GOFC-GOLD GLOBAL OBSERVATION FOR FOREST AND LAND COVER DYNAMICS

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LAND COVER AND CHANGE

Newsletter of the GOFC-GOLD Land Cover Project Office

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PROGRESS IN LAND COVER VALIDATION

CEOS CAL-VAL STANDARD – GLC2000 – FUTURE INITIATIVES

Global and regional land cover maps derived from remotely-sensed data have limitations in the accuracies they can achieve. Validation is important both during the production and after the completion of land cover maps. Understanding and explicit statements of the land cover product accuracy fosters an informed user community, forms the base for good science, interoperability, and resource management. International environmental protocols and agreements imply that land cover products may be independently evaluated and possibly challenged. Ultimately, validation will improve the value of these land cover datasets for a multitude of applications and contributes towards operational terrestrial observations of the land surface.

So far, the knowledge about uncertainties in existing coarse resolution land cover datasets is not satisfying. Validation exercises have been completed to varying degrees for individual land cover datasets. The IGBP DISCOVER and the TREES2000 dataset, however, are the only global land cover products that can be considered thoroughly validated. Other efforts have suffered from limited resources. This includes the lack of funding, the availability of reference data and validation standards, and insufficient international cooperation and coordination. With GOFC-GOLD involvement, recent progress has been made to approach these deficiencies.

CEOS Validation Standard

Previous validation experiences and the scientific state of the art for robust accuracy assessment of regional and global land cover datasets were recently summarized in a 'best practice' document. This consensus-based effort was coordinated by the Committee Earth Observation Satellites (CEOS) with the group on calibration and validation (Cal/Val). The document describes a set of core analysis methods for robust accuracy assessment.

Newsletter content:

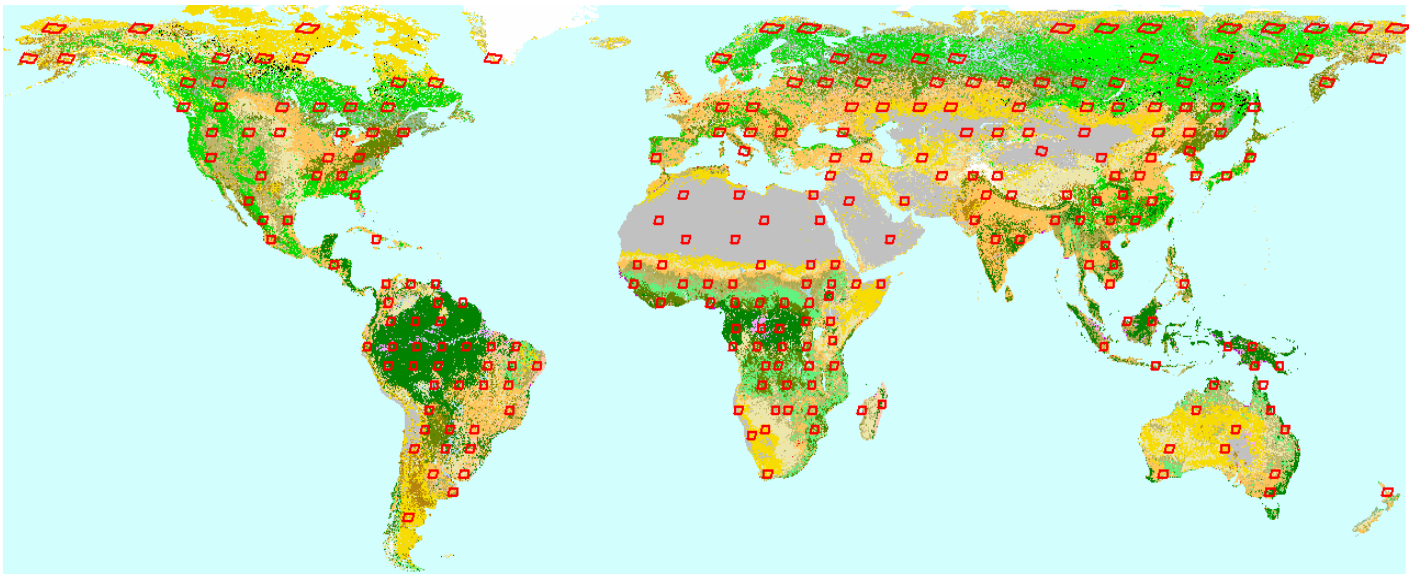

Figure 1: Global distribution of Landsat ETM imagery used for the GLC2000 land cover dataset validation (source JRC).

They should be routinely adopted as a baseline for deriving and reporting of map accuracies. The document is in its final stage of review and will be available soon.

GLC2000 Validation

The Joint Research Center of the European Commission (JRC) has produced a global land cover map for the year 2000 (www.gvm.jrc.it/glc2000). The validation of the GLC2000 product has now been completed. The accuracy assessment relied on two methods: a confidence-building method (quality control based on a comparison with ancillary data) and a quantitative accuracy assessment based on a stratified random sampling of reference data (Fig. 1). The sample site stratification used an underlying grid of Landsat data (WRS-2) and was based on the proportion of priority land cover classes and on the landscape complexity. A total of 1174 sample sites have been interpreted. The first results indicate similar accuracies than for the IGBP DISCOVER dataset. More uncertainty documentation will soon be available.

The GLC2000 validation exercise has provided important experiences. The design-based sampling was conform to the CEOS Cal-Val suggestions and has proven to be successful. Both the GLC2000 legend development and reference data interpretations used the FAO Land Cover Classification System (LCCS). The LCCS-based interface for entering reference data interpretations is shown in Fig.2. This allowed a consistent and transparent integration and scaling of the data sources. Problems in were identified for areas with heterogeneous land cover. This issue appears in both in the GLC2000 (neighbourhood pixel variations) and in the reference data (cartographic and thematic mixed units). For this case, the comparison between classification and reference remains problematic and solutions are needed to deal with these issues in the future. Another interesting outcome of the GLC2000 validation is the accuracy reporting. Error statistics are provided from both the producer and user perspective and includes measures of thematic similarity between land cover classes derived from LCCS. The final GLC2000 accuracy documentations are currently prepared and should be accessible soon.

The next Steps

The concluding discussions of the GLC2000 validation included 'way forward' ideas. There was consensus among involved participants that next steps are needed to further improve the quality and usability of existing and future global land cover products. In general, the political framework, the organizations for international cooperation as well as methodological resources exist to take global land cover validation to the next level and foster a joint harmonization and validation initiative for all global land cover datasets. The focus is on completing primary validations and comparative validations for existing and future datasets, and keeping these validations up to date. GOFC-GOLD with its regional networks in conjunction with the CEOS Cal-Val group seem to be the right implementation platforms to coordinate international forces and consensus building efforts that are essential for such a task to be successful.

To make this effort truly international, it is important to engage many participants and thus a number of funding sources. A good model of cooperation and partnership is needed to find the right sorting of tasks and costs, such that different actors agencies are engaged and provide resources for the appropriate components. All actors as well as the users will profit from such a combined effort. The process of developing this cooperation model is currently ongoing.

One essential requirement for success of this initiative is continuity in satellite observations. This includes coarse scale land cover mapping sensors (e.g. MODIS, MERIS etc.) and higher spatial resolution systems (e.g. Landsat) for continuous accuracy assessment.

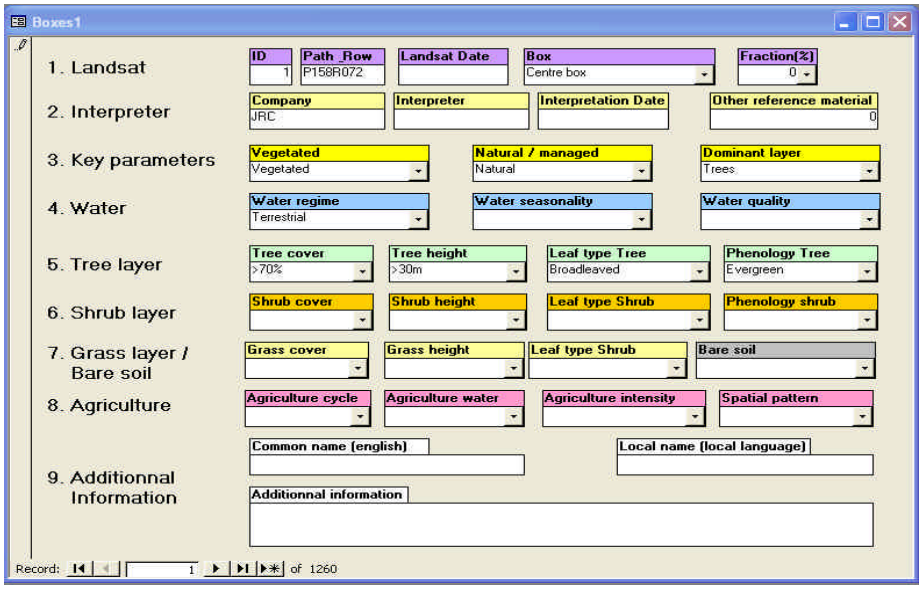

Figure 2: LCCS-based interface for entering reference land cover interpretations from Landsat ETM data developed (Source: JRC)

GLOBAL OBSERVATIONS OF URBAN AREAS

CALL FOR A SPECIAL SESSION AT THE URS2005 CONFERENCE

The persisting dynamic urban change processes, especially the tremendous worldwide expansion of urban population and urbanized area, affect and drive natural and human systems at all geographic scales. Urbanization is the trigger for a variety of other land change processes in natural and semi-natural environments. Any operational efforts tailored at sustainable and desirable future development have to consider urban dynamics as one of the key human-induced processes for understanding and managing our fast changing world.

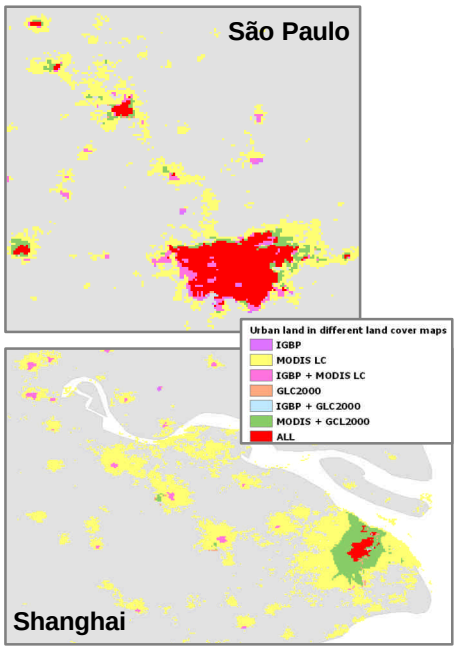

Figure 3: Comparison of urban land in three different global land cover products: IGBP DIS (urban areas from Digital chart of the world), MODIS land cover (urban areas from MODIS (2000), DMSP (1994/95) and ancillary data), and GLC2000 (urban areas from DMSP (1994/95)).

Earth observation has been focused on mapping, monitoring and understanding these urban phenomena for many years, however, with more emphasize on local to regional scales. Global mapping of human settlements faces particular challenging due to spatial and spectral heterogeneity of urban environments, as well as, their small and fragmented spatial configuration. These challenges are documented in the amount of disagreement between urban areas mapped in different global land cover products (Fig.3).

The recent proliferation of new sources of data and tools for data processing, analysis and modeling has provided and opened up avenues for significant progress toward global observations of urban patterns and dynamics. Due to the heterogeneity of global urban characteristics, the key issue is to combine earth observation indicators for characteristics and change in human settlements. Sensors like MODIS or LANDSAT give spectral evidence for built-up areas and the land cover configuration within urban environments; night-time observations by DMSP are a strong indicator of populated areas and population distribution; SAR measurements emphasize the three-dimensional characteristics of urban surfaces; thermal IR data contain information about energy fluxes and local climatic conditions. Other key projects and programs have been looking at representative urban agglomerations world wide to monitor spatio-temporal urban dynamics. The overall goal of earth observation is the mapping, monitoring, and analysis of urban form and processes towards support and improvement of urban modeling, management and planning efforts, and advances in spatial urban theory. Sustainable development activities benefit from the resulting better data, knowledge, and information, if the integrated framework includes a better integration and communication of the earth observation results, and works towards general acceptance of new and innovative techniques in approaching urban dynamics. The recent developments will be discussed in a special session during the URS 2005 conference in Tempe, AZ (Phoenix) in March 2005. This special session is jointly organized by GOFC-GOLD and presentations on the following topics are invited:

- Tools and methods for mapping and monitoring urban areas on global scales
- Urban areas and global land cover products
- Global trends of urban development from earth observation
- Drivers/factors influencing global urban dynamics
- Integration of earth observation data in coarse scale urban modelling
- Economic, ecological and social impacts of urban development
- Forecasts of future urban developments and prospects in observing urban processes

The goal of this special session is to provide a forum for researchers to communicate and discuss these issues within the frame of an urban remote sensing conference. The outcomes of this special session will be summarized in a research synthesis document describing challenges and prospects of global urban observations that can used by organizations like GOFC-GOLD to guide their future directions and efforts. More information is available on the web (http://ces.asu.edu/urs/special.htm). Abstract can be submitted to Martin Herold (c5hema@uni-jena.de) before Nov.15th 2004.

CHALLENGES IN ESTIMATING TROPICAL DEFORESTATION FOR THE 1980's AND 1990's

Tropical forests are critical to the functioning of Earth's ecosystems and are undergoing rapid changes as humans increasingly extract timber and fuelwood, expand and intensify agricultural lands, and migrate into new areas. These dynamics represent key components of the biotic carbon flux (the magnitude of the temperate zone carbon sink is a function of the estimated tropical source), and have strong impacts on biodiversity, and other aspects of ecosystem services. Despite the importance of these forests and the commendable attempts to quantify deforestation, our understanding of the extent and rates of forest change is surprisingly limited. Recent satellite and census-based estimates of net deforestation vary by more than 40% due in part to differences in domain, forest baselines, methods, and definitions (Fig. 4). Uncertainty surrounding tropical deforestation accounts for more than half of the range in global carbon flux estimates, particularly in the 1980s and 1990s when rates of deforestation increased dramatically.

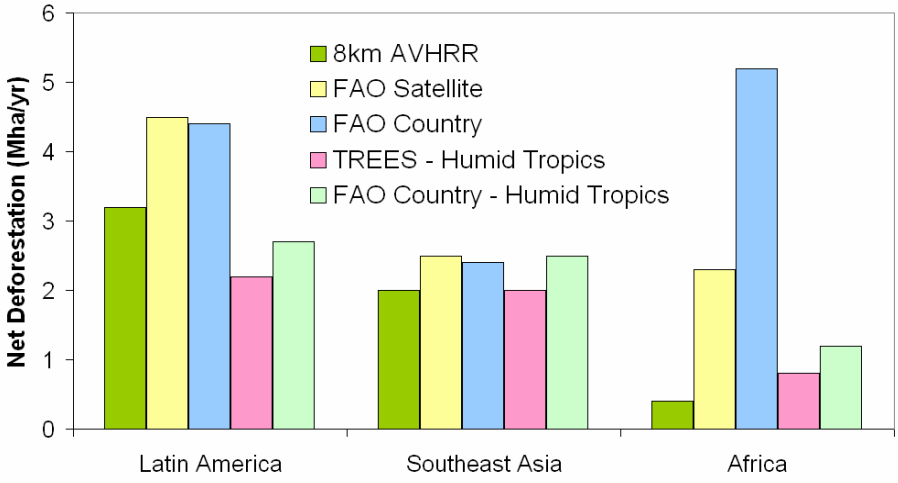

Figure 4: Comparisons of tropical deforestation estimates for the 1990s. Estimates are for total tropics unless specified. (Source: UMd, FAO, TREES)

Available Data Sets

The last two decades are particularly data limited since satellite missions were still developing and most countries lacked the capacity to monitor forest resources. There are three main estimates of tropical deforestation over the 1980s and 1990s: the European Commission's TREES project, AVHRR Land Pathfinder data, and the United Nations Food and Agricultural Organizations (FAO) Forest Resources Assessments (FRA).

The TREES project estimated change in humid tropical forests for 1990-1997 using a "hotspot" statistical sampling strategy to extrapolate change measured at 100 sample sites with high-resolution Landsat imagery (~30m spatial resolution) (1). Because this estimate is based on a sample (~6.5% of humid tropical domain), spatial analysis is not possible. The 8km AVHRR Pathfinder data provides the only comprehensive global coverage for this time period. A NASA-funded project at the University of Maryland (UMd) processed the data into percent tree cover (0-100%) for 1984, 1990, and 1997 and estimated deforestation for the 1980s and 1990s (2). Processing steps were taken to compensate for problems inherent to the AVHRR record such as noisy pixels, sensor degradation, and geolocation errors.

The FAO provides the other source of data for the global tropics based primarily on national statistics provided by each reporting country (3). Many countries with tropical forest lack the capacity to accurately monitor deforestation today, thus national statistics from the previous decades are questionable and may be inaccurate, outdated, and potentially tempered by political considerations (4). Moreover, the methods and definitions are typically inconsistent between countries and assessments making change detection difficult. The FAO added supplementary satellite data analysis for the FRA 2000 based on a 10% random sample of high-resolution Landsat imagery for 1980, 1990, and 2000.

Net Versus Gross Change

The TREES, AVHRR, and FAO estimates may capture only net changes in forest cover, thereby underestimating both deforestation and secondary forest regrowth. The decadal snapshots and coarse spatial resolution likely mask the dynamic patterns of land use that typically follow deforestation, allowing regrowing secondary forest (in fallow or abandoned fields) and plantations to offset the forest area lost through clearing. Tropical forests likely need to be monitored every 2-3 years by high-resolution satellite data to accurately estimate gross deforestation. For the last two decades, however, such detailed information does not exist.

The Way Forward

There are ongoing efforts at the Center for Sustainability and the Global Environment of the University of Wisconsin-Madison in collaboration with the Woods Hole Research Center and UMd to triangulate the TREES, AVHRR, and FAO estimates to produce a spatially explicit consensus-based estimate of deforestation for the 1980s and 1990s. Along the same avenue, the GOFC-GOLD Land Cover Implementation Team has started developing a 'Joint US – European Assessment of Tropical Forest Change'. The initiative is led by Land Cover Team co-chair D. Skole. The approach is to combine the efforts and work towards estimate agreement and try to include the full suite of changes, including logging and degradation. The approach should be community consensus driven and should follow the endorsement of international cooperation outlined by international initiatives like GMES or GEO(SS). The current framework emphasizes a comprehensive assessment including:

- Statements on current state of knowledge,
- Development of a community consensus approach,
- Provide a perspective on value of wall-to-wall and sample frame approaches,
- Provide validation through the other GOFC-GOLD initiatives and regional networks,
- Application using the global Landsat and associated datasets,
- Provide proof of concept for the high resolution elements of GMES, COP Implementation, GEOSS, GISD, etc.,
- Outline "product-driven/science-driven" roadmap for continuity of data.

The efforts include the extension of GOFC-GOLD capabilities to deliver these datasets and products through information systems support.

Major parts of this contribution were prepared by Holly K. Gibbs from the Center for Sustainability and the Global Environment, University of Wisconsin-Madison. For more information please visit their webpage: http://www.sage.wisc.edu/

Key references:

1. Achard, F., H.D. Eva, H. –J. Stibig, P. Mayaux, J. Gallego, T. Richards and J.-P. Malingreau, 2002. Determination of Deforestation Rates of the World's Humid Tropical Forests. Science 297:999-1002.

2. DeFries R., R. A. Houghton, M. Hansen, C. Field, D. L. Skole and J. Townshend 2002. Carbon emissions from tropical deforestation and regrowth based on satellite observations for the 1980s and 1990s. Proceedings of the National Academy of Sciences 99(22):14256-14261

3. FAO, 2000. Global Forest Resources Assessment 2000. FAO Forestry Paper 140, United Nations.

4. Matthews, E. 2001. Understanding the FRA 2000. World Resources Institute, Washington DC.

GOFC-GOLD PRESENCE AT CIF/SAF CONFERENCE

The Canadian Institute of Forestry (CIF) and the Society of American Foresters (SAF), have held joint meetings once every decade since 1930 to strengthen dialogue among forest practitioners who share a common set of values and a commitment to forest sustainability. The joint 2004 Annual General Meeting and Convention was held in Edmonton, Alberta, Canada on 2nd to 6th October, 2004. GOFC-GOLD had an exhibition booth at this conference, which showcased GOFC-GOLD activities (Fig. 5). The presentation was organized by the GOFC-GOLD Project Office in Edmonton, Canada. Murugi Larsen was assisted by Eric Arsenault and Rob Skakun (who work for the Canadian Forest Service, Northern Forestry Centre, Landscape Management Section), in distribution of brochures, newsletters and holding discussions with participants who visited the GOFC-GOLD booth. Students and professors working in remote sensing and landscape management seemed to have the most interest in GOFC-GOLD activities.

Figure 5: Murugi Larsen from the project office in Edmonton, Canada representing GOFC-GOLD during the CIF/SAF conference. October 2004.

GLOBAL LAND COVER NETWORK (GLCN)

AN NEW FAO/UNEP INITIATIVE

FAO and UNEP have launched the Global Land Cover Network (GLCN) in May 2002 during the Artimino conference (Artimino declaration). The success of the FAO Africover initiative in developing effective methodology and tools to produce standardised Land Cover Databases has contributed to the creation of a Global Land Cover Network initiative.

GLCN – What about?

GLCN is an international coordinated effort on the development of global, harmonized land cover mapping strategies, with the objective to provide direction, focus, guidance and standards for harmonization of land cover mapping and monitoring at national, regional and global levels. The initiative is based on the recommendations of the Agenda 21 for coordinated, systematic and harmonized collection and assessment of data on land cover and environmental conditions, reaffirmed at the World Summit on Sustainable Development (WSSD) in Johannesburg 2002.

The **objective of GLCN** is to improve the availability of global information on land cover and its dynamics, harmonizing land cover mapping and monitoring at national, regional and global levels. GLCN will generate essential data needed for sustainable development, environmental protection, food security and humanitarian programmes of the United Nations, and of other international and national institutions.

The ***overall goal*** of the GLCN is to increase the availability of reliable and standardized information on land cover and its changes at the global level. Such information is urgently needed by policy-makers and planners responsible for food security activities, mitigation of natural and human-induced disasters, and environmental protection.

The major ***immediate Objectives*** of the GLCN Network are to support the processes of:

- Harmonization/standardization of classification of cover types
- Determination patterns of land-cover and its associated change
- Projections of human response scenarios
- Support to integrated global and regional modeling e.g. GLC2000, GEOLAND, GLOBCOVER using commensurate standards
- Global assessment of land cover for conventions and treaties
- Long term: Development of databases on land surface, biophysical processes and their drivers.

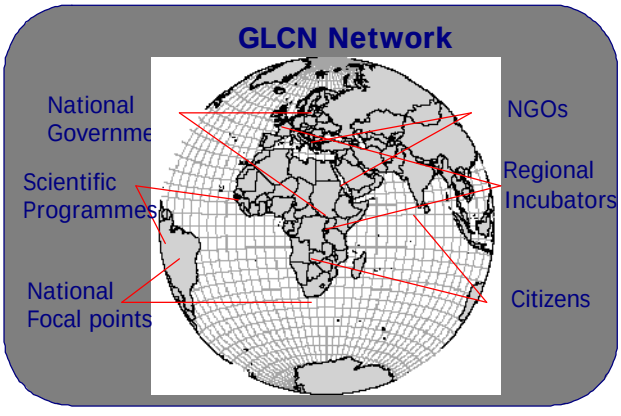

Figure 6: The GLCN Network and participants

There are strong links between GLCN and GOFC-GOLD activities through ESA Project Office in Jena. These activities are endorsed through GTOS. GOFC-GOLD contributed to GLCN meetings in Artimino (2002) and Florence (2004): The current cooperation includes the development of strategic documents and joint implementation efforts.

In order to fulfil these objectives, GLCN will:

- Initiate ***harmonization of land cover definitions***, classification systems, mapping and monitoring specifications among land cover mapping projects based on LCCS.
- Develop ***standardized LCCS-based methodology*** for global land cover baseline datasets and initiate building the database in cooperation with GLCN partners.
- Establish a ***global land cover meta-database***.
- Organize ***training courses and appraisal workshops*** on land cover classification, mapping and monitoring methodologies, and applications of land cover data in sustainable management of natural resources, land use planning and environmental protection.
- Provide ***advisory services to developing countries*** on land cover classification, mapping and monitoring.
- Function as an ***international, politically neutral and not-for-profit clearinghouse*** for land cover information at global and regional levels.

For more information please contact Mr. John Latham, the GLCN Coordinator: john.latham@fao.org

UPCOMING LAND COVER EVENTS

EVENTS / CONFERENCES / WORKSHOPS

November 2004

Regional GOFC-GOLD Workshop:
Satellite-based fire monitoring network in Northern Eurasia: Methods, Data Products, Applications
Venue: Moscow, Russia
Date: 17 November, 2004
Contact: Ivan Csiszar (icsiszar@hermes.geog.umd.edu)

This workshop will be held as part of the conference "Current Problems of the Earth's Remote Sensing from Space" Information on the conference (http://arc.iki.rssi.ru/earth/d33eng.htm).

GOFC-GOLD South America Network (REDLATIF) Regional Fire / Burned Area Mapping Meeting
Venue: Santiago, Chile
Date: 29 - 30 November 2004
Contact: http://gofc-fire.umd.edu/implementation/events/meetings/index.asp

The workshop is planned to be held after the XI International Symposium of SELPER (http://www.selperchile.cl/secuencias/selper2004_sym/index.htm).

March 2005

5th International Symposium on Remote Sensing of Urban Areas (URS 2005) in conjunction with 3rd GRSS/ISPRS Joint Workshop on Remote Sensing and Data Fusion over Urban Areas (URBAN 2005)
Venue: Tempe, Arizona (USA),
Date: March 12-14, 2005
Contact: http://ces.asu.edu/urs/

There will be a special session jointly organized by GOFC-GOLD on 'Global observations of urban areas' (http://ces.asu.edu/urs/special.htm)

June 2005

Northern Eurasia Regional Information Network (NERIN) Meeting
Venue: St. Petersburg, Russia
Date: 17 - 18 June, 2005
Contact: Olga Krankina (olga.krankina@oregonstate.edu)

This meeting will be held prior to the 31st International Symposium on Remote Sensing of Environment (http://www.niersc.spb.ru/isrse/index.shtml)

October 2005

LUCC - 6th Open Meeting of the Human Dimensions of Global Environmental Change Research Community
Venue: University of Bonn, Germany
Date: 9-13 October 2005
Contact: **http://openmeeting.homelinux.org/**

GOFC-GOLD REPORT SERIES:

The GOFC-GOLD reports is online at: http://www.fao.org/gtos/gofc-gold/series.html. The following reports are available:

GOLD-1: CEOS Pilot Project: Global Observation of Forest Cover, Editors: A.C. Janetos, and F. Ahern, Ottawa, Canada, July 7-10, 1997.
GOLD-2: A Strategy for Global Observation of Forest Cover, F. Ahern, A. Belward, P. Churchill, R. Davis, A. Janetos, C. O. Justice, T. Loveland, J.-P. Malingreau, M. Maiden, D. Skole, V. Taylor, Y. Yasuoka and Z. Zhu, Ottawa, Canada, 4 January 1999.
GOLD-3: Global Observations of Forest Cover: Coarse resolution Product Design Strategy workshop report, T. Loveland, Y. Yasuoka, B. Burgan, J. Chen, R. Defries, H.G. Lund, T. Lynham, P. Mayaux, and J.-M. Gregoire, Sioux Falls, USA, July 1998.
GOLD-4: Global Observation of Forest Cover: Fine Resolution Data and Product Design Strategy workshop report, D. L. Skole, W. A. Salas and V. Taylor, Paris, France, 23-25 September 1998
GOLD-5/START-4: Regional Networks for Implementation of the GOFC Project in the Tropics, C. Justice, F. Ahern and A. Freise, Washington, D.C., 15-17 March 1999.
GOLD-6: Southeast Asia Regional GOFC Planning meeting report, I. Gunawan, D. Skole, H. Sanjaya, A. Rahmadi, M. Muchlis, G.A. Adi, L. Gandharum and S.B. Agus, Bogor, Indonesia, 31 January - 2 February 2000.
GOLD-7: Atelier de création du réseau GOFC - OSFAC en Afrique Centrale, P. Mayaux, C. Justice and R.S. Lumbuenamo, Libreville, Gabon, 22-24 February 2000.
GOLD-8: 1st GOFC Science and Technical Board meeting report, F. Ahern, Ottawa, Canada, 21-23 June 2000
GOLD-9: Report of the Miombo GOFC Coordination Meeting, Editors: P. Yanda, P.V. Desanker, and C.Justice, Maputo, Mozambique, 20-22 July 2000.
GOLD-10:Remote Sensing of Forest Cover in Western Russia and Fennoscandia, O. Krankina, St. Petersburg, Russia, 25-27June 2001.
GOLD-11:Summary of Products: Forest Cover Characteristics and Changes Implementation Team. Background document for the GOFC Science and Technical Board, D. Skole, Frascati, Italy, 1 June 2001,
GOLD-12:Global Observations of Forest Cover, Report of the 2nd Science and Technical Board Meeting, J. Townshend, Frascati, Italy, 12-13 June 2001.
GOLD-13:Report of the Forest Cover Implementation Team. GOFCScience and Technical Board Meeting, D. Skole and I. Gunawan, Frascati, Italy, 12-13 June 2001.
GOLD-14:Land Cover Characteristics and Changes Implementation Team report, D. Skole, Toulouse, France, 11-13 February 2002.
GOLD-15:The Toulouse Plan: Implementation of the Land Cover Characteristics and Changes Implementation Team, D. Skole, Toulouse, France, 11-13 February 2002.
GOLD-16:Joint GOFC/GOLD Fire and IGBP-IGAC/BIBEX, Workshop on Improving Global Estimates of Atmospheric Emissions from Biomass Burning, Executive Summary, E. Kasischke, J. Penner and C.O. Justice, College Park, USA, 2002.
GOLD-17:3rd Executive Committee meeting report, J.R. Townshend, Joint Research Center, Ispra, Italy, 17-18 March 2003.
GOLD-18:Land Cover Implementation Team meeting report, M. Herold, K. Neumann and C. Schmullius, Jena, Germany, 2–4 March 2004.
GOLD-19:Report on the Joint GOFC/GOLD Fire and CEOS LPV Working Group Workshop on Global Geostationary Fire Monitoring Applications, E. Prins, Y. Govaerts, and C.O. Justice, EUMETSAT, Darmstadt, Germany, 23–25 March 2004.
GOLD-20:Report on the GOFC-GOLD workshop on harmonization of land cover datasets, Herold, M. and C. Schmullius, FAO, Rome, 14-16 July 2004.

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