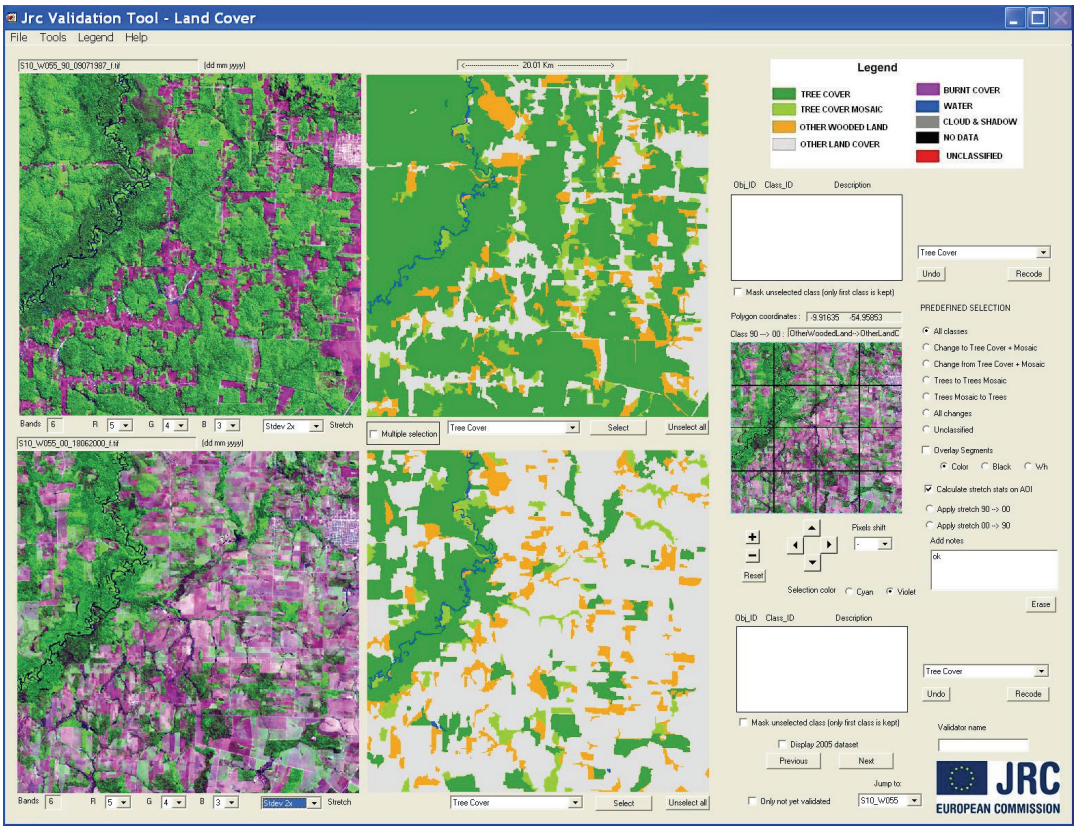
JRC Scientific and Technical Reports

User Manual for the JRC Land Cover/Use Change Validation Tool

Tool developed in the framework to the JRC TREES-3 project, in support to the Remote Sensing Survey of the Global Forest Resources Assessment 2010 of the FAO

Dario Simonetti, René Beuchle and Hugh D. Eva



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Acknowledgments

The JRC Land Cover/Use Change Validation Tool has been developed at the JRC by the team working on the TREES-3 project. The software code has been prepared by Dario Simonetti[1] when the requirements, design and tests of the tool were mainly provided by René Beuchle and Hugh Douglas Eva. The user Manual was prepared by Dario Simonetti and Frédéric Achard, and reviewed by René Beuchle and Hugh D. Eva.

The authors would like to thank all other colleagues from JRC, members of the Remote Sensing Survey team of the FAO FRA-2010 project and many National Correspondents and country experts, for providing constructive feedbacks and useful information in the development of the tool. In particular we would like acknowledge the contributions of Catherine Bodart, Andreas Brink, Silvia Carboni, François Donnay, Ouns Kissiyar, Andrea Lupi, Philippe Mayaux, Rastislav Raši, Hans-Jürgen Stibig, Michael Vollmar (JRC - Global Environment Monitoring unit); Pieter Kempeneers, Fernando Sedano, Lucia Seebach, Peter Strobl, Peter Vogt (JRC - Land Management unit); Adam Gerrand, Erik Lindquist and Rémi D'Annunzio (FAO - Global Forest Resources Assessment 2010).

Abstract

The JRC TREES-3 project aims at estimating forest cover changes at continental and regional levels for the tropical belt for the periods 1990-2000 and 2000-(2005)-2010 based on a systematic sample of forest cover change maps. An operational system has been developed for the processing and change assessment of a large data set of multi-temporal medium resolution imagery (sample units of 20 km x 20 km size analysed from with Landsat imagery). The main task is to assess as accurately as possible for each sample unit the forest cover and forest cover change between two dates.

The analysis includes a crucial final step of visual verification and final assignment of land cover labels which is carried out by forestry national officers or remote sensing experts from tropical countries. The visual interpretation is conducted interdependently on two-date imagery to verify and to adjust the labels pre-assigned to each segment for the different dates. A dedicated stand-alone application has been developed for this purpose. The application is a graphical user interface, called the JRC Land Cover Change Validation Tool. The aim of this tool is to provide a user-friendly interface, with an optimised set of commands to navigate through and assess a given dataset of satellite imagery and land cover maps, and to correct easily the land-cover labels as appropriate. FAO is collaborating with JRC in this work under the Global Forest Resource Assessment (FRA) Remote Sensing Survey. JRC has added functionality to the tool to enable labelling of land-use classes that are part of the FRA classification.

The present technical document, entitled "User Manual for the JRC Land Cover/Use Change Validation Tool" describes the steps for the installation of the tool on a personal computer, as well as the detailed features of this dedicated graphical user interface. The authors welcome feedback from potential users of the tool, in particular reporting of any potential software issue or providing suggestions for improvements of future versions of the tool.

[1] D. Simonetti worked at JRC under the "Specific Contract No 371 implementing Framework Contract No DI/05712", contract signed between the European Commission and the ONE4EU Consortium which includes REGGIANI Spa as contractor.

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1. Background on the JRC TREES-3 project

Research groups at the Joint Research Centre (JRC) are developing methods for monitoring forest cover resources in a global perspective. In particular the JRC TREES-3 project[2] aims at estimating forest cover changes at continental and regional levels for the Tropical belt for the periods 1990-2000 and 2000-(2005)-2010 based on a systematic sample of forest cover change maps. The project is carried out in a collaborative partnership with the Remote Sensing Survey[3] of the Global Forest Resources Assessment 2010 (FRA 2010) carried out by the Food and Agriculture Organization of the United Nations (FAO) and with many regional or national partners. An operational system has been developed by the JRC for the processing and change assessment of a large data set of multi-temporal medium resolution imagery. Time-series of moderate resolution remote-sensing data (mainly Landsat imagery) are attached to each sampling location through a quality-controlled, standardized and decentralized process. For the FAO's FRA2010 RSS exercise, the South Dakota State University (SDSU) produced a global database of multi-temporal 20 km × 20 km sample tiles[4] extracted from the USGS GLS archives. For the portion of the sample tiles that are not available from the GLS database or have persistent cloud contamination, other Landsat imagery or alternative remote sensing data have been used by JRC. This global systematic sampling scheme has been developed jointly by FAO and the JRC to estimate rates of deforestation at global or continental levels at intervals of 5 to 10 years. FAO is using the tool to work with countries to validate land-use and land-use change as part of the FRA work. The tool's interface makes it easy to label land-use changes that are often related to changes in land-cover. Where there is change from or to forest, we are particularly interested in recording what the new land-use is, and thus collecting information on the drivers of forest loss and gain.

A methodology has been selected in view of the need to interpret a large set of multi-temporal medium resolution satellite imagery. The main task is to assess as accurately as possible for each sample unit the forest cover and forest cover change between three dates or along two periods:1990-2000 then 2000-(2005)-2010.The following steps have been developed for the processing & analysis of the sample units:

1. A 5 ha Minimum Mapping Unit (MMU) has been selected as appropriate for the specific purpose of the global assessment.
2. Multi-date image segmentation is applied on calibrated and normalised satellite image pairs; groups of adjacent pixels that show similar land cover change trajectories between two dates are delineated into objects with a 5 ha MMU.
3. Selection of training areas for land cover labelling and production of representative spectral signatures for each land cover class.
4. Automatic classification of segments with pre-assignment of land cover labels: the segments are automatically labelled separately for each assessment date by supervised digital clustering and classification procedures using the set of representative spectral signatures, leading to preliminary forest cover maps.
5. Visual verification and final assignment of land cover labels: visual interpretation will be conducted interdependently on multi date imagery to verify and to adjust the labels pre-assigned to each segment for the different dates.

The analysis includes a crucial final step of visual verification and final assignment of land cover labels which is carried out by forestry national officers or remote sensing experts (this step applies also for land use labels in a second validation process after automatic transformation from land cover to land use). The visual interpretation is conducted interdependently on two-date imagery to verify and to adjust the labels pre-assigned to each segment for the different dates. A dedicated stand-alone application has been developed for this purpose. The application is a graphical user interface, called the JRC Land Cover Change Validation Tool. The aim of this tool is to provide a user-friendly interface, with an optimised set of commands to navigate through and to assess a given dataset of satellite imagery and land cover (or land use) maps, and to correct easily the land-cover (or land-use) labels as appropriate. The present technical document describes the steps for the installation of the tool on a personal computer, as well as the detailed features of this dedicated graphical user interface.

[2] http://ies.jrc.ec.europa.eu/index.php?page=action-42003
[3] http://www.fao.org/forestry/fra/remotesensingsurvey/en/
[4] available at http://globalmonitoring.sdstate.edu/projects/fao/index.html

2. Terms and conditions of use of the Tool

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[5] http://ies.jrc.ec.europa.eu/

3. Overview of the Tool

A dedicated stand-alone application has been developed for visual verification and re-assignment of land cover / land use labels on sample units of 20 km × 20 km size. The visual interpretation is conducted interdependently on two-date imagery to verify and to adjust the labels pre-assigned to each segment for the different dates. The application is a graphical user interface, called the JRC Land Cover/Use Change Validation Tool. The aim of this tool is to provide a dedicated user-friendly interface, with an optimised set of commands to navigate through and to assess a given dataset of satellite imagery and land cover (or land use) maps, and to correct easily the land-cover (or land-use) labels - which are recorded in a ESRI shapefile[6] - as appropriate. The fully automatic and simple navigation through all user sample images makes this stand-alone application a key tool in the validation process, i.e. the visual verification and final assignment of land cover / land use labels.

The present technical document describes the steps for the installation of the tool on a personal computer, as well as the detailed features of this dedicated graphical user interface.

4. Installation

4.1. Minimum System Requirements

For the best visualization of the tool, the screen resolution has to be set up at 1600 x 1200 pixels or finer resolutions. In the case of the "Laptop version" (aimed at Laptop computers with smaller screens) the screen resolution should be set up at 1024 x 768.

4.2. Operating System

Windows OS: NT/2000/XP/Vista/7 (32/64 bit).

UNIX OS: the IDL[7] Virtual Machine or IDL software license has to be installed as the version provided with the tool is valid for Windows Operating System only. In this case of UNIX OS the software "\JRC-GEM\L2\RUN_Validation_Tool.sav" has to be launched. It has not been fully tested by JRC which declines all responsibility for any software errors or deficiencies.

4.3. Installation Procedure

The 'LCC_Validation_Tool' comes as a stand-alone IDL executable package (.sav) running on a distributable version of the IDL Virtual Machine (© IDL see http://www.ittvis.com/).
There is no need for software installation or configuration.

4.4. First execution

In order to run the LCC Validation Tool, double click the 'RUN_Validation_Tool.exe' file, located in the main directory; click 'Continue' when the IDL Virtual Machine Splash Screen pops-up; select the appropriate resolution between "full", "medium" or "laptop" resolution.
From the menu option 'File' and 'Select data file' select the provided *.csv-file. A test file is located in 'Test Data Set' directory.

[6] http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf or http://en.wikipedia.org/wiki/Shapefile
[7] See ITT Visual Information: http://www.ittvis.com/ProductServices/IDL.aspx

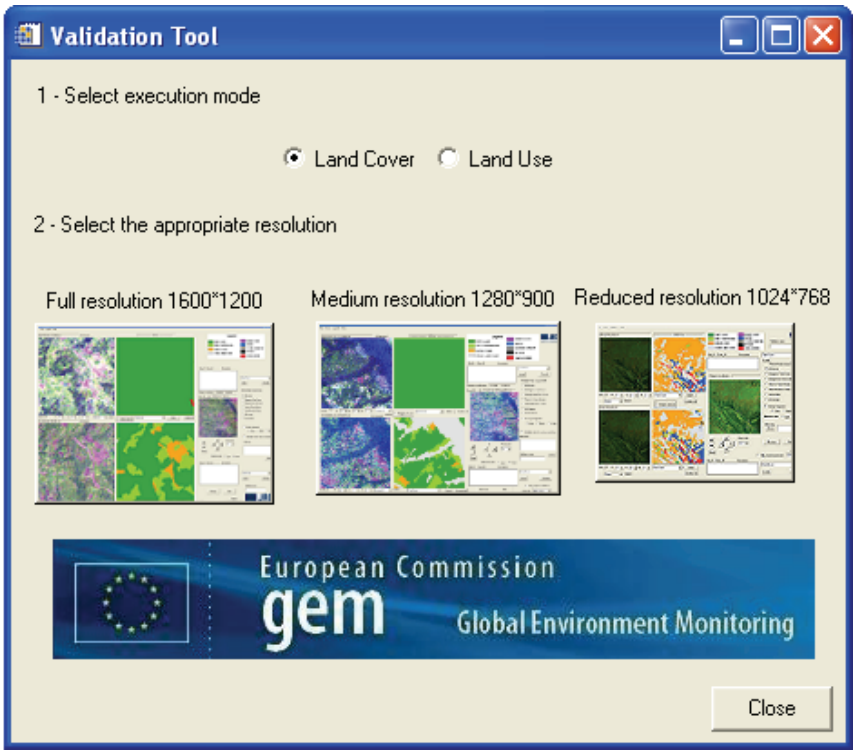
5. Software overview and features

5.1. Start-up

By double clicking the “LCC_Validation_Tool.exe” file, you will first have to select:

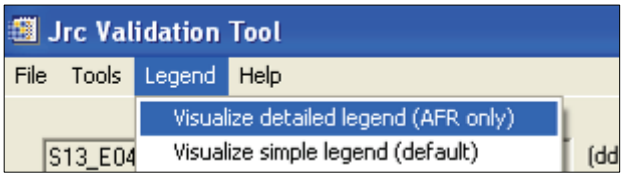
1/ the execution mode (validation of land cover or land use)

2/ the resolution that best fits on the available computer screen.

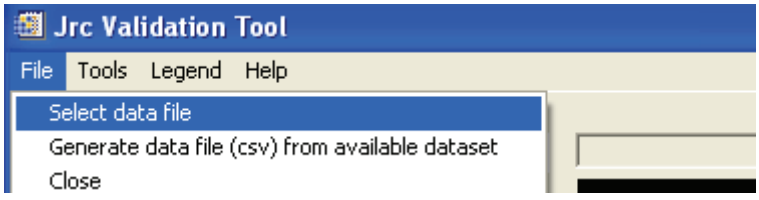


The graphical user interface will then appear as top-screen application.

Note: for JRC sample Units over Africa, the legend need to be changed before opening the data file, using the more detailed land cover legend used for Africa units.

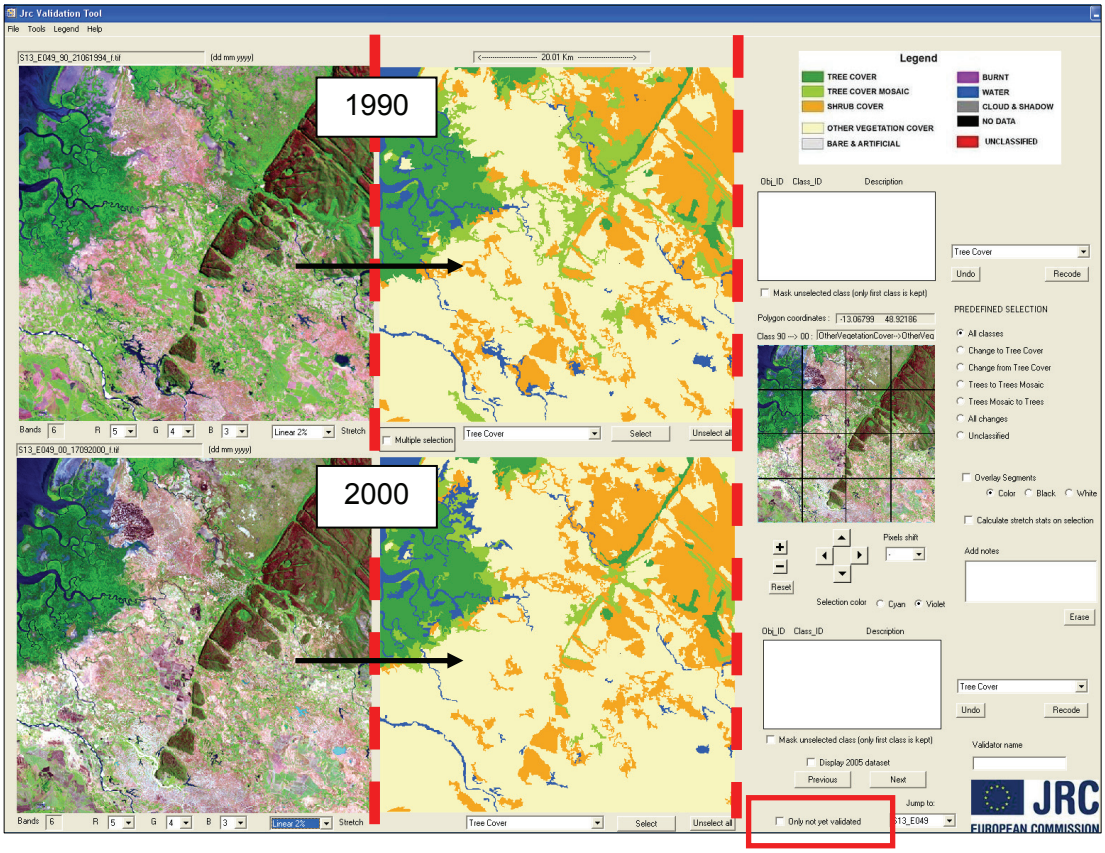


Through the menu *File -> Select data file* is possible to load the *.csv file containing all information regarding the sample datasets the validator has to work with (see Annex1 section for more information regarding the *.csv file structure).



5.2. Interface structure

The interface is divided in 3 sections, the images on the left, the classifications in the centre and the navigation/re-labelling tools on the right; the two windows on top are showing image and according classification from ~1990, while the two windows below refer to ~2000. The legend is on top-right.



When available, the image for year 2005 or 2010 and corresponding land cover map / classification can be displayed by checking the 'Display 2005 dataset' option. The 2000 image and classification will appear then on top while the 2005 data will be shown below. In this case, all 1990-2000 naming/terms will be replaced by 2000-2005 or 2000-2010 naming/terms.

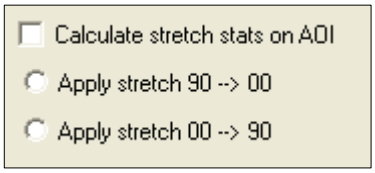
5.3. Options for Display of Satellite Imagery

5.3.1. Image info

The user can find the name of the image (composed of geographical location, reference period and acquisition date) on top of the image window. The number of bands and the band combination currently used to display the colour composite (default is Mid-IR, Near-IR, Red corresponding to Landsat TM or ETM+ bands 5-4-3) are shown at the bottom of the display.

For a better image visualisation it is possible at any time:

- to change the RGB band combination by selecting the according bands from a drop-down list;
- to choose from the drop-down list to the right one of the predefined stretch options;
- to calculate the spectral statistics of a restricted area of one image only (AOI), select a stretch option and apply the derived lookup table to the whole image or even to the image of the other date which is useful e.g. in cases of clouds or problematic full-image statistics.



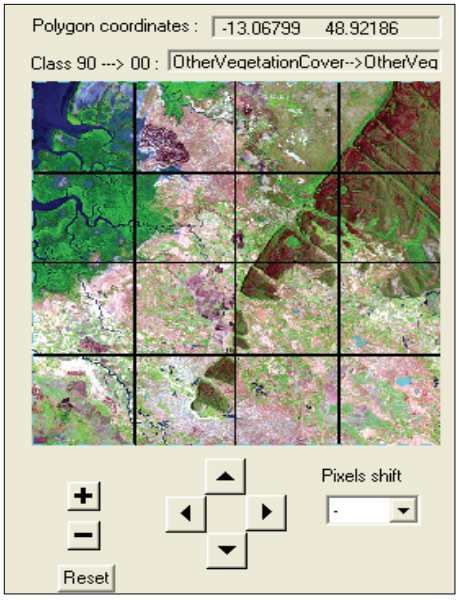
5.3.2. Image flickering

By clicking with the right mouse button over image ~1990 or ~2000 it is possible to overlay the two datasets. This allows for a better identification of land cover/use changes (flickering).

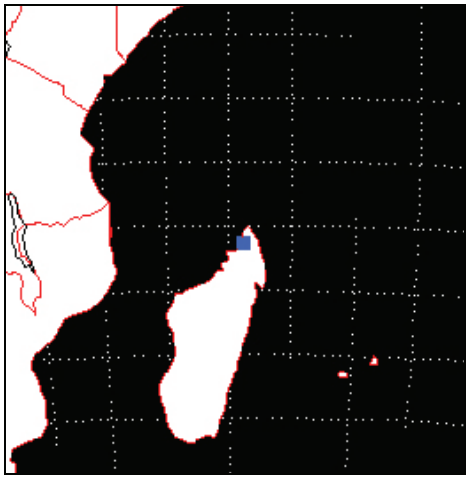
5.3.3. Image navigation tools

The four main display windows (the two images and the two classifications) are always linked together. By using the navigation section it is possible to:

- zoom and pan trough the images by drawing a 'Area Of Interest' (left mouse button) or by selecting a predefined square (1/16, 1/9, 1/4) in the pixel shift options
- increase or decrease the current zoom scale and reset to the full extend
- shift to any direction by a predefined number of pixels or image section (1/16, 1/9, 1/4).



By clicking with the right mouse button over the zoom window, it is possible to visualize the localisation of the sample site.



5.4. Classification Interaction

5.4.1. Classification overlay

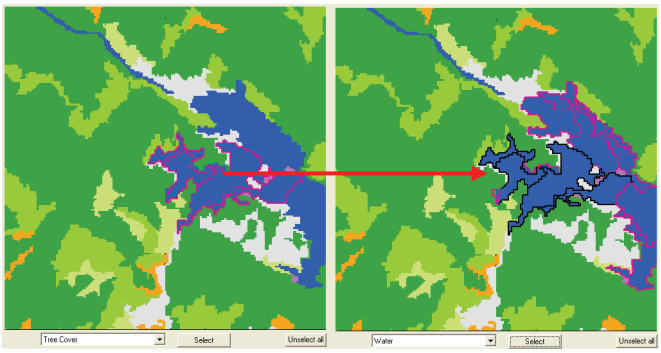
In order to facilitate the validation process, it is possible to display the classified polygon outlines over the images by selecting “Overlay Segments” and to choose among three colour options (‘Color’ = legend colour).

5.4.2. Selection of Polygon(s)

It is possible to select polygons in the image or the classification window by using the left mouse button with two options:
a) One polygon at a time or
b) Multiple polygon selection when the “*Multiple selection*” option is checked

By checking the “*Multiple selection*” option, it is also possible to select all polygons in the visible image portion corresponding to a predefined class (from drop-down list). The two options / methods can be used in sequence.

Notes:
1. by clicking a polygon a second time it will be un-selected (and displayed in black) and removed from the selection list area to the right of the classification window;



2. By flagging the “*Multiple selection*” option, only polygons entirely contained in the visible image portion are selected;
3. all selected polygons will be un-selected if any zoom or panning is done.

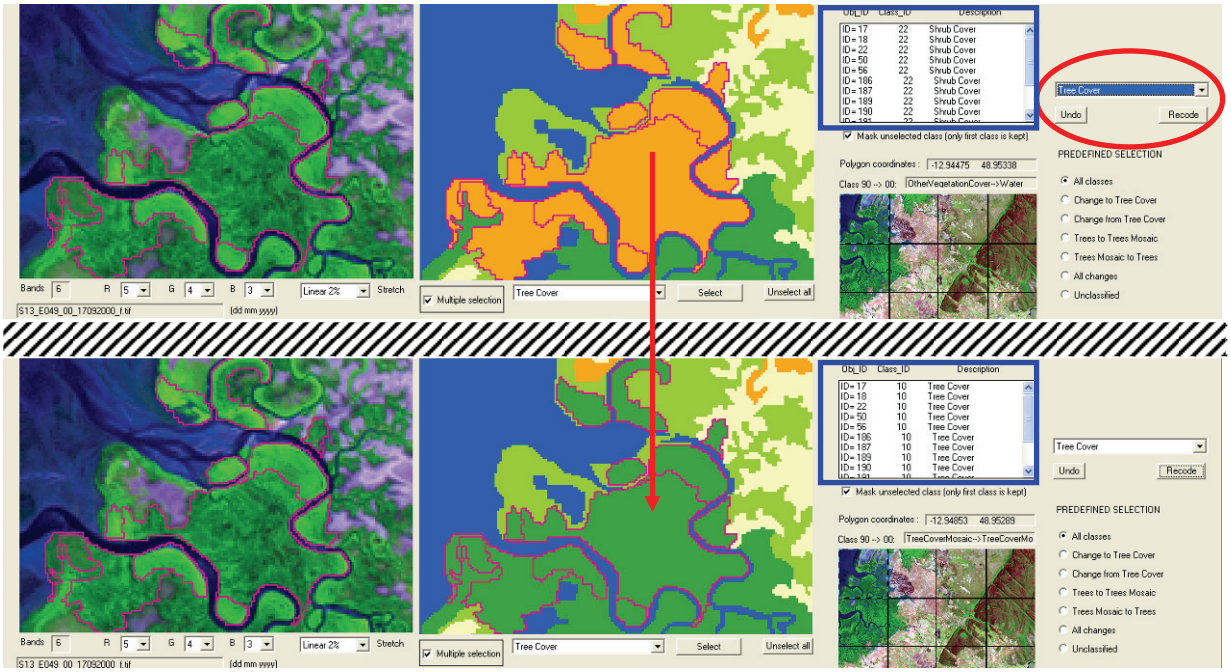
5.4.3. Assigning a new class to a polygon

To assign a new land cover/use class to selected polygons, two steps are necessary:
1. First select the destination class from the drop-list menu,
2. Then click on "*Recode*" button below.

The recoding has to be done independently for the 1990 and 2000 datasets.

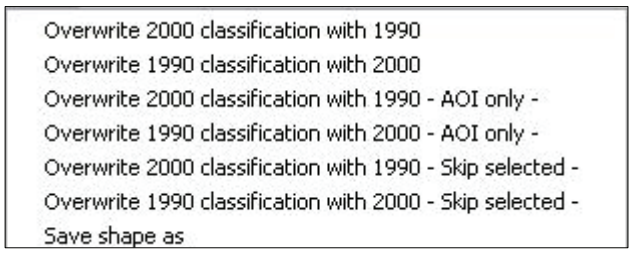
After pressing 'Recode' Class colours and legend are updated accordingly. The selected polygons are kept in the display windows and lists. In case of errors, the "Undo" button can restore the last recode actions.

The example below shows the 1990 dataset before and after a few re-labelling steps.



5.4.4. Overwrite all labels of a map / classification

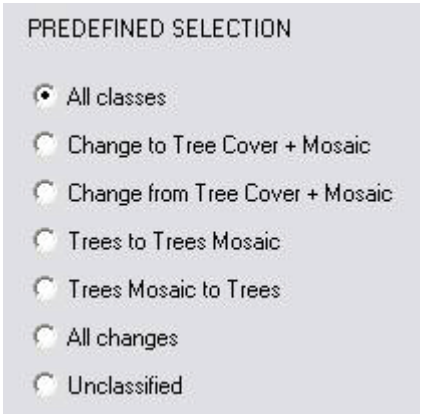
If no change or few changes occurred between two dates, it is possible to copy all the labels of one date to the other date through the menu Tools-> Overwrite. This function can be applied for the whole image or for a specified AOI. The 'skip selected' function will overwrite all the labels of one date to the other one (whole image), except the polygons that are selected.



UNDO is not possible!

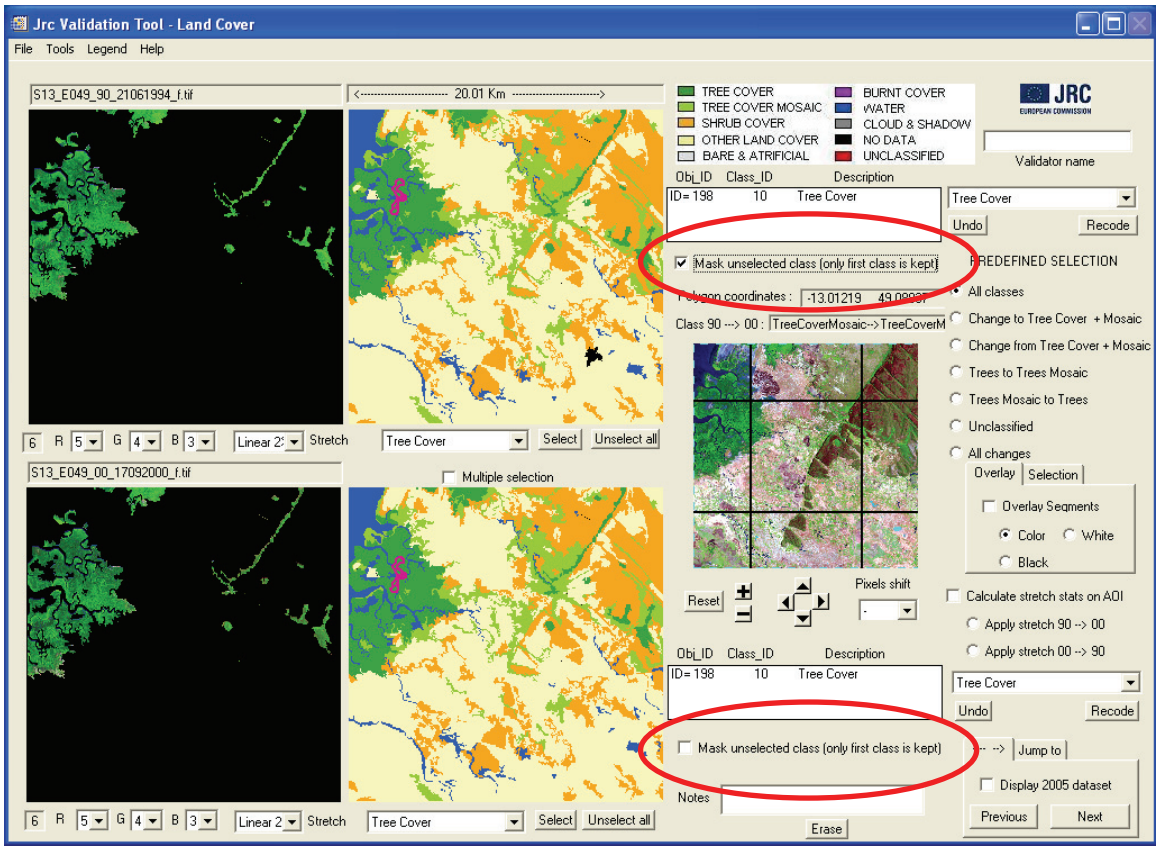
5.4.5. Predefined selection

In order to make the validation process as efficient and rapid as possible, there are different options to display the classification results.



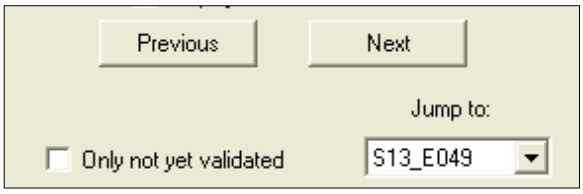
5.4.6. Masking portion of images using classification

By checking the “Mask unselected class” option it is possible to hide all portions of the image that do not match with the class specified by the selected polygon (if more than one has been selected, the reference class is taken from the object at top of the list).
In the example below the class “Tree Cover” has been chosen for visualization; all other classes have been masked in the image windows of both periods.



5.5. Changing working dataset

To change the working dataset (i.e. the sample unit) it is enough to click on the “Next” or “Previous” buttons. The display in the visualization windows appears in the order following the structure of the *.csv file. In case some datasets have already been validated the “Only not yet processed” option can be checked to skip them. As such only not yet processed datasets will be displayed. To go directly to a specified site, the ‘Jump to’ option can be used.



5.6. Save change to shapefile

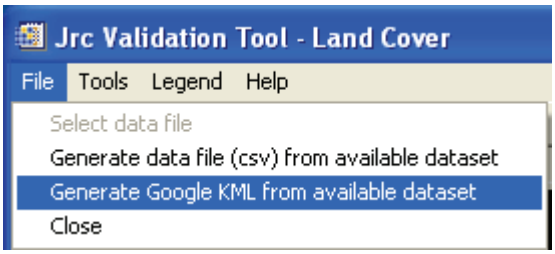
Any re-coded object is automatically saved into shapefile when

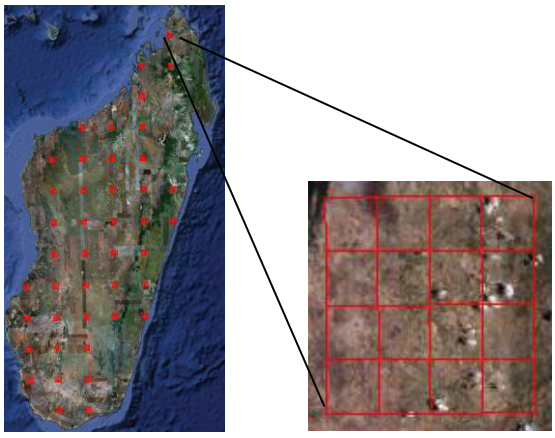
a) The “*Next*” or “*Previous*” button is click or

b) Before exporting the active shapefile (using the “Tool --> *Save shape as*” utility).

5.7. Export outlines of images as Google Earth compatible KML file

Using the “Generate Google KML from available dataset” function in the File menu’ it is possible to generate a Google Earth compatible KML file containing the outlines of the available set of images in the selected folder. For better orientation grid lines have been added with a cell size of 5x5km, dividing the image extent in 16 equally sized grid cells.





Annex I: file structure and known bugs

Input *.csv file structure

The *.csv input file contains the list of sample units to be 'validated', the corresponding shapefiles and related image filenames. It is updated after each session and a backup is created (*name.csv_bkup*). It is a comma delimited file, containing 9 fields:

Lat_Lon, Box90, Box00, Box 05, Classif, Validator, Date, Processed, Changed, Notes

File Naming Convention

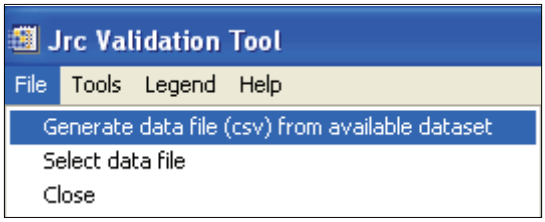
The results of segmentation and automated labelling are provided as shape files (*.SHP and related files *.dbf, *.shx, *.prj), together with the image files (*.TIF).

The shape file name indicates the latitude and longitude of the sample unit centre, e.g.:
• N30_E110.shp (similar to the other associated files .dbf, .shx, .prj)

The corresponding image files are labelled accordingly, indicating in addition the reference year and the acquisition date of the imagery, e.g.:
• N30_E110_90_12121991_f.tif (reference year 1990, acquired on 12 Dec 1991)
• N30_E110_00_11112000_f.tif (reference year 2000, acquired on 11 Nov 2000)
• N30_E110_05_07012005_f.tif (reference year 2005, acquired on 07 Jan 2005)

Building a new csv file based on existing datasets

Using this function is possible to generate a new input csv file based on dataset available in a specified directory: a first search based on *.shp files identifies available datasets to be insert into the csv file; related images are selected using the following criteria: [Shapefile name without extension]*[_90_]*[_f.tif]; same for 2000 and 2005. The operator will assign the desired filename at runtime. The reference template is created automatically.



Format of Attribute Tables

The data base file associated with the Shape file (dbf-file) has the following structure:

ID	AREA	ORG	REC	1990	2000	CH_90_00	ORG_05	2005	CH_00_05
1	123456	1020	1220	12	20	1220	10	30	2030
2	78910	1260	1260	20	60	2060	20	60	6060
Not-used	Not-used	Not-used	Not-used	Used	Used	Used	Not-used	Used	Used

ID, SHAPE	system-generated segment identifications
AREA	indicates the segment area in meter^2
ORG	original extended class codes 1990 and 2000 (concatenated)
REC	class final codes 1990 and 2000 (concatenated)
1990	class code 1990, changes if modified during validation
2000	class code 2000, changes if modified during validation
CH_90_00	class code 1990 and 2000 (concatenated), changes if modified during validation
ORG_05	original class codes 2005
2005	class code 2005, changes if modified during validation
CH_00_05	class code 2000 and 2005 (concatenated), changes if modified during validation

Legend: colours and codes

The colours, class names and associated codes of the legends “Land Cover” and “Land Use” are summarized below. The “Land Cover” legend for Africa differs for 3 classes: a different code for “Other Wooded Land class (22 instead of 20)” and “Other Land Cover” class is divided into two sub-classes: “Other Vegetation Cover” and “Bare & Artificial”

‘Land Cover’ Legend

LAND COVER	CLASS	CODE
	TREE COVER	10
	TREE COVER MOSAIC	12
	OTHER WOODED LAND	20
	OTHER LAND COVER	30
	BURNT	50
	WATER	60
	CLOUD & SHADOW	80
	NO DATA	90
	UNCLASSIFIED	99

Specific classes for Africa LC legend

	OTHER WOODED LAND	22
	OTHER VEGETATION COVER	35
	BARE & ARTIFICIAL	40

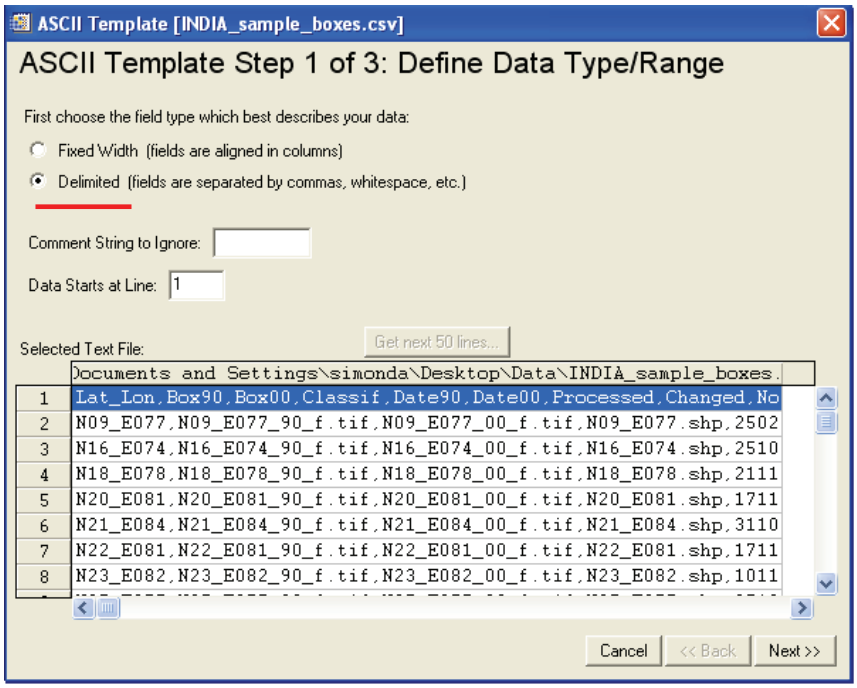
‘Land Use’ Legend

LAND USE	CLASS	CODE
	FOREST	11
	OTHER WOODED LAND	12
	OTHER LAND USE	30
	WATER	18
	NO DATA	99

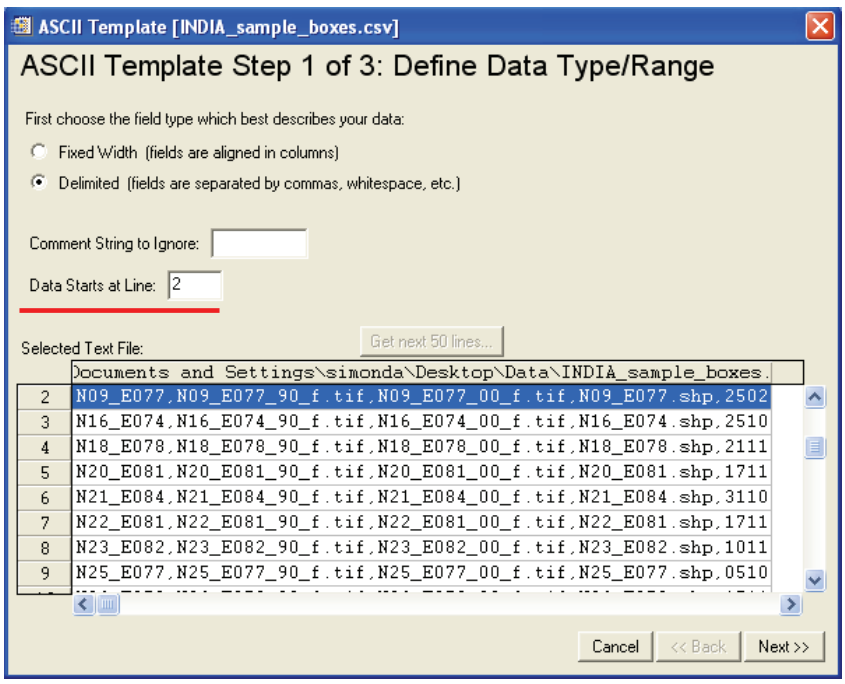
LAND USE	CLASS	CODE
	OTHER TREE COVER	13
	NATURAL HERBACEOUS	14
	AGRICULTURE	15
	BUILT-UP	16
	BARE	17
	WETLAND	19

Building a new input template based on existing csv file

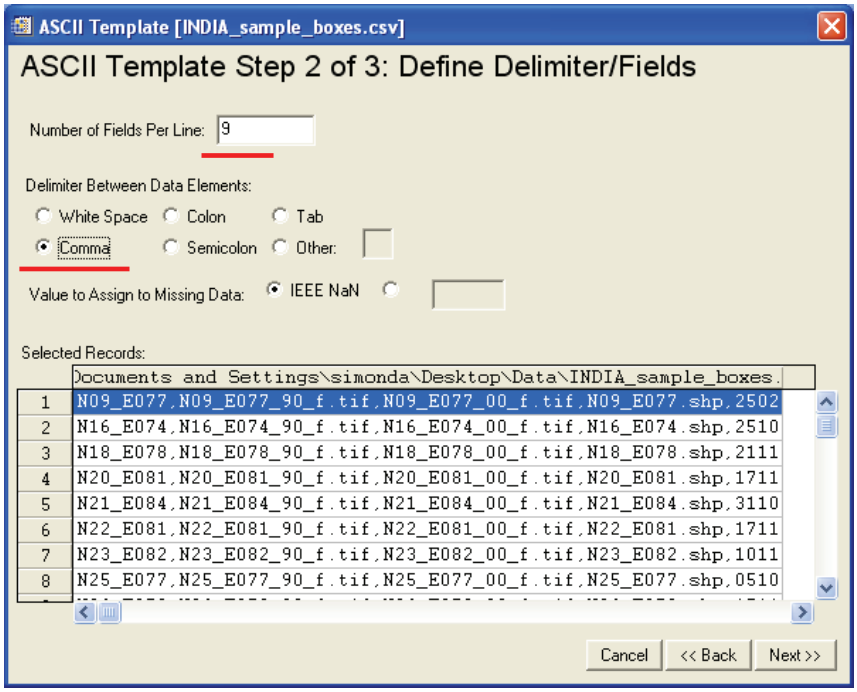
The IDL binary file '[dateset_name]_template.sav' contains information for reading the input [dataset_name].csv file; usually it is provided together with the csv file. In case the '[dataset_name]_template.sav' file gets corrupted or lost or the input csv file is different from what provided (e.g. different name), a wizard will ask to recreate the template.
Wizard step 1 shows the file structure and asks to specify the file structure (select "Delimited")



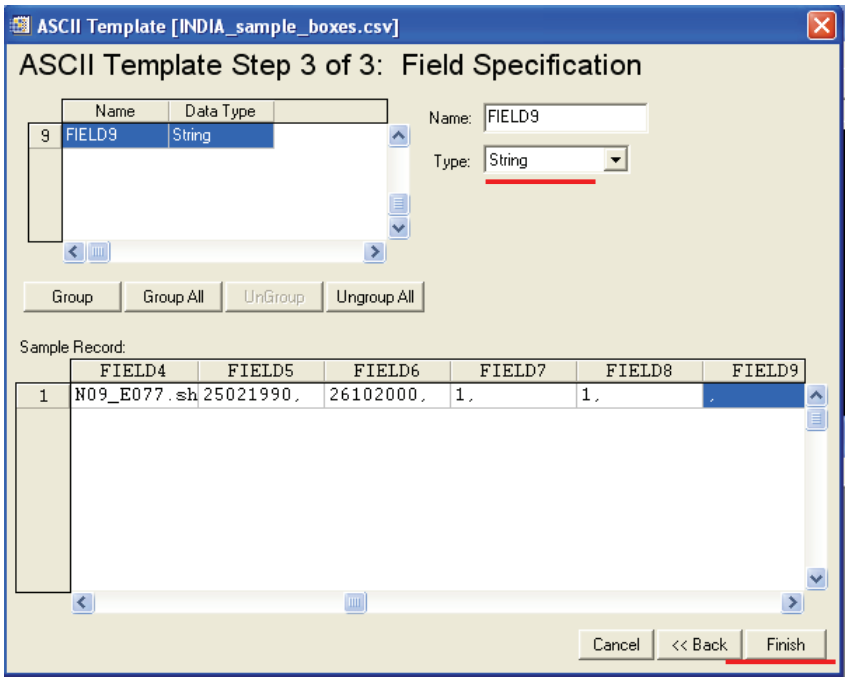
The first line is the header containing fields description that is necessary to skip setting "Data Starts at Line" at 2.



The field delimiter has to be set as “Comma” and it has to be ensured that all nine fields are being detected.

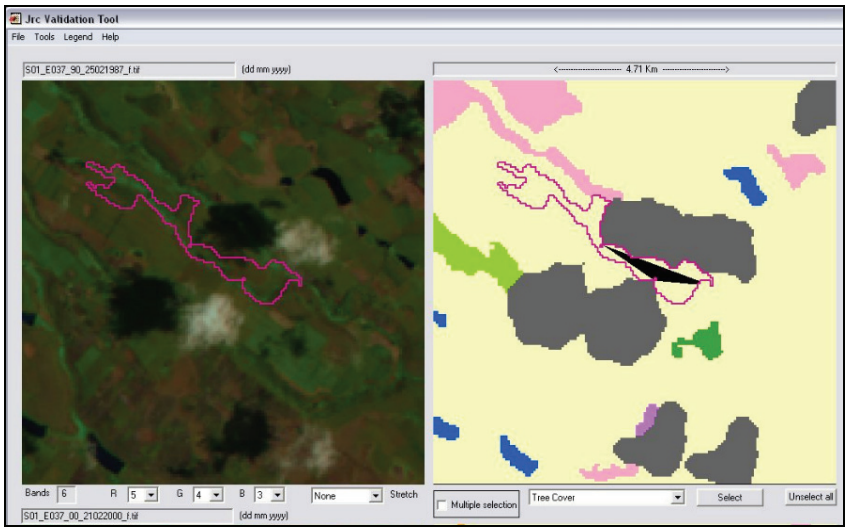


For any field select “String” as “Type” and click “Finish”.



Known Bugs

On rare occasions it is possible to find black triangles on the classification (as seen on the right window in the following image). This is due to a simplification of self intersecting polygons into simple and smaller triangles.



Annex II: selected references related to the JRC TREES-3 project

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Abstract

The JRC TREES-3 project aims at estimating forest cover changes at continental and regional levels for the tropical belt for the periods 1990-2000 and 2000-(2005)-2010 based on a systematic sample of forest cover change maps. An operational system has been developed for the processing and change assessment of a large data set of multi-temporal medium resolution imagery (sample units of 20 km x 20 km size analysed from with Landsat imagery). The main task is to assess as accurately as possible for each sample unit the forest cover and forest cover change between two dates.

The analysis includes a crucial final step of visual verification and final assignment of land cover labels which is carried out by forestry national officers or remote sensing experts from tropical countries. The visual interpretation is conducted interdependently on two-date imagery to verify and to adjust the labels pre-assigned to each segment for the different dates. A dedicated stand-alone application has been developed for this purpose. The application is a graphical user interface, called the **JRC Land Cover Change Validation Tool**. The aim of this tool is to provide a user-friendly interface, with an optimised set of commands to navigate through and assess a given dataset of satellite imagery and land cover maps, and to correct easily the land-cover labels as appropriate. FAO is collaborating with JRC in this work under the Global Forest Resource Assessment (FRA) Remote Sensing Survey. JRC has added functionality to the tool to enable labelling of land-use classes that are part of the FRA classification.

The present technical document, entitled “User Manual for the JRC Land Cover/Use Change Validation Tool” describes the steps for the installation of the tool on a personal computer, as well as the detailed features of this dedicated graphical user interface. The authors welcome feedback from potential users of the tool, in particular reporting of any potential software issue or providing suggestions for improvements of future versions of the tool.

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