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PROGRAMME

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)





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



Land Use

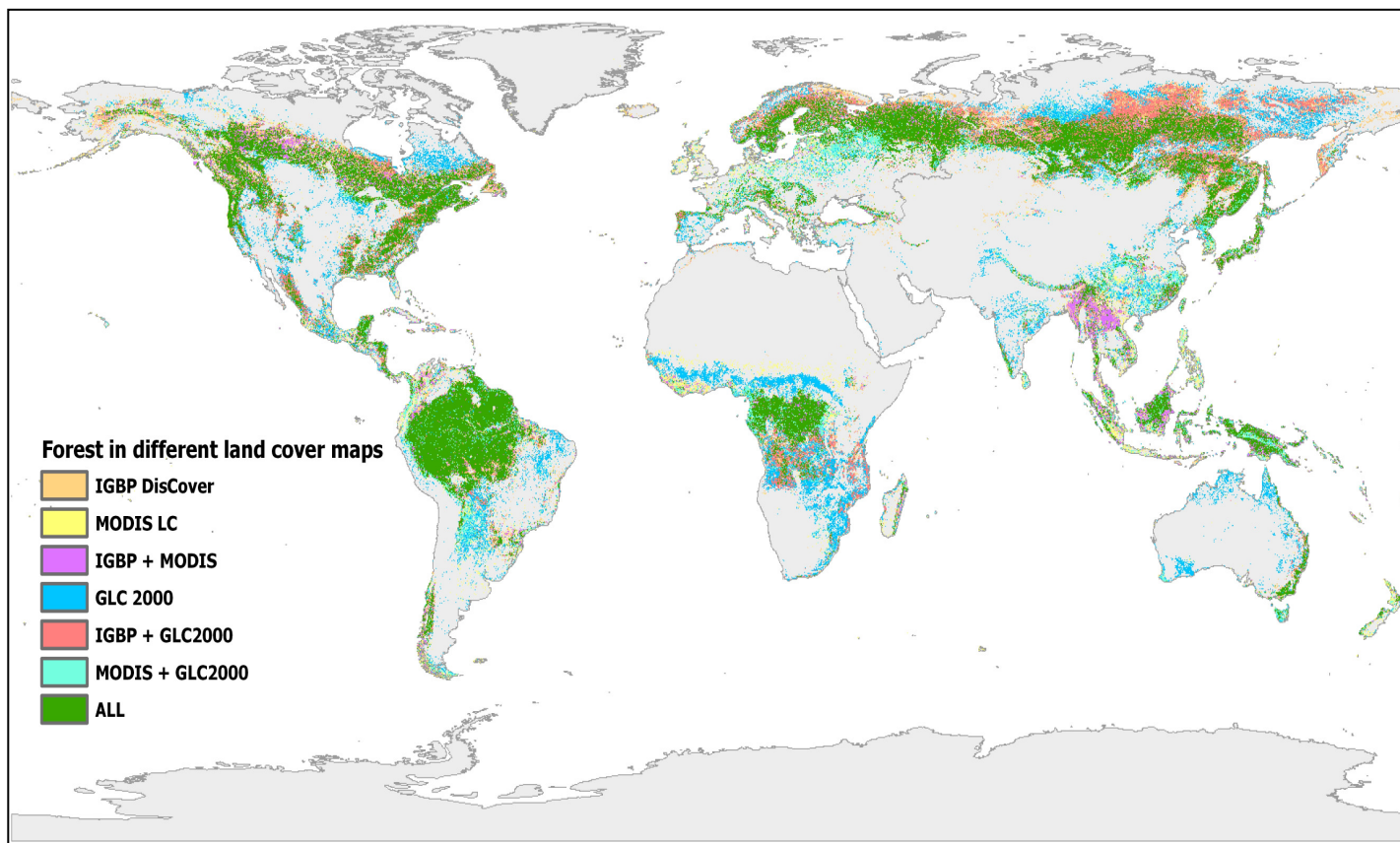
Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce change or maintain it.



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



Forest land in global land cover datasets



Forest definitions:

IGBP legend :

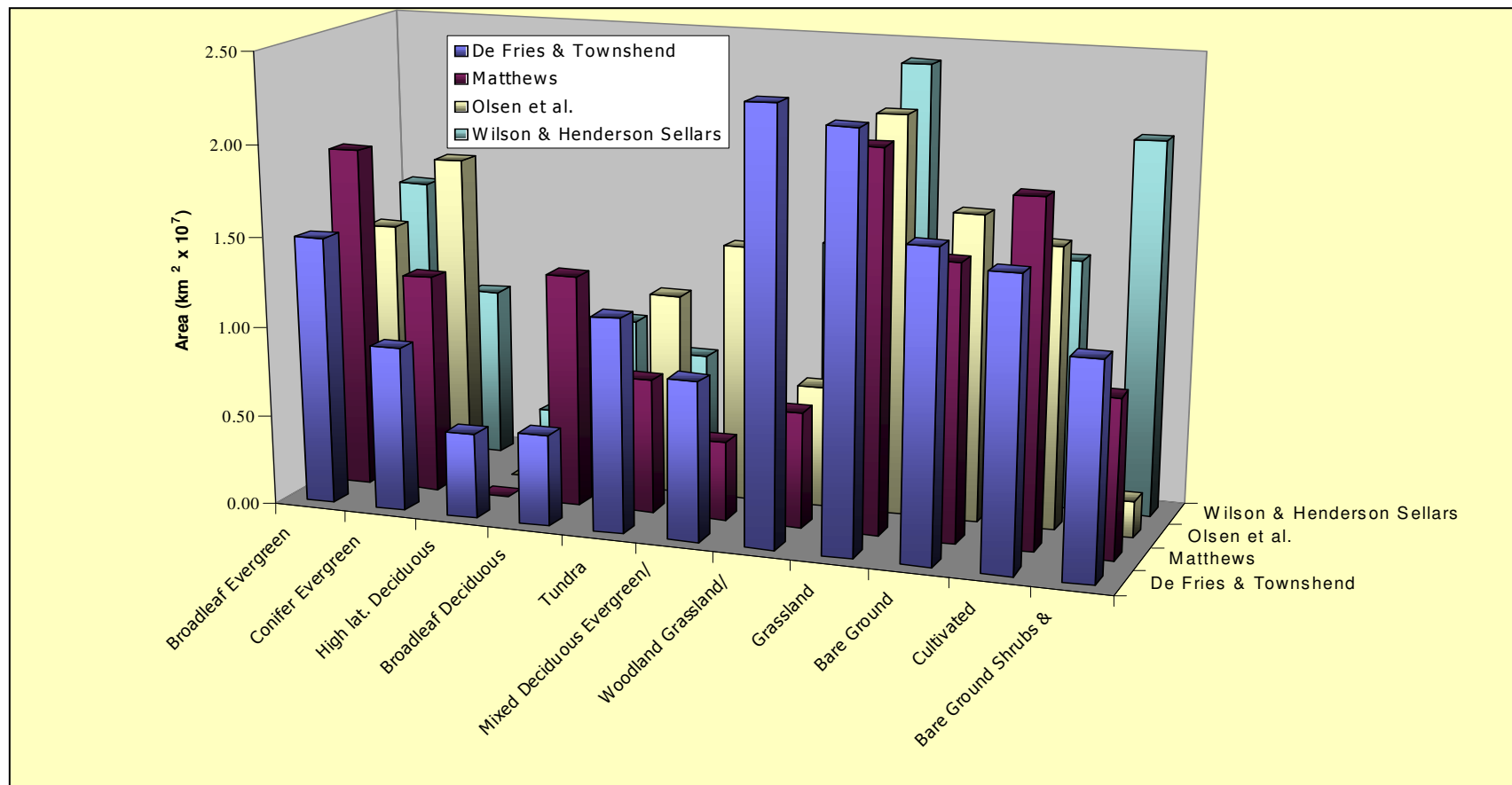
percent tree cover
>60% / tree height
>2m

GLC2000 legend :

percent tree cover
>15% / tree height
>3m



Why do we need standards...?

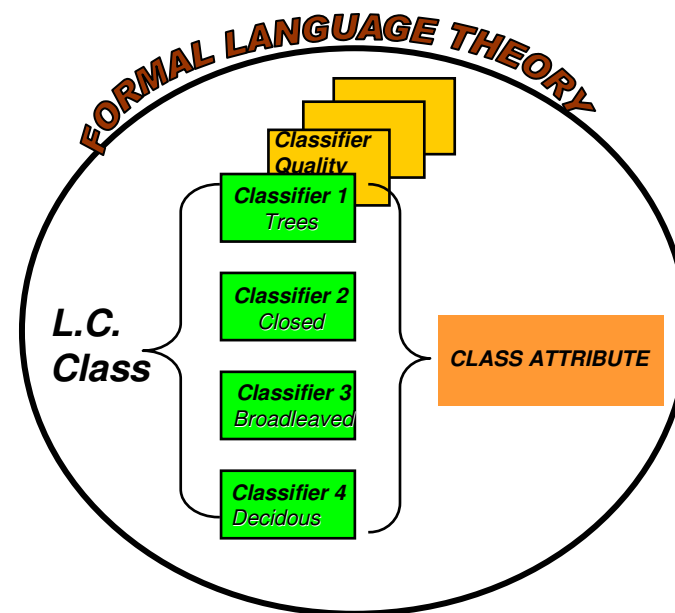


Area estimates: 11 cover types, different global datasets



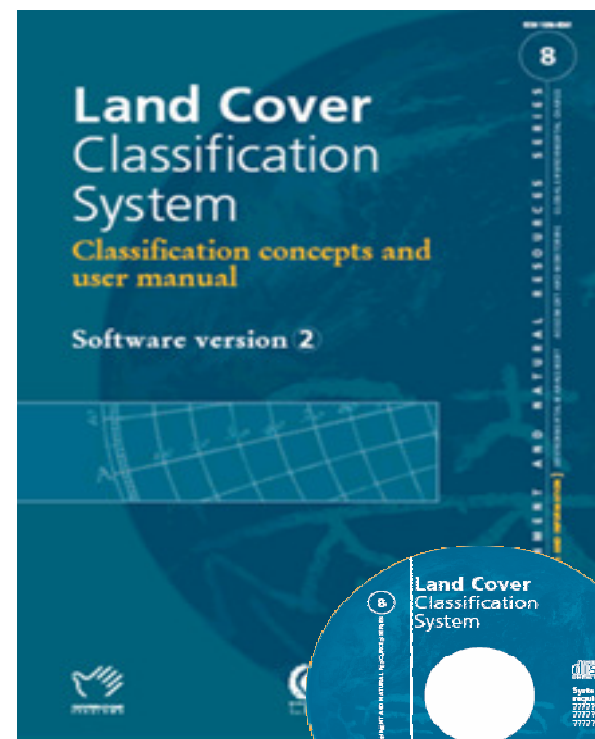
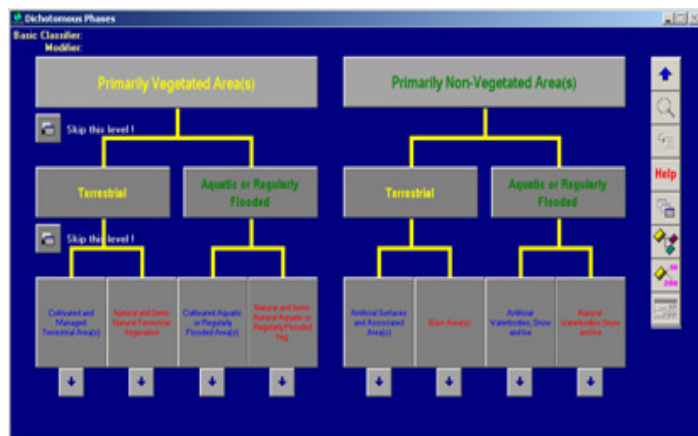
LCCS: basic concepts

- 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)





LCCS resources / software and manuals



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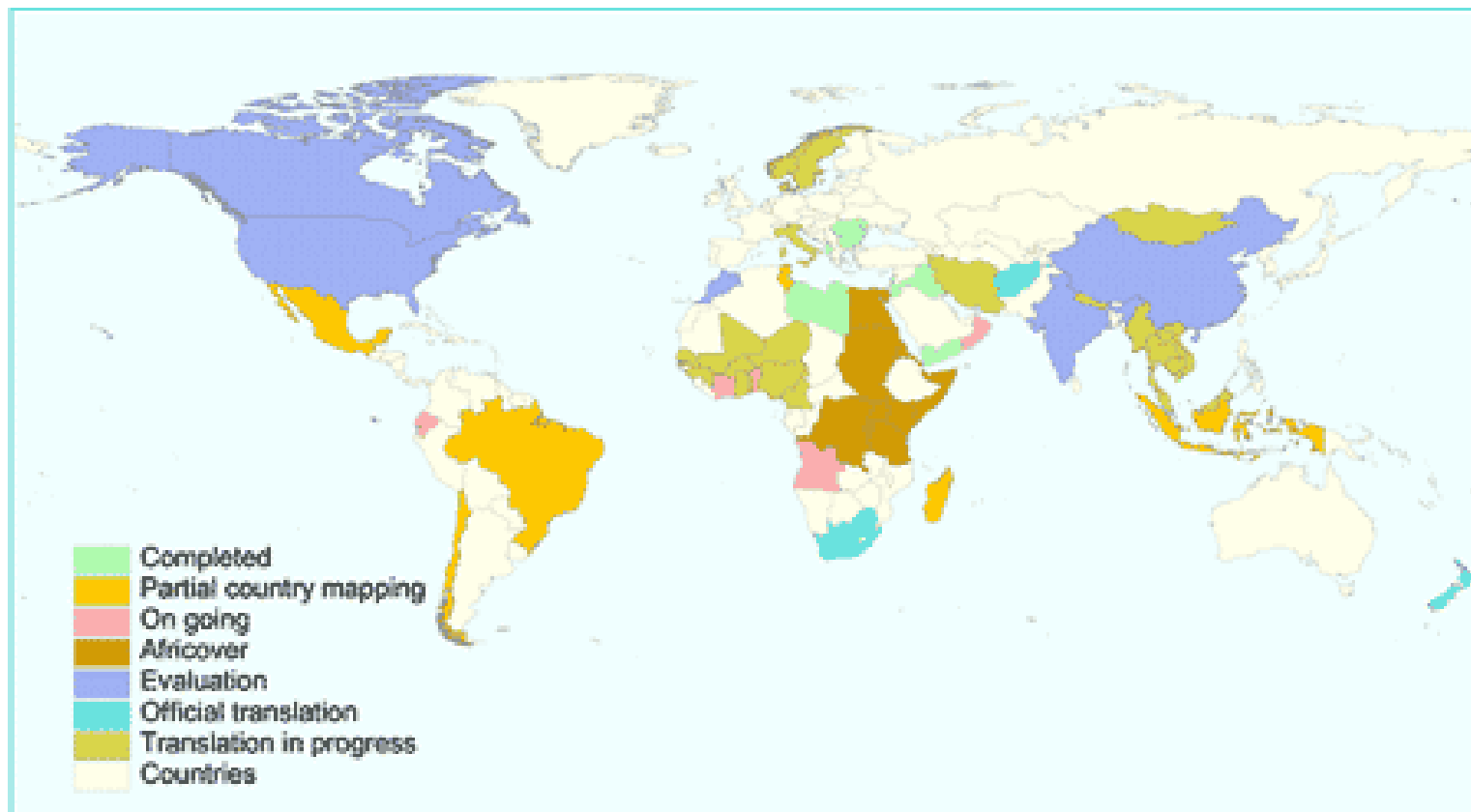
LCCS in the world

- 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 <i>national</i>	COMPLETED <i>sub-national</i>	ON GOING	PLANNED	OFFICIAL	IN PROGRESS	EVAL.
<u>AFRICOVER</u>	Brazil	<u>HYMALAYA</u> <u>region</u>	MEKONG basin	<u>GLC2000</u>	ASIACOVER	Canada
Burundi	Bulgaria	Afghanistan	Cambodia	<u>GLOBCOVER</u>	Burkina Faso	China
<u>DR of Congo</u>	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			
<u>Tanzania</u>		<u>SADC region</u>	Uruguay			
Uganda		Angola				
Albania		Botswana	PROPOSED			
Bulgaria		Lesotho	<u>CAUCASIAN</u>			
Iraq		Malawi	<u>region</u>			
Libyan Arab		Mauritius	Armenia			
Jamahiriya		Mozambique	Rep. of			
Moldova, Rep		Namibia	Azerbaijan			
Oman		South Africa	Georgia			
Senegal		Swaziland	Kazakhstan			
Yemen		Tanzania	Kyrgyzstan			
		Zambia	Tajikistan			
		Zimbabwe	Turkmenistan			
		Cuba	Uzbekistan			
		Ethiopia				
		Morocco				
		Tunisia				
		South Sudan				



LCCS in the world



Distribution of LCCS implementation around the world



LCCS databases

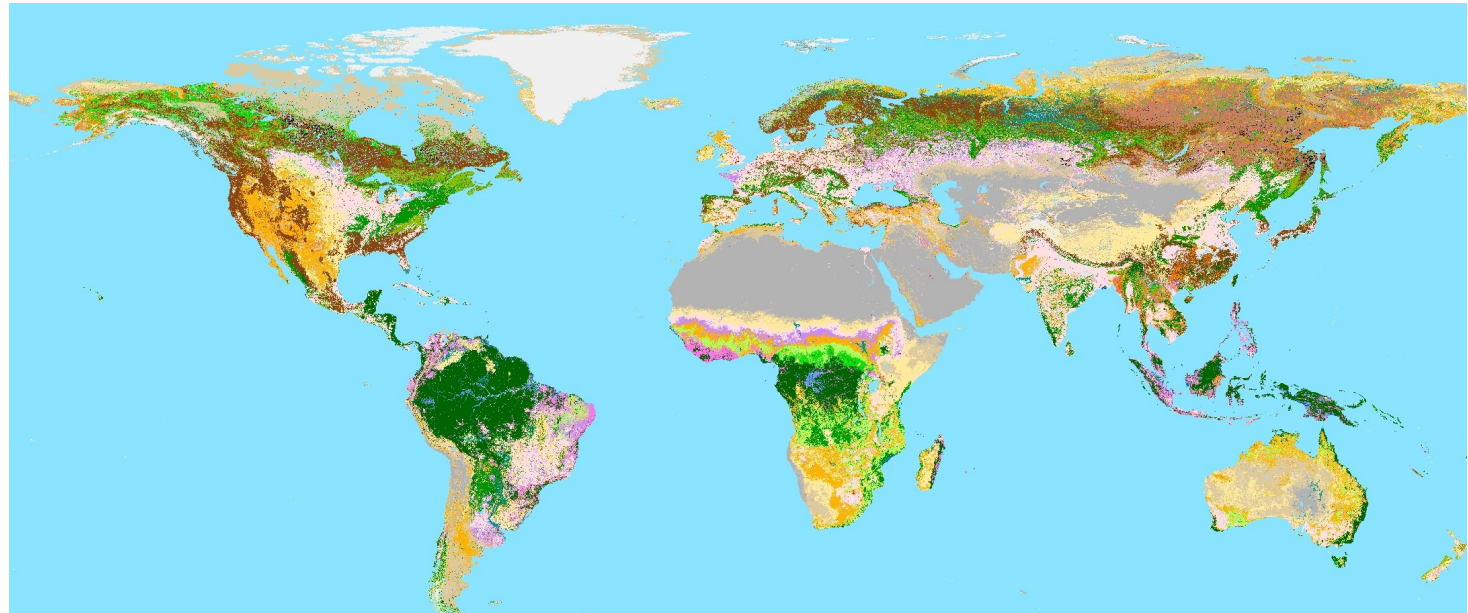
Global Land Cover
(GLC) 2000

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





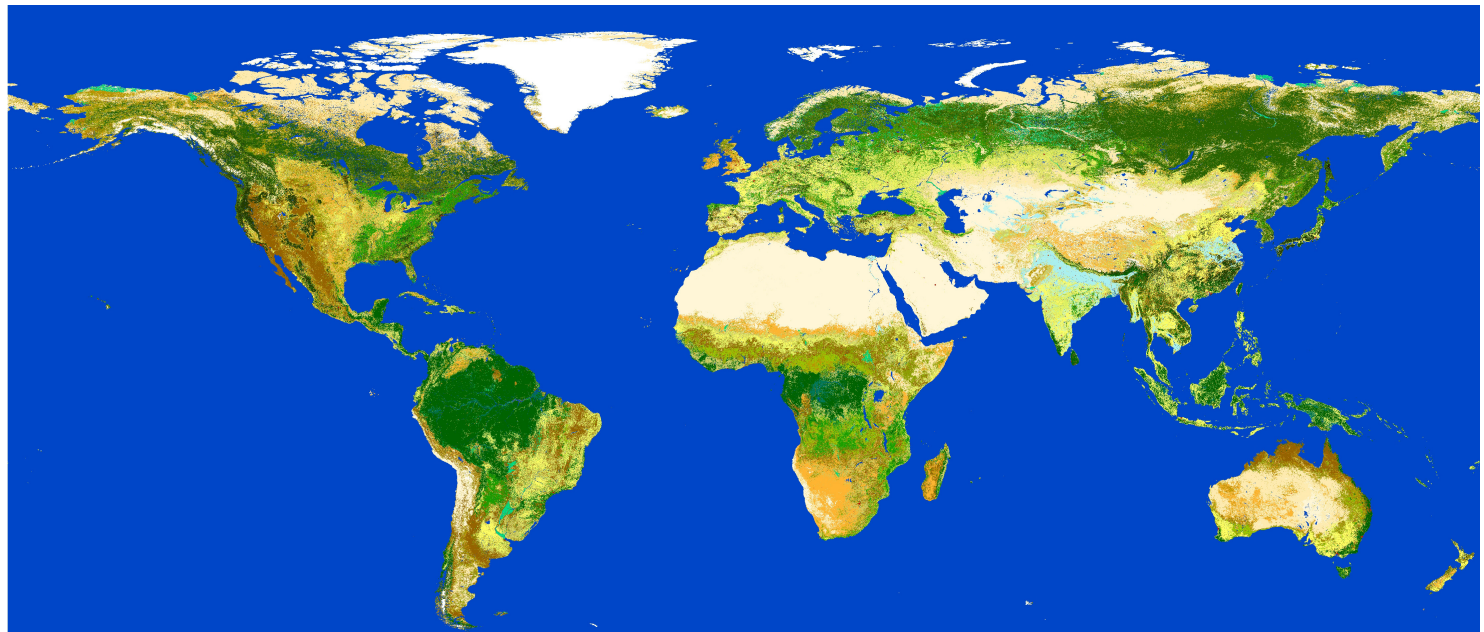
LCCS databases

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**





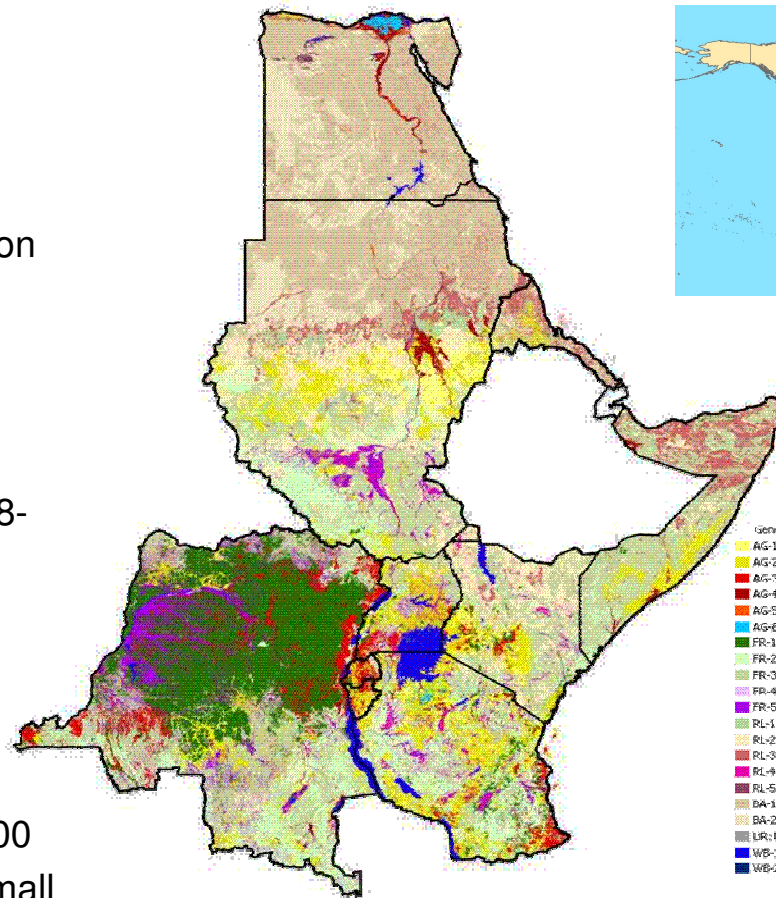
LCCS databases

Africover ~2000

30 m resolution

Facts:

- Mapped area: 2.0 million km²
- 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)



Generalised Land Cover Classes

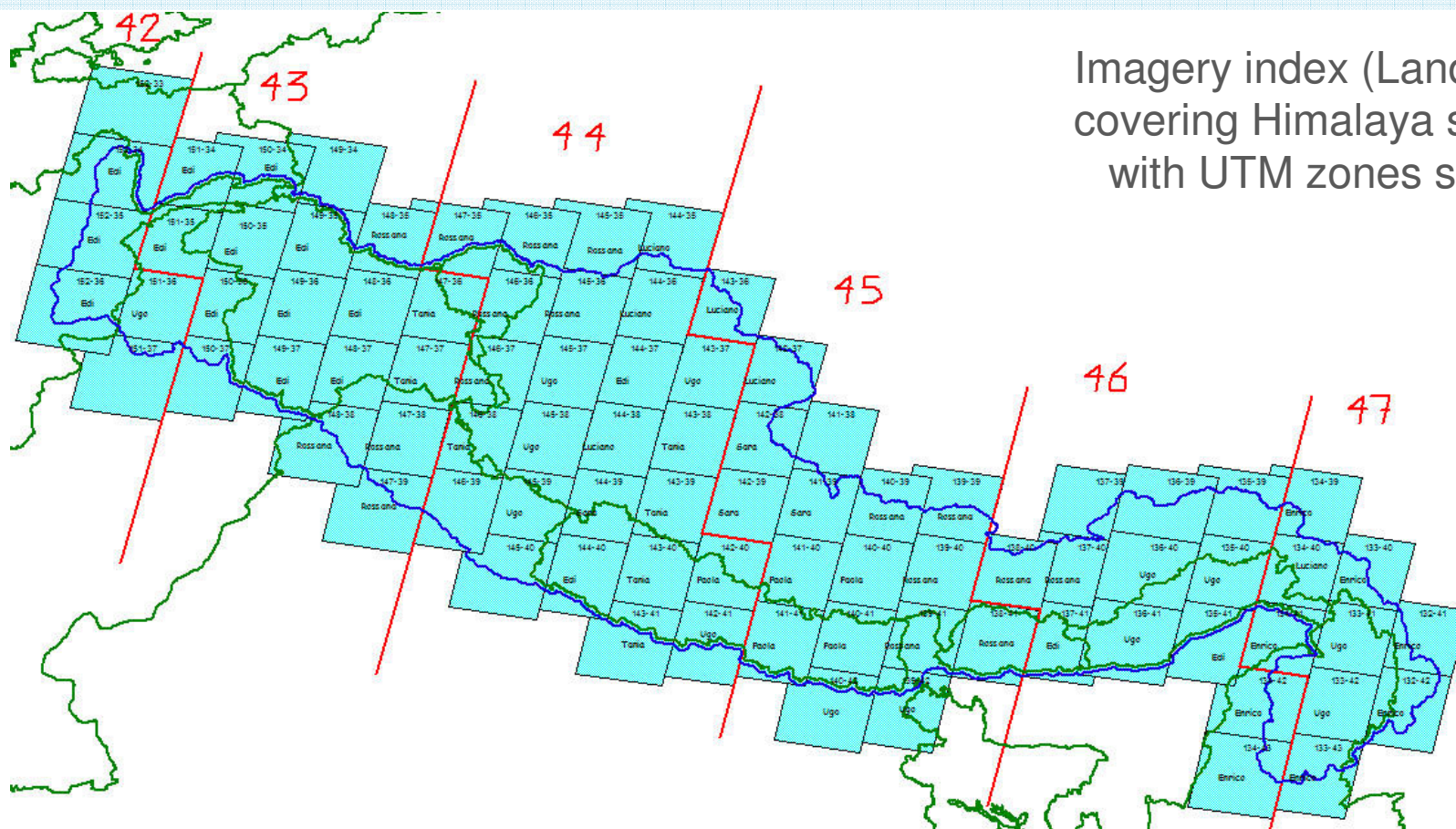
- AG-1: Rainfed herbaceous crops (large to medium)
- AG-2: Rainfed herbaceous crops (small, continuous)
- AG-3: Rainfed shrub crops, tree crops, forests
- AG-4: Irrigated and postflooding herbaceous crops
- AG-5: Irrigated and postflooding shrub crops
- AG-6: Aquatic agriculture
- FR-1: Closed trees
- FR-2: Open to very open trees
- FR-3: Closed to open shrubs and woody vegetation
- FR-4: Aquatic closed to open trees, shrubs and woody vegetation
- FR-5: Aquatic closed to open trees, shrubs and woody vegetation
- RL-1: Open to closed grassland
- RL-2: Tree and shrub savannah
- RL-3: Sparse vegetation
- RL-4: Aquatic closed to open grassland
- RL-5: Aquatic floating forbs (fresh water, ponds)
- BA-1: Bare rock, bare rock with shallow, sand
- BA-2: Loose and shifting sands, bare soil, dunes
- UR: Urban areas
- WB-1: Water (natural and artificial)
- WB-2: Snow



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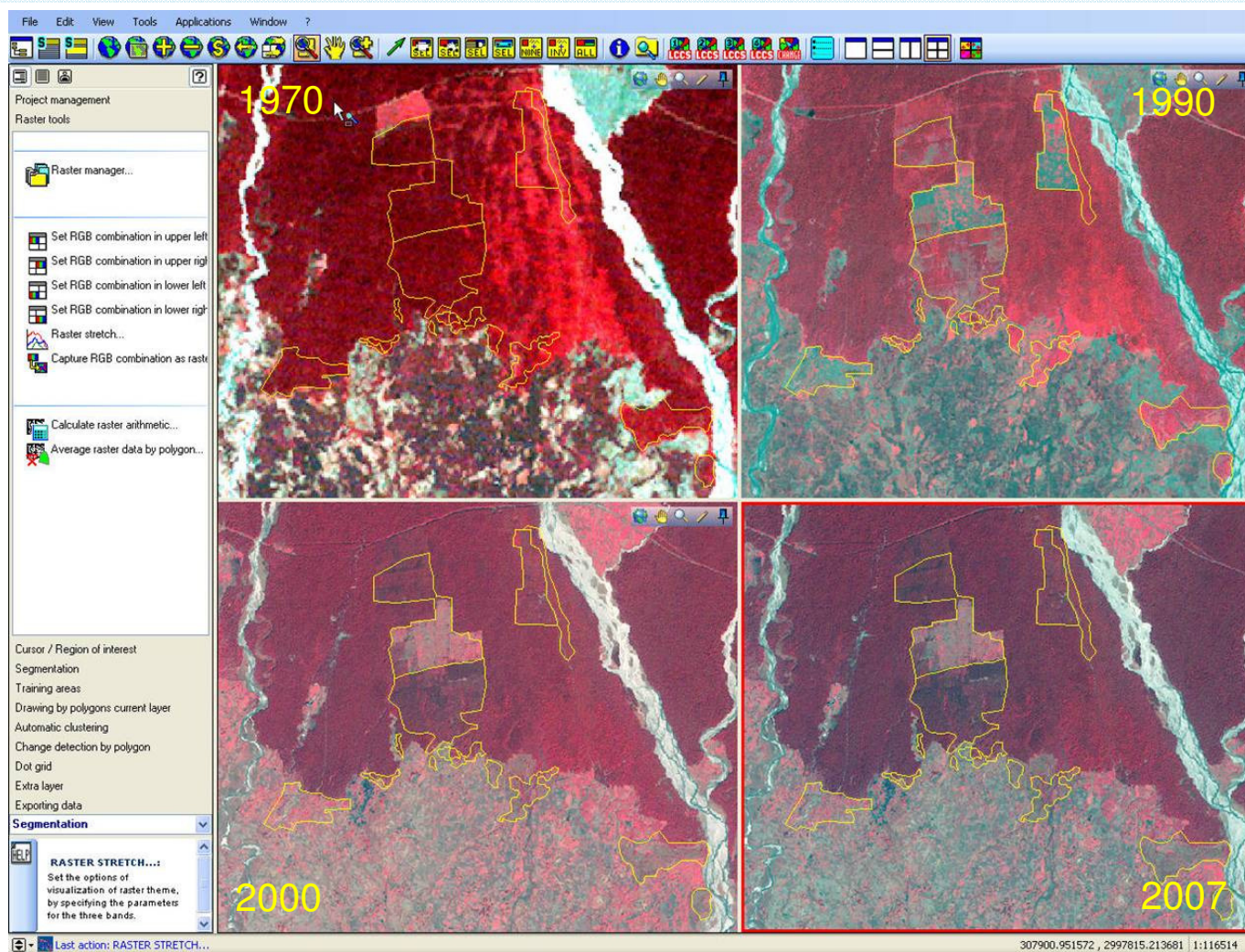
GLCN Regional Harmonization Programme (RHAP): Himalaya



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

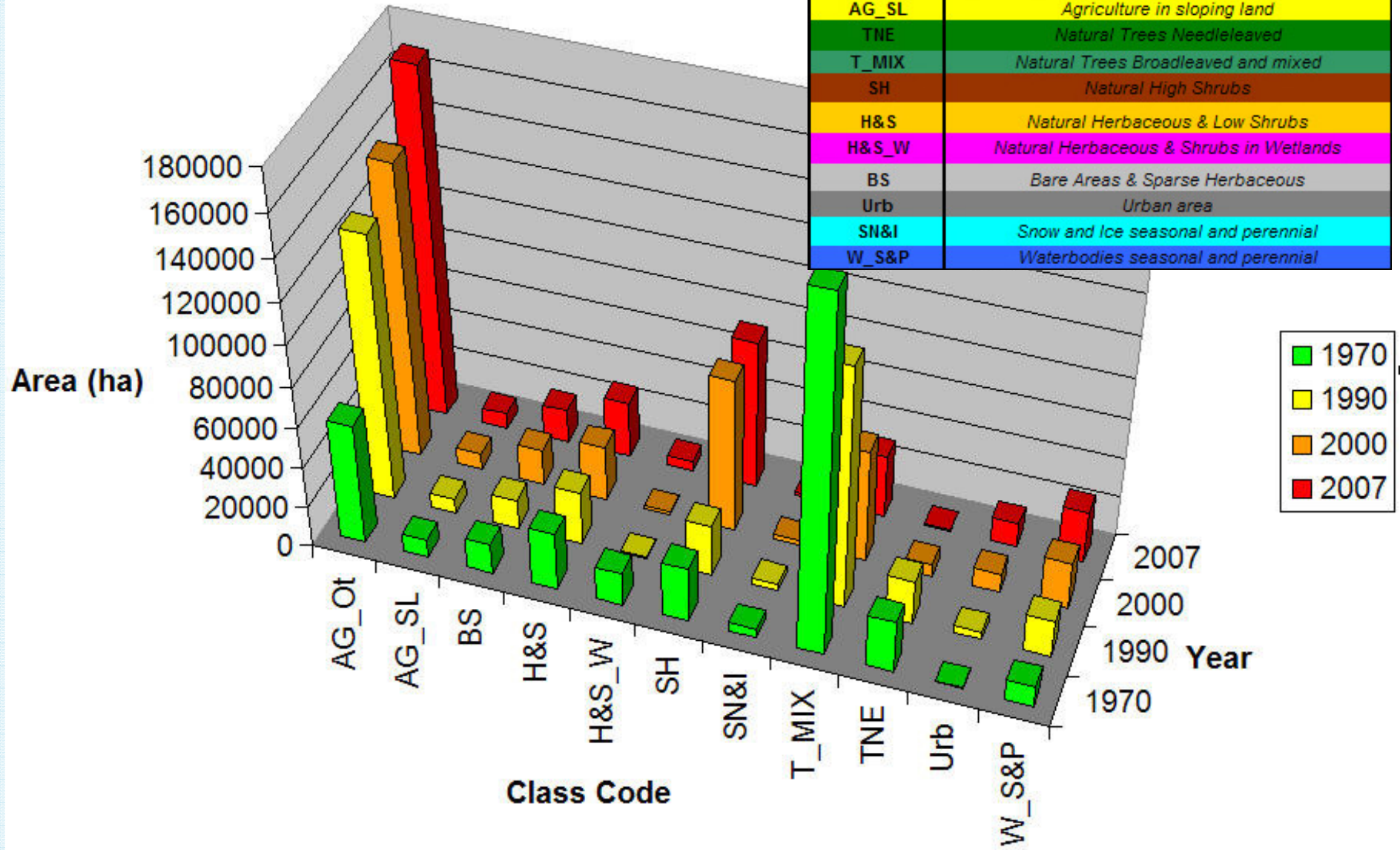


Land cover change mapping



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



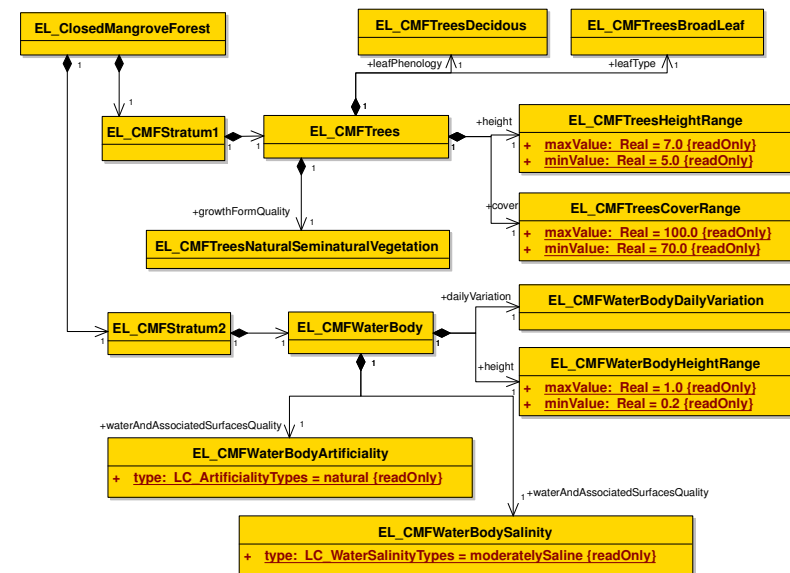


LCCS: towards version 3

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 constraints 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





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

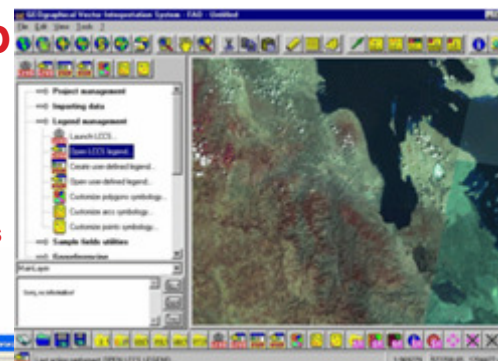




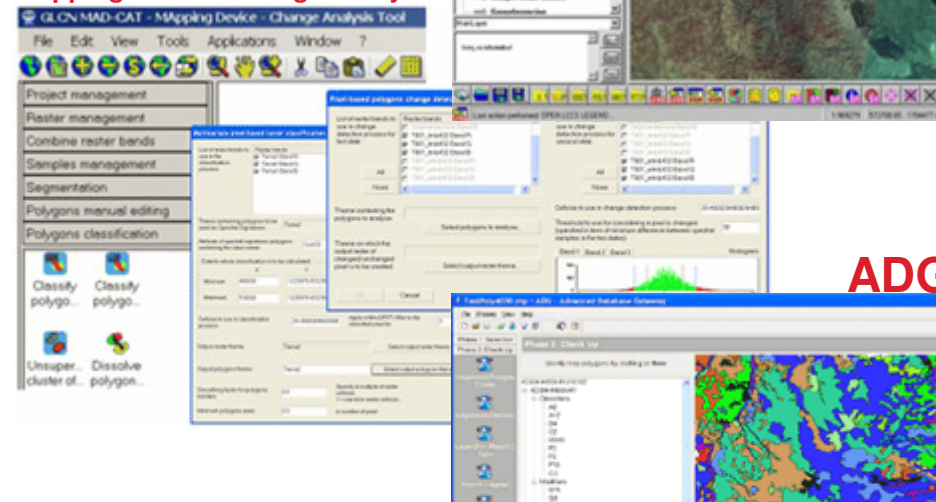
GIS tools and services

- 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



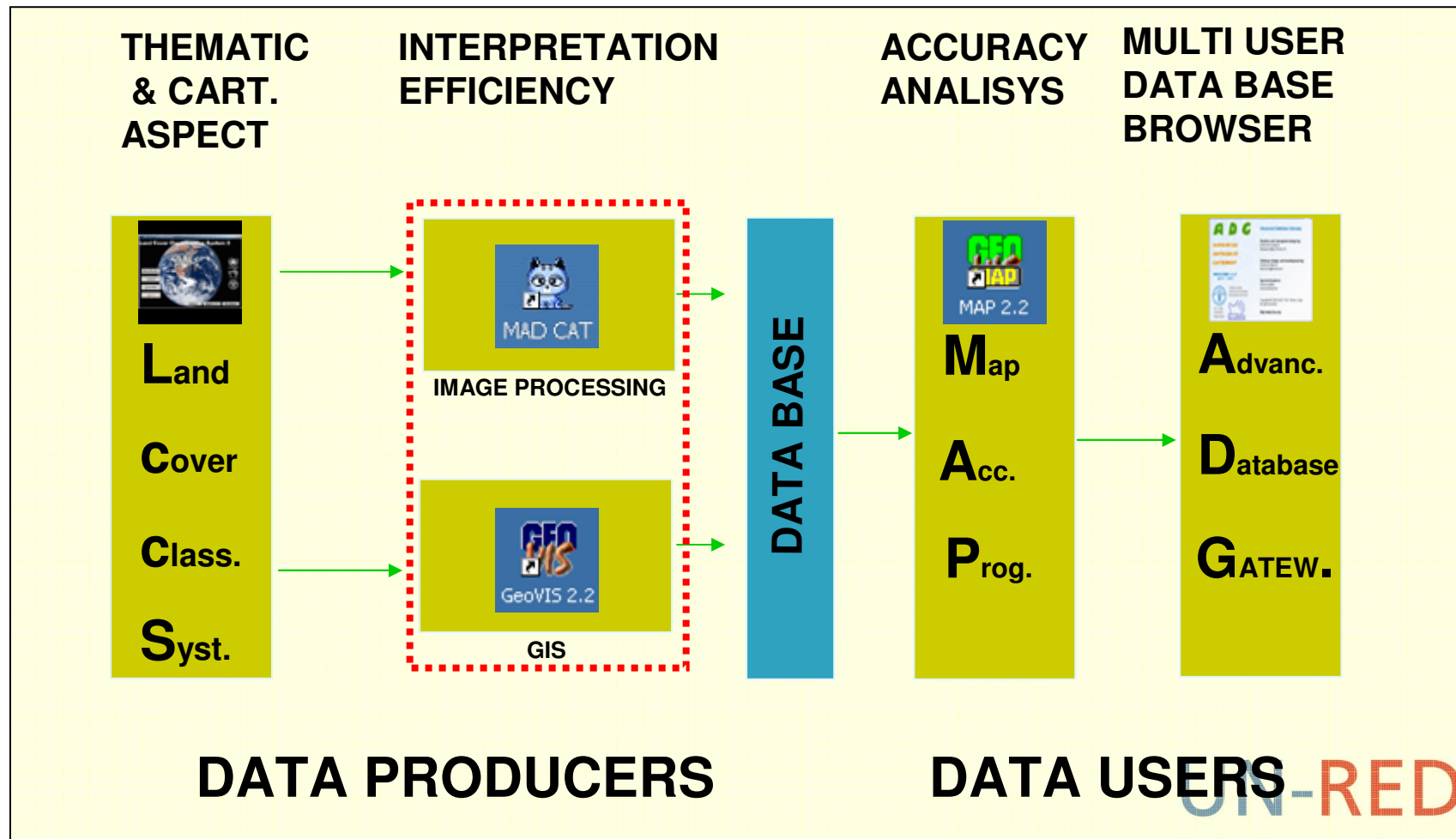
ADG



GeoNetwork



Tools in the framework of data production / analysis

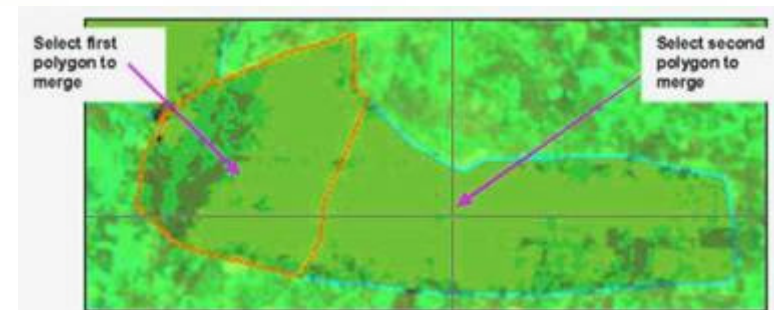
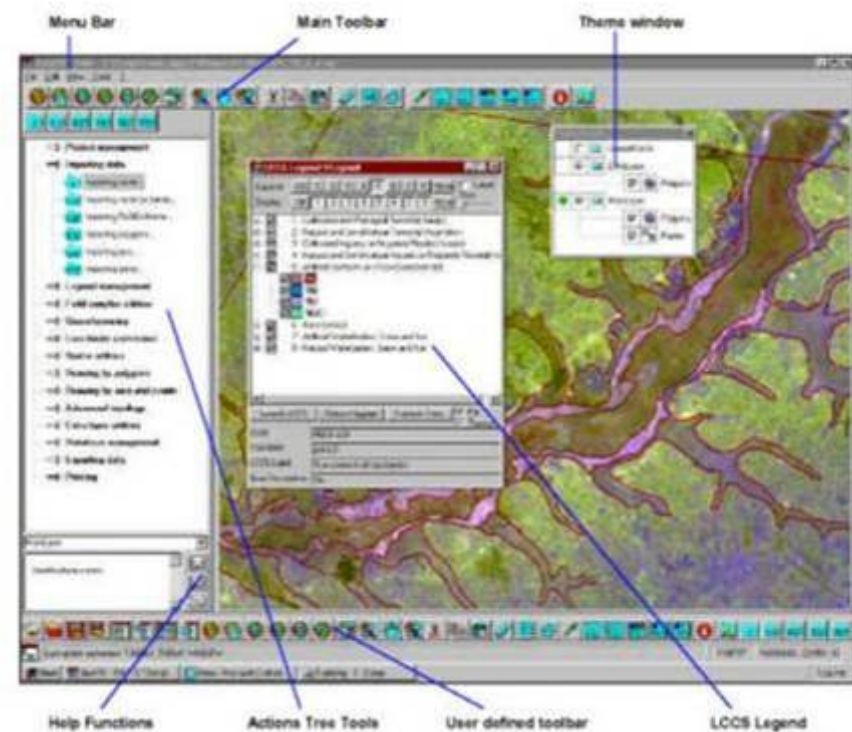




GIS Tools

Geovis

- The Geographical Vector Interpretation System (GeoVis) is a **vector-based editing system** specifically designed for thematic interpretation.
- 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

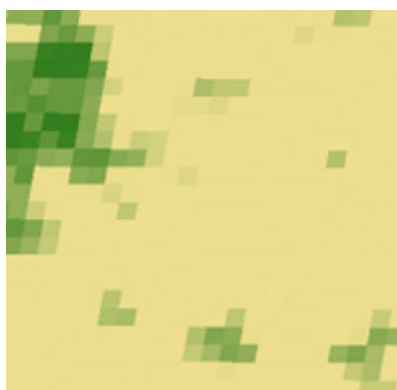




Application of the software

Location: 10° S; 55° W
South America; Brazil (Mato Grosso)

Average **Elevation** ~ 300 m
Tropical & Subtropical Moist Broadleaf Forests biome
Moist Tropical, winter dry

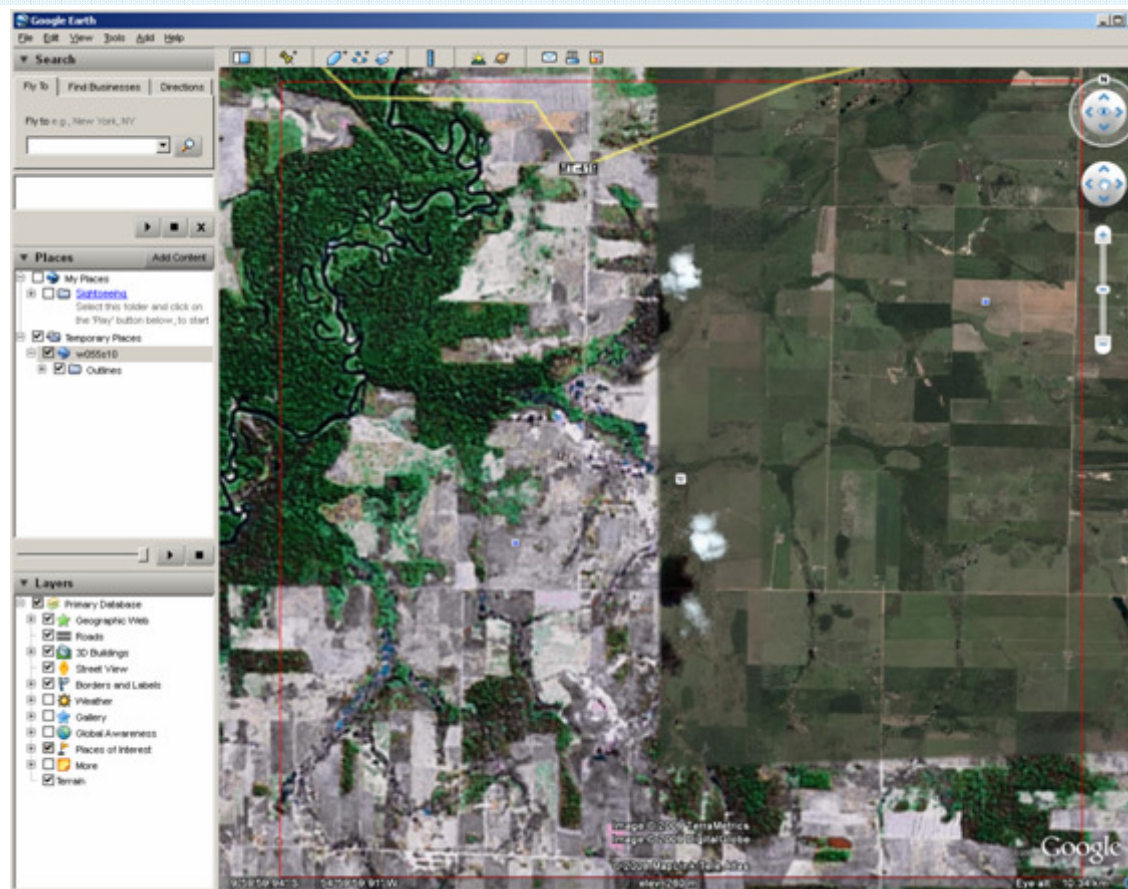


Tree canopy cover

0%



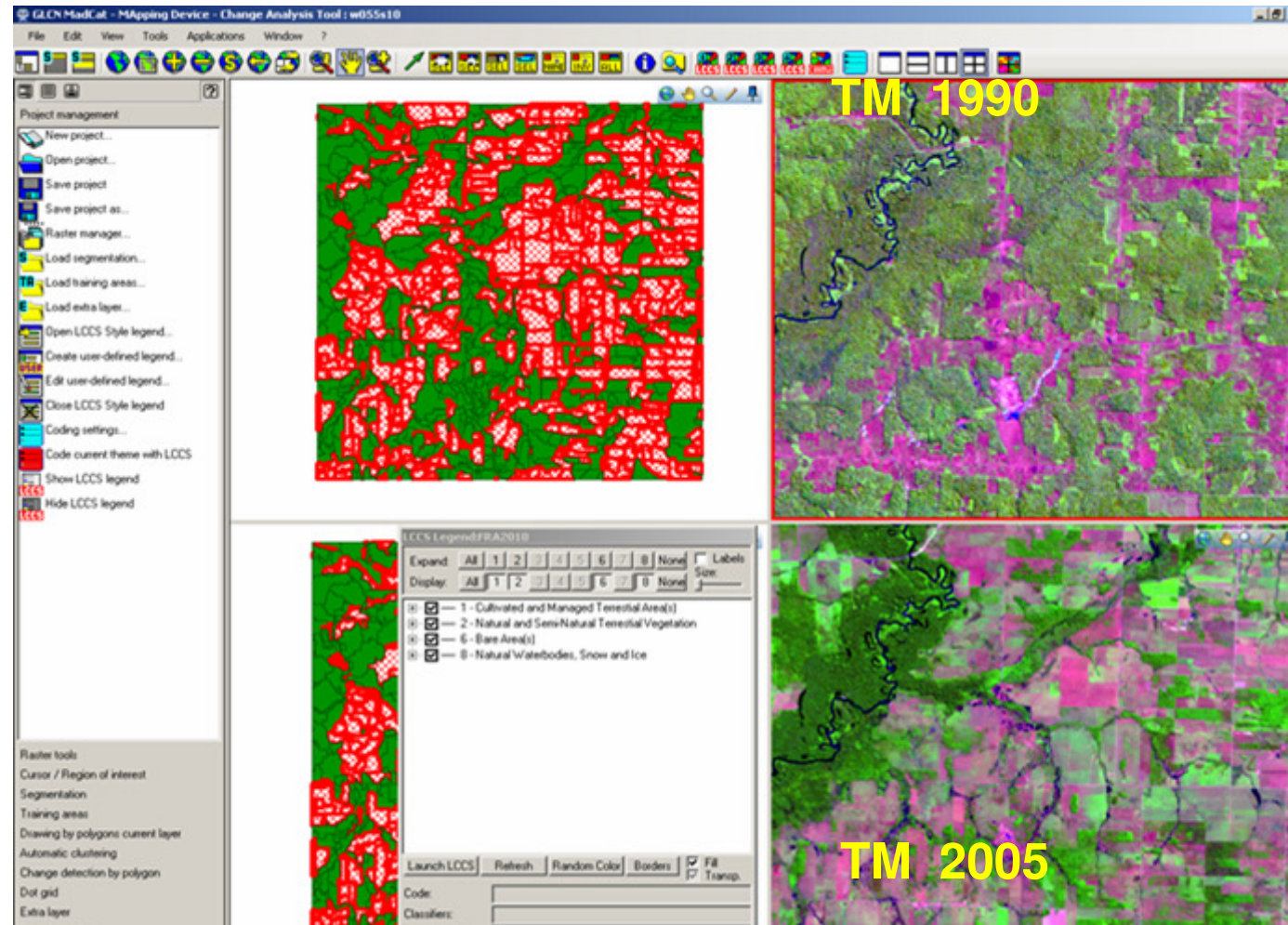
100%



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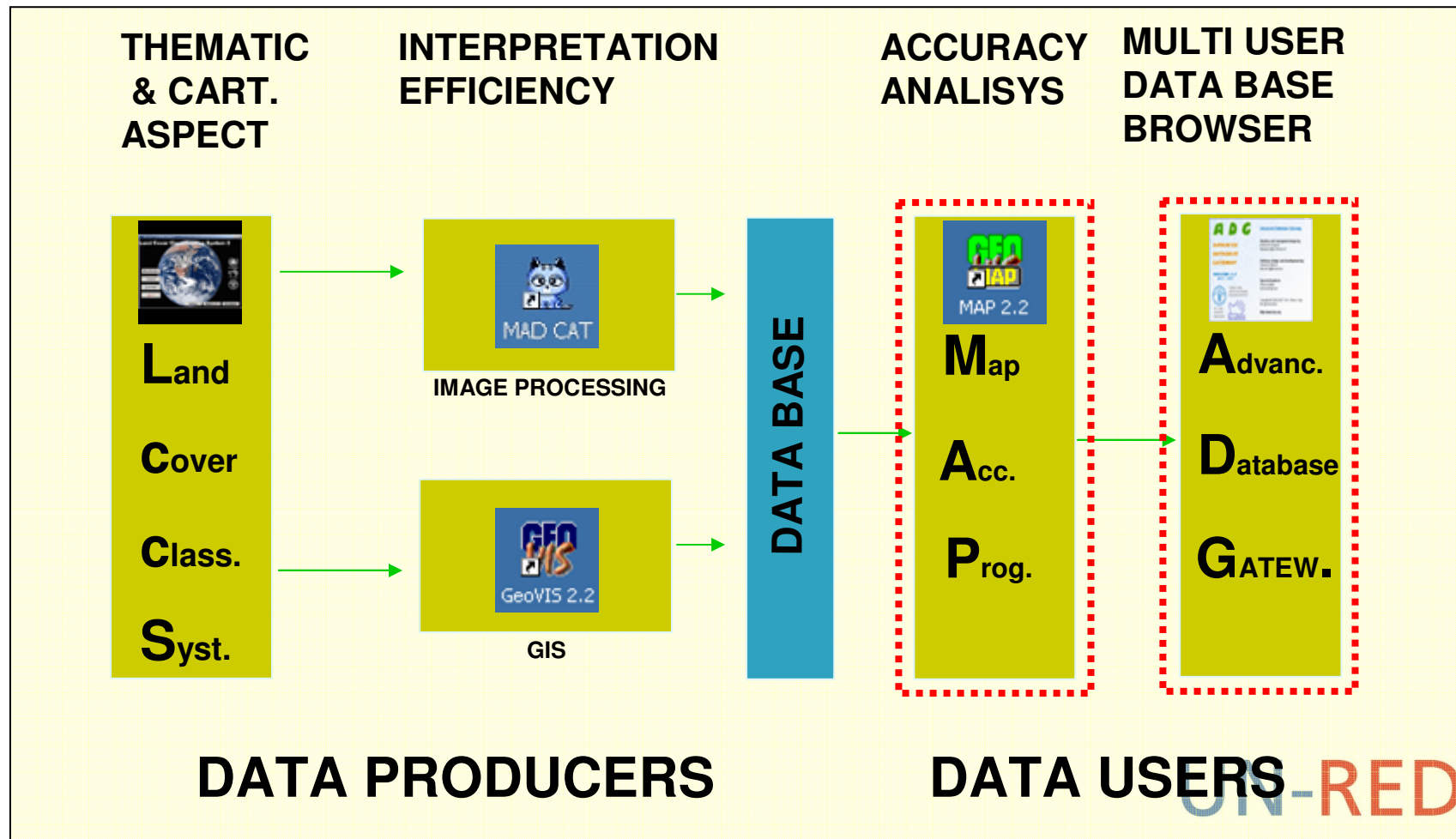


Changes 1990 - 2005





Tools in the framework of data production / analysis

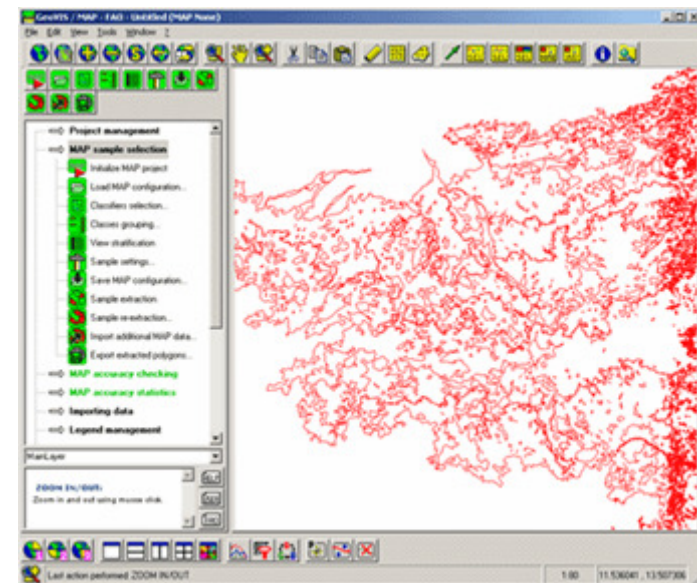




GIS Tools

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 LCSS legend.





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.

The top screenshot shows the 'Advanced Database Gateway' interface. It features a 'Phase 1: Selection' panel on the left with various selection tools like 'Select all polygons', 'Select by point', 'Select by rect', 'Select by polygon', 'Select by shapefile', and 'Cancel selection'. The main area displays a map of land cover polygons with a 'Selection' panel on the right showing 'Database polygons' and 'Add Layer' options. The bottom screenshot shows the 'Classifier Graph Analysis' window. It displays a 'Classifiers Graph' with nodes A1, B1, B2, B5, B6, B7, D1, D9, and W8. A 'Classifiers List' on the right lists classifiers: A1: Tree Crops, A2: Herbaceous Crops, B1: Large To Medium Speed Field, B2: Small Speed Fields, B5: Continuous Field Spatial Ctr, B6: Scattered Chained Field Sp, B7: Scattered Isolated Field Sp, D1: Irrigated Cultivated, D9: Permanently Cropped Area, and W8: Orchards. The bottom screenshot shows a map of land cover polygons with a legend and a histogram.



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GIS services





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

There are 2 messages. (last 4 of 7/4/2009)

Query and order **satellite images**, **aerial photographs**, and **cartographic products** through the U.S. Geological Survey.

Display Tooltips

1. Select your dataset(s)

Click on next to the category name to show a list of datasets.

icon means selected data within the Data Sets can be downloaded at no charge.

- Aerial Photography
- AVHRR
- Commercial
- Declassified Data
- Digital Elevation ([Detailed Link](#))
- Digital Line Graphs ([Detailed Link](#))
- Digital Maps ([Detailed Link](#))
- EO-1
- Forest Carbon Sites
- Global Land Survey
- GLS 2005
- GLS 2005 - Islands (EO-1)
- GLS LIMA (Antarctica)

2. Enter your search criteria

Address/Place name:

Search:

From (mm/dd/yyyy): To (mm/dd/yyyy):

Search these months only.

3. Search >>>

Lat/Long Grid: Dec: DMS:

Map:

Imagery ©2009 TerraMetrics, NASA - Terms of Use

Tap to Selection

Load; it is to be used as a guide for reference and search

Close Clear All Footprints

The up to date Google map is not for purchase or for download; it is to be reference and search purposes only.

Thumbnail	Dataset	Year	Resolution	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View
	USGS Earth Explorer	2008	30m	Download	View



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/>





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.

The screenshot displays the FAO FRA-RRS Information Gateway web portal. The page is titled "Global Forest Resources Assessment Portal" and includes logos for JRC, USGS, and the European Commission. The main content area is divided into several sections:

- About:** A brief description of the portal's purpose and the data it provides.
- Search Tiles Database:** A search interface with fields for Latitude, Longitude, Country, and Ecological Zone. It also includes a "Search" button and a "Show samples in Google Earth" link.
- Map:** A map of South America showing the location of the selected tile (w064s22) in Bolivia.
- Statistics:** A table showing the number of tiles in various states: No data: 93, Preliminary: 3, Validated: 0, Finalized: 0.
- General data:** Information about the selected tile (w064s22), including its location (22°5' 64"W), elevation (813m), and water content (0% of block area).
- Satellite Imagery:** A section for downloading satellite imagery, including Landsat TM (1990) and Landsat ETM+ (2000).
- MODIS data:** A section for downloading MODIS data, including the MODIS Global Forest Canopy Cover and 500m resolution data.

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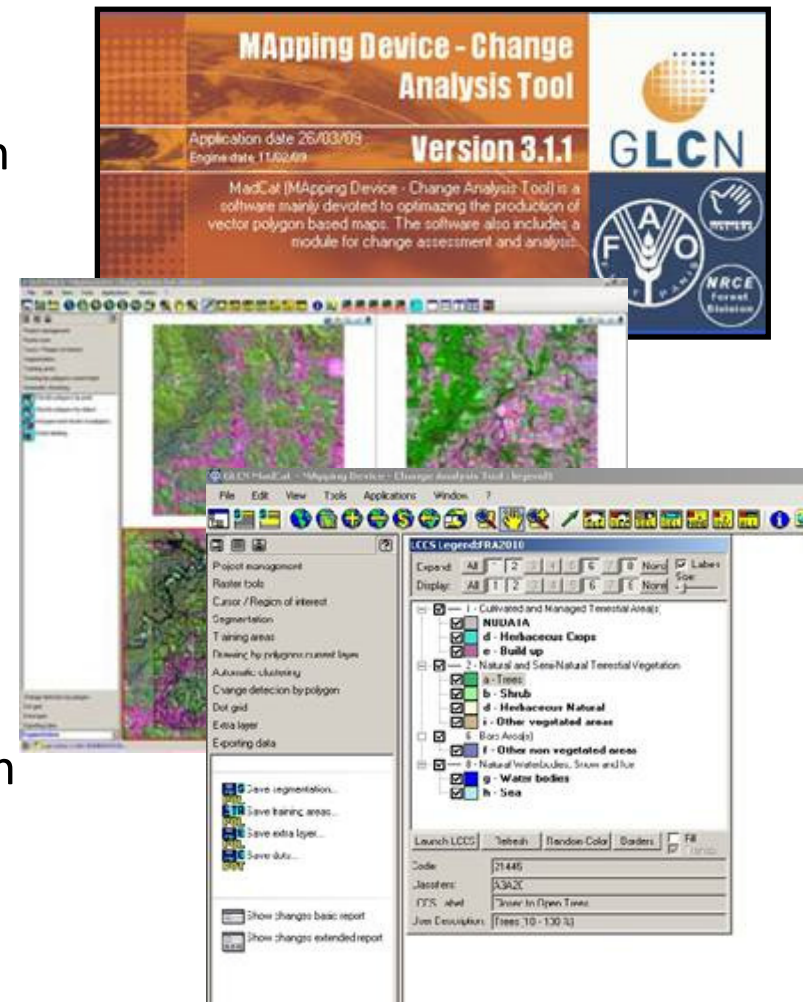
Thank you for
listening!





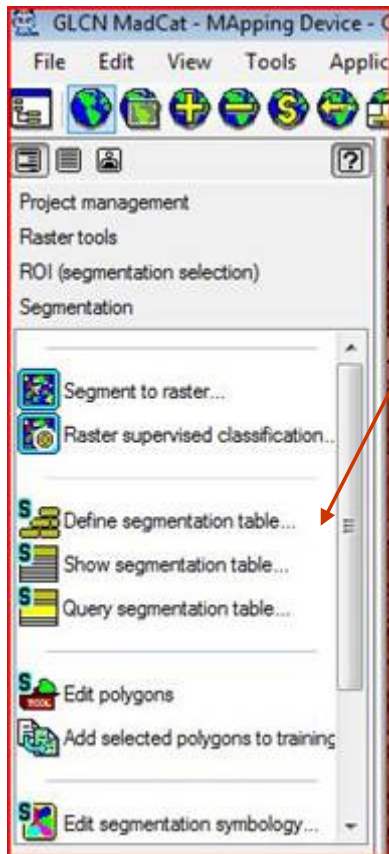
Main functionality

- **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

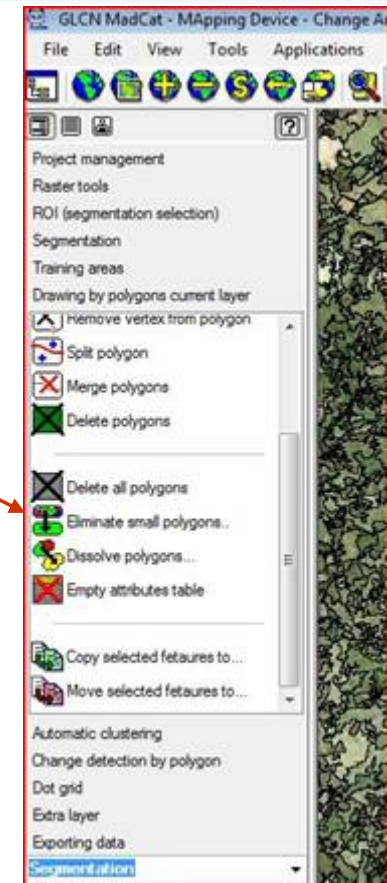
Edit Polygons

Tools to edit polygons:

Add, Split, Merge, Delete

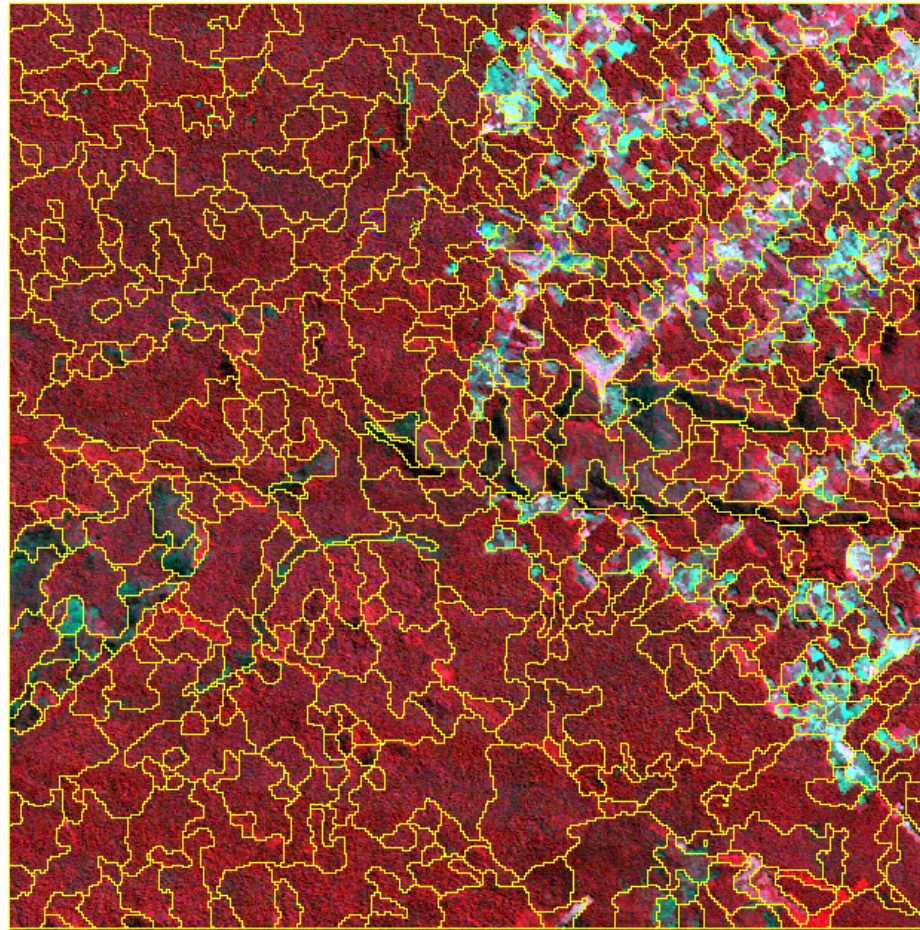
Eliminate, Dissolve

topologically





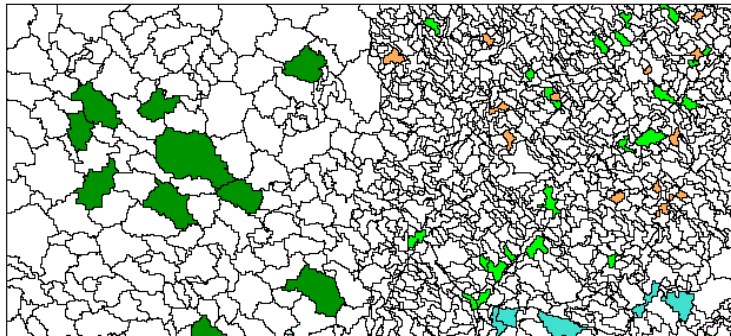
Segmentation



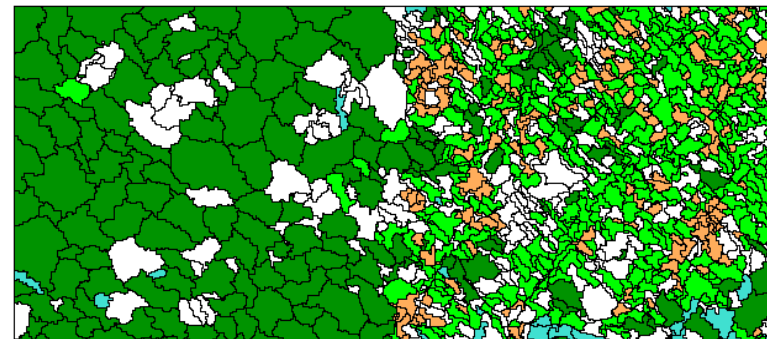
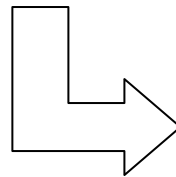
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Smart labelling



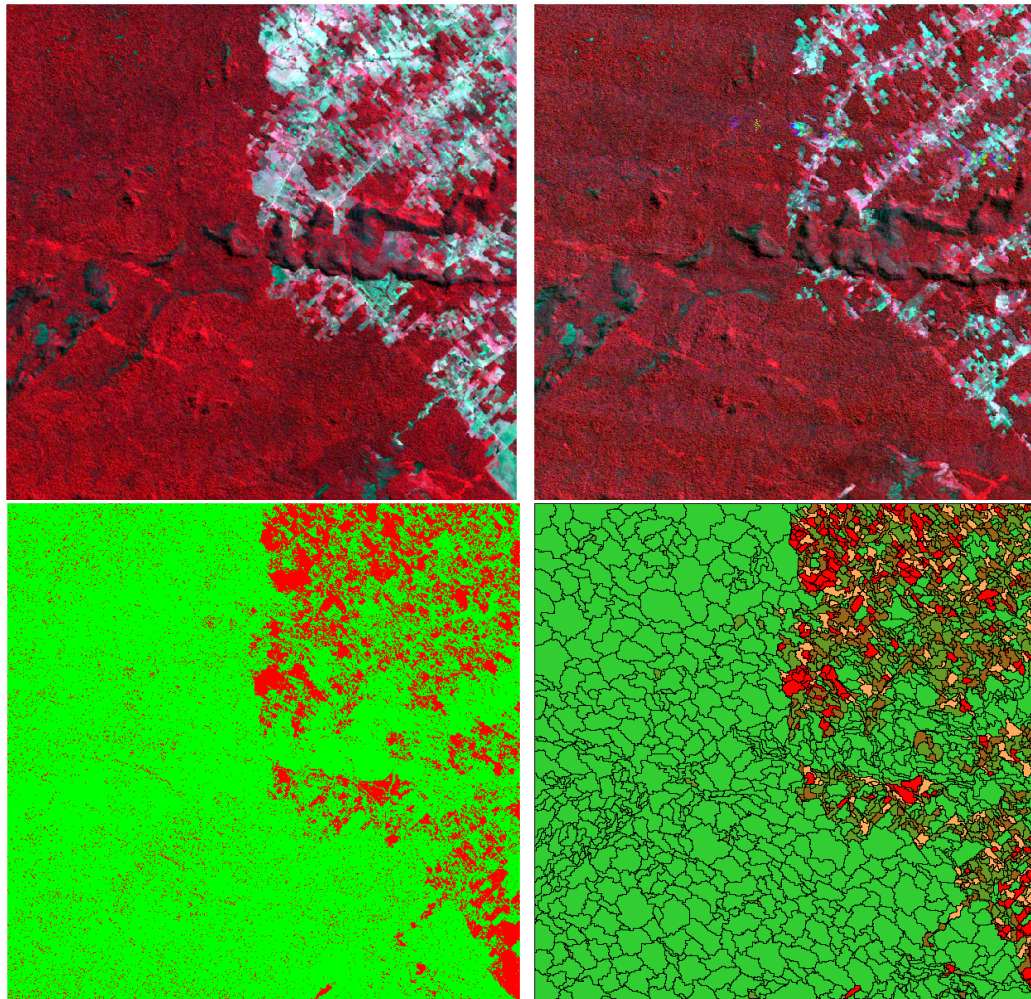
A segmentation with only few polygons labelled



Labels automatically assigned to similar polygons








Change rating



POLYGONS legend ✕

Classified polygons (changeperc)

- Less than 20% 
- From 20% to 40% 
- From 40% to 60% 
- From 60% to 80% 
- More than 80% 



Report of changes

GLCN ModCat - Mapping Device - Change Analysis Tool | w035x10

File Edit View Tools Applications Window ?

GLCN ModCat - Report of changes and trajectories

Save Print Preview Go back Go forward

UNCODED polygons are UNCODED in UNCODED, then they are UNCODED in UNCODED previous year (only in the UNCODED, UNCODED or UNCODED year).

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

Top of document

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 21
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

