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TOWARDS OPERATIONAL OCEANOGRAPHY:

THE GLOBAL OCEAN OBSERVING SYSTEM (GOOS)

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TABLE OF CONTENTS

		page
EXECUTIVE SUMMARY		1
1.	**INTRODUCTION**	2
1.1	THE NEED FOR A GLOBAL OCEAN OBSERVING SYSTEM	2
1.2	THE GOOS CONCEPT	2
1.3	WHY ACT NOW?	3
2.	**THE SCOPE AND OBJECTIVES OF GOOS**	4
3.	**BASIC APPROACH**	4
4.	**MODULES OF GOOS**	5
4.1	CLIMATE MONITORING, ASSESSMENT AND PREDICTION	6
4.2	MONITORING AND ASSESSMENT OF MARINE LIVING RESOURCES	6
4.3	MONITORING OF THE COASTAL ENVIRONMENT AND ITS CHANGES	6
4.4	ASSESSMENT AND PREDICTION OF THE HEALTH OF THE OCEAN	7
4.5	MARINE METEOROLOGICAL AND OCEANOGRAPHIC OPERATIONAL SERVICES	7
5.	**PRACTICAL APPLICATIONS AND ECONOMIC BENEFITS**	7
6.	**IMPLEMENTATION: A PHASED APPROACH**	8
7.	**FUNDING**	9
8.	**GOOS MANAGEMENT, TIMETABLE AND ACTIONS**	9
8.1	INTERNATIONAL CO-ORDINATION	9
8.2	NATIONAL COMMITMENTS	10
8.3	TIMETABLE	10
8.4	MANAGEMENT AND ADVISORY GROUPS	10
8.5	NATIONAL ACTIONS	11
8.6	INTERNATIONAL ACTIONS	11
LIST OF ACRONYMS AND ABBREVIATIONS		13

EXECUTIVE SUMMARY

The world ocean plays a role in a large number of processes occurring at the surface of the earth, influences the human behaviour and in turn is impacted by human pressure as well as various local, regional and/or global natural phenomena. However, there exists as yet no internationally co-ordinated system to observe the ocean on a global scale, to define the common elements of regional marine environmental problems or to provide data on which collective national response or improvement can be built. The Global Ocean Observing System (GOOS), initiated by IOC in co-operation with WMO, UNEP and ICSU, will meet this need.

GOOS is intended to provide a global framework for the gathering, co-ordination, quality control, distribution and the generation of derived products of all kinds of marine and oceanographic data of common utility, as defined by the requirements of a full spectrum of user groups. It will provide the opportunity for rationalization of the present efforts in this domain, in enabling participating countries to make better use of their investement in ocean observations and research for all forms of maritime use. Through training and capacity building, GOOS will enable smaller or less developed countries to participate more actively in the management of their future. Because of the nature and evolution of the ocean, GOOS is conceived as an intrinsically long-term, continuing and operational sytem. It is the only framework being planned for the global co-ordination of ocean observations and it comes in a timely fashion since all the necessary scientific, technical, economic, political and psychological *sine qua non* conditions for its implementation are now in place.

GOOS has to build on national requirements and is based on the principle that by encouraging nations to commit part of their national observational effort to a co-ordinated and integrated plan, and by sustaining that commitment on an on-going basis, benefits for all will accrue beyond the mere sum of the contributions. Economic studies are required to more precisely define and quantify the socio-economic benefits that could be derived from a fully implemented GOOS. It is clear nevertheless that a basic set of ocean observations can be used to generate a wide range of economically important products relevant to maritime activities of various kinds, and more generally help to protect life and property and facilitate commerce, agriculture, energy, transportation, water use activities, tourism, coastal defences, etc.

The basic intention is that observations should be long-term, systematic, relevant to the overall objectives, cost-effective and routine. As a basis for organization, for user-friendliness and ease of planning, GOOS has been defined in terms of five "*modules*": "*climate monitoring, assessment and prediction*"; "*monitoring and assessment of marine living resources*"; "*monitoring of the coastal environment and its changes*"; "*assessment and prediction of the health of the ocean*"; and "*marine meteorological and oceanographic operational services*". It should be noted that these modules are inter-related and will share observations, data networks and facilities, as needed, within the one integrated system. GOOS will be implemented phase by phase, beginning with planning and the initiation of operational demonstrations in each of the five modules; then, the gradual operational implementation of the permanent Global Ocean Observing System; and the continued assessment and improvement in individual aspects and in the entire system.

The required resources for a fully implemented and operational GOOS will consist of two parts: those resources already committed and identified for ongoing and planned observational programmes, and those additional resources required for establishing the adequate observational capability of the marine environment. Existing observational systems are funded from a combination of operational and research programmes. It is essential that GOOS be established with long-term funding, as a permanent service rather than depending upon data collection by research activities that are of limited duration. GOOS represents a recognition that oceanography is now an operational discipline. It is the payoff of decades of investment in ocean research. Detailed estimates of costs have not yet been established, but increased benefits can be expected to exceed the required investment several times over.

The first actions required of Member States are to establish national mechanisms for GOOS planning and development, in close collaboration with their marine user community groups; to define their national needs and priorities; and to strengthen national oceanographic facilities and data collection activities.

1. INTRODUCTION

1.1 THE NEED FOR A GLOBAL OCEAN OBSERVING SYSTEM

The resources of the ocean are of great and in some cases critical importance to the economy of the maritime nations and the well-being of their inhabitants. Furthermore, national investment in coastal and marine industrial infrastructure is of almost incalculable value. The oceans are also profoudly influencing conditions in land-locked nations.

Human pressure is now forcing changes on the oceans of the world at an unprecedented rate. These changes are not as obvious as those on land or in the atmosphere since for the most part they are unseen and gradual; irreversible decline of valuable living resources or the loss of environmental quality may be in train before the warning signs are acted upon or even noticed. Furthermore the oceans are interconnected, and many changes are the accumulated result of global processes or widespread practices that countries acting alone are powerless to alter.

The impact extends to the physical and chemical state of the ocean itself through alterations to the thermal equilibrium brought about by the enhanced Greenhouse Effect, in which the ocean is an active participant.

To develop their marine resources and protect their marine interests, nations have implemented a diverse range of observing systems extending from their coasts to the open ocean, and have exercised territorial rights through the declaration of Exclusive Economic Zones.

Nations have entered into bilateral and international treaties and agreements to protect their marine assets and have invested in national research programmes that are increasingly linked with international programmes to detect and respond to the consequences of change, and to secure the elements of ecologically sustainable development for their own future.

However, despite the global extent of oceanic change, there exists no internationally co-ordinated system to observe the ocean on a global scale, to define the common elements of regional marine environmental problems or to provide the data on which collective national response or amelioration can be built.

In recognition of the need, the United Nations Conference on Environment and Development (UNCED) (1992) has called for the development of a global system of ocean observation to help develop understanding and to monitor change. GOOS is the response to this call, but it is more than this. GOOS will provide the framework for the unprecedented enhancement of marine data and information for all kinds of use: industrial, environmental and managerial. The establishment of GOOS had also been urged by the second World Climate Conference (1990) to provide the oceanographic data needed by the Global Climate Observing System (GCOS) initiated by WMO, IOC, UNEP and ICSU in 1992. In 1989, the IOC Assembly had already called for initiation of GOOS.

1.2 THE GOOS CONCEPT

In parts the necessary observational systems do exist; but they are either for national purposes unconnected with the global issue (such as defence, or for the support of a particular industry or sector), or are in support of a succession of short-term research projects with limited objectives and geographical extent.

GOOS will not substitute for the present national data gathering activity, most of which has well-defined national purposes; but it will extend and provide the opportunity for rationalisation of this effort. By providing tools and access to international research and data applications, it will enable the participating countries to better utilize their investment in ocean observations and research for all forms of maritime use;

and it will facilitate the closer participation of the countries in a co-operative and co-ordinated effort to manage the impact of global change.

This aspect is particularly relevant to the smaller or less developed countries, many or which bear the brunt of environmental degradation. GOOS will, through training, capacity-building and the encouragement of collaboration through an internationally recognised programme, enable these countries to participate more actively in the management of their future.

GOOS is the only framework being planned for the global co-ordination of ocean observations. No alternative option is on the drawing-board. GOOS is not a research programme, although obviously research will continue to be needed to make the observations useful. To this extent GOOS will facilitate relevant research on applications and products, and encourage the development of technologies, but not as ends in themselves.

Many of the changes and other phenomena occurring in the ocean occur gradually and are subject to unexplained variation. For this reason GOOS is conceived as an intrinsically long-term and continuing system, and participation needs to be undertaken with this clearly in mind. Governments are understandably wary of such commitments, but this requirement is the reason why "operational" national observing frameworks are more appropriate than research programmes for the sponsorship of GOOS activity.

1.3 WHY ACT NOW?

Inaction on environmental problems has a multiplicative effect, and the cost of unchecked marine degradation and change is likely to exceed the cost of GOOS by several orders. GOOS is a good investment in the future of the planet.

There are also pressing practical reasons for GOOS to be implemented without delay:

(i) There is now a wide public awareness of global environmental decline. The lack of authoritative, accurate and comprehensive public information on environmental trends breeds partisan opinion, with expedient reaction and sometimes unwise decisions;

(ii) Systems are being developed in parallel for the operational monitoring of global climate and terrestrial environmental change. These will be closely integrated with GOOS and will share observing elements where appropriate;

(iii) For the first time in history, technology is equal to the scale of the task. Satellite remote sensing provides unprecedented detail and geographical coverage of surface features; remote and automated instrumentation has greatly reduced the unit cost of ocean observations, and global data transmission and information management systems have made data access in volume a practical possibility;

(iv) Numerical modelling has advanced to the degree where with accurate and well distributed data, models can accurately reproduce the physical dynamics of the ocean environment. These promise real capability in climate prediction in the near-future, as demonstrated by the recently completed TOGA experiment in the tropical Pacific. Attempts are being made to implement the necessary upper ocean observations on an operational basis, but such observations and logical extensions of them in other oceans need to be placed on a secure implementational footing;

(v) Similarly, numerical models are now being extended to embrace the interaction between physical and biological processes, with the intention of delivering management tools for a wide variety of socio-economic applications;

(vi) International bodies with the responsibility for certain types of ocean data already exist, and national and regional initiatives are being established in anticipation of the implementation of GOOS. These require a strategic framework to guide their development.

2. THE SCOPE AND OBJECTIVES OF GOOS

GOOS is intended to provide a *GLOBAL FRAMEWORK* or *SYSTEM* for the gathering, co-ordination, quality control, distribution and the generation of derived products of all kinds of marine and oceanographic data of common utility, as defined by the requirements of a full spectrum of user groups.

GOOS is *NOT* a functional observing organisation in itself. It is being implemented through the contributions of national agencies, organisations and industries, with the assistance of national and international data management and distribution bodies. Maximum use is being made of existing systems and bodies, and these will be encouraged where necessary to modify and enhance their activity to comply with a co-ordinated GOOS plan.

The overall objectives of GOOS are therefore:

(i) To specify and detail in terms of space, time, quality and other relevant factors, the marine observational data needed on a continuing basis to meet the common and identifiable requirements of the world community of users of the oceanic environment.

(ii) To develop and implement an internationally co-ordinated strategy for the gathering or acquisition of these data.

(iii) To facilitate the development of uses and products of these data, and encourage and widen their application in the use and protection of the marine environment.

(iv) To facilitate means by which less-developed nations can increase their capacity to acquire and use marine data according to the GOOS framework.

(v) To co-ordinate the ongoing operation of GOOS and ensure its integration within wider global observation and environmental management strategies.

3. BASIC APPROACH

GOOS is based on the principle that by encouraging nations to commit part of their national observational effort to a co-ordinated and integrated plan, and by sustaining that commitment on an on-going basis, benefits for all will accrue beyond the mere sum of the contributions. As the founders of IOC noted in regard to the mission of the Intergovernmental Oceanographic Commission, the implementation of GOOS presents far too formidable a task to be undertaken by one nation or even by a few nations.

GOOS is being established by participating Member States, implemented almost entirely through nationally-owned and operated facilities and services, and makes use wherever possible of operational and scientific data-gathering systems/bodies already in place, such as IGOSS, IODE, GLOSS, DBCP, WWW, WCRP, etc. Co-ordination is being provided by IOC in co-operation with WMO, UNEP and ICSU.

The basic intention is that observations should be:

(i) **long-term,** i.e., measurements once begun should continue into the indefinite future; continuity in the observed quantity is to be sought, rather than in the method, as it is anticipated that more effective methods may become available in the future;

(ii) **systematic,** i.e., measurements should be made in a rational fashion, with the spatial and temporal sampling as well as the precision and accuracy tuned to address specific aspects of GOOS;

(iii) **relevant to the overall objectives,** i.e., measurements should be made in view of the end-products required, viz either to document the ocean variables important to the issues underlying the modules of GOOS, or to provide data needed to initialize and validate models that describe and predict these variables in a managerially useful context;

(iv) **cost-effective,** i.e., efforts should be made to maximize the return on available resources (financial and manpower) by applying observational methods that are economical and efficient;

(v) **routine,** i.e., the observations should be considered as an operational responsibility, with the acquisition, quality control, and dissemination of products to be carried out with regularity.

The design of GOOS, and the use of GOOS data, need to be closely linked with the recent and continuing advances in numerical modelling of ocean and coupled ocean-atmosphere systems. GOOS will utilize remote sensing of the ocean surface from satellites and *in-situ* measurements using ship-borne observations, towed and anchored instrument systems, drifting buoys and sub-surface floats. The development of new technology will be fostered. Experimental technology will be incorporated as it becomes operationally useful. Initially, measurements will describe some of the physical, chemical, and biological characteristics of oceans, marginal seas, and coastal waters. Continuous observation and monitoring using consistent techniques that produce compatible data will permit the detection of trends, monitoring, and comparisons among regions, and computation of total global changes.

It is important to demonstrate the effectiveness of GOOS as soon as possible. Data products will be generated as GOOS is developed and integrated, beginning with GOOS operational demonstrations which are urgently needed and should take place in the shortest possible time, in any case before the end of the decade. Early products will be primarily based on single variables or types of observations, such as wave conditions, sea surface temperature, sea ice or depth to the thermocline. More sophisticated products will be based on the synthesis of several variables. Such a flow of products will demonstrate early and continuing economic and social benefits, as applications and interpretations can be made for local and national planning and decision-making purposes.

It will not be possible to sample the ocean densely enough in time and space to provide an adequate description by measurement alone. Only by assimilating the data into suitable models will maximum advantage be taken of the data, and only by using models will it be possible to make predictions. Models can tie the observations together and put them in appropriate context. They can also help identify the nature and location of the most crucial observations. The design of GOOS includes the concept of interdependence among observations, data assimilation, and numerical models. As an example, GOOS data will be used to initialize models predicting climate change and variability. Data from a global observing system must be made available in a timely fashion to all users. This timeliness requirement may be less stringent than that for weather forecasts because of the inherent climate time scales. Data must also be archived properly so that accurate climatological benchmarks can be established. But model outputs, forecasts and related interpretations need to be provided in a timely fashion to user communities and decision-makers.

Substantial training, education and mutual assistance efforts and technology transfer initiatives need to be launched to enable all countries to participate in GOOS and to interpret and apply the resulting data, end-products and information. Many countries suffer from a lack of facilities and skilled personnel to analyse and interpret the data, and even to make use of end-products. IOC is encouraging the concept of partnerships between developing and developed countries.

4. MODULES OF GOOS

As a basis for organization, for user-friendly approach and ease of planning, GOOS has been defined in terms of five "*modules*" ordered according to categories of perceived user interests. It should be noted that these modules are inter-related and will share observations, data networks and facilities, as needed, within the one integrated system. From the user's standpoint, the GOOS modules are intended to be fully transparent: the only important issue is that the required end-products are conveniently provided.

4.1 CLIMATE MONITORING, ASSESSMENT AND PREDICTION

The global atmosphere and the World Ocean are an interactive system. The oceans are both a source and a sink for carbon dioxide and other "greenhouse gases". The ocean also drives the global cycle of evaporation and rainfall. Any possibility of predicting climate changes beyond a few weeks demands that ocean behaviour be taken into account. This module will seek to reduce the uncertainty which now exists with regard to the ocean's role in climate variability.

The Global Climate Observing System (GCOS), to be developed jointly by WMO, IOC, ICSU and UNEP, will provide comprehensive information on the total climate system, involving a multi-disciplinary range of physical, chemical and biological variables and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes. The GOOS climate module will constitute the oceanographic component of GCOS. It is being designed to monitor, describe and understand the physical and biogeochemical processes in the ocean that determine ocean climate variability and its effects on seasonal to multi-decadal climate variability of the atmosphere, and to provide the observations needed for climate prediction. The design and planning of the GOOS climate module is being carried out in close co-operation and harmony with GCOS design and planning. In a sense, this module is already operating in a pilot mode through the efforts of the programmes of the WCRP. In the future, GOOS will pay particular attention to the data requirements of the International Research Institute for Climate Prediction, an important element of the WCRP Study of Climate Variability and Predictability (CLIVAR).

4.2 MONITORING AND ASSESSMENT OF MARINE LIVING RESOURCES

The marine living resources of the world depend on their ocean environment. Changes to that environment will inevitably change the composition and behaviour of the living resources therein. This module will include the development of a system to monitor physical, biological and chemical variables needed to describe the structure and functioning of marine ecosystems as well as the changes in the marine ecosystems over various space and time scales. Sustainable development of living marine resources requires predictive capabilities. Predictions must take into account the effects of environmental changes on the abundance and production of these resources.

GOOS will improve the continuity and quality of data sets, allow access to related information and provide products benefitting the sustainable use of marine living resources.

4.3 MONITORING OF THE COASTAL ENVIRONMENT AND ITS CHANGES

The GOOS coastal module has a high priority to many coastal states because of the importance of the coastal area for development and the intimate effects of coastal changes on economic development and human habitation. Monitoring and documenting changes in coastal and near-shore areas require an interdisciplinary approach that integrates physical, chemical, biological and geological observations with socio-economic uses of the coastal zone.

The GOOS coastal module provides the necessary infrastructure needed for service providers to a wide range of coastal area managements, such as within environmental protection, vessel traffic services, aquaculture, coastal construction engineering, leisure boating, etc. The deliveries of these providers will be a set of specific oceanographic products responding to the needs of the end users. These products will appear

as results of local monitoring and modelling tools, depending on forcing data and boundary conditions made available from the infrastructure level. Typical tools on the local level are dedicated monitoring systems such as coastal radars, tide-gauges and multi-parameter buoys run in tandem with fine mesh numerical models. Typical contributions on the infrastructure level will be the provision of boundary values and possibly forcing data such as wind fields. The role of the coastal module will be to establish and maintain the infrastructure apparatus, as well as to advise on system configuration in order to promote/secure "transportable methodologies" for mutual benefit for all service providers. It is acknowledged that such responsibilities in many cases should belong to regional GOOS organizations.

4.4 ASSESSMENT AND PREDICTION OF THE HEALTH OF THE OCEAN

This module aims to establish a framework for monitoring the levels and trends in levels of pollution on global as well as on regional scales and for assessments of the health of the ocean, in particular the coastal and shelf seas. A primary objective is to monitor and assess contaminant loads in the marine environment with particular emphasis being given to the state and response of marine ecosystems relative to both anthropogenic impact and natural climate change as well as the quality of the water. The data collection and analysis is to be based on the use of commonly agreed methods, standards and techniques. It will include regional components with specific observational networks, geared to problems of each region. The use of repetitive real-time data from satellites will enable more effective and efficient responses to accidental releases of hazardous materials, particularly oil products, to the ocean. In this respect, this module must be closely related to the coastal module.

4.5 MARINE METEOROLOGICAL AND OCEANOGRAPHIC OPERATIONAL SERVICES

Extensive marine meteorological and oceanographic operational services are already available worldwide, in support of a large variety of user groups and applications, ranging from the safety of life and property at sea to major economic and commercial interests such as offshore mining and industry, shiprouting, fisheries, recreation and tourism. These services are provided by both operational national agencies such as national meteorological and/or oceanographic (including fisheries) services and also by private companies, and have traditionally been co-ordinated and assisted through existing programmes of WMO and IOC. In addition, the provision of some form of service may be seen as the logical end-point of all the other modules.

The GOOS services module will therefore seek to assist in enhancing the collection, exchange and processing of oceanographic data to support the improvement and expansion of existing services as well as the development and implementation of new ones, in response to user requirements. Enhancements to modelling, product preparation, service presentation and delivery infrastructure capabilities will also be addressed, as well as aspects of methodologies, standards and procedures. Activities under the services module will be undertaken in direct collaboration with existing WMO and IOC programme activities, in particular those of the World Weather Watch, the WMO Marine Programme and IGOSS, as well as with other modules.

5. PRACTICAL APPLICATIONS AND ECONOMIC BENEFITS

The ability to determine the present state of systems and predict their future conditions is the cornerstone for adequately protecting and managing ocean and coastal areas and for rational use and development of their living and non-living resources. Effective management of oceans and coastal areas is often limited by the high degree of uncertainties in the present information. We need to develop the ability to predict both natural and anthropogenic changes in marine and coastal ecosystems. Ultimately, striking a sustainable balance between environmental protection and economic development is not possible without predictive capabilities.

The long time scale of changes in the ocean and the ocean/atmosphere feedback provide the basis for reliable predictions of the changes, such as of ENSO events, provided adequate data are at hand.

This lead time allows decision makers the unique opportunity to intelligently plan ameliorative actions which can result in realizable savings.

There is also uncertainty about climate change and sea level rise. Response strategies should be based on sound information. Improved systems to collect, interpret, synthesize and disseminate data and information are essential to reduce uncertainties and to improve predictability.

Some seas, especially the coastal areas, are increasingly polluted from the adjacent land via rivers, via the atmosphere, and maritime and dumping activities, on a scale that threatens to impair ecological functions and reduce marine living resources. Effective management and control measures by individual countries require regular and reliable information on the distribution, transport and fate of various contaminants coming from different sources, including those on regional and global scales.

The predictions based on GOOS data will result in benefits in many sectors. A basic set of ocean observations can be used to generate or enhance a wide range of economically important products. Forecasts of winds, temperatures, waves and currents for periods of days to weeks can increase the efficiency and safety, as well as reduce the costs, of maritime activities such as fishing, commercial shipping, offshore oil and gas operations, hazardous spill response and search and rescue operations. Meteorological services, which depend upon data describing ocean conditions, are an essential contribution to the economic well-being of almost every country. Timely warnings of severe or hazardous weather or flooding help to protect life and property and facilitate commerce, agriculture, energy, transportation, water use activities, tourism, coastal defences, etc.

Economic studies are required to more precisely define and quantify the socio-economic benefits that could be derived from a fully implemented GOOS. Such an exercise should be undertaken with the assistance of the Organization for Economic Co-operation and Development (OECD) Megasciences Forum and in collaboration with GCOS. Demonstrations of economic benefits already exist. For instance, as a result of the TOGA Programme, the tropical Pacific is now one of the most densely sampled ocean areas of the world. This new, near real-time data set has been used to develop operational ocean models of the upper Pacific Ocean into which data can be assimilated regularly. As a result:

(i) it is now possible to make predictions of El Niño events with some skill on a time scale of months to a year. Knowing early enough the probability of such an occurrence is the basis for a successful national experiment in Peru (soon to be introduced to Ecuador) which advises farmers on whether to plant cotton or rice in order to maximize crop yields;

(ii) it is also the basis for long-range forecasts in other parts of the world as to whether temperature and rainfall will be above or below average. Current studies in China indicate a relationship exists between El Niño and the winter climate in Southeast China. If validated, agriculture decisions could take advantage of ENSO predictions in this region also;

(iii) economists estimate that the U.S. agricultural sector alone could save US$240 million per year if El Niño events can be predicted nine months in advance. Scientific capability now exists to make these forecasts.

With GOOS in place in the 21st century, climate forecasts should be prepared, disseminated and analysed as routinely as weather forecasts are today.

6. IMPLEMENTATION: A PHASED APPROACH

The implementation of GOOS requires the following phases:

(i) planning, including design and technical definition;

(ii) initiation of operational demonstrations in each of the five modules;

(iii) gradual operational implementation of the permanent Global Ocean Observing System;

(iv) continued assessment and improvement in individual aspects and in the entire system.

A number of activities which can be used to implement parts of GOOS are operational at this time. They include DBCP, GLOSS, IGOSS, IODE and WWW. Enhancements to these activities are being encouraged and it is expected that Member States will support them.

7. FUNDING

Existing observational systems are funded from a combination of operational and research programmes. It is essential that GOOS be established with new operational funding, as a permanent service rather than depending upon data collection by research activities that are of limited duration. GOOS represents a recognition that oceanography is now an operational discipline. It is the payoff of decades of investment in ocean research.

The required resources for a fully implemented and operational GOOS will consist of three parts:

(i) those resources already committed and identified for ongoing and planned observational programmes;

(ii) those additional resources required for establishing the adequate observational capability of the marine environment; and

(iii) resources required immediately to support the GOOS planning and implementation process at the international level.

Detailed estimates of costs have not yet been established, but increased benefits (examples of which are given in Section 5) can be expected to exceed the required investment several times over.

Because of the phased stages of development of GOOS, each with a defined deliverable product, governments can review their commitment to the system at regular intervals. Governments are now being requested to support:

(i) the running and strengthening of the GOOS Support Office at the IOC Secretariat;

(ii) the funding of the Joint IOC-WMO-ICSU Scientific and Technical Committee for GOOS (J-GOOS), its subsidiary Panels and its general planning efforts;

(iii) the GOOS Support Fund established as part of the IOC Trust Fund.

Governments will also be requested to indicate in principle their subsequent support for GOOS as it is implemented.

8. GOOS MANAGEMENT, TIMETABLE AND ACTIONS

8.1 INTERNATIONAL CO-ORDINATION

GOOS requires extensive international collaboration in planning and implementation. Inter-agency co-operation among IOC, WMO, UNEP and ICSU is also essential.

International GOOS co-ordination includes three levels:

(i) intergovernmental mechanism (I-GOOS);

(ii) scientific advisory bodies (J-GOOS and its Panels);

(iii) Support Office (Secretariat).

GOOS planning and development on an international level requires the establishment of links and dialogues with the international bodies dealing with ocean observing and data management systems/bodies of IOC and WMO (CBS, CMM, DBCP, GLOSS, IGOSS, IODE, WWW), as well as research (GIPME, IGBP, OSLR, WCRP, etc.). It will also need interaction with regional activities, including those of IOC, WMO and UNEP and embryo regional GOOS activities such as EuroGOOS and the North-East Asian Regional GOOS (NEAR GOOS), as well as with the bodies dealing with education, training and assistance programmes. Such links are necessary to avoid duplication of national and international efforts and to use rationally the modest resources of the international organizations. It is also essential to establish an early and continuing dialogue with user communities.

8.2 NATIONAL COMMITMENTS

National commitments are required. National institutions responsible for the marine environment need to be established or strengthened in many countries. Operational management of components of GOOS requires close collaboration with national meteorological, space and science agencies, and close interaction with the marine user community.

8.3 TIMETABLE

It is anticipated that a fully operational GOOS can be established by the year 2010. This is based on the expectations of progress in the deployment and testing of new technology (satellite and *in situ*) and of the knowledge to be obtained from current large scale research programmes.

By the year 2000, the formulation of the overall policy will be completed, the scientific, technological and management basis strengthened, the general plans refined and the national and international infrastructures needed for GOOS established. During this period new observational tools will be developed and tested by countries and operational elements of GOOS subsystems will be tested through operational demonstrations.

This and the next decades will see the operational implementation of subsystems and elements of GOOS (particularly the climate module) that will include the use of new elements as well as present ocean observing activities.

8.4 MANAGEMENT AND ADVISORY GROUPS

Advisory and co-ordination mechanisms are needed to achieve scientific integrity, international accountability, and reliable efficiency. GOOS presently includes the following structure:

Intergovernmental co-ordination/planning

(i) the IOC-WMO-UNEP Intergovernmental Committee for GOOS (I-GOOS);

(ii) the I-GOOS Strategy Sub-committee (SSC);

[In addition, there are plans to establish I-GOOS Panels on: Technical Implementation (PTI); Products and Distribution (PPD); and Capacity Building (PCB).]

Scientific and technical guidance for GOOS planning and development

(iii) the Joint IOC-WMO-ICSU GOOS Scientific and Technical Committee (J-GOOS), which serves as "*the primary international body responsible for the scientifically based design and planning phases and testing of GOOS, and related oversight*" and "*advise I-GOOS on all scientific and technical aspects of GOOS*";

(iv) J-GOOS scientific and technical "Panels" are, are being or will be established to deal with various GOOS modules, such as: the Ocean Observations Panel for Climate (OOPC), established as a follow up of the Ocean Observing System Development Panel (OOSDP); the Health of the Ocean (HOTO) Panel; the Panel on Living Marine Resources (LMR). etc.;

Secretariat support to GOOS

(v) the GOOS Support Office (GOOS/SO or GSO) co-ordinates all aspects of the development and implementation of GOOS and supports the above groups. The GOOS/SO is located within the IOC Secretariat. It in particular maintains the GOOS Home Page on the World Wide Web at:

http://www.unesco.org:80//ioc/goos/IOCGOOS.HTML.

8.5 NATIONAL ACTIONS

It is recommended that countries participating in GOOS:

(i) establish (when not already done) a national Committee to define GOOS national needs, provide an internal network and infrastructure, and identify resources and resource requirements;

(ii) strengthen national oceanographic institutions and facilities in directions which are consistent with GOOS implementation;

(iii) accelerate existing ocean data collection activities;

(iv) develop arrangements which will make existing and future data available, in accordance with agreed-upon standards, and facilitate data exchange;

(v) facilitate the local/national/regional implementation of GOOS-related operational demonstrations and training needs/opportunities;

(vi) establish (when not already done) an officially-designated GOOS contact;

(vii) help to plan and develop GOOS at regional and international levels.

8.6 INTERNATIONAL ACTIONS

(i) Contribute to the GOOS Fund established as part of the IOC Trust Fund to support the costs of the planning and developing of GOOS, and provide resources for some of the GOOS operational demonstrations as well as for education and training for capacity building

(ii) Maintain intergovernmental co-ordination required through close collaboration between IOC, WMO, UNEP and ICSU.

(iii) Complete international agreements to achieve a complete and coherent global system involving data collection in all regions of the world ocean.

(iv) Conduct public education and information activities designed to promote understanding of the GOOS concept and its purpose, including publication of information brochures and presentations at relevant regional and international events.

(v) Promote the undertaking of studies on the socio-economic benefits to be derived from GOOS.

LIST OF ACRONYMS AND ABBREVIATIONS

CBS	Commission for Basic Systems (WMO)
CLIVAR	Climate Variability and Predictability (WCRP)
CMM	Commission for Marine Meteorology (WMO)
DBCP	Data Buoy Co-operation Panel (WMO-IOC)
ENSO	El Niño - Southern Oscillation
EuroGOOS	European Consortium for GOOS
GCOS	Global Climate Observing System (WMO-IOC-UNEP-ICSU)
GIPME	Global Investigation of the Pollution in the Marine Environment (IOC)
GLOSS	Global Sea Level Observing System (IOC)
GOOS	Global Ocean Observing System (IOC-WMO-UNEP-ICSU)
GOOS/SO (or GSO)	GOOS Support Office
HOTO	Health of the Ocean
I-GOOS	IOC-WMO-UNEP Committee for GOOS
I-GOOS-PS	I-GOOS Planning Session
ICSU	International Council of Scientific Unions
IGBP	International Geosphere-Biosphere Programme (ICSU)
IGOSS	Integrated Global Ocean Services System (IOC-WMO)
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IODE	International Oceanographic Data and Information Exchange (IOC-ICSU)
J-GOOS	Joint IOC-WMO-ICSU Scientific and Technical Committee for GOOS
JGOFS	Joint SCOR-IOC Global Ocean Flux Study
LMR	Living Marine Resources
NEAR GOOS	North East Asian Regional GOOS
OECD	Organization for Economic Co-operation and Development
OOPC	Ocean Observations Panel for Climate

OOSDP	Ocean Observing System Development Panel
OSLR	Ocean Sciences and Living Resources (IOC)
PCB	Panel on Capacity Building (I-GOOS)
PPD	Panel on Products and Distribution (I-GOOS)
PTI	Panel on Technical Implementation (I-GOOS)
SSC	I-GOOS Strategy Sub-committee
SST	Sea Surface Temperature
TOGA	Tropical Ocean and Global Atmosphere Experiment (WCRP)
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
WCRP	World Climate Research Programme (WMO-IOC-ICSU)
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment (WCRP)
WWW	World Weather Watch (WMO)