GLOBAL OBSERVATION OF FOREST COVER: A CEOS INITIATIVE*

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ABSTRACT

The Committee on Earth Observation Satellites (CEOS) was established to provide a forum for communication, cooperation, and coordination of the earth-observation programs of member states, and for communication among organizations whose primary interest is the use of earth-observation data.

CEOS members have agreed to establish a small number of pilot projects to address issues of great concern to the majority of CEOS members and user organizations. Recognizing that the forests of the Earth play a vital role in several major themes of global interest, including biodiversity, sustainable development of natural resources, and the build-up of greenhouse gases, Global Observations of Forest Cover (GOFC) was identified for development as a pilot project. The first phase of detailed planning of GOFC took place during a workshop in Ottawa, Canada from July 7 to 10, 1997.

GOFC will continue and build on the experience gained by many existing programs. A strategy will be planned to acquire and combine data from high and low resolution optical satellites, and C-band and L-band radar satellites, to enable global coverage to be achieved in a timely fashion, even in areas with persistent cloud cover. A suite of products to be produced by GOFC has been identified, including: 1) Coarse and fine geocoded optical data; 2) SAR data (C and L band); 3) Coarse land cover; 4) Fine land cover; 5) Fire scars; 6) Forest harvest; 7) Forest functioning; 8) Land cover change in areas of rapid change.

To accomplish such an ambitious objective will require a highly coordinated effort by numerous agencies participating on a voluntary basis. In this paper we discuss the current status of GOFC, plans for the future, and indicate how interested parties may become involved.

1.0 INTRODUCTION AND BACKGROUND

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A number of technological developments have converged with worldwide concern about the future of the earth's forests and climate to stimulate international cooperation in a new project called Global Observations of Forest Cover (GOFC).

1.1 ENVIRONMENTAL CONCERNS

The management of the forests of the earth has become an issue of global concern. In addition to traditional anxiety over adequate supplies of wood for fuel, construction, and papermaking, more recent indirect but related concerns centre on issues of soil erosion, watershed protection, biodiversity, recreation and tourism, equitable treatment of indigenous populations, and the buildup of greenhouse gases in the Earth's atmosphere.

These are immense problems, global in scope. The nations of the earth, through the United Nations and other bodies, have laid the groundwork to deal with them. Several initiatives have resulted in numerous institutional developments and scientific studies attempting to better understand and deal with global processes, particularly those driven by increasing population and development pressures.

1.2 TECHNOLOGY DEVELOPMENTS

Since 1972, the earth has been under observation from space with satellites designed to provide more detailed information about earth resources, including forests. The data from these satellites has been widely used to map and monitor forest resources. However, these mapping and monitoring projects have generally been made within individual juristictions, such as states, provinces, or forest management units. Until recently, there has been little effort to use earth observation data, particularly data from the higher resolution natural resource satellites, to create a consistent global picture of the earth's forests, or to monitor changes in the forests worldwide. In response to concerns about the global impact of human activities on the earth's forests, researchers have begun to assemble national, continental, and global data sets from earth-observation satellites in an attempt to provide badly-needed information about the state of the earth's forests, and how they are changing.

A number of scientific collaborations have been created to combine such massive amounts of data with other information about forests and the human and natural processes which affect them, to provide a better understanding of forest changes in the context of the current economic and social situation. As part of its mandate to provide reliable information about the state of the earth's forests, the United Nations Food and Agriculture Organization has also used data from earth observation satellites as part of its Forest Resource Assessments (FAO 1995, 1996).

Examples of these programs have provided essential experience and positive results, including the World Forest Watch (INPE, Brazil), Landsat Pathfinder (NASA, U.S.), TREES (Joint Research Centre, Europe), IGBP 1 km Land cover (NASA, NOAA, USGS), Forest Resource Assessment (FAO, UN), North American Landscape Characterization (U.S. Environmental Protection Agency), and Global Rainforest Mapping (NASDA, Japan and JPL, U.S.).

These efforts have demonstrated that it is technically possible to bring together data from earth-observation satellites of several countries, and to analyze the data to provide better information than previously available about the extent of the earth's forests, how forest ecosystems are functioning, and how they are changing as a result of human activities and climate change

1.3 NON-TECHNICAL BARRIERS

Despite these advances, it is generally recognized that earth-observation technology has not lived up to its full potential in providing information needed to address global concerns about forests and forest management. Non-technical barriers include data cost, data access policy, issues of national sovereignty in the context of global problems, issues of legislation and jurisdiction, and problems of communication between providers and users of technology and data. However, progress is being made in dealing with these barriers. Several Agenda 21 initiatives, including the Biodiversity Convention, the Kyoto Protocol to the United Nations Framework Convention on Climate Change, the Montreal, Helsinki, and Tarapoto Processes leading to Criteria and Indicators of Sustainable Forest Management all represent concrete steps forward by sovereign nations dealing with global problems. All of these initiatives require information about forests to assess progress, although some have progressed further in identifying specific information requirements.

1.4 CEOS RESPONSE

The Committee on Earth Observation Satellites (CEOS) is an organization composed of space agencies, affiliates, and observers linked by a common interest in the provision and use of earth observation data from space. Recognizing the accomplishments to date, but also the shortcomings, CEOS members have developed an Integrated Global Observing Strategy (IGOS) to coordinate earth observation programs in six critical areas, including Global Observations of Forest Cover (Shaffer, 1996 and 1997, Ahern, 1998). The objectives are to increase international cooperation in the integration and use of data from several earth observation satellites for mapping and monitoring the earth's forests, to identify non-technical barriers, to improve the integration of earth-observation and *in-situ* data, and to provide feedback to the space agencies to enable them to better coordinate future space missions. A team of experts met in Ottawa, Canada, in July, 1997 to draft a plan for a co-ordinated program of Global Observations of Forest Cover (Janetos and Ahern, 1997).

Rather than creating a new institution, GOFC seeks to produce a networked international consortium of existing programs. The objectives of the GOFC consortium are

- to produce high quality, multi-resolution, multi-temporal global data sets and derived products of forest cover and attributes;
- with particular attention to areas of rapid change and fragmentation;
- to be repeated for quantitative analysis of subdecadal variation;
- with associated regional applications and methodological investigations;
- for the benefit of multiple user communities;
- with ultimate transition to routine operational use.

Four classes of user groups, each with distinct information requirements, were identified:

- International organizations
- National and regional forest agencies
- Science community (as represented by IGBP, for example)
- International treaties and conventions (e.g. Biodiversity convention, Intergovernmental Panel on Climate Change, Criteria and Indicators of Sustainable Forest Management)

A suite of potential products has been defined (which is expected to meet the information needs of many users from the above categories) including:

- coarse and fine resolution optical data;
- SAR data (L and C band);
- coarse and fine scale land cover maps, to repeated on a 3 to 10 year cycle (depending on budgets and capabilities);
- forest disturbance maps (fire on a one year cycle and harvest on a 3 to 10 year cycle)
- forest functioning variables (LAI, FPAR, PAR) at coarse spatial resolution but fine time resolution;
- land cover change, concentrating on areas of rapid change on a 1 to 5 year cycle.

It is proposed for GOFC to make maximum use of existing capabilities within CEOS partners and affiliates, recognizing that considerable effort will be required to coordinate activities and expand technical and institutional capabilities.

Three phases of GOFC are proposed: (1) a Design Phase, in which technical details of product definition, acquisition, processing, access, distribution, analysis and institutional cooperation are worked out, and in which further consultation with user and operational communities are pursued; (2) a Prototype Phase, in which implementation begins, regional experiments are conducted, and the first set of experimental products are produced; and (3) an Execution Phase, in which the production and distribution of final products is achieved with new acquisitions from Earth observation sensors.

This plan has been endorsed by CEOS members. As a result we are working in 1998 to produce a detailed design of a network of agencies, to work together to develop the requisite systems and know-how to produce the proposed products.

2.0 CURRENT STATUS AND PLANS FOR 1998

A design team planning meeting was held in Washington, DC on January 29-30, 1998. Four design teams were identified, each headed by two co-chairs. A fifth design team is headed by a team of four because it has a more complex task: data acquisition, processing, and access. The names of the design teams (in italics), their co-chairs, and their objectives for 1998 are presented in Table 1.

Table 1. Design teams, co-chairs, and objectives for 1998

Design Team Name	**Co-chairs**
Communication and Coordination	Frank Ahern (CCRS) Robert Davis(FAO)
Objectives: collect and document user requirements, define approaches to project communication, monitor developments in technology and user requirements, liason with users, plan for eventual operational implementation	
Data Acquisition, Preprocessing, and Access	J. P. Malingreau (EC), Chris Justice (UVa), Martha Maiden(NASA), Peter Churchill(JRC)
Objectives: confirm user requirements, design data acquisition strategy; provide detailed level 1 product definition; produce a strategy to achieve data products; define system to catalog, store, and distribute all products	
Fine resolution products	David Skole(MSU) VictorTaylor(NASDA)
Objectives: confirm user requirements, detailed design of all fine resolution products; produce a strategy to achieve products	
Coarse resolution products	Tom Loveland(EDC), Yoshifumi Yasuoka (National Institute for Environmental Studies of Japan)
Objectives: confirm user requirements, detailed design of all coarse resolution products; produce a strategy to achieve products	
Calibration and validation	Alan Belward(JRC), Zhiliang Zhu (EDC)
Objectives: specify calibration requirements for all data; develop validation strategy for all products	

At the Washington meeting, it was recognized that additional cofirmation of user requirements was necessary. As a result, each design team was mandated to solicit membership from user groups and to confirm user requirements in its work in 1998. The communication and coordination design team was given the overall responsibility of collecting and documenting user requirements for the project as a whole. The design teams will be formed under the leadership of the design team co-chairs and meet independently throughout 1998, while keeping the communication and coordination team aware of their progress. A joint meeting is planned for September to carry out an end-to-end design review. We expect to invite representatives from user groups who have not participated in the design process to attend the meeting, to ensure that GOFC plans will be directed toward their requirements. The design will be revised as necessary, and presented to the CEOS plenary meeting in Bangalore, India, in November.

3.0 HOW TO GET INVOLVED

GOFC is a project which is global in scope, with an interest in all forested areas (down to 10% crown cover, in keeping with the FAO definition of forests). The United Nations FAO, the IGBP, and many space agencies are participating or intend to participate in GOFC. There is an ongoing need for additional participation by both suppliers and users of data. Currently there is no external funding; participation requires the committment of individuals' institutions for their time and travel costs. Recognizing the importance of forests in many developing countries, the GOFC team is searching for sources of funds to increase participation by developing countries.

Organizations or individuals who are interested in volunteering their participation in GOFC are invited to contact the first author:

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Following the design phase, there will be a need for space agencies and data production organizations to supply data from a variety of sensors, and process the data into products which have been specified during the design phase. At the same time, it will be important for user agencies to evaluate the resulting products in the context of their information requirements, and provide feedback to improve the response to their needs.

The availability of Internet technology provides a means to communicate within the GOFC project and with the outside world. GOFC is expected to operate through a distributed, global form of project management made possible through the Internet. We expect to establish a website in 1998 which will make GOFC documentation widely available, and use list servers or other appropriate technology for within-project communication. As GOFC begins to produce data sets and derived products, there will be a need for broadband data transfer paths. While the details are still to be defined, we are confident that Internet technology will enable GOFC to become a broadly-based participatory endeavour, linking data providers, processors, and users worldwide.

4.0 CONCLUSIONS

Recognizing the essential contribution which can be made by data from spaceborne earth observation data, a program for Global Observations of Forest Cover has been initiated through the stimulus of the Committee on Earth Observation Satellites in response to numerous environmental and economic concerns related to forest management. A project proposal was prepared in 1997, endorsed by the CEOS Strategic Implementation Team, and subsequently accepted at the CEOS plenary meeting in Toulouse, France. GOFC has now entered its design phase. Five design teams have been formed to carry out the detailed design process during the remainder of 1998. We expect GOFC to become a broadly-based participatory endeavour linking data providers, processors, and users worldwide. It will make optimum use of Internet technology to provide current information about the project, facilitate a distributed form of project management, and make data and products widely available.

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