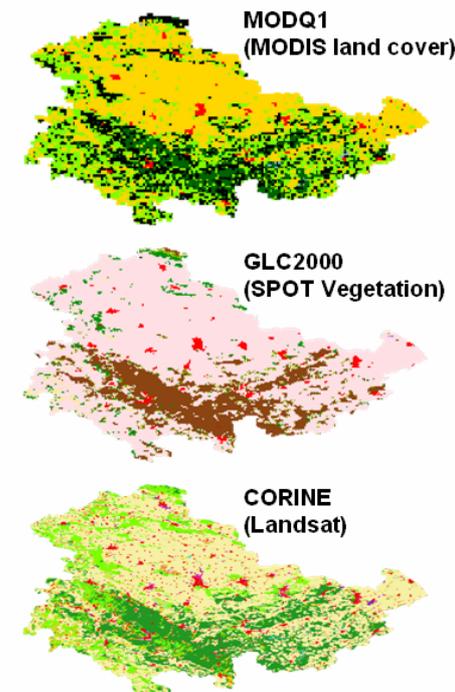


## GOFC-GOLD FOSTERS HARMONIZATION OF GLOBAL AND REGIONAL LAND COVER PRODUCTS

The ESA GOFC-GOLD Project Office organized jointly with FAO's GTOS secretariate a workshop on harmonization of land cover products. The workshop was held 14<sup>th</sup>-16<sup>th</sup> of July 2004 at FAO in Rome. This meeting was fostered by the growing need for detailed and accurate information about land cover and land cover change on different geographic scales. A variety of regional and global land cover products exist, i.e. IGBP Discover, MODIS Land Cover Product, GLC 2000, CLC1990 and 2000 etc.). There is, however, no common language between these different maps and their thematic legends (Fig. 1). This hinders a joint application, in particular for analysis of changes, comparisons between the maps and complicates coordinated efforts in their validation.

The topics of the workshop have been outlined in the previous GOFC-GOLD workshop held in Jena, Germany in March 2004, where GOFC-GOLD, ESA, and GTOS with the Food and Agriculture Organization of the United Nations (FAO) have agreed to jointly foster the harmonization and validation of global land cover products. The workshop brought together key participants essential for a successful implementation of harmonization efforts. Participants include GOFC-GOLD LC-IT members, representatives from FAO and GTOS, ESA, CEOS, IGBP and UNEP, JRC, DLR, research universities focused on land cover mapping (i.e. Boston University, Uni. of Maryland),



**Fig.1 Three land cover products shown for the area of Thuringia/Germany. They are based on different EO sensors and mapping approaches, and varying standards for definition of land cover categories. Harmonization seeks for compatibility and comparability between them.**

and representatives from the Academies of Sciences from Mongolia and Slovakia.

### Framing Harmonization

Harmonization can be understood as a process to union similarities in existing definitions to allow comparisons between heterogeneous land cover datasets. Dataset heterogeneity results from different standards used to derive them and has multiple facets. They include syntactic issues (e.g. logical data models: vector/raster), schematic heterogeneity (e.g. database models, spa-

tial reference systems, cartographic standards) and semantic aspects. The latter one refers to naming and cognitive conceptualizations of land cover legends that have been the main focus of this workshop. The harmonization efforts were started by UNEP/FAO in the early 1990ies. The main objective of this initiative was a response to the need for harmonized and standardized collection of data mentioned in UNCED's Agenda 21 (Chap. 10). Workshop participants from different regional and global earth observation land cover mapping programs and agencies discussed standards and probable inconsistencies in their land cover legends. Harmonization was welcomed as important step to value and apply land cover maps. Harmonization has to involve representatives from producers of land cover maps (space agencies, land cover facilities), product users (FAO/UNEP) and the science community. GOFC-GOLD provides the appropriate framework to establish and coordinate the communication between these actors.

### CONTENTS:

- GOFC-GOLD/FAO workshop on harmonization of land cover products **1**
- The FAO Land Cover Classification System **3**
- Miscellaneous **4**

**Land cover legend translation**

At the previous GOFC-GOLD meeting in Jena, Germany, the FAO/UNEP Land Cover Classification System (LCCS) has been identified as appropriate classification system to provide a common language and legend translation device (see page 3). A tutorial on the LCCS-2 software was held during the workshop. The participants were able to familiarize with LCCS (Fig. 2). Land cover legend translation examples have been discussed and implemented for the case of IGBP and CORINE. The workshop showed that nearly every land cover legend can be translated into the LCCS framework if sufficient information about category definitions is available. These successful examples for legend translation provide the first step in the harmonization. Limitations have been recognized for retrofitting and intercomparison of existing classification schemes even after translation. The harmoniza-



**Fig 2: Discussions during the LCCS tutorial at the harmonization workshop in Rome (from left: C. Schmullius, M. Brady, C. Woodcock, M. Keil, A. Di Gregorio, H.-J. Stibig)**

**Workshop outcomes:**

- o Framework for international harmonization efforts (consensus on theory, key actors, implementation strategy).
- o Application and endorsement of Land Cover Classification System (LCCS-2) as common language and translator.
- o Establishment of test beds for development and evaluation of harmonization mechanisms.
- o Refined strategy for validation global land cover products.

tion efforts should take particular action for future land cover mapping efforts. Thus, LCCS-2 will be endorsed for land cover legend generation and as exploratory tool for comparing classification schemes. GOFC-GOLD LC-IT and

GTOS will recommend LCCS-2 as a standard to space agencies for endorsement to CEOS and any related land cover projects. As part of that process, GOFC-GOLD will work towards international consensus for classification thresholds and a hierarchy of thresholds used in LCCS-2.

**Test beds and case studies**

Expertise for translation, harmonization and comparison between global and regional land cover maps will be gained through case studies coordinated by ESA's GOFC-GOLD Project Office. The goal is to complete harmonization exercises between global and regional datasets in specific test sites like Thuringia/Germany, central Siberia, northern Mongolia and SE-Asia. Comparative analysis and evaluation of the harmonized products are based on local expertise and in situ data. The final documentation will include limitations and capabilities of the harmonization mechanisms, experiences with LCCS-2 and should provide indications for inconsistencies in existing land cover maps.

**Validation of land cover maps**

Since a harmonization strategy forms the basis for a joint valida-

tion of existing global land cover maps this issue has been discussed and proposed during the workshop. In conjunction with the CEOS Cal/Val Group, GOFC-GOLD will push forward an international proposal and identify resources to validate all existing and planned global land cover datasets including ESA's future GLOBCOVER products (AO4681). The general approach is to develop a "living" dataset of validation sites that could be used to verify any new land cover map. The intent is to select sites that are not associated with any specific land cover map and that may retain statistical rigor when used on a variety of maps. The validation will be based on high resolution satellite data and incorporate the GOFC-GOLD regional networks. LCCS-2 provides the framework to translate the individual interpretations into the various legends. This process will foster the capacity building efforts to make LCCS-2 more known and available to the earth observation community.

# THE FAO LAND COVER CLASSIFICATION SYSTEM FOR HARMONIZED AND STANDARDIZED LAND COVER MAPPING

The new version of the Land Cover Classification System (LCCS-2) has been released recently. LCCS provides a comprehensive methodology for description, characterization, classification and comparison of most land cover features identified all over the world at any scale or level of detail.

LCCS was created by FAO and UNEP in response to a need for:

- A **harmonized and standardized** collection of land cover data;
- Availability of land cover data for a **wide range of applications and users**; and
- **Comparison and correlation** of land cover classes.

LCCS is an a priori classifier. Therefore all the classes must be defined before any land cover classification takes place. However, instead of pre-defining the classes, LCCS pre-defines the classification criteria that uniquely identify the classes. The user has to create -one by one- each single class needed. This involves a process of passing from the user's idea of the class, to the creation of the representation of this idea using a meaningful

sequence of classifiers that are able to precisely illustrate this idea of the specific land cover feature. Therefore, the concept is based on the presumption that any land cover class, regardless of its type and geographic location, can be defined by a set of pre-selected independent diagnostic attributes, the classifiers. The LCCS method enhances the standardization process and minimizes the problem of dealing with a very large amount of pre-defined classes.

The number of LCCS classifiers and descriptors used determines the detail with which the land cover is classified. Thus, a larger number of classifiers is needed when more detailed classification (description) of land cover is required.

The heterogeneity of land cover does not allow that the same set of classifiers can be used to define all land cover types. Therefore, these classifiers are tailored to eight major land-cover groups (Fig. 3).

Since the first release of LCCS in 2000 several trainings and workshops have been organized by FAO/UNEP to familiarize users

### Status of LCCS-2:

- Software completed and ready for download from the LCCS web page from beginning of September 2004.
- Manual under language editing phase.
- Manual ready for downloading from the web page from the beginning of September 2004. Printed version from the end of September 2004.
- Translations in French, Spanish and Arabic scheduled for 2005.

For further information about LCCS-2 contact Antonio Di Gregorio: [antonio.digregorio@africover.org](mailto:antonio.digregorio@africover.org)

with LCCS. During the harmonization workshop in Rome (see pages 1 and 2) a tutorial was held to introduce LCCS-2 and gain first experiences in translating existing land cover legends. An example is shown in Figure 4. The IGBP legend was translated based on their class definitions. The comparison shows general differences in terminology (forest versus trees), different types of thematic and cartographic land cover mixtures (e.g. woody savannah versus woodland with herbaceous layer).

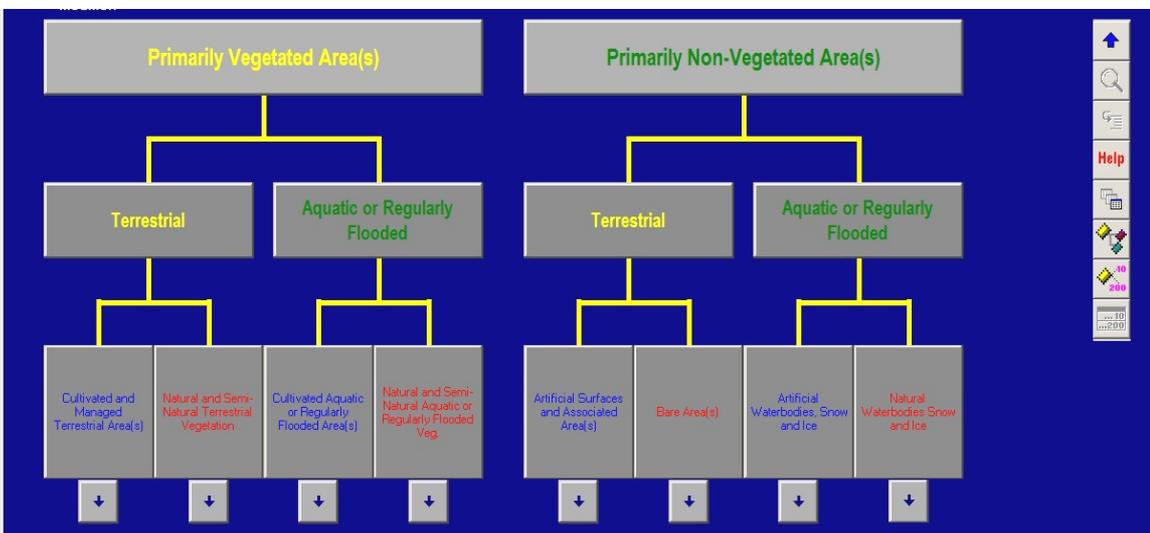
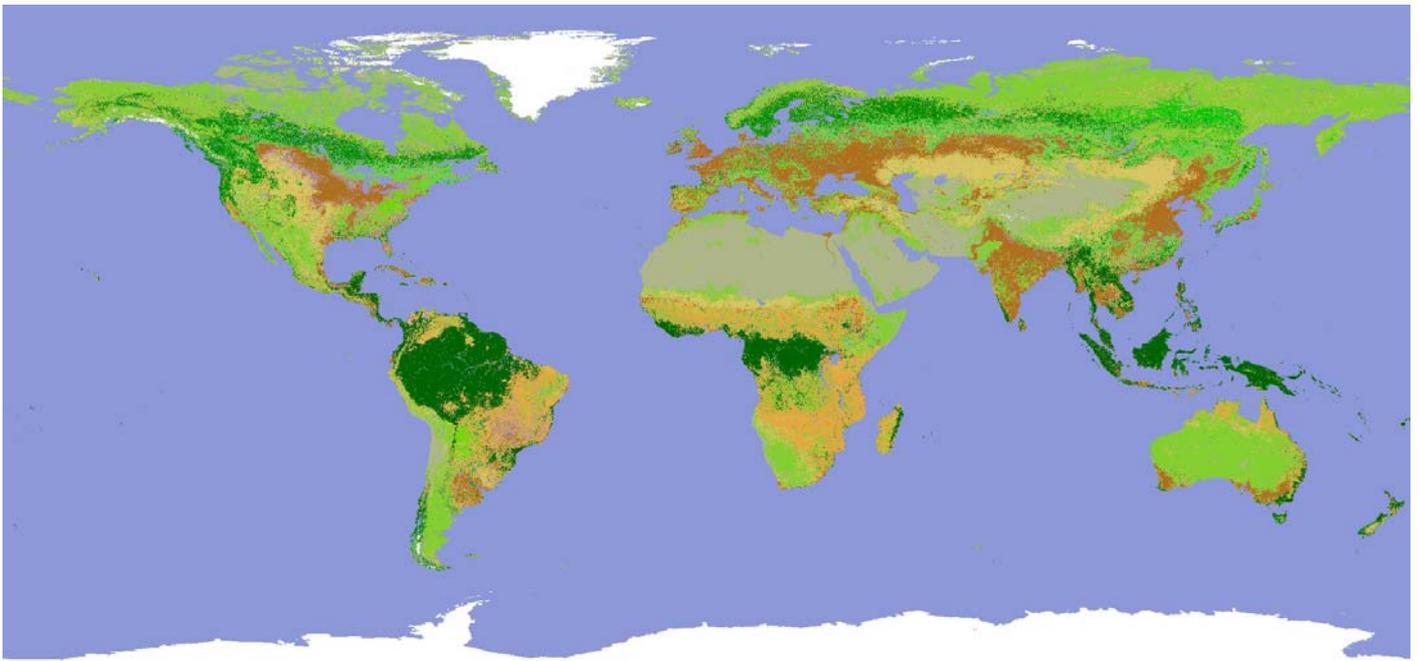


Fig 3: LCCS-2 user interface at the initial dichotomous classification phase.



| Color       | IGBP class                          | LCCCode      | LCCLevel                 | LCCLabel                                                                       |
|-------------|-------------------------------------|--------------|--------------------------|--------------------------------------------------------------------------------|
| Dark Green  | Evergreen needleleaf forests        | 20092        | A3A10B2XXD2E1            | Needleleaved Evergreen Trees                                                   |
| Dark Green  | Evergreen broadleaf forests         | 20089        | A3A10B2XXD1E1            | Broadleaved Evergreen Trees                                                    |
| Light Green | Deciduous needleleaf forests        | 20093        | A3A10B2XXD2E2            | Needleleaved Deciduous Trees                                                   |
| Light Green | Deciduous broadleaf forests         | 20090        | A3A10B2XXD1E2            | Broadleaved Deciduous Trees                                                    |
| Light Green | Mixed forests                       | 20006(1)[Z1] | A3A10B2Z1                | Closed Trees                                                                   |
| Light Green | Closed shrublands                   | 20018-13476  | A4A10B3-B9               | Closed Medium High Shrubland (Thicket)                                         |
| Light Green | Open shrublands                     | 20022-13476  | A4A11B3-B9               | Open Medium High Shrubs (Shrubland)                                            |
| Light Green | Woody savannas                      | 20317-1      | A3A11B2XXXXXF2F4F7G4-A12 | ((70-60) - 40%) Woodland with Herbaceous Layer                                 |
| Light Green | Savannas                            | 20014-3012   | A3A11B2-A13              | Open (40 - (20-10)%) Trees (Woodland)                                          |
| Light Green | Grasslands                          | 21453        | A2A20                    | Herbaceous Closed to Open Vegetation                                           |
| Light Green | Permanent wetlands                  | 0007         | A24                      | Natural And Semi-Natural Aquatic or Regularly Flooded Vegetation               |
| Light Green | Croplands                           | 10025        | A3                       | Herbaceous Crop(s)                                                             |
| Light Green | Urban and built up lands            | 5001         | A1                       | Built Up Area(s)                                                               |
| Light Green | Cropland/natural vegetation mosaics | 10025 / 0004 | A3 / A12                 | Herbaceous Crop(s) / Natural And Semi-Natural Primarily Terrestrial Vegetation |
| Light Green | Snow and Ice                        | 8005 // 8008 | A2 // A3                 | Snow // Ice                                                                    |
| Light Green | Barren                              | 6001 // 6004 | A1 // A2                 | Consolidated Material(s) // Unconsolidated Material(s)                         |
| Light Green | Water bodies                        | 8001 // 7001 | A1 // A1                 | Natural Waterbodies // Artificial Waterbodies                                  |

Fig 4: MODIS global land cover map with IGBP legend. The IGBP legend was translated to LCCS during the harmonization workshop in Rome. The MODIS product is available for download from Boston University: <http://duckwater.bu.edu/lc/mod12q1.html>

## MI SCELLANEOUS

### NEW OFFICE COORDINATOR

Since July 2004 Martin Herold is the new coordinator of the ESA GOFC GOLD project office. He replaced Kathleen Neumann who represented the project office Feb.-June 2004 and will stay involved through the GLCN framework. Mr. Herold received a PhD from the Geography Department of the University of California Santa Barbara. His previous research has focused on mapping and modelling of urban growth and land use change.

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