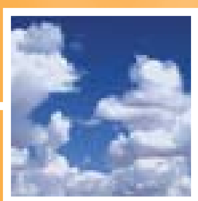
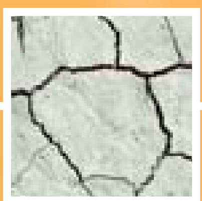
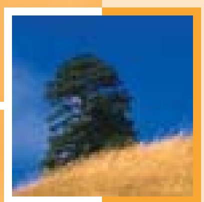
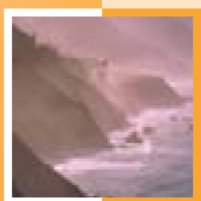
GTOS

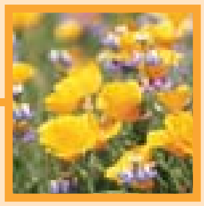
Biennial Report 2002–2003







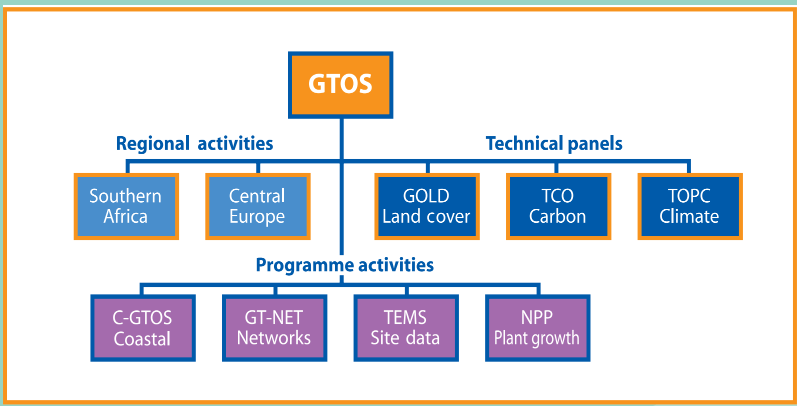




WMO UNESCO UNEP ICSU FAO

GTOS Programme

GTOS PROGRAMME STRUCTURE



A global system for observations, modelling and analysis of terrestrial ecosystems to support sustainable development.

Mission: facilitate access to reliable information on terrestrial ecosystems so that researchers and policy-makers can detect and manage global and regional environmental change.

CONTRIBUTORS TO THIS REPORT

Alan **Belward**, Ray **Bradley**, Robert R. **Christian**, Warren B. **Cohen**, Stith T. **Gower**, Wolfgang **Grabs**, Steffen **Gruenler**, Aurélien **Letourneau**, Bruno **Messerli**, Shaun **Quegan**, Mel **Reasoner**, Markus **Reichstein**, Steve W. **Running**, Robert **Scholes**, Géraud **Servin**, John **Latham**, John **Townshend**, Jeff **Tschirley**, David P. **Turner**, Stephanie **Vertecchi**

Editor: Thorgeir **Lawrence**
Document design: Tomaso **Lezzi**
Publication coordinator: Reuben **Sessa**

Contents

GTOS

Letter from the Chair

Robert Scholes

Adequate information is still lacking for rational decision-making on the future of the Earth

INTENSIFICATION OF EFFORTS

The 2002–2003 period was a critical watershed for global earth observations. The preparations for the World Summit on Sustainable Development (WSSD) in Johannesburg in September 2002 alerted many parties to the fact that ten years after the Rio Earth Summit, we still lacked adequate information for rational decision-making about the future of the Earth. Many sessions at the WSSD emphasized that point, and the report of the Summit called, in several places, for an improved global observation system.

The second Adequacy Report of the Global Climate Observing System (GCOS), to which GTOS contributed, was published in early 2003 and carefully documents the shortcomings in this most basic sector of global information. The conclusions from the Second Adequacy Report were endorsed by the Congress of the World Meteorological Organization, and renewed efforts have been pledged to ensure sufficient coverage and availability of crucial variables, particularly over tropical regions and developing countries. The Report was extensively reviewed by the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body for Scientific and Technological Advice, with the intention of presenting a decision for adoption at the 9th session of the Conference of the Parties, in Milan, Italy, in December 2003.

The Global Earth Observation summit (GEO) was convened in Washington DC in July 2003, partly in response to the growing awareness that a greater level of commitment and co-ordination was required from governments if a sufficiently comprehensive system was to be established. This ministerial-level meeting, attended by representatives from 30 nations and 22 international organizations, including GTOS, has established structures and a work plan to deliver a functional system within years rather than decades.

GTOS has contributed to all these activities, and must orient its ongoing work to achieve maximum success in existing and emerging initiatives. GTOS welcomes the rising awareness of the importance of reliable observations, and offers its experience, networks and resources to help build a satisfactory system. In its own right, GTOS continues to make progress towards an integrated system through which critical global variables relating to the land environment can be collected, combined, reported and archived.

SUPPORT OF THE KYOTO PROTOCOL

The Terrestrial Carbon Observations (TCO) panel completed its design work under the leadership of Dr Josef Cihlar, and is now being made operational through the Chair of Professor Shaun Quegan. The goal of TCO is to have in place, by the end of the first Kyoto Protocol commitment period, all the necessary systems to allow the terrestrial components of the global carbon cycle, including land-atmosphere exchanges, to be quantified with sufficient confidence that the aims of the Protocol can be met. To this end, TCO has embarked on an innovative and comprehensive programme to unify observations derived from ground stations, atmospheric measurements and remote sensing, through the use of mathematical models.

FOREST CHANGE

The Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) panel, under the leadership of Professor John Townshend, has a well established track record in applying remote sensing to quantify changes in forest areas. The panel came to the realization that the task requires more than simply mapping forests, challenging though that may be: it also requires an understanding of changes in landscapes with sparse tree cover; the alternation between forested and non-forested land; and the drivers of the changes, such as fire. For this reason, the panel has repositioned itself as Global Observation of Land Dynamics (GOLD). The name GOFC-GOLD will continue in parallel for a period.

TERRESTRIAL AND COASTAL ECOSYSTEMS

The Terrestrial Ecosystem Monitoring Sites (TEMS) database has grown in both number of locations recorded and the breadth of topics covered. The other main programme activity coordinated by the secretariat, GT-NET, links together many discipline or topic-specific networks. It is within GT-NET that the actual observations are made, by participating organizations around the globe.

The coastal module of GTOS has made considerable progress during the last biennium. Its expert panel has identified the framework for organizing observations and issues relevant to coastal ecosystems, with an implementation plan scheduled for early 2004. Furthermore, Coastal GTOS (C-GTOS) is being linked to other programmes through a proposed coastal theme within the Integrated Global Observing Strategy (IGOS).

BIODIVERSITY ASSESSMENT

A top priority for GTOS in the next biennium is to establish a significant activity in the area of biodiversity observations. Initially, this will take the form of expanding the TEMS module on biodiversity to comprise a comprehensive set of variables, and helping to establish a set of agreed protocols for making the observations. In this endeavour, GTOS will work closely with the research community, represented by Diversitas; the data-holders, many of whom are in the GTOS Terrestrial Networks; and the policy community, represented, for instance, by the UN Convention on Biological Diversity.

NEW GTOS DIRECTOR

In July 2003, the Programme Director of GTOS, Mr Jeff Tschirley, was promoted to Chief of the Environment and Natural Resources Service (SDRN), within FAO. He has seen GTOS through its formative years, and will continue to have a role in its future. His strong leadership contribution is greatly appreciated and will be missed. The incoming Programme Director, Mr John Latham, is a leading expert in the field of remote sensing and its practical application in land cover mapping. The GTOS team looks forward to working with him in meeting the challenges deriving from the expanding expectations of users.

FUTURE PROGRESS

The vision we have for GTOS in the next two years is that it be recognized as an indispensable information partner in the quest for better management of terrestrial and freshwater ecosystems. To this end GTOS will prioritize:

- operational delivery in areas where GTOS is clearly a leading organization;
- planning and implementation in areas within our mandate where GTOS is well-positioned to be a leader, and
- active and non-territorial collaboration with other organizations that share our objectives.

New Programme Director

John Latham

GTOS needs to take a leading role in developing a coordinated global monitoring system

THE ROLE OF GTOS

It is with great pleasure that I take up the position as GTOS Programme Director, and I look forward to working with the many collaborators involved in GTOS activities. I hope to follow the good work of the previous Director, Mr Jeff Tschirley, who has built the foundations of GTOS and will continue to foster the development of the programme in his new role as Chief of the Environment and Natural Resources Service (SDRN) within the Food and Agriculture Organization of the United Nations (FAO). GTOS is at an important stage, as many of GTOS activities are now moving from development into implementation. There is increasing international interest in global observations and it is important that GTOS takes a leading role to bring together existing and new monitoring initiatives to create a coordinated global monitoring system.

EARTH OBSERVATION SUMMIT

In July 2003, at the Earth Observation Summit, thirty-three nations and the European Commission adopted a Declaration that signifies political dedication to move towards the development of a comprehensive, coordinated and sustained Earth observation, with a commitment to significantly advance the ability to gather Earth observation data. To develop these objectives, an intergovernmental ad hoc Group on Earth Observations (GEO) has been created to develop a ten-year implementation plan. Through the Integrated Global Observing Strategy Partnership (IGOS-P), GTOS and the other partners will be involved in achieving the common objectives of both IGOS and GEO, and many IGOS collaborators will be involved in the five GEO subgroups (architecture; capacity building; data utilization; international cooperation; and user requirements and outreach). FAO will also be Co-Chair of IGOS-P from July 2004, and the GTOS Secretariat will be supporting this one-year role.

ACTIVITIES

At the programme level, I will use my experience in the field of natural resources management, land cover dynamics, information management and spatial data infrastructures to support GTOS activities, including the Panels, demonstration projects and the coastal initiative, and to integrate these with my continuing projects, such as Africover (a digital geo-referenced database on land use and geographic referential for Africa) and the recently launched Global Land Cover Network to develop improved information on land cover and dynamics to support global, regional and local initiatives.

FUTURE OBJECTIVES

The critical step is for GTOS activities to start generating useful products that are recognized by the international community, so that a long-term momentum can be generated to attract collaborators and the substantial funding that is needed to generate the information required by end users. Demonstration projects, such as the GTOS Net Primary Productivity Project, have been an excellent way of showing the value-added input that GTOS can provide, but it is now important to develop these projects into fully operational programmes. In the next biennium, the GTOS implementation plan will be revised to take into consideration the individual programmes of the Panels and current developments in Earth Observation. It will also be timely to carry out an adequacy report on terrestrial observation, as was done for climate observations by TOPC. This will provide the information needed to refine our activities and approach the different funding bodies.

The challenge that is facing us is immense, but with growing awareness among the general public and increasing support from governments, the work of the international community is surely going to be increasingly facilitated.

I hope that you enjoy this third biennial report, and would like to offer my sincere thanks to the numerous collaborators who have contributed to the progress made during the past two years and in the preparation of this report. I am looking forward to working with you in the coming years.

www.fao.org/gtos
www.esa.ssc.nasa.gov/geo
www.earthobservationsummit.gov
www.igospartners.org

Terrestrial Ecosystem Monitoring Sites (TEMS) Database

Géraud Servin and Aurélien Letourneau

TEMS provides information on the "who, what and where" in long-term terrestrial monitoring

BOX 1. SITE DATA AVAILABLE

- variables measured
- socio-economic measurements
- climate estimates
- geology
- pedology
- hydrology
- land cover
- location
- contact person(s)
- network(s)
- data policy
- reference area
- monthly estimates of climatic data

BOX 2. WHAT IS TEMS?

TEMS is an international directory of sites and networks that carry out long-term terrestrial monitoring and research activities. It provides information on "who is doing what and where", for use by both researchers and policy-makers.
TEMS is used principally for:

- Modelling, environmental assessment and research programmes.
- Assessing gaps in the geographical coverage of observing systems.
- Linking ground observations with satellite imagery to facilitate integrated regional and global studies.

Register your site now online at:
www.fao.org/gtos/tems/tsite-edit.jsp

DEVELOPMENTS

Major developments have been taking place since the initial web release of the Terrestrial Ecosystem Monitoring Sites (TEMS) database, in early 2001. There are now 47 networks and 1720 ecological research sites registered, which can be browsed by ecological zone (through interactive maps), by measurements made, and by networks, using both simple and advanced search engines.

CLIMATE DATA

Comprehensive information is available for each research site (see Box 1) and this information has been further supplemented with monthly estimates of climate data from the FAO global climate database. Each site now has estimates of daily minimum, mean and maximum temperatures (°C), total precipitation (mm), total potential evapotranspiration (mm), wind speed (m/s), water vapour pressure (hPa) and sunshine fraction.

ICP FOREST

Of the new sites registered in TEMS, 795 are part of IPC Forest (International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests; see www.IPC-forests.org). These sites monitor forest condition across continental Europe, using two different monitoring intensity levels. All sites annually assess crown condition on a 16×16 km grid, and specific sites also measure soil condition and chemistry, foliar nutrient status, meteorological conditions, ground vegetation and air pollutant deposition. Currently, 38 countries participate in the ICP Forests programme.

NEW MODULES

Modules - which contain additional information around a particular topic - for Biodiversity, Forest and Hydrology have been created to allow users improved access to sites and information relevant to their interests.

- The **forest** module contains summary data from the FAO Forest Resources Assessments (FRAs) of 1980, 1990 and 2000 (including tables, graphs and maps), at pan-tropical, regional, subregional and sampling unit levels. They are based on sample and remote sensing data, and were used to complement country data and to provide consistent and reliable detailed information on change processes for 1980-1990.
- The **biodiversity** module contains information on data sources and institutional links, together with a literature and glossary section. Variables relevant to biodiversity are also included, including seven new biodiversity methodology sheets. Recently, efforts have been made to increase the number of data providers, and data sets are now organized by organisms or related variables, and according to

geographical range. TEMS is developing links with biodiversity-relevant networks through a new GTOS initiative to improve monitoring of biodiversity loss (see pages 18).

- The **hydrology module** contains information on variables, data holders, institutional links and relevant literature (see page 28).

FUNCTIONAL IMPROVEMENTS

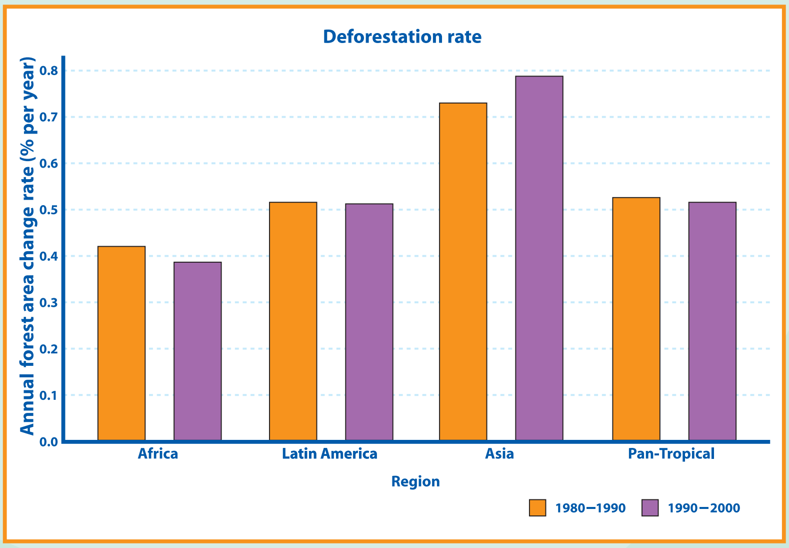
Considerable improvements have been made to TEMS functioning. Information can now be accessed more quickly, and files are easier to download (for example, as zipped files). Since version 2.2, TEMS has been available on mini-CD-ROM to provide users, especially in remote areas with poor or no Internet connection, with improved access to the TEMS database. Mini CD-ROMS are freely available from the GTOS Secretariat.

BOX 3. TEMS FEATURES

- 1 720 ecological research sites.
- 47 site networks.
- 115 environmental variables sheets (description, measurement methods, data holders).
- 60 socio-economic data sheets (for integrated and interdisciplinary analysis of terrestrial data).
- Ecological maps.
- Modules.
- Online registration and updating of TEMS site data and information.

USER SURVEY

A comprehensive TEMS user survey was carried out in early 2002. Users and administrators were asked to comment on TEMS accessibility and utility, and to indicate areas for possible improvement. The survey concluded that TEMS contains useful information that can be easily accessed, but there was still a need for further information and facilitated data sharing, including access to satellite imagery. These and other recommendations are being used to guide future TEMS developments.



Variable	JAN	FEB	MAR	APR	MAY	JUN
Daily Mean Temperature (°C)	7.3 ± 0.6	8.2 ± 0.5	10.3 ± 0.6	13.0 ± 0.7	16.5 ± 0.9	21.2 ± 1.2
Daily Minimum Temperature (°C)	3.2 ± 1.1	3.9 ± 1.0	5.9 ± 1.0	7.9 ± 1.1	11.3 ± 1.2	15.2 ± 1.6
Daily Maximum Temperature (°C)	10.9 ± 0.6	12.6 ± 1.0	15.3 ± 1.2	19.3 ± 1.7	23.3 ± 2.0	27.6 ± 2.6
Precipitation Totals (mm)	156.0 ± 38.5	100.3 ± 36.2	106.3 ± 23.1	96.4 ± 19.3	67.8 ± 13.6	22.7 ± 5.6
Potential Evapotranspiration Totals (mm)	37.9 ± 8.9	51.5 ± 13.5	84.4 ± 13.2	109.4 ± 15.9	140.4 ± 21.2	164.4 ± 22.9
Windspeed ([illegible])	2.1 ± 0.6	2.4 ± 0.6	2.6 ± 0.6	2.4 ± 0.6	2.2 ± 0.5	2.1 ± 0.5
Water Vapor Pressure (hPa)	7.5 ± 0.7	7.2 ± 0.8	8.1 ± 0.7	9.1 ± 0.9	11.4 ± 1.4	13.5 ± 1.4
Sunshine Fraction	0.52 ± 0.07	0.6 ± 0.06	0.63 ± 0.07	0.63 ± 0.07	0.73 ± 0.07	0.73 ± 0.06

TCO Project

Shaun Quegan

Space data, *in situ* data and model-data interaction themes are being developed to meet TCO objectives

BACKGROUND

The Terrestrial Carbon Observation (TCO) initiative was started in 1999 by the Integrated Global Observing Strategy Partnership (IGOS-P) in response to policy and scientific needs for carbon cycle data (see Box 1). The TCO objective is to improve the understanding of the spatial and temporal distribution of carbon sources and sinks in the terrestrial biosphere to allow countries to make informed decisions about limiting the introduction of CO_2 into the atmosphere.

BOX 1. CARBON DATA REQUIRED

Observations needed to understand terrestrial carbon stocks and fluxes:

- land cover and land use history
- net primary productivity
- fire and biomass
- atmospheric fluxes
- soil carbon

TCO PANEL

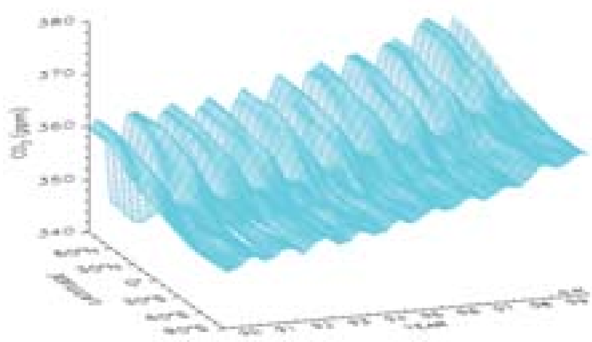
Dr Josef Cihlar, who led the TCO project from its creation in 1999, stepped down in November 2002. The new Chair, Professor Shaun Quegan (see Box 2), is currently assembling the new TCO panel, whose team leaders will develop the three main TCO themes of space data, *in situ* data and model-data interaction. A panel meeting was held in late 2003 to revise the implementation plan, make decisions on short-term and long-term goals, and put TCO projects into operation.

NETWORKING AND DATA GATHERING

Since the end of 2002, TCO has been active in the Central and Eastern European (CEE) region, building links with scientists involved in carbon-related research. The aim is to develop collaborative links within the region and identify and develop regional data sets relevant to TCO. A meeting was held in Prague at the end of 2002, to bring together CEE scientists involved with forest inventories, FLUXNET station data, site ecological data, and site soil organic matter data. The workshop provided an opportunity to jointly assess data availability and current needs.

The data and information received during the year have been placed in a data warehouse, access to which is freely available through the GTOS Secretariat. For some data sets there are a number of restrictions, but a comprehensive metadata list is being developed so that

Global distribution of atmospheric carbon dioxide. Source: National Oceanic and Atmospheric Administration. Climate Monitoring and Diagnostics Laboratory



interested individuals can contact the data holders directly. The issue of data incompatibility will be addressed during a dedicated workshop in Prague in the spring of 2004.

INTERNATIONAL COLLABORATION

TCO is keen to develop its programme through collaboration with institutes and international initiatives involved in carbon studies. For example, TCO collaborated with the Global Carbon Project (GCP) in organizing a meeting on Terrestrial Carbon Observations and Model-Data Fusion (Sheffield, United Kingdom, 3-6 June 2003). Through working sessions, participating scientists developed recommendations addressing the critical actions most needed to improve estimates of the distribution of carbon sources and sinks at regional and global levels. This requires convergence of *in situ* and satellite observations; experimental and modelling strategies; improvements in data acquisition and sharing; and product generation, distribution and use.

The findings of the workshop will be submitted to IGOS-P and a summary article is being prepared for journal submission (*Journal of Global Change Biology*). For additional information on the workshop see: *www.fao.org/gtos/meetSHE.html*

BOX 2. PROFESSOR SHAUN QUEGAN

Director of the Centre for Terrestrial Carbon Dynamics (CTCD), whose purpose is to give a better understanding and greater quantitative estimation of the role of the terrestrial ecosystem in the Earth's carbon cycle.

Professor Quegan's particular expertise lies in the physics, systems and data analysis aspects of radar remote sensing, but his current interests lie in the exploitation of remote sensing technologies in environmental science and the carbon cycle. He is a member of the NASDA Kyoto and Carbon Panel, the ESA TerraSAR Advisory Group, and, until recently, the British National Space Centre Earth Observation Programme Board.

www.shef.ac.uk/ctcd

Land Cover Dynamics

John Townshend

Recent progress in monitoring land cover and fire

INTRODUCTION

Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a GTOS panel aimed at providing a coordinated international effort to supply space-based and *in situ* forest and land cover observation. Its aim is to obtain an accurate, reliable and quantitative understanding of global change processes.

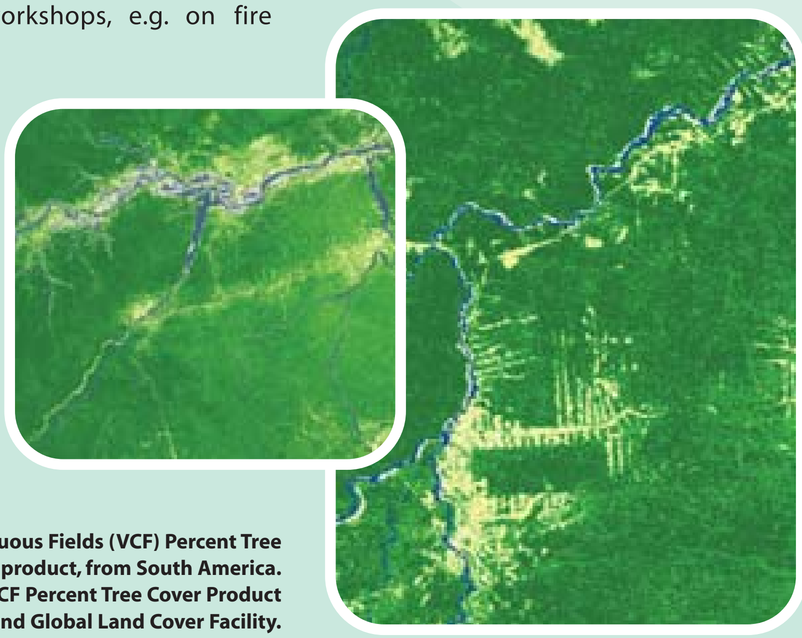
PROGRESS IN THE BIENNIUM

GOFC-GOLD activities have been carried out primarily through the teams for Land Cover and for Fire Implementation. Activities included:

- Development of a global synthesis of areas of rapid land cover change, in support of the Millennium Ecosystem Assessment.
- Collaboration with the Committee on Earth Observation Satellites Working Group on Calibration and Validation (CEOS Cal/Val Working Group) and other entities producing global land cover products, in developing definitions and methods for implementing uniform validation procedures.
- Partnership with FAO to develop assessment of forest cover and change, based on combined use of remote sensing and *in situ* observations, to support the Forest Resource Assessment, using a global sampling design and global Landsat archive.
- Development of a joint North American and European assessment of the status of tropical forests, using earth observation data.
- Contribution to the completed SIBERIA 2 project and the new Boreal Forest project – The Boreas-Machine – that focuses on the analysis of carbon fluxes and greenhouse gas accounting in Eurasia.
- Collaboration in the development of the UN Global Land Cover Network, initiated in 2002, concentrating on support to UNEP and FAO in their needs for Land Cover data and information.
- Organization of topical workshops, e.g. on fire emissions.

FIRE NETWORKS

There has been continuing collaboration with the United Nations International Strategy for Disaster Reduction Working Group 4 on Wildland Fire (UN ISDR WG 4) for the development of regional fire networks. The Geostationary Operational Environmental Satellites (GOES)-based Automated



MODIS Vegetation Continuous Fields (VCF) Percent Tree Cover product, from South America.
Source: **Derived from MODIS 500 m VCF Percent Tree Cover Product for 2000–2001, University of Maryland Global Land Cover Facility.**

Biomass Burning Algorithm (ABBA) system is being adapted for use by the European Meteosat Second Generation (MSG) and there is an agreement for a workshop to establish coordinated use of a network of geostationary operational satellites detecting active fires, to be held in Europe in 2004, involving representatives from Europe, Japan and North America. Daily global active-fire products are now being provided in near-real time by the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments through the MODIS Rapid Response System. Data and imagery are being made available over the Web to a number of international GOFC-GOLD partners. Custom regional Web-GIS mapping is being developed for different regions, providing additional information on location and geographical context of fires.

MODIS Vegetation Continuous Fields (VCF) Percent Tree Cover product, from South America.
Source: Derived from MODIS 500 m VCF Percent Tree Cover Product for 2000-2001, University of Maryland Global Land Cover Facility.

TECHNOLOGY IMPROVEMENT

GOFC-GOLD is keen to promote new technology development, and has been involved in the evaluation and application development of the German Bi-spectral Infrared Detection (BIRD) small satellite technology. Partnerships have also been formed for international involvement in the development of the planned operational USA National Polar-orbiting Operational Environmental Satellite System (NPOESS).

WIDE-AREA COLLABORATION

Much of the work of the Implementation Teams is through regional networks, and considerable progress has been made in the establishment of operational regional networks in Fennoscandia, Central Africa, Southern Africa and Southeast Asia. Remote-sensing-derived products delimiting recently burned areas have been created and distributed for preliminary evaluation. These products are Global Burnt Area 2000 (GBA-2000) of the Joint Research Centre (JRC); Global Burn Scars (GLOBSCAR) of the European Space Agency (ESA); and MODIS.

There is an increasing recognition of the need for validation (accuracy assessment) of the products prior to their use. Collaboration has been strengthened with CEOS Cal/Val Working Group, setting up international validation sites, validation protocols and reporting standards.

To assess the accuracy of the burned-area remote-sensing products, validation protocols developed for Southern Africa are being extended to other regions. Collaboration for *in situ* validation with local partners is being organized by the GOFC-GOLD-Fire regional networks, including Angola, Australia, Botswana, Brazil, Malawi, Mozambique, Namibia, Russian Federation, United Republic of Tanzania, Ukraine, Zambia and Zimbabwe.

EXTENDING GLOBAL INTERACTION

GOFC-GOLD is recognized as a major partner and data provider for science initiatives, such as the Northern Eurasian Earth Science Partnership Initiative. Initial discussions were held on networks in India, extra-tropical South America, and Central America. GOFC-GOLD is encouraging the development of new European-led networks in West Africa and the Mediterranean, reflecting the needs of regional participants. There has also recently been progress in identifying potential partners in China.

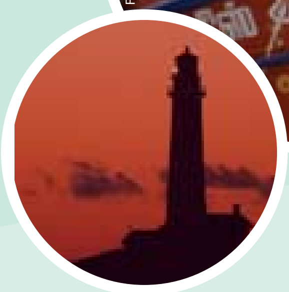
GTOS Coastal Programme

Robert R. Christian

A system to detect, assess and predict global and regional changes associated with land-based and freshwater ecosystems along coasts

GOALS

The primary goal of the GTOS coastal initiative (C-GTOS) is to detect, assess and predict global and large-scale regional changes associated with land-based and freshwater ecosystems along coasts. As coastal areas have intensive human activity and are rich and diverse in natural resources, an understanding of coastal areas is of particular importance in guiding wise national and international policy decisions.



PROGRESS

C-GTOS made considerable progress in this biennium. An expert panel (see Box 1) has identified the framework for organizing observations and issues relevant to coastal ecosystems. An implementation plan is being developed and should be completed in early 2004. Members of the panel have been active in linking to other programmes (e.g. C-GOOS, LOICZ) through a proposed coastal theme within the Integrated Global Observing Strategy (IGOS). Issues that go beyond individual systems and involve use of satellite and remote imaging will be addressed through IGOS.

IMPLEMENTATION

Development of the implementation plan is progressing through a series of expert workshops. The first workshop took place at East Carolina University, Greenville, North Carolina, in October 2002. The second workshop was held at the Joint Research Centre of the Institute for Environment and Sustainability, Ispra, Italy, in March 2003. The third workshop was in La Selva, Costa Rica, in October 2003.

FRAMEWORKS AND PRODUCTS

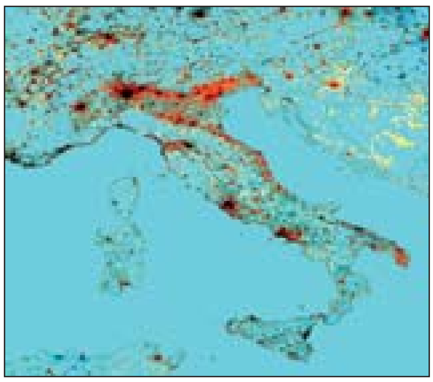
There are several frameworks that provide a suitable structure for meeting the goals of C-GTOS. One is the Driver-Pressure-State-Impact-Response (DPSIR) framework that links ecological and

Figure 1. Changes in night-time lights from 1992–93 to 2000 for Italy

KEY:

Cyan	background – no lights and offshore (land/sea mask applied).
Black	bright lights detected in both time periods (at or near saturation).
Red	Lights much brighter in 2000.
Yellow	New lights in 2000.
Light grey	Dim lighting detected in both time periods – little change in brightness.
Blue	Lights dimmer or missing in 2000 (relative to 1992-93).

Source: **Chris Elvidge of NOAA**



socio-economic conditions and activities. Initially, selected "states" or attributes of coastal ecosystems were identified, including land use and land cover; human populations; quality of water and soil; habitat; sediment delivery; water cycle; and sea level. Monitoring of these states is the initial focus of the observing system. Variables to be monitored or point observations to detect any change in these states were described and linked to prospective sources of information. The Expert Panel then examined networks of programmes known to sample the coastal environment in ways that could support C-GTOS. This information was placed in the context of the TEMS coastal module (see page 6).

OBJECTIVES

The Expert Panel also identified initial short-term objectives and the products needed to establish the monitoring process. An initial narrow range of discrete elements have been selected to structure early activities of C-GTOS, namely:

- Develop an inventory of sites appropriate for observations and analyses of delivery of water, solids and nutrients to coastal waters.
- Construct a functional typology of the coast and evaluate the distribution of functional units. This recognizes that different environmental issues may have unique zones of influence on observed responses.
- Integrate and improve the World Resources Institute Earth Trends coastal habitat maps and link them to land use and land cover.
- Determine and analyse the distribution of coastal population, urbanization and land use, and their effects in the coastal zone.
- Determine and analyse the distribution of conservation and cultural sites in the coastal zone.

These short-term products are designed to provide clear evidence of the value of C-GTOS. Longer-term products will then be developed once a community of observing sites is established and users become more engaged.

All C-GTOS activities are run with the financial support of the National Oceanic and Atmospheric Administration (NOAA), United States of America.

USEFUL LINKS

C-GOOS: GOOS Coastal module,
http://ioc.unesco.org/goos/cozo.htm

IGOS: Integrated Global Observing Strategy,
www.igospartners.org

LOICZ: Land-Ocean Interactions in the Coastal Zone,
www.nioz.nl/loicz

BOX 1. MEMBERS OF THE C-GTOS EXPERT PANEL

- Martin ADRIAANSE
- Dan BAIRD
- Robert E. BOWEN
- Peter BURBRIDGE
- Robert R. CHRISTIAN
- David M. CLARK
- Stephen John DE MORA
- Paul M. DIGIACOMO
- Jorge JIMÉNEZ
- Dale KIEFER
- John KINEMAN
- Michael K. ORBACH
- Géraud SERVIN
- Liana TALAUE-MCMANUS
- Pierluigi VIAROLI
- Helen YAP

Central And Eastern European Regional Project

Reuben Sessa

Regional programmes promote collaboration, exchange of methods, and facilitates the development of regional datasets

OVERVIEW

GTOS regional programmes foster collaboration among scientists, research sites, national and international agencies. This not only allows regional and global data gaps to be identified and filled, but also increases the free exchange of data needed for developing and implementing national, regional and global programmes. The original GTOS Central and Eastern Europe (CEE) programme involved the Czech Republic, Hungary, Poland and the Slovak Republic, but in the last biennium scientists from neighbouring countries (Bulgaria, Romania, Slovenia and Ukraine) have also become involved. One of the main obstacles encountered in the CEE region is that although data are routinely collected, too often the data are not properly processed, stored, indexed nor integrated with other information. This renders data unusable or inaccessible to other potential users. In addition, access to data is also a major problem in the region.

TRAINING IN INFORMATION MANAGEMENT

To overcome the problems of data access, GTOS has continued capacity building activities in the CEE region. A workshop was held in Budapest, 4–6 June 2002, on the use of data management systems for spatial (map), image, tabular (spreadsheet) and unstructured (document) data, as well as the role of metadata. Participants were trained in the use of FAO's data management software (Dynamic Atlas) to a level that would allow them to implement and train others in the use of the software on their return to their institutes. These workshops also provided an opportunity for regional networking and collaboration among scientists.

CARBON DATA ARCHIVING

During 2002–2003, collaborators and consultants were involved in gathering CEE data sets and information relevant to terrestrial carbon observations (see page 8). A workshop in Prague, 17–20 November 2002, brought together 33 experts from the region, who participated in gathering data sets and identifying data gaps that need to be filled to allow accurate estimates of carbon stocks and fluxes to be made for the region. Training was also provided in use of the FAO Dynamic Atlas software, which was used develop a warehouse containing the data and metadata that had been collected. The warehouse has been further supplemented with additional data, e.g. from the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC), and the data is now freely available on request from the GTOS Secretariat.

COMPATIBILITY OF DATA

The recent work in gathering carbon relevant data has shown that there is a large amount of good quality data being gathered. However, this data is often unavailable to general users because of various restrictions, and incompatibility with Western European standards. There is also a lack of coordination, at both the regional and national levels, which makes it difficult to identify available data and data gaps. Data incompatibility due the way data is gathered, processed and archived is a major obstacle in developing regional and global data sets. In the spring of 2004, GTOS will be organizing a workshop to specifically address the issue of standardization of methods used to gather, process and archive carbon-relevant data.

GTOS CEE workshops and meetings were organized with the financial support of the Government of the Czech Republic and with the logistical support of COMENIUS (Pan-European Society for Culture, Education and Scientific and Technical Cooperation).

Gèraud Servin

Capacity building and information management and exchange in southern Africa

FAO/17818/A.Conti

CAPACITY BUILDING

GTOS started its activities in southern Africa in 1999, with a comprehensive survey on Environmental Information Systems, and is considered a new player in the region. In June 2002, GTOS continued to build technical capacities in the region by organizing and supporting a workshop in Pretoria related to natural resources and food security information management and exchange. The workshop was in collaboration with the Agricultural Research Council, Institute for Soil, Climate and Water (ARC-ISCW) of South Africa.

The 25 participants were in positions of senior managerial and decision-making responsibility in government ministries and agencies from Botswana, South Africa, Zambia and Zimbabwe. This workshop confirmed the need for a decision-support tool focusing on publishing and accessing spatial data. The workshop was particularly effective in that it enabled participants from several countries to be trained in the use of the FAO Dynamic Atlas software suite. Dynamic Atlas offers an efficient and simple solution for publishing maps, databases, documents and metadata on the Internet and private Intranets.

Dynamic Atlas Maps interface showing the southern Africa Atlas

SOFTWARE

GTOS provided participants with 30 copies of the Dynamic Atlas software, including a comprehensive data atlas for southern Africa (see figure). The atlas is a good starting point for participants to begin implementing the software and train colleagues in their home organizations. The participants expressed considerable interest in using such tools in their institutes. The workshop also provided an excellent opportunity for exchanging best practices and fostering networking among the participants.

RESOURCE CENTRE

The country representatives were extremely positive about the resource centre concept presented by GTOS. The resource centre would provide spatial data products, management and services through activities that would include:

- strengthening coordination of activities to reduce duplication;
- generating key products and data standards; and
- liberating relevant spatial information that remains unknown and unused.

The implementation of the resource centre now depends on securing sources of external funding, and a project proposal has been submitted to potential donors.

FAO/19296/R.Faidutti

Climate Observations

Alan Belward

Identifying the gaps required to monitor terrestrial processes that affect or are being affected by climate change

ADEQUACY ASSESSEMENTS

Jointly established by the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS), the Terrestrial Observation Panel for Climate (TOPC) is involved in long-term projects monitoring terrestrial processes that affect or are being affected by climate change. During this biennium, the main focus of TOPC was on the second Report on the Adequacy of Global Climate Observing Systems, being prepared for the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The process included assessing current observing capacities relative to the needs of the Convention; identifying gaps in the scientific requirements; and providing preliminary views on progress since the first Adequacy Report.

SCOPE OF MEASUREMENTS

TOPC has identified over 80 terrestrial variables needing to be included in characterizing the climate system and for modelling and analysis of terrestrial ecosystems in support of sustainable development. Descriptions of these can be found on the GCOS and GTOS Web sites.

Global measurement of all variables is currently impossible because of technical, economic and logistical (e.g. physical access) constraints, but progress is being made. In the last few years, substantial progress has been made by the Global Terrestrial Networks for Glaciers (GTN-G) and Permafrost (GTN-P), and a new Global Terrestrial Network for Hydrology (GTN-H) will improve access to hydrological measurements and provide coordination of near-real-time data collection. The Terrestrial Ecosystem Monitoring Sites (TEMS) database is helping coordinate ecosystem observations, and the availability of CO_2 and water flux measurements is improving as the FLUXNET programme expands. In addition to these *in situ* developments, a number of space agencies are now providing relevant observations on an increasingly routine basis.

Of the 80 or more variables currently considered necessary for TOPC, the second Adequacy Report highlighted river discharge, water use, groundwater, lake levels, snow cover, glaciers and ice caps, permafrost and seasonally frozen ground, albedo, land cover, fraction of absorbed photosynthetically active radiation (FAPAR), leaf-area index (LAI), biomass and fire disturbance, for early implementation, because of their significance for UNFCCC. For these parameters, the technology to make adequate measurements is effectively proven, and an infrastructure already exists for making operational measurements. The other 70-plus variables, including soil physical properties and soil moisture, are no less important, and TOPC – working within the GCOS and GTOS frameworks – will strive to improve the adequacy of these observations. In this respect, reference sites measuring such variables (e.g. FLUXNET) need to be sustained and strengthened, with a view to incorporating some of these additional variables into GCOS and GTOS.

FUTURE DIRECTIONS

In spite of the modest advances achieved, it is all too clear that the terrestrial component of the global observing systems remains the least well developed. Yet terrestrial data for climate science, impact and mitigation studies and for sustainable development is significantly increasing. The limited involvement of non-Annex 1 countries in the collection, analysis and dissemination of terrestrial observations is a particular cause for concern, as is the lack of an appropriate intergovernmental organization with a mandate to prepare regulatory and guidance material relating to terrestrial observations. The scientists who have made their expertise available to TOPC will continue to identify ways to redress these shortcomings, and sincere thanks are given for all their efforts.

BOX 1. THE ESSENTIAL ATMOSPHERIC VARIABLES REQUIRED OVER LAND, ICE AND SEA

1. ATMOSPHERIC VARIABLES

Surface

Air temperature
Precipitation
Air pressure
Wind speed and direction
Humidity
Radiation

Upper atmosphere

Upper air temperature
Wind speed and direction
Humidity
Clouds
Earth radiation budget
Solar Irradiance

Atmospheric composition

Carbon dioxide
Methane
Ozone
Other long-lived greenhouse gases
Aerosols

2. OCEAN VARIABLES

Surface

Sea-surface temperature
Sea-surface salinity
Sea-level
Wave characteristics
Sea ice
Circulation
Ocean colour (for biological activity)
Air/sea exchange (fluxes) of water, momentum, heat and gases especially carbon dioxide

Subsurface

Temperature
Salinity
Circulation
Nutrients
Carbon
Ocean tracers
Phytoplankton

3. TERRESTRIAL

Snow-cover
Glaciers and ice caps
Permafrost layer
River discharge
Water use
Groundwater
Lake levels
Albedo
Fraction of absorbed photosynthetically active radiation
Leaf Area Index
Surface Temperature
Fire disturbance
Land cover
Biomass

Observing Terrestrial Biodiversity

Robert Scholes

Currently there is no reliable baseline, at a global scale, for the rate of biodiversity loss

GTOS MANDATE

Biological diversity – the variety of life on Earth – is one of the five focal areas of the GTOS mandate. As GTOS moves from concept to operation, the focal areas are one by one being elaborated into comprehensive programmes. Now that the climate-related observation system has gained momentum, it is time to concentrate on biodiversity.

PURPOSE

At a global scale, the principal potential beneficiaries of such observations are the international treaties that deal with aspects of biodiversity. These include the UN Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, and the recently-signed Convention on Migratory Species. Many other treaties have an indirect interest in biodiversity, including the UN Framework Convention on Climate Change, and the Convention to Combat Desertification. The concept of biodiversity extends beyond "wild" species in natural and semi-natural ecosystems. It also addresses the diversity of domesticated species that are the source of most food and fibre production.

The vast bulk of the diversity in the modern world exists outside of formal protected areas, in the same environments that humans use for agriculture, forestry and settlement. Loss of habitat is one of primary reasons for biodiversity erosion, at rates estimated to be ten times or more faster than the background rate of species turnover. Other contributing factors are overharvesting, persecution, deliberate or accidental poisoning, and – increasingly – climate change.

Recognizing the widespread threats to biological diversity, and its links to human well-being, the UN Millennium Development Goals have a target to reduce the rate of biodiversity loss, by the year 2010. An impediment in reaching this goal is knowing the degree to which it has been achieved. Currently there is no reliable baseline, at a global scale, for rate of biodiversity loss. This is clearly an area where a harmonized, reliable observation system is called for.

IMMENSITY OF THE TASK

One of the main problems in tackling the issue of biodiversity observations is that "biodiversity" is not a single, easily measured thing. First, by definition, it is about many things, and their awesome range of differences. Second, diversity occurs at a range of levels of organization. Obviously one hears about the diversity of species (some 14 million, of which the majority are scientifically undescribed), but equally important are the diversity of ecosystems (assemblages of species, in interaction with their environment), and the genetic diversity that occurs within species. Finally, the diversity at each of these levels can be expressed in terms of composition (what types of things are there), structure (what is their spatial pattern) and function (how do they work) (See Figure 1). Simple measures, such as the rate of species extinction, are easily grasped but hard to prove, and tend to provide information when it is too late to intervene.

ROLE OF GTOS

As in other GTOS focus areas, elements of an observing system exist already at local, national and international scales. Thus most countries have records of biological diversity in herbaria, museums, libraries and various databases, frequently associated with protected areas. At a local scale, worldwide, thousands of voluntary citizen-based organizations make observations of birds, mammals, frogs, insects, fish, reptiles and

plants. Many of the observation sites in the TEMS database routinely include biodiversity observations. GOFC-GOLD activities in mapping land cover is an example of a relevant global activity, along with international databases maintained by the International Union for the Conservation of Nature and other organizations.

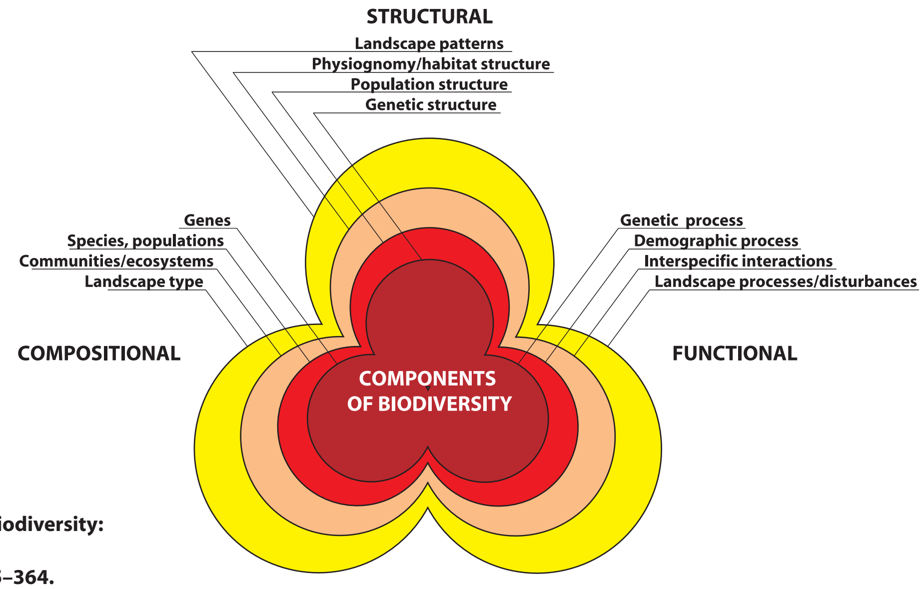
The role of GTOS, in collaboration with many partners, is to help organize these fragments into an efficient and effective integrated system. This will involve promoting harmonization of observations, encouraging the sharing of data, identifying critical gaps, and helping to fill gaps where possible. The key partners in this endeavour are national governments; international research initiatives, such as Diversitas; international biodiversity-related NGOs, such as IUCN and WWF; international treaty organizations; and UN bodies such as FAO and UNEP.

ACTIVITIES

GTOS has been involved in helping to bridge the gap between emerging research and policy needs. On the one hand, GTOS has participated in the redesign of the Diversitas research programme, and, on the other, discussed with treaty bodies and national experts ways to quantify biodiversity and its loss.

The next steps are to establish a GTOS working group to help expand the TEMS biodiversity module into a fully-fledged package of well-considered variables, and then to document and develop, where necessary, agreed protocols for making the observations and sharing the data. A start was made on these activities at the International Symposium on Global Biological Diversity, in Berlin, 1–4 December 2003, where a workshop co-hosted by GTOS and DIVERSITAS was planned to map out the key issues and initiate a process to address them.

Figure 1. The components of biodiversity, at various levels of organization, and in relation to composition, function and structure.



Source: **Adapted from Noss. 1990. Indicators for monitoring biodiversity: A hierarchical approach. *Conservation Biology*, 4: 355–364.**

Monitoring Global Net Primary Production

David P. Turner, Warren B. Cohen, Steve W. Running and Stith T. Gower

The validation of MODIS products using ground site measurements

NET PRIMARY PRODUCTION

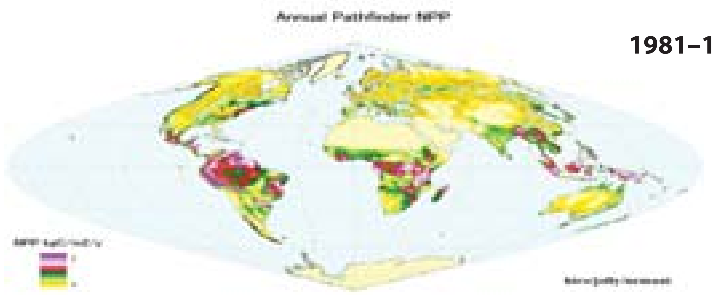
Data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor has been used since 2001 by NASA scientists to produce eight-day estimates of Gross Primary Production (GPP) and annual estimates of Net Primary Production (NPP) for each 1-km² cell of the Earth's terrestrial surface (Figure 1). These data have great potential utility for monitoring the NPP component of the global carbon cycle and for assessing regional responses to climate variation, including effects on agriculture and forestry.

The assessment and validation of these products will require a network of sites focused on validation, and the goal of the GTOS NPP Demonstration Project is to coordinate that validation activity.

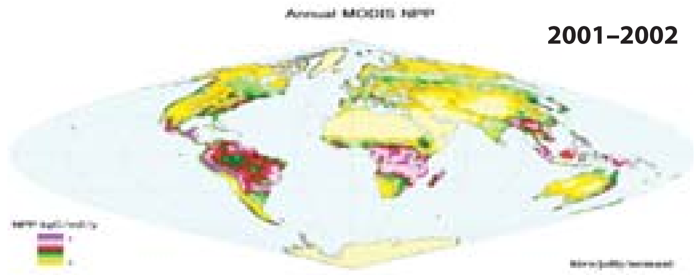
SYSTEMATIC VALIDATION ACTIVITIES

In 2001, the NPP Demonstration Project (in coordination with the BigFoot Project) organized a two-day international workshop to bring together potential contributors to a multi-site validation of the MODIS products (CFLUX 2001). Protocols for measuring NPP and for scaling NPP from plots to the 25 km² (or greater) areas needed for MODIS product validation were discussed. In 2002, a more general MODIS Land Products meeting was held and some of the first direct comparisons with validation data of MODIS products

Figure 1. Global annual NPP from MODIS for the first two years of MODIS data compared with long-term average NPP from AVHRR Pathfinder data, also using the MODIS NPP algorithm



1981–1999



2001–2002

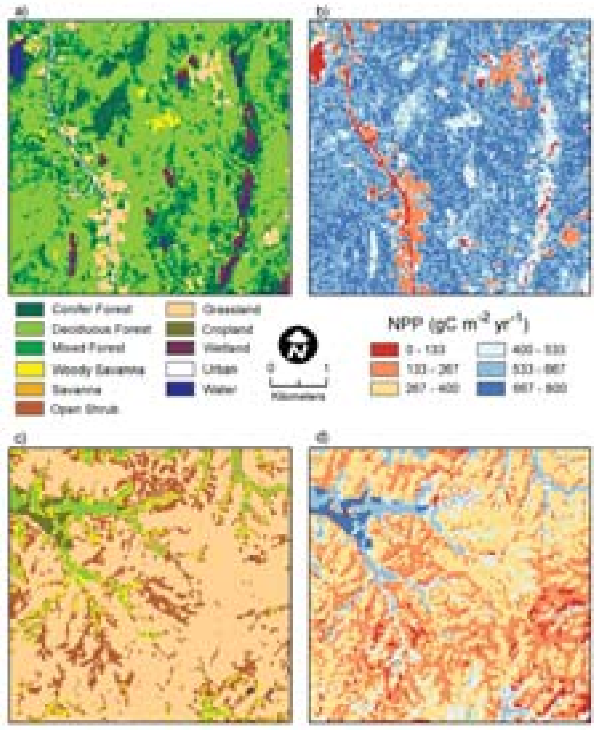
***by*: Nemani, R., Keeling, C., Hashimoto, H., Jolly, W., Piper, S., Tucker, C., Myneni, R., Running, S., 2003**

were presented (e.g. Figure 2). Assessment of the MODIS products included analysis of multiple inputs to the MODIS GPP/NPP algorithm, notably land cover classification, 8-day fPAR (the fraction of photo-synthetically active radiation absorbed by the vegetation), and surface meteorology.

ECOSYSTEM MODEL-DATA INTERCOMPARISON PROJECT

Another active organization that is generating data sets relevant to validating MODIS products is the Ecosystem Model–Data Intercomparison Project (EMDI 2003). NPP estimates are made for areas of 0.5°×0.5°, using a variety of approaches that include mapping of land cover and area weighting of field NPP observations in each mapped class. Results are compared to outputs from globally applied light use efficiency algorithms driven by satellite data, or spatially distributed ecosystem process models driven by interpolated meteorological data. The EMDI Project held a workshop in July 2003 to focus on characterizing the environmental controls of NPP, assessing interannual variation in NPP, and performing model-data intercomparisons.

Figure 2. NPP at the Harvard Forest (HF) and the Konza Tallgrass Prairie (KTP) sites. (a) land cover (HF); (b) NPP (HF); (c) land cover (KTP); (d) NPP (KTP). After aggregation to the 1 km MODIS resolution, the mean and range for Panel b was 592 gC m^{-2} y^{-1} (455-666) while that for the comparable MODIS NPP product was 751 gC m^{-2} y^{-1} (738-789). Mean and range for Panel d was 318 gC m^{-2} y^{-1} (240-450) while that for the comparable MODIS NPP product was 374 gC m^{-2} y^{-1} (347-394).



LOOKING AHEAD

Future plans for the NPP Demonstration Project and the BigFoot Project call for annual workshops to focus on the MODIS products from the previous year. MODIS products will be compared with ground-based observations in each biome, and parameters used in the MODIS GPP/NPP algorithm will be evaluated. These results will be used to update the Internet-based manual with background and protocols for measuring NPP and for scaling it to areas large enough to do validation of MODIS products. The workshop participants will also evaluate the global products for a given year in relation to the year's change in atmospheric CO_2 concentration and to interannual variation in regional and global climate.

RELATED LINKS

Bigfoot:	www.fsl.orst.edu/larse/bigfoot/gtos_home.html
CFLUX 2001:	www.fsl.orst.edu/larse/bigfoot/gtos_home.html
EMDI 2003:	http://gaim.unh.edu/Structure/Intercomparison/EMDI/about_emdi.html
Field Manual 2001:	www-eosdis.ornl.gov/eos_land_val/BigFoot/index_bigfoot.htm

MODIS Validation at Flux Tower Sites

Markus Reichstein and Steffen Gruenler

The use of eddy covariance tower sites data to compare MODIS sensor GPP estimates

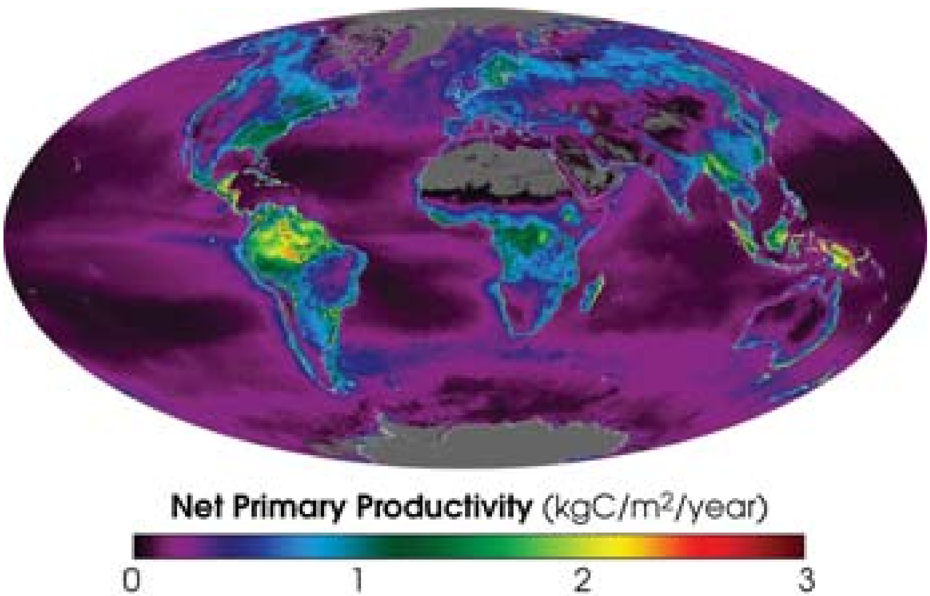
CONCEPT

There are number of FLUXNET sites, where simultaneous observations of canopy structure, leaf-area index (LAI) development, net ecosystem exchange and soil respiration are made. These sites provide an excellent basis for validating the Moderate Resolution Imaging Spectroradiometer (MODIS) remote sensing products that are related to ecosystem structure and carbon and water balance. The MODIS-GPP/NPP algorithm integrates 1°×1°-assimilated meteorological data, the remotely sensed fraction of photosynthetically active radiation (fPAR) absorbed by the vegetation, LAI and landcover information to achieve a global estimate of daily to annual gross and net primary productivity (GPP; NPP) on a 1 km^2 grid. Over homogeneous terrain (1 ha to 1 km^2), the FLUXNET eddy covariance stations sample net ecosystem carbon exchange, which can be split into ecosystem respiration and GPP flux components. Hence, the FLUXNET eddy covariance stations provide an excellent means to evaluate the MODIS-GPP product and other remote-sensing-driven carbon balance estimates.

APPLICATION

In GTOS, there is an ongoing effort to compare GPP estimated using the MODIS sensor with ground-observed data at various European FLUXNET/CARBOEUROPE eddy

Figure 1. Net Primary Productivity



covariance tower sites. The sites selected for comparison range from 38° to 67° N and comprise boreal and temperate conifer forests (spruce, pine), temperate and Mediterranean deciduous forests (beech, oak), Mediterranean evergreen broadleaf forests, and a savannah-type Mediterranean ecosystem.

The analysis is based on the assumption that a sensible evaluation of the MODIS-GPP estimate must account for all error sources that occur during the computation. Thus, in a factorial approach, we analyse (1) the effect of driving the MODIS-GPP model with 1° by 1° assimilated meteorological data versus local meteorological data; (2) the error introduced by remotely sensed estimates of seasonal fPAR/LAI development; and (3) the bias introduced by the MODIS-GPP radiation-use-efficiency model itself.

OUTCOME

Given the independent nature (not fitted against flux data) and the simplicity of the MODIS-GPP model, its overall performance in predicting GPP is remarkable under normal conditions (r^2 between 0.7 and 0.95). The assimilated meteorology does not capture all day-to-day variation, but matches the local tower data well on an eight-day scale. However, at certain sites the meteorological bias influences estimates of GPP significantly. Particularly at high latitudes, the correction of cloud-contaminated fPAR/LAI values enhances GPP estimates considerably. At sites with understorey or a herbaceous spring layer, springtime GPP is often overestimated by the MODIS-GPP model since it cannot account for differences in radiation-use efficiency by canopy and understorey. Furthermore, there is potential for considerable improvements of the GPP algorithm by better accounting for soil drought effects, by reducing the radiation-use efficiency under high-radiation conditions, and by introducing more geo-biological variability. It has been shown that these parts of the MODIS-GPP algorithm can be re-parameterized using CARBOEUROPE eddy covariance data, so the synergistic use of MODIS and CARBOEUROPE data will improve the ability of a global terrestrial observation system.

www.fao.org/gtos/npp.html
www.bgc.mpg.de/public/carboeur/web_TCOS

Global Land Cover Network (GLCN)

John Latham

GLCN will develop harmonized global land cover data required by national and international initiatives

USER NEEDS

Land cover assessment and monitoring of its dynamics are essential requirements for the sustainable management of natural resources and for environmental protection. They provide the foundation for environmental, food security and humanitarian programmes that are crucial in fulfilling the mandates of many UN, international and national institutions. Current monitoring programmes, however, have no access to reliable or comparable baseline land cover data. Therefore, the implementation of a global programme using a fully harmonized approach is essential to increase the reliability of land cover information for a large user community.

Responding to this need, FAO and UNEP have jointly developed a Global Land Cover Network (GLCN), that has the immediate objectives to:

- initiate harmonization of land cover definitions, classification systems, mapping and monitoring specifications;
- develop standardized land cover classification methodology for global land cover baseline datasets and initiate development of a GLCN database;
- establish a global land cover meta-database;
- organize training courses and appraisal workshops on land cover classification, mapping and monitoring methodologies, and applications of land cover data;
- provide advisory services to developing countries on land cover classification, mapping and monitoring; and
- function as an international, politically neutral clearinghouse for land cover information at global and regional levels.

FAO/13729/J.Isaac

AFRICOVER PROJECT

GLCN is based on the successful Africover project, which was established to develop a digital georeferenced database on land cover and a geographic referential for the whole of Africa including: geodetical homogeneous referential, toponomy, roads and hydrography. The project was established in response to a number of national requests for assistance for data required for early warning; food security; agriculture; disaster prevention and management; and many other environmental management activities.

Africover has developed a number of products, including a Multipurpose Africover Database for the Environmental Resources (MADE), produced at a scale of 1:200,000 (and at 1:100,000 for small countries and specific areas). A priority has also been to reinforce national and subregional capacities for the establishment, update and use of land cover maps and spatial data bases to ensure an operational approach and the sustainability of the initiative.

TOOLS

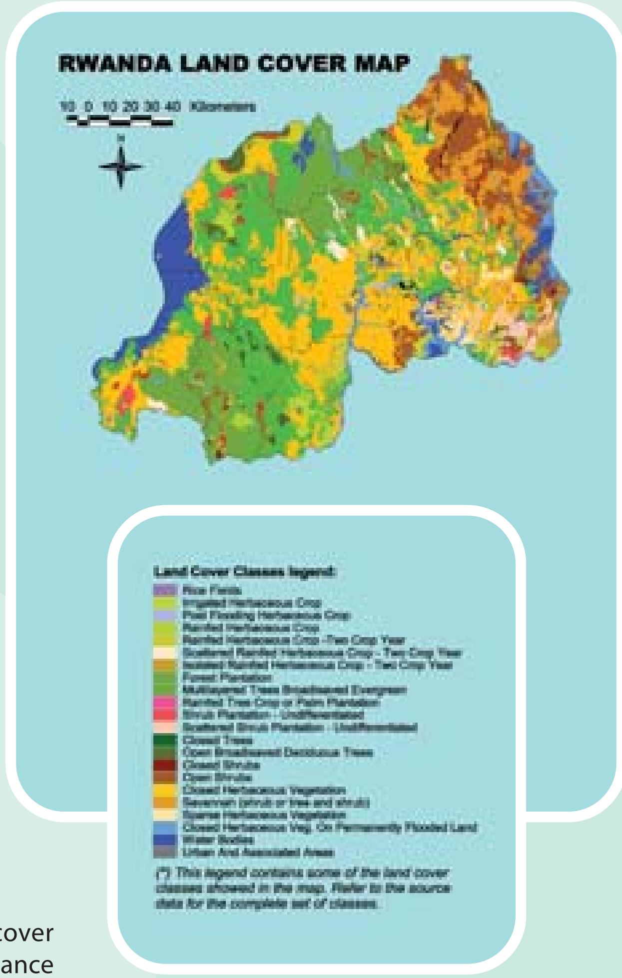
During the Africover project numerous tools and software have been developed which will be used in the GLCN project these include:

The FAO/UNEP Land Cover Classification System (LCCS), which is the only universally applicable classification system in operational use at present. It enables a comparison of land cover classes regardless of data source, economic sector or country.

AIMS is an integrated image processing-interpretation-mapping tool that combines in a synergic way the advantages of digital automatic classification and traditional visual interpretation. AIMS handles all steps from image enhancement, image interpretation to final map output. It enables an interactive use of ancillary data by combining different types of data in geographically linked windows.

GeoVIS is the latest software created, and is a vector-based editing system specifically designed for thematic interpretation. Hence, it facilitates and speeds up all mapping activities based on remote sensing data. It is a user-friendly system that embeds the main tools of vector drawing and editing, including topological functions, with advanced capabilities of raster management and a direct link with LCCS.

The ADG (Africover Database Gateway) and AID (Africover Interactive Database) database development and maintenance software allow the updating of the Africover product by end-users.



ASIACOVER

The renewable natural resources of many Asian countries have come under severe strain over the past two or three decades. Whilst a large amount of data related to land cover exists in Asia, most are not consistent over large geographic areas and therefore cannot be aggregated at regional and/or sub-regional scale, limiting their use.

Hence, the new ASIACOVER Project, which is based on the Africover project and will be part of GLCN, will develop a regional, standardized land cover map and database, integrated with socio-economic information and decision-aid systems for the development of an integrated approach for environmental monitoring, food security and sustainable development.

GTOS INVOLVEMENT

The new GTOS Programme Director, Mr John Latham, is the main coordinator of the GLCN and Africover projects. GTOS will become more involved in these activities, especially as they are so relevant to its objectives.

www.africover.org
www.asiacover.org
www.fao.org/waicent/faoinfo/sustdev/2002/EN0802_en.htm

Understanding Climate Change In Mountains

Mel Reasoner, Ray Bradley and Bruno Messerli

Mountain regions provide critical goods and services, not only to mountain inhabitants but also to lowland communities

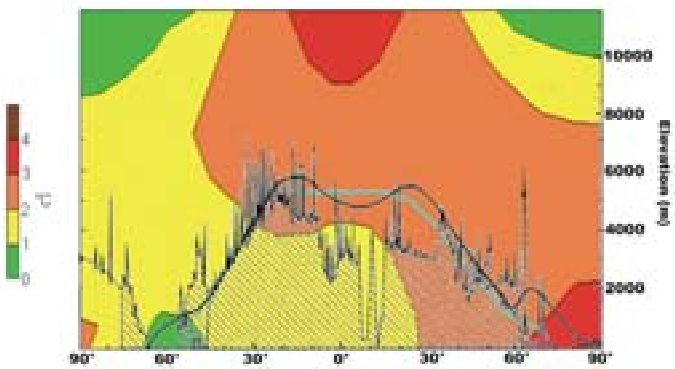
OVERVIEW

The functioning of fragile mountain systems is threatened today by an array of anthropogenic changes, including land use and land cover changes, acidic deposition, increasing atmospheric CO_2 concentrations and climatic change. The combination of high rates of environmental change and increasing economic pressure is significantly affecting the ability of many of the world's mountain regions to provide critical goods and services, not only for mountain inhabitants but also for lowland communities. Considering the disproportionately large number of goods and services that derive from mountain regions, it is critical to understand how the flow of these may be affected by the environmental changes predicted for the twenty-first century.

CLIMATE CHANGE

In its third assessment, the Intergovernmental Panel on Climate Change (IPCC) produced a series of future climate scenarios, based on a number of General Circulation Models. A common feature of these models is that the anticipated warming of the next several decades is expected to be more pronounced in northern high latitudes. A less obvious feature of these IPCC scenarios is that the pattern of warming in the atmosphere is also expected to be more pronounced at progressively higher elevation in the troposphere, along a latitudinal gradient from the Arctic to approximately 30° south of the equator. This has profound impli-

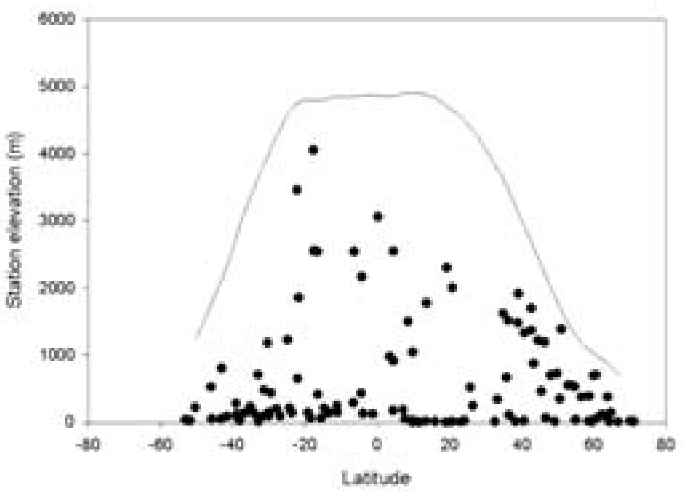
Figure 1. Topographic transect through the western Cordillera of the Americas, superimposed on General Circulation Model-based estimates of zonally averaged mean annual temperature changes expected with two CO_2 levels



Key: *Green line shows freezing level. Note that the largest expected changes are at high latitudes near the surface, and in mid- to low latitudes at higher elevations.*

Source: Cubasch, U., Meehl, G.A., Boer, G.J., Stouffer, R.J., Dix, M., Noda, A., Senior, C.A., Raper, S. & Yap, K.S. 2001. Projections of future climate change. *In:* J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell and C.A. Johnson (eds). *Climate Change 2001:* The Scientific Basis. Contribution of Working Group I to the Third Final Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York NY, USA: Cambridge University Press. 881p.

Figure 2. The current Global Climate Observing System (GCOS) surface network plotted by elevation and latitude along a transect of the North and South American Cordillera. The freezing level is the same as in the previous figure for reference. Note the large observational "data gap" in the mountain zone from ca 40°N to 30°S.



cations for mountain regions because many mountainous areas are situated in the high-altitude zone of anticipated enhanced warming (Figure 1). A number of independent lines of evidence have indicated that the Arctic is already warming at a higher rate than other parts of the globe. The rapidly thinning Artic ice pack and increasing thaw penetration into permafrost are two prominent examples of climate change impacts in the western Arctic, which is warming at a rate three to five times faster than the rest of the world.

MONITORING NEEDS

The rapidly receding alpine glaciers in tropical mountains, such as Kilimanjaro (Kenya), Quelccaya (Andes) and Dasuopu glacier (Himalayas), suggest that enhanced warming may also be occurring at high-elevation sites in lower latitudes, which would be consistent with IPCC model predictions. However, very few high-elevation meteorological stations sites are situated at altitudes that would be appropriate for monitoring this issue. For example, a transect along the crest of the North and South American Cordillera (Figure 2) shows a large observational data gap in mountainous regions between approximately 40°N and 30°S. Although this gap is filled, at least in part, with climatic information obtained from radiosonde measurements, significant discrepancies between radiosonde data and mountain surface data have been observed. Greater warming (and greater increases in freezing-level height) have been recorded at tropical mountain locations than at similar altitudes from radiosonde information above low-elevation stations. It is therefore clear that direct measurements at high-elevation sites are required to assess climatic impacts in mountain environments, and to untangle the climatic and direct anthropogenic drivers.

ESSENTIAL FUTURE STEPS

A complex mix of physical and socio-economic factors currently affects fragile mountain environments and these impacts are in turn likely to have substantial direct and indirect consequences for large segments of humanity. It is therefore imperative that the impacts of climate change in the world's mountain regions are well understood. This understanding will remain elusive unless the rather sparse current network of high-elevation monitoring sites is supplemented by additional long-term monitoring sites in the world's mountain regions.

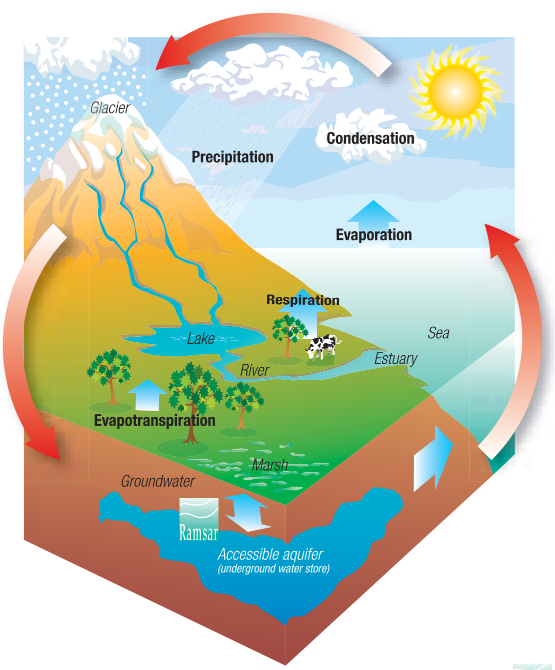
A Global Hydrological Network: From Concept to Implementation

Improved quality and consistency of data is required to develop more accurate global and regional hydrological forecasting and management

BACKGROUND

Global observing systems continue to attract interest, not only among scientists around the world but increasingly also from national governments, and organizations and agencies that require global and regional hydrological information to enhance the quality and timeliness of early warning and climate forecasting products. Increasing the quality and consistency of data, as well as improving understanding of global water processes, is essential in developing more accurate global and regional water balance models that can be downscaled to a basin level, with an increasing temporal resolution. This information is vital to manage variability and change in hydrological regimes, to assess the changing availability of water resources, and to improve forecasting accuracy of hydrological extremes.

Figure 1. Water cycle



Provided by Ramsar Convention on Wetlands

NETWORK SUPPORT

Three major networks and global databases have been established that contribute to understanding hydrology and hydrological processes: The Global Runoff Data Centre (GRDC); the Global Precipitation Climatology Centre (GPCC); and the Global Environment Monitoring Centre on Water Quality (GEMS). Efforts are under way to increase the availability of and access to near-real-time hydrological information to provide timely data and information products for use in modelling, forecasting, research and applications, such as disaster reduction.

Access to global hydrological data and information is a prerequisite in addressing these issues. To facilitate data access, a Global Terrestrial Network for Hydrology (GTN-H) has been developed jointly by the Hydrology and Water Resources (HWR) Department of the World Meteorological Organization (WMO), the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). GTN-H is a global hydrological "network of networks" for climate, that builds on existing networks and data centres and produces value-added products through enhanced communications and shared development.

CURRENT ACTIVITIES

During 2002–2003, GTN-H entered its implementation stage. The first meeting of the Coordination Panel for GTN-H was held from 21 to 22 November 2002 in Toronto, Canada, following an expert meeting on Hydrological Data for Global Studies.

Key issues GTN-H should address in improving current systems include:

- adequacy of networks;
- access to data and information;
- harmonization, including policies, quality control, data formats, coding and transmission;
- data integration, including both multiple platform observations and cross-network data; and
- generation of research- and applications-oriented products.

The meeting noted that most of the information generated from global observation networks is used by developed countries, and is barely used by research and user communities in the developing world. Sharing information across regions is valuable, especially for smaller countries, to complement their spatially or technologically restricted national observation networks. This is in particular important for forecasting purposes using hydrometeorological variables and hydrological data and information from shared river basins.

The Coordination Panel agreed that GTN-H must foster the sharing of information across regions. GTN-H will begin this process by inviting regional representatives, on an ad hoc basis, to solicit input and to also promote awareness of GTN-H as it develops.

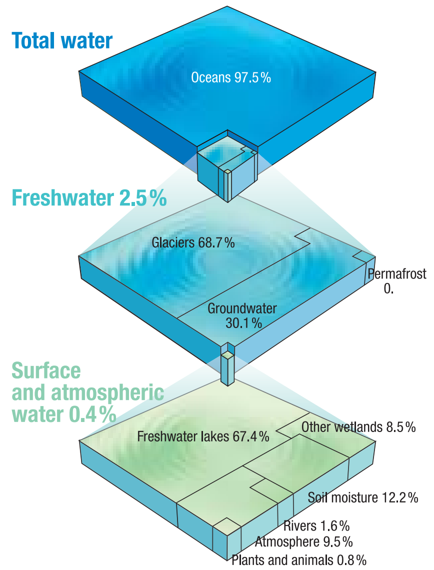
The core function of GTN-H is to act as a portal, thereby improving access to data and information in the context of a global hydrological observing system, and demonstrating the use of standardized metadata formats with selected GTN-H data types to enable users to discover and access data and related information. The data and information will be supplemented by the generation of global-scale data products covering various fields, including products that:

- improve the awareness of what data is available and how it can be accessed (e.g. metadata and maps);
- enhance baseline or core hydrological data and improve our knowledge of hydrology (e.g. gridded runoff datasets, mapped statistics);
- result from the integration of existing data sets (e.g. biogeochemical fluxes); and
- are designed to address specific scientific questions (e.g. reference hydrological data sets for use in detecting climate change).

FUTURE TASKS

Project briefs and an action plan have been developed as a step toward enabling GTN-H to meet expectations in achieving its objectives. This, however, will only be feasible through the active support of member countries and their national meteorological and hydrological services. GTN-H is currently maintained on a voluntary basis by a number of dedicated individuals, but additional resources will be required to further implement this important initiative.

Figure 2. Water availability



Provided by Ramsar Convention on Wetlands

Meetings and Publications

For further information on upcoming meetings, workshops and conferences please consult the GTOS website *www.fao.org/gtos/Resmeeting.html* and the GOFC-GOLD website *www.fao.org/gtos/gofc-gold/events.html*.

SELECTION OF MEETINGS IN 2004

Spring	GLCN Training Workshop	Latin America
Spring	TCO data access workshop	Prague, Czech Republic
April	GTOS Coastal Implementation Plan Workshop	Washington DC, USA
March	GOFC-GOLD Global Geostationary Fire Monitoring Applications Workshop	Darmstadt, Germany
26–28 May	IGOS 11th Partners meeting	Rome, Italy
TBA	GOFC-GOLD Land Cover Workshop on linking *in situ* and remote sensing	St. Petersburg, Russia
TBA	GOFC-GOLD Executive Committee meeting	Edmonton, Canada

2003 MEETINGS

16–18 Dec.	TOPC panel meeting	Rome, Italy
13 Dec.	TCO Panel meeting	San Francisco, USA
2–4 Dec.	GTOS Biodiversity workshop	Berlin, Germany
1–6 Dec.	Asia Cover/GLCN training workshop	Bangkok, Thailand
10–14 Nov.	Africa Sahel GLCN training workshop	Dakar, Senegal
19–22 Oct.	GTOS Coastal Implementation Plan Workshop	La Selva, Costa Rica
7–9 Oct.	GOSIC review	Lewes, USA
7 Oct.	GOFC-GOLD Fire Implementation Team Meeting	Sydney, Australia
9–13 Sep.	GOFC-GOLD Forest Fire Management workshop	Khabarovsk, Russia
17– 23 Aug.	4th Meeting of Southern Africa Fire Network (SAFNET)	Kruger National Park, South Africa
3–6 June	TCO/GCP Improved quantification of global carbon cycle fluxes	Sheffield, UK
16–18 March	GOFC-GOLD Executive Committee Meeting	Ispra, Italy
24–27 March	COOP V	Mazatlan, Mexico
16–18 March	GOFC-GOLD Executive Committee Meeting	Ispra, Italy
3–6 March	Meeting of the GTOS Coastal panel	Ispra, Italy
21–22 Feb.	ICSU Assessment meeting	Paris, France
15–16 Jan.	IGOS Coastal Theme Development Workshop	Washington, DC, USA

2002 MEETINGS

26–31 Oct.	CEE TCO data warehouse building workshop	Prague, Czech Republic
16–18 Oct.	GTOS coastal workshop	Greenville, North Carolina, USA
24–27 Sep.	Fourth session of COOP	Cape Town, South Africa
25–31 Aug.	3rd European Conference on Restoration Ecology	Budapest, Hungary

29 July –1 Aug.	Third meeting of the GOFC-GOLD Southern Africa Fire Network (SAFNET)	Gaborone , Botswana
7–10 July	2nd LBA Science Conference	Manaus, Brazil
25–27 June	TOPC meeting	Ispra, Italy
4–6 June	Southern Africa data/metadata policy workshop	Pretoria, South Africa
4–6 June	CEE Knowledgeware Training Workshop	Budapest, Hungary
30–31 May	7th G3OS sponsors meeting and IGOS-P meeting	Paris, France
6–7 May	FAO/UNEP Global land cover changes	Florence, Italy
1–3 May	GOOS steering committee meeting,	Paris, France
15–19 April	GCOS steering committee	Farnham, UK
11–13 Feb.	GOFC Land Cover Implementation Team Meeting	Toulouse, France
23–25 Jan.	Forest-related definitions	Rome, Italy
22–23 Jan.	TOPC meeting	Rome, Italy

PUBLICATIONS

GTOS 34	GTOS Biennial report 2002–2003
GTOS 33	GTN-H Coordination Panel Meeting report. Toronto, Canada. 21–22 November 2002, GCOS 85, GTOS 33.
GTOS 32	HWRP/GCOS/GTOS Expert Meeting on Hydrological Data for Global Studies report, Toronto, Canada. 18–20 November 2002, GCOS 84, GTOS 32.
GTOS 31	TCO: The Frascati report on *in situ* carbon data and information. November 2002.
GTOS 30	GTOS Biennial report 2000–2001
GTOS 29	GCOS/GTOS/HWRP Expert Meeting on the Implementation of a Global Terrestrial Network - Hydrology (GTN-H), GTOS 29, GCOS 71 Koblenz, Germany. June 2001.
GTOS-28	Global Change and Mountain Regions, The Mountain Research Initiative IGBP 49, GTOS 28, IHDP. 13. January 2001
GTOS-27	Terrestrial Data Management and Accessibility Workshop in Central and Eastern Europe, Vàcràtòt, Hungary. 30 October–4 November 2000
GTOS-26	GCOS/GTOS/HWRP Establishment of a Global Hydrological Observation Network for Climate, Geisenheim, Germany. 26–30 June 2000
GTOS-25	IGOS-P Carbon Cycle Observation Theme: Terrestrial and Atmospheric Components. October 2000 (revised February 2001)
GTOS-24	GTOS Biennial report. 1998–1999
GTOS-23	Terrestrial Carbon Observation, Synthesis Workshop Ottawa, Canada. 8–11 February 2000
GTOS-22	GTOS/GCOS Terrestrial Observation Panel for Climate, fifth session. Birmingham, UK. 27–30 July 1999
GTOS-21	GTOS Regional Implementation Plan for Southern Africa. February 2001

GTOS-20	Regional Implementation Plan for Central and Eastern Europe (CEE). February 2000
GTOS-19	GTOS Steering Committee, second session. Santander, Spain, 15–19 June 1998
GTOS-18	GTOS Data and Information Management Plan. October 1998
GTOS-17	GTOS Implementation Plan. December 1998
GTOS-16	Report of the G3OS, Joint Data and Information Management Panel, fourth session. Honolulu, USA, 28 May–1 April 1998
GTOS-15	GTOS/GCOS Terrestrial Observation Panel for Climate, fourth session. Corvallis, USA, 26–29 May 1998
GTOS-14	GTOS Annual Report -1997. December 1997
GTOS-13	GHOST - Global Hierarchical Observing Strategy. June 1997
GTOS-12	GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 2.0. June 1997
GTOS-11	GCOS/GOOS/GTOS Joint Data and Information Management Panel (JDIMP), third session, Tokyo, Japan. 15–18 July 1997
GTOS-10	Meeting of Experts on Ecological Networks. Guernica, Spain, 17–20 June 1997
GTOS-9	Global Observing Systems Space Panel (GOSSP), third session. Paris, France, 27–30 May 1997
GTOS-8	GTOS Coordination and Implementation meeting. Rome, Italy, 12–15 May 1997
GTOS-7	GTOS and the Conventions. October 1996 (Updated April 1997)
GTOS-6	First meeting of the GTOS Steering Committee, final session Rome, Italy. 2–5 December 1996
GTOS-5	Global Observing Systems Space Panel, second session Geneva, Switzerland. 16–18 October 1996
GTOS-4	In Situ Observations for the Global Observing Systems Geneva, Switzerland. 10–13 September 1996
GTOS-3	Planning Group Report -"GTOS: Turning a sound concept into a practical reality". June 1996
GTOS-2	Expert Meeting on Hydrological Data for Global Observing Systems Geneva, Switzerland. 29 April–1 May 1996
GTOS-1	GCOS/GTOS Terrestrial Observation Panel for Climate, third session Cape Town, South Africa. 19–22 March 1996

All publications are available on request from the GTOS Secretariat or can be downloaded from the GTOS web site: *www.fao.org/gtos/pubs.html.*

STEERING COMMITTEE

Chair
Robert Scholes

Agency Representatives
Salvatore Arico
Division of Ecological Sciences
United Nations Educational, Scientific and Cultural Organization (UNESCO)

Kenneth Davidson
Director, World Climate Programme
World Meteorological Organization (WMO)

Norberto Fernandez
Chief, Early Warning and Observing System Branch
United Nations Environment Programme (UNEP)

Thomas Rosswall
Executive Director
International Council for Science (ICSU)

Jeff Tshirley
Chief, Environment and Natural Resources Service
Food and Agriculture Organization of the United Nations (FAO)

Panel Chairs
John Townshend
Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD)
Department of Geography, University of Maryland

Shaun Quegan
Terrestrial Carbon Observation (TCO)
Centre for Terrestrial Carbon Dynamics, University of Sheffield

Alan Belward
Terrestrial Observation Panel for Climate (TOPC)
Global Vegetation Monitoring Unit, European Commission Joint Research Centre (JRC)

Secretariat
John Latham, Programme Director
Paul Reichert, Remote Sensing Officer
Géraud Servin, Environment Officer
Reuben Sessa, Programme Officer
Stephanie Vertecchi, Secretary

Volunteers
Alexandra Fleming
Steffen Gruenler
Aurélien Letourneau

Special thanks to:
Rebeca Andarias de Prado, Mari Bullock, Josef Cihlar, Rhonda Davis, Helen De Beer, Adhemar Fontes, Thomas Hofer, Karl Morteo, Markus Reichstein, Anne Ricchiuti, Carol Saynor, Chris Schmullius, Anatoly Shvidenko, Rebeka Szabó, Lesley Tench-Mattioni, Katalin Torok, and many others who have assisted in the GTOS programme.

THE GLOBAL TERRESTRIAL OBSERVING SYSTEM

The Global Terrestrial Observing System (GTOS) was established in January 1996 by its five co-sponsoring organizations. It was created in response to international calls for a deeper understanding of global change in the Earth System.

The central mission of GTOS is to provide policy-makers, resource managers and researchers with access to the data they need to detect, quantify, locate, understand and warn of changes (especially reductions) in the capacity of terrestrial ecosystems to support sustainable development. Since its establishment GTOS has been working to improve the quality, the coverage and accessibility of terrestrial ecosystem data.

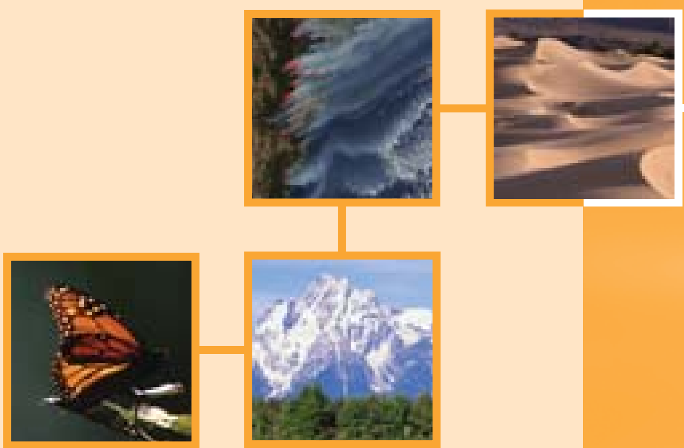
GTOS is developing activities that focus on five issues of global concern:

1. **changes in land quality**
2. **availability of freshwater resources**
3. **loss of biodiversity**
4. **climate change**
5. **pollution and toxicity**

GTOS promotes: integration of biophysical and socio-economic georeferenced data; interaction between monitoring networks, research programmes and policy-makers; data exchange and application; quality assurance and harmonization of measurement methods; and collaboration to develop regional and global datasets.

GTOS Sponsors

FAO :: Food and Agriculture Organization of the United Nations :: *www.fao.org*
ICSU :: International Council of Scientific Unions :: *www.icsu.org*
UNEP :: United Nations Environment Programme :: *www.unep.org*
UNESCO :: United Nations Educational, Scientific and Cultural Organization :: *www.unesco.org*
WMO :: World Meteorological Organization :: *www.wmo.it*



GTOS Secretariat
c/o Environment and Natural Resources Service
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00100, Rome, Italy

E-mail: GTOS@fao.org
Tel: (+39) 06 57052565
Fax: (+39) 06 5703369

www.fao.org/gtos

TC/D/Y5187E/1/01.04/1600