development of a C-GOOS project in support of an ongoing GTOS project,

(iv) use of common resources for joint or separate projects.

Projects are currently being developed separately by C-GOOS and GTOS. Two co-developing projects are GOOS-Africa and the Southern Africa Project by GTOS. The former is designed to improve "*infrastructure in support of operational oceanography and marine meteorology*" and "*support sustainable integrated coastal management*". The latter "*will serve to develop an integrated approach to agriculture and rural development, with respect to data management on terrestrial ecosystems interactions*". This project will conduct preparation studies in four countries (presumably South Africa, Zimbabwe, Kenya and Uganda) "*to assess the availability, quality and institutional capacities to collect and use data and information on terrestrial and freshwater ecosystems*" Can there be coordination of these activities?

Considerable attention is being given to an initiative to establish an observing system in the Adriatic Sea (CAOS). C-GOOS is to use this as a model project. Although GTOS does not have a supporting project in this region, one may be appropriate. Actions for the control of nutrient loading to the northern Adriatic will have to involve land and freshwater management. There is obvious interest in the area by individual nations. Active research and monitoring programs exist in the countries. There is international interest, such as with the International Long-term Ecological Research (ILTER) program. Perhaps this is an opportunity for GTOS to act in support of activities of C-GOOS.

GTOS has two projects that may be of interest to C-GOOS. The first is the Net Primary Productivity (NPP) project. Several countries will coordinate activities on the ground and via satellite images (a new Moderate Resolution Imaging Spectroradiometer (MODIS) sensor for leaf area index) to estimate NPP and net ecosystem productivity. This will be done along the coastal and estuarine landscape as well as inland. Not only is this a GTOS project that may interface with C-GOOS, it represents an opportunity for the two programs to share common scientific resources of satellite imagery. Finally, GTOS is trying to develop a project to relate NPP to biodiversity in coordination with the International Biodiversity Observing Year (IBOY). Biodiversity along the coast is shared concern by both programs. Opportunities may exist to use this shared concern to promote cooperation.

4. RELATED PROGRAMS AND ACTIVITIES

4.1 EXISTING OPERATIONAL PROGRAMS: POTENTIAL BUILDING BLOCKS OF C-GOOS

Thorkild Aarup provided an update on IOC's compilation on a global inventory of coastal monitoring systems.

A GOOS Project Office task team started in early June 1999 to collect relevant information on coastal monitoring systems. The aim was to present a version 1.0 inventory at the C-GOOS IV panel meeting (November 2-5, 1999) and at the LMR III panel meeting (December 8-11, 1999).

Information about national coastal monitoring systems was searched and assembled from:

- existing inventory sources from UNEP, ICES, and other regional and international bodies,
- Internet searches,
- national (GOOS) reports from the I-GOOS meeting (June 23-25, 1999), the GOOS commitments meeting (July 5-6, 1999), and other relevant IOC reports,
- knowledge which the team and/or colleagues might have about monitoring activities in specific regions,
- information solicitation at meetings,
- a direct IOC request in form of a circular letter to Member States.

The focus was on inventorying sustained/long-term routine marine measurements from fixed platforms and buoys and routine ship-based monitoring surveys (of for instance water quality or fish stocks). Short-term scientific cruises and projects were not to be included in this inventory exercise.

An IOC circular letter was mailed in August, 1999 to all IOC Member States (126 in total) asking for information on national coastal monitoring systems. About 20 countries responded to the letter and their information was included in the inventory.

In compiling the version 1.0 inventory the task team tried to accommodate the immediate information needs of the C-GOOS and LMR panels by having an eye out for information on monitoring systems that included key properties and processes that were considered to be required for the measurement programs of C-GOOS and LMR. Table 2 from the report from the C-GOOS III session (Accra, Ghana, 12-15 April, 1999) lists some key properties and processes to be considered for the measurement program of C-GOOS. Many of these properties and processes were also considered important by the LMR panel, which in addition also needed information on: top predators (e.g., sharks, seabirds, marine mammals), commercial shellfish, forage (e.g., non-commercial fish) and nekton, benthos, zooplankton and phytoplankton.

The gathered inventory information covers a wide spectrum of measured variables ranging from meteorology to hydrology to oceanography and to living marine resources. The information details available about national coastal monitoring systems and the responses to the IOC circular letter varied a lot. For some systems, information was only available in broad textual terms, others were described in greater detail, for instance with station metadata listings. Consequently the inventory was developed along two tracks:

- a descriptive one which also includes web-links to institutions/organizations responsible for coastal monitoring systems.
- a station metadatabase.

A simple web-browser based map interface to the station metadatabase was demonstrated. The map interface enables exploration of the station metadatabase in greater detail by providing simple display of station locations for a given parameter family and/or country/region.

The C-GOOS panel expressed satisfaction with the progress on the inventory compilation. It was noted that the map display interface to the station metadatabase would be a useful tool when discussing implementation. The representative of GTOS, Dr. Robert Christian, stated that GTOS would be interested in an inventory of GTOS-related coastal activities and would be interested in “interfacing” with the inventory of coastal monitoring systems. Furthermore the C-GOOS panel did not request major updates to the current version 1.0 inventory before their next panel meeting (May 2-6, 2000).

4.2 AN OCEAN THEME FOR THE IGOS PARTNERSHIP

The Integrated Global Observing Strategy (IGOS) unites the major satellite and surface-based systems for global environmental observations of the atmosphere, oceans and land. The IGOS Partnership established in 1999 a thematic approach to implementation of the IGOS. Recognizing that other themes will emerge, the "Ocean Theme" was chosen to be the "pathfinder" in this approach and an Ocean Theme Team was assembled to formulate guidance. A goal of the Ocean Theme Team is to realize the full potential of current and planned observations, while identifying potential gaps in future observations that represent critical ocean observational records.

An Ocean Theme Paper had been developed by a team chaired by Dr. Eric Lindstrom at the 13th Plenary of Committee on Earth Observation Satellites, 10-12 November 1999 in Stockholm, Sweden. Dr. John Marra has taken over this task.

Tom Malone summarized the comments of the C-GOOS panel (largely provided from Sinjae Yoo and Stephen Walker) to the theme paper.

In general, coastal issues are not sufficiently addressed. More specifically, the "Ocean Biology" (ocean color) description does not properly address coastal problems in terms of either algorithm development and validation or important issues such as long-term trends in phytoplankton biomass and productivity in response to nutrient enrichment or the detection of events such as harmful algae blooms.

Currently most of ocean color data are used for case 1 waters (blue ocean) while the use of data for case 2 waters (mostly coastal waters) are limited due to the lack of case-2 algorithms. In case-1 water, phytoplankton is the major variable and "solving the equation" is relatively simple and robust. On the other hand, there are at least three independent variables that determine color in case-2 waters. This means that more complicated and site-specific algorithm(s) is (are) required. Therefore, the development of algorithms for case-2 waters is a challenge and, to our knowledge, there are no operational case-2 algorithms at the moment.

Although the document mentions "*future development of hyperspectral algorithms for case-2 waters…*", it is the lack of a proper algorithm, not the lack of hyperspectral sensors, that currently limits the utility of ocean color in the coastal waters. Case 2 algorithms can be developed for currently available sensors such as Sea-viewing Wide Field-of-view Sensor (SeaWiFS). This requires extensive in situ data sets of more parameters (since there are more independent variables) on a regional basis. The required bio-optical surveys and research are made by only a few nations and methodology for many of the parameters has not been standardized. Thus, there is an immediate need to coordinate the development of common standards and a global network of coastal sites where such measurements are made.

Also, unlike other types of remote sensing, ocean color sensors have different bands and algorithms, which makes comparisons more complicated. For example, Coastal Zone Color Scanner (CZCS), Ocean Color and Temperature Scanner (OCTS), and SeaWiFS have different wavelengths for some bands in the green (CZCS had 520 and 550 nm; OCTS had 520 and 565 nm: SeaWiFS has 510 and 555 nm). As a result, algorithms are different. It is not clear at this moment if CZCS pigments and SeaWiFS pigments are comparable. (Sinjae Yoo's analysis on East Sea/Japan

Sea SeaWiFS data indicates it is not). Again, the inter-comparison issue is indirectly mentioned, but this issue should be stressed.

In conclusion:

- Ocean biology: A key issue is the proper inter-calibration and comparison method for ocean color sensors that use different bands and algorithms to evaluate decadal changes in the biomass and productivity.
- Despite the importance of coastal ocean biology, ocean color data are not fully utilized due to the lack of operational algorithm(s) for case 2 waters. Research to address this issue should be a high priority.
- The C-GOOS Panel is in the process of determining requirements for remote sensing in coastal waters for GOOS and hope to have this completed in early 2000. This will include a more integrated picture of the roles of remote sensing in the context of *in situ* sensing and measurements. As part of this process C-GOOS intend to solicit input from the IOCCG.

4.3 HEALTH OF THE OCEANS (HOTO)

The HOTO Panel held its most recent meeting in 1997 in Singapore. The meeting concentrated on questions relating to implementation with several countries of potential areas for regional implementation being presented and discussed. All other direct Panel work has been on indicators culminating in a conference on “Human Health Indicators” being held in Bermuda in November 1999.

Because of the close integration of the HOTO Panel and GIPME (Global Investigations of Pollution in the Marine Environment) Program interests, several related topics have also been pursued. These include dissemination and training in rapid assessment techniques for marine pollution (RAMP) for which training workshops was held in Costa Rica in September 1999. These techniques are predominantly biological response measures useful for determining the health status of coastal areas. Effort has also been devoted to the development of sediment quality guidelines for application in relation to the London Convention 1972, the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities (the GPA) and the various regional mechanisms. IOC-UNESCO support for the assessments being undertaken by the Group of Experts on the Scientific Aspects of Marine Environment Protection (GESAMP) has also been provided by GIPME. Through the linkages being developed between GESAMP and Global International Waters Assessment (GIWA), there are also GIPME connections and involvement in GIWA.

Finally, it was noted that, with the development of a new approach to quantifying global human health detriment from diseases, some new estimates of the human health consequences associated with exposures to human sewage constituents suggest that this aspect of the condition of the marine environment may have been underestimated. This may require some adjustment to the priority assigned to human health protection in HOTO to be adjusted in relations to other concerns.

4.4 GLOSS LINKAGE

Eduardo Marone reported on his participation in the GLOSS Group of Experts meeting in Toulouse, France in May 1999. He provided GLOSS with a status report on C-GOOS developments and had described the components in the C-GOOS strategic design plan. He stressed that C-GOOS would depend heavily on the GLOSS network of stations for the implementation of the C-GOOS design and that additional sea-level stations might be needed. Eduardo Marone had also suggested that there could be areas where collaboration between C-GOOS and GLOSS would be possible, most notably with respect to sharing of stations, data collection and capacity building (joint courses).

George Needler mentioned that GLOSS was an implementation program and suggested that C-GOOS provides scientific input to GLOSS within the newly established GLOSS scientific advisory sub-group.

4.5 VIETNAMESE TYPHOON FORECASTING SYSTEM

Typhoons regularly cross Vietnam causing considerable damage in the Vietnamese coastal zone. Yearly an average of 6 typhoons hit the Vietnamese coast but a maximum of 14 typhoons have been observed in one year. The Norwegian Government has been advising Vietnam on the development of a "Strategy and Action Plan for Mitigating Water Disasters in Vietnam". At the C-GOOS II and C-GOOS III sessions (GOOS reports no. 63 and 76) Johannes Guddal had suggested to make this project a C-GOOS pilot project.

A detailed description of the Vietnamese Typhoon Forecasting System was provided by Nguyen The Tuong (see Annex IV).

During the panel meeting it was proposed by Johannes Guddal, Nguyen The Tuong, Wang Hong and B.R.Subramanian to extend this pilot project geographically to the South China Sea and possibly the coast of India. B.R.Subramanian offered to organize a workshop in Madras, India in September/October 2000 to explore the geographic extension further. It was stressed that if the pilot project is extended to the Indian Ocean region, linkage should be made to the IOC, WMO, International Hydrological Program (UNESCO-IHP) sponsored proposal on "Storm Surge Disaster Reduction for the Northern Part of the Indian Ocean".

4.6 THE BALTIC OPERATIONAL OCEANOGRAPHIC SYSTEM (BOOS): DESIGN, IMPLEMENTATION & MAINTENANCE

BOOS is a cooperation between national governmental agencies in the countries surrounding the Baltic Sea responsible for collection, model operations and production of forecasts, services and information for the marine industry, the public and other end-users.

Oceanographic measurements in the Baltic Sea dates back to 1740 and several observing systems/monitoring programs have gradually been put into place each serving their own needs. These observing activities were established as a measure to counter problems/requirements. The observing activities have often been part of the monitoring programs established under intergovernmental organizations and conventions such as the International Council for the Exploration of the Sea (ICES) established in 1899, the Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM) established in 1974 and the Convention for the Protection of the Marine Environment of the North-East Atlantic (Oslo and Paris Conventions - OSPAR) originally established in 1972.

Since the formation of EuroGOOS its Baltic Sea Task team has started to discuss, plan and coordinate activities related to operational oceanography in the Baltic Sea with the purpose of creating a Baltic Operational Oceanographic System.

The objectives of BOOS are:

- Improve and further establish services to meet the requirements of environmental and maritime user groups;
- Co-ordinate, improve and harmonize observation and information systems;
- Increase the quality of and harmonize user-oriented operational products;
- Decrease the production costs of public products and services by sharing the workload;
- Cooperate with HELCOM and other relevant bodies with the aim to avoid duplication of work and to maximize mutual assistance;
- Identify new customers for operational oceanographic products;
- Further develop the market for operational oceanographic products;
- Develop BOOS pursuant to the GOOS Principles;
- Provide high quality data and long time series required to advance the scientific understanding of the Baltic Sea;
- Provide data and forecasts to protect the marine environment, conserve biodiversity, and monitor climate change and variability.

BOOS is being built on existing systems and will develop mainly through commitments from the participating agencies. Already at present most of the components for an operational system are available within national or international programs. The main tasks for BOOS will be to co-ordinate activities, develop operational routines, improve components and harmonize products based on user requirements.

A BOOS Implementation Plan for 1999-2003 has been published (http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/BOOS2000.pdf). During the five-year period BOOS will focus on the implementation of the following projects:

- Optimum Design of a Sustained Ocean Observing Network Operational Oceanography;
- Use of Remotely Sensed Data (Radar, Satellite);
- Development of a Prototype Ocean Data Analysis System;
- Model Coupling and optimization in BOOS;
- Ecological Modeling;
- Harmful Algae Blooms;
- Anthropogenic Load Model;
- Current Assessment of the State of the Baltic Environment;
- A BOOS information system – InfoBOOS.

Can BOOS serve as an example for other areas? BOOS is a test and demonstration case. It is built on the experiences of intergovernmental and institutional cooperation gained during a century. BOOS is also built for the Baltic conditions and for the regional requirements, but still there is a lot of success and failure from past Baltic monitoring activities which could serve as good and bad examples. As BOOS components must be robust, sustainable and cost-effective, the experience of what can be achieved by a certain joint effort may serve as a guidance for others.

4.7 IAEA'S MARINE MONITORING PROGRAM

Stephen de Mora described the activities at the Marine Environment Studies Laboratory (MESL) which is part of the International Atomic Energy Agency's Marine Environment

Laboratory based in Monaco. The IAEA-MEL is the only marine laboratory in the UN system, and within MEL, MESL is responsible for investigating non-nuclear pollution in the marine environment. The bullets below outline the full range of MESL activities in marine pollution assessment and research. Many aspects fall under the auspices of the Interagency (IAEA, UNEP, and IOC/UNESCO) Program on Marine Pollution. More information is available www.iaea.org/monaco.

1. Technique development in marine analytical chemistry
   - New technologies (ICP-MS; hyphenated techniques)
   - New analytes/pollutants (biocides; speciation analysis)
2. Formulation and maintenance of reference methods and guidelines
   - 56 reference methods and 2 technical bulletins all are available in English, and some have been translated into French or Spanish
   - Methods are reviewed and revised on a regular basis, preferably every 4-5 years
   - MESL serves as a focal point for the requests of published material and compilation of users' comments
3. Production of Certified Reference Material (CRM)
   - CRMs are vital for training programmes, intercomparison studies and for regional laboratories to maintain their own AQC procedures
   - MESL has been involved in the production of >20 CRMs characterized with respect to a wide range of organic and metallic pollutants in the past two decades
   - Some CRMs are available for a nominal handling fee to participating laboratories from IAEA Analytical Quality Control Services
4. Intercomparison exercises
   - MESL has organized 25 intercomparison exercises in the past 20 years
   - Although notable achievements have been obtained in regional laboratories, the latest exercise still highlights problems with trace element analyses
5. Education
   - MESL organizes numerous training exercises, both regionally and in-house in Monaco
   - For example, on behalf of UNEP and the International Mussel Watch (IMW), training was conducted in African and Latin American States prior to the commencement of their monitoring programmes
6. Capacity Building
   - MESL staff undertakes quality assurance missions to laboratories throughout a given region and can provide an independent, objective assessment of analytical capabilities and capacities. Objective advice can be provided to prioritize purchase and capacity building to suit the regional targets set.
   - MESL can advise and facilitate the purchase of laboratories supplies (ensure appropriate quality of reagents, readily acquire materials that may be difficult and more expensive to obtain by regional laboratories)
   - Similarly, instrumentation can be purchased centrally.
   - Installation and maintenance of equipment by MESL personnel can be timely and cost-effective.
7. Monitoring Programmes
   - MESL provides expert advice on the establishment of monitoring programmes
   - Assistance is provided with respect to field work and sample collection

8. Research Activities
- Firstly, research is necessary to maintain in-house analytical and marine environmental expertise and thereby to rest in the position to advise on all above points.
- Secondly, expert advice can help regional facilities extend their capabilities beyond simply monitoring programmes.
- Internships to work in Monaco allow access to sophisticated instrumentation, appropriate for specialist training and pilot studies.

4.8 THE U.S. GOOS INITIATIVE

In response to a request from the U.S. Congress a task team (chaired by Worth Nowlin and Tom Malone) had drafted and submitted the report "*Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System*" (http://www-ocean.tamu.edu/GOOS/sw.html). The plan describes the rationale for the observing system and outlines the general requirements for an integrated system that includes both oceanic and coastal components. In regard to the coastal component, the plan makes it clear that (i) many of the elements for an integrated and sustained system are in place; (ii) none of these elements are both integrated and sustained; and (iii) the requirements for the coastal component require a major research and development effort to become fully operational, especially in the realm of biological and chemical sensors.

The Laboratory Network (LABNET) project is being designed under the auspices of the National Association of Marine Laboratories (http://www.mbl.edu/html/NAML/) in USA. LABNET will network laboratories for more timely access to data and information and cost-effective monitoring of coastal waters. The types of data sets that LABNET would network are specific types of monitored information about coastal habitats including: lagoons, bays, estuaries, marshes, rocky shores, coral reefs. significant biological events such as: red tides, diseases in marine organisms, species geographic ranges. LABNET could become a part of the community related observing activities envisioned in the Initial Global Network.

4.9 REPORT OF THE JOINT (LMR/C-GOOS) AD HOC COMMITTEE ON HABITAT

The LMR and C-GOOS panels were charged by the GOOS Steering Committee (GSC) to "*identify 2-3 members who will form an ad hoc joint committee to address the issue of habitat loss from a fisheries perspective (i.e., incorporating into the C-GOOS design observations required to assess and predict the effects of habitat loss on the capacity of coastal systems to support fisheries*)". The LMR panel appointed Mike Laurs and Bodo von Bodungen and C-GOOS appointed John Ogden and Carlos Duarte to the joint committee. The committee report will be available at the C-GOOS V meeting.

5. OTHER BUSINESS

5.1 C-GOOS MEETING REPRESENTATION

Eduardo Marone would represent C-GOOS at the LOICZ 4th Open Science Meeting in Bahía Blanca, Argentina 15-18 November 1999, and Julie Hall would represent C-GOOS at the International Coastal Symposium 2000 is to be held in Rotorua, New Zealand April 24-28, 2000. Eduardo Marone proposed to present a poster on C-GOOS and Thorkild Aarup would provide Eduardo Marone with a draft text.

5.2 VENUE FOR C-GOOS V

Jozef Pacyna offered to arrange the meeting in Gdansk, Poland (Technical University of Gdansk). B.R. Subramanian would inquire about hosting the meeting in Goa, India. It was left to Tom Malone and Thorkild Aarup to explore the venue options further and report back to the panel.

ANNEX I

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ANNEX II

AGENDA

Stakeholder-user group meeting on Tuesday, 2 November 1999
Panel Meeting, 3-5 November 1999

1. **OPENING** (Wang Hong, Malone, Aarup)

2. **WORKING ARRANGEMENTS**

2.1 ADOPT AGENDA & ELUCIDATE GOALS OF MEETING (Malone)
2.2 DESIGNATE RAPPORTEUR (Malone)
2.3 LOGISTICS & ADMINISTRATION (Wang Hong, Aarup)

3. **TOWARD A C-GOOS DESIGN PLAN**

3.1 REVIEW OUTLINE (Malone)
3.2 RESULTS OF STAKEHOLDERS' MEETING (Wang Hong)
3.3 THE INITIAL GLOBAL NETWORK
3.3.1 **Conceptual design** (Thompson)
3.3.2 **Benefits and Products** (Hall)
3.3.3 **Data Management** (Wang Hong)
3.3.4 **Capacity Building & Enhancements** (Marone)
3.3.5 **Implementation Mechanisms** (Needler)
3.3.6 **Identification and Solicitation of Pilot Projects** (Malone)
3.3.7 **Mechanisms for Sustaining and Enhancing C-GOOS** (Ehler)
3.4 PILOT PROJECTS
3.4.1 **Biodiversity and Habitats** (Zingone)
3.4.2 **Coastal circulation & Natural Hazards** (Needler)
3.5 JOINT ACTIVITIES
3.5.1 **LOICZ/C-GOOS** (Pacyna)
3.5.2 **GTOS/C-GOOS** (Christian)

4. **RELATED PROGRAMS & INITIATIVES**

4.1 EXISTING OPERATIONAL PROGRAMS: POTENTIAL BUILDING BLOCKS OF C-GOOS (Aarup)
4.2 AN OCEAN THEME FOR THE IGOS PARTNERSHIP (Aarup)
4.3 HOTO UPDATE (Bewers)
4.4 GLOSS (Marone)
4.5 VIETNAMESE TYPHOON FORECASTING SYSTEM (Nguyen The Tuong, Ryabinin,Guddal)
4.6 THE BALTIC OCEANOGRAPHIC OBSERVING SYSTEM: DESIGN, IMPLEMENTATION & MAINTENANCE (Dahlin)
4.7 IAEA's MARINE MONITORING PROGRAM (de Mora)
4.8 THE U.S. GOOS INITIATIVE (Malone)

4.9 REPORT OF THE JOINT (LMR/C-GOOS) Ad Hoc Committee On Habitat (Malone)

5. BREAKOUT GROUPS (draft the C-GOOS Design Plan)

5.1 WORKING SESSIONS (DETAILED OUTLINES OF CONTENT)
5.2 REPORT OF BREAKOUT GROUP CHAIRS (WITH DISCUSSION AND FEEDBACK)
5.3 WORKING SESSIONS (DRAFT C-GOOS DESIGN PLAN)

6. INTERSESSION ACTION PLAN

Draft the C-GOOS IMPLEMENTATION STRATEGY

7. OTHER BUSINESS

7.1 HOTO, LMR AND C-GOOS INTEGRATION MEETING
7.2 LOICZ SCIENCE MEETING NOVEMBER 1999
7.3 INTERNATIONAL COASTAL SYMPOSIUM 2000, APRIL 2000
7.4 VENUE FOR CGOOS V
7.5 FALL, 2000: C-GOOS + LMR + HOTO = GOOS

ANNEX III

The Strategic Design Plan for the Coastal Component of GOOS

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ANNEX IV

VIETNAMESE STORM SURGE FORECASTING AND WARNING SYSTEM

Valdimir Ryabinin, Nguyen The Tuong and Johannes Guddal

On November 30, 1998, The Government of the Kingdom of Norway and The Government of the Socialist Republic of Vietnam entered into an agreement (the "Agreement"), which envisages the development of a "Data Collection and Satellite Transmission System Including Storm Surge Modeling for Typhoon Forecasting and Warning".

The implementation of the Agreement from the Government of the Kingdom of Norway side is in the hands of the Norwegian Agency for Development Cooperation (NORAD). The Ministry of Planning and Investment (MPI) represents the Socialist Republic of Vietnam. The actual implementation of the Project takes place within the Hydrometeorological Service of Vietnam (HMS). Two major institutions of HMS namely the Marine Hydrometeorological Centre (MHC) and the National Centre for Hydrometeorological Forecasting (NCHMF) participate in the project. In pursuance of the Agreement a contract on institutional cooperation was signed between the HMS and the Norwegian Meteorological Institute (DNMI), which acts as the Norwegian partner institution and is responsible for general and specific professional assistance to the project. Dr. Nguyen The Tuong, the director of MHC is the Project Director.

The participants of the project consider it strongly linked to the activities of the WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) and contributing to the development of the Global Ocean Observing System (GOOS).

Three important components of the Typhoon Warning System (TWS) are being developed under the Agreement including:

- a network of four automatic oceanographic buoys transmitting metocean data via satellite to the existing central station at HMS where the data enter a database;
- a network of four automatic coastal and estuary water level stations transmitting data via satellite or telephone line to the existing central station at HMS with a program for analysis and presentation of collected data;
- a numerical storm surge prediction model.

In addition to the implementation of the three TWS components the Agreement will facilitate further institutional and technical strengthening of the HMS through cooperation with DNMI.

The network of four automatic oceanographic buoys transmitting metocean data via satellite to the existing ground station at HMS is implemented by the Oceanor Ltd. of Norway. The acquisition of the network of coastal water level stations and the storm surge model was based on the following considerations.

Area to be covered by storm surge forecasts. Potential sub-areas requiring higher and coarser resolution storm surge modeling.
The area to be covered by storm surge forecasts includes the whole coastline of Vietnam. There are three natural sub-areas of the coast, for which finer resolution forecasts may be required namely (a) northern zone from latitude 15°N to 22°N; (b) southern zone from latitude 8°N to12°N, and (c) middle zone from latitude 12°N to 15°N. The northern zone including the Gulf of Tonkin is subject

of most frequent and severe typhoons and storm surges. Nevertheless, typhoons and storm surges may affect the other areas as well.

How the storm surge warning will be used, focal places, response times, authorities, media.
Availability of storm surge protection means such as along sea walls, mangroves, etc. Visual signals ('watch lights') are used to show that a storm surge warning is in effect. Governmental media such as radio and television also broadcast the warnings. Warnings are generated by the Hydrometeorological Service of Vietnam and are forwarded to relevant central and local authorities and to regional hydrometeorological forecasting centers for further update and distribution at local level.

Protection means include dikes in the North and Central areas. Some of them require considerable restoration effort. The dikes were built sufficiently long time ago. Since their construction they have decayed in some places. In addition, their design did not take into account the on-going mean sea level rise. There are some mangroves in the far South of Vietnam. However, they are being used as building material by local population and hence are being destroyed quite rapidly.

A considerable attention will be given in future for optimization of and strengthening the warning system associated with the storm surge forecasting.

Existence of adequate resolution bottom topography data for the area of concern, for larger off-shore area, for sub-areas requiring better resolution modeling, and for the on-shore areas subject to inundation in the course of a storm surge. Existence of data on bottom soil type (for calculation of bottom friction) for areas closer to the coast.

A comprehensive database on land use and topography of the coastal impact zone was created in the course of the Vietnam Coastal Zone Vulnerability Assessment Project, which was conducted jointly by the Government of the Netherlands (represented by the Ministry of Foreign Affairs) and the Government of the SR of Vietnam (represented by the HMS).

Information on bottom soil type exists for areas along the coastal zone up to depth of 30 m.

Existing data on meteorological parameters, sea water temperature and salinity in the offshore area.

Monthly mean climate data on meteorological parameters, sea water temperature and salinity exists for the whole area of South China Sea with resolution of 5'.

Effects of tides on storm surges. Tide character (diurnal, semi-diurnal, mixed).
Availability of tidal harmonic constituents for the area of concern or availability of sea level variation observations with length more than one-two months at locations suitable for posing boundary conditions.

Strong interaction of tide and storm surge is confirmed. Complex tidal characteristics including diurnal, semi-diurnal, mixed waves are observed in the whole off-shore area. There are 5 tidal gauges recording sea water level along the coastal line of Vietnam and 2 stations in the off-shore area. Duration of some observation series is longer than 20 years.
Very precise tidal predictions may be apparently obtained if it is possible to specify from 10 to 12 tidal constituents along the above mentioned open boundaries. Such computations were conducted at the Academy of Sciences of SR Vietnam.

Sources of meteorological data (atmospheric pressure at MSL) and wind. Availability of objectively analyzed (OA) pressures and winds for the off-shore area. Resolution of OA winds and atmospheric pressure objective analyses and forecasts. Availability of forecast winds and atmospheric pressures. Existing tropical cyclone forecasts. Their types. Estimates of the forecast skill (overall and seasonal *distribution). Availability of atmospheric pressure and wind forecasts in digital form on electronic media.*

If a typhoon appears in the off-shore area (at distances to the shoreline more than 500 km), the forecasting center issues the following information: location of typhoon center and atmospheric pressure at it, typhoon expected track, maximal wind speed, the velocity of typhoon propagation. The prediction is updated every 6 hours (at 00, 6, 12,18 GMT). Radius of maximal wind is estimated by statistical techniques. Whenever the typhoon appears in the closer area (at distances to the shore line less than 500 km), the forecasting center issues the following information: location of typhoon center, atmospheric pressure at the center, maximal wind speed, the velocity of typhoon propagation, the landfall point of the typhoon. The prediction is updated every 3 hours (at 00, 03, 06, 09, 12, 15, 18, 21 GMT).

The typical uncertainty of the predicted landfall point is about 100 km.

The NCHMF has access to coarse resolution numerical meteorological forecasts available on the WMO Global Telecommunication System (GTS) and on the Internet. In particular, there is quite regular access to meteorological forecasts by the Japan Meteorological Agency.

There is no short-term plan for implementing an objective analysis/data assimilation/hydrodynamic prediction system at the meteorological forecasting service. However, such activities are envisaged in not so distant future. Predictions of typhoon parameters are based on satellite data, use of parallel predictions by other meteorological centers in the region and are produced by a forecaster on duty. Accordingly, the input data for the storm surge model will be calculated using a parametric distribution of wind speed and atmospheric pressure in a tropical cyclone.

Available computing power for the storm surge forecasting. Type of computer(s), operating system, programming languages available, speed and RAM, disk space available for storm surge forecasting related activities (at present and foreseeable for nearest 3 years).

The actual storm surge prediction will be carried out at the NCHMF, which is undergoing quite rapid technical development. Most likely the computations will be made on reasonably powerful personal computers such as Pentium II/III 300-450 MHz with adequate RAM and HDD storage capacities.

In addition, there are plans at the HMS to acquire some work stations but concrete information on this matter is not available.

At present the dominating OS is Windows (95/98/NT) and it is likely that it will keep its significance over the 3-year period. Also, there is a possibility that some of the computers at the center will run under Linux in future. There is no problem with code compilers, such as various versions of FORTRAN. Shortage of modern visualization software is noteworthy.

Personnel engaged in storm surge forecasting. Education and experience in mathematical modeling of ocean circulation and sea level changes (at present and foreseeable for nearest 3 years).

The knowledge and experience of the personnel both at the MHC and at the NCHMF is more than sufficient for successful implementation of the storm surge forecasting system. Overwhelming majority of the staff members graduated from Russian institutes, and almost all of them possess a M.S. or Ph.D. degree.

Availability of historic data useful to make storm surge hindcast verification studies.

A comprehensive project on past storm surges study and hindcasting was conducted by institutes of the Academy of Sciences of Vietnam.

Importance of the on-land flood and storm surge interaction including effects of on-land water bodies and river discharges.

There is consensus on the importance of the storm surge interaction with on-land flooding, which is caused by precipitation associated with seasonal/monsoon activity and tropical cyclone rain. HMS provides information of flooding areas and predicted rainfall data associated with the typhoon. It was decided, however, that activities aimed at account of such interactions would go much beyond the scope of this project.

The prediction of river water discharge is provided for the main rivers in the flood season. For the actual determination of the area affected by a storm surge and for prediction of its height it will be important to take into account interaction of the storm surge with on-land water basins in the area of the River Mekong delta. It is expected that some part of the surge volume may inundate lands located rather far from the sea. The above mentioned Coastal Zone Vulnerability Assessment Project created considerable insight into this matter.

It is planned to complete the installation of tidal gauge stations and numerical models before the tropical cyclone season of the year 2000. Therefore it is possible to expect that already in the year 2000 SR of Vietnam will be better protected from storm surges in all aspects that are dependant on the their forecasting and warning system.

ANNEX V

LIST OF ACRONYMS

AUV	Autonomous Underwater Vehicle
BOOS	Baltic Operational Oceanographic System
C-GOOS	Coastal Panel of GOOS
CAOS	Coordinated Adriatic Observing System
CBA	Cost benefit analysis
CLIVAR	Climate Variability and Predictability (WCRP)
CMM	Commission for Marine Meteorology (WMO)
COMET	Coorporative Program for Operational Meteorology Education and Training
CZCS	Coastal Zone Color Scanner
DBCP	Data Buoy Cooperation Panel
DNMI	Det norske meteorologiske institutt (Norwegian Meteorological Institute)
DPSIR	Driving Force-Pressure-State-Impact-Response
EU	European Union
EuroGOOS	European GOOS
GEF	Global Environmental Facility
GESAMP	Group of Experts on the Scientific Aspects of Marine Environment Protection
GIPCO	GOOS Integrated Panel for the Coastal Ocean
GIPME	Global Investigation of Pollution in the Marine Environment
GIWA	Global International Waters Assessment
GLOSS	Global Sea-Level Observing System
GOOS	Global Ocean Observing System
GSC	GOOS Steering Committee
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
HAB	Harmful Algal Bloom
HELCOM	Baltic Marine Environment Protection Commission
HOTO	Health of the Oceans
HMS	Hydrometeorological Service
IAEA	International Atomic Energy Agency
ICAM	Integrated Coastal Area Management
ICES	International Council for the Exploration of the Sea
ICSU	International Council of Scientific Unions
I-GOOS	Intergovernmental Committee for GOOS
IGOS	Integrated Global Observing Strategy
IGOSS	Integrated Global Ocean Services System
IHP	International Hydrological Program (UNESCO)
ILTER	International Long-term Ecological Research
IMW	International Mussel Watch
IOC	Intergovernmental Oceanographic Commission (UNESCO)
ISO	International Standardization Organisation
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology (WMO/IOC)
JDIMP	Joint Data and Information Management Panel
JGOFS	Joint Global Ocean Flux Study
LABNET	Laboratory Network

LMR	Living Marine Resources
LOC	Local Organizing Committee
LOICZ	Land-Ocean Interactions in the Coastal Zone
MHC	Marine Hydrometeorological Centre
MODIS	Moderate Resolution Imaging Spectroradiometer
MPI	Ministry of Planning and Investment
NCHMF	National Centre for Hydrometeorological Forecasting
NEAR-GOOS	North East Asian GOOS
NGOs	Non-governmental Organizations
NMEFC	National Marine Environmental Forecasting Centre (China)
NMDIS	National Marine Data and Information Center
NOAA	National Oceanic and Atmospheric Administration (USA)
NOPP	National Oceanographic Partnership Program (USA)
NORAD	Norwegian Agency for Development Cooperation
NORLC	National Ocean Research Leadership Council (USA)
NPP	Net primary productivity
OCTS	Ocean Color and Temperature Scanner
OOPC	Ocean Observations Panel for Climate
QAQC	Quality Assurance and Quality Control
SeaWIFS	Sea-Viewing Wide Field-of-View Sensor
START	Global Change System for Analysis, Research and Training
TEMA	Training, Education and Mutual Assistance (UNESCO/IOC)
TWS	Typhoon Warning System
UNESCO	United Nations Educational, Cultural and Scientific Organisation
UNEP	United Nations Environment Program
WCRP	World Climate Research Program
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment

In this Series, entitled

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5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
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17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica lnternacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica ***(Spanish only)***
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources ***(Also printed in French and Spanish)***
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities ***(Also printed in Spanish)***
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CCPS Working Group on the Investigations of 'El Niño' (***Also printed in Spanish)***
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN(OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
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49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic ***(Also printed in French)***
54. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
56. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
57. First Meeting of the IOC *ad hoc* Group of Experts on Ocean Mapping in the WESTPAC Area

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58. Fourth Session of the IOC Consultative Group on Ocean Mapping
59. Second Session of the IOC-WMO/IGOSS Group of Experts on Operations and Technical Applications
60. Second Session of the IOC Group of Experts on the Global Sea-Level Observing System
61. UNEP-IOC-WMO Meeting of Experts on Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change
62. Third Session of the IOC-FAO Group of Experts on the Programme of Ocean Science in Relation to Living Resources
63. Second Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
64. Joint Meeting of the Group of Experts on Pollutants and the Group of Experts on Methods, Standards and Intercalibration
65. First Meeting of the Working Group on Oceanographic Co-operation in the ROPME Sea Area
66. Fifth Session of the Editorial Board for the International Bathymetric and its Geological/Geophysical Series
67. Thirteenth Session of the IOC-IHO Joint Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
68. International Meeting of Scientific and Technical Experts on Climate Change and Oceans
69. UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System
70. Fourth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
71. ROPME-IOC Meeting of the Steering Committee on Oceanographic Co-operation in the ROPME Sea Area
72. Seventh Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Spanish only)***
73. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed** in **Spanish)***
74. UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
75. Third Session of the IODE Group of Experts on Marine Information Management
76. Fifth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
77. ROPME-IOC Meeting of the Steering Committee for the Integrated Project Plan for the Coastal and Marine Environment of the ROPME Sea Area
78. Third Session of the IOC Group of Experts on the Global Sea-level Observing System
79. Third Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
80. Fourteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
81. Fifth Joint IOG-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
82. Second Meeting of the UNEP-IOC-ASPEI Global Task Team on the Implications of climate Change on Coral Reefs
83. Seventh Session of the JSC Ocean Observing System Development Panel
84. Fourth Session of the IODE Group of Experts on Marine Information Management
85. Sixth Session of the IOC Editorial Board for the International Bathymetric chart of the Mediterranean and its Geological/Geophysical Series
86. Fourth Session of the Joint IOC-JGOFS Panel on Carbon Dioxide
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88. Eighth Session of the JSC Ocean Observing System Development Panel
89. Ninth Session of the JSC Ocean Observing System Development Panel
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91. First Session of the IOC-FAO Group of Experts on OSLR for the IOCINCWIO Region
92. Fifth Session of the Joint IOC-JGOFS CO, Advisory Panel Meeting
93. Tenth Session of the JSC Ocean Observing System Development Panel
94. First Session of the Joint CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing
95. Third Session of the IOC Editorial Board for the International Chart of the Western Indian Ocean
96. Fourth Session of the IOC Group of Experts on the Global Sea Level Observing System
97. Joint Meeting of GEMSI and GEEP Core Groups
98. First Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
99. Second International Meeting of Scientific and Technical Experts on Climate Change and the Oceans
100. First Meeting of the Officers of the Editorial Board for the International Bathymetric Chart of the Western Pacific
101. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
102. Second Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
103. Fifteenth Session of the Joint IOC-IHO Committee for the General Bathymetric Chart of the Oceans
104. Fifth Session of the IOC Consultative Group on Ocean Mapping
105. Fifth Session of the IODE Group of Experts on Marine Information Management
106. IOC-NOAA *Ad hoc* Consultation on Marine Biodiversity
107. Sixth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
108. Third Session of the Health of the Oceans (HOTO) Panel of the Joint Scientific and Technical Committee for GLOSS
109. Second Session of the Strategy Subcommittee (SSC) of the IOC-WMO-UNEP Intergovernmental Committee for the Global Ocean Observing System
110. Third Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
111. First Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate
112. Sixth Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting
113. First Meeting of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS)
114. Eighth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of "El Niño" ***(Spanish only)***
116. Second Session of the IOC Editorial Board of the International Bathymetric Chart of the Central Eastern Atlantic ***(Also printed in French)***
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117. IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Fifth Session, USA, 1997

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121. IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional Global Ocean Observing System (NEAR-GOOS), Second Session, Thailand, 1997

122. First Session of the IOC-IUCN-NOAA *Ad hoc* Consultative Meeting on Large Marine Ecosystems (LME), France, 1997

123. Second Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), South Africa, 1997

124. Sixth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico, Colombia, 1996 ***(also printed in Spanish)***

125. Seventh Session of the IODE Group of Experts on Technical Aspects of Data Exchange, Ireland, 1997

126. IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), First Session, France, 1997

127. Second Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 1998

128. Sixth Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1997

129. Sixth Session of the Tropical Atmosphere - Ocean Array (TAO) Implementation Panel, United Kingdom, 1997

130. First Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 1998

131. Fourth Session of the Health of the Oceans (HOTO) Panel of the Global Ocean Observing System (GOOS), Singapore, 1997

132. Sixteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), United Kingdom, 1997

133. First Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1998

134. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IOC/EB-IBCWIO-IW3), South Africa, 1997

135. Third Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), France, 1998

136. Seventh Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting, Germany, 1997

137. Implementation of Global Ocean Observations for GOOS/GCOS, First Session, Australia, 1998

138. Implementation of Global Ocean Observations for GOOS/GCOS, Second Session, France, 1998

139. Second Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Brazil, 1998

140. Third Session of IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), China, 1998

141. Ninth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Ecuador, 1998 ***(Spanish only)***

142. Seventh Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Croatia, 1998

143. Seventh Session of the Tropical Atmosphere-Ocean Array (TAO) Implementation Panel, Abidjan, Côte d'Ivoire, 1998

144. Sixth Session of the IODE Group of Experts on Marine Information Management (GEMIM), USA, 1999

145. Second Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), China, 1999

146. Third Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Ghana, 1999

147. Fourth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC); Fourth Session of the WCRP CLIVAR Upper Ocean Panel (UOP); Special Joint Session of OOPC and UOP, USA, 1999

148. Second Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1999

149. Eighth Session of the Joint IOC-JGOFS CO2 Advisory Panel Meeting, Japan, 1999

150. Fourth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Japan, 1999

151. Seventh Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1999

152. Sixth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 1999

153. Seventeenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), Canada, 1999

154. Comité Editorial de la COI para la Carta Batimétrica Internacional del Mar Caribe y el Golfo de Mexico (IBCCA), Septima Reunión, Mexico, 1998

IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico (IBCCA), Seventh Session, Mexico, 1998

155. Initial Global Ocean Observing System (GOOS) Commitments Meeting, IOC-WMO-UNEP-ICSU/Impl-III/3, France, 1999

156. First Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Venezuela, 1999 ***(also printed in Spanish)***

157. Fourth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), China, 1999