

Sub-task Number: DA-09-03a

Sub-task Title: Global Land Cover

Overarching Task: Global Data Sets

Area: DATA MANAGEMENT

Relevant Committee: ADC

Related Targets: (to be included in 2009)

Sub-task Definition (as given in the 2009-2011 Work Plan):

Provide a suite of global land cover datasets, initially based on improved and validated moderate resolution land cover maps and eventually including land-cover change at high resolution. This activity will benefit directly from the establishment of the Land Surface Imaging virtual constellation (see AR-09-02a).

Leads (GEO Member or PO, Entity carrying out the work, Contact: e-mail):

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Motivation/Background

Land cover is one of the most important properties for observing, describing and studying the environment and in its the 10 year reference document, the Group on Earth Observation (GEO) has highlighted the importance of land cover for all areas of societal benefits. Despite the fundamental importance of land cover information and other land surface characteristics, it is important to recognize that land observations are not operational, as compared to other earth observation domains such as oceans and the atmosphere. Although numerous satellites acquire data suitable for land monitoring, large-scale regional and global mapping and monitoring programs have not reached operational status for delivering internationally accepted land cover and, in particular, land cover change data to serve the many uses and applications.

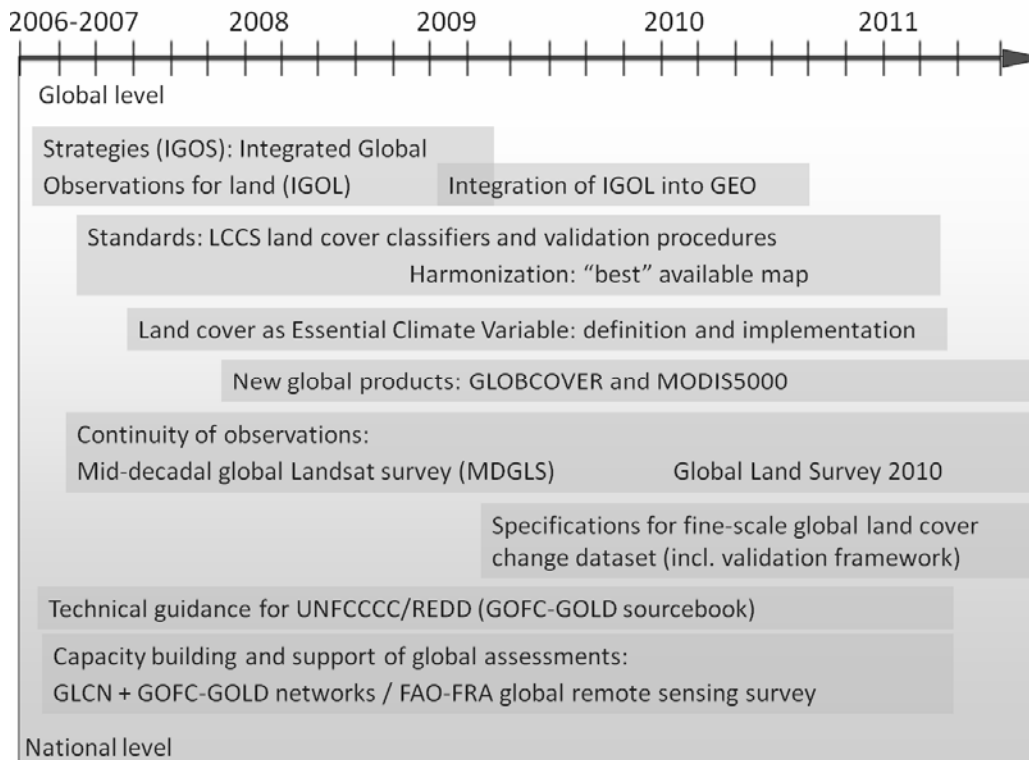
Outputs & progress

Deliverable/output	Recent progress made
<ul style="list-style-type: none"> Availability of global Landsat data in developing countries through USGS-lead Landsat data initiative 	<ul style="list-style-type: none"> Implementation framework in place First regional workshops held in 2009
<ul style="list-style-type: none"> Improved, validated and up-to-date global moderate resolution land cover datasets available for different SBAs 	<ul style="list-style-type: none"> GLOBCOVER dataset and validation exercise completed and documented MODIS 500 global map released recently Planning for next global validation exercise ongoing with next workshop in July 2009 at Boston University
<ul style="list-style-type: none"> Survey of existing land cover datasets and web site data base including technical specifications and access conditions 	<ul style="list-style-type: none"> UN Global Land Cover Network activities for national land cover mapping and harmonization GMES/INSPIRE process to link national and regional land cover observations in Europe

Deliverable/output	Recent progress made
<ul style="list-style-type: none"> Global land cover maps at high resolution repeated on a five year cycle 	<ul style="list-style-type: none"> First specifications defined as part of GMES global land monitoring activities and observing land cover as ECV
<ul style="list-style-type: none"> Global land cover change maps at high resolution repeated initially on a five year cycle and eventually on an annual basis 	<ul style="list-style-type: none"> Progress on particular implementation activities: <ul style="list-style-type: none"> FAO FRA 2010 remote sensing survey UMD global forest change mapping project
<ul style="list-style-type: none"> Definition of community standards for validation of land cover change products 	<ul style="list-style-type: none"> Workshop report for dedicated meeting in Oct. 2008 now available: http://nofc.cfs.nrcan.gc.ca/gofc-gold/Report%20Series/GOLD_38.pdf
<ul style="list-style-type: none"> Requirements, implementation framework and standard reporting guidelines for observing land cover as Essential Climate Variable (ECV) in support of the UNFCCC process 	<ul style="list-style-type: none"> Land Cover ECV report submitted to GTOS and presented to UNFCCC/SBSTA 30 in June 2009: www.fao.org/gtos/ECV-T09.html
<ul style="list-style-type: none"> Regular updates of the GOFc-GOLD technical sourcebook on and procedures for monitoring measuring and reporting on reducing greenhouse gas emissions from deforestation and degradation in developing countries (REDD) in support of the UNFCCC process 	<ul style="list-style-type: none"> New REDD Sourcebook version available online (16. July): http://www.gofc-gold.uni-jena.de/redd/index.php Sourcebook update presented at side event at UNFCCC/SBSTA 30 (June 2009):
<ul style="list-style-type: none"> Comparative global land cover accuracy assessment and living database of land cover validation test sites 	<ul style="list-style-type: none"> General framework presented at CEOS Cal/Val meeting in Missoula (June 2009) Global sample design workshop planned for July 2009 First prototype of comparative global assessment of land cover and specifications for “best available map” exist
<ul style="list-style-type: none"> Specifications and implementation plan for production of high-resolution land-cover and land cover change data products 	<ul style="list-style-type: none"> First specifications defined as part of GMES global land monitoring activities and observing land cover as ECV
<ul style="list-style-type: none"> Successful capacity building workshops 	<ul style="list-style-type: none"> Several GOFc-GOLD regional network meetings and capacity building workshops completed in 2008 and 2009

Activities (operations or work processes through which resources are mobilized to produce specific outputs; outlined in the form of milestones including timelines)

Main objective is to initiate regular analysis and reporting on land cover change and promulgate the use of these products, especially in developing countries. The main activities are summarized in the figure below and further specified in the text:



1. Advocate existing internationally-agreed approaches to systematic land cover characterization (LCCS) and validation (CEOS protocols):
 - a. Develop a formal mechanism for LCCS feedback and improvements such as a steering committee, and solicit input from a broad spectrum of users
 - b. Foster LCCS documentation and implementation activities (capacity building, translations etc.)
 - c. Define a set of minimum land cover generic categories building upon a defined set of LCCS classifiers recommended for land cover maps contributing to global mapping while encouraging the opportunity for provision of additional categorical detail particularly at higher spatial resolutions
 - d. Advocate the use of CEOS Validation protocol for global land cover maps
 - e. Specify validation protocols for high resolution change and vegetation continuous fields (VCF)
2. Make best use of time series data and utilize and validate moderate resolution and land cover data sets (i.e. GLOBCOVER, MODIS products) and earlier 1-km resolution maps (i.e. GLC2000, IGBP-DIS)
 - a. Develop and maintain a reference database of sample sites for baseline global validation
 - b. Compile a "best available" multi-source land cover dataset as indicated by the validation dataset:
 - i. Comparative validation and harmonization (more accurate is better)
 - ii. Most suitable estimate for different user communities (more detail is better)
 - iii. Focus on data 2000-present (more recent is better)
 - iv. Integrate new products (GLOBCOVER, MODIS 500)
 - v. Integrate national and regional datasets where appropriate
 - vi. Make available at native and standard resolutions to support a broad set of SBAs
 - c. Preserve and make available historic time series data

3. Formulate specifications and implement production of a global high-resolution land cover and land change data set and report
 - a. Foster coordination among major existing and evolving programs (GMES, GEO, GLCN, other national cases etc.). Particular emphasis should be put on linking existing regional and global monitoring efforts, i.e. the European CORINE program and ongoing global monitoring activities such as GLOBCOVER.
 - b. Complete a global high resolution land cover map at a minimum of every 5 years, beginning with mid decade (2005) and moving forward and backward in time as the archive of historical satellite imagery permits:
 - i. Define baseline legends using LCCS classifiers
 1. User requirements from SBAs
 - ii. Collect and make freely available high resolution input data:
 1. Global Landsat 1990, 2000 (existing) + new 1995, 2005, 2010
 2. Make available archived ~1995 data
 3. Develop a high resolution dataset for mid-decade (circa 2005) building on Geocover dataset
 4. Coordinate 2010 dataset with contributions from available international assets
 5. Ensure ongoing collection of suitable observations to support future efforts
 6. Support
 - iii. Develop and implement a validation program
 - c. Complete a global high resolution land cover change map, initially every five years and eventually on an annual basis
 - i. Define legends and product specifications
 - ii. Define validation protocols for land cover change
 - iii. Implement a validation program
4. Set up web-based access to land cover data and associated input data
 - a. Support GEO-NETCAST
 - b. Advocate existing data links to land cover information (GLCF, BU, JRC, EEA etc.)
5. Identify opportunities for applying land cover data in areas related to key societal benefits.
 - a. Linking societal benefits, user needs with observation requirements (IGOL etc.)
 - b. Explore and communicate some early success stories (i.e. UNFCCC-REDD, FRA2010 etc.)
6. Strengthen national level capacities to produce and use these products especially in developing countries
 - a. GOFCC-GOLD regional network activities, Global Land Cover Network, bilateral networks etc.:
 - i. Participation in product specification, production and validation
 - ii. Increase access to high resolution imagery (i.e., Landsat, CEOS Land Surface Imaging Constellation) through the implementation of improved data diffusion strategies.
 - iii. Training on accessibility and utilization

Resources (indication of resources – e.g. financial, human – contributed by GEO Members or Participating Organizations to produce outputs)

Support is currently provided through the sponsors of GOFCC-GOLD (in particular ESA, NASA, Canadian Forest Service, Canadian Space Agency), contributing projects (i.e. GLOBCOVER, MODIS) and the USGS.

Architecture and Data Component

1) Please briefly describe any task-related Earth observation resources (data set, system, website/portal) and any related Web Service interfaces that are contributed to GEOSS. State whether these items are or will be registered with the GEOSS Component and Service Registry for access via the GEO Web Portals, and whether any associated standards or other interoperability arrangements will be registered in the Standards and Interoperability Registry.

2) Please also describe what data and information your activity/system needs that you would request to be accessible through the GEOSS Common Infrastructure.

Capacity Building Component

(capacity building is defined to include the development of capacity related to: (i) Infrastructure and technology transfer (Hardware, Software and other technology required to develop, access and use EO); (ii) Individuals (education and training of individuals to be aware of, access, use and develop EO) and (iii) Institutions – building policies, programs & organizational structures to enhance the value of EO data and products).

International capacity building in support of this task:

- 1) UN Global Land Cover Network
- 2) GOFC-GOLD regional networks
- 3) GOFC-GOLD efforts to support of national REDD implementation and capacity development activities
- 4) USGS Landsat data initiative through the GOFC-GOLD regional networks

User Engagement Component

The table below links the GEO areas of societal benefits and global land cover observation requirements and products recommended by IGOL and other documented user requirements. The activities of this task are closely linked with the Community of Practice for Forest Observation.

GEO area of societal benefits	Key land cover observations and recommended products	Relevant observation needs and requirements from IGOL	Examples of documented global user requirements
DISASTERS: Reducing loss of life and property from natural and human-induced disasters	<ul style="list-style-type: none"> • Fire monitoring • Surface cover type changes and land degradations due to disasters 	<ul style="list-style-type: none"> • Fire observations: early warning (i.e. fuel conditions), active fire, burned area/intensity • Location of population and infrastructure 	<ul style="list-style-type: none"> • IGOS – Geohazards theme report • GEO Community of Practice for Disaster Monitoring • GOFC-GOLD strategy for fire observations
HEALTH: Understanding environmental factors affecting human health and well-being	<ul style="list-style-type: none"> • Land characteristics/change for disease vectors • Land cover/change affecting environmental boundary conditions • Demographic and socio-economic characteristics 	<ul style="list-style-type: none"> • Location and extent of settlement patterns • Land use, socio-economic and demographic characteristics • Vegetation characteristics and riparian conditions 	<ul style="list-style-type: none"> • GEO Community of Practice for Health • Requirements advocated by the World Health Organization
ENERGY: Improving management of energy resources.	<ul style="list-style-type: none"> • Bio-fuel production sustainability • Assessments for wind and hydro power generation and explorations 	<ul style="list-style-type: none"> • Biomass yield estimates (forestry and agriculture) • Location and extent of energy consumption 	<ul style="list-style-type: none"> • GEO Community of Practice for Energy
CLIMATE: Understanding, assessing, predicting, mitigating, and adapting to climate variability and change.	<ul style="list-style-type: none"> • Greenhouse gas emissions caused by land cover change • Land cover dynamics forcing water and energy exchanges 	<ul style="list-style-type: none"> • Changes in natural vegetation distributions and land use • Terrestrial carbon stocks and fluxes, biophysical properties, and phenology 	<ul style="list-style-type: none"> • GCOS implementation plan to the UNFCCC • IPCC LULUCF good practice guidance • IGOS Carbon theme report
WATER: Improving water resource management through better understanding of the water cycle.	<ul style="list-style-type: none"> • Land cover change affecting dynamics the hydrological system • Available water resources and quality 	<ul style="list-style-type: none"> • Distribution of water bodies and wetlands • Water use pattern (i.e. irrigation, vegetation stress) and infrastructure 	<ul style="list-style-type: none"> • Ramsar convention

GEO area of societal benefits	Key land cover observations and recommended products	Relevant observation needs and requirements from IGOL	Examples of documented global user requirements
WEATHER: Improving weather information, forecasting, and warning	<ul style="list-style-type: none"> Land cover/change affecting radiation balance and sensible heat exchange Land surface roughness 	<ul style="list-style-type: none"> Biophysical vegetation characteristics and phenology Change of weather-relevant land cover characteristics 	<ul style="list-style-type: none"> Requirements advocated by the World Meteorological Organisation
ECOSYSTEMS: Improving the management and protection of terrestrial, coastal, and marine ecosystems.	<ul style="list-style-type: none"> Human alterations in natural ecosystem development Changes in environmental conditions and provision of ecosystem services Monitoring ecosystem conservation 	<ul style="list-style-type: none"> Land cover and vegetation characteristics and changes Land use dynamics and driving processes 	<ul style="list-style-type: none"> GEO Community of Practice for Forest Observation Millennium Ecosystem Assessment and Development goals + indicators United Nation Environment Program (UNEP) and Global Environmental Outlook GOFC-GOLD observation strategy
AGRICULTURE: Supporting sustainable agriculture and combating desertification.	<ul style="list-style-type: none"> Distribution of cultivation practices and crop production Land degradations and threats terrestrial resources and productivity 	<ul style="list-style-type: none"> Monitoring of food crops (type, rotations, conditions) Forest types and changes (i.e. logging) Land cover and use changes affecting agriculture and forestry 	<ul style="list-style-type: none"> FAO/UNEP requirements for global resources assessment UNCCD requirements
BIODIVERSITY: Understanding, monitoring, and conserving biodiversity.	<ul style="list-style-type: none"> Trends in extent of selected ecosystems, habitats, and species Connectivity and fragmentation of ecosystems 	<ul style="list-style-type: none"> Ecosystem characterization and vegetation monitoring (types, species) Habitat characteristics and fragmentation of invasive and protected species Changes in land cover and use threatening biodiversity 	<ul style="list-style-type: none"> UNCBD 2010 target indicators United Nation Environment Program (UNEP)

Science and Technology (S&T) Component

1) Please briefly describe the elements of scientific research or technological development contained in this Task.

2) In relation to the S&T component(s) of this task, please describe gaps, priorities, continuity needs, barriers, scientific expertise and additional resource needs (this information will be used for developing a gaps and needs assessment in Task ST-09-01)

Members and POs' Contributions to Outputs and Activities above:

(Input is optional. This section gives the chance to Members and POs to provide more details (3-5 lines) on their individual activities, making a clear connection with the Outputs and Activities outlined above).

Australia

Share results on landcover work being undertaken at Geosciences Australia and participate in discussions on harmonisation of landcover products.

Italy

Matching exactly what is required by the sub-task Global Land Cover, Italian Corine Land Cover (scale 1:100.000) is a national level project that makes territorial changes not only a perception, but a real

phenomena quantification. Corine layer is crucial for territorial changes, urban sprawl and biodiversity monitoring. CLC1990, CLC2000 and CLC90-00 changes are already available and the CLC2006 will be ready by the end of 2009. The CLC layers are mapped using 25 hectares MMU (minimum map unit) and CLC changes are represented by 5 hectares MMU.

Japan

AIST: To develop land cover dataset using GEO Grid.

GSI: ISCGM Secretariat developed Global Land Cover by National Mapping Organizations (GLCNMO) datasets. A national land cover dataset was also developed.

NARO: To develop a system to integrate distributed legacy weather datavases and sensor network data, which functions with the GeoGrid system, collaborating with AIST.

NIAES: To development data sets and maps of agricultural land use in East Asia using MODIS data, which is available to clarify the global land cover in agricultural area.

Norway

Norut-Tromsø is one of the leading mapping institutes in Scandinavia utilizing remote sensing data for mapping purposes. At the moment our institute has worked out Vegetation and Land Cover Maps covering the entire Norwegian mainland, the northernmost areas of Northern Scandinavia, Kola Peninsula and Svalbard, Norwegian Arctic. All maps are produced by use of Landsat TM/ETM+ data. As a part of our mapping efforts a production line for creating vegetation maps are being developed.

The production line can be separated into six operational stages:

- (1) spectral classification,
- (2) spectral similarity analysis,
- (3) generation of classified image mosaics,
- (4) ancillary data analysis,
- (5) contextual correction, and
- (6) standardization of the final map products.

Analysis performed on the spectral-only data is often denoted the pre-classification stage of the process, whereas the post-classification process involves analysis and subsequent contextual corrections of the pre-classified image using ancillary data. The quality of the ancillary data sets highly affects the quality of the final vegetation map. For Norway high-quality ancillary data has been available. In the final standardisation part of the process the defined classification units are related and described according to a classification schemes well adapted in the Norwegian botanical tradition.

The contribution to the Global Land Cover programme from our institute will be:

- A) already processed vegetation/land cover maps for the mentioned areas.
- B) For smaller areas (Finnmarksvidda, Northern Norway) change detection demonstrations can be delivered.
- C) Competence in large-area mapping utilizing Landsat images.
- D) A semi-operational production line for creation of vegetation/land-cover maps.
- E) Medium-scale vegetation/land cover maps based on MODIS data covering large areas of North-western Europe.

Spain

Participating organization in projects of ESA, Kyoto-Inv , Forest Monitoring and GLOBCOVER, with data validation.

USA

NOAA: Provide a suite of global land cover datasets, initially based on improved and validated moderate resolution land cover maps and eventually including land-cover change at high resolution. This activity will benefit directly from the establishment of the Land Surface Imaging virtual constellation (see AR-09-02a).

EEA

Global Land Accounting and Globcorine.

ICIMOD

ICIMOD has been working with national partners to provide moderate resolution land cover maps and key hotspots of land cover change for selective HKH region. This activity has been used for wide range of

natural management applications like biodiversity monitoring, land use planning and conservation prioritization. ICIMOD has been working with FAO on land cover mapping to generate standardized and harmonized sub-regional landcover product. This activity will provide basic core data and information on key natural resources and will support varieties of societal beneficial areas.

Participation (Table to be filled in 2009):

Type	Member or PO	Representing	Contact Name	EmailAddress
Lead (PoC)	GTOS	GOFC-GOLD	Martin Herold	m.h@uni-jena.de
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Lead	USA	USGS	Tom Loveland	loveland@usgs.gov
Contributor	Australia	Geosciences Australia	Leo Lymburner	Leo.Lymburner@ga.gov.au
Contributor	EEA	European Environment Agency	Markus Erhard	markus.erhard@eea.europa.eu
Contributor	Germany	GOFC Gold Office (Uni Jena)	Martin Herold	m.h@uni-jena.de
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