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Summary of the GOFC–GOLD Twentieth-Anniversary Regional Networks Summit

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Introduction

Global Observation for Forest and Land Cover Dynamics (GOFC–GOLD) is a coordinated international program working to provide ongoing space-based and *in situ* observations of the land surface to support sustainable management of terrestrial resources at different scales. The GOFC–GOLD program acts as an international forum to exchange information, coordinate satellite observations, and provide a framework for and advocacy to establish long-term monitoring systems. It was established as a part of a Committee on Earth Observation Satellites (CEOS) pilot project in 1997, with a focus on global observations of forest cover. Since then, the program has expanded to include two Implementation Teams: Land Cover Characteristics and Change, and Fire Mapping and Monitoring. In addition, two working groups—Reducing Emissions from Deforestation and Forest Degradation (REDD), and Biomass Monitoring—were also formed. GOFC–GOLD activities are guided by an executive committee, primarily with support from NASA and the European Space Agency (ESA). Over the past two decades, GOFC–GOLD has facilitated the development of several *regional networks* (RNs) to coordinate and exchange information, data, technology, and methods within and between regions. The RNs represent a critical link between national agencies, user groups and the global user and producer communities, and NASA funded land-cover and land-use change (LCLUC) scientists.[1] (See section on *GOFC–GOLD Regional Networks: Current Focus and New Opportunities* on page 31 for more.)

The GOFC–GOLD program celebrated its twentieth anniversary by convening a Regional Network Summit in Tbilisi, the capital of the country Georgia,

GOFC–GOLD Twentieth Anniversary meeting participants. **Photo credit:** Agricultural University of Georgia team

September 13-16, 2017. There were 45 people from 20 countries in attendance—including participants from Africa, Asia, South America, Eastern and Southern Europe, and the U.S. The Summit was jointly hosted by the Scientific-Research Centre of Agriculture and Agricultural University of Georgia in Tbilisi. The Summit provided an opportunity for cross-network learning and experience sharing, and included assessment of past performance and future directions for RNs. The Summit provided a venue for RN members to give presentations on their research, and facilitated lively discussions between participants, who also had the opportunity to partake of an optional field visit—see *Field Visit to the Mountain Landscapes of Mtskheta-Mtianeti* on page 34. A high-level summary of the Summit proceedings follows. Readers are directed to *http://start.org/news/start-gofc-gold-summit-in-tbilisi-looks-at-strengthening-regional-information-and-knowledge-networks* to view individual presentations.

Garik Gutman [NASA Headquarters—*LCLUC Program Manager*] welcomed the participants to the Summit and stated that the GOFC–GOLD program was instrumental in calibrating and validating NASA's Earth observation data that are used for LCLUC

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[1] The most recent of these is the Caucasus Regional Network (CaucRIN), which held its kickoff meeting September 11-12, 2017—in the same location as the meeting being described here.

research, and for strengthening regional LCLUC projects. The meeting's objectives were to:

- Revisit the GOFC–GOLD strategy for strengthening regional networks, including integrating socioeconomic research to address LCLUC problems effectively;

- exchange ideas and experiences across the different regional networks;

- analyze lessons learned during the two decades relating to regional networks and their sustainability; and

- discuss next steps for the regional networks, including current areas of thematic interest.

John Townshend [University of Maryland, College Park—*Former Chairman of the GOFC–GOLD Program*] congratulated the team, via a video presentation, for successfully implementing the program over the past 20 years. He noted that many of the initial protocols set forth for the GOFC–GOLD Program to develop consistent methodologies to map and monitor forests and other land-use types still remain valid today. Townshend emphasized that GOFC–GOLD needs to continue working towards developing best methods and practices relevant to its thematic areas to generate products and information that are useful for policy makers. He thanked NASA and ESA for their support of GOFC–GOLD's activities and requested their continued support.

Anthony Janetos [Boston University—*Chairman of GOFC–GOLD*] reviewed the status of the program and stated that GOFC–GOLD's primary focus over time has been on forest, land cover, fire, and biomass issues, and that the program has successfully addressed calibration, validation, and intercomparison of remote sensing products. He added that the GOFC–GOLD REDD+ Sourcebook[2] emphasizes the role of satellite remote sensing in monitoring changes in forest cover, and provides clarification on the Intergovernmental Panel on Climate Change's (IPCC) guidelines for reporting changes in forest carbon stocks at the national level. As a way forward, Janetos highlighted the need for GOFC–GOLD to address other IPCC-relevant policy issues including: climate mitigation and carbon management; systematic tracking of forest loss and gain (e.g., forest degradation and above-ground carbon retrievals); understanding the role of systematic observations of climate impacts; disentangling human-driven changes from climate-driven changes; and applications focusing on climate adaptation studies. He added that GOFC–GOLD can also contribute to monitoring

and verifying Intended Nationally Determined Contributions[3] and address land-cover contributions to Sustainable Development Goals.

Cheikh Mbow [SysTem for Analysis, Research and Training (START)] stated that START has been leading GOFC–GOLD capacity-building activities since 1997. START has organized many meetings and training workshops in developing countries and has helped to build the RNs. He stressed the need to address problems relating to management of natural resources through capacity-building activities. Mbow noted that partnership enhancement awards involving GOFC–GOLD researchers from developing countries have been useful for building collaborations within developing countries. START will continue implementing the GOFC–GOLD Program objectives through interacting with the executive committee and RN researchers. He stated that START's plan will facilitate cross-network connections and strengthen GOFC–GOLD networks in the coming years.

In the following sections, Implementation Team activities are summarized, as are those of the RNs.

GOFC–GOLD Land Cover Characteristics and Change Implementation Team Activities

The Land Cover Characteristics and Change Implementation Team (LC-IT) is jointly led by **Martin Herold** [Wageningen University, Netherlands] and **Curtis Woodcock** [Boston University]. The LC-IT project office is located in Wageningen, and funded by ESA. Herold reported that the LC-IT is focused on developing and evaluating methods, guidelines, tools, and products useful for land-cover measurements and monitoring using spaceborne 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., by working with the United Nations Framework Convention on Climate Change (UNFCCC). The LC-IT project office has been working closely with the other GOFC–GOLD implementation Team and with RNs worldwide. Within this framework, the ESA LC-IT project office helps to strengthen the GOFC–GOLD objectives to coordinate, promote, and fulfil the GOFC–GOLD land cover implementation plan, and to support ESA-related projects and services. Currently, the LC-IT focuses on:

- Promoting monitoring of land cover as an essential climate variable to the World Meteorological Organization, UNFCCC, and Global Climate Observing System (GCOS), which contributes to the UNFCCC;

[2] REDD+ stands for Reducing Emissions from Deforestation and forest Degradation + Conservation and Sustainable Development. The GOFC–GOLD REDD+ Sourcebook can be found at *http://www.gofcgold.wur.nl/redd/sourcebook/GOFC–GOLD_Sourcebook.pdf*.

[3] Intended Nationally Determined Contributions, or INDCs, is a term used under the United Nations Framework Convention on Climate Change (UNFCC) for reductions in greenhouse gas emissions.

- contributing to the REDD+ process; in particular, by updating the GOFC–GOLD REDD Sourcebook;

- coordinating research and development of the Global Forest Observations Initiative (GFOI);

- developing training materials and e-learning tools for the World Bank Forest Carbon Partnership;

- providing support to space agencies on developing user needs and standards on global land monitoring programs; and

- promoting and developing free and open source data and tools.

Three other presentations focused on GOFC–GOLD land-cover-related themes. **Pontus Olofsson** [Boston University] described how GOFC–GOLD RNs can benefit from coordination with GFOI activities, as the latter's work is focused on developing national forest monitoring systems and associated emissions. Further, the open-source-software tools the GFOI is developing will likely benefit most RN researchers. **Sylvia Wilson** [U.S. Geological Survey] discussed SilvaCarbon, which is a U.S. contribution to GFOI activities, used to conduct forest inventories that include greenhouse gas emissions and reporting. On these topics, Wilson said that GFOI has been organizing several meetings and training in different countries and stressed that there is a stronger need to involve GOFC–GOLD networks in GFOI activities. **David Skole** [Michigan State University] suggested that GOFC should focus on building national forest monitoring systems in different countries and to provide direct technical support for REDD+ activities.

GOFC–GOLD Fire Mapping and Monitoring Implementation Team Activities

The GOFC–GOLD Fire Mapping and Monitoring Implementation Team (Fire-IT) is led by three co-chairs: **David Roy** [South Dakota State University (SDSU)], **Martin Wooster** [King's College, London], and **Jesus Ayanz** [Joint Research Center, Italy]. Roy summarized the Fire-IT's activities, which focus on refining and articulating international observational requirements for fire monitoring and related data products, as well as making the best possible use of data products from existing and future satellite observing systems for fire management, policy decision making, and global change research. The Fire-IT is currently pursuing the following activities:

- Developing and refining geostationary active fire data products;

- developing Landsat 8 and Sentinel-2 moderate-resolution, burned-area data products;

- developing Suomi National Polar-orbiting Partnership (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) coarse-resolution, burnt-area data products;

- refining Suomi NPP/VIIRS 375-m (~1148-ft) and 750-m (~2460-ft) Level-2 (swath) active fire data products and improvement of fire-radiative-power retrievals;

- developing global wildfire information systems to provide wildfire information at local, regional, and global scales;

- agricultural fire mapping and characterization;

- harmonizing polar and geostationary fire radiative power products and integrating plume height and smoke transport information for emissions quantification;

- providing inputs on fire products useful for climate change research to the Global Observing System for Climate (GCOS) community;

- strengthening RNs and assisting them in fire-related research; and

- coordinating with international agencies to develop best practices and protocols for fire observations, including accuracy assessment, in support of producing fire products and essential climate variables.

As an example of these efforts, Roy described how the Fire-IT is collaborating with the Global Wildfire Information System (GWIS) team that is hosted by the European Commission Joint Research Center (located in Ispra, Italy) and was developed under the 2015-2016 GEO Work Program. The Fire-IT plans to hold joint meetings with GWIS staff, including GOFC–GOLD RN participants, with the next meeting scheduled to take place in November 2017 in London, U.K.[4]

GOFC–GOLD Regional Networks: Current Focus and New Opportunities

RNs are a key part of the GOFC-GOLD Program— see **Figure** and **Table** on page 32. The networks enable data providers, scientists, and operational users to articulate information requirements and improve their access to and use of Earth observations data. RNs represent a critical link between national agencies, user groups, the global user and producer communities, and NASA's LCLUC scientists.

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[4] The GOFC-GOLD and GWIS fire implementation meeting took place November 20-23, 2017, in London, U.K. During the meeting, GOFC Fire-IT, regional network representatives as well as NASA-funded GWIS-GEO investigators discussed strategies to strengthen Fire-IT activities listed in the text.

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Olga Krankina [Oregon State University—*Former GOFC–GOLD RN Coordinator*] presented ideas on strengthening the RNs through organizing workshops that regularly bring regional practitioners together, organizing GOFC–GOLD advanced training workshops to involve regional researchers, improving knowledge transfer, and providing guidance to RN researchers on proposal writing, useful for fund raising.
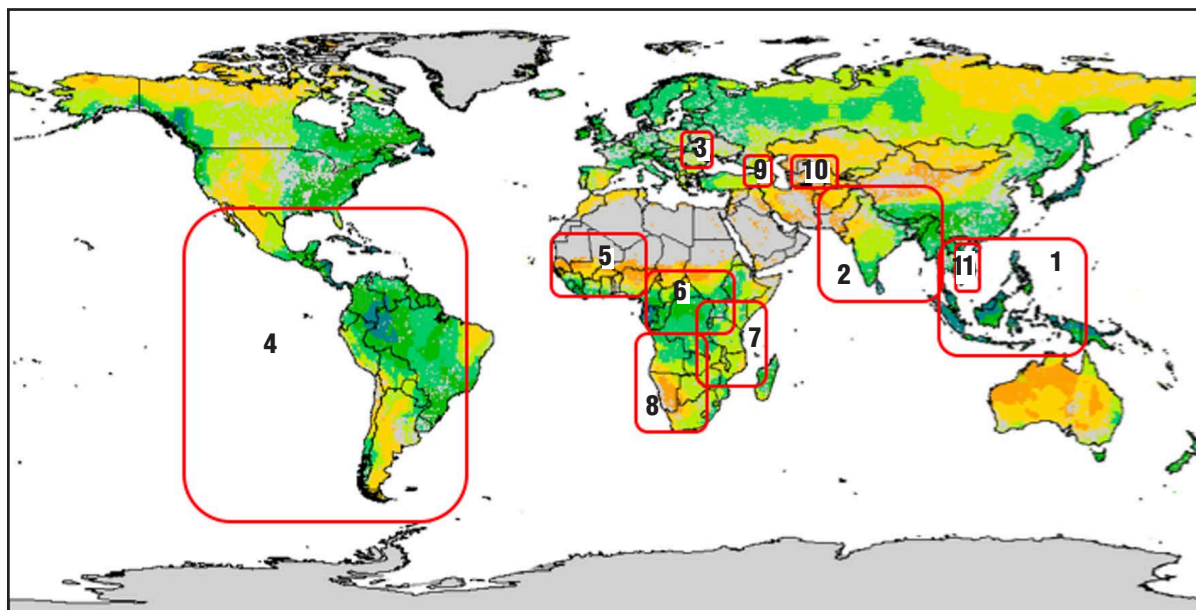
Figure 2. This map shows the currently active GOFC–GOLD RNs. 1. Southeast Asia Regional Research and Information Network (SEARRIN); 2. South Asia Regional Information Network (SARIN); 3. South Central European Regional International Network (SCERIN); 4. Red Latinoamerica de Teledeteccion e Incendios Forestales (RedLaTIF); 5. West African Regional Network (WARN); 6. Observatoire Satellital des Forets d'Afrique Central (OSFAC); 7. Miombo Network (MIOMBO); 8. Southern Africa Fire Network (SAFNET); 9. Central Asia Regional Information Network; 10. Caucasus Regional Information Network (CaucRIN); 11.Mekong Regional Information Network (MekRIN). See Table for a summary of the current and potential activities of each RN.

Table. List of GOFC RNs, their current research foci, and new opportunities. (See caption of accompanying Figure for expansion of RNs.) The information contained in this table summarizes content from presentations by a representative of each RN during the summit. The full presentations can be viewed at the URL referenced in the Introduction.

Regional Network	Current Foci	New Opportunities
Miombo	• Tracking LCLUC in the Miombo Woodlands in southern Africa • Conducting REDD+ research • Managing Miombo's ecosystem and its adaptation to climate change • Addressing human-ecosystem relationships in Miombo landscapes • Using satellite remote sensing for fire characterization	• Capacity building and training in radar remote sensing
SEARRIN	• Addressing peat-land fire related issues • Characterizing transboundary air pollution • Quantifying agricultural residue fires and their impact • Quantifying impact of biomass burning and land-atmosphere interactions • Addressing agriculture and water-resource issues in the region	• Addressing LCLUC specific to agriculture and water resources

Table. (cont.) List of GOFC RNs, their current research foci, and new opportunities. (See caption of accompanying Figure for expansion of RNs.) The information contained in this table summarizes content from presentations by a representative of each RN during the summit. The full presentations can be viewed at the URL referenced in the Introduction.

Regional Network	Current Foci	New Opportunities
SARIN	• Crop-type and -area mapping, and yield forecasting • Crop water-requirements analysis • Drought assessments and early warning • Agricultural fires and pollution mitigation • LCLUC with respect to agriculture • Capacity-building and training activities with respect to remote sensing of agriculture and water resource	• Strengthening regional contacts in the region • Capacity building specific to agriculture and water resources • Evaluating, testing, and validating different LCLUC algorithms
SAFNET	• Providing satellite fire data products • Remote-sensing-based capacity building and training • Validating new satellite fire products • Supporting national and regional fire-policy development • Refining fire service—developed as a part of Monitoring for Environment and Security in Africa (MESA) • Refining Advanced Fire Information Systems (AFIS), useful for near-real-time fire monitoring	• Field validating satellite fire products • Developing fire danger rating training for the region • Enhancing MESA fire services • Engaging more academic institutions in the region
CaucRIN *	• Developing land-cover maps for the entire Caucasus region • Focusing on forest and agricultural LCLUC issues • Performing regional whole-basin LCLUC assessment for Kura River • Conducting planned meeting and training activities—including developing a web portal	*Not Applicable* (Newly formed network)
MekRIN **	• Focusing on the water, food, and energy nexus • Addressing drivers, processes and impacts linking LCLUC to dams in the Mekong region	*Not Applicable* (Newly formed network)
SCERIN	• Assessing forest changes: e.g., disturbances, biomass production, forest LCLUC, and driving forces • Assessing LCLUC and climate change • Validating and verifying data products to support current and future satellite missions • Conducting LCLUC water management (i.e., in watersheds, catchments, dams)	• Addressing LCLUC specific to land abandonment and urban expansion • Validating and verifying regional LCLUC methods and products
RedLATIF	• Characterizing fires using remote sensing • Quantifying agricultural fires and emissions • Addressing lightning fires and their impact • Assessing specific LCLUC impacts on deforestation	• Building expertise in Earth observations data processing and validation • Generating cloud-processing-based fire data products
WARN	• Satellite remote sensing of fires • Calibrating and validating fire products • Quantifying fire emissions	• Examining LCLUC relating to slash-and-burn agriculture • Performing agricultural land-use-change studies

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Table. (cont.) List of GOFC RNs, their current research foci, and new opportunities. (See caption of accompanying Figure for expansion of RNs.) The information contained in this table summarizes content from presentations by a representative of each RN during the summit. The full presentations can be viewed at the URL referenced in the Introduction.

Regional Network	Current Foci	New Opportunities
OSFAC	• Monitoring and evaluating forest-cover loss and changes in Central Africa • Building capacity in remote sensing and geographic information systems (GIS) • Disseminating satellite imagery in the Congo Basin • Identifying and mapping REDD+ priority areas	• Facilitating free access to remote sensing data in Central Africa • Land cover mapping for Central African countries
CARIN	• Performing water-resource management • Addressing land degradation and desertification issues • Drought mapping and monitoring • Agricultural monitoring for improved crop production	• Characterizing LCLUC with respect to lakes and high-elevation forests • Reclaiming saline soils

Field Visit to the Mountain Landscapes of Mtskheta–Mtianeti

The Scientific-Research Center of Agriculture (SRCA) organized an optional field visit for participants to see LCLUC in the mountain landscapes of the Mtskheta–Mtianeti region in Georgia. Mtskheta is the ancient capital of Georgia located 20 km (~12 mi) north of Tbilisi at the confluence of the Aragvi and Mtkvari rivers. There are Oriental hornbeam, oak, and pine forest in the lower foothills, located 500-600 m (~1640-1970 ft) above sea level [*top photo*]; and grasslands and meadows on the mountain tops, located at elevations higher than 2000 m (~6560 ft) [*bottom photo*]. The mountain landscapes are undergoing rapid changes due to urbanization and tourism. Along the way, participants visited the Research Station of SRCA, run by the Georgian Ministry of Agriculture, which focuses on research and development of native, annual, and perennial crops germplasms. A Georgian grapevine germplasm center has been in operation at SRCA since 2009, comprising 437 Georgian native grapevine varieties which are kept as collections. In addition, 150 varieties of wheat, 250 varieties of maize, and different spices, fruits, and legume germplasm varieties are preserved at the Center.

Foothills of Mtskheta, Georgia, with beech, oak, and pine forest in the lower foothills. **Photo credit:** Krishna Vadrevu

Mountain tops with grasslands and meadows in Mtskheta province, Georgia. **Photo credit:** Krishna Vadrevu

Discussion Sessions

Chris Justice [University of Maryland, College Park— *Former Co-Chair of the Fire-IT*] facilitated the meeting's discussion sessions, which are broadly summarized here. The discussion sessions focused on the priorities of the RNs, their sustainability, and the way forward. Across the RNs, the most common issue identified was sustaining funding to carry out RN activities. The GOFC–GOLD executive committee members offered guidance on joint project proposals involving the RN researchers and support for fundraising initiatives. Through START, the GOFC–GOLD team will explore new funding opportunities and communicate them to RN researchers on a regular basis. The GOFC–GOLD executive committee also suggested that RN researchers explore cost-sharing mechanisms while organizing future meetings and trainings. The RN leads asked the GOFC–GOLD executive committee to help strengthen the networks and their host institutions as regional centers of excellence on Earth observation-data processing, product development, and dissemination. RN researchers felt that designing unifying projects involving network researchers from different countries can help bring regional researchers together, which in turn can help long-term network sustainability.

During the discussion sessions, the GOFC–GOLD executive committee also shared expectations for the RNs, which include:

- Sustaining GOFC–GOLD regional activities through regional funding;

- organizing regular meetings (e.g., every two years);

- regularly providing RN researchers with contact information;

- maintaining active RN webpages with descriptions of all project activities and providing links for end-users;

- participating in GOFC–GOLD telecons; and

- providing assistance in capacity-building and training activities not only in their regions, but also through cross-network linkages.

The RN participants noted that there were sometimes parallel efforts in capacity-building activities, meetings, and training by other international organizations in their regions. To avoid duplication of effort, there is an ongoing need to coordinate different training activities with other international organizations. They also stressed the importance of effective communication to disseminate knowledge. In this context, translating GOFC–GOLD outputs to issues that people care about (e.g., land-use change impacts on food, water, livelihoods, human well-being, and the environment) was deemed highly important. Participants also encouraged using social media to share information and disseminate knowledge. This would include reviving the GOFC–GOLD main website with current information on regional projects and contacts. The ensuing discussion also highlighted the need to train regional researchers in recent technologies, to improve access to high-resolution Earth-observation data, and to involve social scientists in developing and fostering participatory approaches to address societal problems.

Conclusion

The Twentieth-Anniversary GOFC–GOLD Summit served as a forum for the exchange of ideas and information across a diverse range of RN researchers, the GOFC–GOLD executive committee, and IT members. RN researchers also emphasized the need to address policy-relevant themes to address regional problems. In addition, the Summit participants recommended increased capacity-building and training activities to advance science in different countries. ■

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