



# **Report of the Land Cover Implementation Team Meeting**

as part of the  
Third GOFC-GOLD Land Cover Symposium

Friedrich-Schiller University  
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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>

## Executive summary

The GOFC-GOLD Land Cover Project Office organized and hosted the Land Cover Implementation Team (LC-IT) Meeting from 15-17 October 2008 at the University Jena, as part of the GOFC-GOLD Land Cover Symposium (13-17 October). More than 120 participants from 31 countries attended the meeting to discuss the status and progress of global and regional land and forest cover observations. Participants included members of the GOFC-GOLD Executive Committee and LC-IT, representatives from international organizations such as the GEO Secretariat (Group on Earth Observations), FAO (Food and Agriculture Organization) as well as scientists and representatives from international research institutes, partner organizations and space agencies.

The last LC-IT meeting was held from 23-26 November 2007, in Boston (Herold et al. 2007). The overall objectives of this year's meeting were to present, assess and discuss the GOFC-GOLD land cover progress in various areas, and to define a team action plan with the next steps for the coming years. The meeting was structured with presentation sessions and group discussions, and included a harmonization workshop where the next version of the UN Land Cover Classification System (**LCSS**) was introduced.

One of the main GOFC-GOLD activities is to engage in the **GEO Work Plan**. Progress was reported for seven tasks where GOFC-GOLD is contributing with a particular focus on the Global Land Cover Task (DA-07-02). The new Work Plan (2009-11) is in development and GOFC-GOLD will continue to contribute to its evolution, and will continue to be engaged in GEO tasks. The next Plan will include a new task on Forest Carbon Tracking with GOFC-GOLD involvement. The IGOL Report, produced with strong GOFC-GOLD involvement, provides a detailed analysis of the status of earth observation concerning different terrestrial fields. The report formulates recommendations and further actions to ensure data consistency and continuity in the future. The IGOL initiative is in transition into GEO to ensure that recommendations and conclusions are addressed within the GEO tasks.

In the framework of the UNFCCC process on research and systematic observations, the GCOS Implementation Plan, and the development of reporting standards for observing **Essential Climate Variables** (ECV), GOFC-GOLD is contributing to three terrestrial ECV's including; land cover, biomass and fire. LC-IT members reported on the development of the land cover and biomass reports, and revised the executive summaries for both for submission to GTOS. The final reports are expected for the UNFCCC SBSTA-30 in June 2009. The REDD working group provides technical expertise on the issue of Reducing Emission from Deforestation and Degradation (**REDD**), and has developed a sourcebook that gives methodological advice for monitoring forest and Carbon stocks. The next version is in preparation for presentation at the SBSTA-30.. The working group with further support capacity building on this issue by co-organizing dedicated workshops in Brazil next year.

GOFC-GOLD supports global mapping activities, such as the ESA **GlobCover** Project and the FAO Forest Resources Assessment 2010 (**FRA-2010**). FAO has invited GOFC-GOLD to participate in capacity building events for the FRA 2010 regional workshops. A major field of activity is global land cover validation. The LC-IT leads an effort to develop a **“best available” land cover map**, and presented the operational land cover validation framework, including a sustained global reference dataset.

The outcomes of the workshop and breakout group discussions have been summarized in a detailed Action Plan, which specifies further action items for each of the LC-IT activities.

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## Acronyms

BOG	Breakout Group
COP	Conference of the Parties
CSIRO	Australian Commonwealth Scientific and Research Organization (CSIRO)
ESA	European Space Agency
FAO	Food and Agriculture Organization
Fire-IT	Fire Implementation Team
FFPRI	Forestry and Forest Products Research Institute (Japan)
GSE FM	GMES Service Element for Forest Monitoring
GEO	Group on Earth Observation
GMES	Global Monitoring for Environment and Security
GOFC-GOLD	Global Observation of Forest Cover and Global Observation of Land Dynamics
GTOS	Global Terrestrial Observing System
ICSU	International Council for Science
IFCI	International Forest Carbon Initiative
IPCC	Intergovernmental Panel on Climate Change
ITC	International Institute for Geo-Information Science and Earth Observation
LC-IT	Land Cover Implementation Team
LIDAR	Light Detection and Ranging
NASA	National Aeronautics and Space Administration
PO	Project Office
REDD	Reducing Emissions from Deforestation and forest Degradation
RN	Regional Network
SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body for Scientific and Technical Advice
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USGS	United States Geological Service
WMO	World Meteorological Service

## **1 Background and objectives**

The GOFC-GOLD Land Cover Implementation Team Meeting (LC-IT) meeting follows the last meeting held in October 2007, at Boston. The purpose of this years meeting was to present, assess and discuss the GOFC-GOLD land cover progress in various areas and activities to define a future action plan for the team. The LC-IT meeting was integrated as part of the 3rd GOFC-GOLD Land Cover Symposium held from 13-17 October 2008, at Jena, Germany. The symposium built the frame for various meetings, including the GOFC-GOLD Strategy Meeting and the Regional Network Meeting.

The objectives of the symposium were to:

1. Provide an overview and update on key GOFC-GOLC land cover team activities
2. Engage the global community of forest and land cover monitoring experts to develop technical consensus in critical areas such as:
  - a. Reducing emissions from deforestation and degradation (REDD)
  - b. Boreal forest monitoring
  - c. Development of standards and reporting guidelines
  - d. Assessment and validation of forest and land cover change
  - e. Linking global and regional land mapping and monitoring initiatives
3. Interact with GOFC-GOLD strategy partners and review the overall GOFC-GOLD strategy to define future priorities and areas of activity, including interactions with political and policy processes
4. Formulate an action plan and foster joint future activities for the GOFC-GOLD land cover team, fire team, regional networks, and partners.

## **2 Participants**

The symposium brought together more than 100 recognized scientists and experts in the field of earth observation and tropical forest cover from 31 nations. Participants included GOFC-GOLD land cover implementation members, representatives from developing countries concerned with avoiding deforestation, scientists from research institutions, technical experts from non-governmental organizations or private companies, as well as a few representatives from space agencies. The full participants list is provided in Appendix A.

## **3 Agenda**

As part of the GOFC-GOLD Symposium, the LC-IT meeting itself took three days. During the first day members of the LC-IT and representatives from partner institutions and agencies reported on the progress of various team activities. The individual sessions addressed; the support of international activities and assessments, global data sets, and regional and national activities. The second day was dedicated to breakout group discussions to develop the future action items. The last day focused on land cover harmonization. The development of the 3<sup>rd</sup> LCCS version was presented and discussed.

Appendix B provides the detailed agenda. With permission of the speakers, all presentations of the workshop are available as ADOBE PDF on the website of the LC-IT PO under: <http://www.gofc-gold.uni-jena.de/sites/Jena08.php>.

## 4 Summary of presentations and discussed topics (Wednesday, 15 October)

### 4.1 Opening and objectives

**Christiane Schmullius** (LC-IT Co-Chair) and **Herbert Witte** (Prorector of University Jena) welcomed all participants and opened the meeting. **Anthony Janetos** (GOFC-GOLD Chair) reviewed the history of GOFC-GOLD, and its goals and structure. Originally defined in 1999 and revised in 2005, the functions of the initiative are described in the “GOFC-GOLD Revised Strategy” (Townshend & Brady 2006). GOFC-GOLD is part of an international partnership and wishes to provide a platform for communication and cooperation between data producers, data users, and the science community. **Curtis Woodcock** (LC-IT Co-Chair) introduced the LC-IT members and their various activities. Currently, 16 internationally accepted scientists are actively involved. Key activities include:

- UNFCCC –GCOS Implementation Plan and ECV Standards
- UNFCCC –GOFC REDD working group
- IGOL –Integrated Global Observations for Land
- GEO Land Cover / Forest Tasks
- Decadal Survey and CEOS LSI Constellation
- Global Validation/Best Map Effort
- Support for GLOBCOVER
- FAO FRA Activities
- Support for regional networks / capacity building
- Cooperation with national monitoring programs
- Boreal Forest Monitoring Activities
- Working with international scientific networks (IGBP, NEESPI, GLP)

In the different sessions of the meeting, LC-IT members and representatives from partner organizations and institutions presented the current status of these projects or initiatives.

### 4.2 Supporting international activities and assessments

On behalf of John Townshend (LC-IT), **Michael Brady** (GOFC-GOLD Executive Director) presented the status of the Integrated Global Observing system for Land (IGOL). IGOL is a theme within the IGOS-Partnership. The IGOL report outlines the observational requirements for a large range of uses where land cover information is needed, including agriculture, forestry, land degradation, ecosystem services and others (online: <http://www.fao.org/gtos/igol/docs/IGOS-theme-report-final-draft.pdf>). The IGOL initiative will ensure that the defined activities will be integrated into GEOSS. GOFC-GOLD is responsible for several implementation tasks. IGOL has provided input to the CEOS LSI effort. IGOL participates in the GEOSS Target Task Team activity to help realign and better articulate GEOSS activities. Further information is available at the IGOL webpage: <http://www.fao.org/gtos/igol/>.

**Michael Brady** (GOFC-GOLD Executive Director) provided an overview of GEO related activities of the LC-IT. In the GEOSS Work Plan, 24 individual tasks require forest observations. The presentation focused on the seven tasks where GOFC-GOLD is involved. key activities, efforts and next steps were presented. Table 1 provides a brief summary.

**Table 1: GEO forest task with GOFC-GOLD involvement**

<b>Task (Lead)</b>	<b>Name/Description</b>	<b>Outcomes, activities, next steps (selection)</b>
AG-06-04 (GTOS, FAO)	Forest Mapping and Change Monitoring	FRA 2010 Remote Sensing Survey: Development of Agreed methodology Development of framework for linking statistical forest data, in situ and satellite observation GEO Forest Monitoring Meeting, Nov. 2008, Brazil FAO Forest Degradation Meeting, Feb. 2009 2009: Capacity building workshops
DA-07-02 (USGS; GOFC-GOLD)	Global Land Cover	Strategy: Integration of IGOL into GEO Standards: LCCS land cover classifiers Harmonization: Development of “best” available map New Products: Contribution to GlobCover Continuity of Observations: MDGLS & GLS 2010 Technical guidance for UNFCCC/REDD
DA-07-03	Virtual Constellations-Land Surface Imaging sub task	Advocate development of “CEOS Constellation Concept” Start designing the system Working Group on Regional Data Set Compilation (under LSI –IGOL co-chairing)
DI-06-13 (CFS)	Implementation of a Fire Warning System at Global Level	Global Early Warning System for Wildland Fire in development
CL-06-03 (GTOS)	Key Terrestrial Observations for Climate	Framework for terrestrial climate-related observations: Progress Report to the SBSTA-26, May 2007 Assessing the status of the development of standards for the Essential Climate Variables (ECV) in the terrestrial domain: Progress Report to the SBSTA-26, May 2007
EC-06-07	Regional Networks for Ecosystems	Develop a global network of organization-networks and coordinate activities to strengthen observing capacity in developing countries
US-06-02	Pilot Communities of Practice	User interface process has been initiated

**Olivier Arino** (ESA) presented the ESA Climate Change Initiative, which includes a range of activities supporting the observation of parameters and products relevant to climate change science. The satellite series of the Sentinels will be operational for the next 20 years: Sentinel-3 ensures continuity of MERIS and ATSR data, while Sentinel-2 ensures continuity of SPOT- and Landsat-type data. The GlobCover Project will be extended. Recently, the quality of the Land Cover Product was validated. The overall accuracy over all classes is 73 %. The product and validation report are available at: <http://ionia1.esrin.esa.int/>. The ATSR world fire atlas provides consistent data for the last 13 years. The observation of land related ECV’s will be expanded to include additional parameters, such as snow cover, soil moisture and Albedo.

**Adam Gerrand** (FAO) spoke about the Remote Sensing Survey (RSS) as part of the FAO Forest Resource Assessment (FRA) for 2010. He presented the outline, expected outcomes and the methodology. Before its global application, the method is currently being tested and refined in a pilot study using a subset of the global scenes selected across varied biomes. The Survey will mainly be based on Landsat data. The South Dakota State University (SDSU) is responsible for the data preparation and has developed a draft online viewer and download system (<http://globalmonitoring.sdstate.edu/projects/fao/index.html>). An important technical issue addressed by FRA-2010 is how existing and new data types (i.e. SAR) can be linked (FRA-SAR). The FRA RSS builds on an international partnership wherein GOFC-GOLD can contribute through assistance in workshops and the validation phase.

**Ruth DeFries** (Columbia University) summarized the activities of the GOFC-GOLD REDD working group in supporting the UNFCCC on the issue of Reducing Emissions from Deforestation and Degradation (REDD). The core team is comprised of a group of eight



remote sensing and forestry experts from international research institutes and universities. The major outcome of the group is the REDD Sourcebook, which provides consensus technical guidance (<http://www.gofc-gold.uni-jena.de/redd/>). The release of the next version is planned for June 2009, for presentation at UNFCCC SBSTA-30. It will contain new sections, for example, on degradation, monitoring regrowth and estimating uncertainties. Detailed information on its development is provided in the REDD workshop report. The team further supports REDD capacity building by participating in dedicated workshops organized by GTZ (German Organization for Technical Cooperation) and the CfRN (Coalition of Rainforest Nations).

**Martin Herold** (GOFC-GOLD LC-IT) and **Mike Wulder** (CFS) presented the background and status of the standards development of Essential Climate Variable (ECV). GTOS was requested by the UNFCCC SBSTA to develop a framework for preparing guidance materials, standards and reporting guidelines for the terrestrial ECVs. Standards reports are in development and include the definitions/units of the ECVs, a summary of existing measurement methods and standards, as well as recommendations for the observation strategy. GOFC-GOLD is responsible for Land Cover (LC), Biomass and Fire. The presentation gave an overview of the LC and Biomass recommendations. One objective for this workshop is to edit the current drafts of the executive summaries of both ECVs for submission to UNFCCC SBSTA before COP-14 (Appendix C, D).

**Espen Volden** (GMES Bureau) focused his presentation on the Global Land Monitoring System of GMES (temporary: Kopernikus), which aims to offer a portfolio of data and products with different levels of elaboration (from pre-processed images to elaborated information). The presentation introduced the product portfolio and the service evolution. Projects from the European Commission Framework Programme (EU FP), as well as from ESA GMES Service (GSE) Element and Data User Elements (DUE) contribute to GMES. CORINE high-resolution soil sealing layer and the Urban Atlas are examples of research projects that became operational services. Further information is available at: <http://www.land.eu/>.

### **4.3 New global datasets and activities**

In the first presentation of the session, **Pierre Defourny** (UCL) presented outcomes of the ESA GlobCover Project. The overall objective of this initiative is to develop and demonstrate a service for production of a global land cover map for 2005/2006. The map will be at 300 m resolution using MERIS Full Resolution data, and will be based on the FAO Land Cover Classification System (LCCS). The 2<sup>nd</sup> version of the Land Cover Product (based on 19 months of acquisition from 2005 and 2006), released in August, represents the first global product at such high resolution. The presentation focused on the validation approach, which was designed according the CEOS Guidelines (2006), and is based on stratified sampling. All products, time series and documentations of the project are available at the GlobCover data access tool IONIA: <http://www.esa.int/due/ionia/globcover>.

**Philippe Mayaux** presented the land cover products and services of the European Commission Joint Research Center (JRC). The JRC is involved in various land cover and forest activities including, forest mapping in Europe, in the Boreal zone, in Central Africa and within the FAO FRA 2010. JRC has produced Pan-European forest maps for the years 1990, 2000 based on Landsat and SPOT (2006). These products are available at: <http://forest.jrc.ec.europa.eu/ForestResources/ForestMap/>. The European Forest Data Center (EFDAC) provides an online map viewer (<http://efdac.jrc.ec.europa.eu/wmi/viewer.phtml>.) where mapping products can be combined with other thematic and administrative data sets. In

the frame of FRA 2010, JRC is responsible for image processing and analysis at the continental level.

**Matthew Hansen** (South Dakota State University) spoke about land cover monitoring activities based on the integrated use of MODIS and Landsat data. He presented results from studies in various regions, e.g. forest change assessments in South East Asia, Brazil, Congo and the Boreal zone. In biome-wide studies the forest cover loss between 2000-2005 was estimated as 4 % of the total forest area (2000) for the Boreal zone, and 2.4 in the Humid Tropics (Hansen et al. 2008). In the conclusion, he outlined that MODIS and Landsat integration through targeted sampling allow rapid change area estimation in monitoring land cover dynamics, and enables internally consistent pre-processing and characterization of the entire land surface. These methods can be transferred to other data sources and systems.

**Curtis Woodcock** (Co-Chair LC-IT) focused his talk on the global land cover validation activity and the development of a “Best available” land cover map. This activity is driven by the GEO task DA-07-02, current global mapping activities (GlobCover, FRA 2010) and monitoring needs in the frame of the UNFCCC. The LC-IT wishes to support the broader land cover community through validation. The idea is to collect ground reference data independent from any single product to support validation of many land cover datasets. A “living reference data set” is envisaged to be comprised of a set of validation sites distributed around the globe, based on high resolution imagery and updated periodically. The presentation emphasized the design of the operational land cover validation framework and next steps for future work.

#### **4.4 Ongoing regional activities and projects**

**Olga Krankina** (Oregon State University) gave an overview of the different GOFC-GOLD Regional Networks and summarized the outcomes of the related workshop held one day before. Together with RN representatives, she briefly introduced ongoing mapping activities of the following networks: OSFAC (Central Africa), Miombo (Southern Africa), RedLaTIF (Latin America) and NERIN (Northern Eurasia). With respect to the LC-IT meeting objectives, it was emphasized that the RNs lead and plan several major land cover mapping activities, which differ in their emphasis and approach. The networks are interested in supporting Land Cover Product Validation Initiative (LC IT), however the application of LCCS requires additional support.

**Markus Erhard** (European Environmental Agency) reported on EEA global activity plans. The EEA strategy supports several land use/ land cover activities that were addressed in the presentation:

- GMES land monitoring services: Support the development of core services, coordinate in-situ component, and facilitate data procurement
- CORINE 2006 and high resolution soil sealing: Analysis of land-cover/-use changes and environmental impacts (e.g. fragmentation)
- GEO-GEOSS, GlobCover, GlobCorine: European and global interaction, environmental change
- Water and ecosystem accounts: Global standards for UN-Environmental Accounting framework (UN, ESTAT, national statistical offices), focus on land

**Stephen Kuntz** (Infoterra) presented the Land Monitoring Core Service of GMES (temporally Kopernikus) focusing on LMCS infrastructure development and demonstration of production capacity and the monitoring concept. The joint web-map server and portal provides access to the products of the different activities: <http://www.land.eu>.

**Christiane Schmullius** (Co-Chair LC-IT) presented several examples of the integrated use of optical and radar observations for Boreal Vegetation Monitoring. For GSE Forest Monitoring test sites in Siberia, ENVISAT ASAR, PALSAR and Landsat data have been integrated for forest disturbance mapping. In the SIBERIA-II Project, data synergy was used to derive various biophysical parameters as an input for vegetation modelling to estimate GHG emission trends. A spatial data infrastructure to facilitate earth system science studies in central Siberia is in development - the Siberian Earth System Science Cluster (SIB-ESS-C, <http://www.sibessc.uni-jena.de/>). Other examples were crop type classification using MODIS time-series data and wetland detection using ASAR data. Land cover products for Eurasia are available on <http://terranorte.iki.rssi.ru/>.

**Mike Wulder** (CFS) summarized the outcomes of the Workshop on Boreal and Temperate Forest Monitoring, which focused on multi-source, multi-scale, sampling for large area forest characterizations. In conclusion, it was emphasized that all different data types provide unique information to aid in forest monitoring and reporting. Data types may differ by spatial, spectral and temporal resolution as well as spatial coverage. Therefore, new data processing, analysis, integration, storage, and retrieval capacities are required. The analysis of annual Landsat time series was emphasized as time series' enhance the signal to noise ratio and allow for identification and categorization of temporal signatures in forests that are associated with disturbance and succession. Early findings of BioSpace, a Canadian Space Agency supported program, were presented to demonstrate how satellite-based monitoring can be used for the observation of key indicators of biodiversity.

#### **4.5 Supporting national activities and closing**

**Susann Minnemeyer** (World Resources Institute) presented the Climate Analysis Indicator Tool (CAIT) developed by the WRI: <http://cait.wri.org>. CAIT is an open access online system, which provides a comprehensive database of GHG emissions and climate-relevant indicators of all UNFCCC countries through an interactive and customizable interface. Currently, to improve the system, procedures are in development to produce global estimates in a timely manner in order to provide an independent check and balance for decision-makers. Another activity is the joint initiative between WRI, Greenpeace Russia and the University of Maryland to map the world's "Intact Forest Landscapes" (<http://www.intactforests.org/>) (Popatov 2008).

**Tom Loveland** (USGS) focused on the GEO Global Land Cover Task (DA-07-02) and emphasized the importance of involving national programs. He underlined that achieving the objective of this GEO task requires the participation of many organizations – from research to operations, especially regarding the specification and implementation of a global high-resolution land cover and land change data set. GOFC-GOLD can assist by providing leadership in organizing and identifying consensus practices and standards. National mapping programs are of crucial importance and Dr. Loveland suggested that how the cooperation between national and global programs can be strengthened should be discussed. He proposed a dedicated GOFC-GOLD/GEO Global Land Cover Task workshop for national land cover programs and research leaders, in order to determine the status of established national land cover programs and identify common standards, methods etc.

**Yoshikazu Fukushima** (Japanese Geographical Survey Institute) reported on the Global Mapping Project of the International Steering Committee for Global Mapping (ISCGM). In response to the UNCED Earth Summit 1992, the ISCGM was established in order to coordinate the production of the Global Map. The product consists of various thematic vector (e.g. transport, boundaries) and raster layers (e.g. elevation, land cover) provided by national

mapping organization in the individual countries. The Land Cover Map of the project is based on MODIS data (2003) and comprises 20 LCCS based land cover classes. The first version was released in December 2008 and is available at <http://www.iscgm.org/cgi-bin/fswiki/wiki.cgi>.

## **5 Breakout group discussions (Thursday, 16 October)**

The 2<sup>nd</sup> day of the LC-IT Meeting was dedicated to breakout group discussions. Participants discussed the following topics:

- BOG 1: Land use and agriculture observations (Lead: Justice, Mollicone)
- BOG 2: Global land cover validation exercise (Lead: Woodcock, Arino)
- BOG 3: GEO Forest Monitoring Symposium (Lead: Brady, Fan)
- BOG 4: ECV observation and standards (Lead: Wulder, Herold)
- BOG 5: Data continuity, access and policy (Lead: Briand, Woodcock)
- BOG 6: Involvement with national programs/networks (Lead: Loveland, Krankina)

Please find below discussion notes of the individual breakout groups. Documents that have been edited during the discussions are provided in the appendix.

### **5.1 BOG 1: Land use and agriculture**

Context:

- Recent large changes in Land use:
  - Identification of intensity and areal extent of LU activities
  - Energy crops
  - Urbanization
- Broader Sustainable Land Use Agenda (WSSD)
- Policy Makers and Land managers interested in the drivers of LU change and the effectiveness of LU Policy:
  - International (inc. IPCC and REDD)
  - National (e.g. challenged to meet IPCC LU info needs)
  - Local
  - Multiple policy aspects
- Several nations have LU inventories and stats:
  - often not well connected to Land Cover mapping
  - satellite imagery confers information on land cover whereas land use often requires additional interpretation or ancillary data
- LU and Climate change issues:
  - LU drivers recognized
  - LU will be an integral part of mitigation and adaptation
- IGOL recognizes the importance of Land Use

Considerations for addressing land use in GOFC-GOLD:

- Need a strategic discussion on what's the role of GOFC-GOLD in LU:
  - Land Cover → Land Cover Change → Land Use (always envisioned)
  - GOFC is concerned with Global > Regional Scale Observations: Satellite, Ground based (in situ), Existing Non Remote Data Sources
  - Monitoring land use change is probably the priority –in that sense there is a strong link to land cover change
  - Need to develop a Longer Term vision of land use in the GOFC GOLD Agenda

- What is the niche / comparative advantage of GOFC GOLD Re Land Use
- Who needs LU information and for what purpose (priority discussion)?
- Issues of scale:
  - Would global LU information be useful (local and national information certainly would)?
  - Social cultural setting of land use
  - Regional approach may be more relevant than global
- Issues of data aggregation and privacy when it comes to socioeconomic and land tenure data
- Remote sensing of LU has received less attention:
  - BUT could be better applied with the goal of perhaps eventually leading to operational products
  - The increased availability of very high resolution data sets make LU more tractable
- What would be the expertise needed in GOFC/GOLD to address LU
  - are there partnerships that need to be fostered
  - what would a LU IT look like
  - would include a combination Fire and LC
- Launch some Preparatory activities
  - Investigating global perspective regional projects balance
  - Near term successes –low hanging fruit
  - Identify some metrics –crop rotation time, productivity, plantation forestry
  - Are there models which could be improved by linking LC to LU e.g. LUCAS inc NZ, SPREAD
- Role of Regional networks could be critical in addressing LU observations → tie into national land use products
- Program Linkages e.g.:
  - UN FCCC and Near Term IPCC relevance –large uncertainty and lack of activity data at the national scale
  - Linkage to GEO Ag Monitoring Task
  - FRA Land use component
  - Next Millennium Assessment

Additional topics raised:

- Agriculture Land Use –impacts of climate –also some common regional issues
- Relationships between LCC and LU -Forest / Woodland and Agriculture:
  - Both Small and large scale expansion
  - Commercial forest plantations
- Land Use in the forests:
  - Logging, Anthropogenic disturbance, Charcoal production
  - Forest Degradation
- Land Use Fire -proximate indicators e.g. geometry:
  - Transnational issue (air quality) –policy implications
  - Regional issue w. very local actors (e.g. residue burning)
- Does LCCS address LU adequately –local>national>global? How can it be used to meet national LU needs
- Grazing/Pasture (more complex than crops)
- ECV's for land use

- FRA LU information being collected by nations at a sample basis
- Monitoring productivity of Land and Success of Land Reform
- IPCC has a first order need for emissions from 6 LU changes ( forest, crop, wetland, grassland, settlement, other land)

In conclusion, Anthony Janetos proposed to hold a small workshop to discuss the preliminary scope in detail.

## **5.2 BOG 2: Global validation exercise**

Objectives:

- Reference data for ‘Best Available Map’
- “Universal” Reference Data for assessment of other maps
- Reference data for area estimation
- Assessment of change?
- Global focus and also regional focus

Response design:

- SPOT imagery (2.5 m):
  - Polygon interpretation
  - Aggregate later to appropriate pixel size (dependent on map being assessed)
- Size of ‘block’ to be interpreted?
- PM suggests 2km x 2km (possibly subsampled within a larger block)
- Assessment unit?

Analysis:

- Basic descriptive accuracy to start (error matrix)
- Accuracy of ‘areas’ (support dependent)

Design criteria:

- Probability sampling
- Stratification?
  - Geographic region (large): Spread the sample, Possibly regional reporting
  - By areas of disagreement
  - Rare classes (at what level of classification?)
- Flexible to supplement (add to) sample for region specific or country specific reporting
- Flexible to combine with existing reference data (completed assessments of other maps)
- Need for compiling and describing existing sources of reference data. ...

Miscellaneous:

- Importance of easy interface for users
- LCCS not natural for all ‘experts’
- Land use information
- Information related to users of the maps
- May be some sample sites that require only Landsat data
- Thematic depth of classification of reference data

### **5.3 BOG 3: Preparation of GEO Forest Monitoring Symposium**

The participants discussed in detail the upcoming GEO Forest Monitoring Symposium to be held the 16<sup>th</sup> October 2008, in Iguacu, Brazil, i.e. the programme and the outline and objectives of the thematic breakout groups. Detailed information is available online at the conferences webpage: <http://www.dpi.inpe.br/geoforest/>.

### **5.4 BOG 4: Executive Summaries for ECV: Land Cover and Biomass**

During the BOG, the Executive Summaries were finalized for submission to GTOS. They are provided in Appendix C and D.

### **5.5 BOG 5: Data continuity, access and policy**

- International polar year – coordination for SAR – maybe GOFC-GOLD
- Science plan, observation requirements – SAR needs
- Pursue access via space agencies – and acquisition plan
- Access- and distribution- infrastructure needed
- For SAR imagery: need a plan

Action Items:

- SAR data requirements (including observations, systematic acquisition strategy, processing, distribution) identify supersites for demonstration projects
- Geo Data Policy – comment from DA-07-02? to DA 06-02
- Reach out to ESA and EC on data access for Sentinel2
- Initiate an LSI Constellation Activity on improved access and archiving of Landsat data (stores in ground stations around the world)

CEOS:

- Data policy
- Offer for processing data from south Africa – for Africa
- Specification of requirements for data as part of GEO tasks?
- Tangible limits to processing capacity for SAR data
- Experiments via supersites –
- Continuity of measurements? Access to data? Data Policy??
- Reach out to GEO Task on Data Policy
- Access to Sentinel Data?? To ESA and EC.

### **5.6 BOG 6: Involvement with national programs/networks**

Presentation (Tom Loveland)

GEO Global Land Cover Task: Provide a suite of global land cover datasets, initially based on improved and validated moderate resolution land cover maps and eventually including land-cover change at high resolution.

- Advocate existing internationally-agreed approaches for land cover characterization and validation
- Utilize and validate moderate resolution time series data and land cover data sets and earlier 1-km resolution maps
- Formulate specifications and implement production of a global high-resolution land cover and land change data set and report
- Set up web access to land cover and associated input data
- Identify opportunities for applying land cover data in areas related to key societal benefits

- Strengthen national level capacities to produce and use these products especially in developing countries

The Challenge:

- Achieving these objectives will require the participation of many organizations -spanning research to operations.
- This is especially the case for the objective to: “Formulate specifications and implement production of a global high-resolution land cover and land change data set and report.”
- GOFC-GOLD can assist the GEO Global Land Cover Task by providing leadership in organizing and identifying consensus practices and standards.

Creating a high resolution global land cover change product:

- Will require continuing consideration of:
  - Earth observation capabilities and advances
  - Land cover standards
  - Land cover mapping methods
  - Resources
- Will require the coordinated participation of a network of land cover mapping organizations.

National land cover mapping programs:

- Should be an essential part of a global high resolution land cover foundation.
- Are necessarily organized to meet agency priorities within the constraints associated with budgets and human resources.
- Often lack contact with research groups and other national mapping programs.
- Must have access to ideas, data, and other resources in order to continue, improve, and sustain their activities.

How do we:

- Engage national cover mapping agencies for the purpose of contributing to global land cover characterization?
- Strengthen national capabilities and contribute to their sustainability?
- Enable the use of best practices and standards across national programs?

Where are the national programs and what is the health of their respective programs?

What is the range of the technical practices in each program?

What are the scales of analysis, classification schemes, methods, and periodicity of mapping?

What can GOFC-GOLD and GEO provide that improves the strength of national land cover mapping programs?

What are the standards needed to merge national land cover maps into a global framework?

What are/where are the gaps in national land cover capabilities and programs?

One approach for involving national programs:

- GOFC-GOLD/GEO Global Land Cover Task could organize a workshop for national land cover programs and research leaders to:
  - Determine status of established national land cover programs (e.g., Africover countries, Australia, Brazil, Canada, China, EU, Mexico, South Africa, US, etc.)
  - Identify common: Standards, Methods, Resources, Research needs
- Establish goals for a high resolution global land cover mapping capability



- Determine approaches for sharing experiences and resources between national programs

#### Potential benefits

- Take a step toward solidifying the global land cover mapping infrastructure
- Achieve some level of agreement on common land cover mapping standards
- Gain a better understanding of the issues ahead for global high resolution land cover mapping
- Improve the basis for accessing validation data for other global land cover products

## **6 Scientific and Technical Board feedback and panel discussions**

**Anthony Janetos** (GOFC-GOLD Chair) opened the session and reviewed outcomes of the GOFC-GOLD Strategy meeting, held on Tuesday, 14 October 2008. With these meetings, the Executive Committee wishes to receive feedback from symposium participants and project partners on GOFC-GOLD. Building on the revised strategy this feedback will help to define future directions and priorities. As introduction, Dr. Janetos reviewed the functions and strategy of GOFC-GOLD and presented the main messages from the first strategy meeting.

In the first meeting, participants acknowledged the success of GOFC-GOLD in providing an interface between scientific and user communities. There is a need for GOFC-GOLD to provide more leadership in ensuring a voice for terrestrial observations in international processes. It was recognized that data quality, validation, and data access are important issues to be addressed. The importance of supporting initiatives on climate change, global fire, and essential climate variables was acknowledged. Of critical importance is the need to strengthen the regional networks and help them access needed resources.

Further questions and issues raised include:

- How will large global validation datasets, e.g. validation data from FRA 2010 be made available?
- How will validation data feed into new global mapping activities?
- Importance of supporting new CEOS activities and working more closely with CEOS
- How should GOFC-GOLD be thinking about land-use and not just land-cover?
- How should we think about supporting national and regional initiatives -methods, strengthening existing regional networks? New networks?

The objective of this group discussion was to concentrate the received feedback to main messages for the GOFC-GOLD Executive Committee. The Committee will take this input and use it to draft a revised strategic plan. In 2009, a meeting of the Executive Committee and external advisors is planned to verify the revised strategic plan.

## **7 LCCS and land cover harmonization (Friday, 17 October)**

**Antonio diGregorio** (FAO) introduced the 3rd version of the FAO Land Cover Classification System (LCCS). He reviewed the basic concept of LCCS and issues that have led to the development of the next version. In LCCS, the creation of a class is done by a dynamic combination of land cover diagnostic attributes called classifiers. The classifiers act as building blocks and can be combined to describe the more complex semantics of each land cover class in any separate application ontology (classification or legend). The first concept of

LCCS was developed more than 10 years ago. Updates were necessary with regard to technical and conceptual points, e.g.:

- Predefined database from which to generate the LC classes
- Tree structure for main land cover groups (dichotomous phase)
- Artificial limits in the definition of layers
- Some complex definitions
- Not fully rigorous separation of pure physiognomic/structural atomic elements from other types of elements
- Limitations to describe some “extreme” LC situations

For the 3<sup>rd</sup> version, a broader Land Cover Meta Language (LCML) has been created. In LCML, a predefined set of basic elements (biotic and abiotic) enriched in their semantic significance with external qualities and attributes can be arranged in different types of strata to describe a wide variety of distinctive and detailed land cover situations (climate, landform etc.). The concept was presented to the ISO at the TC211-ISPRS Workshop in July 2008 in Beijing. LCML has been represented in a UML (Unified Modeling Language). Open issues are its representation in a programming language JAVA or C++ and its link to GIS. More information can be found at: <http://www.africover.org/LCCS.htm>.

**Martin Herold** (LC-IT) presented LCCS legend translations of LC products and harmonization approaches. The translation of legends of existing products is important to explore inconsistency in current approaches and to study agreement and synergy among them. Further international consensus discussions on the adoption of LCCS concept are needed. Existing legends should be translated and revisited. He presented the concept to implement harmonized land cover characterisation based on terminology, and thematic and cartographic standards. In general, LC legends should be developed using LCCS and the common set of classifiers. Explore how a harmonized land cover products can link to, or benefit from existing mapping initiatives on both finer and coarser scales (e.g. in situ and global) and vice versa.

**Wolfgang Lück** (CSIR) summarized South African LC mapping projects and outcomes of a national legend definition workshop. He reviewed requirements for land cover products and recent activities in South Africa.

## 8 Informal LC-IT Meeting and closing

During the last session of the symposium, the LC-IT members discussed and reviewed the outcomes of the individual sessions. The final discussions focused on further actions for the ECV standards development, the validation plan, GEO Global Land Cover Task, IT membership issues and the preparation of a best practices document on accuracy assessment of LC changes. All action items are summarized in the Jena Action Plan (Appendix E).

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## Appendix B – Agenda

<b>GOFC-GOLD land cover implementation team meeting</b>		
Wednesday, 15.10.2008, Dornburg castle		
SESSION 1: Opening and objectives		
09.00-09.15	Opening and introduction	Schmullius
09.15-09.25	Opening remarks from FSU Jena	Witte
09.25-10.00	Drivers/function of GOFC-GOLD activities LC-IT	Janetos
10.00-10.15	activities and meeting objectives	Woodcock
<i>10.15-10.45 Break</i>		
SESSION 2: Supporting international activities and assessments (10 min + 5 min)		
10.45-11.00	IGOL/GEO activities	Townshend
11.00-11.15	GEO task progress for forests	Brady
11.15-11.30	ESA activities: GLOBCOVER/clim. change	Arino
11.30-11.45	FAO FRA 2010 remote sensing survey	Gerrand
11.45-12.00	UNFCCC/REDD activities	DeFries
12.00-12.15	ECV standard for land cover/biomass	Herold
<i>12.15-13.30 Lunch</i>		
SESSION 3: New global datasets and activities (10 min + 5 min)		
13.30-13.45	GMES global land monitoring activities	Volden
13.45-14.00	GLOBCOVER	Defourny
14.00-14.15	JRC activities	Achard/Mayaux
14.15-14.30	Global forest monitoring: MODIS/Landsat	Hansen
14.30-14.45	Global validation/best available map	Woodcock
<i>14.45-15.15 Break</i>		
SESSION 4: Ongoing regional activities and projects (10 min + 5 min)		
15.15-15.30	Regional network activities	Krankina
15.30-15.45	EEA plans and global activity plans	Erhard
15.45-16.00	GMES Land Monitoring Core Service Boreal forest	Kuntz
16.00-16.15	monitoring	Schmullius
16.15-16.30	Russian academy of science activities	Bartalev
16.30-16.45	Global/regional WRI forest monitoring activities	Minnemeyer
<i>16.45-17.15 Break</i>		
SESSION 5: Supporting national activities and closing (10 min + 5 min)		
17.15-17.30	Australian land cover/use monitoring	Caccetta
17.30-17.45	Involvement with national programs	Loveland
17.45-18.00	Accuracy assessment of LC change/area est.	Stehman
18.00-18.15	Global Mapping project - ISCGM	Fukushima
18.00-18.30	Closing discussions and charge for next day	Woodcock/Schmullius
<i>Workshop dinner at Dornburg castle</i>		
<b>GOFC-GOLD land cover implementation team meeting</b>		
Thursday, 16.10.2008, Rose Halls, Room 102		
SESSION 1: Review of day 1 and charge for day 2		
09.00-09.15	Opening and review of previous day	Woodcock/Schmullius
09.15-10.15	Breakout group discussions 1 Potential groups (implementation):	All

	ECV standard: land cover/biomass Global deforestation monitoring Global land cover validation exercise	
<i>10.15-10.30 Break</i>		
SESSION 2: Report and 2 <sup>nd</sup> set of breakout groups		
10.30-11.30 11.30-12.30	Individual group summary presentation Breakout group discussions 2 Potential groups (define action plans): Involvement with national programs (GEO) Regional network action plan Concepts: Land change/use monitoring STB internal discussions	All
<i>12.30-13.30 Lunch</i>		
SESSION 3: Report and discussions		
13.30-14.15 14.15-15.00	Individual group summary presentation Summary discussions	All Woodcock/Schmullius
<i>15.00-15.30 Break</i>		
SESSION 4: STB feedback and panel discussions		
15.30-16.00 16.00-16.30 16.30-17.30	Comments and feedback to GOFC-GOLD Open discussion Outlining future priorities and action plan	Strategy Panel All Janetos
<i>17.30 Adjourn and informal discussions</i>		
<b>GOFC-GOLD land cover implementation team meeting</b>		
Friday, 17.10.2008, Rose Halls, Room 102		
SESSION 1: Land cover classification system (LCCS) concept and tutorial		
09.00-09.15 09.15-10.15 10.15-10.45	Opening and objectives of the day Introduction of LCCS 3 concept and tutorial Discussion/questions on LCCS 3	Woodcock DiGregorio All
<i>10.45-11.15 Break</i>		
SESSION 2: Land cover classification system (LCCS) feedback forum		
11.15-11.30 11.30-11.45 11.45-12.00 12.00-12.30	Harmonization/legend translation Applying LCCS concept: feedback LCCS feedback from regional networks Discussion on next steps	Herold Woodcock Krankina All
<i>12.30-13.30 Lunch</i>		
SESSION 3: Informal LC-IT meeting		
13.30-14.00 14.00-15.00	Team discussions, review of last days Final team decisions on important issues, i.e. ECV standards, validation plan, membership issues etc.	Woodcock/Schmullius
<i>15.00-15.30 Break</i>		
SESSION 4: Defining next steps		
15.30-17.00	Outlining future priorities and action plan	Janetos/ Brady / Woodcock / Schmullius
<i>17.30 Adjourn</i>		

## Appendix C – Land Cover ECV Executive Summary

### *Introduction*

Land cover change is a pressing environmental issue, acting as both a cause and consequence of climate change. Reliable observations are crucial to monitor and understand the ongoing processes of deforestation, desertification, urbanization, land degradation, loss of biodiversity and ecosystem functions, water and energy management, and the influence of land-cover changes on the physical climate system itself. A number of disciplines (i.e. geography, ecology, geology, forestry, land policy and planning etc.) use and refer to land cover and land-cover change as one of the most obvious and detectable indicators of land surface characteristics and associated human induced and natural processes.

Current and future IPCC Assessment Reports are based upon an uncertain understanding of the land surface and related processes. Applications of land cover and land dynamics in climate change related Earth System Models and Impact Assessment Models should be better linked and coordinated. The importance of these issues requires continuous monitoring systems and data.

### *Definition of observation and the units*

Land cover is defined as the observed (bio)-physical cover on the earth's surface. It includes vegetation and man-made features as well as bare rock, bare soil and inland water surfaces. The primary units for characterizing land cover are categories (i.e. forest or open water) or continuous variables classifiers (fraction of tree canopy cover). Secondary outcomes of land cover characterization include surface area of land cover types (ha), land cover change (area and change trajectories), or observation by-products such as field survey data or processed satellite imagery.

### *Available methods standards, protocol, and measures*

Land cover in different regions has been mapped and characterized several times and many countries have some kind of land monitoring system in place (i.e. forest, agriculture and cartographic information systems and inventories). In addition, there are a number of global land cover map products and activities. These activities have been building upon the availability of continuous global satellite observations since the 1980s. With evolving technology, it has become increasingly efficient to derive land cover information from a combination of in situ surveys and earth observation satellite data at global, regional, and national scales. Inconsistencies exist between the different land cover map products or change monitoring systems complicating our ability to successfully synthesize land cover assessments on regional and global scales.

### *Current data, products, and capabilities:*

- Quasi-operational global land cover monitoring integrate information from three common observation scales: e.g. MODIS- or MERIS-type satellite sensor (moderate resolution satellite data), from LANDSAT- and SPOT-type satellite sensors (fine resolution satellite data), and in situ observations (or very high-resolution satellite data). Continuity of observations and consistency for land cover characterization is required for all these scales.
- The UN Land Cover Classification System (LCCS) currently provides a comprehensive, internationally accepted, and flexible framework for thematic

land cover characterization. LCCS uses classifiers enabling compatibility between existing datasets and for future global monitoring systems.

- Global mapping efforts (i.e. MERIS-based GlobCover and those from MODIS) are ongoing to provide consistent and validated land cover data and land cover change indicators worldwide at moderate-resolutions.
- Land cover change estimates require multi-temporal, fine-resolution satellite observations. Archived image data (i.e. global Landsat mosaics) and methods are available to implement a global land cover change monitoring system. Regional and national programs (e.g. CORINE, PRODES) and international initiatives such as the Forest Resources Assessment for 2010 of the FAO use multiple data sources for regional and global assessment of historical forest change processes.
- An independent accuracy assessment using a sample of ground-reference data is an integral part of any land cover monitoring effort. Standard methods for land cover validation have been developed by the international community.

#### *Recommendations*

- Continuity and availability of data is required for all observations scales.
- Continuous monitoring of conditions is recommended over periodic mapping.
- The collection of ground reference data should be continuous and national agencies are encouraged to supply ground reference data in support of calibration and validation requirements.
- Further international development and adoption of land cover and land cover change mapping standards have started and are encouraged to proceed further.
- The international land observation community should coordinate and cooperate to provide useful and flexible land cover validation protocols.
- Internally consistent and synoptic data sets are required to represent global land cover ECV, requiring communication and cooperation between nations.

#### *Recommended action*

Encouragement from the member nations to support and further enable continuity of existing measurement capabilities and to promote a broadening of monitoring abilities is encouraged. Promotion of these above recommendations should be undertaken via relevant national and international agencies and organizations.

## Appendix D – Biomass ECV Executive Summary

### *Introduction*

Vegetation biomass is a crucial ecological variable for understanding the evolution and potential future changes of the climate system. Vegetation biomass is a larger global store of carbon than the atmosphere, by far, and changes in the amount of vegetation biomass already affect the global atmosphere by being a net source of carbon, and having the potential either to sequester carbon in the future or to become an even larger source. Therefore, a global assessment of biomass and its dynamics is an essential input to climate change forecasting models and mitigation and adaptation strategies.

Two other emerging issues contribute to the increasing importance of the biomass role as an essential climate variable: i) the growing use of biomass for energy production, so the increasing percentage of global GHGs emitted from biomass consumption, and ii) the increasing concern on the possibility to significantly reduce global GHGs emissions by avoiding biomass losses from deforestation and forest degradation. In this document the focus is mainly related to living terrestrial above ground vegetation biomass, especially woody biomass.

### *Definitions and units*

Biomass is defined as mass per unit area of live or dead plant material, typically reported in mass per unit area, such as  $g/m^2$ . The carbon pools of terrestrial ecosystems involving biomass are conceptually divided into above-ground biomass, below-ground biomass, dead mass, and litter. The above ground pool of biomass is often well characterized. The below ground component of biomass is regularly estimated as a function of above ground biomass. The remaining pools are less well characterized and require attention. Biomass can be measured through field sampling, extrapolations from spatial data (such as forest inventories), remotely sensed data, modelling, and combinations of the preceding data sources.

In situ measurements entail harvesting plant species, drying them, and then weighing the biomass. These measurements of forest biomass can be aggregated for a small sample area, or extrapolated to wider levels using allometric equations. While this is the most direct and accurate method for quantifying biomass within a small unit area, it is expensive, time-consuming, damaging to the environment and infeasible at large scale. It is these intensive measures that allow for making extrapolations of biomass from measures made from non-destructive field measures or from forest inventory data.

Remote sensing measures the amount of microwave, optical, or infrared radiation that is reflected or scattered by the imaged area in the direction of the sensor. Generally, biomass is either estimated via a direct relationship between that sensed radiation or spectral response. Remotely sensed data provides a synoptic view of the area of interest (that is, the entire area is characterized in the same way with the same data) that enables the estimation of biomass values over large areas. Different models have been developed to derive biomass estimates over large areas incorporating spatial data (such as elevation and radiation), remotely sensed data, and field samples or forest inventory data.

### *Available methods, protocols, standards, validation procedures*

It is well established that in situ measurements are critical to the monitoring of terrestrial carbon stocks, but they impose many limitations, including high costs, inconsistent parameter definitions, inconsistent spatial and temporal scales, and sampling bias in measurements.

While satellite approaches to estimating biomass are becoming increasingly reliable, limitations remain related to accuracy and range of predictions. However, satellite technology allows for increasingly frequent measurement of biomass and several satellite methods have demonstrated potential for providing direct and indirect global above-ground biomass information at high resolution (below 1 km). With improved sensor capabilities combined with previous experience and methods, it is expected that satellite and model based estimates of biomass will provide for the large area monitoring of biomass.

#### *Recommendations*

The recommendations below to be considered to improve the reliability of biomass estimates and their utility to better monitor and understand climate change:

1. Agencies for in situ inventories and remote sensing must work together to allow validation and upscaling of the in situ measurements based on the remote sensing products
2. The harmonization of the different methodologies for data collection and analysis is required for continuous, standardized and geo-referenced forest biomass inventories and ground measurements
3. The quality and quantity of in situ biomass estimates needs to be improved in order to improve the remote sensing validation
4. Forest biomass inventories need to be expanded to tropical forests, non-commercial forests, mangroves and woodlands
5. New allometric functions need be developed for better biomass estimations, to convert above-ground biomass to total biomass, and to be extended over larger geographic areas
6. Deriving biomass data directly from remote sensing remains to be a research task (see below). Large area biomass estimations will benefit from improved land cover datasets (see land cover ECV).
7. Tree height measurements produced by LIDAR technology can be used to improve the derived biomass estimates, or to supply accurate measures of forest structure (as samples or to map larger areas)
8. Synthetic aperture radar (SAR) and optical data can be used to provide estimates of biomass in a synoptic manner over large areas. Further development and integration of SAR and optical data is to be pursued.
9. Exploring the possibility of defining standard biomass data products from active remote-sensing methodologies, such as SAR or LIDAR is also desirable.

## **Appendix E – Land Cover Implementation Team Action Plan**

*UNFCCC – GCOS Implementation Plan and ECV Standards (Herold, Wulder, Schmillius, Arino)*

- Definition of ECV standards for land cover, biomass (and fire)
- Specifications for implementing ECV observations (working group for GOFC relevant ones to develop role models, e.g. for land cover)
- Participation in GTOS/TOPC meeting (29/30 Oct.) and UNFCCC COP 14 side events

*UNFCCC – GOFC REDD working group (Achard, DeFries, Souza, Pandey, Herold)*

- Update REDD sourcebook in critical and new sections by UNFCCC COP 14,
  - 10 + contributors - input required by 20. Nov.
  - Side event in Poznan accepted
- Upcoming meetings:
  - 20/21. Oct. 08: Meeting at UNFCCC Secretariat on Degradation
  - GEO Forest Monitoring Symposium, Brazil, Nov
  - Nov. 08: Capacity development organized by Coalition for Rainforest Nations
- Link with regional networks and GOFC data initiative

*IGOL – Integrated Global Observations for Land (Townshend, Brady)*

- Continuity of IGOL requirements under GEO still critical
- Issues for land use and agriculture monitoring (exploratory working group to be formed)

*GEO Land Cover / Forest Tasks (Brady, Loveland, Herold)*

- GOFC-GOLD contribution to seven GEO forest and land cover tasks:
  - AG-06-04 Forest Mapping and Change Monitoring
  - DA-07-02 Global Land Cover
  - DA-07-03 Virtual Constellations-Land Surface Imaging sub task
  - DI-06-13 Implementation of a Fire Warning System at Global Level
  - CL-06-03 Key Terrestrial Observations for Climate
  - EC-06-07 Regional Networks for Ecosystems
  - US-06-02 Pilot Communities of Practice
- GOFC feedback on GEO 15 year targets!
- GEO forest monitoring symposium: GOFC participation, objectives and contributions clarified
- More salient role for land monitoring in high-level GEO communication (i.e. key intro sections in 2009-11 workplan)
- New task on forest carbon tracking
- GOFC role as service provider for GEO?

*CEOS Constellation(s) and data continuity and availability (Townshend, Woodcock, Jeanjean, Held)*

- Different challenges for optical and SAR data (access to archive and future constellations)
- Needs for further pushing on all levels
- Comment on GEO data policy (Janetos, Brady, Woodcock)
- CEOS LSI Constellation Initiative on Global Landsat Archive
- Letter prepared by Tony to ESA & EC on Sentinel 1 & 2 & 3 data access



- Establish supersites for evaluation of multi-sensor capabilities and synergies, and stimulate space agency support (SAR observation strategy) (Held)

*GOFC validation working group (Woodcock, Wulder, Herold, Achard)*

- Link to CEOS WGCV
- Global Validation/Best Map Effort
  - Concept and some experiences exist for operational validation system and synergy among datasets
  - Next steps:
    - Make best use of existing reference datasets (GOFC to lead)
    - Develop the sample design of new reference dataset
    - Prototype activities on response design
  - Develop proposal for multi-agency support and engagement to develop and implement global validation system
- Accuracy assessment for land cover change and area estimates: Outline of addendum to best practices document and writing assignments

*Support for GLOBCOVER (Arino, Schmullius, Herold, Volden)*

- GLOBCOVER available and validated, and will continue
- Continued support of GOFC team for further development, dissemination, and validation
- Evolving global land cover European initiatives (Kopernikus working group)

*FAO FRA Activities (Hansen, Achard, Mayaux, Schmullius)*

- GOFC LC-IT members practically involved in remote sensing survey
- Joint GOFC-GOLD contributions to RSS to be further specified, i.e. quality control, regional network involvement etc.
- GOFC push for urgent access to Landsat data
- Link to supersite approach

*Support for regional networks / capacity building (Krankina, Brady)*

- Number of land cover activities within regional networks
- Key role for global validation and involvement in FRA2010 (participation in regional workshops) & REDD
- USGS data initiative as near-term activity

*Cooperation with national monitoring programs (Loveland)*

- Initial start through data initiative
- Stronger role under GEO

*Boreal forest monitoring activities (Schmullius, Wulder, Olsson)*

- Workshop outcomes ...

*LCCS*

- Standard GOFC-GOLD recommended legends (GEO task)
- Better communication with national/regional mapping programs

*Working with international scientific networks*

- Earth System Modeling and Integrated Assessment community

- IGBP, NEESPI, GLP (strategy review)

*Remaining (broader) issues:*

- Old/new GOFC themes: biophysical variables, land use/agriculture
- Updating strategy and actions
- LC-IT membership