

GOFC-GOLD



Global Observation of Forest
and Land Cover Dynamics

GOFC-GOLD

Global Observation of Forest Cover and Land Dynamics



Land Cover
Project Office

Providing international expertise and
coordination for global observation of forest
cover and land dynamics

Brice Mora



SCERIN workshop, Prague, June 16-21, 2013



Need for reliable land cover information has never been stronger

- Scientific requirements (a driver of global change as well as responding to climate change)
 - Climate modelling, carbon cycle,
 - Other biogeochemical cycles
 - Hydrological cycle
 - Understanding of vulnerability of human societies
 - Drivers of land cover change
- Sustainable development (World Summit on Sustainable Development)
- To support international agreements (Convention on Biological diversity, UNFCCC etc.).
- Natural resources management
- Important demand from various user communities

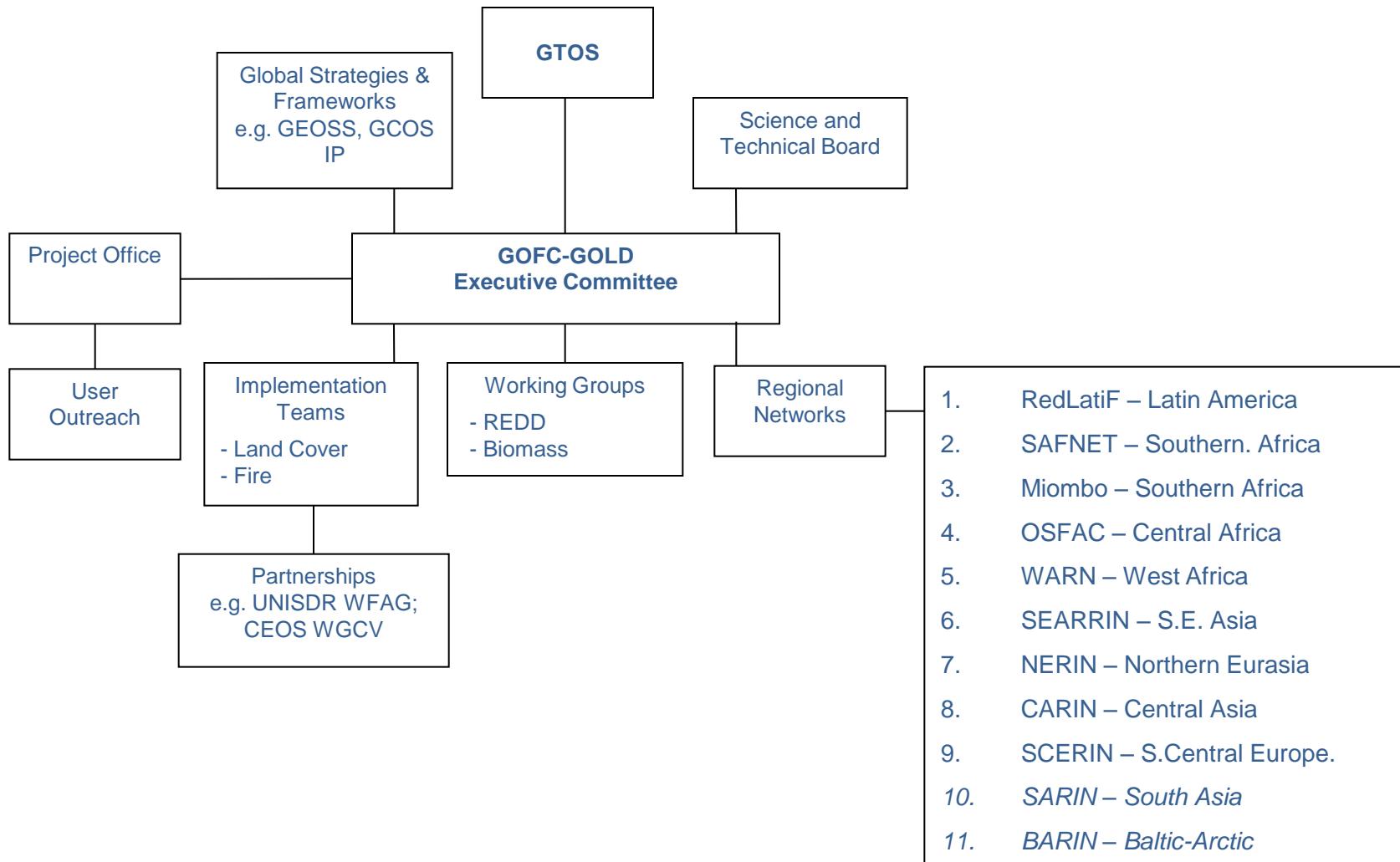
Background to GOFC-GOLD

- Developed in 1997, originally under the Committee on Earth Observation Satellites (CEOS):
 - To test the concept of an Integrated Global Observing System (IGOS)
 - To improve use of Earth Observation data to address major problems of global concern
 - To improve coordination of national programs
 - To improve co-operation between providers and users of Earth Observation data for regional and global applications
- Has become one of the Panels of the Global Terrestrial Observing System GTOS (FAO GTOS Secretariat)
 - Helping to address the Carbon Theme of the IGOS Partners
- Sponsors: FAO, WMO, UNEP, UNESCO, ICSU, EC-JRC, ESA, NASA, USGS, CSA, CFS

What is GOFC-GOLD?

- A coordinated international effort to ensure a systematic and continuous program of space-based and on-the-ground forest and land cover observations
- A network of participants implementing coordinated research, demonstration and operational projects
- A vision to share data, information and knowledge, leading to informed action and decision support
- A long term process of building an improved match between Observations, Data Products and User Needs

What is GOFC-GOLD?



GOFC-GOLD on-going work & achievements

- Land Cover IT
 - Extensive use of historical archives, global products, emphasis on validation, LCCS classification scheme

GEO Global Land-cover and Land-cover Change Task



Coordination *Prof. Martin Herold (Wageningen U., The Netherlands),
Dr. Brice Mora (GOFC-GOLD Land Cover Office)*

Structure

- C1: Global Land Cover Datasets and Service
Coordinator: Prof. Jun Chen (National Geomatics Center of China)
- C2: Global Land Cover Validation and User Engagement
Coordinators: Dr. Christian Steenmans, Dr. Tobias Langanke (European Environment Agency)
- C3: Global Land Cover Methodology and Capacity Building/Outreach
Coordinators: Prof. Martin Herold, Dr. Brice Mora

GEO Global Land-cover and Land-cover Change Task



Task SB-02-C1

Recent Progress and Key Outputs for 2013

- Release of global land cover products (Tsinghua U., China), ESA/Louvain-la-Neuve, Belgium)
- Global land cover information portal (NGCC, China)
- Land Cover Classification System (LCCS) standard
- Mechanism among ESA and USGS for joint operations for new satellite data

GEO Global Land-cover and Land-cover Change Task



Task SB-02-C2

Recent Progress and Key Outputs for 2013

- Develop harmonized products, translation rules (legend)
- Initiate collaboration for GEO portal connecting all major GLC websites (portals: NGCC, GOFC-GOLD LC, EEA: Eye on Earth platform)
- NGCC to release 30m water product for verification
- GOFC-GOLD LC / Boston U. VHSR reference dataset
- GLC reference data portal by GOFC-GOLD Land Cover Office
- Crowd sourcing: how to benefit from these initiatives (Geo-wiki, Oklahoma photo library, etc.)?

GEO Global Land-cover and Land-cover Change Task



Task SB-02-C3

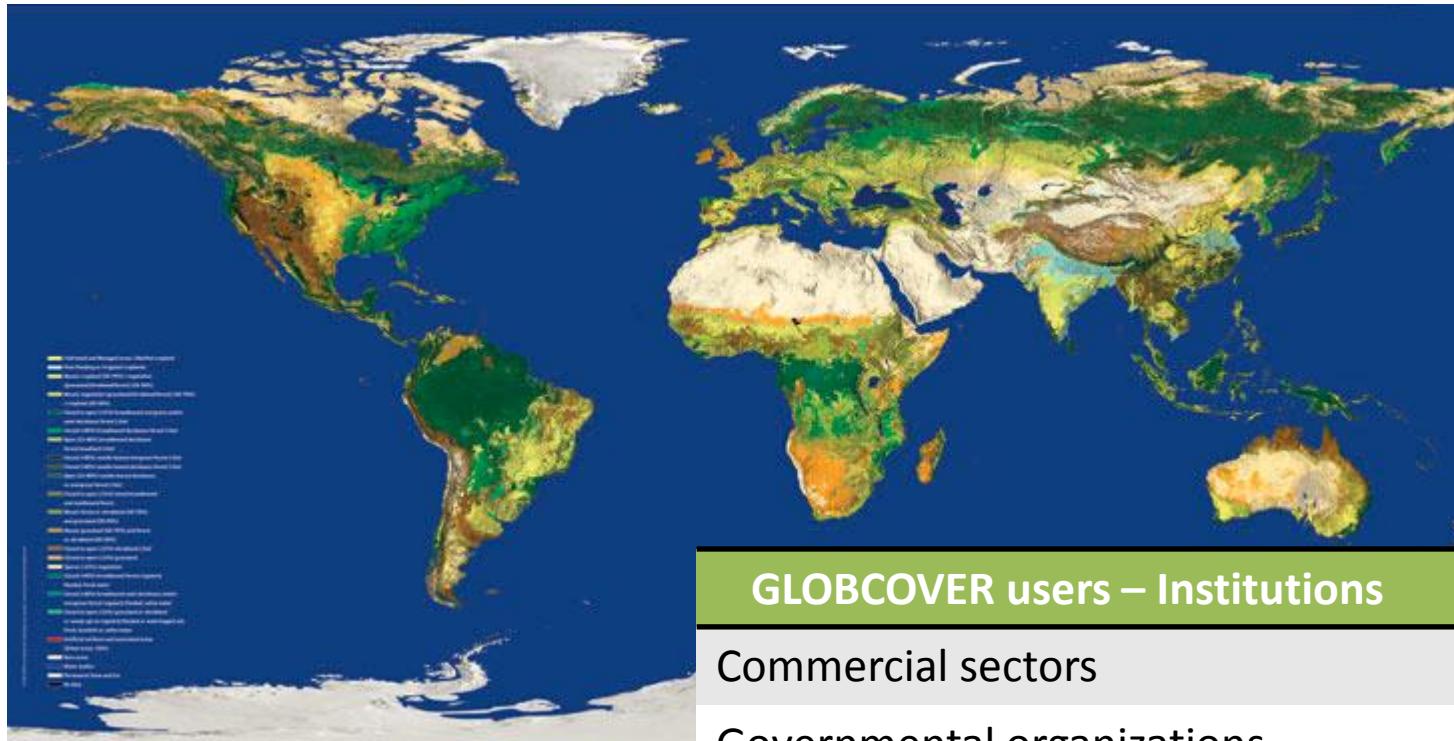
Recent Progress and Key Outputs for 2013

- Benefit from sub-tasks C1, C2
 - GLC maps and validation data portals
 - standardized procedures
 - validation tools
- Workshops and symposiums, reports, special issues
- Capacity development workshops
 - China
 - GOFC-GOLD Regional networks (11)
 - Boston/USGS workshops

Existing Global LC datasets

Dataset	Sensor	Spatial resolution	Time of data collection
IGBP DISCover	AVHRR	1 km	1992-93
UMD LC	AVHRR	1 km	1992-93
MODIS LC	MODIS	1 km	Jan-Dec 2001
MODIS LC	MODIS	500 m	2001-2008
GLC2000	SPOT 4 VEGETATTION	1 km	Nov 1999- Dec 2000
GLCNMO	MODIS	1 km	2003
GlobCover	MERIS	300 m	2005-2006
Globcover 2	MERIS	300 m	2009
FROM-GLC	Landsat	30 m	2010

ESA GlobCover 2005, 2009 products

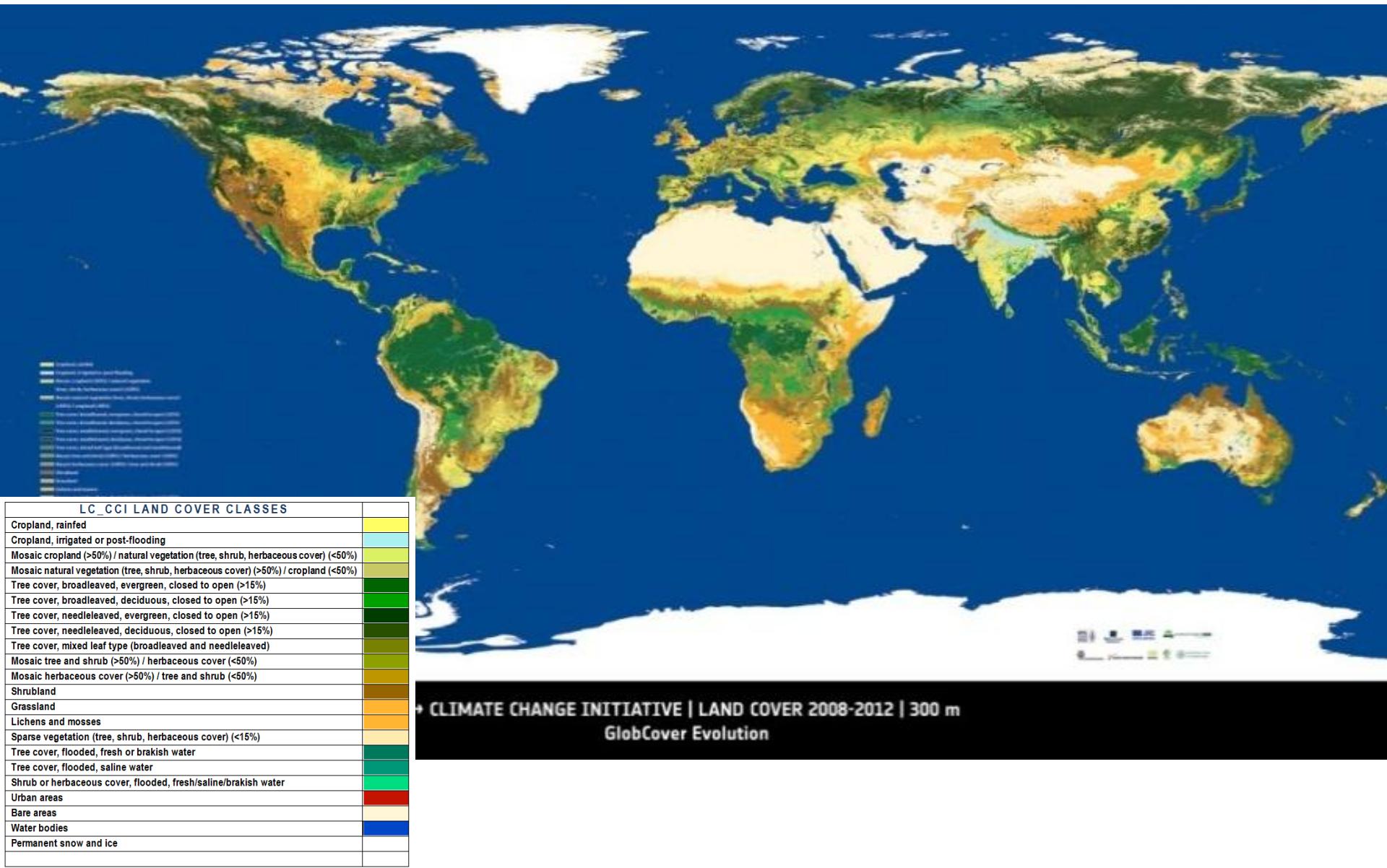


> 50,000 downloads
since 2010

GLOBCOVER users – Institutions	Proportion (%)
Commercial sectors	21
Governmental organizations	14
Non-governmental organizations	17
University/ research institutions	48
Total	100

Source: ESA/WU Globcover user survey 2010 (N=372)

ESA Land Cover CCI products



GLC data web portals

The screenshot shows the homepage of the Eye on Earth website. At the top left is the logo 'eye on earth'. To its right is the tagline 'Sharing is everything' and a navigation bar with links for HOME, GET STARTED, LEARN MORE, CONTENT PROVIDERS, BLOG, and LOGIN. A search bar is also present. Below the header, there's a large blue banner with social media icons for YouTube and Twitter, and a call-to-action button 'Follow us on Twitter'. The main content area features a 'FEATURED' section with a green background, containing a link to 'Explore environmental maps and apps. Contribute your observations. Create and share.' Below this are five categories with arrows: STATEMENT, AIR, WATER, NATURE, and NOISE. To the right of the featured section is a video player showing a NatureWatch video titled 'NatureWatch - NatureWatch'. Further right is a sidebar for 'NASA Earth Data' featuring the USGS logo, NASA LP DAAC logo, and links for HOME, ABOUT, and PRODUCE. At the bottom, there's an 'EXPLORE' section with a link to 'Discover new information by exploring these great maps and presentations'.

EEA

NASA Earth Data Data Discovery Data Centers Community Science Disciplines Search EOSDIS + Documents

USGS science for a changing world

LP DAAC
LAND PROCESSES DISTRIBUTED ACTIVE ARCHIVE CENTER

NASA LP DAAC

HOME ABOUT PRODUCTS GET DATA TOOLS USER COMMUNITY CUSTOMER SERVICE Search

ASTER Overview
ASTER Policies
ASTER Products Table
MODIS Overview
MODIS Policies
MODIS Products Table
Other Data Links

Home > MODIS Products Table > MCD12Q1

NEWS FEED SITE MAP

Land Cover Type Yearly L3 Global 500 m SIN Grid

MCD12Q1

The MODIS Land Cover Type product (Short Name: MCD12Q1) provides data characterizing five global land cover classification systems. In addition, it provides land cover type assessment, and quality control information. The following version-specific tabs delineate details for V5 and V51 MCD12Q1 products.

Short Name: MCD12Q1

This image represents the 2015 land cover types for the



Land Cover Project Office

+ Home + Contact

Project

- > Overview
- > Team

Office

- > Activities
- > Newsletter
- > Workshops
- > Documents

USGS Home
Contact USGS
Search USGS

Search 

IS FEED  SITE MAP 

SIN Grid

Welcome to the GOFC-GOLD Reference Data Portal Beta version opened on April 2013

GOFC-GOLD



Global Observation of Forest Cover and Land Dynamics

esa



ceos



Map **Satellite**



North Atlantic Ocean

Map data ©2013 MapLine - Terms of Use

Spatial distribution of some reference data available on the portal

Finer Resolution Observation and Monitoring - Global Land

Homepage Download by MODIS Tile (FROM-GLC) Download by Path/Row (FROM-GLC)

News
Release of FROM-GLC-agg (08 February, 2013)
 FROM-GLC-agg download web URL: http://modis-ags.larc.nasa.gov/selected_products/modis_aggs_8.1.html
 If you do not know the MODIS tile number of your area of interest, please click http://modis.land.ges.nasa.gov/MODLAND_grid.html to use their spatial query to find it out.
 If you do not know the Landsat Tile Number, please click http://modis-ags.larc.nasa.gov/agg_coltiles.php to use their spatial query to find it out.

About FROM-GLC
 Global land cover data are key sources of information for understanding the complex interactions between human activities and global change. FROM-GLC (Finer Resolution Observation and Monitoring of Global Land Cover) is the first 3 m resolution global land cover maps produced using LandTrendr Mapper (LTM) and Enhanced Thematic Mapper Plus (ETM+) data. Our long-term goal in FROM-GLC is to develop a multiple stage approach to mapping global land cover so the results can better meet the needs of policy making and can be easily updated and cover additional datasets.

Classification system

Level 1 Type	Level 1 Code	Level 2 Type	Level 2 Code	Level 2 Type	Level 2 Code	Level 2 Type	Level 2 Code	Level 2 Type	Level 2 Code	Level 2 Type	Level 2 Code
Crop	10	Rice	00/1	Greenhouse	00/12	Other	00/13				
Grass	20	Mangrove	00/21	Forest	00/22	Orchard	00/24				
Water	30	Lake	00/31	Urban	00/32						
Impervious	40	00/30									
Bareveg	50	00/50									
Baresoil	60	00/60									
Impenveg	70	High shrubs	00/81	Low shrubs	00/82	Gravel	00/93	Snow/ice/rope	00/94	Dry riverbed	00/95
Bareice	100	00/101	Ice	00/102							
Cloud	120										

Legend

Land cover type (Level 1)	Level 1 Code	Level 1 Color	V Value	S Value	B Value
Cropland	10	Red	143	255	115
Grass	20	Green	74	255	0

NASA

NGC

GOFC-GOLD reference data web portal

The screenshot shows the homepage of the GOFC-GOLD Reference Data Portal. At the top, there is a header bar with the project logo 'GOFC-GOLD' (Global Observation of Forest Cover and Land Dynamics), the logos of its partners 'esa' and 'WAGENINGEN URN', and the text 'Land Cover Project Office'. Below the header is a navigation menu with links to 'Home', 'Project' (Overview, Team), 'Office' (Activities, Newsletter, Workshops, Documents, Calendar), and 'Info' (LCCS, Reference Data, EO sensor table, Links). The main content area features a large 'Welcome to the GOFC-GOLD Reference Data Portal' message, followed by the 'Beta version opened on April 2013' note. It includes the 'GOFC-GOLD' logo, the 'esa CEOS' logo, and a map showing the spatial distribution of datasets available on the portal. The map displays numerous red circular markers scattered across Europe, North Africa, and parts of Asia and Africa, indicating the locations of available datasets. A legend on the left side of the map shows icons for a person, a plus sign, and a minus sign.

GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics

Land Cover Project Office

Home Contact

Project

- Overview
- Team

Office

- Activities
- Newsletter
- Workshops
- Documents
- Calendar

Info

- LCCS
- Reference Data
- EO sensor table
- Links

Welcome to the GOFC-GOLD Reference Data Portal
Beta version opened on April 2013

GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

esa CEOS

Map Satellite

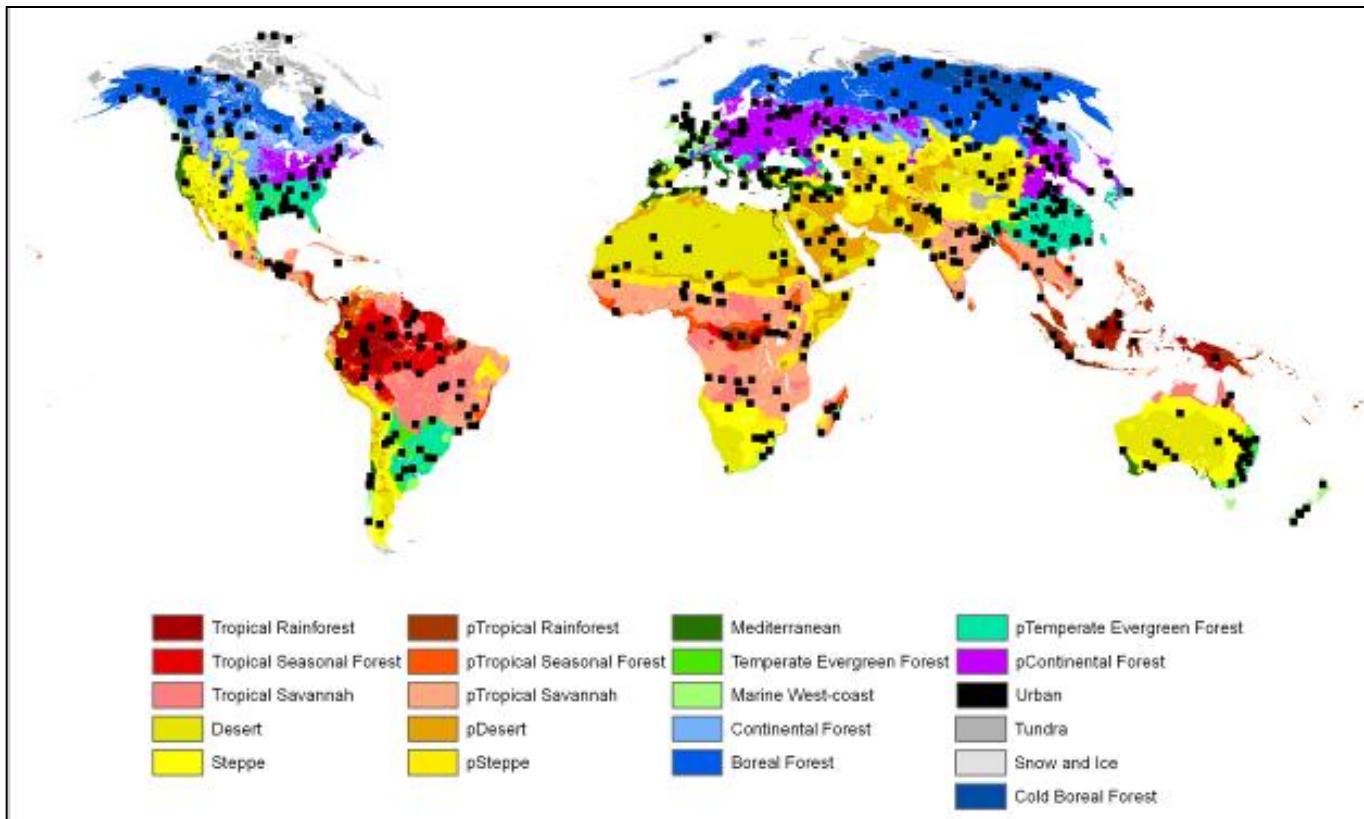
North Atlantic Ocean

Iceland United Kingdom France Spain Portugal Italy Malta Greece Turkey Iraq Iran Saudi Arabia Sudan Egypt Libya Algeria Niger Mali Niger Pakistan India Thailand Mongolia Kazakhstan Ukraine Poland Sweden Norway Finland Iceland United Kingdom France Spain Portugal Italy Malta Greece Turkey Iraq Iran Saudi Arabia Sudan Egypt Libya Algeria Niger Mali Niger Pakistan India Thailand Mongolia Kazakhstan Ukraine Poland Sweden Norway Finland

Spatial distribution of the datasets available on the portal

Global reference validation database for accuracy assessment of land Cover

GOFC-GOLD / Boston U. VHSR dataset (500 samples)



Land Cover Classification system

- Developed by FAO and UNEP as comprehensive and standardized classification system for mapping purposes.
- Independent from mapping scale
- Allows dynamic creation of classes using combination of LC diagnostic attributes called *classifiers*.
- Last version of the LCCS: LC Metadata Language (LCML – LCCS v.3) proposed as standard by the International Organization for Standardization (ISO): ISO 19144-1.
- Complementary specifications under development (reference WI 19144-2).
- Herold, M., Hubald, R., & Di Gregorio, A. (2008). *Translating and evaluating the land cover legends using the UN Land Cover Classification System (LCCS)*. Network (p. 189). Jena, Germany.
http://nofc.cfs.nrcan.gc.ca/gofc-gold/Report%20Series/GOLD_43.pdf

GMES Sentinel Missions



Sentinel 1 – SAR imaging

All weather, day/night applications, interferometry

2013 (A), 2014+ (B)



Sentinel 2 – Multispectral imaging

Land applications: urban, forest, agriculture,..
Continuity of Landsat, SPOT

2014 (A), 2015+ (B)



Sentinel 3 – Ocean and global land monitoring

Wide-swath ocean colour, vegetation, sea/land surface temperature, altimetry

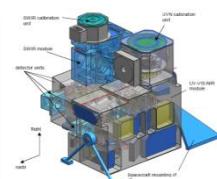
2014 (A), 2015+ (B)



Sentinel 4 – Geostationary atmospheric

Atmospheric composition monitoring, trans-boundary pollution

2018



Sentinel 5 and Precursor – Low-orbit atmospheric

Atmospheric composition monitoring

2014 (5P), 2019

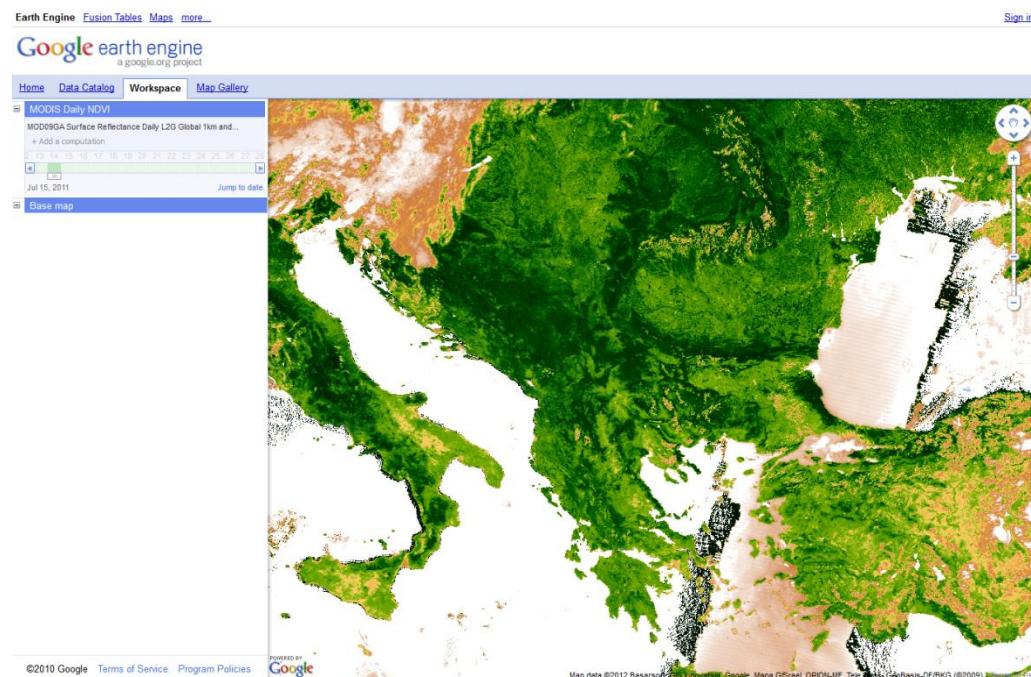


Free and open data policy!



Cloud-computing and web-based approaches to support forest monitoring

- “Cloud-based” databases and data processing platform Google Earth Engine
- Landsat-based products available
- In discussion to support regional networks and validation test site network



MODIS daily NDVI for July 15, 2011

Samples of GOFC-GOLD achievements

- Land Cover IT
 - Extensive use of historical archives, global products, emphasis on validation, LCCS classification scheme
- Fire IT
 - Global fire risk using satellite data, global and regional fire assessments

GOFC-GOLD Fire-IT activities



GOFC-GOLD Fire-IT activities

VIIRS: Visible Infrared Imager Radiometer Suite

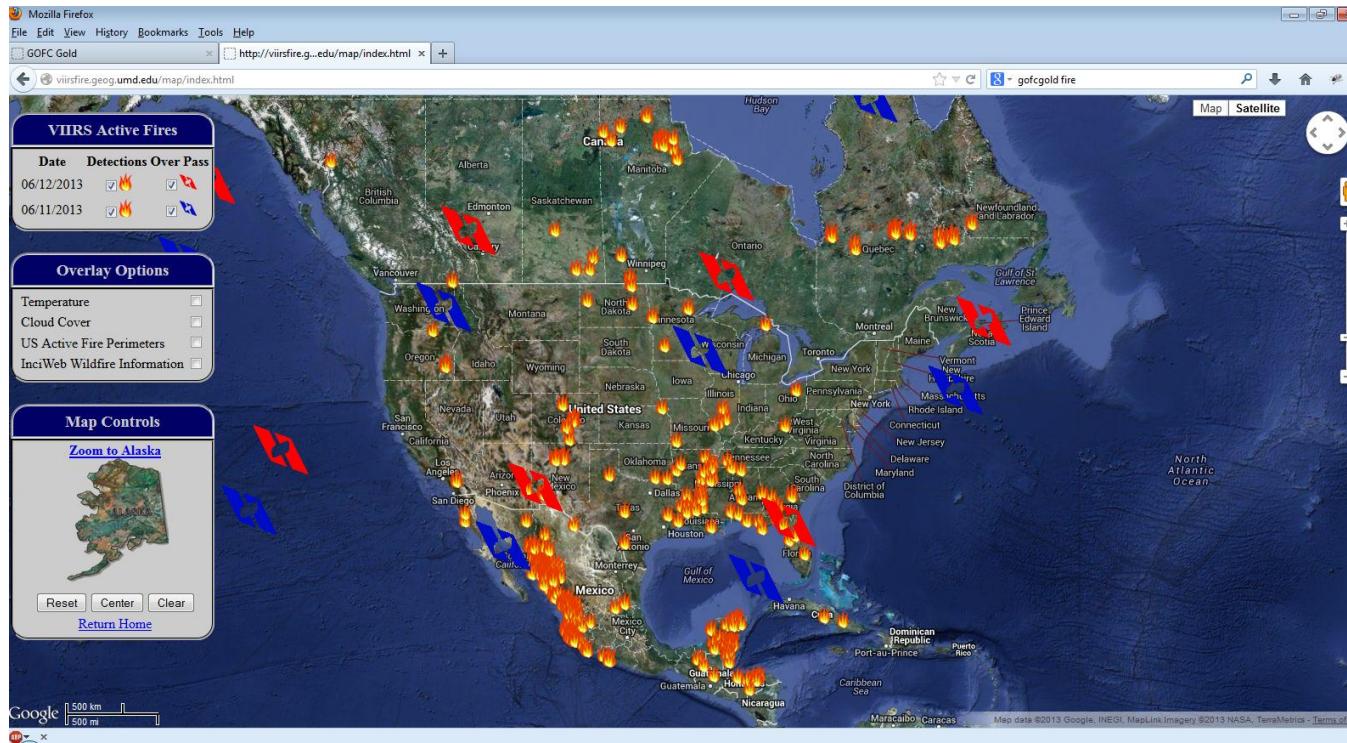
- on-board of the Suomi National Polar-orbiting Partnership (NPP) satellite
- launched in 2011
- light shortwave data
- first fire detections in 2012
- continuation of high quality active fire monitoring capabilities started with the Moderate Resolution Imaging Spectro-radiometer (MODIS)
- significant improvement vs. Advanced Very High Resolution Radiometer (AVHRR) on operational polar satellites.



GOFC-GOLD Fire-IT activities

VIIRS Fire Detection Map

- Online tool
- Products available for download

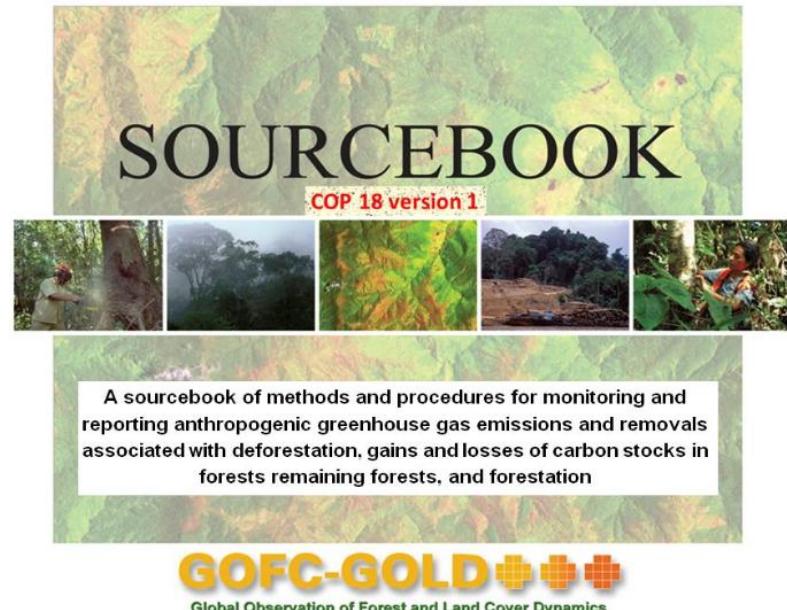


Samples of GOFC-GOLD achievements

- Land Cover IT
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- Fire IT
 - Global fire risk using satellite data, global and regional fire assessments
- REDD working group
 - Several activities around the Sourcebook and beyond

Reducing Emissions from Deforestation and Forest Degradation

- GOFC-GOLD REDD working group formed in 2006 to address key technical issues (i.e. degradation, accuracy assessment).
 - “Sourcebook” on technical capabilities for monitoring deforestation and its emissions
 - 7th version for UNFCCC COP 18
 - Includes role of land cover and fire analysis in REDD
 - Updated for REDD+ (Deforestation, Gains and Losses of Carbon Stocks in Forests Remaining Forests, and Forestation)
 - Future updates: evolving technologies (Radar, Lidar), degradation, RLs/RELs
- <http://www.gofcgold.wur.nl/redd>



Reducing Emissions from Deforestation and Forest Degradation



Capacity development in national forest monitoring
Experiences and progress for REDD+

Edited by
Brice Mora, Martin Herold, Veronique De Sy,
Arief Wijaya, Louis Verchot and Jim Penman



http://www.cifor.org/publications/pdf_files/Books/BWijaya1201.pdf

COSUST-253; NO. OF PAGES 11

ARTICLE IN PRESS

Available online at www.sciencedirect.com



SciVerse ScienceDirect

Current Opinion in
Environmental
Sustainability

Synergies of multiple remote sensing data sources for REDD+ monitoring

Veronique De Sy¹, Martin Herold¹, Frédéric Achard², Gregory P Asner³,
Alex Held⁴, Josef Kellndorfer⁵ and Jan Verbesselt¹

<http://www.norway.org.et/PageFiles/628168/De%20Sy%20et%20al,%202012%20-%20Synergies%20of%20multiple%20remote%20sensing%20data%20sources%20for%20REDD%20monitoring.pdf>



Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/envsci



Assessing capacities of non-Annex I countries for national forest monitoring in the context of REDD+

Erika Romijn ^{a,*}, Martin Herold ^a, Lammert Kooistra ^a, Daniel Murdiyarso ^b, Louis Verchot ^b

^aLaboratory of Geo-Information Science and Remote Sensing, Wageningen University, P.O. Box 47, 6700 AA Wageningen, The Netherlands

^bCenter for International Forestry Research, Jl. CIFOR, Situgede, Bogor 16115, Indonesia

<http://www.sciencedirect.com/science/article/pii/S1462901112000202>

Samples of GOFC-GOLD achievements

- Land Cover
 - Extensive use of historical archives, global products, emphasis on validation, LCCS classification scheme
- Fire
 - Global fire risk using satellite data, global and regional fire assessments
- REDD
 - Several activities around the Sourcebook and beyond
- Networks
 - Bringing regional expertise to bear in many parts of the world
- Biomass
 - Galvanizing the scientific community to pursue new opportunities

Continued Strategic Thrusts

- Advocacy for free and open access to data
- Continuity of observations and coordination of observing programs
- Importance of validation of products
- Moving towards higher-level products
- Building capacity in regional networks
- Engaging regional experts with important processes and activities

GOFC-GOLD



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THANK YOU

brice.mora@wur.nl

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GOFC-GOLD / UNFCCC web resources

- GOFC-GOLD:
<http://www.fao.org/gtos/gofc-gold/>
- GOFC-GOLD land cover project office:
<http://www.gofcgold.wur.nl/>
- GOFC-GOLD fire project office:
<http://gofc-fire.umd.edu>
- GOFC-GOLD REDD sourcebook:
<http://www.gofcgold.wur.nl/redd>
- IPCC background paper on use of remote sensing in LULUCF sector (GOFC-GOLD 33):
<http://www.fao.org/gtos/gofc-gold/series.html>
- UNFCCC/SBSTA technical paper on costs of monitoring for REDD
<http://unfccc.int/resource/docs/2009/tp/01.pdf>

Earth Observation sensors

Visit EO Sensor table on

<http://www.gofcgold.wur.nl/>

Available GLC map products

Dataset name	Spatial resolution	Sensor name	Time of data collection	Input data	Classification method	Classification scheme	Validation	Absolute positional accuracy (RMSE)	Area weighted thematic overall accuracy	Reference
IGBP DISCover	1km	AVHRR	1992-1993	Monthly NDVI from 10 day composites	Unsupervised clustering	IGBP 17 class	Independent validation datasets	~1 km	67%	(Loveland et al., 2000 , Husak et al., 1999 , Scepan et al., 1999)
UMD land cover product				Monthly NDVI and 5 bands from 10 day composites	Supervised classification tree	Simplified IGBP 14 class	Evaluated using other dataset			(Hansen et al., 2000)
MODIS land cover	1 km	MODIS	Jan-DEC 2001	16 day composites of 7 bands and EVI	Supervised decision tree	IGBP, UMD and other	Cross validated	1-1.5km	71.6% ±2.5%	(Friedl et al., 2002, Friedl et al., 2010, Strahler et al., 2003, Strahler et al., 1999)
MODIS land cover 5	500 m		2001-2008	Monthly EVI, LST and 7 bands from 8 day composites	Supervised decision tree boosting	5 different LC Classification system			74.8% ±1.3%	
GLC 2000	1 km	SPOT 4 VEGETATION	Nov 1999-Dec 2000	Monthly to 3 monthly NDVI composites	Optimal classification methods	LCCS 22 class	Independent validation datasets	300m ~1/3 pixel	68.6% ±5%	(Bartholomé and Belward, 2005 , Mayaux et al., 2006)
GLCNMO	1 km	MODIS	2003	16 day composites of NDVI and 7 bands	Supervised classification	Modified LCCS 20 class	Independent validation datasets	141-277m	81.2%	(Tateishi et al., 2011)
Glob Cover	300 m	MERIS	2005-2006	Bi-monthly from 10 day composites	(Un)supervised spatio-temporal clustering	LCCS 22 class	Independent validation datasets	77m	73.1%	(Bicheron et al., 2008, Bontemps et al., 2011, Defourny et al., 2011)
Glob Cover v2			2009						67.5%	
FROM-GLC	30 m	Landsat TM/ETM +, MODIS	Circa 2010 (3/4), circa 2000 (1/4)	Landsat, 16-day MODIS time series, bioclimatic products	Supervised classification methods	8 land cover classes	Independent validation datasets	30 m	66%	(Gong et al., 2013)

GLC Data portals

- National Geomatics Center of China GLC data web portal (water, settlements, cropland, etc.)

http://www.globallandcover.com/glc/index2_en.html

- 30m GLC map product (Tsinghua University)

<http://data.ess.tsinghua.edu.cn/index.html>

- GOFC-GOLD Land Cover Office GLC Reference data portal:

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

- GOFC-GOLD Regional Networks

<http://www.fao.org/gtos/gofc-gold/networks.html>

- USGS MODIS Land Cover products

https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1

Literature

- Gong, P., Wang, J., Yu, L., Zhao, Y., Zhao, Y., Liang, L., Niu, Z., et al. (2013). Finer resolution observation and monitoring of global land cover: first mapping results with Landsat TM and ETM+ data. *International Journal of Remote Sensing*, 34(7), 2607–2654.
- Strahler, A. H., Boschetti, L., Foody, G. M., Friedl, M. A., Hansen, M. C., Herold, M., Mayaux, P., et al. (2006). Global Land Cover Validation: Recommendations for Evaluation and Accuracy Assessment of Global Land Cover Maps. Luxembourg. http://nofc.cfs.nrcan.gc.ca/gofc-gold/Report%20Series/GOLD_25.pdf
- GOFC-GOLD. (2012). A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals associated with deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation - Version COP18-1 (p. 225). Wageningen, The Netherlands. <http://www.gofcgold.wur.nl/redd/index.php>