Global Terrestrial Observing System

Implementation Plan
Version 2.0

M.D. Gwynne
Nairobi
December 1997

Acknowledgements

This Implementation Plan could not have been prepared without the collective inputs of the GTOS Steering Committee, its ad hoc Sub-committee on GTOS implementation, and its Working Group on GTOS Implementation all chaired by Dr Michael Glantz. Particular thanks for their help, ideas and suggestions go to the following: Anne Aubert, Stein Bie, Marc Bied-Charreton, Johannes Bouma, Robert Brinkman, Claudio Caponi, Antonio Cendrero, Marion Cheatle, Josef Cihlar, Mickey Glantz, Tony Janetos, Peter Jones, Hal Kibby, Vitaly Kimstach, Angus McEwan, Gwynneth Martin, Stefan Mildner, David Norse, Terry Parr, Peter Peterson, Steve Running, Bob Scholes, Wim Sombroek, Tom Spence, Colin Summerhayes, Bernard Tinker, Izgrev Topkov, John Townshend, Jeff Tschirley, Carl Christian Wallen, David Williams, and Shidong Zhao. The Implementation Plan rests heavily on the excellent fundamental work of the ad hoc Scientific and Technical Planning Group for GTOS under its Chairman Dr. David Norse, and embodied in its report of June 1996.

Contents

Global Terrestrial Observing System (GTOS)

Implementation Plan
Version 2.0

Executive Summary

A. Background

Global Change

The world today is undergoing a period of rapid change. Human numbers have increased dramatically in the past two centuries and there are now few land areas of Earth where people do not live. Their presence and activities have had a profound effect on the environment of the planet and its natural ecosystems. Land has been cleared for cultivation and livestock. Huge cities and industrial developments cover large areas. In recent decades rapidly increasing waste emissions from industry have been liberated into the air and waters, and deposited onto land surfaces. These waste emissions are having increasingly severe impacts on the environment and many are proving to be health hazards, or are toxic, to people and other organisms. The distributions of natural ecosystems and their constituent species are consequently changing, biological diversity seems to be decreasing, and the climate is being altered bringing yet more changes so that major agriculture zones seem to be shifting position. These changes are now collectively termed global change.

Data Needs of Scientists

For the last 50 years or so scientists have become increasingly aware of global change and its likely effects, and their consequences for human well-being. They have begun to investigate the environmental and ecological processes involved and to develop mathematical simulation models for some of them at scales ranging from the local to the planetary. As scientific knowledge has increased and the effects of global change have become more obvious to many, there has been a call from scientists for more and better data to enable better scientific understanding of the processes involved, and the development of improved models for making more accurate and reliable forecasts of impending global changes and their consequences.

Data Needs of Governments

At the same time national economic planners and resource managers, especially in developing countries, have begun to realise that national renewable natural resources, including managed agricultural ecosystems, have to be used wisely and in sustainable ways if they are going to continue to support the people. It has become obvious in recent years that sustainable use of renewable natural resources can only be achieved if there is sound understanding of where these resources are located, their extent, how they function, and how they are affected by changing local circumstances. Consequently, national planners and resource managers have been seeking reliable data and information on which to base national development policies and strategies, to manage relevant national programmes, and to achieve the wise use and management of national renewable natural resources including those of managed lands. Much of this information can only be obtained from scientists through their research programmes.

B. Global Observing System

Background

In the last five decades there have been attempts to monitor the global environment and its components, the best known of which was the Global Environment Monitoring System (GEMS) which involved 23 interactive thematic networks. This was, however, largely financed with international funds and so lacked the resources to develop to where it could operate in all geographic regions and cover all the topics deemed necessary. Only governments have the technical and financial means, and the political will, to undertake planetary scientific observations of the type, scope and magnitude required to gain scientific understanding of what is involved in global change. Similarly, only governments have the resources to obtain the data and information necessary to attain national sustainable development and the ability to achieve it, in spite of global change effects, through implementation of the right policies, strategies and actions. Recognition of the need for good data of the right types by both national planners and scientists, and the growing realization by governments that they need sound scientifically based environmental and resource information for national development, have brought these two user groups closer together resulting in the evolution of a new worldwide system for studying global change and trying to fathom its causes and effects. This has become the Global Observing System (GOS).

The Three Global Observing Systems

GOS is not a functional entity but operates as three separate but closely related observing systems. The first, the Global Climate Observing System (GCOS), deals with climate and climate related aspects of the global environment. The GCOS Secretariat is located in the World Meteorological Organization (WMO) at Geneva. The second, the Global Oceanographic Observing System (GOOS), deals with ocean and coastal aspects of the global environment. The GOOS Secretariat is located at Paris in the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The third and youngest, the Global Terrestrial Observing System (GTOS), deals with terrestrial aspects of the global environment, including both natural and managed ecosystems. The GTOS Secretariat is located currently in the Food and Agriculture Organization of the United Nations (FAO) at Rome. This Implementation Plan is concerned with making GTOS operational, and with its future development. The Plan rests firmly on the foundation laid by the GTOS Planning Group in its 1996 report (see Annex II).

GTOS and Governments

Basic Involvement Strategy

Without the active technical involvement and financial support of governments, GTOS is unlikely to succeed. It is important, therefore, that before the end of the Establishment Phase of GTOS (end 1998) a GTOS strategy for involving governments in GTOS should have been developed. Basic elements of the strategy will be an initial Expert Group meeting involving a few countries from each of the main geo-political regions, followed by GTOS missions to individual governments. The implementation of this strategy will be costly in terms of funds and staff time, but both must be spent if the vital goal of the active participation of governments in GTOS is to be obtained.

Intergovernmental Mechanism

Another option that should be explored is the development for GTOS of some form of intergovernmental mechanism in which governments would specify the directions in which GTOS would move and the activities it should undertake. The mechanism could be analogous to that of the Intergovernmental Panel on Climate Change. Such an approach would directly involve governments in GTOS and ensure that it received from them adequate technical and financial support. Links with the present Co-sponsor agencies would be maintained.

C. Global Terrestrial Observing System (GTOS) - General

Definition and Scope of GTOS

GTOS is a dedicated long-term, integrated, user-driven observing system for monitoring the extent, form and function of terrestrial ecosystems, including those of managed lands, and detecting and measuring alterations in them resulting from climate changes, changes in human activities such as land-use and industrial development, and changes from other causes such as tectonic activities. GTOS addresses the total terrestrial ecosystem complex, including coastal systems, and thus considers biological, chemical and physical properties as well as terrestrial, oceanic, hydrological and atmospheric processes. GTOS is, therefore, global in scope with comprehensive worldwide coverage and deals with phenomena that are global in their nature or impact. In these respects GTOS works closely with, or through, the other two Global Observing Systems and must continue to develop close inter-system working links in the future, especially when seeking funds for joint activities. This applies particularly to the development and implementation of a joint GCOS/GOOS/GTOS Coastal Observing System as part of Coastal GOOS.

GTOS Key Global Change Issues

GTOS has five broad but key global change issues which are its priority action areas:

- Land-use and land-cover change, including land degradation and the sustainability of managed ecosystems;
- Water resources management;
- Loss of biodiversity;
- Climate change;
- Pollution and toxicity.

The issues are along thematic lines because GTOS must be directed at specific users and their needs. In general the issues are concerned with anthropogenic impacts on terrestrial ecosystems. In the beginning GTOS will concentrate on Land-use and Land-cover change, Water resources, and Climate change. GTOS is thus helping to obtain better understanding of some of the basic issues confronting sustainable human development: food and food availability; freshwater supply and demand; changes in terrestrial ecosystems and their life support capacities; changing biological diversity; and exposure of people and other life forms to toxic and hazardous substances.

Partners in GTOS

GTOS has limited staff and few financial resources. It must, therefore, build on existing national and international networks and facilities so that in effect it is a network of networks. Each partner network joins GTOS because it has access to the facilities, data, and information of other partners in GTOS. Partner networks are fundamental to the success of GTOS so that they must have a say in how GTOS operates, the underlying science, and the directions in which GTOS should go. Accordingly, a GTOS Terrestrial Observation Network Panel should be established to provide a forum at which participating networks can discuss GTOS and its actions and so influence the decisions of the GTOS Steering Committee. GTOS will never be a source of international funding for national programme activities, capacity development, and scientific research but it will be able to offer advice on how to obtain the necessary financial support.

GTOS Governance

There are four international GTOS Co-sponsor organizations (UNEP, FAO, UNESCO, and ICSU) which collectively form the primary authority governing GTOS and from which all other governing authority descends. The GTOS Steering Committee provides general guidance directly, and indirectly through its subsidiary Panels and Working Groups. A small GTOS Secretariat provides the continuity to keep GTOS operational on a-day-to-day basis.

GTOS Finance

Crucial to the future of GTOS is its financial support. At the moment (1997) the four Co-sponsors provide insufficient annual funds to enable GTOS to get off the ground properly. Although it is not intended that GTOS should ever command large financial resources, it will need seed money with which to start. Accordingly, the Co-sponsors must ensure that there are adequate funds and staff available to keep a small GTOS Secretariat running for the next three years, ie to 2000. Without a fully functional GTOS Secretariat many important development activities necessary to start GTOS and keep it going will not be carried out. It is important, therefore, that a funding strategy is worked out for getting support for the Secretariat, and for the future funding of all GTOS projects and programmes on an activity by activity basis. As an aid to this a GTOS Database of Donors should be built up within the GTOS Secretariat, and a GTOS benefits package produced that shows the advantages to organizations, countries and donors of participating in, or supporting, GTOS. These will allow GTOS to develop a sound understanding of donor and grant giving bodies (bilateral, multilateral, foundation, industrial, etc.) in order that projects and activities can be matched to appropriate donors, and couched in forms that are more suitable for support by those donors.

GTOS Periodic Review and Audit

GTOS can only progress satisfactorily if its achievements are critically reviewed at regular intervals to ensure that it continues to adapt to the changing development and scientific needs of the time, and takes advantage of advances in relevant technology. It is also essential to carry out regular financial and administrative audits of GTOS to ensure that it continues to operate in the most cost-effective manner. Periodic Programme Reviews of GTOS should take place every three years, with the first at the end of 1999. Each review should be preceded by two technical assessments of the use being made of GTOS data and information by countries, and by international programmes. These assessments will be important inputs to each GTOS periodic revue. The financial and administrative audits of GTOS should be carried out at regular intervals in

accordance with the practice and procedures of the organization that is host to the GTOS Secretariat (currently FAO).

D. Global Terrestrial Observing System (GTOS) - Programme

GTOS Programme Development

GTOS has three programme implementation phases: Preparatory, Establishment and Development. Each of these is one year long with the first starting in early 1997. By the year 2000 GTOS will be operational and its future directions will then be more clear. Early in its career GTOS must develop policies for key action areas to include data and information release, publications, public relations, products, and, importantly, early warnings. These policies are guidelines and not rigid rules of conduct and will help shape the future of GTOS while allowing it to retain the flexibility of approach that it must maintain to be successful. An important element of GTOS development are the GTOS Data and Analysis Centres where data will be held, processed and analyzed. The first such centres will almost certainly be those already associated with GTOS partner networks. The GTOS role of each of these centres will have to be determined by negotiations between GTOS and the current operators of each centre.

GTOS Observations and Data

The emphasis throughout GTOS is in the production of high quality, reliable, believable information and data obtained in an harmonized cost-effective manner, and collected to answer specific questions already posed by users. They are accordingly at spatial and temporal scales appropriate to user needs. Spatial and temporal scaling aspects of GTOS data will have to be addressed early in GTOS development particularly in regard to upscaling and the extrapolation of data from observing sites to other, often larger, areas. Key to the production of GTOS data is the five tier Global Hierarchical Observing Strategy (GHOST) which is an incompletely nested sampling system that allows at one extreme for many variables to be collected at a few sites, and at the other extreme, a few variables to be collected at many sites. GHOST was designed specifically for observing climate-related variables. GTOS will have to test its applicability in other GTOS sectors. In making these data gathering observations only the most suitable proven methods for data acquisition, management and analysis are used. All data are backed by metadata that allows users to comprehend why and how the data were gathered and by whom. The Terrestrial Ecosystem Monitoring Sites (TEMS) strategy and database will play a key role in ensuring GTOS data are accompanied by adequate metadata. A series of required climate-related terrestrial variables on which observations should be made has already been identified and defined by the GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC). A similar series is needed for non-climate topics though it is recognised that this will be a very complex task which may need topic specific expert groups. The resultant data from GTOS can thus be used with confidence by both national policy makers, planners and socio-economists, and by the international science community. Where required, data are transformed into other forms more suitable for use in regional and national economic development. As far as possible, all data generated through GTOS will be readily available to potential users in a free and unrestricted manner at a cost no greater than that of reproduction and delivery. As information and data release are at the heart of GTOS it is important that GTOS develops its own information and data management plan tailored to its specific requirements as soon as it can.

GTOS and User Needs

At the beginning of its career, GTOS will have to spend considerable time and effort in carrying out extensive surveys of potential users of GTOS data and their needs. These users will be from many areas but fall into two broad categories: those associated with regional and national planning and development (policy makers, planners, technicians, managers), and those in the scientific research community, including international scientific programmes. Care will have to be taken when considering potential users from the private sector in view of the unrestricted nature of data release postulated for GTOS. Initial contacts with potential private sector users should be mainly among the large multinational companies whose activities impinge on or affect the environment since some already have environmental policies in place which might make discussions easier. User needs, once identified, will form the basis for the development of future GTOS Programmes and their component activities. These needs will be reformulated into questions for which answers will be sought, which in turn will determine the actual variables to be observed and the methods to be used.

GTOS Networks

GTOS Prototype Network (GTOS Landnet)

GTOS will need to establish at an early stage a demonstration network of networks to test the ideas underlying the GTOS concept. To prepare this prototype network a number of existing monitoring networks known to be interested in the GTOS idea should be assembled to discuss GTOS and exchange views on possible participation. If sufficient agree, those interested should be invited to join. A meeting to this effect was held in Guernica, Spain, in June 1997 as a result of which it was agreed to start GTOS Landnet as the Prototype GTOS. The first practical results from GTOS Landnet are unlikely to be available before the end of 2000 (ie after the first review of GTOS at the end of 1999). Participating networks in GTOS Landnet will be initial members of the GTOS Terrestrial Observation Network Panel mentioned above.

Other GTOS Networks

The overall programme of GTOS will become very diverse because of the complex nature of the terrestrial observations required to support work in its five priority global change issues. Thus several GTOS programmes will be operating at the same time, each of which will be developed separately according to user needs and the availability of potential network partners. Each programme will be a long-term activity co-ordinated by the GTOS Secretariat. For administrative convenience and public relations each should be given a short programme name that identifies it as being an activity within GTOS and immediately indicates its main activity field, for example, GTOS Biodiversity, GTOS Climate, GTOS Coast, GTOS Glaciers, GTOS Land, GTOS Radiation and GTOS Water.

GTOS and Early Warnings

Advance announcements of impending or rapidly progressing ecosystem changes, especially adverse changes, will become one of the most useful and important functions of GTOS. But at the same time, however, early warnings often have very large cost implications and possible social and socio-economic consequences so they must be thought through carefully and should not be issued lightly. GTOS must consult widely and draw up a carefully thought through GTOS Early Warning

Policy. As an aid in developing this policy GTOS should establish a GTOS Early Warning Panel which will subsequently keep GTOS early warning actions and implications under review.

E. GTOS in the Future

Background

How GTOS will develop in the next century will largely depend on how it progresses between 1997 and 1999. However, global changes will continue and new environmental issues will be identified, both of which will have to be faced by GTOS. Improvements in telecommunications and computer capabilities may lead to major changes in GTOS users and user demands. Ordinary people worldwide accessing GTOS from their homes or workplaces are likely to become one of the leading users of GTOS resulting in the use of GTOS data in new and innovative ways. GTOS must be prepared to respond to these changes. Scientists will have better models with greatly improved predictive capabilities requiring data obtained with improved precision and accuracy of measurement which will have to be reflected in GTOS procedures. Observations on new variables will be asked for as scientific understanding of environmental processes increases resulting in increased observational demands on GTOS which it must be prepared to meet. Socio-economic data gathering techniques will improve at all levels allowing more meaningful application of global change data to national development. Better links between science and development, in which GTOS must play a role, will result in more sensitive indicators, and improved indices and other relationships for determining social and ecological responses to global change. These could have profound implications for the future development of GTOS and the applications of its findings.

GTOS Networks

GTOS networks will continue to grow and improve both in coverage and scope as the value of GTOS becomes more apparent. This will be further enhanced as scientists begin to realize that the planet must be regarded as a functional unit in which compartments and processes are all interconnected. What happens in one place affects what is happening in other places. GTOS is an ideal vehicle for obtaining better data and understanding of these interlinkages. A core set of variables should be identified that will allow the state of the global environment to be tracked. GTOS will play a key role in this and should establish a GTOS Global Warning Network that will draw attention to any significant perturbations in the state of any of the core variables and call for an investigation. GTOS Special Purpose Networks should be brought into operation to make measurements on variables not normally observed but which have been identified as of interest on theoretical grounds or because they have been found to be involved in perturbations observed by the GTOS Global Warning Network or other global monitoring systems.

GTOS and Sustainable Development

Helping nations towards sustainable development will probably become the most important activity for GTOS in the future because it will affect in one way or another the lives and well-being of most of the world's population. Data from GTOS will enable better understanding of the processes of the environment and renewable resource utilization thus enabling greatly improved, more rational, national development planning. This must, in turn, lead to improved living conditions for people especially in developing countries. GTOS will have to concentrate on providing countries with sound practical advice on establishing national observing systems directly related to national development. To do this effectively GTOS should establish a GTOS Sustainable

Development Unit within the structure of the GTOS Secretariat. As part of its sustainable development effort GTOS should also negotiate with individual countries for access to environment-related national statistical data. If these national data have been collected in accordance with acceptable international quality assurance and control procedures they will be valuable additions to GTOS databases that will not only aid sustainable development activities but will also contribute toward improving the science base of GTOS.

The Global Observing Systems (GOS) and the Future

The three Global Observing Systems can be considered as inter-related elements of a single Global Observing System. In the future, therefore, it may prove more advantageous to turn this understanding into reality. If this should prove attractive (financially and administratively) to governments and to the sponsoring agencies, the three observing systems should be merged and the resultant GOS placed within the United Nations Secretariat, though it could be located outside New York as long as it is seen to be a United Nations body.

I. Needs and Rationale

A. The Changing Global Environment

1. The Biospheric Layer

All life on Earth occurs within the narrow confines of a thin layer on the surface of the planet. This layer extends above the planetary surface for a few hundred kilometres, to the bottom of the oceans for a few tens of kilometres, and into the land surface for a few kilometres. Relative to the diametre of the planet this is a very thin layer, almost a smear. It comprises three interlinked compartments, the largely gaseous atmosphere, the surface crustal land masses, and liquid water forming the mainly saline oceans, shallow freshwater lakes and rivers, and water deposits in the upper crustal layers. This biospheric layer is greatly affected by the enormous and continuous, but fluctuating, stream of radiative energy that falls upon the Earth from the outpourings of the sun. It is also affected by the consequences of the lesser amounts of internal planetary energy released from radioactive decay and from the gravitationally induced squeezing of the interior of the planet.

2. Beginnings of Life

These energy fluctuations, heightened in their variability by the annual orbiting of the Earth around the sun and the progression of the entire solar system through the complex radiative environment of deep space, cause the surface of the Earth to be in a constant state of interactive flux, a state that continues to this day. It is this highly variable surface environment that led to conditions for self-replicating life to start and to evolve continuously by constantly adapting to global and local changes in resource and energy availability. The story of life is thus one of how organisms evolve, develop and adapt (or do not adapt) to environmental change.

3. Human Technology

In geologically very recent times one species evolved to the point where it developed technology which gave it the capacity to use and exploit the resources of the planetary surface for its own purposes in ways that no other species had been able to do before. This has allowed this species, humanity, to spread over the Earth's surface and to exert its influence on all but the most remote and inhospitable parts. The consequences of this exploitation are today rapidly affecting the nature of the surface layers of the planet in ways that profoundly affect all forms of life living in them. The extent and rapidity of these global changes are unusual in the history of the Earth; what is unique to the present is that these changes are being caused by one species.

4. Global Change

Two Challenges

Of the many challenges facing humanity today, two of the largest relate to global change. The first is to understand the nature and causes of global changes, their extent and the speed at which they are occurring. The second is to determine the consequences of global changes upon people, their health, and their well-being.

Global Change and the Use of Models

Global changes can only be understood properly by knowing how the basic environmental processes involved actually work, and what happens when they are altered. This requires developing and testing theoretical mathematical models of relevant processes, and making careful accurate and precise measurements of selected relevant environmental variables so that data of known reliability are available for analysis, and for testing and verifying the models. To be of value to people the models must relate to the real world and this can only be done by using real world data in real world situations. Well developed and tested models allow predictive statements to be made about likely future conditions; the better the model, the better and more practically useful are its predictions.

Scientists and Planners

The second challenge is more difficult to meet because it involves the transformation of scientific data and knowledge into usable forms that are relevant to national development and personal well-being, and ensuring that these data are provided both quickly and routinely to those who will use them. Sustainable development very much rests on planners and managers having the right sorts of reliable natural resource and environmental data when they need them. Planners cannot afford to wait for the outcome of lengthy scientific investigations. They need useful data that they can rely on and they need them quickly. This need can only be met if planners and scientists work closely together right from the start so that each group knows the needs and capabilities of the other.

B. Global Observing Systems (GOS)

1. Global Observing Systems versus monitoring systems

Global Observing Systems (GOS) are an important means of achieving the necessary scientific understanding of environmental processes and of global change in that they provide long-term reliable global data series that are essential for predictive model calibration, validation and further development. Current operational monitoring systems have usually been designed to help answer specific scientific questions and are thus limited in scope and purpose.

The wider more comprehensive GOS are generally more complimentary to broader scientific research approaches, such as that of the IGBP Global Change Programme, which will use many of the data collected or generated through the GOS. Relevant GOS data, especially terrestrial data, can also be made available more readily to national planners and managers to use directly in economic planning and development, or in translated forms, or as a basis for the generation of more useful secondary and tertiary data such as social, economic and environmental indicators. Also the very term `observing' has a more open, less proprietary tenor to it than the more possessive and watchdog sounding `monitoring'. This alone makes observing systems more acceptable to many of the more politically sensitive potential partners in a GOS.

2. Assessments and Uses of GOS Data

Data from traditional Global Monitoring systems are usually analyzed within the system in accordance with the purpose for which they were gathered so that it is the system that produces the intended assessments. In the Global Observing System approach all data are collected with the same rigour and care but without the GOS necessarily being responsible for more than a few of the subsequent analyses and assessments (apart from initial data verification).

Thus GOS data, routinely gathered and openly made available to the international community, eg through the Internet, can be utilized by a wide variety of users - both institutional and individual - for a multitude of purposes ranging from model verification and improvement to the preparation of more traditional status and trend assessments. This has both advantages and disadvantages. Data are more readily available to a wider variety of users, but these same data may then be used for purposes very different from the original objectives for which they were gathered. Also countries may object to making national data that they consider sovereign freely available to others. This is particularly so if countries think that these data could benefit economic rivals or be used as the basis for their own economic exploitation through market manipulation.

3. The three Global Observing Systems

Three closely linked global observation systems are in operation: the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), and the Global Terrestrial Observing System (GTOS). The first two are functional and the third is at the end of its initial preparatory stage and is about to start its establishment phase (see VI.A.1.). The intention is that together the three GOSs will provide the nations of the world with integrated, multi-scale monitoring of global change and its effects.

Global Climate Observing System (GCOS)

Sponsored by UNEP, WMO, IOC of UNESCO, and ICSU, GCOS is a dedicated observing system to meet the scientific requirements for monitoring the climate, detecting climate change, and for predicting climate variations and change. GCOS does not make observations or generate data products, but encourages, co-ordinates, or otherwise facilitates observations which must be made by national and international organizations in support of their own requirements as well as common goals. GCOS is thus supported by national governments and implemented through national agencies and organizations, with the assistance of national and international data management and distribution bodies. It is intended that in the future GCOS will be able to specify needed observations, recommend appropriate techniques for measurements and data management, establish mechanisms for transmission, storage and distribution of GCOS data and data products, participate in capacity building and training activities, and advise in the application of GCOS data and information to national economic and sustainable development. For practical purposes the GCOS programme can be divided into seven broad interlinked categories (termed `missions' by GCOS):

- Global radiative properties;
- Ocean characteristics;
- Ocean-atmosphere boundary;
- Atmospheric dynamics;
- Atmospheric composition;
- Land-atmosphere boundary;
- Land-biosphere climate response.

Of these seven categories it is the last two, the land-atmosphere boundary and the land-biosphere climate response, that are most relevant to GTOS and offer the most potential for co-operation between GTOS and GCOS. Data gathered through GTOS, however, also be of some relevance to three other GCOS categories (global radiative properties, atmospheric dynamics, and atmospheric

composition). Priority should be given to developing a joint GOOS/GCOS/GTOS coastal observation system.

Global Ocean Observing System (GOOS)

Sponsored by UNEP, IOC of UNESCO, WMO, and ICSU, GOOS is a mechanism for gathering, analyzing and assessing all types of marine and oceanographic data that are of common worldwide importance and utility as defined by a very broad spectrum of user groups. GOOS is a mainly a facilitative mechanism but also plays a key co-ordinating role in some activities. Emphasis is given to ensuring quality control of GOOS data and derived data products. Special attention is given to the distribution of data and information and in ensuring that GOOS outputs are in forms appropriate to specific users. GOOS is supported by national governments and implemented through national agencies, organizations and industries, with the assistance of national and international data management and distribution bodies. On the basis of user needs the GOOS programme has been divided into five inter-related modules that share observations, data networks and facilities. The GOOS modules are, in order of user interest:

- Climate monitoring, assessment and prediction;
- Monitoring and assessment of living marine resources;
- Monitoring and prediction of the coastal marine environment (Coastal GOOS);
- Assessment and prediction of the health of the oceans;
- Operational marine meteorological and oceanographic services.

Of these five categories it is the first three, climate monitoring and assessment, living marine resources monitoring, and the coastal marine environment, that are most relevant to GTOS and offer the most potential for co-operation between GTOS and GOOS. Priority should be given to developing a joint GOOS/GCOS/GTOS coastal observation system.

Global Terrestrial Observing System (GTOS)

Sponsored by UNEP, FAO, UNESCO and ICSU, GTOS is a network of networks for obtaining the terrestrial data needed to detect, locate, and quantify changes (especially reductions) in the form and function of terrestrial ecosystems (see III.A. and III.B.1. below). This Implementation Plan is concerned with the concept, organization, structure, programmes, development and future of GTOS.

II. Vision and Principles

A. Vision Statement

The Global Terrestrial Observing System (GTOS) is an international co-operative partnership mechanism to collect and provide to policy makers, resource managers and researchers the data needed to detect, locate, and quantify changes (especially reductions) in the national or global capacity of terrestrial ecosystems (including managed ecosystems) to support sustainable development and improvements in human welfare, and to help advance scientific understanding of such changes.

B. GTOS Is and Is Not

1. GTOS Definition

GTOS is a dedicated long-term, integrated, user-driven observing system for monitoring the extent, form and function of terrestrial ecosystems, including those of managed lands, and detecting and measuring alterations in them resulting from climate changes, changes in human activities such as land-use and industrial development, and changes from other causes such as tectonic activities.

2. GTOS Scope

GTOS addresses the total terrestrial ecosystem complex, including coastal systems, and thus considers biological, chemical and physical properties as well as terrestrial, oceanic, hydrological and atmospheric processes. In this respect it works closely with, or through, the other two Global Observation Systems. GTOS is thus global in scope with comprehensive worldwide coverage and addresses phenomena that are global in their nature or impact.

3. GTOS Time Trends

GTOS does provide continuity of information collection over the long-term periods which are consistent with the rate at which global processes occur (years to decades) in order to allow sensitive and timely detection of trends in change.

4. GTOS Data

GTOS does not itself make observations although it may generate data products. Rather GTOS encourages and otherwise facilitates the making of observations by national and international organizations in support of their own requirements and objectives, as well as in support of common goals. GTOS is thus mainly a facilitator.

5. GTOS Research

GTOS is not a research programme and does not undertake research in the field or laboratory. GTOS does, however, support and collaborate with existing international and national research programmes by making available relevant quality assured data for their use. Conversely, the research programmes advise GTOS about the variables on which observations are needed and on how they should be measured.

6. GTOS Finance

GTOS does not financially support or staff observation programmes at any scale (global, regional, national, local). Consequently it does not and will not control large financial resources. It does, however, advise and guide those who need finance for the implementation of GTOS related activities on how to seek and obtain the necessary funds from recognised bilateral and multilateral funding sources.

C. GTOS Data Collection Objectives

1. Objectives

a. Identification of Relevant Factors

The identification and quantification of the natural and anthropogenic factors that affect terrestrial ecosystem function and structure.

b. Factor Rating

The determination of the relative importance at national, regional and global levels of the natural and anthropogenic factors that affect terrestrial ecosystems and their interactions.

c. Changes Over Time

To distinguish between short-term natural variations or perturbations, and long-term changes of anthropogenic origin.

d. Modelling Possible Future Changes

The provision of assistance to modelling and multidisciplinary dynamic analysis of possible future changes in terrestrial ecosystems. These changes must not only be detected and described, but understood and predicted.

2. Attainment of Objectives

GTOS will meet these data collection objectives by adopting appropriate mechanisms to:

- Achieve an equitable partnership between data generators and data users through an harmonized and equitable system for integrated terrestrial monitoring and assessment that meets both the relatively immediate needs of national governments and the longer-term needs of the global change research community;

- Develop an hierarchical system of sites, remote sensing imagery, and variables that can provide the data essential for the clarification of the key questions and uncertainties on the resilience or vulnerability of terrestrial ecosystems to anthropogenic forces and their possible responses to them;

- Support the upgrading of site instrumentation and management where appropriate, and establish additional monitoring sites to ensure adequate representation of the dominant or most sensitive managed agro-ecosystems, biomes and ecotones;

- Bring existing monitoring networks into a global network of networks, and catalyze the establishment of new networks as required;

- Gain international acceptance for a common data management framework with internationally accepted protocols and procedures for the collection, harmonization and free exchange of compatible data;

- Support national monitoring systems and programmes in training and project preparation, and provide advice and assistance in obtaining external financial help.

D. Main Principles

GTOS Governance

1. Guiding Principle

The GTOS Co-sponsoring organizations collectively are the primary authority governing GTOS with all other governing authority descending from them.

Sponsors Group for the Global Observing Systems

The organizations supporting the three Global Observing Systems, including GTOS, have formed a Sponsors Group (see Annex I) as a mechanism for improving inter observing system co-operation, limiting duplication, and facilitating administration thus reducing costs.

GTOS Co-sponsors and the GTOS Steering Committee

The Governing Bodies of the organizations that Co-sponsor GTOS have ultimate authority over GTOS since each must give its prior approval, for each of its budgetary periods, on the level of administrative and financial support that its organization provides to GTOS. The Co-sponsor organizations agree that GTOS should be a programme within the United Nations System. The Co-sponsors are the organizations which collectively take legal and administrative responsibility for GTOS, its general direction and operation, and for ensuring the funding for the GTOS Steering Committee and its subsidiary bodies, and for the GTOS Secretariat (see V.B.1-2. below). Funds for this purpose are deposited in a specially created GTOS Trust Fund administered by the host organization of the GTOS Secretariat (currently FAO). The Co-sponsors provide the GTOS Steering Committee with Terms of Reference governing its composition, general responsibilities, and powers, by which it provides practical political, scientific, technical and general directional guidance to GTOS. The GTOS Steering Committee is composed of independent individuals selected by the Co-sponsors together with representatives of the Co-sponsors; it operates under a Chair chosen from among the independent members. The Chair of the GTOS Steering Committee reports directly to the Co-sponsors. The Director of the GTOS Secretariat reports to the Chair of the GTOS Steering Committee. The Steering Committee has a number of limited-life subsidiary bodies, such as Panels and Working Groups created as required for specific purposes, available funds permitting.

GTOS Panels

GTOS Panels are expert groups appointed, subject to available resources, by the Chair of the GTOS Steering Committee to consider and make recommendations on designated specific topics. Panels have no specified length of life but they may be disbanded by the GTOS Steering Committee on the recommendation of its Chair. Panels are composed of outside experts (about 80%) augmented by Steering Committee members (about 20%). Each may co-opt additional members for particular discussion items should this be necessary. The most important of these Panels will be the GTOS Terrestrial Observation Network Panel (see V.B.2.b. below) which will provide most of the scientific and technical guidance to the GTOS Steering Committee while also

serving as a forum for allowing direct input into GTOS management from the networks participating in GTOS. The Chair of a GTOS Panel reports directly to the Chair of the GTOS Steering Committee on all major substantive issues, and liaises with the Director of the GTOS Secretariat on administrative, financial and related matters.

GTOS Working Groups

Working Groups are informal limited-life subsidiary bodies of the GTOS Steering Committee composed of members of the Steering Committee. Each is created by the GTOS Steering Committee to consider, develop or evaluate specific topics and issues. The Chair of each Working Group reports to the Chair of the GTOS Steering Committee and liaises with the Director of the GTOS Secretariat on routine matters (see V.B.2.c. below).

GTOS Secretariat

The Secretariat provides the continuity necessary to keep GTOS operational and so is the functional centre of the system. The Director of the GTOS Secretariat reports to and liaises with the Chair of the GTOS Steering Committee over liaison with and operation of the national networks comprising GTOS, and keeps the Co-sponsors informed on progress and problems within GTOS (see V.B.3. below). The Director also attends meetings of the Sponsors Group of the Global Observing Systems.

2. GTOS Value-added Role

Guiding Principle

Data products produced through GTOS have enhanced value to users because they result from related focused inputs from more than one GTOS participating network.

GTOS Synergistic Approach

Participation in GTOS will add to the value of data and information obtained from individual international or national observing networks by providing complementary information from the other networks on the principle that two bits of related data have more information value when they are considered together than when they are apart. Linking networks together within GTOS will, for example, widen the range of studies possible, extend spatial and temporal coverage, and through inter-comparison exercises and model testing, will greatly improve predictive power. Integration of networks within the GTOS framework will also enable the applicability of protocols and standards to be more widely tested thus greatly facilitating national and international quality control. Such integration will also assist in more cost effective use of capital equipment and facilities by encouraging their collaborative use. Most importantly, the making available to each network participating in GTOS of the data series collected by the other component networks will materially aid in developing more effective, better based, common national management and resource utilization policies and strategies that will be of correspondingly greater value to governments and others concerned with sustainable development.

3. GTOS Data Quality and Harmonization

Guiding Principle

Data produced through GTOS are high quality, compatible, comparable, reliable and can be used with confidence by policy making bodies, international programmes, and the scientific community.

GTOS Harmonization Framework and Levels

A conceptual science and methods framework is needed to ensure that ongoing national programmes with different aims, but brought together within GTOS, produce compatible data for use in subsequent analyses. The framework would also allow better co-ordination of research and observational activities by helping to ensure that all the necessary data are being collected. Such a framework would provide clear guidelines to be followed in specific observation situations. To encourage and achieve harmonization GTOS should seek representation on bodies that define protocols and standards, and should actively promote the protocols and standards that GTOS adopts. In most cases three levels of harmonization can be recognised.

Metadata Harmonization

The first and most general level is that of recording information on who is doing what, where, how and why. Such metadata information is required for all co-ordination activities and as a basis for decisions on where to employ financial resources most effectively. The proper collection and distribution of such information is an harmonization task in itself.

Data Integration and Data Aggregation

To provide harmonized information to GTOS users the data collected in different environmental research and monitoring programmes at different sites must first be integrated to ensure that the data of different origins are compatible and can be compared. The data must also be aggregated further for local, national, regional and global analyses and for use at different levels of decision making. Thus integration and aggregation must be performed both within and between the different programmes of the various networks taking part in GTOS. To do this satisfactorily will require reaching agreement on the definitions of objects, classification systems (eg vegetation, land-use, land-cover) and the formats for data handling and exchange. Similarly any models used in GTOS should be comparable and compatible in supporting the integration and aggregation of data.

Data Collection and Generation

Ensuring data compatibility in basic data gathering for GTOS will require that the same parametre be recorded in the same way using the same units, averaging time, sampling frequency and codata. Ensuring GTOS data comparability will require that data have a properly documented and defined level of quality. Since it is not possible to apply standardised measurement techniques globally, quality assurance and quality control will be the main means of achieving useful harmonization at this level.

GTOS Quality Assurance and Quality Control

Data quality assurance programmes, including direct quality control, are applied at different levels in the data gathering process. These include: in the field or laboratory, at the GTOS Data and Analysis Centres, in approvals to the final database, and in simple statistical and graphical evaluations to check on the validity and representativeness of the acquired data. Because of the geographical nature of GTOS, wherever possible GTOS data should be spatially and temporally referenced. GTOS should consider developing more than one level of quality control so permitting GTOS to record unusual or sparse but valuable data that otherwise might be lost. In all cases the true reliability of these data should be indicated. Application of quality control procedures will give GTOS data international and scientific credibility, indicate their reliability, and ensure their acceptance by users in both the development and scientific communities.

4. GTOS Data Ownership and Distribution

Guiding Principle

GTOS data are normally distributed in an open and unrestricted manner to encourage free flow of data and information between GTOS data providers, GTOS data processors, and GTOS data users, while respecting national sovereignty of data originating in states.

Unrestricted Data Availability

In general past, present and future data and information generated or supplied through GTOS should be readily available to potential users in a free and unrestricted manner. This means that users can obtain them at no more than the cost of reproduction and delivery without charge for the data and data products themselves. Wherever possible checked and verified data should be placed in the public domain and made readily accessible through direct access to databases held by GTOS Data and Analysis Centres (see VIII.A.1.c. below) using both on-line and off-line means, and through the World Wide Web. This is in accordance with the call made at the United Nations Conference on Environment and Development (Rio de Janeiro, 1992) for an increasing global commitment to exchange scientific data and analyses and for promoting access to strengthened systematic observations. GTOS should develop appropriate policies and protocols for use in this area.

Restricted Access Data

The above not withstanding it is recognised that some institutions and governments may have strict rules regarding access to, and use of, data acquired by them. In other cases data obtained through GTOS may be thought of sufficient sensitivity that some national governments may not wish selected data series concerning their countries to be readily accessible to all potential users. This may apply particularly to some types of data about national renewable natural resources of economic significance which might be open to adverse manipulative use in the market place. In such instances the right of a sovereign state to limit the distribution and availability of such primary data will be respected by GTOS. In such cases, GTOS should then enter into discussions with the government or institution concerned to develop a protocol controlling the release of the restricted national data series for specified agreed purposes such as in the development, testing and verification of certain scientific models.

5. GTOS Methods Evolution

Guiding Principle

Wherever possible the most suitable, practical, proven and cost-effective methods for data acquisition, data management, and data analysis are used within GTOS.

GTOS Methods

The most suitable tried and tested advanced methods for data gathering, handling and analysis must be used within GTOS. Methods recommended for GTOS should in general be available in both developing and developed countries. New methods in all sectors with which GTOS is involved are constantly evolving and these should be kept under review by GTOS. With very few exceptions, however, new methods should not be introduced into GTOS until they have moved out of the research realm and have become tested and proven operational tools. Review of relevant methods should become an on-going activity of the GTOS Terrestrial Observation Network Panel which should make recommendations to the GTOS Steering Committee as appropriate.

6. GTOS Data Use

Guiding Principle

GTOS data are of selected variables chosen to meet specific user needs, and are made available to users in forms, including transformations and derivations, appropriate to those needs.

GTOS Data Uses

GTOS is a user driven system in which data are gathered on variables chosen to help answer specific questions posed by potential users in policy making bodies, international programmes and the scientific community. The variables selected are those that can provide the most information about the topic of interest for the least expenditure of time, effort and money. Most directly measured data relate to the present but in some cases sample analyses will produce information about past environmental events (eg historical temperatures or past vegetation types). GTOS data can be supplied as straight data, or they can be transformed into secondary or tertiary data such as indices or composite indicators that may be more suitable for some uses. Data can be measured directly with known precision and accuracy, or they can be derived from indirect sources such as satellite images. In these cases a relationship must be established between actual observations made at a particular site and the indirect satellite measurements. GTOS site data will, therefore, be used extensively as ground truth for calibrating satellite data. GTOS data will also be used to develop, test and verify a wide range of environmental and ecological models for global change studies, and for use by planners, development economists and sociologists.

GTOS Data Scales

GTOS must be able to provide data at the scales needed by users which will vary from local to global. At local and national scales many more fine resolution data points are required to meet user needs than is the case for global scale assessments (see VIII.F.1-5 below).

7. Identification of Gaps

Guiding Principle

On-going GTOS programme actions are taken to help close known data and information gaps relevant to the priority areas of GTOS.

Gaps in Data and Knowledge

There are major uncertainties and gaps at all levels in knowledge including, for example, environmental and ecological processes and their functions, the extent of ecosystems and their component species, and the availability and sustainability of exploitable natural resources including unpolluted air, soil and freshwater. Many important data series are not available or are only partly developed (eg changes in soil properties, soil carbon, erosion rates, and contaminant deposition patterns). There are also gaps in knowledge of how these are affected by altering patterns of industrialization, increasing urbanization, and other expressions of social change. Gaps occur in the analytical tools and methods available for effectively and meaningfully analyzing environmental and ecological data, including some very basic classification systems necessary for proper analyses and assessments (eg global classification systems for vegetation, land-cover and land-use). In short, there are no sectors or areas in which GTOS will work where there are not important gaps in data and information.

Identification of Gaps

Data generated or obtained through GTOS can be used to help close many important knowledge gaps. However, GTOS cannot, and should not, attempt to contribute to the closure of all known information gaps. GTOS must, therefore, identify knowledge gaps that are of significance and which affect any of the five priority areas of GTOS. Other gaps should be left for attention in future phases of GTOS. The GTOS Network Observation Panel should take the lead in identifying important gaps in geographical, ecosystem, and observation coverage, and in method development and data management techniques. The Panel should also make suggestions on how the gaps might be closed, or at least narrowed. Gap identification and review will be an important on-going activity of the Panel.

III. General Activities and Users

A. Basic Philosophy

The philosophy underlying GTOS is that the land surfaces of the world and their natural resources are of fundamental importance to people and to human well being. Terrestrial ecosystems, including managed ecosystems, can only support people directly (and indirectly) if they are used wisely and efficiently in ways and at rates that allow renewable resources to be replenished rather than to be destroyed - that is in ways that are sustainable. This can only be done well if there is a proper understanding of the natural resources base; the extent of the different constituent ecosystems, how they work, and what affects them and why. Such a scientific understanding requires relevant data but at the moment there is no co-ordinated system for getting the necessary information. It would be fruitless to try to monitor everything so that GTOS must clearly focus on what users need in the way of terrestrial information. Priorities must then be assigned among data collection efforts, and to products derived from them, in terms of quantifiable benefits that can actually be delivered. End products must always be in forms relevant to the intended users, thus scientists will tend to need specified accurate and precise data whereas national planners and managers will usually require these same data to be transformed into other forms (indicators, indices, etc.) more readily used by them.

B. Facilitation of National and Regional Programmes

1. Shared Experiences

At national level each industry and service sector has its own different requirements for specialised data products. GTOS will, therefore, have to study a representative sample of user groups to see exactly what they need (see IV.E. and V.E. below). By analogy the findings of these studies can then be extended to similar industries, and to other countries with similar environmental and economic conditions. GTOS will, through direct contacts and through its information and public relations activities, make countries within a region appreciate the practical benefits of sharing in the experience of others with similar economic and environmental conditions.

National and Regional Activities

To facilitate national and regional GTOS related programmes GTOS will have to work closely with the relevant national or regional authorities to identify what types of information they need and for what purposes. GTOS will also have to review existing national and regional facilities and capabilities to determine what can be done at present, and what could be done in the future with additional technical assistance. Once this has been completed it will be possible to specify what GTOS products will be required, in what forms, and by when. GTOS will then be in a position to work closely with national and regional experts to develop an appropriate production line for each product (see IV.B.3. below). These activities should be first undertaken in the form of a few selected case studies with different scenarios. Outside funding should be sought for these case studies.

2. Product Production Lines

To succeed GTOS will have to deliver meaningful, usable products. To do this successfully GTOS will have from the start to adopt ways and means for product delivery similar to those that are current in the commercial world. This will normally involve using for each product a specific production line approach in which consecutive actions are identified between recognition of product need, to product delivery and use. A pathway of this sort will show at what point or junction key actions take place such as quality assurance and quality control procedures, or junctions, for example, where supplementary data are slotted in, or particular analyses take place. Such an approach allows different operators on the production line to be identified and their actions located. Adherence to commercial techniques such as this will ensure that GTOS products are what are required by the users and that they are delivered when needed and in the right forms.

C. Collaboration and Support for Research Programmes

1. GTOS and Science

Science is what converts terrestrial data measurements into different forms of information that can be used by different user groups. Thus scientists are an important user group of GTOS data as well as being data suppliers. The needs of scientists must be respected, for without the proper understanding of environmental processes and functions provided by the scientific community the information gathered through GTOS cannot be put to use by national planners and socio-economists with any confidence. Scientific effort and needs will considerably influence the design and operation of GTOS itself and will affect the development of many useful or beneficial GTOS

products. Thus, although not the major reason for developing GTOS, scientific design and scientific analyses are crucial in ensuring that GTOS produces data and information that are of value in national economic development.

2. International Research Programmes

GTOS must have a sound scientific basis if it is to produce meaningful products. GTOS does not have the technical capabilities and financial resources to become a research programme in its own right. Therefore, it is essential that GTOS develops close collaborative links with the scientific community through functional research programmes. GTOS needs to be aware of current research developments and findings in its major programme areas if it is to keep these programmes abreast of present relevant knowledge. Research findings could, for example, sometimes influence or even change GTOS observing techniques and sampling strategies. Most importantly, GTOS must work closely with scientists that are developing or improving environmental and ecosystem models that could be used by GTOS (see IV.E.2. below). IGBP has been closely involved with the development of GTOS since it began and should be its senior scientific research partner (see VI.E.2.a. below). There are many other research programmes with which GTOS could profitably develop links. GTOS, through the GTOS Secretariat should ensure, available resources permitting, that GTOS is represented at important research programme meetings, not just to learn of developments, but to make the research community aware of what GTOS does and the opportunities for collaborative work that it offers.

D. Guidance for Funding

1. Funding and the Co-sponsors

By accepted United Nations procedure it is the responsibility of the Co-sponsors to arrange adequate funding for any joint programme that they have formally agreed to sponsor. Thus it is the Co-sponsors who officially must seek the needed funds for GTOS if they cannot adequately budget for its needs from their own resources. However, the GTOS Co-sponsors can, and should, delegate some of that authority otherwise they will find themselves also responsible for carrying out all the routine GTOS fund raising associated with obtaining normal outside support for GTOS projects. This routine fund raising should be carried out by the GTOS Secretariat, after consultations with the Chair of the GTOS Steering Committee, operating within the financial and administrative rules and procedures of the host organization (FAO). Additionally, members of the GTOS Steering Committee can help in fund raising by drawing upon their own experience to suggest possible strategies and funding sources. By this arrangement the Co-sponsors are responsible for funding policy and approaches to major donors (the latter can also be delegated) while routine fund raising is the responsibility of the GTOS Secretariat under the guidance of the Chair of the GTOS Steering Committee. The GTOS Secretariat will keep the Co-sponsors regularly informed of fund raising needs, actions and progress, and will seek advice and help from them where necessary.

2. Strategy

The funding strategy for GTOS will be to obtain funds to support individual activities, events, projects and products ranging from single technical meetings and publications to longer-term programme activities, rather than to seek massive funds for the support of the whole programme. This is in keeping with the concept of GTOS as being a system that builds primarily on what exists

already and does not have large funds of its own. At an early stage of GTOS a long-term funding strategy for GTOS should be developed.

3. GTOS Database of Donors

Funds for GTOS activities should be sought from a variety of individual donors ranging from bilateral and multilateral to foundations and industry. To make this fund raising proceed smoothly it is important to understand the aims and goals, sectoral and geographical limitations, and other constraints of each potential donor. The GTOS Secretariat should, therefore, develop a donor database in which a full profile of each donor is lodged and updated regularly. This will prevent GTOS making unfortunate approaches leading to waste of time and loss of credibility.

4. GTOS Budgetary Planning and Fund raising

Once the GTOS programme has been decided and a preliminary implementation plan agreed, each phase of that programme should be broken into carefully costed constituent parts, allowing for annual inflation. The programme phase covering GTOS Years 4-10 should, for budgetary and audit convenience, be considered in blocks of two years, leaving Year 10 as a transition year to the new GTOS decade to follow. Wherever possible GTOS budgetary planning should be at least two years in advance. For each budgetary period those activities for which external finance is to be sought should be identified. The aims, objectives, scope, duration and cost of each should be compared with what is known about the mandates of various donor agencies. Once there has been a match between desired activities and likely donors, the activities should be looked at afresh to see whether they could be reformatted in any way to make them better fit the mandate requirements of the potential donors. This procedure should be followed for all projects, large and small, long-term or short-term, for which funding is sought. Fund raising and budgeting are always closely related.

E. Potential Uses of Data

1. Magnitude and Impacts of Global Change

Global Change

Global change encompasses far more than just climate change. It also includes changes in atmospheric composition such as the increasing concentrations of carbon dioxide and the other radiative trace gases. These greenhouse gases have direct impacts on vegetation and the other biota vegetation supports, as well as the better known indirect effects through climate change. Global change also includes changes in land-use resulting from economic, technological and social pressures that are the result of changes in human numbers and social conditions. It is generally thought that this human dimension of global change will have a more profound influence on terrestrial ecosystems and their future than will changes in climate or atmospheric composition. Such changes are likely to be largest in the tropics. However, in global change the driving forces are strongly interactive and very interrelated rather than independent which makes understanding more difficult to attain. A widely used example of this complexity is where social and economic pressures lead to clearance of very large areas of tropical humid forests. Destruction and reduction of the forests alters gaseous input into the atmosphere so modifying atmospheric composition in ways likely to contribute to global warming. This increased warming will allow expansion of intensive agriculture toward higher latitudes which could, in turn, probably cause further emissions of greenhouse gases into the atmosphere. These types of interactions will result in a changing

mosaic of ecosystems across the land surfaces of the world. Thus the key to understanding global change, its extent, and its consequences, is the understanding of human driven changes in land-cover, land-use, and soil conditions and their interactions with rapidly changing atmospheric composition and climate.

Requirements for Global Change Study

Understanding the magnitude of global change and its effects has two basic requirements. Firstly, numerical simulation models are necessary to sort out the multiple interactions and feedbacks involved. In order to incorporate processes operating at different temporal and spatial scales the models must be hierarchically scaled from a set of nested observations, measurements and models. Secondly, geographically referenced data will be needed to provide parametres for these models. Thus to meet this need a variety of verified, consistent and accurate data sets must be available covering several levels of spatial and temporal resolution.

2. GTOS and Global Change

GTOS and Global Data

Scientists working in the global change field consider that global science is still data-limited so that great efforts will have to be made to develop and validate relevant global data sets. Of the needed data sets those relating to land-cover and land-use are probably the two most important and are perhaps the two most difficult to develop. Networks co-operating in GTOS will be able to provide reliable quantitative seasonal and long-term site specific ground data from national ground sites. Such terrestrial data will be of direct value in model calibration and testing, and will also help in getting better interpretation, verification and calibration of broad scale data obtained from satellites.

GTOS and National Data

Global change is affecting every country resulting in alterations in land-use patterns and land-cover. This is particularly so in developing countries where the bulk of the population is still largely dependent on peasant agriculture and on pastoral livestock production. The economic development of these countries requires that their national policy makers, planners and resource managers have reliable quantitative information about the renewable natural resources of their countries, and about environmental problems that each country may be facing (eg drought, coastal erosion, toxic waste disposal). This information is frequently lacking. The GTOS mechanism can help these countries to fill their data and information gaps through provision of appropriate data in forms that can be used by governments, and by advising them on how to set up and operate, or improve, their own national terrestrial observing systems. This should also include advice on obtaining the necessary initial funds for establishing networks and for national staff training. At the national level, therefore, national policy making agencies will receive through GTOS information that will help them to clarify the potential effects of global change on the managed and natural terrestrial ecosystems for which they have responsibility. Activities such as these are likely to be some of the most important and valuable functions of GTOS since they contribute to national economic development as well as contributing to attaining better scientific understanding of the magnitude of global change and its impacts.

3. Development and Validation of Models

Models are mathematical expressions of system function. Because of the complexity of even simple biological or environmental systems, simulation models are usually constructed as a series of block units which can later be interrelated to encompass progressively larger and larger parts of the total system. At each step the model is tested or validated against independent observations on the real system. Global change models are extremely complex and require, at all stages, a wide range of real data for testing and validation. Often many of the needed data are not available. GTOS could be a source of such data, as well as providing field sites for model testing. At an early stage, therefore, GTOS should have discussions with some of the leading scientific modellers in the global change field to determine what role GTOS could play as a source of relevant data from different ecosystems and from different parts of the world. This would mean carefully defining the variables that would have to be collected through GTOS, from where, when, and in what forms.

Facilitation of Early Warnings

Early warnings based on data and information generated through GTOS would largely constitute advance announcements of impending or rapidly progressing ecosystem changes, especially where these involve reduction in extent, or adverse change in biological composition, or degradation of productive quality and life-support capacity, including pollutant and contaminant problems. In such cases early warnings might necessitate important changes in current land and resource use, or industrial practice, to mitigate possible adverse effects.

Early Warning Sensitivities

Provision of early warnings is likely to be one of the most politically and economically sensitive issues that GTOS will have to face. Yet it is essential that such early warnings are issued (the need for early warnings was recognised as far back as 1972 at the United Nations Conference on the Human Environment). How these warnings are to be drawn up and by whom, and how they are to be issued and to whom are questions that must be faced by GTOS early in its development. Early warnings have possible global consequences the costs of which could run into hundreds of billions of dollars. This must be understood before any warnings are issued. Because of its importance GTOS should approach this with care and caution and seek advice widely before agreeing to any early warning release mechanism. Both GCOS and GOOS should be involved in these discussions from an early stage.

GTOS Early Warning Panel, Report and Policy

Once the scope of the GTOS programme has been agreed GTOS should produce a report on early warnings and how to provide them. It is inevitable that early warnings of various types will be made also by people and organisations outside the formal GTOS networks but using GTOS data that are in the public domain. This aspect should also be considered in the early warning report. The report should then be the central discussion document for an expert Panel to develop further. It will require several meetings before a satisfactory approach to early warnings can be developed. The result will be a general early warning release policy (Priority C) with suggested implementation mechanisms for each of the main sectors with which GTOS is concerned. What is required for early warnings about pollutant emissions may not be suitable for early warnings of situations and events that might need remedial changes in land-use. The GTOS expert Panel will subsequently keep GTOS early warning actions and implications under review.

4. Scientific Understanding

Scientific Understanding and Process Studies

The biosphere is the product of a wide range of interactive ecological and environmental processes that vary in rate according to fluctuations in environmental factors and degrees of feedback. To limit environmental degradation and its consequences it is necessary to identify the processes concerned and then obtain a sound scientific understanding of the nature, function and effects of each. To simplify this task the overall Earth system can, in effect and with caution, be decoupled and the whole broken into subsystems. There are two interacting subsystems relevant to GTOS, the physical-Climate subsystem and the biogeochemical subsystem, linked by the global hydrological cycle and by state variables such as concentrations of the radiative trace gases, surface roughness, and albedo. GTOS is concerned with aiding those trying to obtain better scientific understanding of the processes involved in the biogeochemical subsystem and their effects. Close liaison between GTOS and these scientists is essential. Reports on GTOS activities in this field should reach the science community on-line and through newsletters to create among them an awareness of the GTOS mechanism.

Scientific Understanding and Process Models

Modelling is fundamental to scientific understanding because to model a particular aspect of the biosphere correctly and repeatedly on the basis of its component processes is a real test of whether or not predictive understanding of that component has been achieved. Models also provide an indispensable way of organizing current knowledge and identifying critical gaps. Usually, the aim is not to produce ever larger and more complex models, but to produce a family of them of varying complexity and realism to deal with specific questions. Models have to be designed in such a way that their predictive characteristics can be tested with existing or planned data. A major science role for GTOS will be to work closely with those investigating and modelling processes concerned with the function of terrestrial ecosystems and ensure that they receive through GTOS the right sorts of data from the right places and of the right quality and reliability. GTOS will also be able to provide assistance in the testing and verification of terrestrial process models. The GTOS Secretariat should as soon as possible, as an ongoing process, start to build links with these scientists directly and through the GTOS Steering Committee and its other constituent bodies.

Scientific Understanding and National Development

A sound understanding of the science that underlies ecosystem and environmental processes means that land management data generated through the resultant process models are more reliable and easier to use for national economic development and practical land management. GTOS must ensure, therefore, that scientists work closely with national planners and resource managers to ensure that science findings about ecosystem and environment processes are couched in forms and terms that can be used by national authorities for practical planning and development purposes (see IV.E.6. below). Ensuring this co-operation must be an on-going task of the GTOS Secretariat.

5. Effects of Toxic Exposures

Chemical Exposure

A broad spectrum of toxic chemicals, often in complex mixtures, is being released constantly into the local, regional, national and global environments. The types of chemicals involved include heavy metals, and persistent organic compounds such as organo-chlorines and polycyclic aromatic hydrocarbons and their metabolites. In animals these substances act as carcinogens, carcinogenesis modulators, genotoxins, and reproductive development toxicants; many are neurotoxins. These emissions are largely from industrial, disposal and energy production activities in both industrialised and developing countries. The widespread growth in the production and use of synthetic organic chemicals, plastics, pesticides and drugs, particularly over the last fifty years, is one of the main causes of increases in these emissions. There are three main types of emission sources; those from point sources (industrial plants), area sources (agriculture, households, small businesses and light industries), and mobile sources (mainly vehicles and aircraft).

Critical Loads

Uptake of these substances can adversely affect the health and well being of most organisms by altering the efficient functioning and metabolism of their constituent cells, which can result in illness, incapacitation, or even death. Each organism, or ecological sector, has a quantitative critical load of exposure to single or groups of specific pollutants below which significant harmful effects do not usually occur, according to present knowledge. Above the critical load level adverse effects may occur. Human health, the health of other organisms (including crops and domestic livestock), and the health of ecosystems are all disturbed by contaminant deposition that exceeds their critical loads.

Direct and Indirect Effects

The effects on organisms can be through direct exposure to the substances in the environment (intake of air, water and food, or through physical contact), or indirect where the contaminants affect other organisms on which the primary organism depends for survival. For example, in a given area, if contaminants deposited onto soil, water and grass from the air lead to changes in the vegetation species mix and a downgrading of its nutritional quality, any grazing animals dependent upon that vegetation will be adversely affected, which will, in turn, affect those that eat the grazers as a main source of food. This is as applicable to managed agricultural systems as it is to natural wildlife.

The Role of GTOS

The worldwide monitoring of environmental contaminants allows trends in concentrations of substances in ecosystems to be assessed and enables predictions to be made of the development of contamination and of other deleterious effects. It also assists in the improved determination of critical load exposure levels of various specified contaminants and groups of pollutants for people, species, and ecosystems under different environmental conditions and in different geographical locations. Thus it provides fundamental information for protecting the environment. Monitoring of concentrations of specified contaminants in air, water, soil and biota is essential for introducing controls for the use and discharge of substances which may be detrimental to human health and to the natural environment. These activities require the systematic collection of material in the field and its analysis using special methods and precautions at all stages of sample handling. Many of

the required data can be obtained through the GTOS networks. These will include samples gathered for chemical and physical analyses, as well as relevant quantitative data on changes in the extent, distribution and species composition of both managed and wild biota. GTOS can thus play a very important part in improving human health and well being throughout the world and in improving the state of the global environment. This area is potentially a very important user sector for GTOS.

6. Planning for Sustainable Development

Sustainable Development

Sustainable development is generally said to be development which meets the demands of today without destroying the possibilities for future generations to satisfy their needs. In other words, a renewable natural resource should only be exploited at a rate that it can sustain without it degrading in the long-term. At a sustainable rate of exploitation the renewable resource is able to regenerate at a rate at least equal to the rate of its removal by exploitation. As with natural balanced ecosystems, in sustainable development, user pressures are balanced by productive responses of the resource system. Thus the resource will continue to exist into the future and will still be there to go on supporting generations to come.

Relevant National Information

To achieve sustainable development is, however, far from easy. To attain it countries must first have a sound knowledge of the extent and nature of all their environmental natural resources, not just those that are renewable. Each country must then consider these resources in terms of its national economic and social goals, and the aspirations of its people. Each country has its own air, water, soils, biota and underlying geology which together form the national environment which is available to support its people. To do this wisely requires knowing the extent, condition, function and rate of change of each element of the national environment. Countries often do not have this information. National planners cannot develop wise policies for sustainable development without reliable information and data about their national resources upon which to base them.

GTOS and Sustainable Development

Data obtained through the GTOS networks will play a major role in helping countries, particularly developing countries, move towards sustainable development. This can be done in three main ways.

Direct Supply of Data

GTOS must supply directly relevant data and information to countries in forms that can be used readily by national planners and managers. This will require GTOS data to be transformed or to be used as a basis for the generation of secondary or tertiary data such as environmental indicators or economic indices. Scientists and socio-economists will have to work together to ensure that what comes out of GTOS is what is needed by national economic planners.

Advice on National Observing Systems

Advise individual governments on how to design and establish, or improve existing, national terrestrial observing systems that would enable the government to obtain the sorts of national

resource and environmental data that it needs for national planning purposes. These could be joint activities with either or both of GCOS and GOOS. This advice should be provided through national projects funded by donors. Some of these short-term (months) advisory projects should be developed into longer-term (years) donor funded case studies to demonstrate the usefulness of using GTOS type data in planning for sustainable development.

Better Scientific Understanding

GTOS data will help in obtaining a better scientific understanding of basic environmental and ecological functions. This improved knowledge, when applied to national data, will make those data more meaningful and reliable so making them more useful in planning for sustainable development.

IV. GTOS Structure

A. GTOS Elements

The GTOS system consists of three elements. Throughout this document the term “GTOS” used on its own means the entire GTOS system. Individual elements of the GTOS structure are mentioned only where it is appropriate to distinguish them.

1. GTOS Networks

The networks of national stations, sites and areas where observations are made and data and information are collected. Included in GTOS Networks are all the centres, designated and un-designated, where GTOS data are stored, managed or analyzed, and where assessments and other forms of evaluation are made.

2. GTOS Programme

The work programme of GTOS; the reason for gathering and analyzing the data and information.

3. GTOS Management

GTOS Management provides the means for bringing together the various independent national networks that comprise GTOS and in making their liaison and co-operation easier, more cost effective, and more productive.

B. GTOS Management Element

At present this has three components.

1. GTOS Co-sponsors

Role

The Co-sponsors are the organizations that together sponsor GTOS by formally taking international legal and administrative responsibility for its existence and operation, and for the

funding of its Secretariat. Each Co-sponsor contributes a jointly agreed amount annually, mainly towards the operational costs of the GTOS Secretariat. The GTOS Co-sponsors meet to discuss common approaches and problems with the Co-sponsors of GCOS and GOOS annually and on a time-to-time basis at meetings of the Sponsors Group for the Global Observing Systems held under the auspices of the UNEP Earthwatch Programme.

Membership

Currently there are five Co-sponsors of GTOS - the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU). There is no limit to the number of organizations that can become Co-sponsors providing the existing Co-sponsors agree to the new candidates, and that each candidate formally agrees to a stipulated annual input to GTOS supporting funds, and formally recognises its legal and administrative responsibilities as a Co-sponsor.

2. GTOS Steering Committee

The Steering Committee comprises the Main Steering Committee and its subsidiary bodies.

Main GTOS Steering Committee

Role

The Steering Committee provides scientific, technical and general directional guidance to GTOS. This may be done directly or through relevant subsidiary bodies that it may establish. The Steering Committee meets on a time-to-time basis, preferably annually, depending on available funds. The Chair of the GTOS Steering Committee reports to the GTOS Co-sponsors. The GTOS Steering Committee can create limited-life GTOS subsidiary bodies, such as Working Groups and Panels, for specific purposes as required and funds permitting.

Membership

The Steering Committee is a group of 15-20 independent experts invited to participate in their personal capacities, augmented by one representative of each of the Co-sponsoring organizations. Independent individuals are invited by the Co-sponsors to join the GTOS Steering Committee on a voluntary basis. Co-sponsor representatives serve as members for an indefinite number of years and each Co-sponsor can change its representative at its own discretion. Each term of membership for an independent member is three years and members may not serve for more than two consecutive membership terms. The Steering Committee can co-opt additional persons from time to time to attend particular Steering Committee meetings when the Chair considers that discussion on a specific agenda topic needs expert opinion beyond that within the expertise of the Steering Committee.

GTOS Terrestrial Observation Network Panel

The heart of GTOS is a worldwide network of representative sites and observational facilities at which terrestrial observations are made. These sites are mainly those already within existing national and international networks that are co-operating in GTOS. Other GTOS sites will be

developed in the future as gaps in coverage are revealed. To ensure that GTOS develops along sound scientific lines and in ways that do not contradict the already operational aims and goals of each participating network, it is essential that each participating network is represented on a Terrestrial Observation Network Panel where it will have a voice in determining how GTOS will operate and the directions in which it will move. This Panel will be, therefore, in effect the GTOS Scientific and Technical Committee that was proposed, along with a GTOS Steering Committee, at the Fontainebleau meeting in 1992 but which was rejected by the Co-sponsors because of the cost. Such a body is very important if GTOS is to succeed because it is vital that active terrestrial scientists in the forefront of their fields should keep GTOS abreast of current scientific findings and applications. The reports of the Panel will come before the GTOS Steering Committee which will consider them in light of current political, economic, social and development needs thus giving GTOS the requisite geopolitical and scientific balance. The need for each participating network to have a voice will pose logistic and financial problems since GTOS could eventually have more than 100 participating networks and thus genuinely be a network of networks. Suggestions for dealing with this are made below. The panel is thus a supplement to the Steering Committee and not a replacement for it, nor can Panel duties be undertaken adequately by the Steering Committee; both are needed.

Role

The GTOS Network Observation Panel has no operational mandate and exists to provide the GTOS Steering Committee with scientific and technical guidance on all matters relating to the implementation and operation of GTOS terrestrial observation programmes (eg GTOS Landnet) including practical advice on means to facilitate their on-going operation. This guidance includes advising on the future expansion of GTOS networks, observational and analytical aspects of GTOS, identification of important gaps in geographical, ecosystem and observation coverage with suggestions on how the gaps might be closed, necessary metadata, harmonization approaches including quality assurance and quality control procedures, evaluation of methods for use within GTOS, and national scientific and technical capacity building and training. Individual Panel members and their respective organisation may be asked to assist from time-to-time in some operational tasks such as transforming scientific data into other forms for use by national policy makers.

Membership

The Panel is composed mainly (about 75%) of scientists from networks participating in GTOS and members of the GTOS Steering Committee (about 20%) plus a few (about 5%) independent scientists of distinction who may have no direct role in GTOS and its networks. Each participating network is entitled to be a Full Member and have one representative on the Panel. This will be workable until participating networks number more than 20. At this point it will be necessary, for logistic and financial reasons, to implement a two tier membership of the Panel. Ten participating networks will be designated Founding Network Members and be granted permanent membership of the Panel. As such they will be entitled to attend all future meetings of the Panel. Founder Networks would be those well developed networks that have had a significant influence in the design and establishment of GTOS, or those which are innovative in scientific approach, or are of particular geographical importance (eg AMAP, CERN, CGIAR, ECN, Fluxnet [especially Euro Fluxnet], LTER, ROSELT, etc.). All other network members will then be able to attend Panel meetings on a rotational basis the rotational cycle depending on the total number of participating networks. All members will be able to communicate with other members at any time either directly or through the GTOS Secretariat. The Chair of the Panel will report to the Chair of the

Steering Committee. The GTOS Secretariat will serve as the focal point for the Panel and act as its Secretariat.

GTOS Network Assembly

If the number of networks participating in GTOS increases to more than 20 it may be necessary (see ii above) for GTOS to create a GTOS Network Assembly. Every three years GTOS will bring together Panel members from all the participating networks so that progress can be reviewed and common successes and problems fully discussed. The GTOS Steering Committee will take part in this assembly. GTOS Network Assembly findings and recommendations will be published.

GTOS Working Groups

Role

Working Groups are informal subsidiary bodies of the GTOS Steering Committee and are created by its Chair on the recommendation of Steering Committee members. Each Working Group is led by a designated member of the Steering Committee. Working Groups are created to consider, develop or evaluate specific topics and issues thought relevant to the GTOS programme and its operations. Working Groups have no fixed length of life but are generally short-term. Each is disbanded on completion of its work. Working Groups normally do not meet but communicate and interact by electronic means. Very occasionally, however, a topic may be of such complexity or importance that electronic communication is not sufficient and an actual meeting is required. If the Chair of the Steering Committee approves, and available funds permit, the GTOS Secretariat will support such a meeting.

Membership

Each Working Group is comprised of those Steering Committee members who volunteer to join because they are interested and knowledgable in the discussion subject. Working Groups may seek advice (or co-opt where necessary) from those on the GTOS Roster of Experts and from others not members of the Steering Committee or Roster.

3. GTOS Secretariat

Role

The Secretariat provides the continuity necessary to keep GTOS operational. The Director of the Secretariat reports to and liaises with the Chair of the GTOS Steering Committee over liaison and operation of the national networks comprising GTOS, and keeps the Co-sponsors informed on progress and problems.

Organization

A small full time but modestly funded administrative secretariat headed by an internationally recruited Director. The Secretariat should be located in a national or international host organization (currently FAO [1997]). Secretariat staff are staff members of the host organization for administrative and audit purposes. In addition to the Director, the Secretariat should have two other professional staff and appropriate secretarial services. The Secretariat should also be able to accommodate additional support staff supplied from or through other sources, such as Junior

Programme Officers, Associate Experts, senior retired academic and industrial staff, and direct short-term secondment from governments and industry.

V. GTOS Programme

A. GTOS Programme Development and Priorities

1. GTOS Programme Implementation Phases

Chapters VI. to X. deal with the programme of GTOS. The scheduling of the GTOS activities given below is dependent upon the degree of success of fund raising by the GTOS Co-sponsors. The development of GTOS falls into four overlapping phases:

- Preparatory Phase: For practical purposes January 1997 is taken to be the starting date for this phase although all earlier GTOS formulation activities, including preparation of the important Report of the GTOS Planning Group, are included in this phase. See Chapter VII.

- Establishment Phase: To start about January 1998. See Chapter VIII.

- Development Phase: To start about January 1999. See Chapter IX.

- GTOS in the 21st Century: To start about January 2000. See Chapter X.

2. GTOS Programme Priority Ratings

The following levels of priority have been assigned to activities in each GTOS phase:

- Priority A - High Priority; to be acted upon as quickly as possible;

- Priority B - Normal Priority: Routine activities;

- Priority C - Medium Priority: Important, but implementation can be delayed if necessary.

Priority rating assignments are always for the year for which each is given; ratings for the same action may be different in subsequent years.

B. Policy Development

In the list of required actions that follows it is obvious that many involve the development of various policies for GTOS. These policies are not intended to restrict or confine GTOS which must remain flexible if it is to adapt usefully to continually changing world conditions. They are policies, not rigid rules of conduct. Policies provide background that will help guide those in control of GTOS to meet successfully the future challenges and problems that GTOS will face. Policy development should be started early in GTOS and kept under review throughout. The following policies are considered in this document:

- Policy on Data and Information Release (see VI.E.4.b. and VIII.A.1.a.); Priority A

- Policy on Publications (see VIII.A.2.); Priority B

- Policy on Public Relations (see VIII.A.3.); Priority A
- Policy on Products (see VIII.A.4.); Priority A
- Policy on Early Warnings (see IV.E.3.b.). Priority C

C. GTOS Programme Areas

1. Key Global Change Issues

Priority A

The GTOS Planning Group identified five broad but key global change and national development issues which it recommended should be the focal topics for GTOS in its initial development stages. The first meeting of the GTOS Steering Committee (Rome, December 1996) endorsed and accepted this view. The five issues are along thematic lines because GTOS must be directed at specific user needs. They are primarily concerned with anthropogenic impacts on terrestrial ecosystems. The five issues [not ranked in importance] are:

- Land-use and land-cover change, including land degradation and the sustainability of managed ecosystems;
- Water resources management;
- Loss of biodiversity;
- Climate change;
- Pollution and toxicity.

Each of these key issues will require at least one specialist GTOS network of networks (see VI.D.1. below). It is likely that a particular site can participate in more than one specialist GTOS network but it should not be considered obligatory for all GTOS sites to make observations on all five key issues. The initial GTOS Prototype network should concentrate on not more than three of the key issues. The most suitable for initial demonstration purposes are probably Land-use and Land-cover change, Water resources, and Climate change.

2. The Global Hierarchical Observing Strategy (GHOST)

Priority A

Background

The GTOS Planning Group recognised that it is not possible to know everything, everywhere, all the time. Consequently, if GTOS is to succeed it must use a sampling strategy that provides adequate spatial and temporal resolution but is at the same time practical and cost effective. Such a system, GHOST, was devised by the joint GCOS/GTOS Terrestrial Observation Panel for Climate for use in three main climate-related areas - land surfaces, freshwater ecosystems and ice surfaces - of direct programme interest to GCOS and GTOS, and which could also relate to the work of GOOS. The strategy is hierarchical and allows at one extreme for a large number of variables to be measured at a few sites for a limited period, and at the other extreme, for a few variables to be measured regularly at a large number of sites. The hierarchy divides fairly naturally into five distinct tiers (although some sampling facilities might straddle more than one tier) but is an

incompletely nested system. Models will play an essential role in filling gaps in space and time that are always left by a sampling system. In general GHOST tiers 1 (large area experiments) and 2 (research centres) will generate models which are run, tested, and interpolated using data obtained from tiers 3 (stations), 4 (sample sites), and 5 (remote sensing).

GHOST in the Future

The ability of GHOST to produce meaningful data useful to national planners and scientists alike will have to be demonstrated and should form an important goal of the GTOS Prototype Network (see VI.C.4.b. below). In future GTOS activities, the applicability of GHOST to other GTOS programme areas such as biological diversity, and pollution and toxicity, for which it was not designed will have to be tested and demonstrated (Priority C).

D. GTOS Prototype Network

1. GTOS Networks

Priority B

The programme of GTOS will inevitably be very diverse because of the complex nature of the terrestrial observations required to support work in its five priority global change areas. For organizational convenience, therefore, it will be necessary to have several GTOS programmes in operation at the same time. Each programme will be developed separately according to user needs and availability of participating networks. For administrative convenience and public relations each should be given a short programme name that identifies it as being an activity within GTOS and immediately indicates its main activity field, eg GTOS Biodiversity, GTOS Climate, GTOS Coast, GTOS Glaciers, GTOS Land, GTOS Radiation and GTOS Water. The implementation and development of each programme will be a long-term activity co-ordinated by the GTOS Secretariat.

2. GTOS Prototype Network

Priority A

Before starting GTOS properly it will first be necessary to demonstrate that the network of networks concept underlying GTOS is workable and realistic. A successful demonstration will be an aid in obtaining future support funds for GTOS activities. The best demonstration will be one in which some interested existing networks are brought together to form a prototype GTOS the main aim of which will be to demonstrate the feasibility of GTOS. The GTOS Secretariat should, therefore, prepare a list of not more than 50 existing monitoring networks and programmes which could be possible partners in GTOS. From these, after study of what is known about the goals, programmes and organization of each, 20 that seem most suited to be start-up partners in GTOS should be selected. Criteria for selection should include a focus on terrestrial ecosystems, interest in international activities, recognised scientific and technical capabilities, actively gathering data, extent of coverage with at least some coverage of data poor regions, some functional complementary elements with other potential network partners, and expectation of programme continuity.

After informal preliminary contacts these 20 should be invited to a meeting* to discuss the possibility of working together to form a prototype GTOS. At this meeting the networks should

indicate what they would like to get out of a system such as GTOS, and what they could contribute to it. Those networks that are favourably disposed toward the idea of GTOS should then be formally invited to become a participating network of the prototype GTOS. It is likely, for administrative reasons, that less than half those networks attending the meeting will be able to accept this invitation, but this should be sufficient to get GTOS under way. A centre in one of the participating networks should be agreed upon to act as the Secretariat of the Network; it should liaise with the GTOS Secretariat. Starting the GTOS Prototype Network is a GTOS activity of the highest priority.

N.B. Such a meeting was held at Guernica, Spain, in June 1997. It was attended by 11 networks. By December 1997 six of these networks had accepted a formal invitation to join the prototype GTOS which was given the name GTOS Landnet.

3. GTOS Terrestrial Observation Network Panel

Priority A

The role and function of this Panel are described above (see V.B.2.b.). The most important point about the Panel is that networks which are voluntarily participating in GTOS, and without which GTOS could not function, must have a say in how GTOS is run, what it does, and how its data and information outputs are used. Membership of the Panel will allow them to have this say especially since the Panel will also have about 20% of its members drawn from the GTOS Steering Committee (see V.B.2.b.ii. above). The GTOS Secretariat will act as Secretariat to the Panel. This Panel should be established and brought into operation as quickly as possible, available financial resources permitting. Its creation should have the highest GTOS priority.

4. GTOS Prototype Network (GTOS Landnet) Goals

Priority A

The prototype network should demonstrate the ability of individual participating networks to work together within the framework of GTOS and to attain previously declared specific goals. Any scientific goal selected should be achievable and within the present observation and analytical capabilities of participating networks without the need for supplementary resources. These goals will be finalised by the GTOS Terrestrial Observations Network Panel working with the GTOS Secretariat. Possible goals should include the demonstration of:

Administrative and Managerial

- Smooth and efficient administrative co-operation.
- Smooth and efficient financial co-operation.
- Unrestricted data movement between participating networks.
- Sharing of network factor and data analytical facilities.
- A useful forum for comparison of methods used by the networks.
- A learning environment for the promotion of free exchange of ideas and experiences between networks.
- Enhancement of programmes by working together to achieve outputs at a value level significantly above that of each network alone.

- The production of useful resource management and scientific reports and maps, and technical analyses such as the use of observational data both directly and in models, identifying data gaps and approaches to filling them, and upscaling issues.

Scientific

The Guernica meeting in June 1997 considered that of the five GTOS priority areas, terrestrial ecosystems should be the main focus for the GTOS prototype network. Accordingly, an achievable and important scientific goal in this area was identified:

- Rapid and efficient preparation, from a relatively sparse network of sites, of a useful global product with regional or local relevance such as a set of outputs that have Net Primary Productivity (NPP) as their common foundation. This would include the derivation of Net Ecosystem Production (NEP) which is of crucial importance in the global carbon cycle. The NPP product would also be transformed into regionally specific crop, rangeland, and forest yield maps for land management applications. To produce the products would require assembling long-term data series of such important variables as precipitation, temperature, soil water holding capacity, soil nitrogen content, land-cover and Leaf Area Index (LAI). Each of these series is a valuable output in its own right.

- The practicality of the Global Hierarchical Observation Strategy (GHOST) in obtaining meaningful sample data that are useful to both national planners and scientists, and which contribute to valuable GTOS data products.

An alternative possible future goal for the prototype network might be:

- Development of an international database of forest cover from which information about forest cover and its changes could be derived. This would be in support of the project proposed by the Committee on Earth Observation Satellites (CEOS) and would be based upon the integration of satellite and in situ observations.

E. User Needs Identification

Priority A

1. Rationale

GTOS must undertake extensive consultations with potential associates and user groups that are already involved in global data management or which operate sectoral systems or networks relevant to GTOS, in order to ascertain what these potential users would like to see GTOS do, and what they themselves might contribute to GTOS. Where possible the priorities for their qualitative and quantitative needs from GTOS should be established. It is essential that these consultations be held as soon as practical as input from them is essential to the proper direction and development of GTOS. Although these consultations are an important initial activity of GTOS, the consultative process is an on-going one that will continue throughout the life of GTOS. The consultations should be organized by the GTOS Secretariat and carried out by Secretariat staff, Co-sponsor staff, or consultants, as appropriate. Available financial resources permitting, it would be cost effective to recruit a GTOS Secretariat staff member for 2-3 years whose main duty would be to carry out,

or organize, user needs assessments. The first round of these assessments should be completed by the end of the GTOS Establishment Phase, or soon after (see VII.D. and VIII.D. below).

2. International Agencies, Organizations, and Programmes

Priority A

Of the many potential international associates of GTOS and users of data from it there are seven user groups to which priority attention should be given. The GTOS Secretariat should develop close contact with each of them and keep the GTOS Steering Committee informed of developments by, and with, each.

International Geosphere-Biosphere Programme (IGBP)

This ICSU activity is a research programme to describe and understand the interactive physical, chemical and biological processes that regulate the total Earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human actions. IGBP has 11 Core Project activities of which the most relevant to GTOS are the Global Change System for Analysis, Research and Training (START), Land-Ocean Interactions in the Coastal Zone (LOICZ), Biospheric Aspects of the Hydrological Cycle (BAHC), Global Analysis and Modelling (GAIM), IGBP Data and Information Systems (IGBP-DIS), Land-use/Land-cover change (LUCC), and, most importantly, Global Change and Terrestrial Ecosystems (GCTE). IGBP has from the very beginning substantially contributed to the philosophical development of GTOS. IGBP should become the main scientific research partner of GTOS. As such it could play a significant role in developing GTOS scientific specifications, and contribute to calibration, validation and other aspects of quality control. IGBP could be of particular help in defining core measurements and field sites (natural and managed) and in the development of algorithms for use with remote sensing satellites. More direct contact is now needed with the relevant programmes and core projects of IGBP to ascertain how data and information from GTOS activities could contribute substantively to those programmes. It should also be determined how these programmes could contribute to GTOS activities thus developing interactive mutually beneficial partnerships. The GTOS Secretariat should develop close contact with the IGBP Secretariat and those of the relevant IGBP core programmes. The GTOS Steering Committee should be kept informed about IGBP activities.

Consultative Group on International Agricultural Research (CGIAR)

This is a potentially very important user group for GTOS data and information. Sponsored by the World Bank, FAO, UNEP and others, the CGIAR mandate is to undertake research to increase agricultural production, to combat poverty, and to protect the environment. Thus the 26 CGIAR organizations are concerned with agriculture, forestry, livestock, land-use and other related activities and so with the sustainable development of developing countries. It now has 16 major centres throughout the world, most associated with a number of research sites and study areas of up to 200,000ha each. In the last decade the CGIAR organizations have become increasingly concerned with how representative are their study areas, and with the problems of extrapolation of the findings from their sites and study areas to other parts. They have thus developed considerable Geographic Information System capabilities in several of organizations which are starting to act as lead GIS agencies for the whole system. CGIAR also hold a large number of sophisticated databases such as that on climate held by the Centro Internacional de Agricultura Tropical (CIAT)

in Cali, Colombia. The aims and interests of the CGIAR Organizations are directly relevant to those of GTOS. Direct contact is now needed between GTOS management (GTOS Steering Committee and GTOS Secretariat) and the most relevant CGIAR organizations to find out what they would like from GTOS and what they might contribute to it. Initial contacts should be with the International Rice Research Institute (IRRI), Los Baños, Philippines; Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; International Livestock Research Institute (ILRI), Nairobi, Kenya; International Service for National Agricultural Research (ISNAR), The Hague, Netherlands; International Center for Research in Agroforestry (ICRAF), Nairobi, Kenya; Center for International Forestry Research (CIFOR), Bogor, Indonesia.

International Council of Scientific Unions (ICSU)

Created in 1931, ICSU is a non-governmental organization that promotes international scientific activity in all branches of science and the application of science for the benefit of humanity. ICSU has two categories of membership: national Academies of Science or national Scientific Unions (currently 95); and international Scientific Unions (currently 25). In fulfilment of its mandate ICSU initiates, designs and co-ordinates major international, interdisciplinary research programmes which have included the International Geophysical Year (1957-1958), the International Biological Programme (1964-1974), and more recently the ongoing International Geosphere-Biosphere Programme: A Study of Global Change (IGBP), which compliments the joint WMO/ICSU World Climate Research Programme. ICSU also creates interdisciplinary bodies which undertake activities and research programmes of interest to several member bodies. These include activities in the antarctic, oceans, space, and water research, problems of the environment, genetic experimentation, solar-terrestrial physics, and biotechnology. ICSU also serves as a focus for the exchange of ideas, the communication of scientific information and the development of scientific standards. It, therefore, organises more than 600 scientific conferences, congresses and symposia each year. ICSU also assists in the creation of international and regional networks of scientists with similar interests. Because ICSU is in contact through its membership with several hundred thousand scientists from all parts of the world, ICSU is increasingly called upon to act as spokesperson for the world scientific community on all science related subjects, including the environment. ICSU is, therefore, a Co-sponsor of all three Global Observing Systems (GCOS, GOOS, GTOS). It is the membership of ICSU that will provide many users of GTOS data. These will range from individual scientists (both research and applied), national academies and the international scientific unions. Most scientists involved in GTOS will be associated already with ICSU in one way or another. The main ICSU programmes will prove the principal scientific users of data obtained through GTOS, notably IGBP, the World Climate Research Programme, and the International Human Dimensions of Global Change Programme (IHDP). Several of the ICSU Special Committees will have interest in the work and findings of GTOS. These include the Scientific Committee on Antarctic Research (SCAR), the Committee on Data for Science and Technology (CODATA), the Scientific Committee on Problems of the Environment (SCOPE), the Committee on Food Security (CSFS), the Committee on Space Research (COSPAR), the Scientific Committee on Water Research (SCOWAR), the International Programme of Biodiversity Science (DIVERSITAS), and the Panel on World Data Centres (WDC) which covers geophysical, solar and environmental data. GTOS should develop good contacts with these groups though staff, fund, and time limitations will prevent GTOS being represented at more than a few of their meetings. It is important that those involved in GTOS are aware of the work of each of these groups so that they can be brought into GTOS activities when appropriate. Since data obtained through GTOS can support many ICSU activities and vice versa, liaison development between GTOS and the ICSU groups should be an ongoing priority task for the GTOS Secretariat.

Secretariats of Environment Related International Conventions

International conventions are an important means for regulating the use of the environmental and natural resources. Consulting the secretariats of these conventions will provide insights into the types of data and information that States Parties to the conventions require in order to meet their convention obligations. Some of this contact work has already been done for GTOS but several relevant conventions have not yet been consulted, notably those concerned with coastal areas, and some of the larger regional conventions. Convention Parties are potentially an important user group for GTOS data and information. Contact with the Convention Secretariats is also a possible means of getting States Parties to the conventions to participate in GTOS.

Intergovernmental Panel on Climate Change (IPCC)

Originally convened in 1988, IPCC has a mandate to review the current scientific literature and data on climate change, summarise the findings, and present policy options. It has done this through a series of three major assessment reports, drawing upon the knowledge and experience of more than 2,000 climate scientists world-wide. The conclusion of the most recent IPCC assessment is that "the balance of evidence suggests a discernable human influence on global climate." This wording suggests that the evidence for such an influence is far from satisfactory. The development and behaviour of global climate models confirms this view. While these models are unquestionably the most effective tool available for predicting future climate changes due to human activities, at present they are not able to look back and show past climates as they actually were. Only in 1997 has a model been developed that can predict the present climate from times in the past with any accuracy (National Centre for Atmospheric Research, Boulder, Colorado). Climate scientists will, therefore, need additional reliable data from all over the world, especially terrestrial data, in order to improve their climate models. GTOS could play an important part in enabling these terrestrial data to be obtained.

State of the World Reporting

Several organizations prepare annual or biennial reports on the state of the world or the state of some segment of it (regional or sectoral). These organizations include the World Resources Institute (WRI), the Worldwatch Institute, and UNEP, formerly with its Environmental Data Report, and now through its new Global Environment Outlook (GEO). There are also sectoral reports produced by FAO, the World Bank and IUCN. The perceptions of the compilers of these broad overviews might help to identify important environmental questions and gaps in knowledge and understanding, especially relating to sustainable development, that might otherwise be missed and with which GTOS could assist.

International Programmes

There are many ongoing international programmes in environment and resource related fields that would materially benefit from an association with GTOS. Additional reliable data from geographical areas not included in their present systems would enhance the value of these networks and the information they provide to users. Association of these international programmes through GTOS would create a partnership of data providers and data users that would together better meet the needs of national governments and the global change research community. The World Health Organization (WHO), for example, is responsible for international global monitoring networks on urban air quality, freshwater quality, mycotoxins, and malaria, onchocerciasis and other vector borne diseases. In addition WHO is becoming increasingly concerned with the

epidemiology of other global or widespread human diseases. All of these WHO international programmes would benefit from additional terrestrial data against which to set their own data. The World Conservation Monitoring Centre (WCMC) has become in the last decade the leading international programme for obtaining, holding and analyzing global biological diversity, terrestrial ecosystem, and conservation data. The Smithsonian Center for Tropical Forest Studies has an unparalleled global network of long-term high intensity tropical forest observation sites. The UNEP Global Resources Information Database (GRID), especially its Norwegian Centre at Arendal, is now a major repository of georeferenced global, regional and national environment related and ecological data. All these and many more would benefit from additional data generated through the GTOS networks. GTOS Secretariat should identify relevant international programmes and open discussions with those responsible for each, as time permits, with a view to their participation in GTOS as a future user of the system.

3. National Governments and National Programmes

Priority A

Developing Countries

Major users of GTOS data and information will be national governments, especially those of developing countries, where data and information products produced through GTOS are expected to assist in helping countries towards attaining sustainable development. Products available through GTOS will have practical implications for governments on the development, management and wise utilisation of most national renewable natural resources and will thus benefit the production, marketing and distribution of food and other economic crops and in improving land-use. They will also help governments to understand better the possible future consequences for them of global change and related climate change phenomena such as the EL Niño.

Industrial Countries

Many industrialised countries already have well established functional national terrestrial observing and assessment programmes whose aims and objectives are very similar to those of GTOS. Examples are the Chinese Ecosystem Research Network (CERN) of the People's Republic of China, the Long-Term Ecological Research Network (LTER) of the United States and the Environmental Change Network (ECN) of the United Kingdom. Unlike most states in the developing world, the observing networks of industrialised countries are mainly concerned with gathering reliable data that help to obtain improved scientific understanding of basic environmental and ecological processes. Better scientific understanding allows the development and testing of more realistic predictive models. Existing national networks would thus benefit from the acquisition of high quality data from observing sites in other areas and regions since this would lead to further improvements in the predictive models. Practical application of these improved models will result in better resource and environmental management. Existing national networks are, therefore, very good candidates for grouping together into a prototype GTOS since each network would benefit by being able to access data and information from the others. Participation in GTOS would thus benefit them all with consequent improved models leading to better economical development and wiser use of land and national resources in all countries - developing and developed.

Consultations

Financial, staff and time constraints will not allow meaningful discussions by the GTOS Secretariat to be held directly with all governments. It is essential, however, that at an early stage GTOS begin discussions with a range of governments from the different geographical regions to ascertain their views on GTOS, what sort of products they could use from GTOS, and what national activities of theirs could contribute to GTOS. Particular attention should be paid to how data from GTOS should be made available to individual governments and in what forms. The attitudes of governments to the issuance of early warnings by GTOS should also be determined, especially possible mechanisms to be used. A useful way of opening these discussions would be for GTOS to convene a consultative meeting with a representative group of governments. An indication of how governments currently perceive their needs for environmental data can be obtained by talks with the Secretariats of some of the environmentally related Conventions to see how these Secretariats consider that States Parties to the Conventions view their international monitoring and assessment obligations under the terms of the Conventions.

4. Private Sector Customers

Priority C

Rationale

Modern transport and communication systems are rapidly breaking down national barriers and a new common global culture has arisen, is spreading, and will have a dominant influence on the world's long-term future. The rise of this common culture was inevitable once post World War II global economics brought about the development of multi-national, market driven, commercial organizations. These new economic colossi transcend national boundaries and many now have more world-wide political and economic influence than most of the world's national governments. Today multi-national company staff consider themselves as belonging to a particular company rather than coming from a particular country. There is a growing awareness that environment and development really are linked - in all countries. People are increasingly recognising that life without industry is very difficult in the modern world; at the same time industrialists are becoming aware that environmental care by them may have long-term cash benefits, as well as being good for customer relations, and the health of the people upon which most of their industries depend. It is essential, therefore, that GTOS develops close links with the private sector world wide.

Approach

The term `private sector' covers a very diverse range of potential users of GTOS data and information. One uniting factor is that all private sector operators are functional in order to make money for themselves. Consequently, as part of their money making operations, they all buy and sell data, information, products and services. Thus for GTOS to become associated with the private sector it must have a clear policy on data and information release which has been approved by all the GTOS Co-sponsors. This policy must recognise national sovereignty over national data and the implications of this for various data series obtained through GTOS activities. The commercial value and implications of data gathered through or for GTOS must also be recognised. GTOS will not be able to communicate with all elements of the private sector, thus it should initially concentrate on the large multinationals that impinge on or affect the environment. These include those concerned with fossil fuels, power generation, chemicals, water, transport (including space systems), construction, nuclear energy, telecommunications and insurance. The first contacts can

best be made on an industry by industry basis through fora and mechanisms already established by others, such as the UNEP Industry and Environment Office in Paris. Later direct contacts with individual multi-nationals can be established. The possibility of having staff seconded from individual companies to the GTOS Secretariat for topic specific short-term assignments should also be explored.

VI. Tasks for the Near Term: GTOS Preparatory Phase

A. Strengthening GTOS

1. Define GTOS more clearly

Priority A

Rationale

The existing GTOS characteristics, objectives and principles have been set out earlier (see Chapter III above). These have their origins in the deliberations of the GTOS Planning Group and are excellent broad first approximations. However, in order to enable GTOS to function efficiently these need to be further developed, refined and sharpened so that they can more easily be translated into practical actions that reflect current knowledge levels, information needs, and financial conditions.

Approach

The GTOS Secretariat, in close co-operation with the Working Group on GTOS Implementation, should attempt to define GTOS more clearly in light of the experience gained in the Preparatory Phase and the findings of the various Working Groups established by the GTOS Steering Committee (see VII.C.2. below). This must be done before too many other GTOS programme actions are begun.

2. Establish GTOS Boundaries

Priority A

Rationale

GTOS cannot, and should not, undertake activities in every field concerning terrestrial ecosystems and the terrestrial environment. GTOS actions will have to have priorities set and levels of actions fixed. To do this effectively the scope and operational limits for each section of its programme will have to be clearly defined.

Approach

The GTOS Secretariat, in close co-operation with the Working Group on GTOS Implementation, should begin to define more clearly the scope and operational boundaries of GTOS in light of the experience gained in the Preparatory Phase and the findings of the various Working Groups established by the GTOS Steering Committee (see VII.C.2. below). Each of the five priority areas for GTOS (see VI.C.1. above) will have to be reviewed and possible GTOS short-term and long-

term actions in each determined. Short-term selection will be largely determined by the present capabilities and programmes of the current participating networks. Long-term selection will also be influenced by present network capabilities but must also consider future needs for additional observations, sites and geographical representation. When these have been decided a strategy for meeting these needs must be prepared to include bringing in new participating networks, developing new sites, introducing new instrumentation, and obtaining the necessary financial support. This should be started immediately but will be an on-going activity of the GTOS Secretariat working in close co-operation with the GTOS Steering Committee and its Working Groups.

3. Prepare a GTOS Implementation Plan

Priority A

Rationale

GTOS, as with all the Global Observing Systems, is exceedingly complex in concept, scope and function. To focus GTOS, at least in its early stages of development, a GTOS Implementation Plan should be prepared to act as a guide to future directions and actions. The plan should not be regarded as a fixed course of action that must be followed since GTOS should retain sufficient flexibility of approach to be able to respond quickly and efficiently to changing world conditions - political, financial and environmental.

Preparation

The GTOS Implementation Plan should be prepared by the GTOS Steering Committee and be completed before the end of the GTOS Preparatory Phase (1997). It should be made available to the Steering Committees of both GCOS and GOOS. Neither GCOS nor GOOS yet have an Implementation Plan though that for GOOS is nearing completion. The Joint Scientific and Technical Committee of GCOS agreed at its meeting in September 1997 that a GCOS Implementation Plan should be prepared.

4. Obtain Funding to Support the GTOS Secretariat for 1998-2000

Priority A

Funding Needs

For GTOS to succeed there must be a small full-time professionally staffed unit that is responsible for day-to-day liaison and operations within the system, and to provide the continuity necessary to develop and run GTOS (See V.B.3. above). Support funds should be sufficient to meet staff and office costs, travel in search of additional funding for operations and projects, and for publishing the first GTOS reports. GTOS cannot, and should not, be run by networked specialists working on GTOS in their spare time. Although currently (1997) located within FAO the financial, staffing and office base of the GTOS Secretariat remains far from secure or satisfactory. The period 1998-2000 will be crucial for GTOS development. Consequently, it is estimated that in this period the GTOS Secretariat will need some $300,000 per year additional to the present support provided by the four 1997 Co-sponsors. A very high priority must be given by the GTOS Co-sponsors to securing these additional funds.

Funding Strategy for 1998-2000

Priority A

As a first step a strategy for funding the GTOS Secretariat for the period 1998-2000 must be prepared. This strategy should consider direct approaches to governments, contain innovative ideas, and be implemented as soon as possible. The immediacy of the need to support the Secretariat means that this strategy should be developed and implemented independently of the long-term funding strategy for the GTOS Programme elements to be worked out later. Without a functional Secretariat to keep it going, GTOS is likely to remain little more than an interesting concept.

5. Develop a GTOS Benefits Package

Priority A

Rationale

Governments, agencies and organizations need to know what benefits might accrue to them from association with GTOS. To assist GTOS Secretariat staff and other GTOS officials in their discussions with these bodies a practical benefits package should be prepared stating, and illustrating with examples, the advantages of participation in GTOS. This package should be designed so that it can be quickly adapted and supplemented to suit each particular case.

Governments

There are relatively few global environmental and ecological monitoring and observing activities. At national and regional levels, however, there is an enormous data collection effort since only governments have the technical capacity and financial resources to run long-term monitoring and assessment programmes and their associated databases and analytical centres. The latter activities would benefit materially from mutual association through a liaison mechanism like GTOS that would allow each to access reliable related data from other geographical areas not readily available to it at present. Most governments would benefit by participation in GTOS because of the insights that participation will provide into achieving sustainable development and the efficient and wise utilisation of renewable natural resources. Without the involvement and participation of governments in GTOS progress in developing GTOS will be slow. It is important, therefore, that at an early stage of GTOS governments be made aware of GTOS and the potential benefits to be gained by association with it. A benefits package of the sort outlined above would help to bring about this awareness. In an actual approach to a government, this package would usually be supported by other material outlining the benefits that would arise from the participation of that particular country.

Agencies and Organizations

Existing monitoring and observing networks are run under the authority of controlling bodies and have their own programmes with their own goals and objectives. Those operating these networks may not easily see why they should agree to have their network become a participant in a new observing system which does not have a large budget. GTOS must, therefore, have clearly thought out ideas on the benefits that association with GTOS would bring to a particular network before discussions with that network are opened. The potential gains of participating in GTOS to agency

and organization scientific programmes should be made clear. The GTOS benefits package will be a valuable background tool to discussions with potential partner networks.

Preparation

This can best be prepared by the staff of the GTOS Secretariat in association with members of the GTOS Steering Committee.

B. Developing the Prototype Network

Priority A

1. Concept Development

The basic format to be taken by the GTOS Prototype Network (now known as GTOS Landnet) was worked out by potential participating networks at the Guernica meeting in June 1997. However, the details of how this network will be established, function, and grow still have to be decided. In particular, the goals must be refined and defined in terms of science, land management, and other possible applications. The role and types of models in network analyses must be considered in relation to activity goals. Methods validation and assembly of background data are two necessary activities at this stage. Output products must be agreed upon and defined. Of special importance is to decide on how data and information products arising from the network will be made available to the various categories of users - governments, national planners, international programmes, scientists and the general public. Concept development will be the responsibility of the GTOS Terrestrial Observation Network Panel liaising with the GTOS Secretariat.

2. Organizational Development

Before the GTOS Prototype Network can become operational the potential participating networks must be officially brought into the system. This procedure should be started early because getting approval to join GTOS could be a lengthy process and might in some cases involve first obtaining the approval of the governing body of the organization supporting the network. To start the approval procedure letters of invitation from the Chair of the GTOS Steering Committee should go to the head of the sponsoring organization of each network. The GTOS prototype Network can be started with just two participating networks but it would be better if there were about five since achievement of goals would then be more meaningful (see VII.B.1. above). Representatives of participating networks will have to be brought together before network launch to agree on the programme details, network goals, and administrative and scientific procedures. A suitable venue for this would be the first meeting of the proposed GTOS Terrestrial Observation Network Panel. Particular attention should be given to agreeing on how data are to be collected, analyzed and interpreted, and by whom. Procedures should also be developed and agreed for allowing other networks to join the GTOS Prototype Network at various times after it has started. Organizational development should be carried out through the GTOS Secretariat which will liaise closely with the Chair of the GTOS Steering Committee.

C. Further Develop GTOS Working Groups

Priority B

1. Roles

As described above (see V.B.2.c.) Working Groups are limited life informal subsidiary bodies of the GTOS Steering Committee and are comprised of members of the Steering Committee who volunteer to undertake these additional duties. They are usually topic or area specific and members of a Working Group normally communicate with each other by electronic means. Their purpose is to provide the GTOS Steering Committee with informal but expert opinion on specific items and areas, including programme development proposals and suggestions for improvements in operating methods. Each Working Group establishes its own Terms of Reference. There is no theoretical limit to the number of Working Groups that can be established. It is likely that an important issue developed by a particularly active Working Group might be more than could be dealt with by electronic communication and would require that Working Group to meet. If this situation does arise GTOS should support such a meeting, available resources permitting.

2. Existing GTOS Working Groups

The following GTOS Working Groups were started at the first meeting of the GTOS Steering Committee (Rome, December 1996):

- Working Group on GTOS Implementation

Purpose: To develop an implementation plan for GTOS.

- Working Group on Coastal Zones

Purpose: To develop a strategy for GTOS to deal with coastal zone issues.

- Working Group on Site Criteria

Purpose: To develop a draft set of criteria for sites to join the GTOS networks.

- Working Group on Biodiversity

Purpose: To develop a strategy for how GTOS will develop the biodiversity issue.

- Working Group on Social Issues

Purpose: To determine how to handle the societal issues within the context of GTOS.

- Working Group on Earth Science

Purpose: To develop a strategy for dealing with land degradation issues.

These Working Groups should be reviewed and reconsidered, their Terms of Reference agreed upon, and their tasks refined (see VII.C.3. immediately below).

3. Working Group Support

The Working Group concept is an excellent one in theory but does not always succeed in practice. A successful Working Group is one in which the interest and enthusiasm of its members is kept alive so making the Working Group productive. It is general among Working Groups that the busier people are in their normal duties, the more active they prove in Working Groups. To further

stimulate Working Groups GTOS Secretariat should explore ways of making the Working Groups more attractive to their members. These attractions could include:

Occasional support to some Working Group meetings

GTOS Secretariat should provide financial support (direct, or from donors) for an occasional meeting of a particular Working Group to enable an in depth discussion of an important issue that has been developed by the group.

Author credit on each GTOS Working Group Technical Report

Working Group reports could be structured to form GTOS Technical Reports, each with its authorship credited to all Working Group members by name. Thus all Working Group members would be able to consider each report of their Working Group as a publication of which they were authors.

D. Initiate User Needs Assessment
Priority A

1. Background

Some potential users of GTOS and their main GTOS related programmes are given above (see VI.E.). As GTOS is intended to be a user driven system, discussions with each of these groups should start quickly to ascertain what they would like from GTOS, and what they might put in to it.

2. Consultations

The user-needs consultative process is an on-going one that will continue throughout the life of GTOS, although most of the important discussions should have been completed by the end of the GTOS Establishment Phase in early 1999. The GTOS Secretariat will organize and co-ordinate these consultations. The results from each group of discussions should be published as a GTOS report in the manner already done for the GTOS visits to the Secretariats of eight major environment related global conventions. At the end of the first round of consultations a user needs consultative workshop should be held (see VIII.D.2.).

E. Outreach to GCOS and GOOS

Priority B

1. Global Climate Observing System (GCOS)

Co-operation between GCOS an GTOS has been excellent and on-going from the very start of GTOS. It is fair to say that if it were not for the interest in GTOS shown by the GCOS Secretariat and the practical support it has given to the early stages of GTOS, there would be no GTOS today. This applies particularly to the development of the GCOS/GTOS Plan for Terrestrial Climate-related Observations which was financed and supported by GCOS. The two Secretariats must ensure that future contact is maintained at the present excellent level.

Areas of Future Co-operation

Of the seven GCOS categories (see II.B.3.a.i-vii) it is the land-atmosphere boundary and the land-biosphere climate response, that are most relevant to GTOS and offer the most potential for co-operation between GTOS and GCOS. Data gathered through GTOS may, however, also be of some relevance to three other GCOS categories (global radiative properties, atmospheric dynamics, and atmospheric composition). Priority should be given to holding preliminary discussions on the development of a joint GOOS/GCOS/GTOS coastal observation system, starting with a strategy and an implementation Action Plan.

2. Global Ocean Observing System (GOOS)

Of the five GOOS modules (see II.B.3.b.i-v) the most relevant for potential co-operation with GTOS is that of Coastal GOOS. This module is also of concern to GCOS. The three observing systems should, therefore, plan and operate their coastal observing activities together. Any joint coastal Global Observing System programme must be closely associated with the IGBP Core Project on Land-Ocean Interactions in the Coastal Zone (LOICZ). To a lesser extent the GOOS modules on marine living resources and the health of the oceans are also areas of potential co-operation with GTOS. Outputs from GTOS may also have relevance to the GOOS climate module.

Areas of Future Co-operation - Coastal GOOS

Priority A

Coastal GOOS comprises three elements - biologically related; marine navigation; and coastal hazards. GTOS interests lie principally with the first which can be further divide into land-use, habitats, and water quality, to which can be added biological diversity including living marine resources. It is also possible that GTOS could have a role in the coastal hazards element but this would be of lower priority.

Defining Coastal Areas

Priority A

An early priority action for GTOS must be to agree, in association with GOOS, on a working definition of coastal areas. An important point in the definition is to fix the distance inland of the landward boundary of coastal areas. Faced with a similar problem the UNEP Regional Seas Programme decided that this distance should be up to 200km from the shore so that the lower reaches of large rivers and the land-use of the coastal hinterland, especially the coastal plains, could be included. GTOS and GOOS should adopt the general definition of coastal areas used by the Regional Seas Programme, bearing in mind that at times it will have to be modified to fit particular circumstances.

GOOS/GCOS/GTOS Coastal Observation System

Priority A

High priority should be given to holding preliminary discussions with the Secretariats of GCOS and GOOS on the development of a future joint GOOS/GCOS/GTOS coastal observation system, starting with a strategy and an implementation Action Plan. The specific coastal area information needs of each of the Global Observing Systems must be ascertained. While there is a reasonable

idea of the information required from a coastal observing system for GCOS and GOOS, this still has to be determined for GTOS. In deciding needs it must be borne in mind that this programme must contribute to scientific understanding as well as have inputs into the national economic development of participating countries. It must also be decided whether the programme will start with one or two locations where ideas and feasibility are tested before expansion to other areas, or whether it will be a network of sites from the beginning. It is possible that these problems will be resolved quickly in which case an operational coastal GTOS might be feasible at an early date. It is essential in the development of this programme that those responsible liaise from the start with the IGBP Core Project on Land-Ocean Interactions in the Coastal Zone (LOICZ) and with the Regional Seas component of the UNEP Water Programme which have, respectively, practical experience in scientific research in coastal areas, and in national economic development of coastal zones.

3. Inter-Secretariat and Programme Contacts

Priority B

Although independently operated and staffed, and with different user communities, the three Global Observing Systems are regarded by many as being, in essence, three inter-related elements of a single Global Observing System. It is important, therefore, that they work very closely together. GTOS can and should foster this operational liaison in the following ways:

Secretariats

Priority B

The three Secretariats have already recognised that the work of each of the other two Global Observing Systems directly impinges on the programme and work of their own GOS. The Director of the GTOS Secretariat should, therefore, routinely inform the other two Directors of important actions that are being proposed by GTOS, programme progress and problems, and important findings. This is best done on an informal basis (telephone, electronic mail, postal mail) to reduce the reporting burden on the Director. The three Directors should meet together for informal consultations not less than once per year. This can be facilitated by the GTOS Secretariat Director by inviting the Directors of the Secretariats of GCOS and GOOS to meetings of the GTOS Steering Committee (see VII.E.3.b. below). In addition all GTOS publications and electronic outputs (including non-substantive and public relations products and publications) should be sent as issued to the Secretariats of GCOS and GOOS. Reciprocal arrangements should be negotiated in each case.

Steering Committees

Priority B

The Directors of the three Secretariats should invite the Directors of the other two Secretariats to all meetings of their respective Steering Committees. At each meeting of the GTOS Steering Committee, the Director of the GTOS Secretariat should schedule special agenda items for GCOS and for GOOS where their respective Secretariat Directors will talk about their own GOS programmes. The other two Directors would be invited to attend the whole GTOS Steering Committee meeting and not just for their particular agenda item. This would also provide opportunities for regular joint consultations by the three Directors (see VII.E.3.a. above).

Working Groups

Priority B

The Director of the GTOS Secretariat should inform the Directors of the GCOS and GOOS Secretariats of the contact details and activities of each of the GTOS Working Groups so that they may inform their own Steering Committees. It should be made clear that substantive comments on Working Group activities would be welcomed from GCOS and GOOS.

Standing Panels

Priority B

From time to time GTOS may need to establish advisory bodies with a longer working life than the more short-term Working Groups; these would be Standing Panels. In each case the Chair of the GTOS Steering Committee, on the recommendation of the Committee, should approach the Chairs of the Steering Committees of GCOS and GOOS to consider the desirability and feasibility of establishing a joint Standing Panel.

Co-operative fund raising

Priority B

Several elements of the future GTOS Programme will be joint ventures with one or both of the other two Global Observing Systems. Potential donors are usually swamped by the number of requests for funding that they receive. Donors will always give more weight and greater consideration to requests for financial support for joint projects that originate from one agency acting on behalf of all the others involved. The Director of the GTOS Secretariat should ensure that this approach is followed where GTOS is co-operating in projects with GCOS and GOOS.

F. Participation in Joint Standing Panels

1. Joint Data and Information Management Panel (J-DIMP)

Priority B

Background

The Joint Scientific and Technical Committee of GCOS established a Data and Information Management Panel (DIMP) to formulate, implement and oversee the GCOS data and information management system. In particular DIMP was to solicit data series from the climate community for GCOS based on data needs identified by the GCOS science panels, identify gaps in data available to GCOS, and co-ordinate efforts to redress these data deficiencies, bearing in mind the need for data quality to be of acceptable standard. Right from the start it was recognised that the data and information system for GCOS should be developed as a common framework that would accommodate data and data products from the climate modules of GOOS and GTOS as well as the World Weather Watch (WWW). DIMP has, therefore, always included representatives of these programmes as members. DIMP also includes people with a broad range of expertise in a number

of climate related backgrounds and disciplines. DIMP is a highly focused problem solving group that concentrates on resolving crucial issues affecting the quality of data and access to them. With the more active involvement of GOOS and GTOS in this panel it was recently (1997) renamed the Joint Data and Information Management Panel (J-DIMP) to signify that it now serves all three Global Observing Systems. Subsequently, (Tokyo, July 1997) the role of J-DIMP was reviewed and modifications suggested to better accommodate the requirements of the three Global Observing Systems, with the Terms of Reference being revised to reflect these changes. However, the practicalities of the transition from DIMP to J-DIMP are not simple and it will take some time before the change is properly reflected in the work (and composition) of the panel. Suggestions have also been made for improving the mechanisms for interaction between J-DIMP and the science panels.

J-DIMP and GTOS

DIMP has done excellent work for GCOS and has established a GCOS Data and Information Framework that can also handle similar types of data from the climate related modules of both GOOS and GTOS.

GTOS Data and Information Management Plan

Priority A

The DIMP panel has drawn up a very good GCOS Data and Information Management Plan that has been thought through with such care that it will be able to accommodate GCOS future changing needs for some time to come. This GCOS plan, however, cannot as it stands serve as an exact model on which to base a similar plan for GTOS. The development of a well thought out Data and Information Management Plan specifically for GTOS and its terrestrial interests is, therefore, an essential activity that must be undertaken by GTOS as soon it can (see VIII.A.1.f. below). The plan should start with clearly stated principles which should relate to those now being established for both GCOS and GOOS.

GTOS participation in J-DIMP

Priority B

J-DIMP will be an increasingly important panel in which GTOS should continue to participate and play an active part. GTOS should find material ways to support this panel and its work. J-DIMP is shortly to begin to define a common set of directory level metadata items, develop guidelines for metadata for specific types of data, and to examine software for metadata collection and management. GTOS should, therefore, participate in the metadata work of J-DIMP and relate it to the development of TEMS (see TEMS; VIII.A.5. below).

2. Global Observing Systems Space Panel (GOSSP)

Priority B

Background

The steering bodies of the three Global Observing Systems (GCOS, GOOS, GTOS) recognized the need for a comprehensive approach to space-based observational activities and decided to establish

an advisory panel that was common to the three observing systems. The panel was to inform the observing systems on ways in which space-based data could enhance their global programmes, and would also promote the space-based observational requirements of user communities carrying out global studies. It would do this by recommending to the space agencies how these requirements might be met. In other words, GOSSP is intended to be the focus for exploiting space systems in meeting the objectives of the global observing systems. GOSSP has served the three Global Observing Systems very well, particularly GCOS. However, the situation has changed and each of the observing systems is now taking a more active and direct role in space-based data affairs. Increasingly, the three observing systems, and their Co-sponsors, are them-selves present at key satellite meetings such as those of the Committee on Earth Observation Satellites (CEOS). This means that GOSSP no longer has to report on their activities, proposals and needs. Similarly, there is now no reason for GOSSP to report on satellite technology developments to the observing systems since such developments are quite adequately covered in reports produced by bodies such as CEOS. There should, therefore, be a careful review of the future role of GOSSP with a view to either reconsidering, refining and improving its activities, or closing it down as no longer being necessary. One possible role for GOSSP that should be explored would be to provide advice on telecommunication developments and facilities of relevance to the Global Observing Systems (to include, for example, aspects of high speed high volume data transfer, access systems, satellite telecommunication to remote areas, automatic data acquisition stations, animal tracking by satellites, and security measures).

GOSSP and GTOS

GTOS should press for the mandate of GOSSP to be reviewed and refined. If GOSSP continues with a refined mandate, GTOS should continue to support GOSSP and should contribute to its financial requirements. If it is decided to close GOSSP, adequate financial provision should be made for GTOS to be present at CEOS and similar key fora at which regular substantive presentations on GTOS and its programme should be made.

3. Terrestrial Observation Panel for Climate (TOPC)

Priority B

a. Background

The TOPC is a joint panel established by GCOS and GTOS to ensure that there is a co-ordinated plan for obtaining the terrestrial observation requirements for GCOS and for the climate change requirements for GTOS. The plan provides a rationale for the structure of the initial operating system and outlines basic guidelines for its implementation. It describes the minimum set of land-based variables that are required to understand the climate system and its variability and to predict, detect and assess the impacts of climate change. The data and information management needs identified in the plan have been passed to the Joint Data and Information Management Panel (J-DIMP). Details of those observations that can best be made from space have been provided to the Global Observing System Space Panel (GOSSP). The panel has produced two versions of the plan for terrestrial climate-related observations: Version 1.0, November 1995; Version 2.0, June 1997. Implementation of this plan will be done jointly by GCOS and GTOS in co-operation with the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP), and other international and national institutions and programmes.

b. TOPC and GTOS

TOPC is the most successful of the standing panels in that it has produced a scientifically sound and practical observation plan for the climate interests of GCOS and GTOS. TOPC will keep the plan under review and will refine and update it as circumstances require. As GTOS begins to develop its various special networks, it is certain that it will have to reconsider its data requirements and better define the variables that it measures. TOPC will play an important part in aspects of this reconsideration. This work is vital to GTOS so that GTOS should continue to participate in TOPC and its work. Financial support to TOPC from GTOS should be made, available financial resources permitting.

4. GOS Panel on socio-economic aspects

Priority A

Background

All three Global Observing Systems are involved in activities that will produce findings that could have considerable impacts on society, and on national socio-economic development. This is particularly true of GTOS where some of its priority issues include changes in land-use, land-cover, agriculture, pastoralism and other forms of managed ecosystems, freshwater, contaminants, and pollutants. It is necessary, therefore, to identify the socio-economic variables that are needed for the interpretation of global change, and to determine ways in which natural resources data from the observing systems could be used in socio-economic accounting. The need for societal benefits from the observing systems to be identified and defined, and made known, is widely recognised but all three observing systems are composed largely of physical and biological scientists and so lack expertise in this area. This need has been identified by the Sponsors Group for the Global Observing Systems as a priority concern.

GTOS and the Joint Socio-economic Panel (J-SEP)

There is little doubt that this is an area of great relevance to GTOS and the other observing systems. It is, however, an area in which there is little happening within the GOSs and it remains a large gap in GOS design and function. GTOS should, therefore, in accordance with the suggestion of the Sponsors Group, as soon as possible and available resources permitting, take the lead in establishing and operating a Global Observing System Joint Socio-economic Panel (J-SEP) along the lines of J-DIMP and TOPC. Funds to support this activity initially should be sought from external sources if internal GTOS funds are not available.

VII. Tasks for the Near-term: GTOS Establishment Phase

A. Strengthening GTOS

The actions outlined below should be started towards the beginning of the Establishment Phase and will be heavily influenced by the practical experienced gained in the Preparatory Phase.

1. Develop and implement GTOS policies for information and data

Priority A

For GTOS to be an effective system the data and information generated through it must be those needed by specific potential users and in forms that they can utilise. This requires that at an early stage of GTOS a series of policies must be developed that will guide its data, information and product releases. All aspects of data management and information should be co-ordinated with the other two Global Observing Systems (GCOS, GOOS).

GTOS Policy on Data and Information Release

Priority A

GTOS should place as much of its data and information as feasible in the public domain so that they are readily available to a wide variety of national and international users. This, however, means that many of the analyses, assessments and early warnings of various types based on data obtained through GTOS will be made increasingly by people and organisations that are outside the formal GTOS network. Data may, therefore, be used in ways and for purposes for which their collection was never intended. Also, governments may at times insist that some information and data obtained through GTOS, and pertaining to their particular countries, should not be in the public domain and should not be released without their prior formal consent. The release of GTOS data of different levels of reliability will also have to be considered. The question of data release to the private sector and associated commercialisation aspects will be an important issue that the policy will have to address. The policy should enshrine as far as possible the principle that GTOS data should be free and unrestricted so that they have an open distribution to all who need them. They should go to accredited users without charge so that their cost is no more than that of reproduction and delivery without charge for the data and products themselves. A clear basic policy for handling these situations and similar aspects will have to be worked out early in the life of GTOS and kept under continual review. This can be done through the GTOS Panel and Working Group suggested below.

GTOS Data Management

Priority B

General Principles

Priority B

GTOS data management should, as far as possible, use already existing management and communication systems. The selection will, at least initially, be greatly influenced by those systems already in use within the existing national observing system networks that comprise the prototype GTOS. The systems should be flexible enough to link with other systems and databases that are not yet participating in GTOS. Data available to GTOS should be available, as far as possible, on-line at all stages after the initial checking and verification. Basic freshly collected field and laboratory data should not be made available in any form until initial checking and verification has been completed (except by special arrangement for approved activities). GTOS Data and Analysis Centres (see VIII.A.1.c. immediately below) should be linked together primarily by electronic methods and open to on-line user access. Thus the data system should have a distributed structure and use standard analytical, interpretation and reporting facilities.

GTOS Data Management Focal Areas

Priority B

GTOS should develop a data management and information system that should focus on the following activities: development of databases to hold regional and sectoral data, both primary and derived, and associated data products; development of a long-term data referral system to identify the locations and access requirements of different types of data held both within and without GTOS; a database of metadata (see TEMS; VIII.A.5. below); and acquisition of appropriate tools for handling and sorting data. As models and similar instruments will be important to GTOS, consideration should also be given to assembling information on applicable models, interpretive tools, and decision support systems.

GTOS Working Group on Data Management and Information

Priority B

Data and information are vital to GTOS so that a GTOS Data and Information Working Group should keep the data approaches and problems of GTOS under constant review. This informal group of Steering Committee members (see V.B.2.c. above) should be supported by a standing advisory Panel on Data and Information Release (see VIII.A.1.e. below).

GTOS Data and Analysis Centres

Priority A

Criteria must be developed for selecting and designating sectoral GTOS Data and Analysis Centres where data will be assembled, verified, and managed. Wherever possible GTOS Data and Analysis Centres will be existing national or international centres that have agreed to take on the additional GTOS role. The first such centres will almost certainly be those already associated with the partner networks and programmes that were brought together to form the prototype GTOS network. The role of each GTOS Data and Analysis Centre will have to be determined through negotiations between the existing centre, GTOS Secretariat and, most importantly, the national partner networks involved. This will require agreement on the responsibilities of the particular Centre with regard to GTOS data and its analysis. In general, each centre will carry out first-cut data verification. Centres will also be involved in quality assurance procedures but will not necessarily take part in further data analyses or the production of assessments. This will depend largely on the nature of the observational data, the analyses required, and the organization and analysis capabilities of the centre. Normally, GTOS data will, by prior agreement, be analyzed or assessments made at centres specified by GTOS for the purpose. Each GTOS Data and Analysis Centre will have to agree to abide by the terms of the GTOS Data and Information Release Policy. It would be advantageous to GTOS, the partner networks, and to the Centre itself, in terms of public relations, if each was formally identified as a GTOS Data and Analysis Centre and displayed an official public designation to this effect (plaque, parchment, medallion, etc.).

GTOS Data and Information Products

Priority A

GTOS products will take many forms ranging from printed reports and papers to electronically held data sets and CD-ROMs. Some will be wholly scientific and technical, some will be advice

formally transmitted to governments, while still others will be for the general public. Problems that must be addressed include languages of publication (cost versus public awareness advantages), distribution methods, and, critically, whether to charge for products, to release them at no cost, or to do both. Cost effectiveness must always be a paramount concern. See VIII.A.4. below.

GTOS Panel on Data and Information Release

Priority A

Role

Information and data release are at the centre of GTOS. They are vital to science, essential for national economic development, and can be potentially politically sensitive. Consequently, an advisory Panel should be established to keep under review GTOS data and information needs and releases. An important ongoing task of the Panel would be to consider how data and information from GTOS could be used by countries for national policy making and economic development. This should include recommendations on the mechanisms of data flow and the need for specific types of secondary and tertiary data transformation products. Particular attention should be given to suggesting how this should be done and who does what. The Panel should report to the Chair of the GTOS Steering Committee but should liaise with the GTOS Secretariat over routine operations. This Panel should only be established if outside funding is available specifically for its support since it can only operate efficiently if it meets from time to time; electronic communication is unlikely to be sufficient.

Membership

The Panel should largely consist of outside experts from both developing and industrialised countries together with a few members of the GTOS Steering Committee. The Panel should not consist exclusively of scientific, technical and data experts although these should predominate. Some Panel members should have had experience of the practical use of GTOS type data at national level, and some should be familiar with the political sensitivities that can arise over the release of national data.

GTOS Data and Information Management Plan

Priority A

The above items should be brought together, and enlarged upon, within a Data and Information Management Plan that is designed specifically for GTOS and its terrestrial interests. Preparation of this plan should begin as soon as practical and it should relate to similar plans that have been developed or are being developed for GCOS and GOOS respectively. The plan already developed for GCOS cannot be used as an exact model for GTOS since the latter has different basic interests and serves different user groups (see VII.F.1.b.i. above).

2. Develop and Implement a GTOS Policy on Publications, and a GTOS Publications Programme

Priority B

An information and publications policy for GTOS should include both electronic and paper publications. This must be formulated at an early stage of GTOS so that it can be implemented

early in the GTOS Establishment phase. Careful consideration should be given to the number of different types of publication needed to ensure that GTOS and its work receive adequate coverage. There should not be so many that confusion results; the fewer the better. Serial publications might include Steering Committee Reports, Meeting Reports, Scientific and Technical Reports, Assessments, Bulletins and a GTOS Newsletter (to appear not more than twice per year). A peer review mechanism for all GTOS scientific and technical products should be outlined. Publications in each series should be clearly identified and consecutively numbered. Provision should also be made for publication of a time-to-time substantive monograph series. Electronic publications should include data series, maps, images, models, etc. These may be in CD-ROM and diskette forms as well as placed on the Internet. The latest issues of substantive serial publications should also be placed on the Internet. The Publications Policy should outline the content and style of each product type. How GTOS publications relate to the existing publication programme and distribution system of the GTOS host organization should also be considered. The policy should also contain GTOS principles for co-publication with associate and other co-operating organizations. It is important that GTOS is properly acknowledged in scientific and technical papers based on data acquired through GTOS and published in journals and books by those taking part in GTOS activities. The policy should contain appropriate credit wordings as a guide to authors.

3. Develop and Implement a GTOS Policy on Public Relations

Priority A

Good public relations are essential to the well-being of GTOS and its long-term future. Good public relations do not just happen, they have to be created. A Public Relations Policy will provide a framework for getting the most benefit for GTOS from the work of GTOS. It is essential that GTOS consider this policy carefully for poor public relations can adversely affect funding, while good public relations can enhance funding. To ensure the credibility of GTOS must be a basic public relations tenet. Thus GTOS must never claim anything that it is not doing, or cannot do, or cannot deliver. This policy must relate to the GTOS policies on information and data, and on publications, and should cover media exposure, event coverage (meetings, product launches, interviews, etc) and situation reporting. Thus GTOS should consider mechanisms for making timely public statements on relevant current environmental situations and events of topical global and regional concern (press releases, press conferences, radio and television bulletins and interviews). The public will quickly learn to look to GTOS for an informed unbiased account of what is happening. GTOS public relations activities should take advantage of, and use as far as practical, the public relations facilities of its Co-sponsors, especially those of the GTOS host organization.

4. Develop and Implement a GTOS Policy on Products

Priority A

Rationale

GTOS will be judged by what it delivers. For GTOS to be a success the outputs produced by it must be reliable, valuable and useful. Outputs will range from basic data sets of the variables observed, through transformed, derived and generated data that are in forms more easily handled by specific user groups, to technical assessments of the state and trend of particular environmental factors, situations or areas. All GTOS activities must, therefore, have the end product users in view

right from the start. It is essential, therefore, that in the early planning stages of any GTOS activity the desired end products and their users are clearly identified. The scientific design of these end products and their incorporation into the activity implementation plan at its very beginning is crucial. Special attention must be given to examining in the planning stage how GTOS data might be used to provide a sound basis for subsequent economic analyses. To do this efficiently and consistently requires a well thought out GTOS Product Policy to provide a guide in activity planning.

GTOS Data and Information Users

GTOS data and information users fall into three main categories:

Policy-makers and Planners

Priority A

Mainly from national governments but also from some international programmes. They need from GTOS national environmental and ecological data on factors affecting the health, well being, and social economic development of the peoples in their country. National renewable natural resources have very great national economic value so that they need to be managed efficiently and in sustainable ways. Policy makers and planners are, therefore, interested in any changes that are occurring, or are likely to occur, in the extent, health and quality of national renewable natural resources of economic significance, including rates of change. They thus need GTOS data and information in forms that can be used in national planning and for economic analysis. They often require the generation of secondary and tertiary data such as social, economic and environmental indicators. Consequently, national policy makers and planners need to work closely with scientists in the early planning stages of GTOS activities to ensure that data relevant to their requirements are collected or generated. GTOS data are vital for efficient national planning and wise economic development.

Technicians and Managers

Mainly from national and international agencies and organisations associated with the operation and management of technical development and application programmes. They use data and information generated through GTOS for more efficient operation of their programmes. They also advise GTOS on their new and continuing data and information needs.

Research Scientists

Mainly environmental and Earth system scientists associated with existing national and international scientific research programmes. The chief interest of most scientists using GTOS data is in improving scientific understanding of environmental and ecological processes and how they affect the biosphere and its component parts. This involves direct field and laboratory investigations as well as indirect studies using simulation models. Scientists, therefore, will also have inputs to GTOS, particularly in the early stages of any activities, by providing advice and firm guidance on the variables to be observed, the measurement units, the techniques to be used, and on appropriate methods of data analysis and data management.

GTOS Output Products

Priority A

Some GTOS products will be scientific, some will be technical, and others will be general information. Each, however, must be carefully and clearly defined in terms of content and format before the start of relevant GTOS activities. User needs will govern the both the types of product and their content. Of special importance is to decide on how GTOS data and information products will be made available to the various categories of users - governments, national planners, international programmes, scientists and the general public - and whether to charge for them (see VIII.A.1.d. above).

GTOS Policy on Products

Priority A

A GTOS policy in this area is fundamental to the long-term success of GTOS and should be developed at the earliest opportunity through the GTOS Steering Committee and the GTOS Secretariat. It should embody all the considerations expressed earlier in this chapter (see VIII.A.4 above) so that it provides sound guidelines for the future on GTOS products and their utilization. The Policy should pay particular attention to the possible implications of charging for GTOS products. The Policy should relate closely to the GTOS Policy on Data and Information Release (see VIII.A.1.a. above), and to the GTOS Policy on Publications (see VIII.A.2. above).

5. Review the Terrestrial Ecosystem Monitoring Sites (TEMS) Strategy and Database

Priority B

TEMS Background

The need to have basic information about the sites where terrestrial data are obtained, and about the programmes which obtain them, has long been obvious and was a basic tenet of the former Global Environment Monitoring System (GEMS) and its Harmonization of Environmental Monitoring (HEM) programme. Without such information it is often difficult to interpret correctly the data that originate from sites since the original reasons for taking the data, the measurement and analytical methods used, and the quality control procedures applied, are not always readily apparent. If data are to be used by others their reliability, compatibility, and comparability must be known. These background information elements are now collectively termed metadata. The Terrestrial Ecosystem Monitoring Sites (TEMS) database was originally developed at UNEP, Nairobi, as an activity within GEMS. Subsequently, TEMS was moved to the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) in Zurich where it was updated and improved.

TEMS Information

TEMS is an international directory of metadata about monitoring stations and their activities; it is not a compilation of basic variable data. The current principal objective of TEMS is to document existing long-term monitoring sites which may be suitable for inclusion within GTOS as its participating networks increase and its programmes become more clear. The database contains basic information on site characteristics such as the date the site was established, latitude and

longitude, altitude, geology, hydrology, biome, and biological communities present. Brief information about the scientific programmes being carried out at the site or to which site data contribute is also included, as are the names and addresses of contacts.

TEMS Now and in the Future

Most recently the Global Climate Observing System (GCOS) has begun to make TEMS more relevant to its needs and in so doing has made a number of enhancements that will directly benefit GTOS. New sections on some GCOS networks and on glaciers have been added, and a section on permafrost is planned. TEMS can now be linked directly to basic data sources if this is required. A PC version of TEMS will also be available soon. At the moment (1997) TEMS can be searched by geographic location (latitude and longitude, and country), variables measured, network name, GCOS and GTOS topical areas, and eco-regions. A search capability by contact names will be added shortly. The TEMS database proved extremely valuable during the planning phase of GTOS. It will be an important tool for both GTOS and GCOS as these programmes move toward full implementation since it can supply metadata on ecological monitoring sites, and at the same time provide scientists and planners with direct links to data centres. It also allows GTOS and GCOS to identify existing sites and to analyze potential gaps in the coverage of critical variables. The need for metadata by all the Global Observing Systems has recently (July 1997) been stressed by their Joint Data and Information Management Panel (see VII.F.1.b.ii above) which will make TEMS even more relevant to their programmes.

Review of TEMS

Priority C

TEMS has grown according the varying needs of the different organizations that have had responsibility for it. Its database reflects these changing needs. Consequently, there should now be a critical review of the existing database to determine where TEMS might best fit into the overall strategies of both GTOS and GCOS. The review should look at ways to make TEMS metadata more appropriate to the needs of both GTOS and GCOS, suggest changes in search capabilities and data display, and recommend ways for updating and improving the current information held. The procedures for registering and including new sites in the database should also be examined. The TEMS review could best be undertaken by a small team of members of the GTOS Steering Committee and the GCOS Joint Scientific and Technical Committee.

6. Develop Periodic Review and Audit Procedures for GTOS

Priority C

Rationale

Throughout its life GTOS must be reviewed and its programme audited at regular intervals to ensure that it continues to adapt to the changing development and scientific needs of the time, and takes advantage of advances in relevant technology. If this is not done GTOS will become fixed in its mode of operation and quickly lose its importance. Regular programme and financial audits ensure that planning and output schedules are adhered to, and that financial resources are not wasted.

Timing

GTOS Programme Reviews and audits should be carried out every three years with the first taking place in the last three months of 1999, the others being held in the last quarters of 2002 and 2005.

Review Team

These reviews will be carried out by independent development specialists and scientists selected and appointed in their personal capacities by the GTOS Co-sponsors after consultation with the Chair of the GTOS Steering Committee. Members of the review team should be drawn from both developed and developing countries and should be three or five in number. They will work to Terms of Reference drawn up by the Co-sponsors after consultation with the Chair of the GTOS Steering Committee. The review of 2005 should also consider the possible future of GTOS over the next decade (ie 2006-2015).

Technical Assessments

Priority C

In the year immediately preceding each of the programme reviews of 2002 and 2005 two technical assessments should be made whose findings will be inputs to the programme reviews.

GTOS Data Uses by Countries

Priority C

Assessment of the uses being made by countries, particularly developing countries, of data and data products obtained through GTOS and their perceived value to those countries; reports to be issued in years 2001 and 2004.

GTOS Data Uses by International Programmes

Priority C

Assessment of the uses being made by co-operating international research programmes of data obtained through GTOS, and the value of these data in improving scientific understanding of basic environment and ecological processes; reports to be issued in years 2001 and 2004.

Financial and Administrative Audits

Priority B

Financial and administrative audits of GTOS will be carried out at regular intervals in accordance with the practice and procedures of the organization that is host to the GTOS Secretariat, currently FAO.

7. Define an Initial Set of Variables for Non-climate Topics

Priority A

Rationale and Approach

Priority A

GTOS is about terrestrial systems and their observation. Before GTOS can function efficiently it must identify what must be observed, and how, when and where to do it. This is a fundamental task for GTOS that must be started as soon as possible and can be expected to take some time to develop satisfactorily. The non-climate terrestrial topics are very diverse so that it may be necessary to deal with them through topic specific international expert groups that would select and define an initial selection of important variables for each topic. As there will be overlap between topics, at the end of the process the results from all the expert groups should then be considered together by another international expert group drawn from all the topic areas to produce the final GTOS list of basic and desirable variables to be observed.

International Expert Groups

Priority A

Areas to be considered by the international expert groups should be biological diversity, ecosystem form and function (including ecological processes), freshwaters and fresh water ecosystems, toxicity and contaminants, land-use and land-cover (including agriculture and pastoral systems), and coastal areas (including coral reefs). All groups should consider their selections and definitions with respect to both managed and natural ecosystems. All work by these groups should be seen against the set of climate-related terrestrial observations previously chosen and defined by the joint GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC) since some needed variables will have been already included in the climate-related set. The methods used by TOPC in selecting, defining and presenting its chosen variables should be used as a model for the expert groups. GTOS and GOOS should be kept informed of these expert group meetings and invited to take part or to co-sponsor specific meetings where the areas to be considered are of obvious mutual interest (eg coasts and reefs).

Funding

Priority B

Although necessary, the expert group approach called for here is expensive and perhaps beyond the present financial resources of GTOS. External funds to support individual meetings should, therefore, be sought from donors that specialise in supporting international expert meetings of this kind.

B. Starting the GTOS Prototype Network (GTOS Landnet)
Priority A

1. Start

Priority A

It is possible that not all networks that have agreed to participate in the GTOS Prototype Network (see VII.B.2. above) will be ready to begin operations at the same time. Rather than delay commencement, the network should start with those ready to do so by the agreed starting date, the

others joining later. Provision should also be made for further networks to join even though they were not part of the original group.

2. Schedule

Priority A

The GTOS Prototype Network should start early in 1998 with a view to having the first analyses completed and issued by the end of 2000. The first 6-9 months will necessarily be taken up by design, planning, methods validation, and assembly of background data. Data will begin to flow from the sites into the system from mid to late 1998.

3. GTOS Data and Analysis Centres

Priority A

Identify, discuss and agree with the data and research centres associated with the networks participating in the GTOS Prototype network on their potential role as GTOS centres for databases, data analysis and production of any required assessments. This will involve visits to centres by some staff of the GTOS Panel on Terrestrial Observations and the GTOS Secretariat to the centres for technical discussions and facility review.

4. Other GTOS Networks

Priority B

As the GTOS Prototype progresses GTOS Secretariat working through the GTOS Steering Committee and its subsidiary bodies will start to catalyze and support the establishment of new GTOS networks as required.

5. GTOS Network Assembly

Priority C

If the number of Networks taking part in GTOS grows rapidly and exceeds 20 it may be necessary in the Establishment Phase to introduce the GTOS Network Assembly to allow all participating networks to have a proper opportunity to influence the way that GTOS is operated and managed (see V.B.2.b.iii. above).

C. Continue Working Groups

Priority B

When working properly the GTOS Working Groups are an effective means of developing ideas and solving problems about what GTOS is, how it operates, and how its findings are applied in practice. They should be maintained and supported as in the Preparatory Phase (see VII.C.2. above). The Working Groups should be kept under review by the GTOS Steering Committee and new ones created as new challenges are faced by GTOS. They should continue to be topic specific although no Working Group should be allowed to become a permanent fixture.

D. Finish User Needs Assessment

Priority A

1. Background

Priority A

A programme of consultations to assess the needs from GTOS of major potential associates and user groups was started in the early Preparatory Phase of GTOS (see VII.D. above). This task is important to GTOS because it is a very good means of ensuring that GTOS networks are acquiring the right types of data and are producing products that are useful to development planners and other national authorities, and to the scientific community. The first round of these assessments should be completed by the end of the GTOS Establishment Phase, or soon after.

2. GTOS Users Consultative Workshop

Priority A

Representatives of the various user groups should be brought together in a Consultative Workshop at the end of the first round of discussions in order to consider together the findings that have come from the individual group assessments. The recommendations of this workshop will form a useful guide towards the development of GTOS in the 21st Century. The workshop should be attended by some members of the GTOS Steering Committee, representatives of GCOS and GOOS, and the Co-sponsors.

3. Workshop Report

Priority A

The workshop report should be published and should include summaries of the individual group assessments, as well as the report and recommendations of the meeting. The report should be widely circulated and consideration should be given, available financial resources permitting, to translating it into other United Nations official languages (Priority C).

E. Develop a GTOS Strategy for Involving Individual Governments

Priority A

1. Background

Without the active technical involvement and financial support of governments GTOS is unlikely to succeed. Governments have to be convinced that GTOS can contribute to finding cost effective realistic solutions to their environmental and renewable natural resource problems, and that it can also help the scientific community gain better understanding of the basic environmental and ecological processes that underlie global change. It is important at this stage of GTOS, therefore, that a strategy for bringing about national support for GTOS is thought out, based on practical experience gained up to this point.

2. The GTOS strategy

Priority A

During the Preparatory and Establishment Phases of GTOS the GTOS Secretariat and other GTOS officials, including the Co-sponsors, will have had informal talks on GTOS with representatives of a wide range of governments. These will have been from different geographical areas, and will include industrial and developing countries. These valuable informal contacts will have enabled the GTOS Secretariat to develop an appreciation for how most governments view GTOS. This appreciation will influence how the GTOS involvement strategy should be developed and the form it will finally take. Basic elements of the strategy will be an initial Expert Group meeting involving a few countries from each of the main geo-political regions. This will be followed by the first of a series of GTOS missions to individual governments. The form and scope of these missions will be greatly influenced by the findings and recommendations of the Expert Group meeting. It may eventually prove advantageous to develop a more formal intergovernmental mechanism for GTOS. These points are further developed in IX.C. below.

F. Address Scaling Issues

1. Spatial and Temporal Scales

Priority B

A major problem for all terrestrial observing system is the spatial and temporal scales at which data are gathered and the relevance of data obtained at one scale to other data obtained at different scales. Spatial and temporal scaling issues are of the utmost importance to GTOS and the utilization of its data and products.

Spatial Scales

Land observations are commonly made at a wide range of spatial scales from broad satellite coverage to site specific measurements on the ground. Thus spatial data may represent areas ranging from one metre or less to hundreds of kilometres. Terrain is inherently heterogenous but the degree of apparent heterogeneity is a function of the spatial scale at which data gathering observations are made. The finer the spatial scale used, the greater the heterogeneity that can be recognised. Some global change questions can be dealt with adequately by using fairly coarse spatial scales, but others, such as those involving wetlands, or burning, require much finer resolutions to resolve adequately. The in situ site measurements necessary to understand and model processes are made at finer resolutions still. No single scale will be adequate for all GTOS activities and it is likely that studies will require extrapolation across several spatial scales. Integrated models that can be used at all scales are unlikely to be developed so that, for example, in global analyses it is more probable that layered models will be used to provide inputs into other models in a hierarchical approach.

Temporal Scales

Temporal scale difficulties are even more difficult to resolve since it is usually not easy to extend information on biological functions such as photosynthetic rate, and uptake of water by plants, from daily to longer time scales in terms of years or decades. To do this satisfactorily requires

large scale information across gradients on a wide range of phenomena (eg vegetation physiognomy, species composition, and ecosystem changes).

2. Upscaling

Priority A

Site specific ground data, if sufficiently frequent spatially, can be clumped to develop useful but coarser resolution wider area data planes, and these in turn can be further clumped to form even more broad scale but still useful data planes of greater areal coverage. The reverse, however, is not true and it is not possible to derive meaningful site specific fine resolution data from broad scale data such as those normally available from resource assessment satellites. Thus it is possible to go from fine scale to broad scale in a meaningful way but not usually from broad scale to fine scale. In practical terms this means that useful fine scale data specific to small ground sites cannot normally be derived from broad scale satellite coverage unless the constituent pixels of that coverage are themselves very fine. However, the relationship between information content and spatial resolution of satellite data is usually non-linear and there are also resolution windows that are associated with any given terrain type. Also terrain heterogeneity is normally seasonally dependent which affects the scale at which it is useful to record data. Consequently, many workers have found that a resolution of 500m is a useful working compromise as a lower limit for deriving reliable site data from satellite coverage. GTOS will have to review upscaling in relation to its programmes and outputs.

3. Extrapolation of Site Specific GTOS Data

Priority A

Spatial scale changes are of importance to national planners and resource managers because they need to know the relevance of site or area specific data to wider geographical areas beyond the borders of the observation sites, and whether data obtained in one area can be used to develop or manage another of similar environment and ecology. This becomes even more important when site specific data originate beyond national borders and are supplied through an international system such as GTOS. This is an important aspect of the national level GTOS programme because many potential users of the system, such as national governments and convention secretariats, are concerned with the development and management of specific sites and localities which are themselves at the moment outside GTOS system coverage and are likely to remain outside in the future.

4. Workshop on Scales and GTOS

Priority B

At an early stage of the Establishment phase of GTOS an international expert group should be convened to consider the problems of spatial and temporal scale changes with regard to the scientific and resource management utilization of GTOS data. SCOPE 35 (Scales and global change; 1988) should be one of the background documents for the workshop.

5. GTOS Technical Panel on Scales and Scaling

Priority B

After the Workshop, and based upon its recommendations, a Technical Panel of mainly outside experts should be established to keep under review spatial and temporal scale aspects of the use of GTOS data for planning, management and scientific purposes at both national and global levels. As the Panel findings will also be of value to both GOOS and GCOS joint support for it should be considered. Scale problems will continue to be important to GTOS so that the panel is likely to become a standing one.

G. Outreach to GCOS and GOOS

1. Implement First Phase of a Coastal Programme

Priority A

Providing the programme proposal has been adequately developed (see VII.E.2.a. above) and appropriate funding has been obtained a joint GOOS/GCOS/GTOS coastal project should be started as either a network or a series of feasibility test areas.

H. Continue Participation in Joint Standing Panels

1. Joint Data and Information Management Panel (J-DIMP)

Priority B

GTOS should continue to participate in J-DIMP and should support its work financially, available financial resources permitting.

2. Global Observing Systems Space Panel (GOSSP)

Priority B

GTOS should continue to support GOSSP if it is continued with a redefined and improved mandate after its proposed review (see VII.F.2.).

3. Terrestrial Observation Panel for Climate (TOPC)

Priority B

GTOS should continue to participate in TOPC and should support its work financially, available financial resources permitting.

4. Joint Socio-economic Panel (J-SEP)

Priority A

At this point J-SEP is potentially the most important of the Joint Panels and GTOS should put continued effort, time and resources into ensuring its successful functioning and continuity.

VIII. Third-year Tasks: GTOS Development Phase

A. Review GTOS

Priority A

The first independent review of the review programme designed earlier (see VIII.A.6.) should be carried out. Reports arising from the review should be submitted to the Co-sponsors and given wide and public distribution.

B. Facilitate Data Distribution and Access

Priority B

Implementation of the GTOS Policy on Data and Information Release developed earlier (see VIII.A.1.a. above) should be continued. If funds allow, the GTOS Panel on Data and Information Release should be established and supported (see VIII.A.1.e. above). The GTOS Steering Committee Working Group should continue to consider relevant aspects and mechanisms. Additional centres to act as GTOS Data and Analysis Centres should be brought into the network as necessary (see VIII.A.1.c. above). The GTOS Secretariat should negotiate protocols for the release and distribution of any data that may have been placed under restricted access by a government. Requests for GTOS data from private sector commercial companies should be considered carefully and dealt with strictly according to the GTOS Policy on Data and Information Release. Wherever possible GTOS data should continue to be distributed to accredited users in a free and unrestricted manner without charge except for the costs of reproduction and delivery.

C. National Governments

1. First Expert Group meeting for ascertaining the role of governments in GTOS

Priority A

Rationale

Ultimately, the future of GTOS, as with all the Global Observing Systems, rests with governments. Without their active involvement, and technical and financial participation, there can be no GTOS. It is, therefore, crucial to the long-term success of GTOS that some form of mechanism for involving governments in GTOS is developed. Such a mechanism will not only largely overcome potential political difficulties but will also ensure a better financial basis for GTOS allowing it to develop more fully and usefully in the future. The first Expert Group meeting will be an important initial step towards developing a suitable long-term mechanism by which GTOS can more efficiently function in the future.

Expert Group Meeting

Priority A

The first Expert Group meeting to advise the Co-sponsors on national participation in GTOS should be convened in Year 3. The aim of this meeting will be to send to governments the message that those responsible for GTOS want and need their participation and to know their views and requirements. Representation should be from 2-4 countries in each of the geo-political regions of the world. For this meeting GTOS should prepare a background document for formal transmission to participating governments well beforehand and which would then serve as a discussion paper for the meeting. This is an important and expensive activity which should only be undertaken after careful preparation and when adequate funding is available.

2. First GTOS mission to individual countries

Priority A

Rationale

The active involvement and participation of governments in GTOS is essential (see IX.C.1.a. above). The First Government Expert meeting will help to clarify the views of governments on the value and use of GTOS to them. The meeting will not, however, be able to do more than set out general terms and conditions for the involvement of governments in GTOS. Individual countries will have their own particular needs and considerations which will vary considerably from country to country. This variability will reflect national geography and location, social and economic condition, scientific status and interest, and political considerations.

Approach

Two to three representative countries should be chosen in each geographical or geo-political region. A small GTOS mission should be sent to the governments of each selected country. The advantage of this approach is that in each country a wider range of opinions of government officers and office holding politicians can be obtained through a properly programmed mission than would be the case if a single national representative of a country attended a meeting. Thus in each country visited it will be possible to obtain the high level views of the Ministry of Foreign Affairs and the Ministries of Finance, Economic Planning and Development, as well as the technical ministries, scientific institutes, universities and other relevant bodies.

Timing

The visits by GTOS to governments should not begin until after the meeting of the First Expert Group for ascertaining role of governments in GTOS has been held because the conclusions of that meeting will shape the agenda and discussions of the GTOS missions. It will be more cost effective to schedule visits by a single GTOS team so that it visits 2-3 countries in the same region consecutively on the same mission.

Mission Composition

The small number of staff in the GTOS Secretariat means that these missions will not normally be carried out by Secretariat staff. They will thus have to be undertaken by others (Co-sponsors, co-operating agencies, consultants, etc.). Wherever possible those undertaking these missions should

be very familiar with the GTOS programmes and the details of their operations. They should also have a sound knowledge of the countries to be visited.

IX. GTOS in the 21st Century

A. What the Future Holds: an Introduction

Priority A

It is difficult to foresee at this range (1997) how GTOS will develop in the next century even though that century is less than three years away. Known global changes will continue and new issues are certain to come to the fore. Political and commercial developments throughout the world are changing rapidly. In some areas living standards are improving and in other parts the reverse is true. Telecommunications systems, home and office computing facilities, and personal electronic information and leisure capabilities are making such rapid advances that by 2010 it is likely that major accessors and users of GTOS type data may well be individuals from the general public. GTOS will have to respond positively to these changing conditions and changing users. Also scientists will have developed better, more realistic models with greatly improved predictive capabilities. These models will need improved precision and accuracy in variable measurements which will have to be reflected in GTOS procedures. Observations on new variables will be called for as scientific understanding of environmental processes increases. Better links between science and development will result in more sensitive indicators, and improved indices and other relationships for determining social and ecological responses to global change. Socio-economic data gathering techniques will improve at all levels allowing more meaningful application of global change data to national development. GTOS programmes will have to take these new developments and approaches into account. The actions given below are just some of the more likely avenues along which GTOS may develop.

B. GTOS Networks

Priority B

Normal observations: These will continue to be made through the normal GTOS programme networks. Each of these networks is thematic in that it is mainly concerned with a particular environmental sector, eg GTOS Biodiversity, GTOS Climate, GTOS Coast, GTOS Land, GTOS Radiation and GTOS Water. These programmes are all long-term activities which will continue to form the backbone of GTOS into the next century.

C. State of the Environment Global Observations

1. Global Environment Inter-connections

Priority A

In the first decade of the next century there will be increasing scientific perception that the planet must be viewed as a functional entity in which what happens in one part can influence what happens in all other parts; everything is interconnected to some degree. The recent realization of the global consequences of the El Niño phenomenon is an example of these inter-connections that has just achieved worldwide prominence. The global effects resulting from the 1991 volcanic

eruption of Mount Pinatubo is another example. It will, therefore, become increasingly important to observe the state of the planet as a whole.

2. GTOS and the Global State of the Environment

Priority A

To observe the global state of the environment efficiently in a meaningful but cost-effective way it will be necessary first to identify and define a carefully selected set of core variables to be monitored worldwide. This is more difficult than it may seem because few environmental issues are actually global in nature. Most occur at local or regional level, often with large differences in the natural and socio-economic factors affecting them. They are considered global when they occur throughout the world with such frequency that they seem global by distribution. Nevertheless, many scientists consider that it is possible to identify and define a key set of core variables that will indicate the state of the global environment and its perturbations and potential changes. Once identified, data on each of these key variables will have to be gathered routinely for decades to come. Related tasks for GTOS in the 21st century will include:

Key Core Variables

Priority A

GTOS will play an active part in identifying and defining a limited set of key core variables that can be used to observe the state and trends in the global environment. GTOS will be the lead observing system in identifying the terrestrial variables of this key set. Each of these core variables will be one that is crucial to important environmental functions and processes. Some of these variables will also be measured from space using Earth observation satellite systems. A change in the state of a given core variable will mean that there is a change occurring in the functions or processes in which this variable is involved.

GTOS Global Warning Network

Priority A

Watchdog observations: GTOS will have a set of internationally designated core watchdog observing stations carefully placed around the world, perhaps 400 in number. These will routinely measure the same equally carefully chosen, internationally agreed, set of core variables using harmonized measurement techniques and the same quality assurance and quality control procedures. The purpose of this GTOS Global Warning Network will be to keep the global terrestrial biosphere under constant observation. Through it GTOS will draw attention to any significant perturbations in the state of any of the core variables being observed. The causes and likely consequences of these perturbations can then be examined. This GTOS network will thus function as a global security alarm system that keeps the globe under constant observation but when an intruder appears (ie. there is a significant change in the state of one or more of the observed variables) it will sound an alarm and call for an investigation. Such a system will allow the unexpected to be noticed and acted upon. Hopefully, the GTOS Global Warning Network will be linked to similar networks in GCOS and GOOS, or there will be a single integrated Global Observing System Global

Warning Network involving all three observing systems. Such a global watchdog observing system will be of fundamental benefit to all nations, and to national planners and scientists alike.

D. GTOS Special Purpose Observing

1. GTOS special observations

Priority A; as required

At times it will be necessary to obtain data and information on an environmental factor or effect which is not included in the normal observing system networks. This may entail setting up one or more special purpose observing networks. These may be global in scope or they may be local, or regional, depending on the factors involved and their distribution. Related tasks for GTOS in the 21st century will include:

Special Variables

Through data obtained from its Global Warning Network, its normal observing networks, and its participation in assessment activities, GTOS will assist in identifying environmental variables not normally observed but about which information is now required. Where necessary GTOS will design and ensure the operation of an appropriate GTOS Special Purpose Observing Network.

GTOS Special Purpose Networks

Special observations: These are made through special, probably limited-life, networks created to measure one or more variables not normally observed and which have been identified as being of concern or interest either on theoretical grounds, or because they have been found to be involved in an unexpected perturbation observed by the GTOS Global Warning Network or a similar system. Thus a GTOS Special Purpose Network would be concerned with the origin, transport, deposition and targets of a particular specified element, chemical, substance, or group of substances. These networks may be constructed as a network of existing networks in the normal GTOS manner, or they may be specially created for the purpose, if funding is available.

E. GTOS and Sustainable Development

Priority A

1. Background

The environment has become part of every aspect of everyday life and the demands for environmental information are now far beyond the status and trend data traditionally supplied through global environmental monitoring networks. Information pertaining to the environment is now increasingly required to support and guide socio-economic and environmental policy processes, financial resource allocation, and action planning at national, regional, and global levels. This in turn means that global monitoring and reporting activities must provide many different types of information derived from many different sources and pertaining to many sectors of society. Sustainable development activities will probably grow into the largest programme area of GTOS. Related tasks for GTOS in the 21st century are given below.

2. GTOS Sustainable Development Unit

Priority A

GTOS should develop (but not fund) an international mechanism for providing advice and guidance to individual governments on adapting or creating cost-effective national observing systems tailored to particular governments that will enable a government to obtain the data and information that it needs for managing its renewable natural resources, including agriculture, pastoral, and other managed ecosystems, in ways that are sustainable. This mechanism will also provide, where necessary, advice on how best to finance all, or parts, of the national observing system. The mechanism will grow naturally out of the earlier work of GTOS but it will undoubtedly require the creation of a small unit within the GTOS Secretariat specifically for this purpose. Additional funds to support the unit will have to be sought.

3. National Statistical Data

Priority B

Many nations, including developing countries, routinely gather national statistics, including environmentally related data, for national economic planning. Many local organizations also gather environmentally related data. These data often form the basis of national state of the environment reports which regularly summarize the status of current national environmental knowledge. These data are increasingly becoming available to non-national users. In many cases they are high quality, completely reliable, and are accompanied with very good metadata. In other instances, however, this is not true and the data can only be used with caution. Nevertheless, national statistics do present a potentially valuable source of terrestrial data that could be used by GTOS provided national harmonization, quality assurance and quality control procedures used in their gathering are to internationally acceptable standards, and reasonable metadata are available. GTOS should develop an association with national statistical offices with a view to not only obtaining national data but also assisting countries to improve the quality and reliability of the environmental and renewable natural resources statistics they collect. Additional data could be made available to countries through GTOS. This association could be developed through the proposed GTOS Sustainable Development Unit (see X.E.2. above). GTOS association with national statistical programmes will help GTOS to be seen to be more relevant to the development needs of countries.

4. Satellite Data

Priority B

Data obtained from sensors in space will become more reliable, better in quality, more readily available, and cheaper. GTOS systems will develop improved ways to verify and use space data in their assessment and analytical models. This applies particularly to the use of space data for global change studies of ecosystem changes (extent, species composition, and quality) including biological diversity aspects. An important future function for GTOS will be to help guide countries, particularly developing countries, into better more efficient use of space data for sustainable development purposes. GTOS should catalyze co-operative studies between countries and the space agencies.

5. International sustainable development activities

Priorities B and C

A number of international sustainable development initiatives will be undertaken in future years. These will range from improving the definition of sustainable development to long-term case-studies to demonstrate the feasibility, applicability and practical benefits of sustainable development concepts. Some will be within the framework of United Nations activities, while others will be national or regionally sponsored. GTOS must ensure that it is actively involved from the beginning in all the major international sustainable development programmes, and is fully aware of all other sustainable development actions. GTOS staff must take part in important sustainable development programme meetings both to learn more about national sustainable development needs, and to inform about GTOS. An association of this sort will improve the relevance of the sustainable development aspects of the GTOS programme, and will further enhance the reputation of GTOS among developing countries.

F. GTOS and Science

Priorities A and B

Great strides have been made in recent years in the development of environmental and ecological function models that approximate closely to the real world. This process will continue in the future. The scientific community will, therefore, be constantly refining and clarifying its data needs and better defining the accuracy and precision with which measurements should be made. New variables will be emphasized as research reveals their importance. There will then be calls for more data on these variables in order to answer specific scientific questions. GTOS must, therefore, continue to work closely with the scientific community and with the major international scientific programmes. This close association will help to make the GTOS programmes more meaningful to the world as increased scientific knowledge is translated into practical applications so improving human living standards and social well being.

G. GTOS and the Public

Priority A

There has been a marked increase in environmental awareness in the last decade. People all over the world have begun to realize that they really can be affected by a changing environment. This has resulted in worldwide increased demand for soundly based, scientifically reliable, easily understood information about the environment, how it works, why it is thought to be changing, what these changes will mean to people, and what can be done about it if these changes are not beneficial. This demand peaks at times of oil spills, nuclear releases, industrial accidents, volcanic eruptions, droughts, floods and other environment related incidents. GTOS must develop a series of clearly written, authoritative, well illustrated but brief pamphlets on environmental problems as they effect terrestrial systems and people. Additional funds should be sought to translate them into major languages appropriate to different regions (eg Arabic, Chinese, French, Spanish, Russian, etc.). GTOS must be prepared to issue frequent authoritative update bulletins on individual environmental incidents and situations as they arise. This should include television interviews, press conferences, radio statements, and web site material, in addition to the more traditional press releases. Properly done this will considerably benefit the long-term reputation and recognition of GTOS and its work.

H. GTOS and the Governments

Priority A

The question of involving governments in the work of GTOS and in its support has been touched upon in several parts of this Implementation Plan. Ultimately, the future of GTOS, as with all the Global Observing Systems, rests with governments. Without their active technical and financial participation there can be no effective GTOS. Some form of Intergovernmental Advisory Mechanism for GTOS would, therefore, be an advantage since it would not only overcome potential political difficulties but would ensure the financial future of GTOS. Establishing an Intergovernmental Advisory Committee or Panel on GTOS, similarly structured, for example, to the Intergovernmental Panel on Climate Change (IPCC) is one possibility that should be explored. The preparatory work for setting up such a mechanism would include securing funds for holding the first meeting, and for increasing the size of the GTOS Secretariat to cope with the extra work load that supporting this panel would entail. This approach, if carefully formulated, would ensure that governments have a real say in how GTOS is developed and run even though GTOS remains a United Nations activity.

I. GTOS and the Global Observing Systems

Priority C

Although all three observing systems have had separate origins in response to different user groups calling for data, they will come closer together as they develop because their interests overlap. Each needs the help and inputs of the others because each has as its main concern one of the three major compartments of the biosphere (air, land, water) but needs data about the other two. Once each observing system is properly functional it would be more efficient administratively and programmatically if all three could be brought together within a common United Nations framework as programme elements of a single Global Observing System. The Global Observing System would be better housed as a separate body within the United Nations secretariat although it would maintain very close contact with the present United Nations host organizations and with the present Co-sponsor organizations.

Annex I. Sponsors Group for the Global Observing Systems

1. There are three Global Observing Systems: the Global Climate Observing System (GCOS); the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS). Together the three are sponsored by six international organizations: the United Nations Environment Programme (UNEP); the Food and Agriculture Organization of the United Nations (FAO); the United Nations Educational, Scientific and Cultural Organization (UNESCO) and its Intergovernmental Oceanographic Commission (IOC); the World Meteorological Organization (WMO); and the International Council of Scientific Unions (ICSU). UNEP and ICSU sponsor all three Global Observing Systems. Each of the Global Observing Systems has found an institutional home in a different host agency (GCOS in WMO; GOOS in IOC; GTOS in FAO).

2. The three observing systems were founded independently and at different times, and so are at different stages of development with GCOS being the most advanced and GTOS being the least developed. Since they share many approaches, interfaces and common problems, the Co-sponsors felt that development of the Global Observing Systems should be guided by a common strategic framework and close working relationship. Consequently, the sponsoring organizations formed the Sponsors Group in late 1996. UNEP, working through its Earthwatch programme, assumed responsibility for providing secretariat support for the Sponsors Group. The first meeting of the Sponsors Group was held in January 1997. The group meets annually but additional meetings are held by mutual agreement should they be needed.

3. The Sponsors Group provides an important opportunity for the Global Observing Systems to be considered by their sponsoring organizations in a concerted fashion. The Group agreed that the secretariats and sponsors should share information with all of the members of the Sponsors Group regardless of whether they were formally a sponsor of the system in question. It has discussed at length many of the problems faced by the Global Observing Systems such as national and international visibility, financial support, and participation. Unfortunately, progress in these areas has so far been limited. Thus the sponsoring organizations have not yet been able to take proper advantage of the forum provided by the meetings of the Sponsors Group to further the three Global Observing Systems and bring them closer together in form and function. They have, however, identified a GOS Panel on Socio-economic Benefits as a priority need for GOS since a clear definition of the societal benefits from the GOSs will help to build and maintain support for all three GOSs. They have also examined the roles of the governing bodies of each sponsor since the support of governments is essential for maintaining the observing systems in the work programmes and budgets of the sponsoring organizations.

4. The Committee on Earth Observation Satellites (CEOS) and the International Group of Funding Agencies for global change research (IGFA) have called for an Integrated Global Observing Strategy (IGOS) as a joint product of all the agencies involved in the collection and analysis of space-based and in situ ground data. This need has been recognised by the Sponsors Group with the result that UNEP has prepared a draft IGOS strategy as a proposed umbrella for the three observing systems and any other international observing activities. CEOS and IGFA are also preparing a draft IGOS strategy. These will be considered at future meetings of the Sponsors Group.

Annex II. Executive Summary of the GTOS Planning Group Report

(The text below is from the June 1996 report of the ad hoc Scientific and Technical Planning Group for a Global Terrestrial Observing System. The Chair of the GTOS Planning Group was Dr David Norse of University College, London. The report was submitted to the GTOS Co-sponsors in December 1995. Bibliographic details are: GTOS Planning Group (1996). Global Terrestrial Observing System - GTOS. Turning a sound concept into a practical reality. pp xii + 114; 8 Annexes. London: UNEP, FAO, UNESCO, WMO, ICSU).

The objectives of the Planning Group's proposals are to:

- Make the case for the establishment of a Global Terrestrial Observing System - Why do we need a GTOS?
- Recommend its primary function - What will GTOS do?
- Present options for its operation - How will it be organised?
- Outline the main costs and benefits - How much cost, how much gain?
- Suggest what needs to be done - Where do we go from here?

Why Do We Need a GTOS?

Terrestrial ecosystems are the foundation of social and economic well-being because they are the main source of food and other basic needs. They also play a vital role in the regulation of atmospheric, biogeochemical and hydrological processes. Yet we do not know how, where and over what time frame humankind is endangering terrestrial and freshwater ecosystems including coastal zones. We do not even fully understand the role of these ecosystems in global processes. In particular, we cannot answer five inter-related questions central to sustainability development:

- Food and renewable resources: can the land feed another 5-6 billion people?
- Fresh water: where, when and by how much will demand exceed supply so as to cause supra-national problems?
- Toxins: do they or will they cause major trans-boundary threats to human and environmental health and the capacity of ecosystems to detoxify them, and if so where and when?
- Biological diversity: where and what type of biological resources are threatened with loss, and where will these losses irreversibly damage ecosystem function or socio-economic progress?
- Terrestrial ecosystems: where, when and how much will they change in response to global atmospheric, climate and land-use changes, and how will this impair their capacity to support life?

Such questions have led nations to sign the climate change, biodiversity and desertification conventions, to adopt Agenda 21 and other actions relating to deforestation and environmental

protection in general. Many of these conventions and actions require better terrestrial observation data, but the international community has yet to establish the means of obtaining them.

We lack spatially and temporally comprehensive data on the physical environment, on terrestrial ecosystem processes, and on the socio-economic driving forces that are changing them. There is no global mechanism for the collection of compatible data, and so there is a critical gap in the current observing systems for climate (GCOS) and the oceans (GOOS). Consequently, we cannot determine whether major policy changes are needed now and at high economic and social costs, or if both the impacts and the correction processes are longer term.

Without GTOS, we will continue to see major investment in non-compatible systems, a consequent data or data integration gap, and a lack of support for international conventions. With GTOS we will be better placed to identify pressure points and determine how best to use Earth's resources to achieve sustainable development.

What Will GTOS Do?

Given the above questions, the central mission of GTOS should be to provide the data needed to detect, quantify, locate and give early warning of changes (especially reductions) in the national or global capacity of terrestrial ecosystems to support sustainable development and improvements in human welfare. It should also help advance our understanding of such changes.

These objectives should be accomplished through an integrated and equitable partnership of data providers and users that meets both the short-term needs of national governments and the longer-term needs of the global change research community, GTOS's focus should be on five key development issues of global concern:

- Land use change, land degradation and the sustainability of managed ecosystems
- Water resources management
- Pollution and toxicity
- Loss of biodiversity
- Climate change.

GTOS should be directed at specific needs and at overcoming the deficiencies in the existing global and regional observational systems. It should not be directed at data collection for its own sake, and research should not be a major function, though it should identify research needed to improve observational and information systems. But GTOS should support research programmes and collaborate with IGBP, DIVERSITAS and others in the assembly of appropriate data sets.

To make a unique contribution to our ability to manage the planet wisely, GTOS must:

- Be global in scope, meaning both that its coverage is comprehensive (but regionally balanced and resolved) and that it should address phenomena that are global in their nature or impact.

- Provide continuity of information collection over the long-term - periods from years to decades which are consistent with the rate at which global processes occur in order to detect trends sensitively and in a timely fashion.

- Be an integrated system in which the separate pieces of information add to each other's value. For example, GTOS data must not only detect and describe changes, but allow them to be understood and predicted.

How Will It Be Organized?

GTOS should operate on the basis of a partnership of partnerships formed largely from existing sites and networks (plus others like WHYCOS which are in the process of development), and on present and planned remote sensing systems. Implementation should be essentially bottom-up, with GTOS providing the framework within which the output from the spaced-based Earth Observing Systems and the existing databases such as GEMS/Water and the Global Runoff Data Centre (GRDC) can be integrated with in situ observations. Actions should be both direct and catalytic. The core of the proposed system is a hierarchical sampling strategy, with four tiers of decreasing complexity and frequency of in situ observations and a fifth tier to provide global coverage largely through satellite remote sensing. At one extreme, detailed data is collected almost continuously at a few large sites and, at the other, a large number of small systematically located sites are sampled at intervals of five years.

The establishment of such a hierarchy and the data management and exchange system to support it should be undertaken by a Central Co-ordinating Unit (CCU) with some international secretariat functions. The CCU should be linked to regional and national bodies of variable form and structure, since they should evolve in response to user and provider initiatives rather than being part of a pre-set structure. The CCU should have two guidance mechanisms - a Steering Committee for strategic considerations and a Technical Advisory Group - plus some 40-50 corresponding members who would contribute to and/or comment in writing on proposals for the implementation of GTOS. In addition, ad-hoc or permanent supporting bodies should be established to guide the development of operational plans for particular functional or thematic components of the programme. As far as possible, these bodies should be joint activities with GCOS and GOOS.

Guiding Principles

Guiding principles for GTOS's data management system should be common or compatible with those for GCOS and GOOS. The data management system should be constructed, as far as possible, using off-the-shelf application tools and existing or planned communication systems. It should be sufficiently flexible to incorporate or link to data sets originating outside GTOS, since GTOS may not hold much of the data but provide an access mechanism for dispersed data sets. Data links between the centre, the regions and other data centres would be primarily electronic with magnetic and optical disks as a parallel alternate system, especially during the transitional period.

How Much Cost, How Much Gain?

A substantial proportion of the required infrastructure is already in place and funded, so the incremental costs of the proposals will be low compared for a totally new system. The operating costs of existing terrestrial observing systems are over US$300 million. GTOS, on the other hand,

will initially cost less than one million dollars per year possibly rising to about US$3.4 million after five years.

The costs of launching GTOS should be phased over five or ten years, and built up in a modular fashion. This would permit multiple financial mechanisms to operate, with individual donors supporting those modules that are consistent with their issues or regional priorities. In the early stages, average annual operating costs could be some US$700-850k for the CCU, guidance bodies, and initial actions to link existing monitoring sites and networks. During the first five years the operating costs of strengthening and extending these activities, and some capital costs would rise to about US$5 million. In the medium-term total costs would rise to around US$12 million if the resources can be found to extend regional activities, improve some existing sites and to fill gaps in the spatial coverage of the monitoring sites.

The proposed activities would improve the returns from major investments in independent in situ observation systems by providing complimentary regional or global data, and in earth observation satellites and remote sensing devices by providing comprehensive ground truthing. The drawing together of existing but disparate databases, sites and networks into a common framework with the standardization or harmonization of measurements and terminology would increase substantially the usage and value of such data and information. The GTOS activities would support global change research programmes by contributing to the refinement, calibration and validation of the GCM, ecosystem and carbon cycle models.

The provision of globally comprehensive and timely data on anthropogenic impacts on terrestrial ecosystems will help UN agencies - and the secretariats of the Climate, Biodiversity, Desertification, Ozone and other conventions and treaties - to fulfil their mandates. It will also help them and multi-lateral donors advise their member governments on priorities for sustainable development.

National benefits include support to planning, natural resource management and environmental agencies, opportunities for staff training, promotion of contacts and interactions between scientists of participating nations, and greater access both to new technology for environmental assessment and management and to financial support catalyzed by GTOS. The strengthening of national terrestrial ecosystem monitoring should make a contribution to more general socio-economic development by helping to identify opportunities for - and undesirable consequences of - developments project at all scales. GTOS would help countries add the global dimension to national environmental strategy formulation, obtain data for national global research programmes, develop better policy planning tools and meet reporting obligations under the post Rio conventions.

Where Do We Go From Here?

The Planning Group recommends the progressive implementation of GTOS, starting in 1996 with a five-year programme. Priority in 1996 should be given to:

- Finding an institutional home for GTOS

- Establishing the institutional framework and some of the operating mechanisms.

- Completing a more extensive dialogue with potential partners already involved in global data management and harmonization or operating global, regional, national or sectoral systems and networks or sites.

- Setting up a pilot framework drawing together a sub-set of existing observing systems.

- Launching data management and harmonization procedures.

- Developing the detailed operational plans for later stages of implementation.

- Obtaining the supplementary funding for future development of GTOS from multi- and bi-lateral donors and other institutions.

Over the following four years, a start should be made on upgrading existing sites and filling the most urgent of the gaps in the geographic, biome or crop coverage of natural and managed terrestrial ecosystems, and promoting regional bodies.

Annex III. Acronyms

AMAP	Arctic Monitoring and Assessment Programme
BAHC	Biospheric Aspects of the Hydrological Cycle
CCU	Central Co-ordinating Unit
CEOS	Committee on Earth Observation Satellites
CERN	Chinese Ecosystem Research Network
CFS	Committee on Food Security
CGIAR	Consultative Group on International Agricultural research
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Centre for International Forestry Research
CODATA	Committee on Data for Science and Technology
COSPAR	Committee on Space Research
DIMP	Data and Information Management Panel
DIVERSITAS	International Programme of Biodiversity Science
ECN	Environmental Change Network
FAO	Food and Agriculture Organization of the United Nations
FLUXNET	Flux and Energy Exchange Network
GAIM	Global Analysis and Modelling
GCOS	Global Climate Observing System
GCTE	Global Change and Terrestrial Ecosystems
GEMS	Global Environment Monitoring System
GEO	Global Environment Outlook
GHOST	Global Hierarchical Observing Strategy
GOOS	Global Ocean Observing System
GOS	Global Observing System
GOSSP	Global Observing Systems Space Panel
GRDC	Global Runoff Data Centre
GRID	Global Resources Information Database
GTOS	Global Terrestrial Observing System
HEM	Harmonization of Environmental Measurement Unit
ICRAF	International Centre for Research in Agroforestry
IGBP	International Geosphere-Biosphere Programme
IGBP-DIS	IGBP-Data and Information Systems
IGFA	International Group of Funding Agencies for Global Change
IGOS	Integrated Global Observing Strategy
IHDP	International Human Dimensions Programme
ILRI	International Livestock Research Institute
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
IUCN	International Union for the Conservation of Nature (World Conservation Union)
J-DIMP	Joint Data and Information Management Panel
J-SEP	Joint Socio-economic Panel
LAI	Leaf Area Index
LOICZ	Land-Ocean Interactions in the Coastal Zone Programme
LTER	Long Term Ecological Research Network

LUCC	Land-use/Land-cover Change
NEP	Net Ecosystem Productivity
NPP	Net Primary Productivity
ROSELT	Réseau d'Observatoires de Surveillance Ecologique à Long Terme
SCAR	Scientific Committee on Antarctic Research
SCOPE	Scientific Committee on Problems of the Environment
SCOWAR	Scientific Committee on Water Research
START	System for Analysis, Research and Training
TEMS	Terrestrial Ecosystem Monitoring Sites
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCMC	World Conservation Monitoring Centre
WCRP	World Climate Research Programme
WDC	World Data Centres
WHO	World Health Organization
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WRI	World Resources Institute
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research
WWW	World Weather Watch