Regional Networks for Implementation of the Global Observation of Forest Cover (GOFC) Project in the Tropics

Washington, D.C. USA

15 - 17 March, 1999

Justice, C., Ahern, F. and Freise, A.

GOFC-GOLD Report No. 5

START Report No. 4

Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a continuous program of space-based and in situ forest and other land cover observations to better understand global change, to support international assessments and environmental treaties and to contribute to natural resources management.

GOFC-GOLD encourages countries to increase their ability to measure and track forest and land cover dynamics by promoting and supporting participation on implementation teams and in regional networks. Through these forums, data users and providers share information to improve understanding of user requirements and product quality.

GOFC-GOLD is a Panel of the Global Terrestrial Observing System (GTOS), sponsored by FAO, UNESCO, WMO, ICSU and UNEP. The GOFC-GOLD Secretariat is hosted by Canada and supported by the Canadian Space Agency and Natural Resources Canada. Other contributing agencies include NASA, ESA, START and JRC. Further information can be obtained at
http://www.fao.org/gtos/gofc-gold

START

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Edited by
Chris Justice
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GOFC

CCRS
Canada Centre for Remote Sensing

Regional Networks for Implementation of the Global Observation of Forest Cover Project in the Tropics

A Joint START / GOFC / CCNS Workshop
March 15-17, 1999
Washington, D.C.

Report of the Workshop

Edited by
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Executive Summary

This workshop was the first in a series of regional and thematic implementation planning and coordination meetings for the Global Observation of Forest Cover (GOFC) project. GOFC is a pilot project of the Committee on Earth Observation Satellites (CEOS) aimed at strengthening operational provision and use of satellite data for forest monitoring. The GOFC project falls within the Carbon Theme being prepared for the Integrated Global Observing Strategy (IGOS) Partnership by the FAO and Global Terrestrial Observing System. The workshop was designed to bring together representative data users from tropical regions to assist in the design of the implementation of GOFC and to discuss the potential role of regional networks. Tropical regions play a potentially important role in GOFC due to the significance of tropical forest monitoring both for closing the carbon cycle and for forest resource management. There is also a considerable amount of on-going forest monitoring within tropical regions that could provide a foundation for GOFC implementation.

The workshop was organized into a series of breakout groups by region (Southeast Asia, Africa, Asia, and Latin America), identifying existing GOFC-relevant projects and data sets, identifying outstanding data requirements and capacity building needs, and suggesting near and mid - term activities. The presentations and detailed information regarding the workshop can be found at www.start.org and www.gofc.org/gofc. The workshop participants developed a number of recommendations relating to the Tropical Forest component of GOFC and the GOFC Program itself.

Recommendations concerning the tropical forest component of GOFC

The workshop supported the need to develop regional networks and linkages to improve the acquisition and distribution of data and the creation and distribution of products needed to improve information on forests within tropical forests.

In relation to remote-sensing capabilities, the participants recognized the limitations of current systems, the need to improve these observational systems, the need to improve data acquisition strategies, the need to improve data delivery and the need to reduce and/or share the costs associated with data acquisition and processing. They supported the overall strategy advocated by GOFC to bring about such improvements, while providing input with respect to specific changes needed to address regional needs.

The attendees recognized the need to transmit these requirements to CEOS, and endorsed GOFC as an important vehicle to carry out this communication.

The participants made it clear that improving technology transfer between the developing countries in large geographic regions (e.g. Latin America, South East Asia) was going to be a significant component of tropical GOFC activities and agreed that a significant outcome of the pilot projects in the regions would be the development of a sustaining regional network of experts. Participants stressed the

importance of inter- and intra-regional capacity building within GOFC and that this should include training opportunities.

The workshop identified some of the common goals between national interests and GOFC that should guide regional pilot projects, namely carbon and biodiversity reporting required for the United Nations Framework Convention on Climate Change (UNFCCC) and International Convention on Biological Diversity, biomass assessment for national forest planning and management, process understanding of land cover changes and spatial analysis, and identifying special areas for their value, goods or services (for example potential new conservation areas, carbon sequestration projects, monitoring of concession areas).

Recommendations concerning the entire GOFC project

The workshop participants:

- Encouraged better definition of benefits to stakeholders within a multi-scale approach that fully takes account of the needs of users at national, regional and global scales.
- Asked the GOFC Secretariat to take actions leading to the provision of improved information (including contact information) about the various stakeholders in GOFC.
- Emphasized the need to clearly define the goals and roles of GOFC and to clarify its responsibilities in relation to other international organizations with interests in and responsibilities for forest cover.
- Recommended to the GOFC Secretariat that there should be much broader dissemination of the goals of GOFC to a larger audience including the general public and policy makers.
- Urged that additional institutional support be sought to better develop the goals of GOFC through strengthening of the coordinating infrastructure at international, regional and national levels.
- Urged the GOFC Secretariat to consider issues of governance of GOFC and that part of GOFC concerned with tropical forests.
- Asked the GOFC Secretariat to address the issue of data and information quality control.
- Urged that in developing an operational GOFC effort, active involvement of appropriate national governmental representation be sought and included.

In summary, the workshop confirmed that there is strong support for the overall goals of GOFC and a large amount of interest in the tropical regions to participate in GOFC and to help develop operational pilot activities. The next step with respect to the tropical component of GOFC will be to hold a series of regional coordination meetings to strengthen and expand the GOFC regional networks and to identify and initiate a suite of regional GOFC projects. [*Ed. Note: These follow-up regional coordination meetings are being planned for 2000*].

The GOFC Tropical Workshop

1.0 Workshop Objectives

The objectives of the Tropical Workshop were to:

1. Review and obtain feedback on the GOFC Implementation Strategy in the context of needs of nations with tropical forests
2. Refine the global change research and associated policy requirements of GOFC
3. Discuss areas of desired collaboration to formulate realistic plans to proceed including:
    1. Identifying GOFC data sets of primary interest and their assimilation
    2. Identifying tropical nations' needs and wants arising from the UNFCCC
    3. Identifying potential project contributions
    4. Strengthening *in-situ* data collection and data access
    5. Identifying technical constraints on participation and possible solutions
    6. Identifying institutional constraints on participation and possible solutions
    7. Identifying areas of agreement and how to proceed.

To achieve these objectives the meeting was organized around a number of background presentations on GOFC, followed by a series of national presentations describing GOFC related projects and tropical countries. These were followed by a number of regional presentations focussing on requirements from GOFC and potential projects. The full agenda is provided as Appendix 2.

2.0 National Presentations

Workshop participants were given the opportunity to present examples of activities conducted within their institutions and/or nations which were related to the GOFC effort. The actual presentations are available via the START website: www.start.org/GOFC

Table 1. Presentations of national activities related to GOFC by workshop participants.

South America	
Fires and Deforestation in Brazil	João Pereira, IBAMA
Peugeot Project to Create a Carbon Sink in the Amazonian Forest	Ichtiaque Rasool, Consultant
CIAT and CSI	Glen Hyman, CIAT
Bolivian Association of Remote Sensing for the Environment-ABTEMA	Sophie Moreau, ABTEMA
Asia	
Tropical Forest Mapping and Monitoring in China	Zengyuan Li, Institute of Forest Resources Information, Chinese Academy of Forestry
Forest Survey of India	Devendra Pandey, Forest Survey of India
Africa	
Operational Vegetation Mapping and Monitoring in Zimbabwe	Dominick Kwesha, Zimbabwe Forestry Commission
Overview of SADC Land-Cover Projects	Manuel Ferrao, National Remote Sensing and Cartography, Mozambique
Miombo Regional Mapping and Suggestions for Monitoring	Paul Desanker, University of Virginia
Forest Cover Monitoring in Namibia	Harold Kisting, Ministry of Environment and Tourism
Southeast Asia	
Forest Monitoring Activities in Thailand	Ongsomwant Suwit, Forest Resources Assessment Division
Forest Monitoring Activities in Indonesia	Iwan Gunawan, TIDSA-TPSA
Mapping of Tropical Forests in the Philippines	Virgilio Santos, National Mapping and Resource Information Authority
International	
Global Forest Watch	Catherine Plume, World Resources Institute

3.0 Regional Breakout Group Deliberations

3.1 Southeast Asia

3.1.1 Regional Requirements for GOFC Implementation

- Coordination

It is clear that coordination of forest monitoring within and between countries in the region is lacking. There was a consensus that this is a major obstacle to GOFC implementation and plans are needed to establish formal coordination within countries and within regions.

- Expansion into less developed countries in region

Scientists from Indonesia, Malaysia, Philippines, and Thailand participated in the discussion and felt that within their countries, and in Singapore, there exist adequate knowledge and technical expertise and experience for forest mapping activities. However, this expertise may not exist in all countries in the region (e.g. Laos and Cambodia). There should be an attempt to engage these other countries through some level of technical interchange and capacity building which could lead to expansion of the current regional network.

- Develop regional baseline data.
    1. Basemap at 1:1,000,000 scale.
    2. The regional GOFC classification scheme (see Table 2) needs more thought. The current classification scheme does not include classes that are important to this region. For example, development of aquaculture in mangrove forests is an important agent of forest conversion in the region and would need to be separated from other types of forest conversion. Plantation forests are another important forest class in this region. Key Southeast Asia regional exceptions to the broad GOFC classification systems need to be identified.
- Temporal frequency of forest inventories for monitoring should be in the 3-5 year range.
- Validation of regional and national products is critical to the success of GOFC. Existing national datasets should be the focal point of the validation activity.
- Map projections need to be standardized. Existing national spatial databases are in different projections or use different datum. There is a need for developing a region wide standard. This should be incorporated into the basemap product.

Table 2. GOFC Land and Forest Cover Classification Scheme

Land Cover Classes					
Water					
Permanent Snow and Ice					
Barren or sparsely vegetated					
Built-up					
Croplands					
Herbaceous					
Forest	Leaf type	Needle	Broadleaf	Mixed	
	Leaf longevity	Evergreen	Deciduous	Mixed	
	Canopy cover	10-25%	25-40%	40-60%	60-100%
	Canopy height	0-1 m (low shrub)	1-2 m (tall shrub)	>2m (trees)	
Forest special theme: flooded forest					
Spatial resolution: 1 km (coarse) and 25 m (fine)					

3.1.2 Existing Projects / Datasets

Existing infrastructure for systematic forest mapping exists in the Southeast Asian region. Within the region, the institutions involved in this type of research vary from academia to national agencies. There are several new initiatives and projects focusing on forest fire mapping and monitoring. While these projects are in the demonstration phase and are not yet operational, there are plans to move toward operational framework. There are several conservation sites within each country that are routinely mapped in detail. Experiences and data from these activities could prove to be valuable for a GOFC regional pilot project.

Ongoing regional projects and GOFC-type activities in Southeast Asia:

- Geographical Survey Institute in Japan has a global mapping project with participation from Philippines, Thailand, and Vietnam. This project focus on a broad range of land cover types, not just forests. Analysis is at a scale of approximately 1:2Million (1km grids) with plans to evolve the project to utilize GLI and MODIS data in the near future.
- NASA Landsat Pathfinder project focuses on mapping forest extent for most of the Southeast Asian region on a decadel time step (early 1970s, mid-1980s, and mid-1990s). This project has analyzed several hundred Landsat MSS and TM images for the region, using a hybrid approach of digital classification techniques followed by visual interpretation for refinement.
- TREES project of the MTV unit of European Community Joint Research Center has created a complete forest cover map for Southeast Asia based on multi-temporal AVHRR data with 1km resolution.

Of these regional projects, the results from the TREES and Landsat Pathfinder projects represent useful resources for GOFC. The classification maps of forest extent are available from the Monitoring Tropical Vegetation unit at the JRC and Tropical Rainforest Information Center at Michigan State University. The AVHRR and Landsat data used in these projects are also available at almost no cost to GOFC. In addition to these satellite data sets, a CDROM has been created under the support of NASA and IGBP with regional AVHRR and Landsat data sets and GIS layers of biophysical and socio-economic data.

Ongoing national projects and GOFC-type activities in Southeast Asia:

<u>Philippines</u>

- Bureau of Forest Management in Department of Environment has the mandate for forest mapping in the Philippines. The goal of this project is to complete national inventory of forests every five years. Satellite and aerial photos are used in the 1:250k scale analysis.
- WWF has a Global Environmental Facility (GEF) funded project focusing on protected areas management. This project has 10 sites in the Philippines, with ecoregional planning using GIS and remote sensing technologies.

<u>Thailand</u>

- Forest Resources Assessment Division of Royal Forestry Department has the mandate for forest mapping and monitoring in Thailand. The national forest inventory is updated at least every three years. Forest / non-forest maps area produced at 1:250k, with more detailed Level II and Level III classes at the 1:50k site scale. The analysis is based on visual interpretation of historic aerial photos and recent Landsat data. This activity has been operational since the early 1960s.
- Royal Forestry Department and National Research Council of Thailand have a joint Forest Protected Area mapping project. This mapping is at a scale of 1:50k for over 100 national parks and wildlife sanctuaries using Landsat TM data. The current plan is to update each map every 5 years.

Malaysia

- National Forest Inventories project in Malaysia has created forest resource maps for Peninsular Malaysia. These maps were initially based solely on aerial photos, but since the early 1980s they have relied on both aerial photos and Landsat imagery. The national inventories are carried out every 10 years starting in 1972. In 1990, the Continuous Forest Monitoring System (CONFORMS) was established to map and monitor forest in Peninsular Malaysia using both remote sensing and GIS techniques.
- Sabah Forestry Department established an operational Sabah Forest Management Information System (SFMIS) for Sabah Malaysia.. This project utilizes remote sensing and field data for routine monitoring. A similar system is being developed for Sarawak. Landsat TM data are being used to create 1:250k scale maps of forest extent and status.

Indonesia

- Department of Forestry has the mandate for forest mapping in Indonesia and have implemented a National Forest Inventory project. Remote sensing data are used to map forest extent at 1:250k for the entire country of Indonesia. These forest maps are used as the basis of countrywide forest use planning and permits.
- Indonesian Fire Monitoring project is a joint activity with GTZ, supported by EU and JICA funding. Goal is to move forward for monitoring transboundary haze.

3.1.3 Required New Projects / Data

In addition to the regional datasets listed above, it was stressed that GOFC should leverage existing projects in the region. For example opportunities exist to use the sites developed for SARCS / LUCC case studies (phase II sites in Indonesia, Malaysia, Philippines, and Thailand) as well as BIOTROP sites in Indonesia (Jambi Province in Sumatra and Western Kalimantan). Effort should also be expended to harmonize the data from the number of existing national forest mapping and monitoring projects (not all of which have been listed above). Differences in data standards and research objectives will make this a considerable challenge.

New sites will have to be created to expand regional coverage to include more countries and to capture data of significant environmental, scientific, political, and social interest.

3.1.4 Intra-regional Capacity Building Activities

Workshops on techniques and methods for mapping and monitoring forest are needed in order to expand the current network in Southeast Asia. In addition to a workshop series, a mechanism for technical interchange needs to be set up. This could be coordinated through a regional GOFC project office.

3.1.5 Potential GOFC Activities in Southeast Asia

Near term activities: next 6 months:

1. Assessment and documentation of baseline datasets and products with an evaluation of their availability. Dr. Sharifah Mastura Syed Abdullah from Universiti Kebangsaan (Malaysia) offered to synthesize these materials for the region provided each country provides a listing of their country's data sets.
2. Coordination to develop requirements for the regional GOFC office. The role of this office would be to facilitate and coordinate the initial tasks of basemap generation, harmonization of existing data sets to create baseline, and methods for development of new baseline data set using CEOS provided data bundles of satellite data.
3. Develop strategy for obtaining core-funding support.
4. Formulate plans for expanding within existing countries and engaging other countries in the region into the GOFC activities

Mid-term activities: next 12-18 months:

1. Development of initial basemap.
2. Workshop to define harmonization approach and plans for the development of new baseline data set from CEOS data bundles. This workshop should be held within next 12 months to keep momentum from this initial workshop.
3. Select sites for pilot activities. Will need guidance on how GOFC will evolve to provide insight into best approach for expanding the regional network.

3.2 Africa

3.2.1 Regional Requirements for GOFC Implementation

1. Routine satellite monitoring constrained by: capacity (brain drain, high turn-over), costs and equipment, lack of continuity between projects, lack of coordination between projects with different objectives but using similar data
2. Detailed discrimination of vegetation types difficult by TM
   Extensive ground truthing is required for visual interpretation or automatic classification
3. Visual interpretation is time consuming, 3-5 years for national mapping projects, after which information needs to be updated.
4. There are a lot of heritage databases - not always well documented for new applications, and not always suitable for newer applications (new variables needed). On the other hand, detailed local vegetation studies are too often ignored by the remote sensing community.
5. Data availability is often a constraint - cost, as well as availability of imagery especially for Central Africa.
6. Small initiatives are constrained by cost of TM data.
7. The validation of remote-sensed products poses several problems due to the low accessibility of observed areas.

3.2.2 Existing Projects / Datasets

Ongoing regional projects and GOFC-type activities in Africa:

- The Miombo Network is developing a regional land cover map (for the miombo countries of Angola, Zambia, Tanzania, Malawi, Mozambique, Zimbabwe, and parts of the Democratic Republic of Congo). This is based on national land cover maps developed during the early 1990's based on Landsat TM.
- Many regional projects are involved in the mapping and the monitoring of forests in the central African countries (Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon) : EU TREES and ECOFAC, US Landsat Pathfinder and CARPE, REIMP, NASDA GRFM. These projects are mainly interested in deforestation estimates and conservation issues.
- FAO's Africover has ongoing mapping activities in Africa.

Ongoing national projects and GOFC-type activities in Africa

Various national mapping efforts based on combinations of Landsat TM, SPOT, and Radar for the 1990's for Southern and Central Africa exist but complete details available vary by country. Data availability is an issue in certain countries where digital products are costly. National mapping and monitoring activities were funded by different developmental / aid agencies such as World Bank, US AID, European agencies (GTZ, etc). The products listed below are just examples, complete and accurate information for all countries was not readily available during discussions.

<u>Tanzania</u>

1. National mapping project based on 1995 Landsat TM data, funded by the World Bank, produced land cover map sheets covering the whole country.
2. Detailed stand-level mapping at several sites as part of other projects.

<u>Malawi</u>

1. National mapping based on 1992-3 TM data.
2. Malawi Environmental Monitoring Project funded by US AID to monitor expansion of agriculture at a national level.

<u>Mozambique</u>

1. 1985 National Land Use Map
2. National Forest Inventories that produced biomass maps at scales from 1:50K to 250K
3. Provincial Forest Inventory based on TM
4. Latest mapping of land cover nearly complete (8 of 10 provinces complete) using Landsat TM data of year of mapping, so data from 1995-1998 (map will be mosaic of maps developed with different years data).

<u>Zimbabwe</u>

1. National Land Cover maps using TM at 1:250K for 1992 funded by GTZ
2. Monitoring activities with extensive field campaigns in hot spot areas for forest and catchment management and biodiversity
3. Inventories of gazetted forests
4. Plot-level measurements for forest growth and yield

Namibia

1. Forest Cover Map 1992-94 based on TM and SPOT (1:50K finished)
2. Continuous Forest Inventory plots established recently (300-400)
3. Studies of fire scars in the Caprivi
4. Environmental Profiles and Monitoring on going.

Central African countries:

Country	Institution	Product	Data	Date	Coverage
Central Africa Republic	PARN	Land Cover map and Forest Inventory ~1:150,000	aerial photos	1993	Forest regions
Cameroon	CETELCAF	Forest types map; 1:200,000	Landsat TM	1992	National level
Gabon	DIARF	LC Map and Forest Inventory, 1:200,000	JERS radar and aerial photos	1996	2/3 country
Democratic Republic of Congo	SPIAF	Forest Map 1:1M	Landsat (1985)	1995	National
Eq. Guinea	CUREF	LC Map at 1:100,000	SPOT	1997	National

3.2.3 Required New Projects/Data

Consistent (observed) baseline land cover/land use maps/data at the sub-regional level (such as Southern Africa or the Miombo Region) are incomplete and are produced only at coarse resolution. It is highly desirable to have estimates of land cover for the region as a whole, at a spatial resolution that captures the nature of land use (mostly small scale farming resulting in extensive fragmentation), for natural resources management and conservation monitoring. Pilot monitoring activities may address change and degradation of conservation and forest areas in the Miombo region utilizing spatial and temporal monitoring. Results would be applied to land use typology and modeling to address carbon budgets, biodiversity, and hydrological consequences.

3.2.4 Intra-regional Capacity Building Activities

There is a general feeling of awe at the large number of potentially useful remote sensing products, available and under development. It is a challenge for many people working in the regions to keep abreast of what is available, how to access it and use it, and where to look/who to ask.

It is suggested that tutorials be organized from time to time to introduce potential users to the breadth of products – while some of this information can be acquired over the Web in some countries, majority of users in the regions remain isolated. It is recommended CD's be produced to package this information, especially if updated often.

There is an obvious need to develop capacity for the long-term, beyond short-term workshops that expose users to the issues and potential. Real capacity will only be viable if done through graduate education. It is highly desirable to build in higher training in all projects. Some continued training/training on the job is a short-term solution where some capacity exists, including study visits.

3.2.5 Potential GOFC Activities in Africa

Baseline Mapping for the Miombo Region, SADC Region

There is a clear need for regional land cover / land use baseline maps, preferably covering the whole Southern Africa region and not just one biome type like Miombo. In Southern Africa, work is underway to produce a regional land cover map – building upon independent national mapping efforts, most of which were carried out during the same time period of 1990-2, using based on Landsat TM imagery. Other projects such as SAFARI 2000 and regional bodies such as SADC, would be interested in a broader coverage for all of Southern Africa. It is proposed that the Miombo regional mapping activity work with the rest of SADC countries in Southern Africa to develop a baseline for all of Southern Africa. This would provide a baseline land cover map for the 1990-2 era, and could be compared with the 1-km land cover products that are based on AVHRR data (IGBP DISCover, JRC products, and University of Maryland). The Miombo Network will follow-up with the appropriate SADC regional office responsible for forestry and mapping.

Synthesis of existing regional datasets for Central Africa

Many regional vegetation maps have recently been produced from optical (coarse and fine resolution) and radar data: Landsat Pathfinder, TREES, GRFM-JRC ERS and JERS mosaics. Recent studies have shown that the different types of sensors must be combined to produce a reliable map with the relevant vegetation classes. Indeed, each type of data has its own limitations: fine resolution optical data suffer from the cloud coverage of the region, coarse resolution optical data from the spatial resolution and radar data from the low thematic discrimination.

Land Cover Attributes for 1-km Mapping and Continuous Fields

One of the most promising products for regional to global applications is the mapping of continuous fields of land cover. It is proposed that attributes be collected across the Southern African region to help improve the continuous field products – both to help train the classification algorithms, but also to provide some level of validation. These maps, when accompanied by an estimate of accuracy and precision, will greatly improve studies that require quantitative information on land cover information.

Synthesis of Available Data (Biomass, Forest Inventory), and Sampling Design for Monitoring Forest Cover and Change, and Degradation

Most of the proposed GOFC activities would benefit existing data collected by national forestry departments (and others) about their forests, such as through permanent sample plots. It is suggested that some effort be made in synthesizing what is available in relation to carbon accounting and budgeting studies, and other mapping. These data should also contribute to design of an appropriate sampling strategy for monitoring cover changes and degradation, in relation to the major needs defined by carbon questions, biodiversity and conservation and natural resource management.

Workshops

Workshops are proposed to address development of carbon models for Southern Africa that are linked to remotely sensed data products, collation of forest inventory data, development of case studies, and various information systems that would facilitate GOFC in Southern Africa. Potential workshop topics include: biodiversity mapping, forest carbon models and *in situ* biomass data, and spatial/landscape analysis methods (focused on describing attributes of landscape structure and "hot spot" areas). Pilot studies on the conservation issues are currently led by ECOFAC and WWF in Central Africa and could be extrapolated to other biomes

GOFC Southern Africa Gateway

One constraint for scientists in developing countries is the access to web-based resources that point to available remote sensing data and its richness, in a cost-effective and timely manner. It is highly desirable that a web page be developed specially for Africa (Southern Africa as a pilot) that highlights available data products, richness of existing archives (spatially explicit richness of particular imagery, for instance number of scenes of TM for given locations). This would include regular updates on new remote sensing products, and could provide online (CD-ROM) ordering of data (such as Landsat 7 data). Prototypes for this include Landsat pathfinder systems for the Amazon and Central Africa (TRFIC, Michigan State University).

Twinned Research Proposals

Collaborative proposals between regional and other scientists are encouraged to help implement GOFC related projects. A commercial data buy for the whole of Africa (initial priority maybe Central and Southern Africa), including gap-filling for historical data would be extremely useful to implementation GOFC activities. It is strongly suggested that current data archives of Landsat (and MSS) data for the Miombo be strengthened to fill in gaps in data, and secure historical data where these data may be in danger of being lost.

3.3 Asia

3.3.1 Regional Requirements for GOFC Implementation

There is a strong need to develop a regional network suitable for GOFC purposes in Asia. Members of the proposed network would need to address harmonisation of national data for regional initiatives, exchange of methodologies, and distribute information on ground truth data collection and validation. Potential networks which could be built upon include those of the FAO and AIT.

3.3.2 Existing Projects / Datasets

Ongoing regional projects and GOFC-type activities in Asia

Country	Sensor	Scale	Map classes	Cycle	Use	Institution
Japan	JERS	Regional			Land cover	

Ongoing national projects and GOFC-type activities in Asia

Country	Sensor	Scale	Map classes	Cycle	Use	Institution
China	TM, SAR	1 M, 250,000	Veg type and Forest density	5 yrs (first time)	Policy and planning	CAS, CAF
Nepal	Mixed	250,000	Same	10 yrs	Policy, management	ICIMOD, FRDP
India	IRS (LISS II)	250,000	Same	2 yrs	Policy and planning	FSI, Dept Space
Other countries to be identified						

3.3.3 Required New Projects / Data

Prior to the development of a regional pilot project members of the GOFC network will have to prioritise the regional needs. Anticipated needs include increased access to fine resolution optical data and SAR at reduced cost, improved interpretation techniques and classification scheme compatibility, methodologies to assess data accuracy, and procedures to promote capacity building.

3.3.4 Potential Activities

Recognising that there is a lack of "GOFC" network in Asia, we propose to establish an Asian GOFC regional network consisting of members of the forest monitoring community, satellite data providers / agencies, and the research community. Communication between network members will be conducted using email. Official GOFC representatives will be identified to provide a "mandate" from the national programs. Asian participants from this workshop will, with the assistance of the GOFC Secretariat, inform country ministries about GOFC objectives and approaches. Asian region GOFC activities will be co-ordinated through Dr. Devendra Pandey of the Forest Survey of India.

A regional workshop, hosted by the Forest Survey of India, will be conducted in the next 9-12 months. Invitees will include network country representatives, ministry level officials, carbon researchers, and space agency resource people. Funding will be sought from appropriate agencies and organisations. Preliminary topics for the agenda include:

- Forest monitoring
- Management agencies
- National inventory system
- Classification system
- A strategy toward an integrated Asia forest cover database
- Discussion on carbon budget and other science issues within national, regional, and international policy context

An operational demonstration project will be designed following the regional workshop. This project would create an integrated Asia forest cover baseline database, including operational forest cover mapping. High quality satellite data would be used for estimation of biophysical parameters. A regional data bundle, including field data and suitable for CD-ROM distribution, would be an expected output.

3.4 Latin America

3.4.1 Regional Requirements for GOFC Implementation

- Annual survey of Amazon deforestation
  Currently carried out by Brazil but has important implications for other Amazon countries. There exists a need to lower the costs, particularly labor costs, associated with this survey.
- Fire monitoring for some areas (e.g. Santa Cruz, Bolivia; Brazilian Amazon)
- Monitoring of forest change nationally outside the Amazon
- Tracking and understanding planned and unplanned changes, especially the growth of settlements and agricultural areas
- Knowledge sharing and knowledge transfer
- Ensuring quality standards for the end products is very important for the region
- Monitoring National Parks to avoid degradation and deforestation
- There is an urgent need for a network of professionals who can work together and actually have time to work together.

3.4.2 Existing Projects / Datasets

Ongoing regional projects and GOFC-type activities in South/Central America:

PanAmazonas is related to the PRODES (see below), but included all the Amazon countries for an International Space Year exercise in 1992. This was a one-shot effort that has not been repeated.

PATHFINDER is a NASA-sponsored project focuses on 70's, 80's and 90's land cover change in Peru and Bolivia (University of Maryland) and Brazil (Michigan State University). It is evolving toward digital analysis and away from visual analysis.

The TREES project of the European Commission has created a complete forest cover map for South America with 1km resolution and is currently assessing the deforestation rates by a sample of Landsat scenes.

UNEP / GRID is developing a new project for landscape ecology and gap analysis with The Nature Conservancy for Panama, Colombia, Ecuador, Peru, Bolivia, and Paraguay.

NASA and USGS are conducting a post-Hurricane-Mitch land cover mapping project in Honduras and Nicaragua.

SEAMAP from the US Forest Service intends to carry out a land cover classification of the Caribbean islands using TM data. This project will begin in Puerto Rico with a trial using 4 TM scenes.

Ongoing national projects and GOFC-type activities:

Brazil

1. PRODES is the annual wall to wall assessment of land cover change in the Brazilian Amazonia, with more emphasis on hot spots. This is the world's largest operational forest monitoring project, using more than 200 TM images each year.
2. PROARCO is the new daily fire monitoring program in the Brazilian Amazon headed by IBAMA. Hotspot maps and fire statistics are produced daily.
3. ONF and Peugeot are developing a project to re-forest a 5000 ha area of deforestation in the Brazilian State of Mato Grosso and monitor the regrowth with remote sensing.

It has been suggested that PRODES, PROARCO, LBA, and PATHFINDER coordinate to develop methodological and institutional models for development of improved methods of analysis and standardization.

Of the above projects, only the TREES dataset is readily available. The PRODES data exists only in analog form. The images and overlays can be consulted at INPE. The Pathfinder data are becoming available for a fairly low per-scene reproduction cost, but the number of scenes is large so a complete dataset would be expensive.

Other Countries

Most countries have land cover classifications at medium scale derived from TM. These are available in the form of paper maps.

AVHRR data are readily available in most countries.

3.4.3 Potential Intra-regional Capacity Building Activities and Potential GOFC Activities in South / Central America

IGBP LUCC (Brazil office) could be a vehicle or arm for GOFC in South American region. Specific technical issues which need to be addressed include, data harmonization across the region, mechanism for updating existing products, cost of commercially available remote sensing data, and geo-referencing of images. NASA is sponsoring a global Landsat geo-referencing project that could help alleviate this problem. GOFC could facilitate access to this project.

Implementation of GOFC at a regional level would create a professional and institutional specialist network at the regional level, provide increased access to the latest techniques and datasets, and provide an opportunity to harmonize methods and results regionally. This last would provide extremely valuable information to policy-makers.

Implementation of GOFC in the region would be conducted through pilot studies to address technical and institutional difficulties at a manageable scale. Discussions of potential pilot study sites include the concern that they should be located, if possible, in the border areas between South American countries and that the NASA project, already underway in Central America, could be an appropriate starting point for GOFC. Potential locations for pilot projects in the region included:

1. Colombia -piggyback on TREES sites in the Andes, savanna, and rainforest to develop methods and foundation for national scope programs similar to Brazil.
2. Venezuela
    1. Imataca
    2. South Maracaibo
    3. Other TREES sites
3. Work in the border areas between South American countries
4. Puerto Rico (4 TM scenes) in conjunction with USDA, could be pilot study area
5. NASA project site in Central America (Honduras, Nicaragua)
6. ONF/Peugeot project site in Mato Grosso (Brazil)
7. The Nature Conservancy Landscape ecology and gap analysis for Panama, Colombia, Ecuador, Peru, Bolivia, Paraguay

All participants stressed the need for a workshop to discuss institutional and methodological aspects of setting up operational forest monitoring projects. The objectives would be to help countries that are trying to get established in forest monitoring, identify their capacities and needs, and develop common methodologies in remote sensing data analysis, field measurements, mapping etc. Regional workshops may include:

- Coordination to present methods of the different principal existing projects and adopt a common methodology,
- Training at regional and national levels, and
- Technical to define mapping units/legends.

Workshop participants identified data that would be used most frequently to develop a GOFC activity in the region (MODIS, CBERS, NOAA-AVHRR, and LANDSAT-TM) and organizations that could be used to help coordinate GOFC activities (IGBP/LUCC office at INPE and SELPER).

Immediate actions to be undertaken by the workshop participants include identification of a GOFC-country coordinator for each participant country, identification of potential partners not in attendance (i.e. SELPER, IAI, UNEP, UNAMAZ), and development of national inventories of on-going projects.

3.5 Common Themes Across the Regions

From the presentations it was possible to identify some common themes across the regions. There was a common willingness from all the regions to participate in GOFC. There is an immediate need for GOFC network organizing/forming workshops to inform potential players and involve a broader participation beyond the representation at this workshop. These workshops would be used to provide a better identification of contributions and contributors to GOFC. All regions showed a strong interest in strengthening their existing regional data set activities. These

activities included refining existing compilations or new data initiatives and updating current inventories. The regional networks would like early access to CEOS resources such as information on data access, new data sets, algorithms and technical backstopping on data use and analysis.

4.0 Towards the Implementation of the GOFC Tropical Component

4.1 A Regional Approach

GOFC is aimed at enabling a satellite-based forest monitoring process in the different tropical regions rather than developing a series of externally funded one-time projects. GOFC is a pilot activity and by design will be prototypical. At this stage in GOFC implementation we need to identify a number of critical pilot activities and demonstrate and secure their continuation.

From this workshop it was clear that there is already much in place with respect to tropical forest monitoring and that GOFC could help make and strengthen linkages between existing resources (human/institutional). Individual linkages can be formed into networks that can facilitate and implement GOFC activities. These networks can be utilized to create opportunities and partnerships to secure necessary new resources and to articulate the need for future new or different resources

The different regions of the tropics are at different stages in the evolution of tropical forest monitoring. The GOFC Tropical component will take a regional approach to implementation addressing region specific needs. Regional networks can be used to connect necessary elements of an operational monitoring system, benefiting from different capabilities and experiences. These networks will need to be cultivated and supported by GOFC. Once the initial task of establishing and activating regional networks has been achieved, considerable benefits will be gained from strengthening intra - regional linkages, for example by sharing lessons learned and best practices with respect to establishing operational monitoring.

4.2 Roles and Responsibilities

For the implementation of the Tropical Component of GOFC as a series of pilot activities, one can envision various potential roles and responsibilities from different players. For example, the CEOS partners would be tasked with providing satellite data and information packages and improved technologies for data access and distribution. Various groups would contribute to providing analyses of forest cover and forest cover change. Such groups might include: global change science teams using the START networks, national or regional forest mapping and management groups, NGO's or private sector organizations. The UN/FAO could play an important role in bringing this about, particularly through its regional forest commissions.

National forest stand data and forest inventory information would be provided by national agencies working with regional science teams. The International Union of Forestry Research Organizations (IUFRO) could facilitate this process, particularly through its subgroups on Remote Sensing and World Forest Monitoring, Remote Sensing Technologies and GIS, and Forest Fire Research.

Data dissemination could be undertaken by regional networks in collaboration with CEOS partners. CEOS/WGISS can play an important role in both technical developments and implementing and testing regional networks.

Evaluation of methods and assessments might be undertaken by the global change research or international forestry programs, and can be aided by CEOS/WGCV.

Implementation will require coordination within GOFC: between the regional networks and CEOS partners with respect to establishing data requirements, between the global change networks and national programs with respect to meeting common data needs, and between the global change networks and the policy community with respect to articulating the policy relevance of the analyses. Facilitating such interaction will be an explicit task for the GOFC management structure. GOFC will require a strong element of 'self' organization. Regional networks will need to organize themselves. Regional points of contact will need to be established. Regional networks will benefit from CEOS resource contacts facilitating access to data and new technologies.

4.3 Funding GOFC and Mobilizing the Regional Efforts

GOFC will not fund projects directly but provides an umbrella under which funding for GOFC activities may be sought. Three approaches to the funding of GOFC projects can be envisioned. A low or minimalist 'quid pro quo' funding approach where CEOS partners provide new data packages to 'already funded' projects, that would use these products for analyzing forest cover and change and thereby contribute to GOFC objective of facilitating the development of operational monitoring systems. An intermediate approach where provision of new data packages is augmented by core funding to the network for general regional GOFC activities including workshops, network coordination etc. A full-funding approach with provision of data packages and core funding for specific research projects and activities. It is likely that GOFC will consist of all three approaches.

Regardless of the funding approach, true partnerships are needed at the project level and issues of equity, credit and recognition amongst partners must be addressed. Good collaborations between partners will be essential for the success of GOFC.

4.4 Policy Awareness

To be effective in establishing operational monitoring it is important that GOFC serve national interests. Given the Carbon Theme context of the GOFC activity within CEOS, the greatest gains will be in areas of overlapping interest between the global change community and national policy making. The following are some of

the common goals between national interests and GOFC that should guide pilot projects:

1. Carbon and biodiversity reporting required for the UNFCCC and International Convention on Biological Diversity.
2. Biomass for national forest planning and management
3. Process understanding of land cover changes
4. Spatial analysis - identification of special areas for their value, goods or services (e.g. potential new conservation areas, carbon sequestration projects, monitoring of concession areas)

There is an urgent need to help national and regional policy bodies become aware of what GOFC is trying to do in terms of enabling timely operational forest monitoring and providing data to better understand the forests and carbon issues. At the regional level, there is a need to identify 'key' individuals or organizations as early as possible and involve them in the GOFC process / network. There is the need for a targeted outreach activity associated with providing information on the goals of GOFC. For example a GOFC policy outreach package could be developed explaining policy relevance of GOFC that could be used / modified by the regional networks. This might best be initiated at the GOFC Secretariat.

4.5 GOFC Tropical Network Elements and Status

There are a number of elements that would ideally be included in a regional network:

1. Space Agencies, Instrument Builders / Operators
2. Satellite Data Providers
3. Remote Sensing Research Community
4. Satellite Forest Monitoring Groups
5. Forest *in-situ* data managers
6. Forest Carbon and Carbon Policy Researchers
7. National Forest Policy Developers / Makers / Implementers
8. Forest Information Users

It is recognized however that in all cases such networks will need to be developed. In most cases existing regional networks developed in the context of START and the international global change community would need to be enhanced to meet the GOFC goals. Currently these networks include members from the remote sensing research community, satellite forest monitoring groups and forest information users. Addition of the other necessary elements would be a high priority a series of proposed regional meetings. From the regional breakout groups the following summary was made of the status and steps that could be taken:

<u>Latin America</u>

1. GOFC network needs to be created - national to regional
2. The Inter-American Institute for Global Change Research (IAI) can play a role in Latin America similar to that of IGBP / START in other parts of the world.
3. the existing SELPER network could be engaged
4. good potential for lateral transfer of monitoring experience from Brazil to other countries in the region.

Asia
1. mixed capacity for GOFC activities
2. good potential for lateral transfer of monitoring methods from India

South East Asia
1. good network in place through LUCC
2. good capacity for GOFC activities
3. could be expanded to include other countries

Southern and Central Africa
1. networks in place - Miombo / REIMP / TREES / CARPE
2. limited capacity to implement GOFC activities

4.6 Near-term Activities

The following near-term (18 month) activities were highlighted during the workshop and presented as a 'strawman' in the final plenary session.

1. mobilize or form networks to identify and implement the priority GOFC activities
   - hold regional GOFC workshops inviting potential players from the desired network elements
   - identify regional GOFC Points of Contact
   - identify CEOS GOFC regional resource people

2. across the board resource raising for GOFC implementation by GOFC members - broaden the membership

3. early access to or delivery of existing and new CEOS data and tools by regional participants

4. packaging and enhancing regional operational forest monitoring activities as demonstrations of what is needed and what can be achieved.

5. planning mid-term GOFC project data needs

6. articulating long-term needs to IGOS-Partners and CEOS.

7. policy awareness raising on the relevance and feasibility of operational tropical forest monitoring

5.0 Workshop Recommendations

Through plenary and working group discussions, the workshop participants developed a number of recommendations relating to the Tropical Forest component of GOFC and the GOFC Program itself.

With respect to this workshop, the participants:

1. Supported the overall goals of the GOFC project.
2. Supported the need to develop regional networks and linkages to improve the acquisition and distribution of data and the creation and distribution of products needed to improve information on forests within a regional context, especially the tropical forests.
3. In relation remote-sensing capabilities recognized:
   i) the limitations of current remote sensing systems
   ii) the need improve these observational systems
   iii) the need to improve the acquisition strategies
   iv) the need to improve data delivery systems.
   v) the need to transmit these requirements to CEOS
   vi) the need to reduce and / or share the costs associated with data acquisition and processing
4. Recognized that improving technology transfer between developing countries was going to be a significant undertaking of any GOFC activities for tropical forests
5. Agreed that a significant outcome of the pilot projects in the regions would be the development of a regional network of experts
6. Stressed the importance of inter- and intra-regional capacity building within any GOFC activity and that this should include training opportunities

With respect to the entire GOFC project, the workshop participants:

1. Encouraged better definition of benefits to stakeholders within a multi-scale approach that fully takes account of the needs of users at national, regional and global scales.
2. Asked the GOFC Secretariat to take actions leading to the provision of improved information (including contact information) about the various stakeholders in GOFC.
3. Emphasized the need to clearly define the goals and roles of GOFC and to clarify its responsibilities in relation to other international organizations with interests in and responsibilities for forest cover.
4. Recommended to the GOFC Secretariat that there should be much broader dissemination of the goals of GOFC to a larger audience including the general public and policy makers.
5. Urged that additional institutional support be sought to better develop the goals of GOFC through strengthening of the coordinating infrastructure at international, regional and national levels.
6. Urged the GOFC Secretariat to consider issues of governance of GOFC and that part of GOFC concerned with Tropical Forests
7. Asked the GOFC Secretariat to address the issue of quality control.
8. Urged that in developing operational GOFC effort, active involvement of appropriate national governmental representation be sought and included.

References

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De Gier, A. , E. Westinga, S. Beerens, P. van Laake, and H. Savenije, 1999. User Requirements Study for remote sensing based spatial information for the sustainable management of forests, Netherlands; Ministry of Economic Affairs, Ministry of Foreign Affairs DGIS, Ministry of Agriculture, Nature Management and Fisheries, Final Report, 25 pp plus Executive Summary.

Appendix One: Meeting Participants

Name	Organization and Country
Abdullah, Sharifah Mastura Syed	Universiti Kebangsaan Malaysia, Malaysia
Ahern, Frank	CCRS, Canada
Baskinas, Luz Teresa	WWF Philippines, Philippines
Bryant, Dirk	WRI , USA
Butthep, Chetphong	National Research Council of Thailand Thailand
de Assis Oliveira, Francisco	Department of Forestry, Brazil
De Gier, Alfred	ITC, The Netherlands
Desanker, Paul	University of Virginia, USA
Ferrão, Manuel Fernandes G.	CENACARTA, Maputo, Mozambique
Guerra, Francisco	Institute of Engineering Foundation, Venezuela
Gunawan, Iwan	BPPT, Indonesia
Helmer, Eileen	USDA Forest Service, USA
Higuchi, Niro	INPA, Brazil
Huber, Otto	Universidade Simon Bolivar, Venezuela
Huppe, Heather	USAID, USA
Hyman, Glen	CIAT, Colombia
Janetos, Tony	World Resource Institute, USA
Justice, Chris	University of Virginia, USA
Karim, Othman A.	Universiti Kebangsaan Malaysia, Malaysia
Kisting, Harold	Ministry of Environment and Tourism, Namibia
Kushlin, Andrey	The World Bank,USA
Kwesha, Dominick	Zimbabwe Forestry Commission, Zimbabwe
Li, Zengyuan	Chinese Academy of Forestry, China
Mahmud, Mastura	Universiti Kebangsaan Malaysia, Malaysia
Maiden, Martha	NASA Headquarters, USA
Mayaux, Phillippe	Africa Coordinator TREES Project,
Moreau, Sophia	ABTEMA, Bolivia
Mwale, Paulos	SADC Forestry Technical Co-ord. Unit Mawali
Navanugraha, Charlie	Mahidol University, Thailand
Nlyungeko, Jean	C/o Tropical Soil Biology and Fertility Programme (TSBF), Kenya
Pandey, Devendra	Director Forest Survey of India, India
Pereira, Joao Anonio Raposo	IBAMA, Brazil
Plume, Catherine	WRI, USA
Putera, Agus Eka	SEAMO BIOTROP, Indonesia
Rahmadi, Andi	BPPT, Indonesia
Ranson, K. Jon	NASA Headquarters, USA
Rasool, Ichtiaque	Office National des Forests, France
Roy, David	University of Maryland,USA
Salas, Bill	University of New Hampshire,

Samek, Jay	Michigan State University, USA
Sanjaya, Hartanto	BPPT, Indonesia
Santos, Virgilio	NAMRIA, Philippines
Shrestha, Narayan kaji	Forests, Trees and People's Programme Kathmandu, Nepal
Shugart, Hank	University of Virginia, USA
Silapathong, Chaowalit	Thailand Remote Sensing Center
Singh, Ashbindu	UNEP, USA
Skole, David	Michigan State University, USA
Suyamto, Des Ariyadhi	Southeast Asian Impacts Centre,Indonesia
Townshend, John	University of Maryland, USA
Turner, Woody	NASA Headquarters, USA
Virji, Hassan	START Secretariat, USA
Williams, Darrel	Landsat Project, NASA / GSFC, USA
Yanda, Pius	Institute of Resource Assessment , Tanzania
Yanine, David	IDEAM, Colombia
Yasuoka, Yoshifumi	University of Tokyo, Japan
Zhiliang, Zhu	EROS Data Center, USA

Appendix 2: Workshop Agenda

Day 1, March 15, 1999
9.00 am - Welcome from START – Hassan Virji

Session 1. Introductory Session

Objectives of the Meeting – Chris Justice
CEOS Pilots and the GOFC Objectives – Martha Maiden
GOFC Current Design – Frank Ahern (30 minutes)
- Land Cover / Land Cover Change
- Biophysical Attributes
- Fire Monitoring

GOFC and policy and reporting implications for Climate Change – Tony Janetos

10:00 am - Coffee Break

Summary of Global Change GOFC Tropical Data and Information Requirements – Dave Skole
Summary of Tropical Forest Management Data and Information Requirements – Alfred DeGrier
Comments on the World Bank's activities on sustainable forestry - Andrey Kushlin

12.00 - Lunch

Session 2. What is currently being done that fits the GOFC Framework

Examples of Tropical Forest Mapping and Monitoring Projects

A series of 10 minute presentations will provide examples of existing tropical forest mapping and monitoring projects, briefly summarizing the data, methods used and lessons learned for operational forest monitoring.

South America
- João Periera
- Ichtique Rasool
- Glen Hyman
- Sophie Moreau

Asia
- Li Zengyuan
- Devendra Pandey

Africa
- Dominick Kwesha
- Manuel Ferrao
- Paul Desanker
- Harold Kisting

Southeast Asia
Ongsomwang Suwit
Iwan Gunawan
Virgilio Santos

Global Forest Watch – Dirk Bryant and Catherine Plume

Tea Break

Session 3. Examples of Data Sets and Projects for GOFC Tropical Studies

A series of 15 minute presentations will provide examples of satellite data and their availability for tropical forest monitoring**.**

Overview of remote sensing data sets for GOFC – Chris Justice
European data sets for tropical forest monitoring – Philippe Mayaux
EDC AVHRR 1km data and the Global Forest Mapping Project – Zhiliang Zhu
Radar data for tropical forest monitoring - Vic Taylor/Frank Ahern
Landsat Pathfinder Data Sets – John Townshend / Dave Skole
Landsat 7 status report and tropical acquisition planning - Darrel Williams

Summary of the day and Planning for Day 2 – Chris Justice

Day 2, March 16 – 9.00 am

Session 4. Breakout Group I - How could we build on existing activities ?

- Africa
- South and Central America
- Asia
- Southeast Asia

Topics to include: developing operational demonstrations of mapping, change detection, data, networking, capacity building, reporting

Plenary Report Back

12.00 Lunch

Session 5. Breakout Groups II and III

(Regional working groups from the previous session were maintained but the charge to them was expanded to include the following questions. Therefore, the groups responded by identifying gaps (II) and resources (III) within their region.)

II. What are the gaps and how do we coordinate activities into GOFC operational pilot projects ?

III - How would we go about scoping and securing resources needed to implement GOFC tropical component ?

Plenary Report Back from Breakout Groups

6.00pm Social Event

Day 3, March 17 9.00am

Session 6. Strawman Approach to GOFC Tropical Implementation

Panel Discussion: building and strengthening the GOFC Tropical Partnerships: desired activities and next steps.

Coffee Break

Formulation and discussion of workshop recommendations: open discussion

Finish at 12.00

Appendix 3: Reports from Breakout Groups generated at the Workshop

GOFC **Southeast Asian** Breakout Group Report

Chair: Dr. Iwan Gunawan, BPPT, Indonesia
Rappateur: Mr. William Salas, UNH, USA

Breakout Session #1: Current activities in region

1. Roundtable Discussion: Current activities relating to forest mapping and monitoring in region were discussed and summarized. Discussion revealed that there are numerous activities in region that could both help and benefit from GOFC. These activities are at various stages of development and implementation. General themes and outcome of these discussions were:

- Existing infrastructure for systematic forest mapping exists in Southeast Asian region. Within the region, the institutions involved in this type of research vary from academia to national agencies.
- There are several new initiatives and projects focusing on forest fire mapping and monitoring. While these projects are in the demonstration phase and are not yet operational, there are plans to move toward operational framework.
- There are several conservation sites within each country that are routinely mapped in detail. Experiences and data from these activities could prove to be valuable for a GOFC regional pilot.
- It is clear that coordination within countries in the region is severely lacking. There was a consensus that this is a major obstacle and plans are needed to establish formal coordination within country and within region.
- It is clear that for the countries (Indonesia, Malaysia, Philippines, and Thailand) that participated in this discussion, there exist adequate knowledge and technical expertise and experience for forest mapping activities. However, this expertise may not exist in all countries in the region (e.g. Burma, Laos, and Vietnam). There should be an attempt to engage these other countries through some level of technical interchange and plans to expand the current regional network.
- While several countries are poised to implement forest mapping and even monitoring type activities, it was clear that a major constraint is availability of adequate satellite data. For example, availability of high quality, low cloud cover data in the Philippines prevents any systematic forest mapping initiatives. Some parts of the Southeast Asian region are severely data limited.

2. Regional Needs:

- Develop regional baseline data.
  - Basemap at 1:1,000,000 scale.
  - Regional GOFC classification scheme needs more thought. The current classification scheme does not include classes that are important to this region. For example, development of aquaculture in mangrove forests is an important agent of forest conversion in the region and would need to be separated from other types of forest conversion. Plantation forests are another

important forest class in this region. Key Southeast Asia regional exceptions to the broad GOFC classification systems need to be identified.
- Temporal frequency of forest inventories for monitoring should be in the 3-5 year range.
- Validation of regional and national products is critical to the success of GOFC. Existing National datasets should be the focal point of the validation activity.
- Map projections need to be standardized. Existing national spatial databases are in different projections or use different datums. There is a need for developing a region wide standard. This should be incorporated into the basemap product.

3. Southeast Asian GOFC Operational Demonstration Project: Approaches for initiating regional GOFC demonstration project were discussed. A phased approach was agreed upon. Initial activities should focus on and build off of ongoing case studies along with a creation of an initial regional baseline using existing national/regional data. Follow up activities should focus on creating new regional data sets using a standard set of protocols and methods based on new suite of satellite data that will be available over the next few years. Current satellite data availability severely limits the prospects of a successful GOFC pilot in Southeast Asia. Regional "data bundles" of satellite data including, for example, Spot VEGETATION and Landsat 7 ETM are needed to update the initial regional analysis with a more recent baseline derived from remote sensed data using a standard approach for the region.

Approach for the initial activities:

Build off existing case studies in region e.g.:

- Use sites developed for SARCS/LUCC case studies. These sites should include the phase 2 sites in Indonesia, Malaysia, Philippines, and Thailand.
- Use BIOTROP sites in Indonesia (Jambi Province in Sumatra and Western Kalimantan).
- Create new sites to expand regional coverage to include more countries in region (e.g. Burma, Laos, and Vietnam).
- Create new sites to capture regional environmental, scientific, political, and social issues in region (e.g. site in Indonesia to study forest fire and trans-boundary haze).

Regional harmonization of existing data sets.

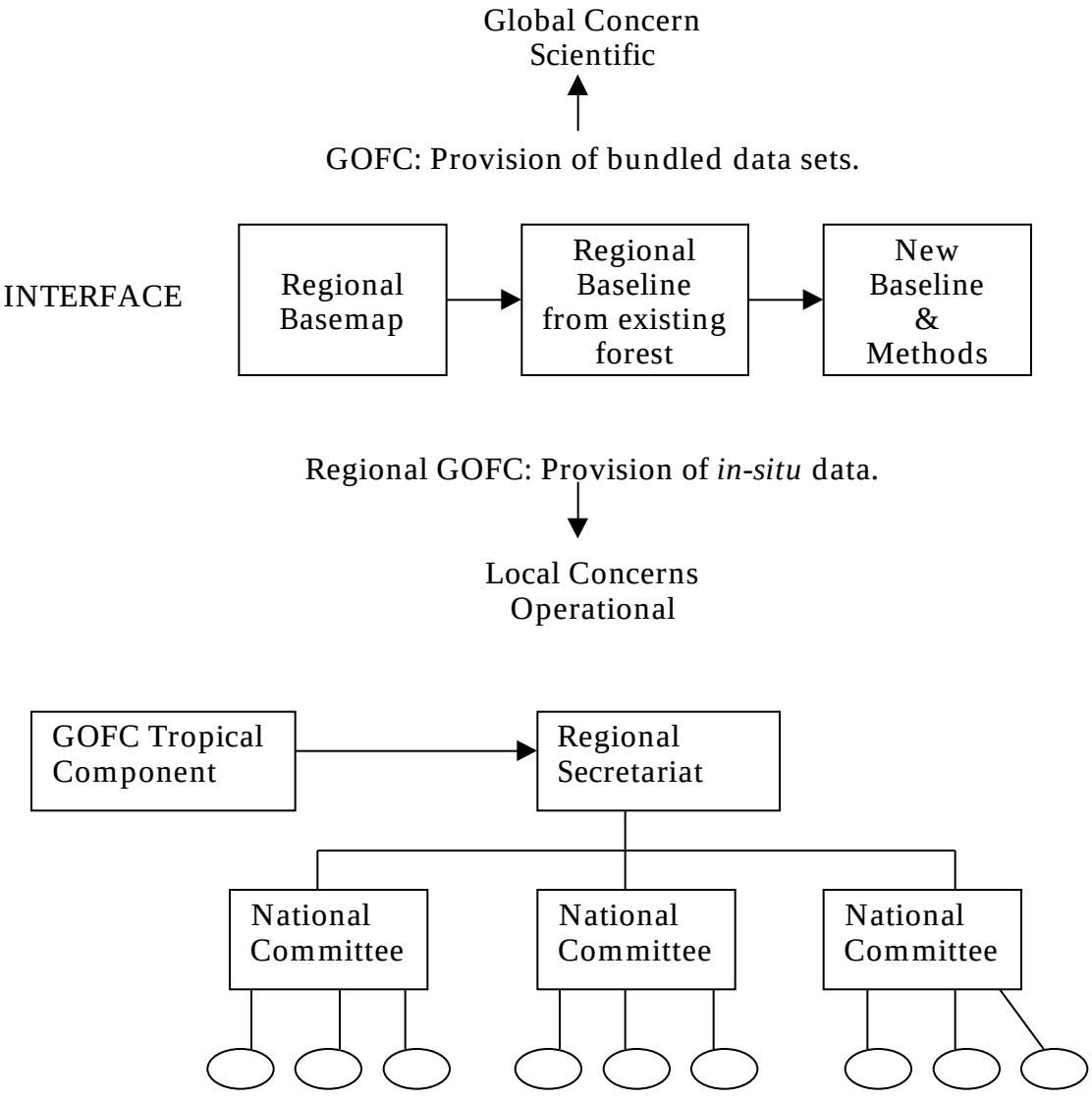
- There are many forest mapping and monitoring projects in the region. The results from these projects represent an extremely useful resource and taken collectively could represent an initial baseline data set for GOFC.
- There are several technical issues in the harmonization process that will require careful attention to create an initial regional baseline data set for GOFC. For example, differences in data standards across region and different national objectives exist that have potentially strong implications for regional harmonization.

Breakout Session #2: What are the gaps and how do we coordinate activities into regional operational pilot projects.

- Main Assets:
  - Demonstrated commitment in region for forest mapping and monitoring.
  - Proven record
  - Open, existing network.

- Existing projects to build GOFC:
  - SARCS/LUCC Case Studies
  - Expanding the network

There should be a balance between global, regional, and national requirements.



Think of GOFC as a framework for regional and national cooperation! GOFC will not meet all the national needs in region, nor will the national projects meet all of the GOFC requirements. Need to focus on best way to build a bridge between these activities.

Possible funding scenarios:

- Data only. CEOS partners create regional data bundles for use in existing activities in Southeast Asia.
- Data and core funding support. CEOS partners create regional data bundles and provide some core funding to support regional project office for GOFC and coordination workshops.
- Data, core funding support, and pilot applications: CEOS partners create regional data bundles, provide some core funding to support regional project office for GOFC and some workshops, and provide some funding for regional pilot project(s).
- Full GOFC support: Support to create operational GOFC system for region. Not a realistic scenario at this point.

The group spent some time discussing possible suggestions for GOFC activities in region over the near to mid-term timeframe. It was suggested that a regional project office for GOFC be developed. The role of this office would be to facilitate and coordinate the initial tasks of basemap generation, harmonization of existing data sets to create baseline, and methods for development of new baseline data set using CEOS provided data bundles of satellite data.

Near term activities: next 6 months

- Assessment and documentation of baseline datasets and products with an evaluation of their availability. Dr. Sharifah Mastura Syed Abdullah from Universiti Kebangsaan Malaysia offered to synthesize these materials for the region provided each country provides a listing of their country data sets.
- Coordination to develop requirements for the regional office.
- Develop strategy for obtaining core funding support.
- Plans for expanding within existing countries and plans for engaging other countries in the region.

Mid-term activities: next 12-18 months

- Development of initial basemap.
- Workshop to define harmonization approach and plans for the development of new baseline data set from CEOS data bundles. This workshop should be held within next 12 months to keep momentum from this initial workshop.
- Select sites for pilot activities. Will need guidance on how GOFC will evolve to provide insight into best approach for expanding the regional network.

GOFC **Africa** Working Group Report

Group Composition:
Pius Yanda (Chair)
Paul V. Desanker (Rappateur)
Harold Kisting
David Roy
Dominick Kwesha
Manuel Ferrao
Paulos Mwale
Jean Niyungeko
Philippe Mayaux
Matt Hansen
Dirk Bryant

Next Steps for Africa

- Baseline Mapping for the Miombo Region, SADC Region
- Pilot Monitoring Activities - Change and Degradation (Conservation Areas and Forests)
  Spatial and Temporal Monitoring of Miombo (in the context of a land use typology and models - carbon, biodiversity and hydrological applications)
- Land Cover Attributes for 1-km Mapping and Continuous Fields
- Synthesis of Available Data (Biomass, Forest Inventory), and Development of Conceptual Models for Carbon and Sampling Design for Monitoring Forest Cover and Change, and Degradation
- Workshops: Satellite Forest Carbon Models and in-situ Biomass Data
  State of the art for using remote sensing in forest inventories for the miombo region, case studies, design of a forest information system for GOFC, library of forest inventory data
- Workshops: Biodiversity Mapping: Intact versus fragmented mapping of the Miombo Region
  Results of the regional mapping and identification of hot spot areas for detailed monitoring.
- Meta-data: what is available high resolution data and its richness (e.g. TM)
- Twinned Research Proposals
- Miombo Forest Characterization Tool - Graphics / Web display and access to different data sets for the miombo region.
- Commercial Data Buy for the Miombo Region, including gap-filling for historical data

Additional Operational Projects

a. Regional Projects
   - The Miombo Network is developing a regional land cover map (for the miombo countries of Angola, Zambia, Tanzania, Malawi, Mozambique, Zimbabwe, and parts of the Democratic Republic of Congo). This is based on national land cover maps developed during the early 1990's based on Landsat TM.

- SADC has developed proposals for regional-level mapping and forest inventory, funding has yet to be identified.
- TREES is involved in central Africa through the REIMP project, among other activities.
- CARPE
- FAO's Africover has ongoing mapping activities in Africa.

b. National Projects: Various national mapping efforts based on combinations of Landsat TM, SPOT, and Radar for the 1990's for Southern and Central Africa - complete details available vary by country. Data availability an issue in certain countries - digital products available for a price. National mapping and monitoring activities were funded by different developmental/aid agencies such as World Bank, US AID, European agencies (GTZ, etc). The products listed below are just examples, complete and accurate information for all countries not readily availability during discussions.

Tanzania
- National mapping project based on 1995 Landsat TM data, funded by the World Bank, produced land cover map sheets covering the whole country.
- Detailed stand-level mapping at several sites as part of other projects.

Malawi
- National mapping based on 1992-3 TM data.
- Malawi Environmental Monitoring Project (MEMP) funded by US AID to monitor expansion of agriculture at a national level.

Mozambique
- 1985 National Land Use Map
- National Forest Inventories that produced biomass maps at scales from 1:50K to 250K
- Provincial Forest Inventory based on TM
- Latest mapping of land cover nearly complete (8 of 10 provinces complete) using Landsat TM data of year of mapping, so data from 1995-1998 (map will be mosaic of maps developed with different years data).

Zimbabwe
- National Land Cover maps using TM at 1:250,000 for 1992
- Monitoring activities with extensive field campaigns in hot spot areas for forest and catchment management and biodiversity
- Inventories of gazetted forests
- Plot-level measurements for forest growth and yield

Namibia
- Forest Cover Map 1992-94 based on TM and SPOT (1:50,000 finished)
- Continuous Forest Inventory plots established recently (300-400)
- Studies of fire scars in the Caprivi
- Environmental Profiles and Monitoring on-going.

Central Africa: *Country; Institution; Product; Data; Date; Level*

- CAR; PARN; Land Cover map and Forest Inventory ~1:150,000; aerial photos; 1993; over Forest regions
- Cameroon; CETELCAF; Forest types map; 1:500,000; Landsat TM; 1992, National level
- Gabon; Dir. De Eaux et Forests; LC Map and Forest Inventory, 1:200,000; radar JERS and aerial photos; 1996; 2/3 country
- DRC; SPIAF; Forest Map 1:1M; Landsat (1985); 1995; National
- Eq. Guinea; CUREF; LC Map at 1:100,000; SPOT; 1997; National level.

Lessons Learned

- Many national projects have successfully mapped land cover/land use, using mostly visual interpretation. Maps are a combination of land use and land cover.
- Single time imagery (TM, SPOT, Aerial photos) reflect current climatic regimes - extreme climatic events such as those related to El Nino can give misleading impressions)
- Routine satellite monitoring constrained by: capacity (brain drain, high turn-over), costs and equipment, lack of continuity between projects, lack of coordination between projects with different objectives by using similar data
- Vegetation type discrimination difficult by TM
- Extensive ground truthing is required for visual interpretation
- Visual interpretation is time consuming - takes 3-5 years for national mapping projects, after which information needs to be updated.
- There are a lot of heritage databases - not always well documented for new applications, and not always suitable for newer applications (new variables needed).
- Data availability is often a constraint - cost, as well as availability of imagery esp for Central Africa.
- Small initiatives are constrained by cost of TM data.

Potential Contributions of Existing Projects to GOFC

- Context, institutions and familiarity with local forests and mapping
- Process studies to help "understand" causes and trends in land cover change ("hot spots", etc), in particular the social and economic context of land use and land cover changes.
- Detailed data for calibration and validation.
- Joint activities especially in "hot spot" areas.

Role of Regional Networks

- Existing relationships through networks can facilitate data distribution.
- Leverage to negotiate discounts for data from commercial stations (e.g. SAC).
- REIMP has negotiated a discount of 30% on SPOT data for its members.
- Regional Networks should facilitate regional harmonization of national maps (not individual institutions).

Priority of Regional Needs

- Baseline land cover (or forest map) for whole region before any monitoring can commence [will GOFC develop global or regional baseline maps, or will subregions use their own baselines??] Would these have to apply a uniform GOFC legend?
- Data is required ideally at multiple times per year for hot spot areas where there is national or project interest, annually. Capacity and methods required to process data timely. Most data needed are TM and SPOT, less familiarity with others.
- Regional coverage to be linked to GOFC requirements in terms of timing.
- Other products such as VCL, offer great potential for new measurements - however need better understanding of the numerous opportunities offered by these new instruments.
- Airborne Video and other data for validation of GOFC products are another priority.

Adequacy of Interpretation

- Miombo nations have extensive expertise in visual interpretation. However, interpretation difficult for single scenes.
- There is increasing potential for unsupervised methods. On-going efforts are testing different approaches.
- Databases exist to train classification - need collation / rescue.
- Will GOFC require a uniform classification process across the regions?

Product Accuracy Requirements

GOFC products will need to be validated.

National and regional policy needs high accuracy. National mapping efforts have typically required 80% accuracy or better.

Data Delivery Systems

Users will need flexible delivery - timely, not only web-interfaced, but also CDs and mail.

Regional data archiving (data warehouses) are desirable - however long-term commitments are difficult without long-term core funding.

Suggest regional points of contact to act as conduits of information to users and back to data providers.

Thoughts on Implementation at Regional Level

- Build upon existing networks and groups
- Allow new projects or new regional groupings to develop based on common themes and questions outside of existing frameworks.

Common Goals between National and GOFC

The following are some of the common goals between national interests and GOFC that should guide pilot projects:

- Carbon and biodiversity reporting required for biodiversity and GCC conventions
- Biomass for national forest planning and management
- Process understanding of land cover changes
- Spatial analysis - identification of special areas for their value, goods or services: e.g. potential new conservation areas, carbon sequestration projects, monitoring of concession areas.

GOFC **Asia** Breakout Group Report

Session 1

I. Existing Programs

Country	Sensor	Scale	Map classes	Cycle	Use	Institution
China	TM, SAR	1 M, 250K	Veg type & forest density	5 yrs (1st time)	Policy & planning	CAS, CAF
Nepal	Mixed	250K	Same	10 yrs	Policy, management	ICIMOD, FRDP
India	IRS (LISS II)	250K	Same	2 yrs	Policy & planning	FSI, Dept. Space
Japan	JERS	Regional			Land cover	
Other countries to be identified and entered						

II. Role of regional network

1. Strong need for regional network is recognized. A regional network suitable for GOFC purposes does not exist today in Asia.
2. Compatibility and standardization of the national products are highly desirable.
3. Exchange of methodology is an important task of the regional network.
4. Assist in field data collection, validation of products.
5. Potential networks to build upon: FAO and AIT.

III. Prioritization of regional needs

1. Fine resolution optical and SAR at affordable price.
2. Need to improve interpretation techniques and classification scheme compatibility.
3. Accuracy assessment is essential.
4. GOFC to promote capacity building.

IV. Operational demonstration project

1. Use high quality satellite data for estimate biophysical parameters.
2. Create an integrated Asia forest cover database, including operational forest cover mapping.

3. Produce a regional data bundle (by CEOS), including field data.

Session 2
Question: What could the region do for GOFC?

Recognizing that there is a lack of "GOFC" network in Asia, we propose to establish and facilitate an Asian GOFC regional network consisting of:

- Forest monitoring community
- Satellite data providers / agencies
- Research community

The network will operate using email communications. Need to identify official national representatives to GOFC to provide a "mandate" for national programs.

Propose a regional workshop in the next 9-12 months. Invite the network country representatives, ministry level officials, carbon researchers, and space agency resource people. Will request financial support from GOFC and START for the workshop. Workshop will be hosted by Forest Survey of India with the following preliminary agenda:

I

- Forest monitoring
- Management agencies
- National inventory system
- Classification system

II

- A strategy toward an integrated Asia forest cover database
- Discussion on carbon budget and other science issues
- Within national, regional, and international policy context

Question: What can GOFC do for the region?

- High quality satellite data at affordable price
- Institutional strengthening (capacity building and more)

Session 3
Question: What to do next?

- Participants at the Washington DC workshop will brief country ministry-level officials about GOFC.
- GOFC will inform country ministries about GOFC objectives and the intention of the regional network.
- Forest Survey of India will take the lead to establish this Asian network.
- The network will develop a proposal for the workshop, and will request resources from START and GOFC.
- Hold the workshop as planned.

GOFC **Latin America** Breakout Group Report

Session 1:
Present
Frank Ahern, CCRS
Woody Turner, NASA

Sophie Moreau – Chair, La Paz *Bolivia*, There is a lack of coordination in Bolivia. There is a 1992 land cover map for Bolivia and most mapping is with Landsat. The deforestation calculations from different studies do not agree. There is a lack of coincidence in the land cover maps. ABTEMA has a AVHRR and SeaWifs receiving station. ABTEMA is trying to coordinate to address problems of duplication of effort and data availability. The new Forestry Superintendency of Bolivia has a mandate for monitoring the new Forestry Law. The National Met and Hydro Service could participate in GOFC as a data provider and user, especially related to global climate change inputs. PROMOBOSQUE, a technical branch of the private sector, is monitoring forests and interested in sharing data. There is a need for training and development of methodologies for classification and monitoring. There is a lack of funding and development of human resources. SINAB, the association of native American groups, has a GIS lab and is interested in participated in land cover, land change activities.

John Townsend, Univ. of *Maryland*, Landsat Pathfinder Project. They support GOFC through Pathfinder. They could work on data sharing and availability issues, including metadata. They want to make data available at low costs and accessible. There is a need for standardization and GOFC could work towards availability and standardization.

João Pereira – Rapporteur, Brasilia, *Brasil*, IBAMA. Environment, forest, wildlife and rubber are the historic foci of the institutions that were merged to form IBAMA Offices in every state in Brasil, national parks and reserves, Forest exploitation planning. Brasil is going through some decentralization; remote sensing center in Brasilia with network of RS labs in Brasil. A user of INPE information, mapping of 240 scenes of the Amazon for deforestation calculation, 1:250,000 scale 6.5 ha accuracy, they released 97 data last year, work with law enforcement of forestry activities; fire work in the PROARCO program with daily fire information on web pages (www.ibama.gov.br).

Icthiaque Rasool, International Consultant- – *USA (working in Brasil)* – long term vegetation change in Mato Grosso, Brasil; working with INPE, French Guiana,

Niro Higuchi, INPA,….. IGBP, LBA College *Brasil*, in-situ studies, ground truthing, (we need to invite institutions, not individuals; UNAMAS, Association of Amazonian Universities has developed network related to forest in Amazonia, office in Belém Brasil)

Franciso Oliviera, ecologist, FCAP, University of Agrarian Science, Belém, *Brasil*; in-situ studies in ecosystem ecology and biogeochemical processes; links with

EMBRAPA, CPATU (agroforestry branch of EMBRAPA). SCETAM – local secretary of the Environment.

David Yanine – *Colombia*, IDEAM, Instituto de Hydrology, Meteorology and Environment. Subdirectorate of Ecosytems. they are working on Land Cover mapping (David showed 1.5 m scale map) from images, 67 Landsat TM scenes with plans and mandate for updates and monitoring every 2 years. Colombian Environmental Information System – a network of 5 principal institutes and 34 regional autonomous organizations. . Von Humbolt Biological Institute, Amazonian Research Institute,

Glenn Hyman – International Center for Tropical Agriculture (CIAT), Cali, *Colombia* CIAT has land cover monitoring projects in the Central American hillsides, the Colombian Savanas and the Peruvian lowland Amazon. These projects are use Landsat and radar data.

Ashbindu Singh, UNEP / GRID, Regional Coordinator, Environmental Information and Assessment – North America. 2 activities relevant to GOFC; Data inventory in Central America and high resolution land cover map for Central America – all for post MITCH reconstruction work…… Landscape ecology and gap analysis for Ecuador, Peru, Bolivia, Paraguay, project is associated with CDC (Conservation Data Center) centers in each country - under Biodiversity Convention and Global Environment Facility.

Otto Huber, vegetation, Univ. Simon Bolivar, *Venezuela*, ground truth, forest inventory, botany, terminology in vegetation science.

Francisco Guerra, Geographer, *Venezuela*, Engineering Inst. Digital image Processing Center, Univ. Simon Bolivar. LUCC-IGBP responsible in Venezuela, TREES work for Ven.

Eileen Helmer, Int'l Inst. Of Tropical Forestry, USDA Forest Service, Puerto Rico, Land cover and vegetation mapping of the *Caribbean islands* with Nature Conservancy and Eros Data Center. Puerto Rico will be pilot study area before rest of the region. They are working on mapping methodologies related to automated classification, eg the use of forest inventory data and other ancillary data in the classification process.

Alfred de Gier, ITC, Forestry Division Head, Training and Research, participation of international projects with the aim of institutional strengthening and capacity building, users are main focus. There is a need for tailored training that perhaps ITC could fill under the umbrella of GOFC. ITC has very strong land use and remote sensing programs. He sees ITC with a supporting role, in the areas of capacity building.

<u>People and Institutes that should be involved in GOFC</u>

Von Humbolt, Amazonian Research Institute, Inst. Geografico Augustin Codazzi,

Peruvian Amazon Research Institute (IIAP) Iquitos, Peru, Fernando Rodriguez Achung, Director Programa de Ordenamiento Territorial, IIAP, Av. Abelardo Quinones Km. 2.5 Iquitos. Tel (094) 265515. Fax. (094) 265516. Email. poa@rail.org.pe.

Carmen Meneses – SICA, Jefa, Sistema de Informacion Computerizada del Ambiente, Ministry of the Environment y Renewable Natural Resources

CIDIAT-GTZ, Interamerican Center for integrated Development Land and Water

Elvecio Pernia, Faculty of Forestry, University of the Andes, Merida, Venezuela

Maximina Monasterio-Univ. of the Andes, CIELAT International Center for Ecological Studies of the Tropical Andes

Latin American Forest Institute- Merida

SIGIS (Alejandro Cinaceiso) private consulting firm

CCAD – Central American Commission on Environment and Development - Mesoamerican Biological Corridor – 100, 50, 12 m data from JERS-1 with Landsat to bolster data. They have an airborne SAR mission for selected sites

Experimental University of Guayana (Elio Sanoja)
SILVOLAB – French Guiana
SIVAM – Brasil – Surveillance of the Amazon

UNAMAZ Association of Amazonian Universities has developed network related to forest in Amazonia, in Belen Br

Ministry of Science and Technology – Brasil GCC / IPCC
Ministry of Environment –PPG7 Program
Environmental Secretaries of each state in Brasil.

<u>Generalizations in Session 1 discussions</u>

1. There is a variety of specialized work going on in every country
2. Difference in knowledge level and need for a harmonization (training and methodology exchange)
3. Varying levels of usage of satellite data and development of forest information systems (Nat. Mapping –TM, Specific Mapping Radarsat,ERS,JERS and AVHRR data ready available at Local Stations)
4. There is great enthusiasm and willingness to participate to GOFC in every nation
5. There is a lack of coordination inside and between countries
6. There are difficulties with respect to data availability, sharing, metadata and other data issues (specific agreements)
7. There is a an interest is in more detailed land cover knowledge, beyond forest-nonforest classification

8. There are many organizations that should be in GOFC, including private sector organizations - and we have made a list of these
9. We need to identify needs and benefits in the context of GOFC

Session 2

What would the LAC group like to do under the GOFC project, what technical objective?

PRODES – annual wall to wall assessment of land cover change in Amazonia, with more emphasis on hot spots. PanAmazonas is PRODES but includes all the Amazon countries. PATHFINDER focuses on 70's, 80's and 90's land cover change, is evolving toward digital analysis and away from visual analysis.

What is the best way to set up a national and regional forest monitoring system? PRODES+PROARCO+LBA+PATHFINDER methodological and institutional models for development coordination for improved methods, standardization;

IGBP (with office in Brasil) could be a vehicle or arm for GOFC in South American region. NASA

Georeferencing images is a technical constraint. Landsat has a global georeferencing project and GOFC will facilitate access to this project.

We need pilot studies. Not only for technical problems, but for institutional problems as well.

Potential Pilot Projects

- Colombia – piggyback on TREES to develop methods and foundation for national scope programs similar to Brasil.
- Work in the border areas between South American countries
- Caribbean region. Puerto Rico (4 TM scenes) in conjunction with USDA, could be pilot study area
- NASA project in Central America could be a vehicle for remote sensing

Workshops and training proposed

- Workshop to discuss institutional and methodological aspects of setting up operational forest monitoring projects. One objective would be to help countries that are trying to get established in forest monitoring.

Appendix 4: Panel Discussion

Panel Discussion, March 17, 1999
Led by: John Townshend

Key points made by panel members:

Chris Justice
- GOFC is about making and utilizing linkages: networks and partnerships;
- GOFC should facilitate creating opportunities to secure necessary new resources;
- GOFC will succeed best if it results in a participatory, internally developed and operated monitoring process, rather than an external process;
- This workshop has shown that tropical portion of GOFC should take a regional approach to implementation;
- The regional networks will require nurturing; intra-regional opportunities need to be addressed later;
- GOFC will only succeed to the extent that those who have the ability make something happen;
- The regional networks need network points of contact and CEOS resource facilitators;
- GOFC will need to address issues of equity, credit and recognition for contributors; START has experience in this area and can help;
- We can identify three levels of project:
  - Minimum: can be done with new data provided to existing projects;
  - Medium: needs new data plus core funding to the network;
  - Maximum: needs new data plus core funding to the network plus funding to carry out specific activities.

Frank Ahern
- GOFC is a mechanism to bring people together and get things done;
- The best results will be achieved through "learning by doing": get projects started and produce significant results.

David Skole
- Produced a diagram showing the many linkages which can involve GOFC;
- Suggested that it may require the creation of a "GOFC Institute" with broad participation.

Sophie Moreau
- GOFC will succeed when we all make it "our" project;
- Each group should consider what it can contribute;
- We need to leave the meeting with a facilitator / focal person for each region;
- Each region should build an electronic link (not a web page);

Hassan Virji
- An important issue is what is the real nature of the partnership?
- START wants to be a strong partner; START can help with:
  - Regional workshops;

- Training;
- Summer students;
- Facilitating the formation of the Latin American network.

Philippe Mayaux
- There certainly is a need for better coordination of activities;
- Need many partners coming from the forest ministries as a condition of success.
- Some priority areas for R&D work:
  - Change detection;
  - Validation of products;
  - Networks and accessibility of data and products.

Dirk Bryant
- Who is the constituency; who is the client?
- Need to bring end users in at the beginning;
- The clients should include the private sector and civil society.

Discussion from the Floor:

Ichtiaque Rasool: Few CEOS agencies are concerned about the user; what can GOFC do to balance the carbon budget?

> Responses:
> Townshend: The space agencies are trying to do better; IGOS is an expression of this; some space agencies are hamstrung.
> Ahern: The new Landsat-7 data acquisition and distribution policy is an example of a serious attempt to make earth-observation data more available and more used.
> Skole: there has been considerable advance by the research community in understanding Amazon deforestation. The carbon budget is not closed because of the biomass uncertainty. The community is now asking new and more difficult questions. The large inter-annual variability in deforestation creates additional problems.

Devendra Pandey:
- GOFC needs to become better known, as a partnership which can facilitate the use of earth-observation data for sustainable development;
- The mandate of GOFC needs to be well spelled out;
- The design teams should include the regional representatives.

John Townshend:
- CEOS does not want to own GOFC; it wants buy-in from other organizations;
- It is an IGOS pilot project which means that GOFC is supposed to be prototypical;
- Some aspects should become operational in a short time frame;
- Long term operation will not be done by NGOs, universities, or research groups; it will be done by governments; therefore we need a mechanism to engage governments;
- The GOFC classification system must include the FAO classification;

- We need a formalism for the organization.

Iwan Gunawan (?)
- Regular observation of forest cover has to become routine at the national level;
- Have to build a constituency in many parts of the world;
- Education and outreach is important; reach the general public with a leaflet or poster;
- GOFC is a process; this was a fruitful meeting with a good outcome;
- It is important to identify this activity primarily as a public service rather than a means for strong-arm governance.

Paulos Mwale
- Need to form linkages with the UNFCCC and the Convention on Biological Diversity; governments will relate to this.

Ichtiaque Rasool: Are their minimum quality standards for products to be accepted for GOFC?

> Response (Martha Maiden): Products will have to include documentation of quality, not quality standards per-se.

Alfred de Gier: human and institutional capacity is an issue.

> Response (Chris Justice): Experience has shown that capacity building cannot be done in a vacuum, on-the-job training (participating in actual projects) and capacity building is very effective. Projects will need the resources to get the job done.

Hassan Virji: What is the status of the non-tropical portions of GOFC:

> Response (Chris Justice):
> The boreal/temperate part will be different; there already exist some good activities in this region;
> The Forest Fire Monitoring and Mapping component is moving quickly and is very promising a coordination workshop is planned for November;1999.
> The Forest Biophysical Processes component will help move from remote sensing R&D to operational products.

Narayan Kaji Shrestha: This workshop has neglected the human side; the Nepalese experience on popular management is that data and studies can be misused by government against the interests of the people.

Appendix 5: Table reproduced *(with permission)* from de Geir et al. 1999

Table: Ranking* of the relative importance by theme for the different user levels

Theme	Global	Supra-national	National	Sub-national	Local
Land and forest cover	1	1	1	1	1
Forest degradation	1	1	1	1	1-2
Forest function allocation	3 (1)	3 (1)	1	1	2 (1)
Forest types	2 (1)	2 (1)	1	1	1
Biodiversity	1	1	1	2	3 (1)
Biomass data for carbon sequestration	1	1	1	2	3
Land tenure	3	3	1	1	2
Fire damage	2	2	1	1	1
Fire hazard	3	2	2	1	1
Fire detection	2	2	2	1	1
Forest health	2	3	1-1	1-2	1
Forest products	3	2	2	1	1
Forest-depending communities	3	3	2	1	1
Stand parameters	3	3	3	2	1
Site parameters	3	3	2	2	1
Socio-economic parameters	3	3	2	2	1

***1 = high, 2 = moderate, 3 = low**

The numbers between brackets are the ranking expressed by NGO representatives, if this differed from the ranking by the GO representatives

Appendix 6: List of Acronyms

ADEOS-2	Advances Earth Observing Satellite
AIT	Asian Institute of Technology
APAR	Active Phased Array Radar
ATSR	Along Track Scanning Radiometers
AVHRR	Advanced Very High Resolution Radiometers
CARPE	Central African Regional Program for the Environment
CBERS	China Brazil Earth Resources Satellite
CEOS	Committee on Earth Observation Satellites
CIAT	Centro Internacional de Agricultura Tropical
CSI	Consortium for Spatial Information (CGIAR-affliated)
DISCover	Data and Information Systems Cover
ECOFAC	Ecosystems Foresttiers d'Arfique Centrale
ENVISAT-1	Environmental Satellite 1
ERS	Earth Resources Satellite
ESA	The European Space Agency
EU	European Union
FAO	Food and Agriculture Organization of the U.S.
GIS	Geographic Information Systems
GLI	Global Imager
GOFC	Global Observation of Forest Cover
GRFM	Global Rainforest Mapping Program
GTZ	German Society for Technical Cooperation
IBAMA	Instituto Braaileiro do meio Ambiente e dos Rescursos Naturais Renovavis
IGBP	International Geosphere Biosphere Programme
IGOS	Integrated Global Observing Strategy
INPE	Brazilian National Institute for Space Research
JRC	Joint Research Center European Commission
MERIS	Medium Resolution Imaging Spectrometer
MODIS	Moderate Resolution Imaging Spectroradiometers

MTV	Monitoring Tropical Vegetation
NASA	The U.S. National Aeronautics & Space Administration
NASDA	National Space Development Agency of Japan
ONF	French National Office of Forestry
PROARCO	Programa de Monitoramento de Queimadas e Prevenção de Controle de Incêndios Florestais no Arco do Desflorestamento na Amazônia (*Program for monitoring of buring and planning of control of forest fires in the arc of deforestation of Amazonia*)
PRODES	Projeto de Desflorestamento na Amazônia (*Amazonia deforestation project*)
REIMP	Regional Environmental Information Management Project
SADC	South African Development Community
SAFARI 2K	Southern Africa Fires Atmosphere Research Initiative 2000
SELPER	Sociedad De Espoecialistas LatinoAmericanos En Percepcion Remota (Latin American Society of Remote Sensing Specialists)
SPOT	Satellite Pour l'Observation de la Terre
TM	Thematic Mapper
TREES	Tropical Ecosystem Environment Observation by Satellite
UNEP / GRID	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
US AID	U. S. Agency for International Development
USGS	United States Geological Service
WWF	World Wildlife Fund

Appendix 7: Background on GOFC Project

In 1997, the Committee on Earth Observation Satellites (CEOS) established an initiative to increase the effectiveness of CEOS members' investments in earth observation technology by establishing an Integrated Global Observing Strategy (IGOS). An important component of IGOS is a number of pilot projects to strengthen communication and collaborative ties between CEOS agency data providers and those organizations and communities that need remotely-sensed data, aimed at increasing the communication between users and providers of data. One of the six IGOS pilot projects is Global Observation of Forest Cover *(*GOFC) which is couched within the broader CEOS thematic area of the Carbon Cycle.

GOFC is a project to instigate and facilitate activities which will ultimately result in routine, on-going acquisition and use of data from spaceborne and local sensing to provide information on forests needed for carbon cycle research and policy and for sustainable management of forested areas at national, regional, and global scales. This will be made possible through the cooperative investments of satellite data providers, end users, and other organizations, much as a global system for meteorological observations is implemented today.

The strategic design of GOFC (Ahern, et al., 1998) calls for three primary components: Forest Cover Characteristics and Changes, Forest Fire Monitoring and Mapping, and Forest Biophysical Processes. Each component utilizes satellite-based earth observations and ground-based in-situ data, with different time-scales, user foci, and approaches to data assimilation and distribution. There are important synergistic interconnections between the three components (Figure 1).

Forest Cover Characteristics and Changes

The Forest Cover Characteristics and Changes component is the one with the greatest importance to a wide spectrum of user communities. Indeed, land cover and land cover change have been identified as a critical information requirement for assessment of global change and its impacts. Information concerning forest cover characteristics and changes is an essential component of the reporting requirements of the UNFCCC and the International Convention on Biological Diversity. Areas that are considered of highest priority include those of rapid change, particularly in tropical and boreal forests. These are often contact zones at the margins of these forests between areas of relatively high population and anthropogenic alteration and relatively unpopulated areas. The satellite data needed for this component are a combination of extensive and periodic coverage high spatial resolution data from instruments such as Landsat 7, SPOT and IRS with global daily coverage from moderate resolution instruments such as the AVHRR, MODIS and Vegetation.

Forest Fire Monitoring and Mapping

The Forest Fire Monitoring and Mapping component is the close to being operationally implemented. Several previous initiatives have laid the groundwork; while the extensive fires of 1998 in many parts of the world have provided an additional sense of urgency and enhanced international effort. The primary users are organizations with an interest in having current information on forest fire

activity at the national, regional and global scales, and on having reliable annual estimates of the area burned. The global change community is also interested in this information because it is a critical input to atmospheric emissions and carbon budget models. Much of the needed satellite data for this component can be provided through coarse-resolution sensors (e.g. AVHRR, ATSR, GOES, DSMP, SPOT-Vegetation, and eventually MODIS), at lower cost and data volume than applications which need fine resolution data.

Forest Biophysical Processes

The Forest Biophysical Processes component aims to enhance the international collaboration between scientists to utilize satellite data to derive such variables as the length of the growing season, leaf area index and absorbed photosynthetically active radiation and to reliably estimate net primary productivity of forests. This will be an important contribution to understanding the global and regional carbon budgets a vital input to the discussions and negotiations under the UNFCCC. The primary earth-observation data for this component will come from the MODIS sensor on the NASA Terra spacecraft, the GLI sensor on NASDA's ADEOS-2, and MERIS on ESA's Envisat-1.

The GOFC Tropical Workshop is one of the first activities undertaken to bring about the implementation of the Forest Cover Characteristics and Changes component of GOFC.

Figure 1. Interconnections of GOFC Components.