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Assessment of area and area change

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Content

- Classification Systems (LCCS)
- Mapping and GIS tools
- GIS services

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Land Cover Classification System (LCCS)

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Land Cover

Land cover (LC) is the observed (bio)physical cover on the earth's surface.

LC: includes vegetation and man-made features as well as bare rock, bare soil and inland water surfaces

- one the most important elements for description and study of the environment
- one the easiest detectable indicators of human interventions
- a critical parameter for environmental databases
- changes quickly over time

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Land Use

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce change or maintain it.

- land use establishes a direct link between land cover and the actions of people in their environment.

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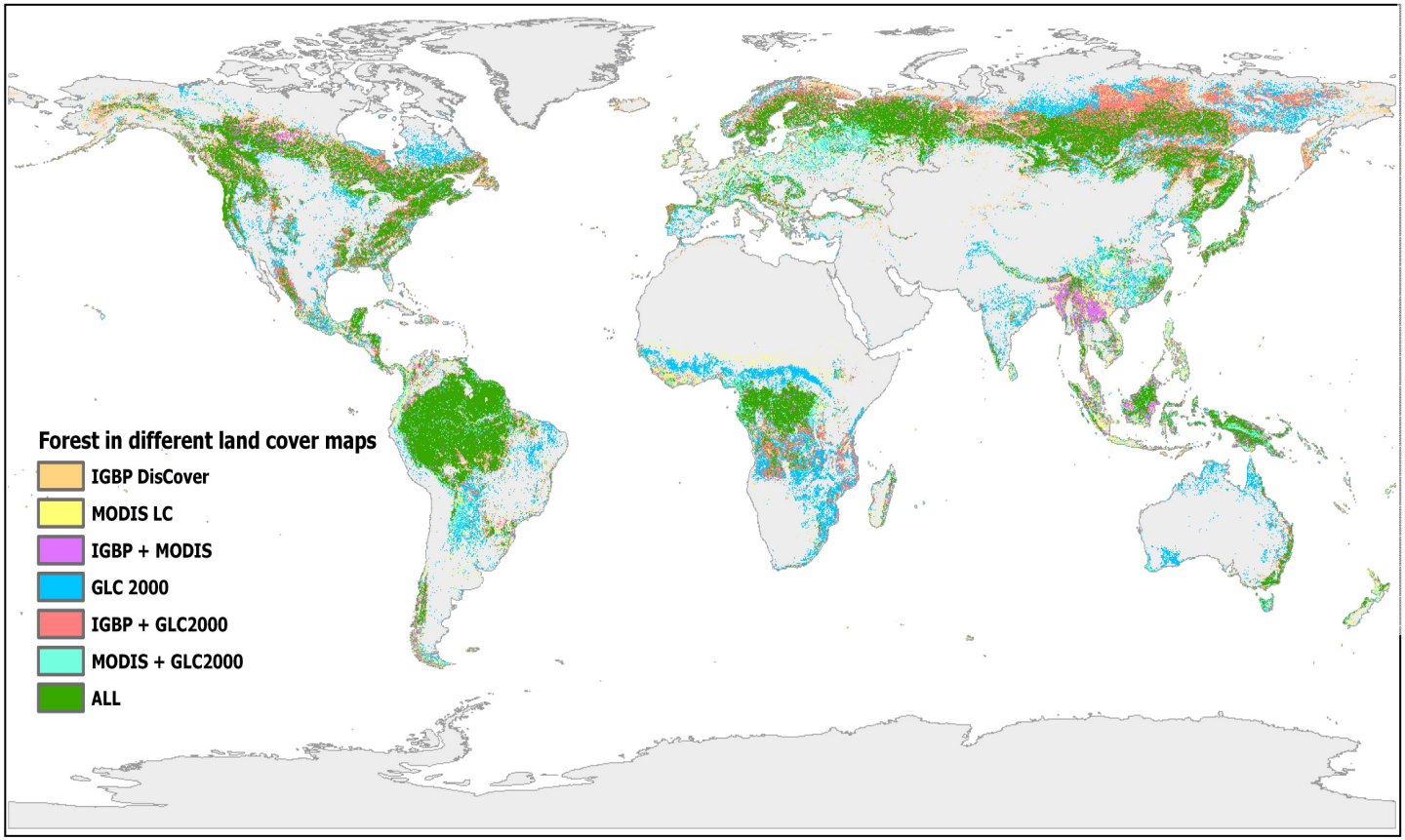
Forest land in global land cover datasets



Forest definitions:

IGBP legend :
percent tree cover >60% / tree height >2m

GLC2000 legend :
percent tree cover >15% / tree height >3m

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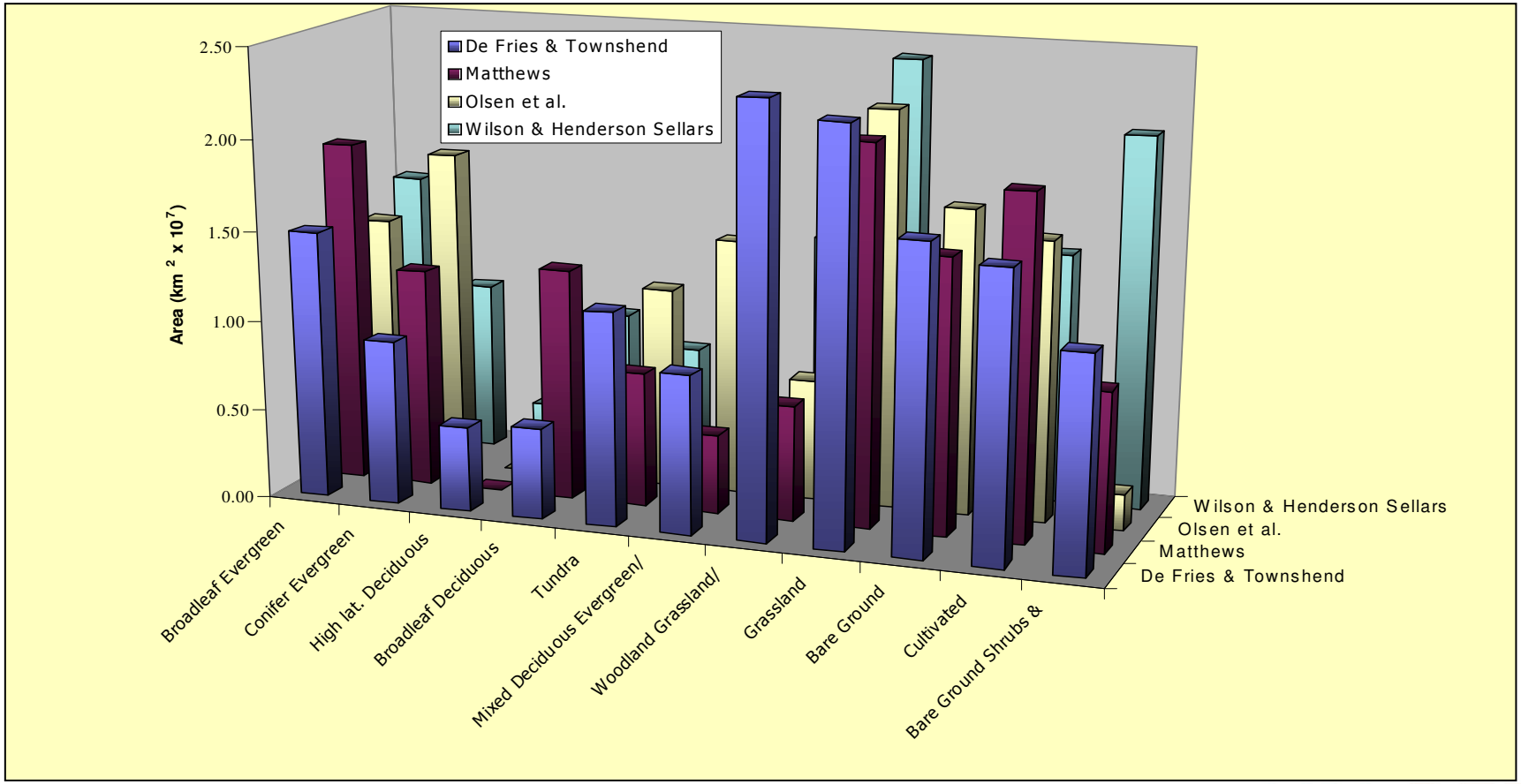
Why do we need standards...?



Area estimates: 11 cover types, different global datasets

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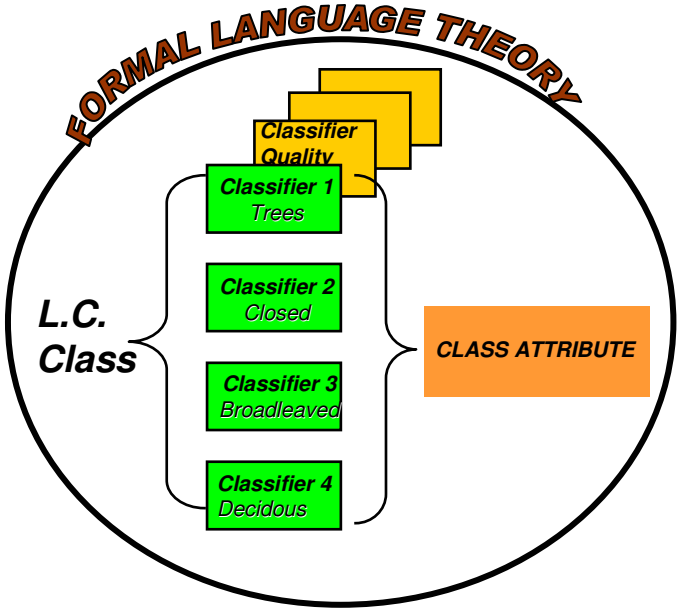
LCCS: basic concepts

- LCCS is a language to describe in a standardized way the different land cover features. As in any language, there are words (**classifiers**) and a syntax (**classification rules**) allowing to create a semantic concept (**land cover class**)
- In LCCS, the creation of a class is done by a dynamic combination of land cover diagnostic attributes called **classifiers**
- The classifiers act as building blocks and can be combined to describe the more complex semantics of each land cover class in any separate application ontology (classification or legend)



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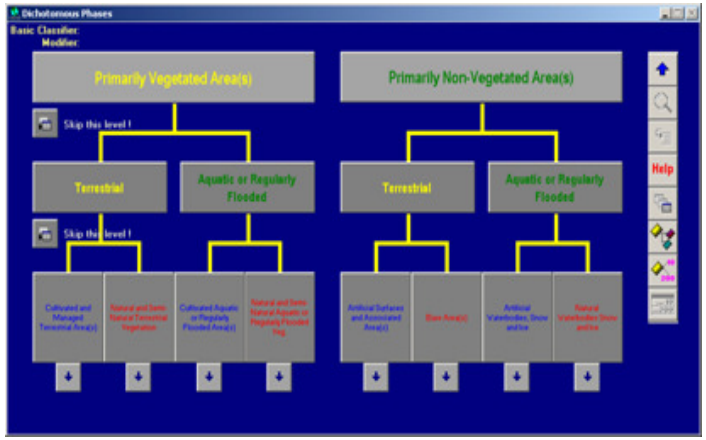
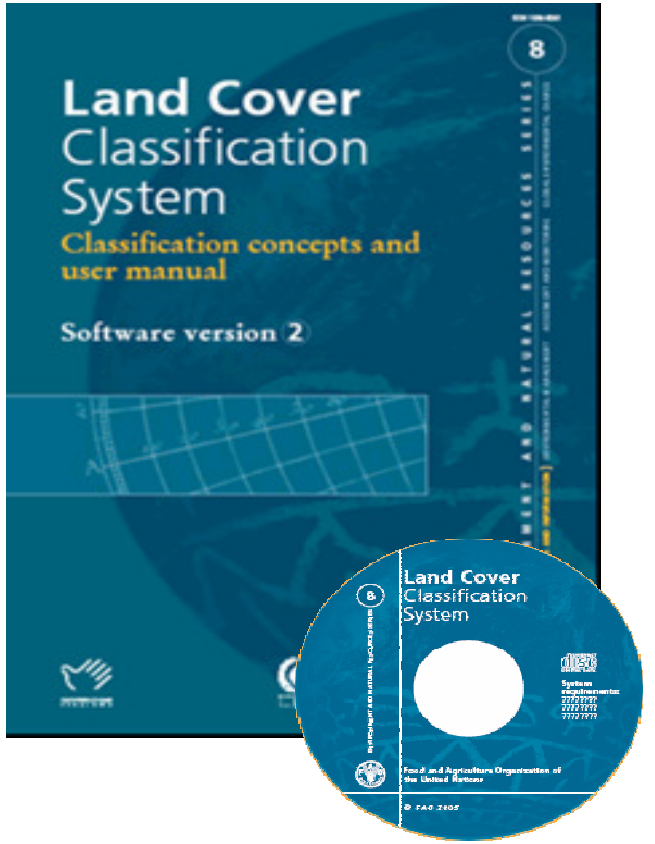
LCCS resources / software and manuals





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LCCS in the world

- LCCS is widely adopted by both national and international organizations for a variety of initiatives.
- Inside the GLCN's www.glcn.org Regional Harmonization Programme (RHP), Himalaya, Ethiopia, Sudan, SADC, Mekong basin and Caucasian regions are being mapped (Himalaya) or are planned to be in the next future.

MAPPING WITH LCCS				LEGEND TRANSLATION		
COMPLETED *national*	**COMPLETED** *sub-national*	**ON GOING**	**PLANNED**	**OFFICIAL**	**IN PROGRESS**	**EVAL.**
AFRICOVER	Brazil	HYMALAYA region	MEKONG basin	GLC2000	ASIACOVER	Canada
Burundi	Bulgaria	Afghanistan	Cambodia	GLOBCOVER	Burkina Faso	China
DR of Congo	Chile	Bangladesh	Lao PDR	Afghanistan	Ghana	Jordan
Egypt	Indonesia	Bhutan	Thailand	Lebanon	Guinea	Mexico
Eritrea	Madagascar	China	Viet Nam	India	Malaysia	Syria
Kenya	Mexico	India	China	New Zealand	Mali	USA
Rwanda	Tunisia	Myanmar	South Sudan	South Africa	Mongolia	
Somalia		Nepal	North Sudan		Nepal	
Sudan		Pakistan	Seychelles			
Tanzania		SADC region	Uruguay			
Uganda		Angola				
Albania		Botswana	**PROPOSED**			
Bulgaria		Lesotho	CAUCASIAN region			
Iraq		Malawi	Armenia			
Libyan Arab Jamahiriya		Mauritius	Rep. of Azerbaijan			
Moldova, Rep		Mozambique	Georgia			
Oman		Namibia	Kazakhstan			
Senegal		South Africa	Kyrgyzstan			
Yemen		Swaziland	Tajikistan			
		Tanzania	Turkmenistan			
		Zambia	Uzbekistan			
		Zimbabwe				
		Cuba				
		Ethiopia				
		Morocco				
		Tunisia				
		South Sudan				

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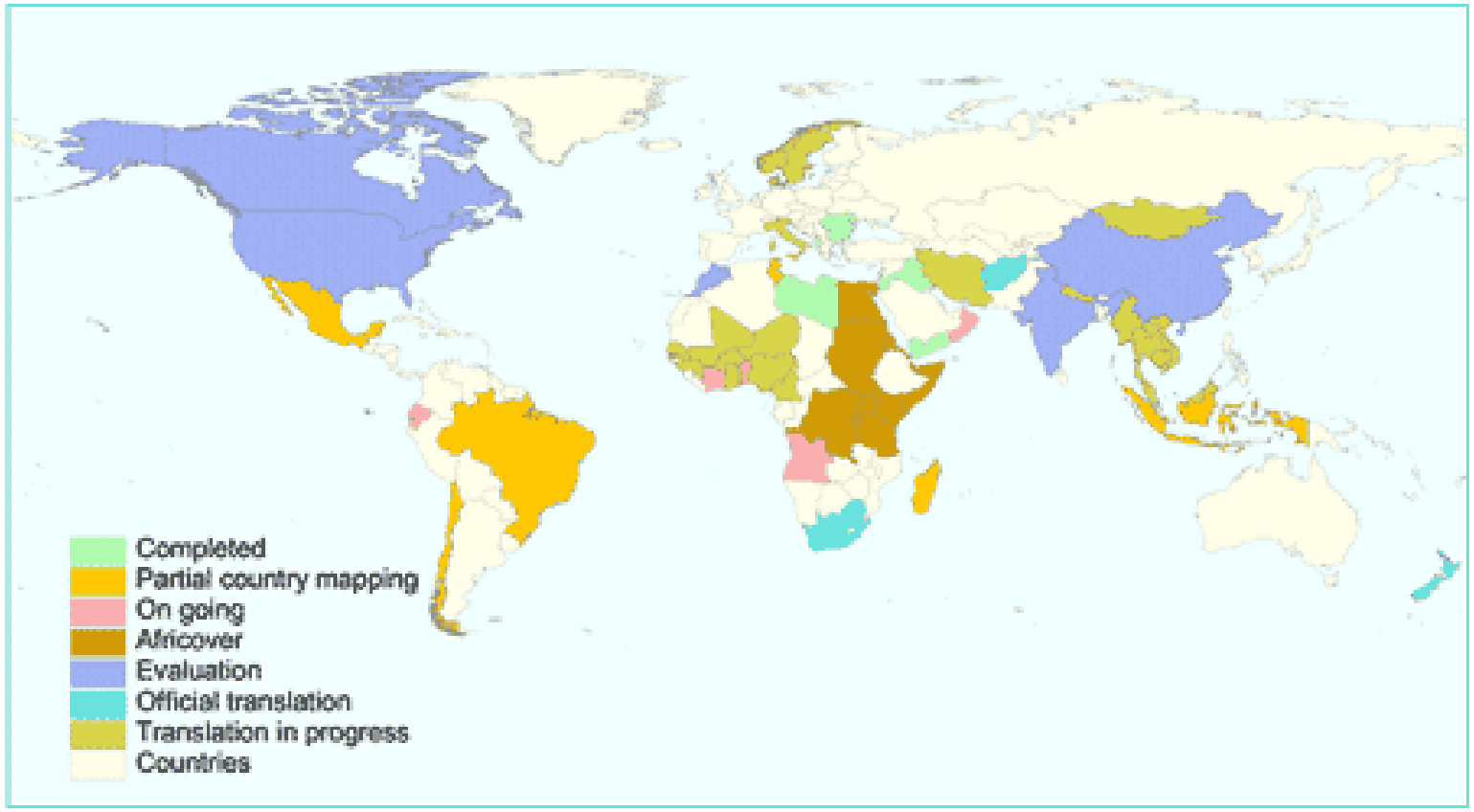
LCCS in the world



Distribution of LCCS implementation around the world

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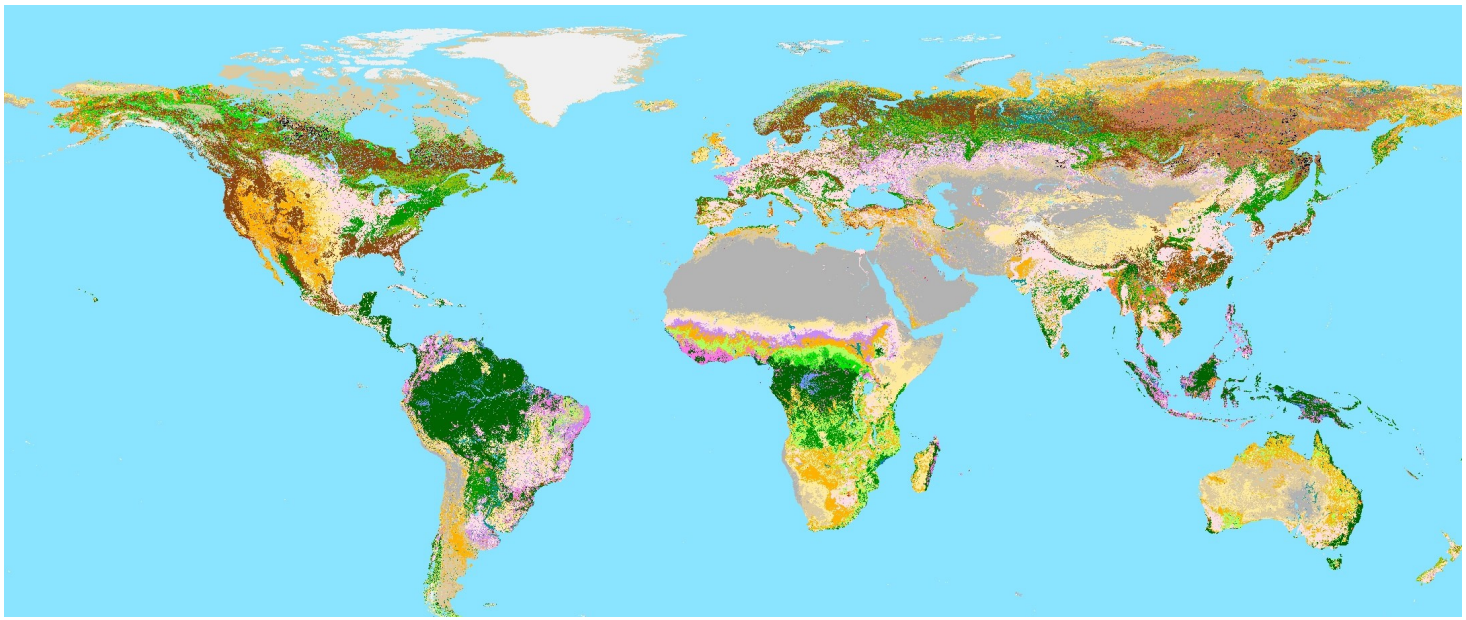
LCCS databases

Global Land Cover (GLC) 2000

1 km resolution

The dataset was sponsored by members of the VEGETATION programme, including JRC. Each partner used the **Land Cover Classification System (LCCS)** produced by FAO and UNEP, which ensured that a standard legend was used across the globe



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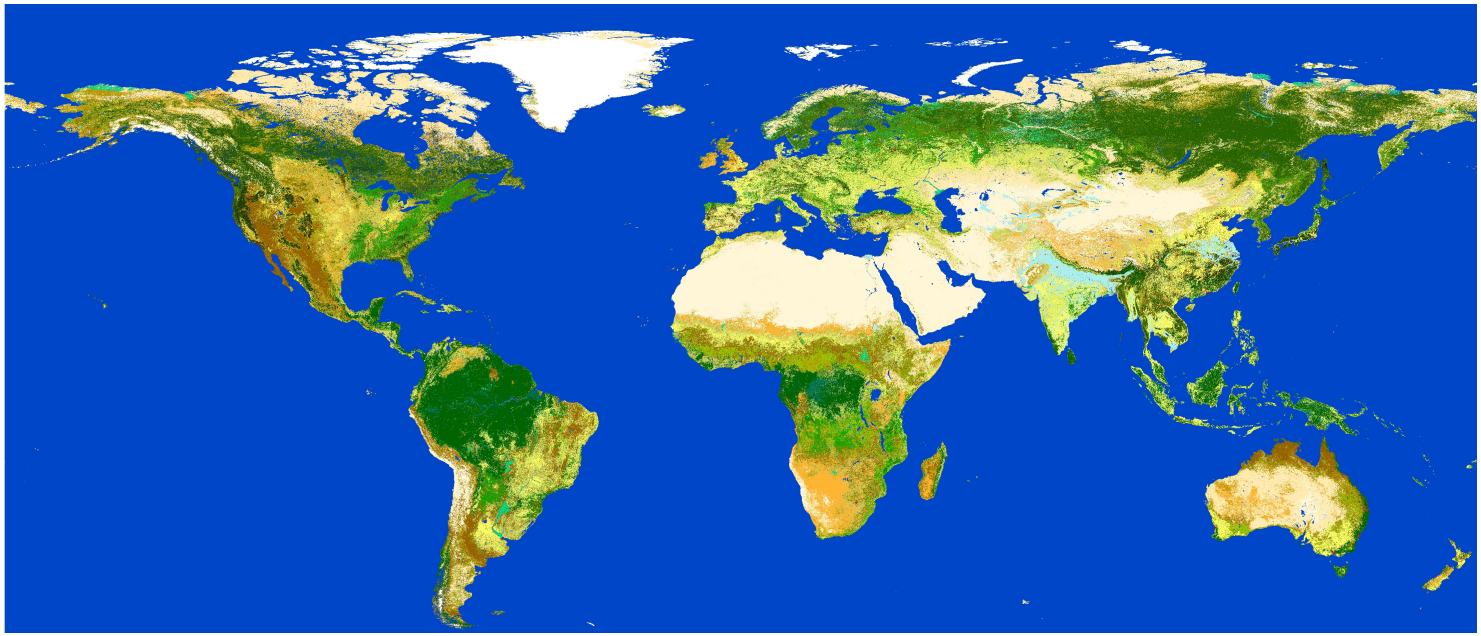
LCCS databases

GlobCover ~2006

300 m resolution

The GlobCover Land Cover product is based on ENVISAT MERIS data at full resolution from January 2005 to June 2006. The GlobCover Land Cover product is labelled according to the **UN Land Cover Classification System**



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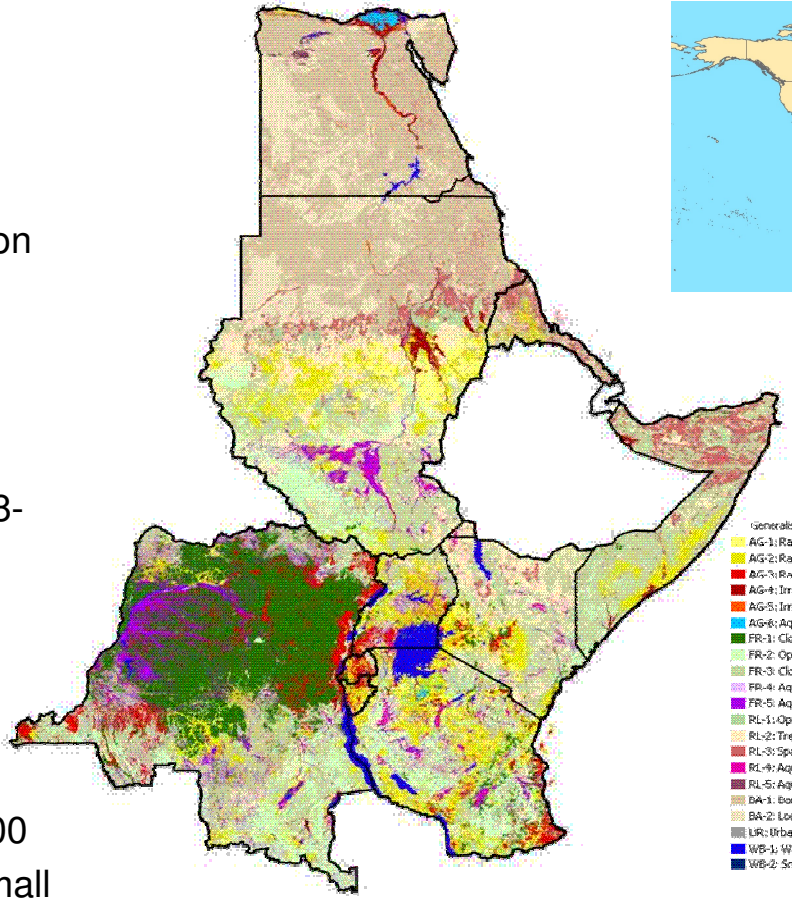
LCCS databases

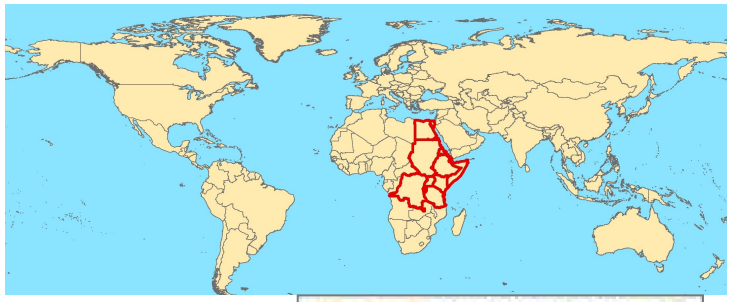
Africover ~2000

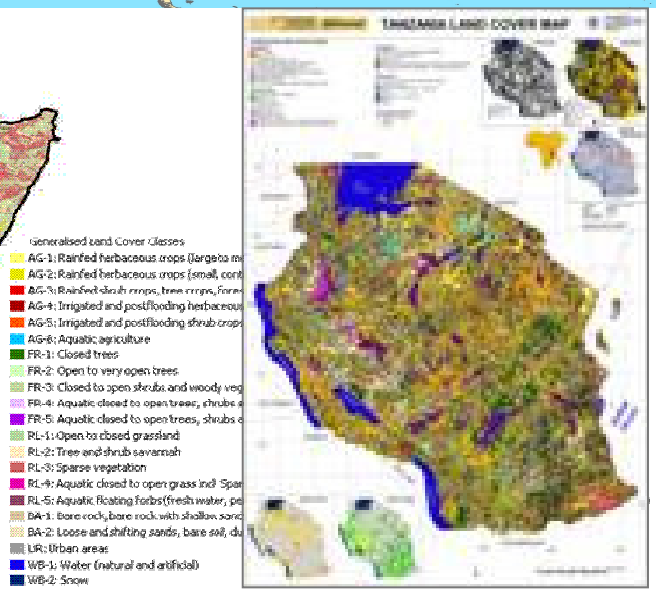
30 m resolution

Facts:

- Mapped area: 2.0 million km^2
- Countries covered: 10
- Landsat Scenes used: more than 400
- Period of activity: 1998-2004
- Result: Multipurpose Africover Database for the Environmental Resources (MADE) produced at a 1:200,000 scale (1:100,000 for small countries and specific areas)







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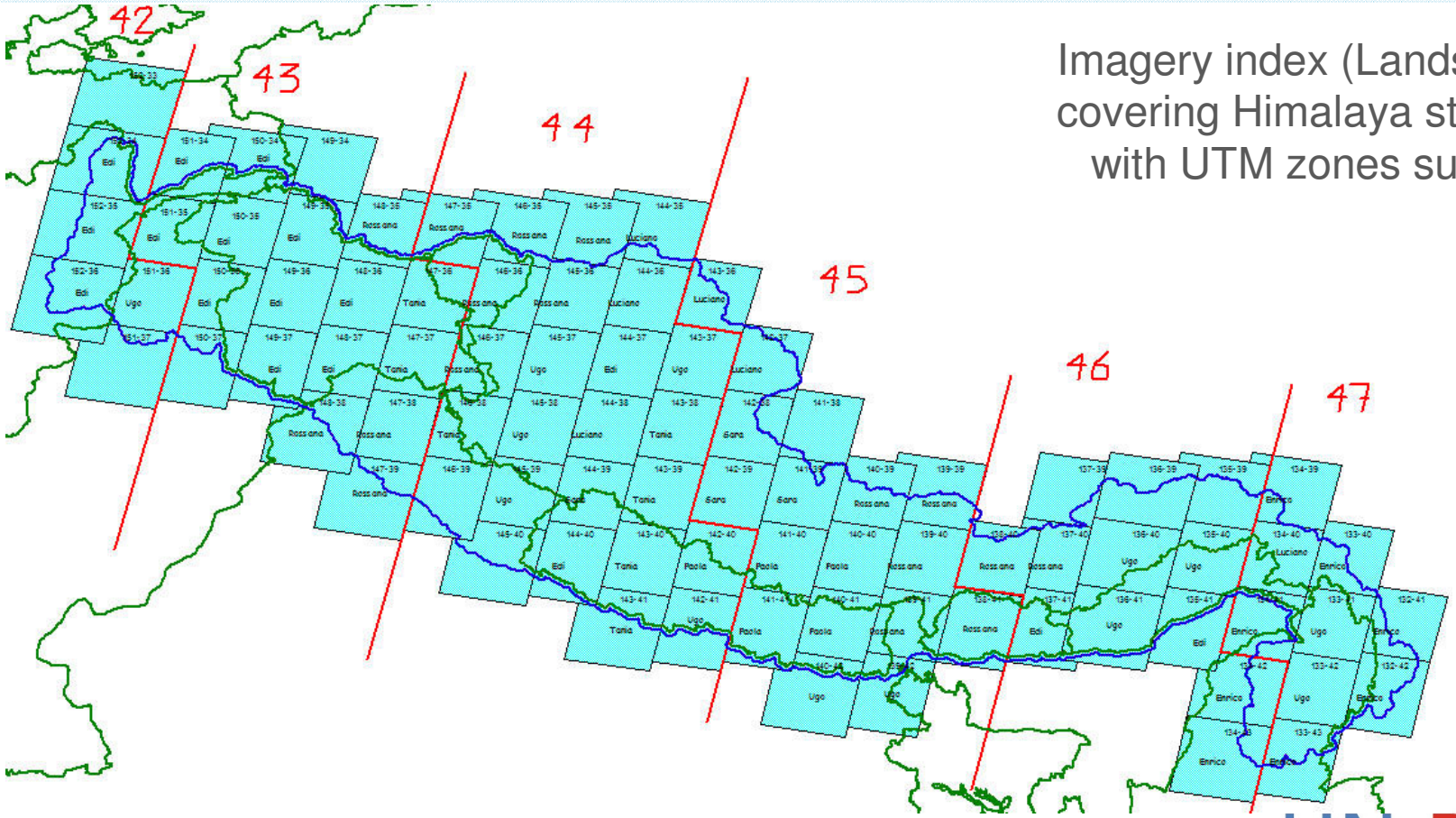
GLCN Regional HArmonization Programme (RHAP): Himalaya



Imagery index (Landsat ETM) covering Himalaya study area with UTM zones subdivision

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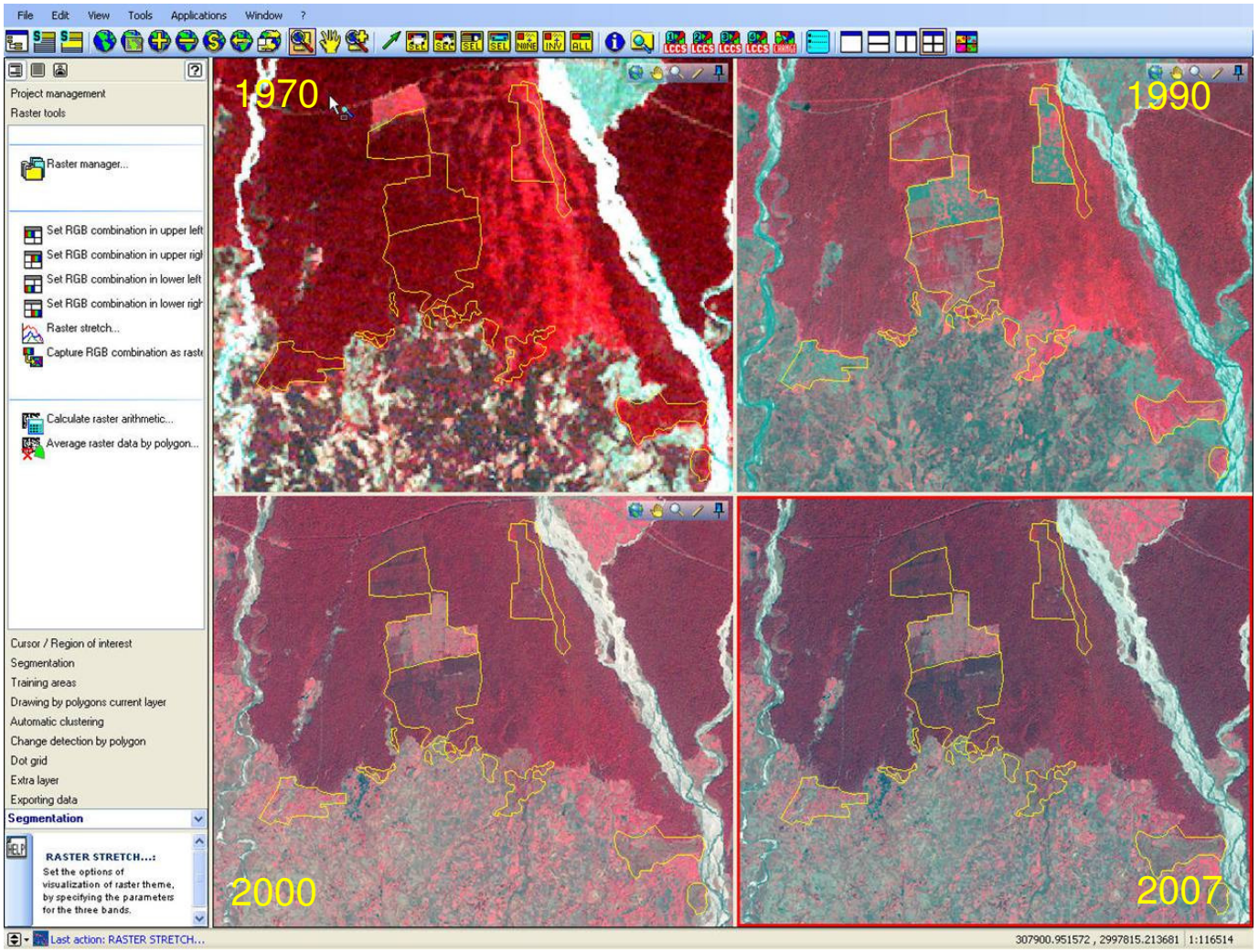
Land cover change mapping



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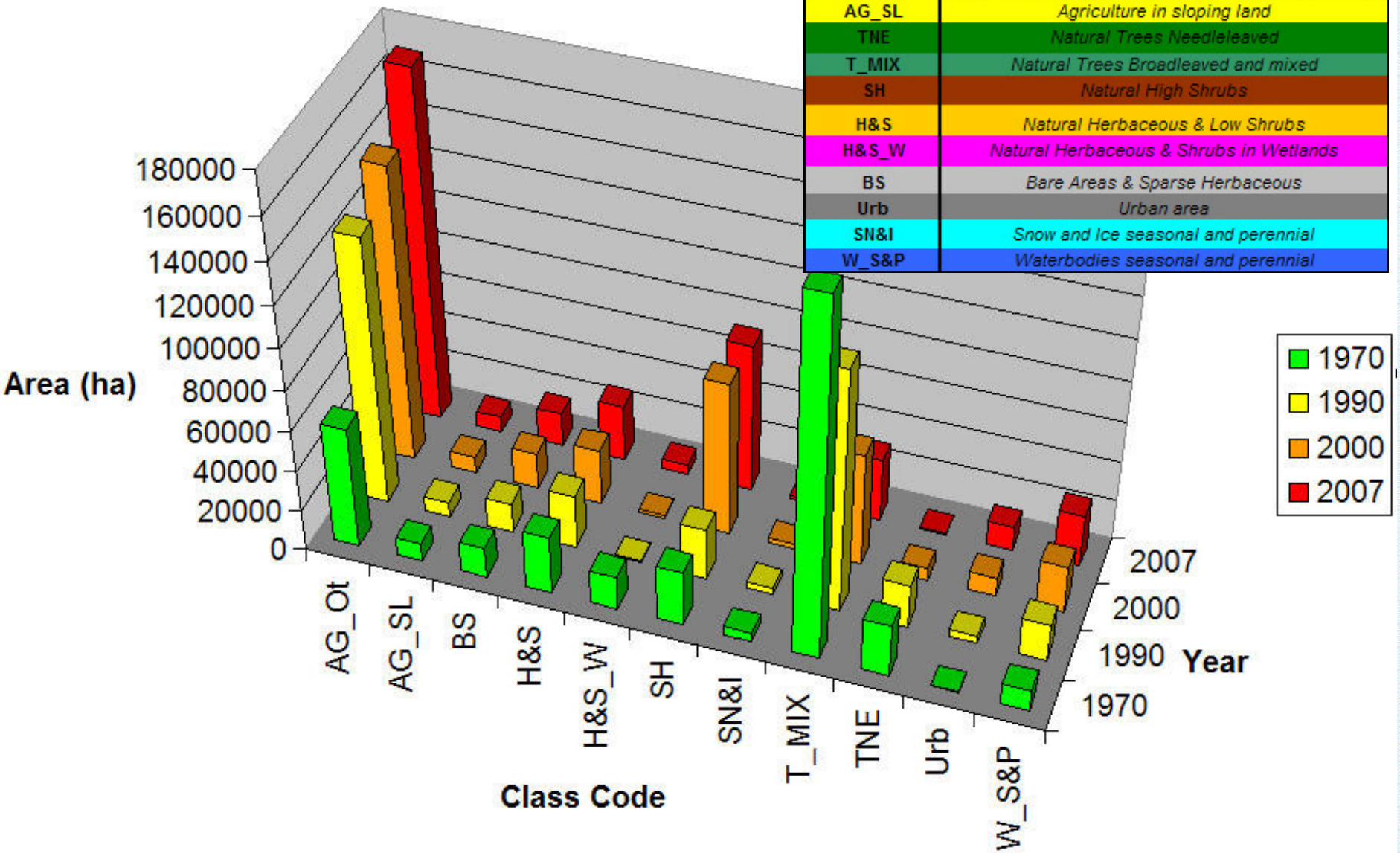
Himalaya Changes Overview

Aggregated User Label	Aggregated Class Name
AG_Ot	*Agriculture in valley floor or in not specified landform*
AG_SL	*Agriculture in sloping land*
TNE	*Natural Trees Needleleaved*
T_MIX	*Natural Trees Broadleaved and mixed*
SH	*Natural High Shrubs*
H&S	*Natural Herbaceous & Low Shrubs*
H&S_W	*Natural Herbaceous & Shrubs in Wetlands*
BS	*Bare Areas & Sparse Herbaceous*
Urb	*Urban area*
SN&I	*Snow and Ice seasonal and perennial*
W_S&P	*Waterbodies seasonal and perennial*

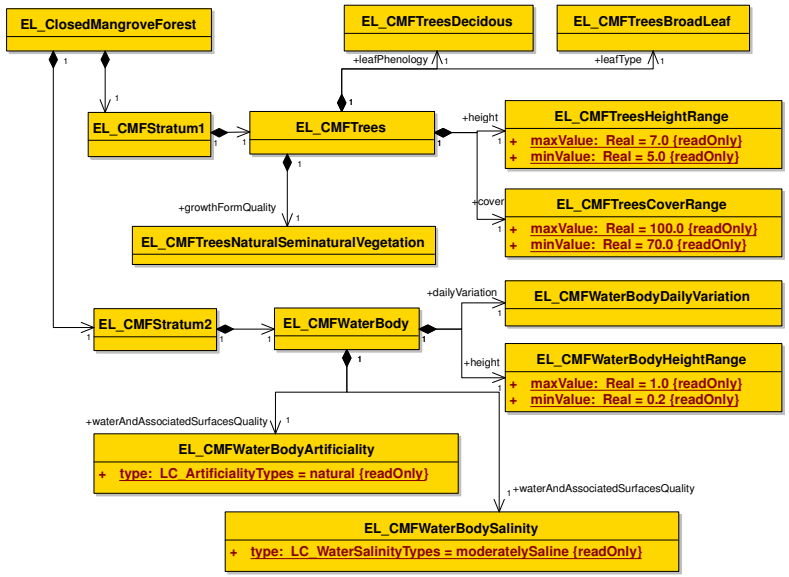


LCCS: towards version 3

From LCCS to LCML (Land Cover Meta Language)

- From the concept of LCCS, a broader Land Cover Meta Language (LCML) has been created. LCML represents a picture of the classification model with limited constrains between different elements forming a land cover class.
- LCML has been represented in a UML (Unified Modeling Language)
- **Pathway to ISO standardization as part of UNFCCC terrestrial framework**

Example of LCCS3 class: Closed mangroves trees



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UN-REDD & LCCS

Benefits for MRV

Major benefits of using LCCS are the great compatibility and comparability of different land cover data base across space, time and source imagery. LCCS was originally created in response to a need for:

- A harmonized and standardized collection and reporting on the status of land cover
- Availability of land cover data for a wide range of applications and users
- Comparison and correlation of land cover classes between different systems/approaches
- Comparison of land cover classes between and within countries
- FAO utilizes consistent and harmonized land cover and land cover change databases as a precursor of land use and land use change database. This also contributes to standardized application of methodologies across countries

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Mapping and GIS Tools

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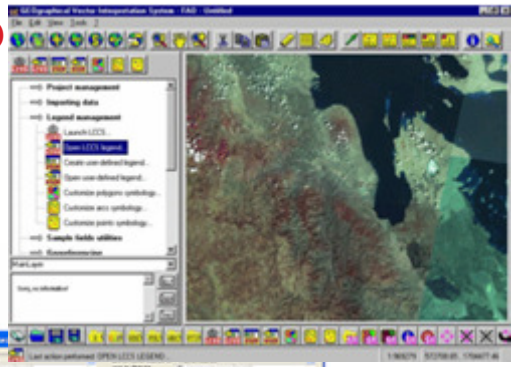
GIS tools and services

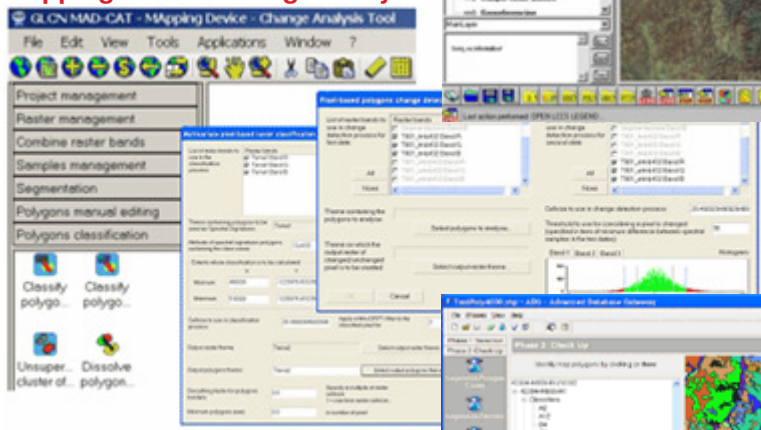
- FAO has a long experience in developing spatially-enabled tools and implementing services in support of mapping of **area and area change activities**, **data** and information dissemination.

- This session of the presentation provides an overview of FAO tools and services that could be adopted in support of the programme's activities.

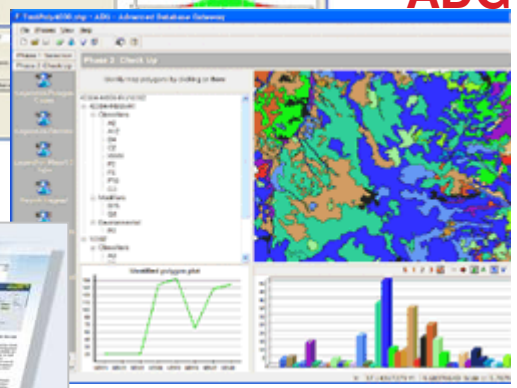
Geovis/Map



Mapping Device-Change Analysis



ADG



GeoNetwork

Tools in the framework of data production / analysis

THEMATIC & CART. ASPECT

INTERPRETATION EFFICIENCY

ACCURACY ANALISYS

MULTI USER DATA BASE BROWSER

Land Cover Class. Syst.

MAD CAT

IMAGE PROCESSING

GeoVIS 2.2

GIS

DATA BASE

MAP 2.2

Map Acc. Prog.

Advanc. Database GATEW.

DATA PRODUCERS

DATA USERS

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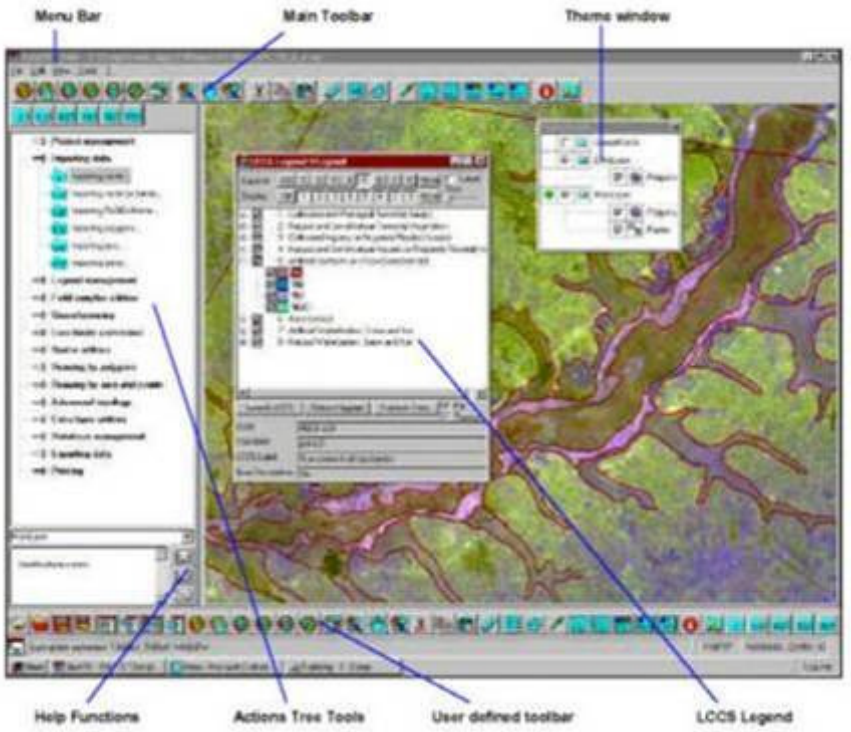
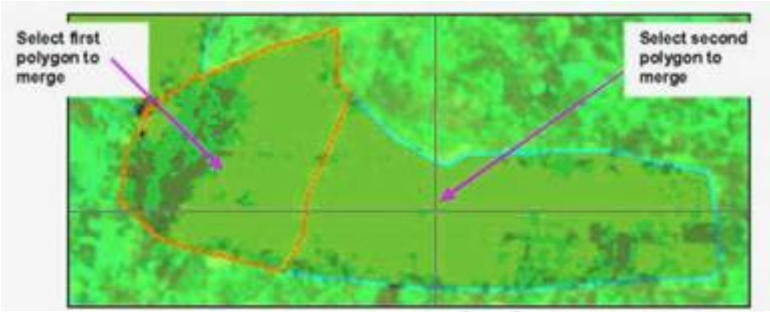
GIS Tools

Geovis

- The Geographical Vector Interpretation System (GeoVis) is a **vector-based editing system** specifically designed for thematic interpretation. I
- It facilitates and speeds up all mapping activities based on remote sensing data.
- It is very user-friendly and embeds powerful vector drawing and editing functions.
- It has a direct link with LCCS.





GIS Tools

Mapping Device – Change Analysis Tool

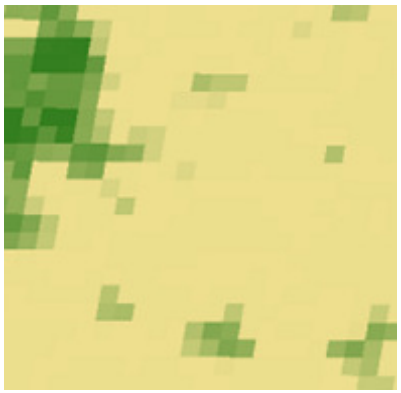
- Application designed by FAO
- Uses object-base classification
- Current version 3.1.1 – Release March 2009
- Wizard driven installation
- Implemented using .Net Framework
- Requires Windows XP / Vista
- Free to use for FAO programmes
- One time activation needed:
  - Institution, User Name, Address, PC CODE
  - send request by email
- Automated online updates / notification

Mapping Device Change Analysis Tool

- A stand-alone, interactive and completely integrated application for mapping, change detection, editing, validating and reporting
- Graphical interface and testing environment; editing tools
- Interactive analysis and visualization of results, User friendly, intuitive, easy to use interfaces, Embedded analysis engine
- Direct link with LCCS
- Supports large datasets and batch macro editing
- Built-in reporting capabilities

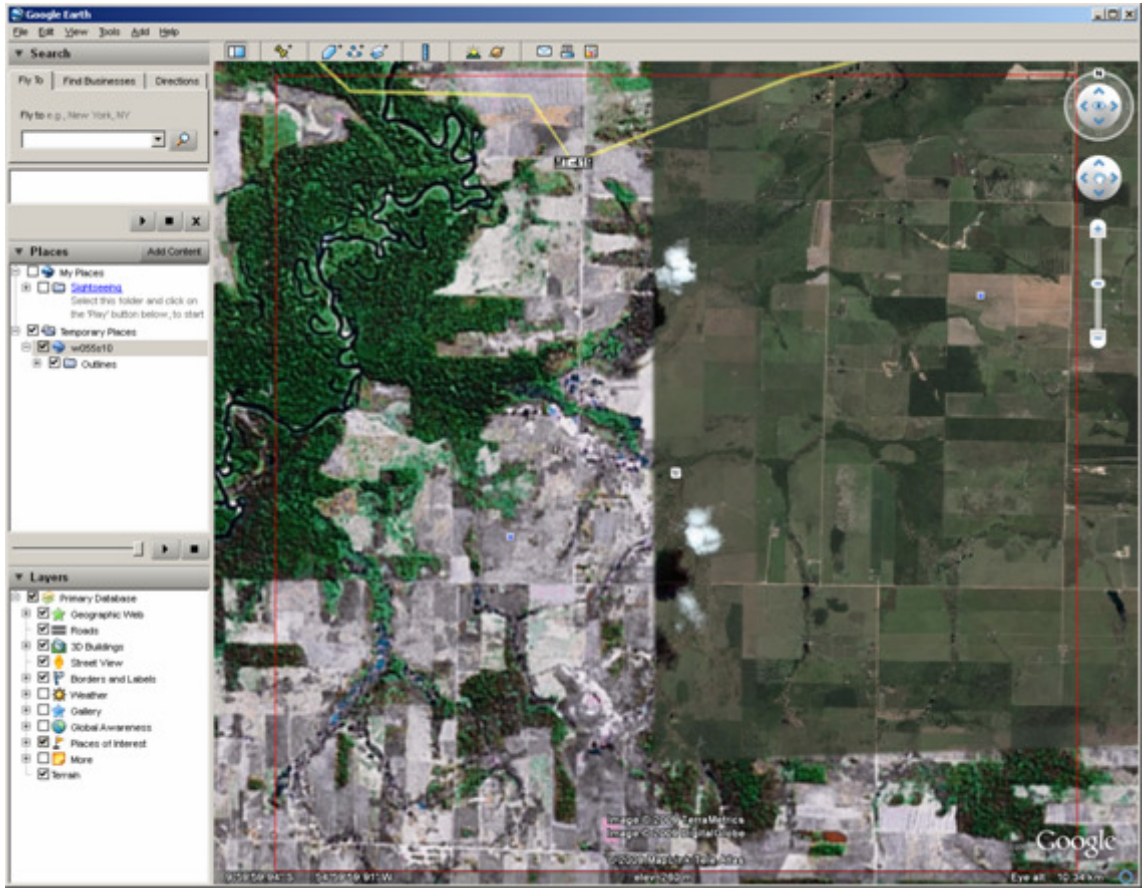
Application of the software

Location: 10° S; 55° W
South America; **Brazil** (Mato Grosso)
Average **Elevation** ~ 300 m
Tropical & Subtropical Moist Broadleaf Forests biome
Moist Tropical, winter dry



Tree canopy cover

0% 100%



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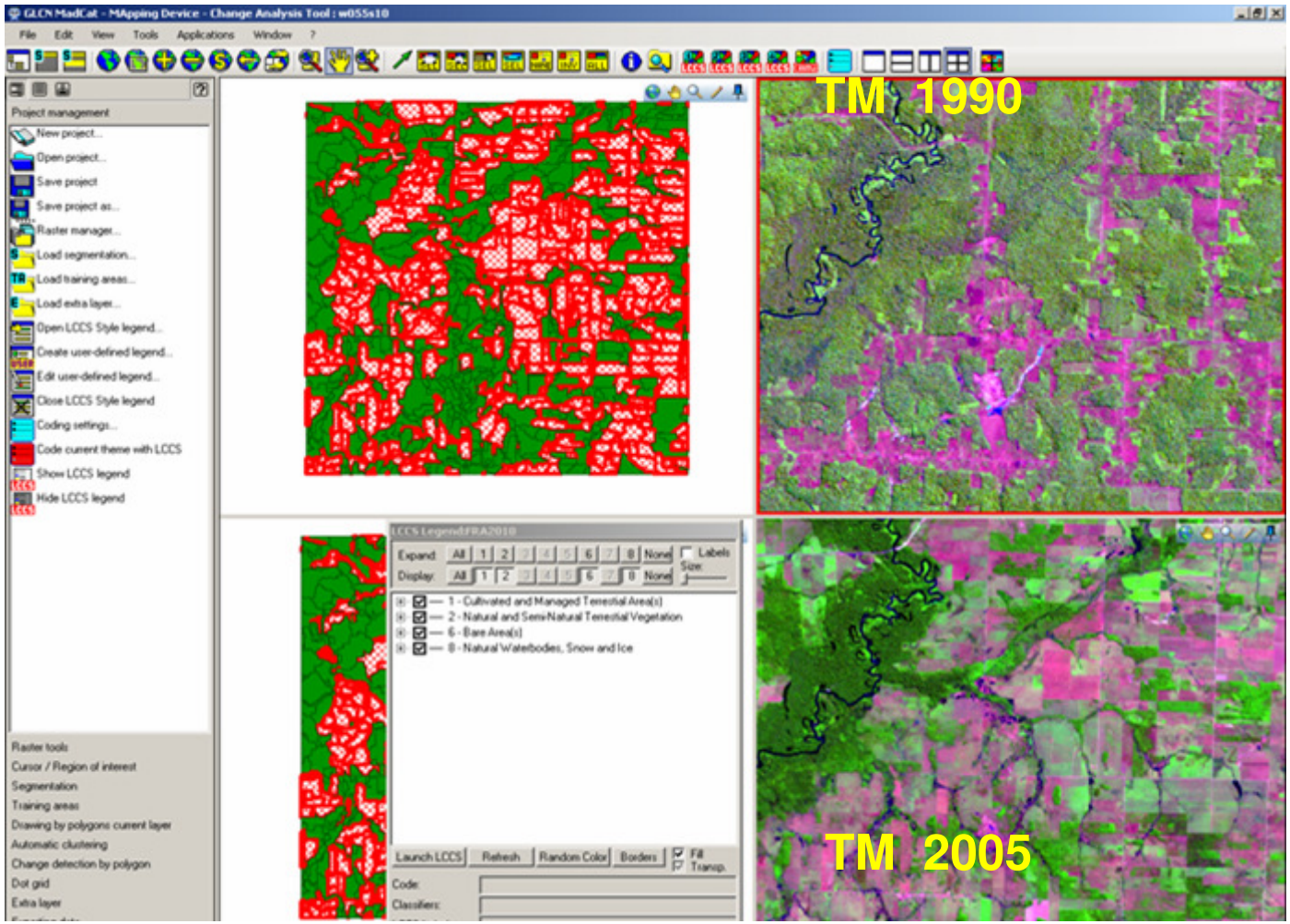
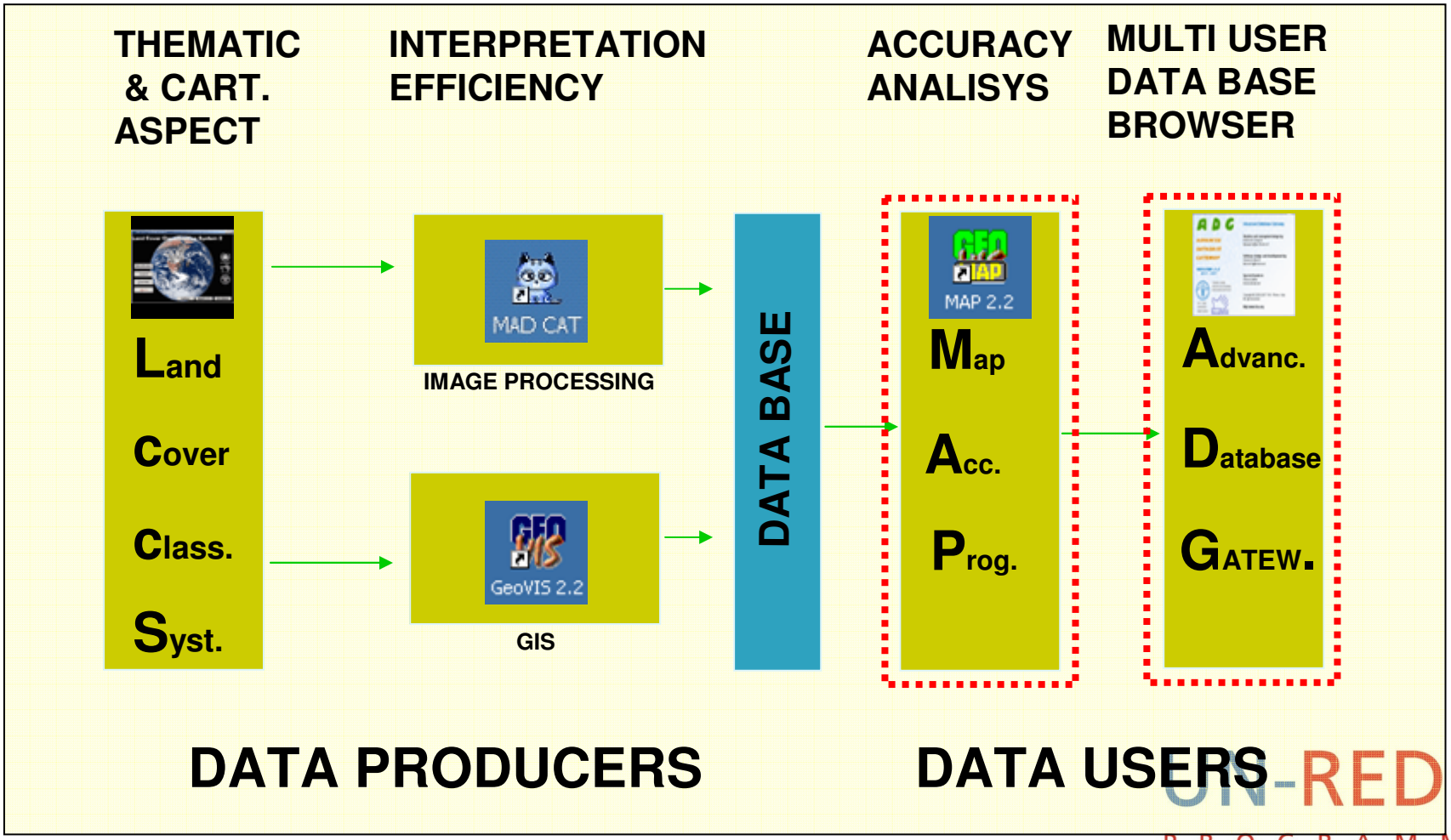
Changes 1990 - 2005



Tools in the framework of data production / analysis



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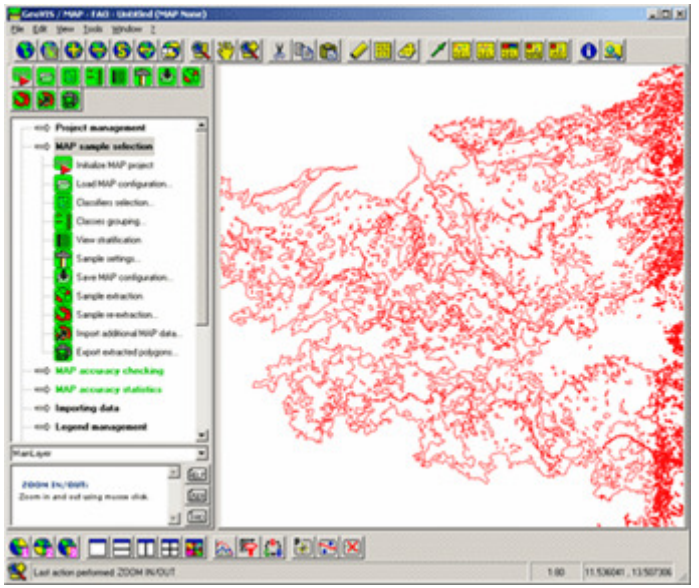
GIS Tools

Mapping Accuracy Program (MAP)

- GeoVis comes with MAP, a statistical program that allows the automatic calculation of the thematic mapping accuracy using different methods and different expected level of statistical confidence.
- It is used to estimate the accuracy of land cover data sets with an LCCS legend.



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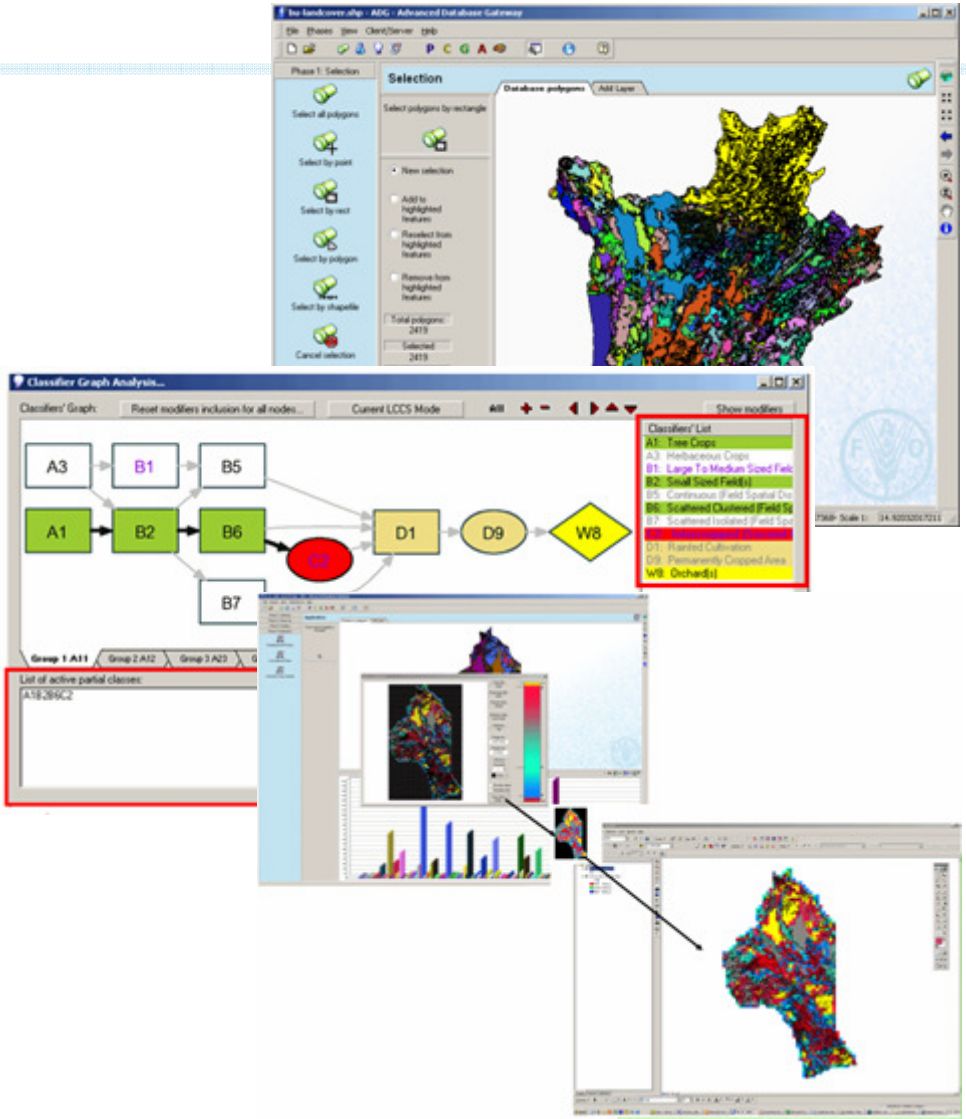
GIS Tools

Advanced Database Gateway (ADG)

- ADG is a cross-cutting interrogation software that allows the easy and fast recombination of land cover polygons according to the individual end-user requirements.
- Polygons from data sets with an LCCS legend can be aggregated at the level of classifiers.
- New classes can be created and stored.



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GIS services

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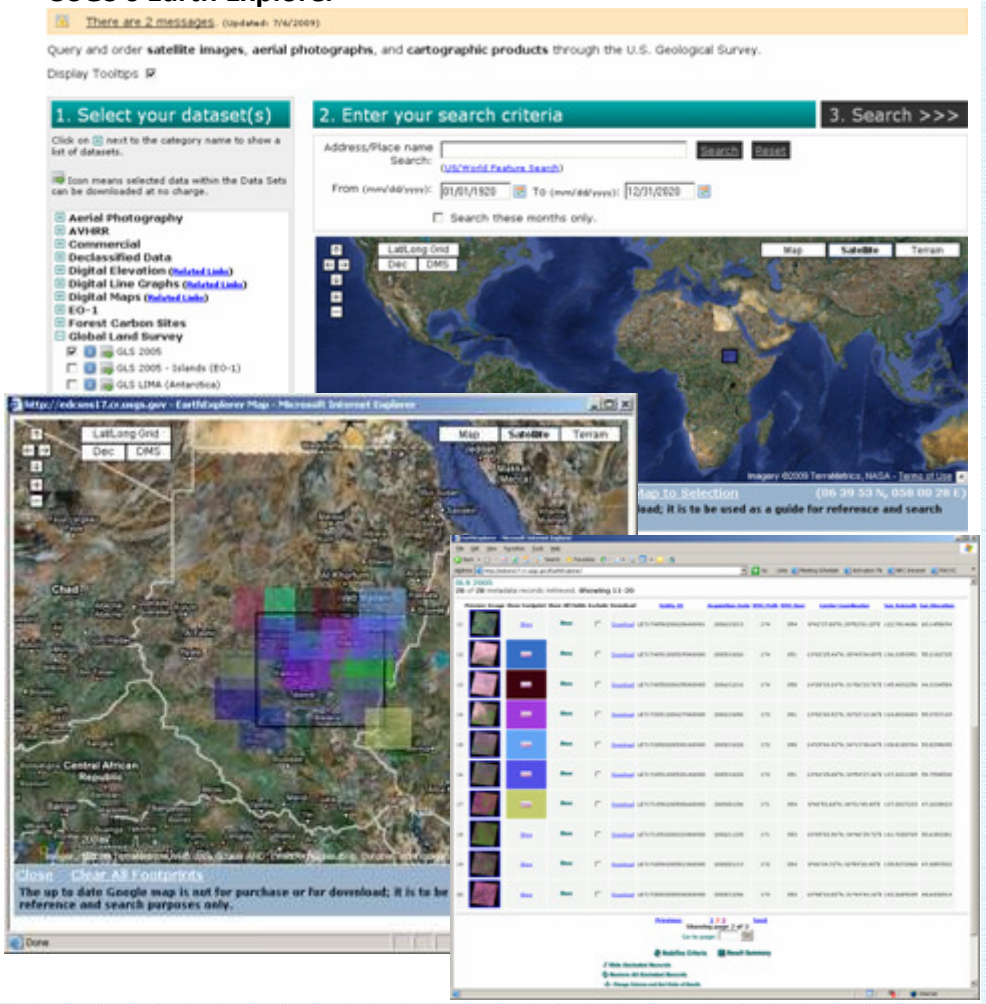
GIS Services

Programme needs...

1. Decentralized and secure mechanism for sharing and exchanging data, including **satellite images**, maps and related statistics.
2. Technologies based on the International Standards Organization (ISO) and Open Geospatial Consortium (OGC) standards.
3. Flexible development environment to easily meet end-user needs and project requirements.

USGS's Earth Explorer



GIS Services

FAO Geonetwork Opensource

- GeoNetwork opensource was developed by FAO, WFP and UNEP
- **Provides WEB access to metadata, spatial data and interactive maps.**
- Adopts a modern architecture based on the principles of Free and Open Source Software (FOSS) and International and Open Standards for services and protocols.
- A number of International agencies (WFP, OCHA, CGIR, ESA, etc..) have adopted this technology for their data and information dissemination strategy.

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FAO implementation of GeoNetwork opensource

FAO Metadata Catalogue *portal*

- GeoNetwork engine has been used to implement the largest spatial data repository in the FAO Headquarter.
- **Stores almost 7000 records (more than 4000 local).**
- It is maintained by FAO and its partners.
- Accessible at: *http://www.fao.org/geonetwork/*

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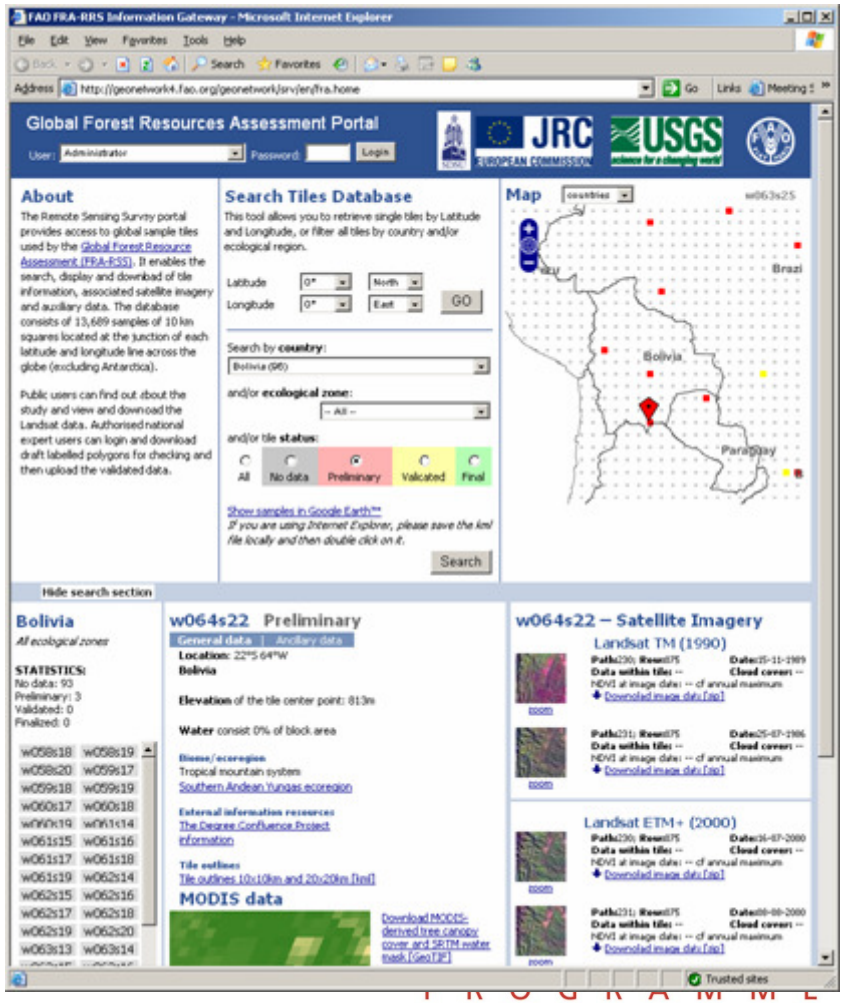
FAO implementation of GeoNetwork opensource

FRA-Remote Sensing Survey *portal*

- GeoNetwork is also the engine of the new FRA-Remote Sensing Survey information management system.
- Centered around the 13689 tiles (10x10 km) distributed world wide at each degree intersection.
- Tile data and information is **retrieved**, **downloaded** and analyzed.
- The system manages **ancillary data**, allows **remote uploads**, and is administrated through **user accounts**.
- More details will be given during a following presentation.



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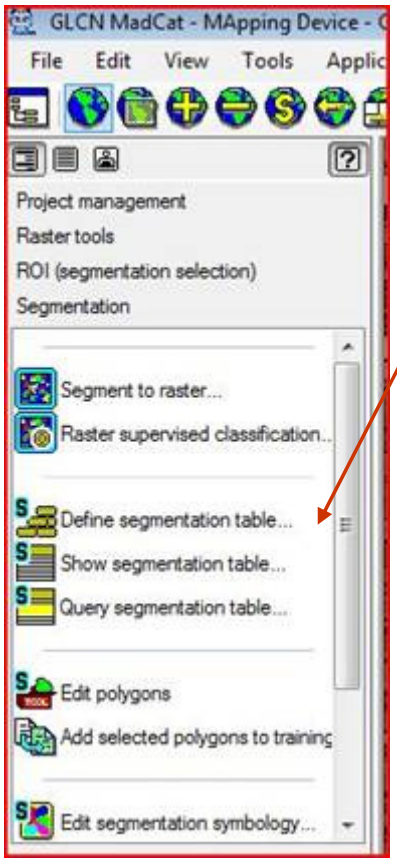
Thank you for listening!

Main functionality

- **Multiple window** editing environment, synchronized and un-synchronized window visualization and multiple band combination
- Multivariate raster **segmentation**
- **Raster** bands arithmetic and normalization
- **Automatic object based classification** using Minimum Distance, Maximum Likelihood and ISODATA
- **Smart labelling** of objects of interest based on few user defined samples
- Semi-automated pixel based **change detection**,
- **Pattern recognition** filters, Cross Correlation Analysis
- **Dot Grid** analysis
- **Reporting**

Editing tools



Tools for Table Attribute Management

Define segmentation Table

Show segmentation Table

Query

Edit Polygons

Tools to edit polygons:

Add, Split, Merge, Delete

Eliminate, Dissolve

topologically

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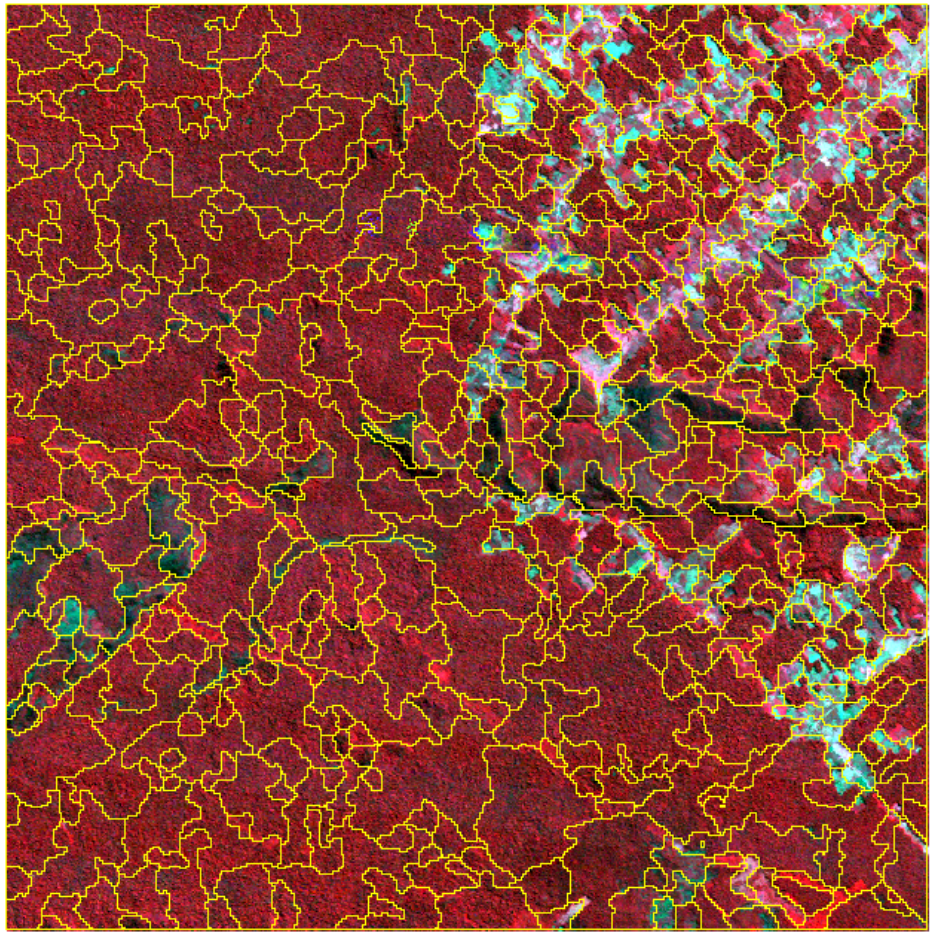
Segmentation



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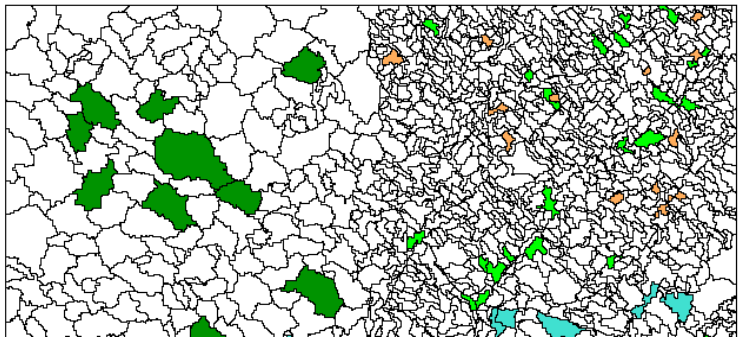
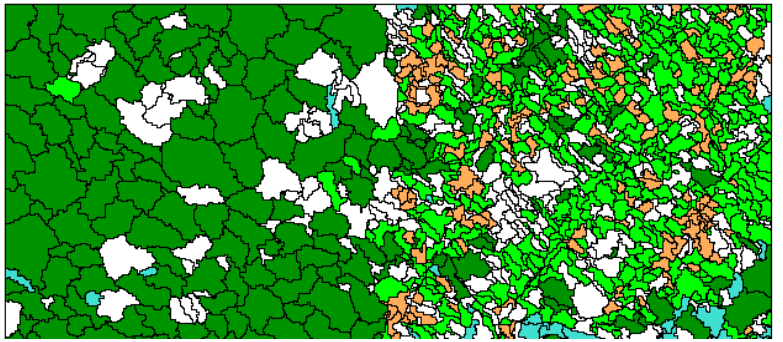
Smart labelling



A segmentation with only few polygons labelled



Labels automatically assigned to similar polygons

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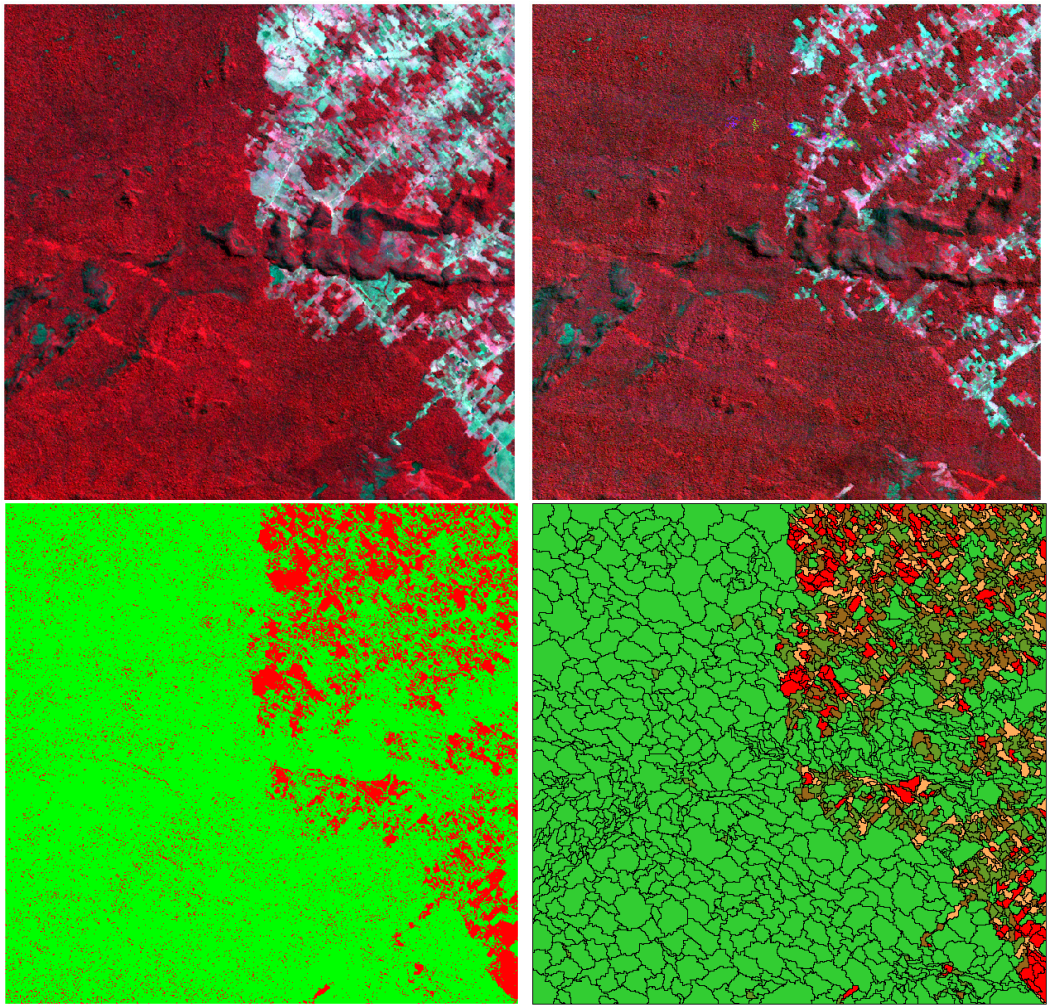
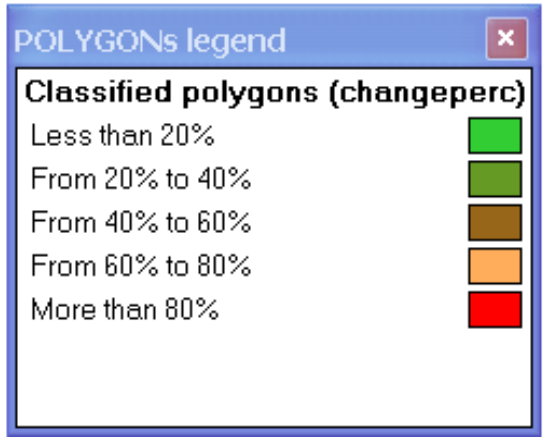
Change rating





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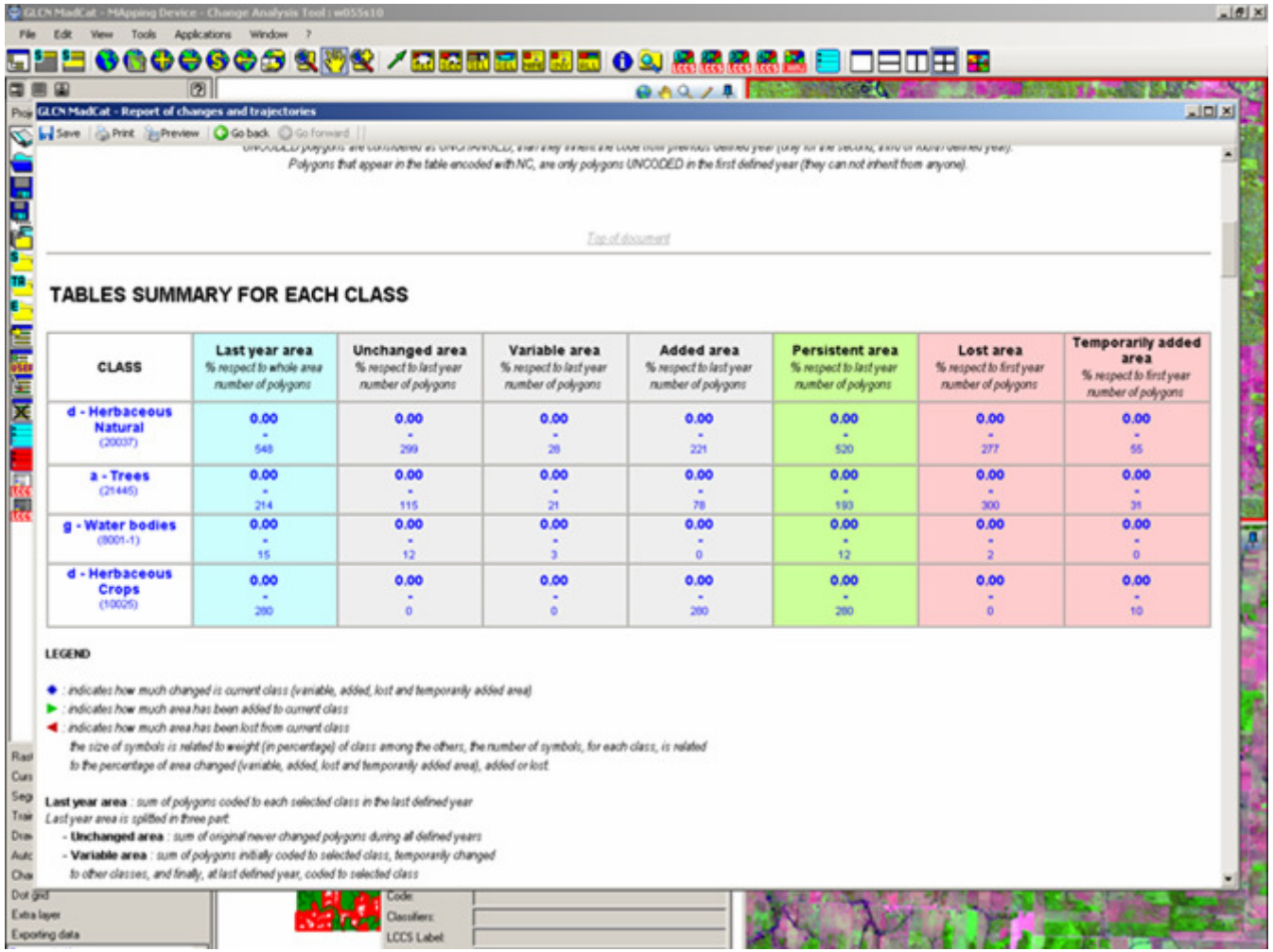
Report of changes



GLCN MadCat - Report of changes and trajectories

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Polygons that appear in the table encoded with NC, are only polygons UNCODED in the first defined year (they can not inherit from anyone).

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TABLES SUMMARY FOR EACH CLASS

CLASS	Last year area % respect to whole area number of polygons	Unchanged area % respect to last year number of polygons	Variable area % respect to last year number of polygons	Added area % respect to last year number of polygons	Persistent area % respect to last year number of polygons	Lost area % respect to first year number of polygons	Temporarily added area % respect to first year number of polygons
d - Herbaceous Natural (20037)	0.00 - 548	0.00 - 299	0.00 - 28	0.00 - 221	0.00 - 520	0.00 - 277	0.00 - 55
a - Trees (21445)	0.00 - 214	0.00 - 115	0.00 - 21	0.00 - 78	0.00 - 193	0.00 - 300	0.00 - 31
g - Water bodies (8001-1)	0.00 - 15	0.00 - 12	0.00 - 3	0.00 - 0	0.00 - 12	0.00 - 2	0.00 - 0
d - Herbaceous Crops (10025)	0.00 - 280	0.00 - 0	0.00 - 0	0.00 - 280	0.00 - 280	0.00 - 0	0.00 - 10

LEGEND

- : *indicates how much changed is current class (variable, added, lost and temporarily added area)*
- : *indicates how much area has been added to current class*
- : *indicates how much area has been lost from current class*

the size of symbols is related to weight (in percentage) of class among the others, the number of symbols, for each class, is related to the percentage of area changed (variable, added, lost and temporarily added area), added or lost.

Last year area : *sum of polygons coded to each selected class in the last defined year*
Last year area is splitted in three part:
- **Unchanged area** : *sum of original never changed polygons during all defined years*
- **Variable area** : *sum of polygons initially coded to selected class, temporarily changed to other classes, and finally, at last defined year, coded to selected class*

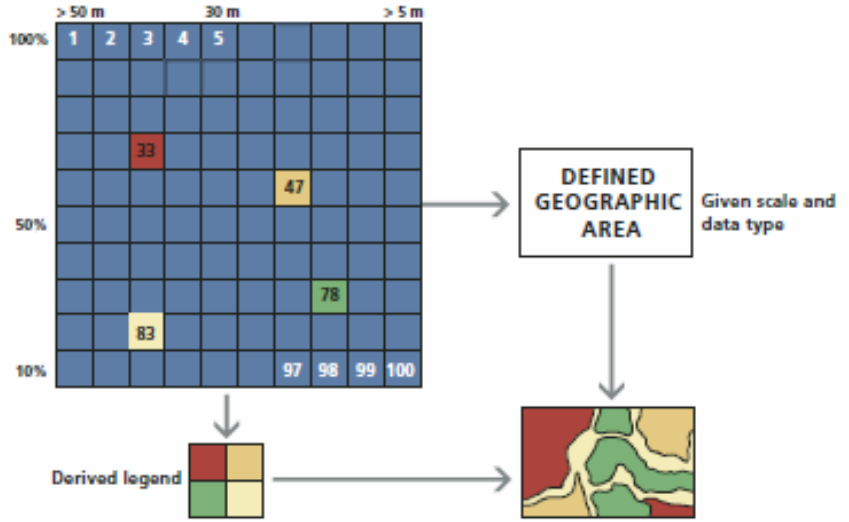
Code:
Classifiers:
LCCS Label:

Classification and legend

A **classification** describes the framework with the names of the classes and the criteria used to distinguish among them.

The **legend** is the application of a classification in a specific area using a defined mapping scale and specific data.

FIGURE 2.3
Legend as application of a classification in a particular area



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