GOFC-GOLD GLOBAL OBSERVATION OF FOREST AND LAND COVER DYNAMICS

Report of the 3rd GOFC-GOLD Land Monitoring Symposium

Wageningen 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.

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Acronym list

CIFOR	Center for International Forestry Research
COP	Conference Of Parties
ECV	Essential Climate Variable
EEA	European Environment Agency
ESA	European Space Agency
FAO	Food and Agriculture Organization
Fire-IT	Fire Implementation Team
GCOS	Global Climate Observing System
GEO	Group on Earth Observations
GFMC	Global Fire Monitoring Center
GFOI	Global Forest Observation Initiative
GLC	Global Land Cover
GOFC-GOLD	Global Observation of Forest Cover and Land Dynamics
GTOS	Global Terrestrial Observing System
ICSU	International Council for Science
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre
LC-IT	Land Cover Implementation Team
NASA	National Aeronautics and Space Administration
REDD	Reducing Emissions from Deforestation and forest Degradation
RN	Regional Network
START	System for Analysis, Research and training
UNCBD	United Nations Convention on Biological Diversity
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 Survey
WG	Working Group
WMO	World Meteorological Organization

Introduction

The 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 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.

More specifically the primary function of the Land Cover Implementation Team (LC-IT) is to develop and evaluate methods, tools and products for land cover measurements and monitoring using space-borne and in-situ observations. The LC-IT assesses current needs and deficiencies for global and regional monitoring to support Global Change research, national and regional forest inventories and international policy (i.e. through working with the UN Conventions). The LC-IT cooperates with the GOFC-GOLD Fire-IT, WGs, and worldwide RNs.

The Fire-IT is aimed at refining and articulating the international requirements for fire related observations and making the best possible use of fire products from the existing and future satellite observing systems, for fire management, policy decision-making and global change research. One of the primary goals the Fire-IT is to establish an operational network of fire validation sites and protocols, providing accuracy assessment for operational products and a test bed for new or enhanced products, leading to standard products of known accuracy.

Two previous GOFC-GOLD Symposiums were organised in 2006 and 2008 in Jena, Germany at Friedrich Schiller University. The last Symposium was attended by more than 150 persons coming from research institutes, academic research, non-governmental organisations and private sector. Beside presenting GOFC-GOLD progress in various areas and activities, the Symposium was aimed at engaging the global community of forest and land cover monitoring experts to develop technical consensus in critical areas (REDD, boreal forest monitoring, standards in reporting guidelines, land cover map validation. This third GOFC-GOLD Symposium is intended to provide the land cover monitoring community an opportunity to discuss current challenges related to REDD+, Land Cover ECV, GEO, GLC mapping and validation activities. The Symposium will provide members of the GOFC-GOLD ITs, WGs, and RNs an opportunity to discuss the future of the upcoming priorities and organisation (structure, orientations, internal and external synergies).

Objectives of the Symposium

The GOFC-GOLD Office organized this Symposium to review the recent research accomplishments in the global land cover and forest monitoring in the arenas of research, implementation, support of international assessments, and capacity development in developing countries. Specific activities from GOFC-GOLD and its partners were reported. The Symposium outlined the specific research, applications and development needs that should be targeted by GOFC-GOLD in the future.

The Symposium was an opportunity for GOFC-GOLD to communicate on its advancements and on its contributions to a series of international initiatives notably those that aim at standardizing and harmonizing GLC mapping procedures. In addition the Symposium enabled the members of the GOFC-GOLD to meet other international experts. Therefore the Symposium was an opportunity to present state-of-the-art research and provide recommendations for future work based on identified research gaps.

The outcomes of the meeting will enable GOFC-GOLD to provide its sponsors (Food and Agriculture Organization, United Nations Educational, Scientific and Cultural Organization, World Meteorological Service, International Council for Science and United Nations Environment Programme) with updated scientific and technical information to support internationally coordinated initiatives like the COP events, those from the Global Terrestrial Observing System, and those from the Group on Earth Observations.

Gathering the GOFC-GOLD members permitted the update of the long-term objectives of the organization, and strengthen its leading role in the GLC and forest mapping community.

Detailed objectives of this Symposium were:

1) Present, discuss and synthesize the achievements of the on-going GOFC-GOLD Implementation Teams (IT), Working Groups (WG), Regional Networks (RN)) and partners activities:

- Update on REDD+, its working group and the recent developments at UNFCCC COP-18 in Qatar (Fall 2012)
- Contributions of GOFC-GOLD to update the REDD sourcebook
- Contributions of GOFC-GOLD to GEO Land Cover and Land Cover Change Task (SB-02)
- Contributions of GOFC-GOLD land cover team to GEO Forest Carbon Tracking task and the Global Forest Observation Initiative (GFOI)
- Contributions of GOFC-GOLD LC to the development of global land cover validation efforts and the development of new databases
- Progress on observing Land Cover as ECV
- Update on the GOFC-GOLD Fire-implementation team
- Update and planning for the GOFC-GOLD regional network activities

- Present and discuss progress of the Biomass working group
- Engagement with key international initiatives: partners and users: GEO, UNFCCC, GCOS, GTOS, IPCC, FAO, CIFOR, ESA, JRC, NASA, USGS, EEA, UNCBD, and others

2) Discuss the new orientations the GLC and forest mapping communities have taken after COP-18 and the needs for observing land cover as essential climate variable (ECV).

3) Review of the internal organization, general and specific objectives of the GOFC-GOLD including the place and role within the series of international bodies and initiatives regarding the on-going and emerging needs of the global land cover user communities.

Organizing Committee Leaders

GOFC-GOLD Land Cover Project Office and Wageningen University

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Organised on April 15-19 the GOFC-GOLD Symposium proposed a series of workshops that provided opportunities for experts to present and discuss background, progress, and future steps of scientific and technical programs. The table below provides the list of workshops, their co-hosts and organisers. All sessions were opened to the public.

Workshop	**Co-host**	**Organisers (*leader in bold letters*)**
REDD+ WG	CIFOR	**Mora**, Herold, Achard
Land Cover Team	Boston U. / Wageningen U.	**Woodcock**, Herold, Mora
Fire Team	NASA	**Justice**, Goldammer, Arino, Vadrevu
Land Cover validation	CEOS Cal/Val WG	**Woodcock**, Herold, Olofsson
Land Cover ECV	GCOS	**Herold**, Richter, Arino, Defourny
Regional Networks	NASA-START	**Krankina**, Justice, Hoffmann
GEO GLC Task	GEO	**Sarantakos**, Mora, Arino
Plenary Session	Wageningen University	**Herold, Janetos**, Justice, Woodcock, Arino

Sponsors

GOFC-GOLD Land Cover Office (GOFC-GOLD LC Office)

European Space Agency (ESA)

System for Analysis, Research and Training (START)

Group on Earth Observations (GEO)

Global Climate Observing System (GCOS)

National Aeronautics and Space Administration (NASA)

Center for International Forestry Research (CIFOR)

Wageningen University Research (WUR)

Access to presentations

Presentations can be accessed from this page:

http://www.gofcgold.wur.nl/sites/Gofcgold_Symposium2013_Presentations.php

Summary of the Land Cover Team sessions

Monday, April 15, 2013		
SESSION 1, Venue Atlas 1, 2 Chair: Martin Herold		
9.00-9.15	Opening	*Martin Herold, Curtis Woodcock*
9.15-9.30	Building, Sustaining and Advancing Collaborative Long Term Land-Cover Monitoring under Australia's Terrestrial Ecosystem Research Network (TERN)	*Alex Held*
9.30-9.45	Nationwide forest estimates in Sweden using satellite data and airborne LiDAR	*Håkan Olsson*
9.45-10.00	Overview of new MODIS and Landsat data derived products to characterise land cover and change over Russia	*Sergey Bartalev*
10.00-10.15	Status of RAISG Pan-Amazonia Network	*Carlos Souza Jr.*
10.15-10.30	Monitoring of tropical Deforestation and land cover changes in Protected Areas: JRC perspective	*Frédéric Achard, Zoltan Szantoi*
10.30-11.00	*Break*	
11.00-11.15	ESA activities and prospects for Global Land Cover monitoring	*Frank Martin Seifert*
11.15-11.30	ESA Land Cover CCI – Processing chain	*Sophie Bontemps*
11.30-11.45	ESA Land Cover CCI - Overview	*Pierre Defourny*
11.45-12.00	A global water body dataset from Envisat ASAR data: product generation and validation	*Sophie Bontemps, Pierre Defourny, Maurizio Santoro*
12.00 Closing of the session		
SESSION 2, Venue Atlas 1, 2 Chair: Curtis Woodcock		
1.30-1.45	Landsat-scale observation and monitoring of global land cover: progress and experiences from China	*Peng Gong*
1.45-2.00	Estimates of carbon stocks of India's forests	*Devendra Pandey*
2.00-3.00	Discussions, break out groups: - Next steps for the LC-IT	*All*
3.00-3.30	*Break*	
3.30-4.50	Discussions, break out groups	*All*
4.50-5.15	Report back on discussions	*All*
5.15 Closing of the session		

Alex Held, Director of AusCover TERN Facility the Australia's Terrestrial Ecosystem Research Network. The TERN is an Australian ecosystem community that provides infrastructure for networking, data collection and sharing. The AusCover RS data facility aims to produce and deliver long-time series od satellite-based biophysical map products and research at national scale.

Carlos Souza from IMAZON, Brazil presented the status of RAISG Pan-Amazonian network. RAISG is network for exchange and integration of socio-environmental geospatial information to support processes towards sustainable development and cultural and biodiversity in the Amazon basin. The network coordinates transnational analyses. The network produces maps and statistics on the level of deforestation.

Curtis Woodcock from Boston University / GOFC-GOLD Land Cover-IT presented a time-series analysis to assess land cover type, condition and change using Landsat data. Curtis W. advocated the use of time series analysis to improve reliability of of LC information. The combination of Landsat and Sentine-2 data will enable a revisit time period of 5 days for a given location on the globe.

Devendra Pandey, former DG of Forest Survey India / consultant presented the methods and results on the estimation of carbon stock in the forests of India. Compliance with IPCC guidelines, now Tier-2 approach, several allometric equations are generated from field measurements for branch wood and leaves.

Frank-Martin Seifert from the European Space Agency (ESA) presented ESA's activities and perspective for Global Land Cover Monitoring with the status of the Sentinels 1, 2 and 3. Sentinel 1-A will be launched in October 2013, Sentinel 2-A will be launched in October 2014. The Earth Science Advisory Committee recommended ESA to implement BIOMASS, a P-band radar mission, as its 7th Earth Explorer mission. ESA presented some Data User Element Calls for 2013 (GlobCurrent, GlobTemperature, Sentinel-2 agriculture, GlobBiomass).

Hakan Olsson from the Swedish Forest Agency presented nationwide forest estimates in Sweden using satellite data airborne Lidar. Forest biomass retrieval from nationwide laser scanning trained with national forest inventory plots is feasible. But the production is a sensitive issue for the commercial sector. In addition to laser are there several more techniques for obtaining 3D data related to the forest canopy (including also radargrammetry, to be studied in a planned EU FP 7 project).

Pierre Defourny from UCL, Belgium presented the ESA Land Cover Climate Change Initiative. Map products is aimed to meet requirements from the GCOS to help fundamental research on climate understanding and studies on impact and mitigation assessments at various scales. An automated

processing chain is being developed with Envisat-MERIS input data (300m). Map products for 3 epochs (2000, 2005, 2010) will be released during fall 2013.

Peng Gong from Tsinghua University, Beijing presented progress and experiences from China on a Landsat-scale observation and monitoring of global land cover project. The best LC product provided an overall accuracy of 66%. Other map products are being produced like water bodies, cropland

Sergey Bartalev from the Russian Academy of Sciences / GOFC-GOLD Land Cover Team presented an Overview of new MODIS and Landsat data derived products to characterise land cover and change over Russia: forest cover, biomass, burned areas. A web portal service VEGA was presented. It is used to provide vegetation status analysis tools based on multi-annual and near-real-time EO data.

Sophie Bontemps from UCL, Belgium presented the development of a water body data set derived from Envisat ASAR data. The processing chain for the land cover maps produced within the Land Cover CCI was presented as well.

Zoltan Szantoi from EC-JRC presented a project aimed to the Monitoring of Tropical Deforestation and Land Cover Changes in Protected Areas. The Digital Observatory of Protected Areas (DOPA) initiative proposes a set of web based tools to Assess, Monitor, and Forecast Biodiversity at the Global Scale.

Summary of general discussions

1. There are new and updated global land cover maps (ESA-CCI, China and USGS activities)

2. Seemingly bright future for land and forest monitoring (Landsat 8, ESA-Sentinels, EE7 Biomass)

3. Moving towards including 3D (Optical and LIDAR data) and using multiple remote sensing data sources (Optical and Radar as part of ESA LC-CCI)

4. There is a need for investments and better ground reference data (integrating networks - TERN, inventories, T-LIDAR …) and locally tuned approach, i.e. adaptive global mapping (LAGMA)

5. Global observation datasets for national and regional use (some are becoming too good: Hakan/Sweden, raising political and economic issues; increased use of remote sensing for Russian national forest inventory, used in India already), role of R&D and science: show results rather papers (RAISG)

6. Use of time series for more consistent land cover mapping and track changes (Russia, ESA LC-CCI, Landsat)

7. Sharing of knowledge and information across boundaries and involve stakeholders (RAISG)

8. Develop land cover and change data for specific users (i.e. biodiversity, climate modellers) and for specific thematic areas (i.e. water bodies, wetlands, urban, cropland)

Summary of the Fire-IT sessions

Monday, April 15, 2013		
SESSION 3, Venue Lumen 1, 2 Chair: Chris Justice		
9.00-9.20	GOFC Fire-IT Status and Updates	*Justice, Goldammer and Vadrevu*
9.20-9.40	Round the table introductions of participants	
9.40-10.00	Global Geostationary Network and Fire Products	*Giglio*
10.00-10.20	Fire Observations from New Instruments	*Giglio*
10.20-10.50	*Break*	
10.50-11.10	VIIRS Fire products update (Webex/Skype)	*Csiszar*
11.10-11.30	Discussion on fire related sensors	*All*
11.30-11.50	Sentinel products update	*Plummer*
11.50-12.10	Discussion	*All*
12.10	*Closing of the session*	
SESSION 4, Venue Lumen 1, 2 Chair: Krishna Vadrevu		
1.30-1.50	Burned area and validation- next steps	*Boschetti*
1.50-2.10	Fire-CCI project updates	*Itziar (Chuvieco team)*
2.10-2.30	Terrestrial Observation Panel for Climate (TOPC)-Fire ECV update including CEOS LPV	*Tansey*
2.30-2.50	Discussion on burned area validation	*Lead: Roy*
2.50-3.30	*Break*	
3.30-3.50	User needs perspective – fire management	*Goldammer, GFMC*
3.50-4.10	User needs - institutional cooperation at regional level	*Gitas/Zalidis, Balkan Env. Center*
4.10-4.30	User needs panel discussion – International Biomass burning initiative (IBBI) – IGAC project - Atmospheric science perspective	*Kaiser*
4.30-5.10	User needs panel discussion	*All*
5.10	*Closing of the session*	

Tuesday, April 16, 2013		
SESSION 6, Venue Lumen 1, 2 Chair: Johann Goldammer		
8.30-8.50	Progress and potential roadmap for the global fire EWS and activities	*de Groot*
8.50-9.10	European Forest Fire Early Warning System (EWS)	*Jesús San-Miguel*
9.10-9.30	Seasonal forecast model for the Global EWS	*Brown (Desert Research Institute)*

9.30-9.50	Discussion on Fire EWS	*Lead: Justice*
9.50-10.30	*Break*	
10.30-10.50	UN-REDD Fire-GOFC source book updates and next steps	*Boschetti*
10.50-11.10	WALFA project	*Maier*
11.10-11.20	SAFNET update	*Frost*
11.20-11.30	Briefing for preparation of Session 10 – Collaborative activities with Fire IT	*Hoffmann*
11.30-11.50	Discussion	*All*
11.50 Closing of the session		

Thursday April 18, 2013		
SESSION 11, Venue Lumen 1, 2 Chair: Chris Justice		
1.30-1.50	Latest updates and research on fire radiative energy products	*Wooster*
1.50-2.10	FRP emissions	*Kaiser*
2.00-2.10	Update on Global Fire Emissions Inventory	*Van der Werf*
2.20-2.30	Evaluation of tropospheric emission products in relation to fires	*Vadrevu*
2.30-2.50	Discussion on fire emission products	*Lead: Wooster*
2.50-3.30	*Break*	
3.30-3.50	User needs Forestry perspective (Webex/Skype)	*Hinkley*
3.50-4.10	Fire regional network update	*Hoffmann*
4.10-4.50	Regional Networks and Round table on next steps for GOFC GOLD Fire IT - Discussion	*Justice,Vadrevu*
4.50-5.10	Action items and final remarks	*Justice, Vadrevu*
5.10 Closing of the session		

Summary of discussions available online soon in Earth Observer magazine from NASA (early summer 2013)

Summary of the Global Land Cover Validation session

Tuesday, April 16, 2013		
SESSION 5, Venue Atlas 1, 2, 3 Chair: Curtis Woodcock		
8.30-9.00	Progress on USGS/Boston U./GOFC-GOLD Global Land Cover database and Accuracy Assessment Good Practices	*Curtis Woodcock*
9.00-9.15	Validation strategy of the CCI-LC exercise	*Frédéric Achard*
9.15-9.30	Chinese global land cover validation activities	*Peng Gong*
9.30-9.45	GOFC-GOLD global land cover reference data web portal	*Brice Mora*
9.45-10.15 Break		
10.15-11.30	Discussions, break out groups	*All*
11.30-12.00	Report back on discussions	*All*
12.00 Closing of the session		

Curtis Woodcock introduced his team's work on good practices for assessing accuracy and estimating area of land change. The issue on this topic and the examples of good practices are published in Remote Sensing of Environment recently. Main discussion is about sampling design, response design and analysis of the assessments. Response design is more complicated since it is hard to get reference data for the first time period. In the reporting of the accuracy, more emphasis on reporting the original confusion matrices and confidence intervals should be emphasized. Further focus on the change products of the REDD+ context can be achieved.

Secondly, designing a global reference database for assessing accuracy of land cover maps is also presented. The main aim is to generate a reference dataset that is suitable for different maps. There reference data can also be augmented regionally or thematically. World-wide 500 sites will be mapped with very high resolution images, semi-automatically segmented, object based classified and analysed. Land cover entities will be delineated and it can also be aggregated to different maps' scale requirements. Moreover, USGS is also producing Landsat-scale GLC map and subset of 500 VHR datasets are used in the validation of the map. USGS analysed 225 sites with general 4 classes from 2 m VHR data so far. For Boston/GOFC-GOLD's data 33 maps are created as of March 2013. Wageningen University is helping for the generation of those samples. Since minimum mapping unit of the datasets is much smaller, different kind of tests could be made such as the impact of generalization on the accuracy. GOFC-GOLD LC-IT tested this and accuracy gets better as you use

coarser resolution maps. However, there is a question on how to aggregate these data into coarser resolution of the GLC maps. Legends of the reference data are land cover identity and it can be transferred to different legends such as IGBP and LCCS legends with the augmentation processes. GOFC-GOLD can also use the regional networks to help with the sample interpretation.

Frederic Achard presented the validation strategy of the CCI-LC exercise. Validation of CCI-LC will be based on GEOS framework stage 3 requirements. Sampling design is based on systematic + stratified + random selection. Although systematic sampling is often criticized, it also has its own advantages. Validation process will have its own online interface. This is developed by UCL and ready to be used now. Systematic sampling of FAO is not equal probability by latitude but it is corrected for the LC-CCI. Level of certainty in the interpretation, changes in 2000, 2005 and 2010 will be recorded from Landsat images. NDVI profile is also used for three epochs. Involvement of independent experts is announced for the session participants. The validation data generation is expected to be finished by October.

Peng Gong presented current activities on Chinese global land cover validation datasets. Information on land cover maps that has been produced and validated were reviewed to inquire what specific land cover of the region has been done so far. In total, around 6000 papers were reviewed and land cover literature were also spatialized into a database. The information such as the accuracy of the land cover map, number of land cover maps over certain area, hot spot of land cover mapping can be visualized in the database. The validation data generation for FROM-GLC validation went through several processes. Firstly, validation dataset has been interpreted and crosschecked. Quality control of that was also done through the second round of sample verification. Finally, all the samples were checked again by one person who performed best. For equal area hexagons, 5 samples were randomly selected. However, they tested that even two samples for hexagons result a stable data outcome. The accuracy of the different number of samples did not vary much. Other than Landsat TM level, they also recorded 500 x 500 area homogeneity. This subset of the dataset can be used for validating coarser resolution GLC maps. Reference data includes available high resolution maps, interpretation confidence, pure classes, crosschecking and quality checking. 37% large sample can be used for coarser GLC maps. 60% of the sample had high resolution images available in Google Earth. Confidence level is very high (80%). The limitation of this reference data is that it is time dependent since it is derived from single data images. They are also collaborating with Steffen Fritz (IASA) to combine the two systems. Global analysis and Global map software were created for the interpretation process. They are available online.

Brice Mora discussed about the reference data web-portal for GLC maps. GOFC-GOLD is working to release GLC reference datasets after consolidations. GOFC-GOLD also recommends the proper use of the datasets based on the suitability for certain applications. Web portal is now at prototype stage. The objectives of reference data sharing, independence issue, and other datasets to include could be discussed further.

Discussion session

From different talks of this morning, one could observe there have been good progress in the field and CEOS Cal/Val Working Group keeps working actively. Participants also need to think about putting more work towards an operational CEOS stage 4 validation. Further emphasis can also be on the validation of land cover change. There are some data getting available on forest change. LC-CCI validation data could also be regarded as a start towards change validation data.

Incorporating crowd sourcing data into the validation of GLC maps is becoming an important topic. There are some disadvantages of crowdsourcing related to probability sampling and the quality of the interpretation. However, since the use of reference data depends on what the objectives are, crowd sourcing dataset could still be useful. The mapping community can also implement crowd sourcing data collection in a smarter way i.e., introducing sampling designs. It is required to understand when crowd sourcing can help and create a crowd sourcing data collecting system according to the requirements of the community.

FAO RSS and LC-CCI data are based on systematic sampling which is not the best probability sampling scheme. The problem of systematic sampling has been the estimating of errors, and that is not entirely impossible since many institutes are working on this field. On the other hand, sampling scheme is not really an important issue, but an operational response design is. Thus, it is important to sit together to design an operational reference data collection approaches in a collaborated way and apply for funding sources to really implement it.

In the plenary sessions, a compilation of the current status on the land cover validation working group. Appropriate means to progress on the response design should be discussed as well. Looking into the participatory approaches, what and when crowd sourcing data can be used should also be focused.

On the issue of reference data on biomass:

Australia is trying to develop a reference data system for biomass. Mexico already released plot data. Sweden and Australia will release data soon. GEOCARBON is also trying to put together some regional data. But there are lots of inconsistencies in these datasets. It is necessary to engage regional networks with validation activities. The use of geo-wiki biomass to collect regional plot data should be considered. For biomass plot data, it is better if donors push to make the ground data available to the public. Now it is not really happening and data producers are quite possessive on the data. Terrestrial Lidar information is also an option for biomass reference data but it is not mature yet for operational observation. This is investigated in tropical areas.

More active work from the biomass working group of GOFC-GOLD should be achieved. But there is a lack of devoted resources (funding and staff) currently. A biomass mission can be proposed. It should be discussed further discuss in coming sessions.

Summary of the Plenary session

Wednesday, April 17, 2013		
PLENARY SESSION, Venue: Hof Van Wageningen Hotel		
Opening		
8.30-8.40	Wageningen University	*Martin Herold*
8.40-8.50	Netherlands Space Office	*Joost Carpay*
8.50-9.00	Overall discussion on GOFC-GOLD	*Anthony Janetos*
Update on GOFC-GOLD activities		
9.00-9.15	Achievements and progress of the Land Cover IT	*Curtis Woodcock*
9.15-9.30	Achievements and progress of the Fire IT	*Chris Justice*
9.30-9.45	Achievements and progress of the Biomass WG	*Christiane Schmullius*
9.45-10.00	Achievements and progress of the REDD WG	*Martin Herold*
10.00-10.15	Achievements and progress of the Regional Networks	*Olga Krankina*
10.15-10.45 Break		
Panel 1: Links to UN Conventions and REDD+		
10.45 - 12.00	5-10 min talks followed by a discussion *Participants*: IPCC GHG Inventories and Remote Sensing UNFCCC Secretariat World Bank	 *Jim Penman* *Jenny Wong* *Alex Lotsch*
12.00-13.30 Lunch break		
Panel 2: Coordinated global observations		
13.30 - 14.45	5-10 min talks followed by a discussion *Participants*: Global Climate Observing System European Environment Agency Group on Earth Observations / GFOI	 *Carolin Richter* *Chris Steenmans* *Simon Eggleston*
Panel 3: Key research and development initiatives		
14.45 - 16.15	5-10 min talks followed by a discussion *Participants*: European Space Agency / Climate Change Initiative	 *Stephen Briggs*

	Joint Research Centre UNCBD/GEOBON	*Philippe Mayaux* *Andrew Skidmore*
16.15-16.45	*Break*	
16.45-17.15	Synthesis and closing discussion	*Anthony Janetos*
17.15	*End of Plenary Session*	

Role of GOFC-GOLD from panellists' point of view:

Joost Carpay from the Netherlands Space Office made a warm welcome to the participants and acknowledged the key role of GOFC-GOLD in research and development activities on land monitoring. The Netherlands programme manager and delegate at ESA added GOFC-GOLD provides an key link between space agencies, scientists, policy makers and other users of earth observation data.

Jim Penman (University College London / GEO GFOI): GOFC-GOLD, via the REDD sourcebook notably, should provide continuously updated review of applicable science and technologies relevant to IPCC and GFOI.

Jenny Wong (UNFCCC): GOFC-GOLD activities should:

1. Keep serving as a complement to the IPCC guidelines and provide practical, hands-on guidance and technical support to the methodologies for measuring and monitoring emissions and removals (not just satellite or remote sensing approaches but also ground-based approaches)
2. Further contribute to the establishment of robust and transparent national forest monitoring systems and the monitoring of emissions and removals and changes in forest carbon stocks resulting from REDD-plus activities;
3. Further contribute to monitoring and addressing drivers of deforestation and forest degradation;
4. Further contribute to developing national GHG inventories for the forest land use sector
5. Further contribute to constructing national forest reference emission level and/or forest reference level;
6. Further contribute to addressing displacement of emissions (leakage) and risks of reversals (permanence)

Andrew Skidmore (U. Twente / GEO BON): GOFC-GOLD could provide input to the Essential Biodiversity Variables though information on: Species distribution, Population abundance, Population structure by size/age class, Phenology, Disturbance regime, Habitat structure, Ecosystem extent and fragmentation, Ecosystem composition by functional type.

Philippe Mayaux (EC-Joint Research Centre): The JRC expects from GOFC-GOLD:

1. GOFC-GOLD as a scientific community

- Biannual meetings very useful (program scanning, personal contact, orientation from the policy…)

- Specific methodological developments (REDD+, validation)

- Joint validation of products (datasets, methods…)

- Stronger engagement with policy-makers

2. GEO and GOFC-GOLD

- Need for clarification between the two panels

- GEO more oriented to the production, while GOFC-GOLD focused on science

3. Regional Networks

- Need for "real" networks: resource issue

- Coordination with other regional policy networks (REDD, biodiversity)

Summary of discussions on the topics/themes GOFC-GOLD should focus on in the next five years

A series of issues were pointed out and discussed. At the same time as the science continues to develop, countries are being asked to implement what they can for changes in forest carbon. There is a clear need for both practical, actionable advice as the science improves.

• The evolution of the relationship between GOFC-GOLD and GEO means that we will need to provide scientific foundations across the various core projects

• The same is true for other core issues of GOFC-GOLD – fire, land-cover change

Positive outcomes of GOFC-GOLD work but also a need for more baseline work has been reported:

• Access to data has been successful, but we must remain vigilant on this issue

• Importance of higher-order products and evaluation of products in order to make their use easier and more widespread

• Lots of implementation is inherently regional and national – empowering countries and regional experts to contribute is a long-term task

New emerging themes were discussed:

• Assistance to emerging themes – e.g. Essential Biodiversity Variables

• Rising interest and scientific capacity for remote biomass measurements

• Ensuring that terrestrial ECV's relevant to our expertise have an evaluation process that leads to a consensus view of adequacy

• The importance of helping to build scientific consensus – both to help focus the research agenda and to provide guidance to policy makers

The idea of making a sourcebook dedicated to biodiversity monitoring in forested areas with RS-based methods was discussed and supported by some participants in the audience and among the panellists.

Summary of the GEO GLC Task session

Thursday, April 18, 2013		
SESSION 8, Venue Atlas 1, 2, 3 Chair: Georgios Sarantakos		
8.30-8.45	Overview of the GEO Land Cover and Land Cover Change Task (SB-02)	*Martin Herold*
8.45-9.00	Outcomes of GEO IX Plenary and GEO updates	*Georgios Sarantakos*
9.00-9.15	Task activities	*Chris Steenmans*
9.15-9.45	Land Cover CCI: current status and next steps	*Frank Martin Seifert/* *Olivier Arino*
9.45-10.00	The 30 m global land cover products from China: datasets and methodology	*Peng Gong*
10.00-10.15	Towards global land cover change monitoring with Landsat	*Matt Hansen*
10.15-10.45 Break		
10.45-11.30	- Discussions, break out groups: - Next steps	*All*
11.30-12.00	Report back on discussions	*All*
12.00 Closing of the session		

The main objectives of the session were:

- Present progress and activities on:
    1. Global land cover datasets
    2. Validation and user engagement

- Discuss:

    1. Most advances of the task are individual progress reports - what are key areas to evolve on the group level and where GEO can add value?
    2. Many users/SBAs/GEO tasks need land cover data – how to understand and meet their needs?
    3. Most activities are global with little interactions with GEO members – how to better engage with regional and national-level initiatives?
    4. What are the contributions and expectations from GEO (other tasks and GEO Members) 2013, and for 2015?
    5. How to engage in more capacity building?

- Outcomes of discussions:

Summary of presentations:

Georgios Sarantakos from the GEO Secretariat presented the structure and objectives of GEO, GEOSS, the progress made and the future milestones.

Chris Steenmans from the European Environment Agency presented the sub-task C2 on Global Land Cover Validation and User Engagement from the SB-02 Global Land Cover Task. Expected achievements by 2015 are:

1. General concept for GLC Validation (sampling design etc.)
2. Harmonized database for validation of GLC datasets
3. Established and tested methodology to augment and streamline existing global validation data by continental, regional or national data

Presented avenues for making progress towards the objectives are:

1. Agree on GLC validation strategy (sampling design, stratification etc.) that can be applied to existing and future GLC datasets
2. Work towards a harmonized universal GLC validation dataset (database)
3. In the meantime (before harmonized universal GLC validation dataset available): validation of available GLC products with particular emphasis at 20-30m product by GEO national members and others (e.g. EEA)

Examples of validation data in Europe were presented (e.g., Corine Land Cover, Urban Atlas 2006). EEA is developing urban validated maps for European cities with more than 100.000 habitants. Same product will be developed for the cities with more than 50.000 habitants.

For the validation it is important to consider:

a) what classification is used

b) start from the objectives (why we produce this map) in order to define the accuracy required to achieve

c) take into consideration historical data but be clear what these data have been developed for

The LC products could be clustered into three categories:

a) LC state

b) LC condition (changes but due to the seasonal change)

c) LC change (changes the same season over years)

The categories b and c should be clearly distinguished from each other.

At the urban products presented the urban climatology is not targeted now but is taken into consideration at the regional scale.

The continuity of the space missions is a challenge but the community counts on the missions interoperability/compatibility/constellation.

Frank Martin Seifert from the European Space Agency presented the Land Cover project within the Climate Change Initiative. Please refer to sessions of the Land Cover Implementation Team on Monday for details.

Matt Hansen from the USGS presented some work towards global land monitoring using Landsat data. Concluding remarks were:

1. Global medium resolution monitoring of land cover change will soon be routine
   –At a scale appropriate for many science applications (<=30m), including carbon cycle science, biodiversity modelling, etc.
   –With near-real time delivery of change information
   –Data policy is critical and commercial models for data <=5m will not allow for global monitoring (targeted, sample-based only)
2. Validation is critical
3. Change attribution likewise critical
4. From-to pathways also needed (for example primary intact, degraded and other forest types to palm, acacia, etc.)
5. Other land dynamics in the works – bare ground/vegetation cover, water, crop type (sampling versus mapping in some cases)
6. For developing countries needing to monitor land cover, challenges remain
   –High-performance computing is needed
   –How best to develop capacity in this context?
7. Where will the community be in 10 more years?

The University of Maryland is preparing Global LandSat cloud-free composites.

Peng Gong from Tsinghua University, Beijing, presented some 30-m global land cover products developed in China for wetland, water bodies, land cover, urban settlements and croplands in China. Land cover change maps are produced also. A web-based land cover map validation tool was presented as well.

General discussion

The idea of supersites for validations, e.g. validation of products for multiple purposes, should be better explored.

There are more and more products out there that create confusion. What is useful and for what and what is not should be defined by this group.

A better connection to the UN system (stronger links) is needed.

Due the classification issues, there is a trend for the production of dynamic services instead of static products.

Summary of the Land Cover ECV session

Thursday, April 18, 2013		
SESSION 9, Venue Atlas 1, 2, 3 Chair: Martin Herold		
1.30-1.50	Introduction to GCOS activities and need for GOFC-GOLD input	*Carolin Richter*
1.50-2.10	Observing land cover as ECV: overview	*Martin Herold*
2.10-2.30	ESA CCI approach for Land Cover ECV	*Pierre Defourny/* *Frank Martin Seifert*
2.30-2.50	Progress from Committee on Earth Observation Satellites on terrestrial ECVs	*Carolin Richter,* *Mark Dowell*
2.50-3.30	*Break*	
3.30-4.50	- Discussions, break out groups	*All*
4.50-5.10	Report back on discussions	*All*
5.10	*Closing of the session*	

Carolin Richter introduced the GCOS activities and need for GOFC-GOLD input. The GCOS communicate and facilitate with climate components of WMO, GOOS, GTOS and other research programmes such as IGBP, as well as other communities that contribute to climate observations. GCOS has three panels such as atmospheric, ocean, and terrestrial observation panel for climate. GCOS recognized around 50 ECVs so far and 13 of which are terrestrial ECVs. With carbon and land cover related issues GCOS communicate with GOFC-GOLD. GCOS updated its implementation plan in 2010 and there are three land cover related actions which need to be addressed:

1. Produce reliable and accepted methods for land cover validation.
2. Generate annual produces documenting global land cover characteristics and dynamics at resolution between 250m and 1 km.
3. Generating maps documenting global land cover based on continuous 10 to 30 m land surface imagery every 5 years.

GOFC-GOLD along with other agencies and groups such as CEOS WGCV, GLCN are involved in this actions. GOFC-GOLD can help by monitoring terrestrial ECVs of land cover, fire and biomass. Moreover, the input from GOFC-GOLD community is also needed in areas of progress on ECV land cover domain, REDD+ capacity development, strategic issues such as climate requirements for global in-site observations. In the next GCOS implementation plan, expert inputs are needed as well. GCOS

organized a questionnaire on available ECV data and intend to set up a consolidated ECV database. An important issue to address is which of the dataset will be chosen as ECV? There is an incompatibility in the observation of ECVs. There will be an assessments on the ECV products. Internationally accepted guidance is needed for this.

Martin Herold discussed about observing land cover as ECV. There are 5 GCOS tasks for land cover. In three tasks, there have been good progress but in tasks such as development of in situ reference network for land cover and regular fine resolution land cover maps and change, there have been less progress. Methods for land cover map accuracy assessments, international standards for land cover maps and annual land cover products are in good shape so far, and some datasets are getting available to the community.

There is also a study on making use of the existing land cover reference datasets, and there have been efforts on making them available to the community. There is a series of products on moderate scale monitoring of land cover such as using MODIS and MERIS data. But, not a lot in fine resolution observation, although some new products from China and USGS are expected. From this variety of products, it is not clear which one should be considered as the ECV.

Moreover, there is some land and forest change datasets such as JRC TREES, FAO, UMD/USGS are getting available. The issue with the fine scale is that it attracts much more user communities than climate group particularly REDD+.

It is necessary to know what are the requirements that GCOS expects. In this, it is important to know the ideal reporting way to GCOS and GTOS. Report through other agencies such as CEOS could be done. This kind of different ways should be canalized as long as it comes up to TOPC. Although, direct interaction with the TOPC would be preferable.

Pierre Defourny discussed about ESA CCI approach for land cover ECV. Climate change initiative of ESA targets several ECVs. These ECV observations work closely with the climate modelling groups (CMUG), and regular meetings and multiple feedbacks are given on the ECV observations. The GCOS requirements are fulfilled in most cases by the CCI ECVs but some requirements are partly met. There are 3 climate modelling groups on the LC-CCI projects as partners. For these partners, land cover is used three different ways. From the user surveys, an analyse of the requirements of climate modelling groups was performed. The key concerns of the users are: long term consistent observation of land cover, consistency among the different model parameters, relationship between land cover class and PFTs, flexibility of land cover data in different applications. Quality flag of the land cover data is also important. Requirements of GCOS and CMUG do not match exactly with each other, but they have similar tendency. These requirements are not achieved with the existing GLC maps. It is still not certain that whether the requirements will be fulfilled or not. That is why the concept of land cover need to be looked again. Land cover is conceptualized with stable and dynamic components. The climate user groups use different climate models. Some concerns about different PFTs and some

(IAM) looks into the human impact. Land cover map classes are transferred to 14 plant functional types. With the help of LCCS classifier, class legends were translated to PFTs. A translation of the legend for each models of PFTs is undergoing. However there were some inconsistencies due to the concept of PFTs and definition of classes. Also, it is necessary to pay attention to small details such as data format (NetCDF), aggregation rules, reprojection etc to provide to the user groups. This kind of interactions were possible through the project. However, long term sustained interaction would be challenging. Moreover, climate models are usually tuned for special land cover maps, so modellers do not easily change the GLC maps.

Carolin Richter discussed about the progress from CEOS on terrestrial ECVs. CEOS is the space arm of the GEO community. This is the body to provide the data on climate monitoring. CEOS is starting some activities on assessing data for different ECVs according to the requirements of GCOS. There are plenty of ECV products around for instance, there are at least 8 different products available on sea ice. Therefore, it is important to know which one of these can be used. A set of ECVs (snow cover, fapar, soil moisture) was evaluated. ECV inventories were conducted. 45 questions targeted on space agencies via web interface. Up to now, 225 datasets were recorded in www.ecv-inventory.com . The assessments will be available in April and at the end of the year fully. There are 4 land cover datasets that have been submitted, but they are not from this community.

Discussion

It is necessary to work directly with GCOS on the reporting and ECV inventories. There is also an issue regarding the future of GTOS. It should be preferable to work as a panel about the ECV datasets on land cover to avoid inconsistencies. There are several land cover datasets, and consolidation of those data need to be done. An important issue is that all the ECV products should be described in a complete way, with metadata of methods, quality flags etc., It is also needed to be clear on what has been done for creating the products, and good documentation on that should be provided. These ECVs products should be checked according to the CEOS requirements, and assessed which of the data can provide a good information. The outcome will be structured as a database of the ECV products.

The disagreement of the ECV products is an issue. However, with different user perspectives, different datasets can still be chosen. In addition to documenting, inter-comparison of different ECV products can be very informative. These differences will help to understand different assumptions of product generation. Inter-comparison should be done in regional areas since the accuracy of the land cover map vary regionally a lot. Some information on the comparison of different datasets that pass some kind of threshold which will help the users could be provided. Also, the record on what and how the datasets are being used could be informative for the users. It should be emphasized that the consistency of the datasets is important for the climate modellers. There are also different kinds of user communities and the requirements vary. For instance, the observation of land cover is not really

required by climate modellers, from the observation point of view it could be useful especially for REDD+.

Summary of the Regional Networks session

Thursday, April 18, 2013		
SESSION 10, Lumen 1,2 Chair: Olga Krankina		
8.30-9.10	Workshop objectives and RN introductions (round table)	*Olga Krankina, RN reps (9 networks – 3 min each)*
9.10-9.20	Functions of networks within GOFC-GOLD	*Janetos*
9.20-9.35	Review and discussion of Regional Network Data Initiative and training	*Krankina, Woodcock, RN reps*
9.35-9.50	Collaborative activities with Fire IT	*Hoffmann, Justice, Goldammer*
9.50-10.10 Break		
10.10-10.25	Collaborative activities with Land Cover IT	*Woodcock, Herold*
10.25-10.55	Collaborative activities with REDD and Biomass WGs	*Mora, Schmullius*
10.55-11.10	START collaboration with Regional Networks	*Hassan Virji*
11.10-11.45	Review of RN coordination and general discussion of next steps	*Olga Krankina, Moderator, Anja Hoffmann rapporteur*
11.45-11:50	Report back on discussion and concluding remarks	*Hoffmann, Krankina*
11:50 Closing of the session		

GOFC-GOLD Regional Networks provide a way to promote collaboration among scientists to increase the access to, and the use of, earth observation data. The current GOFC-GOLD strategy includes a commitment to strengthen networks in developing regions. At present, there are 11 networks. There was a summary presentation from a representative of each Regional Network.

1. South-Central Europe (SCERIN) Jana Albrechtova
2. Northern Eurasia (NERIN) Olga Krankina
3. Baltic-Arctic (BARIN) Gregg Taff
4. Latin America (RedLaTif) Gerardo López Saldaña/ Alberto Setzer
5. Southern Africa (SAFNET) Philip Frost/ Navashni Govender
6. Southern Africa (Miombo) Natasha Ribiero
7. Western Africa (WARN) Vincent Von Vordzogbe
8. Central Africa (OSFAC) Landing Mane
9. Southeast Asia (SEARRIN) Thatheva Saphanthong
10. Central Asia (CARIN) Nadija Muratova/ Alim Pulatov
11. South Asia (SARIN) Krishna Vadrevu

Functions of the Networks within GOFC-GOLD

Anthony Janetos, Chair of GOFC-GOLD, stated that the three parameters for success of the regional networks are:

- Strong leadership coupled with continuity among network members
- A research agenda designed to meet regional needs
- Access to external funding from international initiatives.

There is a need to improve links between each Regional Network group and the National Institutions within the region as a way to improve access to funding sources and to make sure that data is accessible for constituents. Although it is not possible for GOFC GOLD to support all Network activities, GOFC-GOLD, in cooperation with START, provides funding in support of regional meeting meetings to facilitate training and on-going activities as a catalyst for each Network.

Collaborative Activities with Fire Implementation Team

Chris Justice discussed how Fire Implementation activities support the Regional Networks. Building on the remarks of Dr. Janetos, he emphasized the GOFC-GOLD is an umbrella organization and not a funder. The activities empower regional scientists to use readily accessible data to contribute to the needs of the region. He emphasized that is driven from the bottom-up and that this is no top-down decision making. Anja Hoffmann discussed the support of networks with a fire focus and opportunities for capacity building.

Collaborative Activities with Land Cover IT

Curtis Woodcock talked about Essential Climate Variables and invited RN members who are focused on Land cover activities to contact him and Martin Herold.

Collaborative Activities with REDD and Biomass Working Groups

Chris Schmullius describe various global projects and the new satellites that were launched by the European Space Agency, all of which provide increased capabilities for tracking biomass changes. She discussed the need for local validation of degradation of ecosystems. She invited people to visit the GEO Forest Tracking Portal. She reported that there is a goal to organize the first GOFC-GOLD Biomass Network meeting to be held in Spring, 2014.

Brice Mora noted that REDD remote sensing data will be represented at the next COP. He presented slides to show the current state of mapping that has been completed to date. REDD activities are available to all Regional Networks.

Regional Network Data Initiative and Training

The most recent Data Initiative and Training Sessions were held during May 2012 with 8 scientists in attendance for one week at the EROS Center in South Dakota, USA and the second week at Boston University. The next sessions will be held during May 2014 at the same locations.

David Roy discussed the issues related to internet access for the data, which is now available via internet for those who have high speed connections. He suggested that it may be more efficient to send the data on DVDs to scientists who do not have high speed internet access.

Regional Networks and START Collaboration

Skip Kauffman reported on current status of the 3-year grant to START from NASA (ending in 2014) in support of Regional Network activities. The remaining funds will be used to sponsor the final Data Initiative. There will be partial support for additional network meetings. Networks will need to present a meeting proposal, which will need to be approved by the GOFC-GOLD Executive Committee.

He noted that it is time to begin the process for preparing a new proposal to NASA in 2014. It will be important to document the successes of the Networks as they have emerged and matured. In response to the need to stabilize the Networks, START proposes to establish Terms of Reference for the Regional Networks to include: 1) A statement of what is common to each Network, 2) The specific activities of each Network (e.g., fire, land cover, etc), 3) A designated leader, and 4) A mechanism for finding and retaining members.

Summary of the REDD+ WG session

<table>
<tr><td colspan="4">Friday, April 19, 2013</td></tr>
<tr><td colspan="4">SESSION 12, Venue Atlas 1, 2, 3

Chair: Brice Mora</td></tr>
<tr><td>8.30-8.45</td><td colspan="2">Opening, Updates on REDD+ WG activities</td><td>Martin Herold,

Brice Mora</td></tr>
<tr><td>8.45-9.00</td><td colspan="2">Update of the GOFC-GOLD sourcebook</td><td>Brice Mora</td></tr>
<tr><td>9.00-9.15</td><td colspan="2">Progress on international negotiations (UNFCCC) and GFOI activities</td><td>Jim Penman</td></tr>
<tr><td>9.15-9.30</td><td colspan="2">CIFOR activities</td><td>Daniel Murdiyarso</td></tr>
<tr><td>9.30-9.45</td><td colspan="2">Joint FAO-INPE effort in the context of REDD+: status and challenges</td><td>Inge Jonckheere</td></tr>
<tr><td>9.45-10.00</td><td colspan="2">JRC future activities: (TropForest and) ReCaREDD projects</td><td>Frédéric Achard</td></tr>
<tr><td>10.00-10.15</td><td colspan="2">Capacity building for national-scale forest monitoring in DRC, Indonesia and Peru</td><td>Matt Hansen</td></tr>
<tr><td colspan="4">10.15-10.45 Break</td></tr>
<tr><td colspan="4">Parallel sessions</td></tr>
<tr><td></td><td>GEO GFOI – GOFC-GOLD linkages</td><td colspan="2">R&D technical session</td></tr>
<tr><td>10.45-11.00</td><td>Some suggestions on better linking GFOI and GOFC-GOLD activities.

By Herold/Woodcock</td><td colspan="2">REDD baseline mapping method from SPOT and Landsat imagery in the Congo Basin. By Hervé Poilvé</td></tr>
<tr><td>11.00-11.15</td><td rowspan="5">Discussion topics:

- Sourcebook and MGR developments

- GOFC-GOLD leadership for R&D activities</td><td colspan="2">Modelling above ground biomass and carbon stock of tropical forest of Nepal using very high resolution satellite images and airborne Lidar.

By Yousif Hussin</td></tr>
<tr><td>11.15-11.30</td><td colspan="2">RapidEye for REDD.
By Axel Penndorf</td></tr>
<tr><td>11.30-11.45</td><td colspan="2">USG Collaboration for implementing MRV systems - SilvaCarbon program.
By Sylvia Wilson</td></tr>
<tr><td>11.45-12.00</td><td colspan="2">MRV for REDD+ implementation: WWF’s local to global ongoing experience.
By Naikoa Aguilar-Muchastegui</td></tr>
<tr><td>12.00-12.15</td><td colspan="2">Lidar applications for REDD+ activities. By Erik Næsset</td></tr>
<tr><td colspan="4">12.15 Closing of the morning session</td></tr>
</table>

SESSION 13, Venue Atlas 1, 2, 3		
	GEO GFOI – GOFC-GOLD linkages	*R&D technical session*
1.30-3.00	Discussions	Discussions
3.00-3.30	*Break*	
3.30-4.30	Report back on discussions	
4.30	*Closing of the session*	

Parallel session on GEO GFOI - GOFC-GOLD linkages

A parallel session on GEO GFOI and GOFC-GOLD linkages was organised. Avenues for an increased partnership were discussed further after initial discussion in February 2013 during last GFOI meeting. It was decided that:

- It should involve GOFC-GOLD, GFOI and FAO
- Specialisation rather than only coordination should be sought

The relationship between the REDD Sourcebook and the MGD was discussed as well:

- 2 complimentary documents:
    - GOFC-GOLD REDD+ Sourcebook:
        - Resulted from request from different (REDD+) actors in 2005
        - Sourcebook is mostly conceptual with concrete examples
        - Broader scope: proof and demonstrate what is scientifically proven (in national contexts), a wider range of options with more technical detail and with up-to-date information on evolving technologies
        - Audience: REDD+ practitioners (national and sub-national) and science + technical community
    - GFOI Methods and Guidance document:
        - Initiated under GEO as part of GFOI
        - Aim on guidance and being more of a manual
        - Focus on approaches that are ready for operational implementation
        - Audience: national REDD+ focal points and technical implementers for design of REDD+ MRV and monitoring systems

On the development of the GFOI R&D plan, following actions were decided:

- Develop 5 pages R&D plan building upon priorities from GFOI advisory board (FAO/UN-REDD, WB FCPF, UNFCCC-Sec.):
    - Start with condensed version from current R&D plan draft
    - In parallel undertake a gap analysis review of key R&D needs (using as basis the R&D Plan Annex)
    - GFOI office to develop first draft by end of April to be sent to Advisory Board (to build-in additional and urgent needs)
    - Then consolidation among GFOI office and GOFC-GOLD project office by June'13
    - Share with prospective donors and countries

- GOFC-GOLD should take a co-leadership role working with GFOI/FCT team in defining, implementing the R&D Plan, and synthesizing results from the GFOI R&D activities
    - With annual GFOI Science meeting
    - GOFC-GOLD community need expansion and need to build group of experts from both current GFOI and GOFC-GOLD side

On the capacity development side of the GFOI it was decided that we need to:

- Build on agreements for coordination between FAO/UNREDD and GFOI Office & SilvaCarbon.
    - Share information on regional and national activities and workshops every 3-4 months among FAO (Inge), Silvacarbon (Sylvia), GOFC-GOLD (Olga), as decided at FAO – FCPF – Silvacarbon meeting Rome, April 2013.
    - Exchange on identified points of contacts from regional and local experts and implementing agencies
    - Inventory of training materials & open-source tools
- Coordinate joint regional needs analysis on MRV implementation and responsible implementation body
    - preferably take countries' training needs into account
- Develop joint training materials (FAO/UNREDD/GOFC-GOLD/GFOI) (with support from FCPF?)
- Aim for a joint GFOI Countries meeting and GOFC-GOLD Regional Networks meeting (once a year?)

Parallel session on REDD R&D Technical session

Axel Penndorf presented the products and services RapidEye can provide for REDD+ monitoring activities; wall-to-wall mapping and forest degradation tracking notably. RapidEye can propose user data license specifically designed to meet specific country needs.

Erik Naesset from the Norwegian University of Life Sciences presented some Airborne Laser Scanning (ALS) applications for REDD+ activities. He showed the potential of ALS to provide information that can hardly be derived form of other RS techniques. ALS can provide more precise results with much less ground data. He explained the success of ALS for REDD+ projects and reporting depends on the cost-effectiveness compared to other data sources (costs versus precision).

Hervé Poilvé a REDD baseline mapping method from SPOT and Landsat imagery in the Congo Basin. This project is managed by the Agence Francaise de Developpement in partnership with Astrium, IGN France and ONF International. The project tested novel classification approaches using vegetation models coupled with atmospheric models

Hervé Poilvé announced a consolidated SPOT data archive (since 1986) will be made available for free for REDD projects in the Congo Basin region.

Naikoa Aguilar-Muchastegui presented WWF MRV activities and approaches for REDD. WWF fosters the use of community-based monitoring, and asks for guidance on how to choose the best datasets and techniques among thee variety of solutions provided by the scientific community. GOFC-GOLD can help to make MRV methods more practical, efficient, robust, with the support of practitioners.

Sylvia Wilson from USGS presented the SilvaCarbon project aimed to assist developing countries in monitoring and managing forest and terrestrial carbon. Activities are spread across the globe in Africa, South America and Asia. SilvaCarbon provides technical advices, training material and sessions to governments and cooperates with the GEO GFOI programme. Future plans will consist in making calibration sites for Lidar-based studies and expand community-based monitoring activities.

Yousif Hussin from University of Twente presented a study aimed at estimating above ground biomass and carbon stock of tropical forests of Nepal using very high resolution satellite data and airborne Lidar. Future step is to upscale estimates to the whole forest area using medium resolution images.

Summary of main discussion points and vision for future activities of GOFC-GOLD

This section summarises discussion outcomes from the Land Cover IT and from the Plenary session panellists on the future of GOFC-GOLD. Synthesis of the discussions of the Fire IT will be synthesized in an article to be published this summer, in the Earth Observer magazine from NASA. We refer you to the session summaries for more details.

1. Strengthen the role of the panel with the increasing importance of GOFC-GOLD as international and independent expert platform:
    - Ensure continued support for the Land Cover Project Office, currently funded by ESA, as international focal point and leading the GOFC-GOLD land cover activities
    - Create and extend more formalized relationships with key international processes such as:
        - UNFCCC REDD+ implementing bodies (i.e. Worldbank FCPF, UN-REDD, bilateral programs)
        - GCOS/TOPC to ensure a proper representation of land cover, fire and biomass issues in the ECV process
        - GEO GFOI to build synergies with on-going and successful GOFC-GOLD activities
2. Continue to demonstrate and support the use of remote sensing coupled with in situ observations as a set of reliable tools able to support the global user organizations (such as the UN Convention and the science community), in particular for:
    - The increasing number of global land cover mapping interests and investments (ESA-CCI, China and USGS activities)
    - The move towards global land cover monitoring in Landsat8/Sentinel 2 era (including use of archived data)
    - Advocate for open and free access to higher pre-processing level EO products
    - Develop land cover and change data for specific users (i.e. biodiversity, climate modellers) and for specific thematic areas (i.e. water bodies, wetlands, urban, cropland)
3. Coordinate and implement the required next steps for the harmonization of land cover and land cover legends and protocols for the validation of global land cover classifications in cooperation with the CEOS working group on calibration and validation
4. Gain international consensus on international best practices and standards for harmonization and validation for monitoring land (cover) change and moving towards an operational land cover validation framework:
    - Finalize guidance and best practices for land change and area estimates
    - Further develop the GOFC-GOLD land cover reference data portal to provide further guidance and make datasets available to a broader community of users
    - Further scope a framework for an operational land cover validation system with GOFC-GOLD in the lead and seek options for implementation (i.e. in the context of the ESA LC-CCI)
5. Further scientific and conceptual developments of operational and community consensus strategies observing strategies with respect to land cover change, land dynamics and land use conversions:
    - Use of time series for more consistent land cover mapping and track changes (Russia, ESA LC-CCI, Landsat)
    - Completion of the GOFC-GOLD/Boston University VHSR-based global land cover validation dataset

- Interest in developing community consensus Level 2 and 3 observation products that are targeted for monitoring of land changes
- Engage and support global change assessments such as those of FAO's Forest Resources Assessment
- Moving towards including 3D and using multiple remote sensing data sources
- Increase partnership and use of global observation datasets for national and regional use; in particular for land change
- Advocacy for more investments and better ground reference data (integrating networks -TERN, inventories, T-LIDAR ...) and locally tuned approach, i.e. adaptive global mapping (LAGMA)

6. Contributions of GOFC-GOLD Land Cover Office to GEO Tasks
    - Continue direct contribution and leadership for implementation of GEO's work plan in the areas of land cover and forest monitoring as it matures the Global Earth Observing System of Systems (GEOSS).
    - Continue leading and coordinating role in GEO's global land cover task
    - Build stronger links with GFOI (member of Steering Committee already) where GOFC-GOLD should lead or strengthen the link to science in the more operational character of GFOI
    - Provide expertise to other GEO Tasks like GEO BON (e.g., development of handbook/sourcebook material).
7. REDD+ working group
    - Help further to build scientific consensus – both to help focus the research agenda and to provide guidance to policy makers on REDD+, via GFOI notably
    - Keep coordinating update of the Sourcebook
    - Develop further hands-on guidance and technical advice on REDD+ activities (drivers, RELs/RLs, national forest monitoring systems, leakage)
    - Keep providing expertise to complement the IPCC GPG in general
8. GOFC-GOLD as a scientific community
    - Sharing of knowledge and information across boundaries and involve further stakeholders (e.g., RAISG)
9. ECV – CCI and TOPC
    - Increased participation in coordination between GCOS and GTOS via TOPC
    - Foster consensus view on ECV product to ensure adequacy with evolution of user requirements
    - Continue involvement in validation of LC ECV products
10. Continue to support capacity building and the transfer of information and observational technologies to the developing world:
    - Further involvement in regional networks
    - Develop training material in link to the sourcebook
    - Develop cooperation with local experts for international programs (e.g., land cover map validation)

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