

FACULTY OF GEO-INFORMATION SCIENCE
AND EARTH OBSERVATION

ITC

MaMaSe Toolbox Installation,
Configuration and User Guide

XML Version 1.0

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Abstract

The MaMaSe Sustainable Water Initiative is aimed at improving water safety and security in the Mara River Basin to support structural poverty reduction, sustainable economic growth and conservation of the basin's ecosystems. In this four year programme the people and institutions in the basin will be supported in a process of structural change, promoting water-wise economic development that lifts people out of poverty and sets them on a sustainable path to improved well-being and self-reliance.

This toolbox supports the development of a rangeland information system with different information "ProdUser" communities that considers spatial-temporal carrying capacity of the Maasai Mara park and surrounding rangelands for livelihoods based on livestock and wildlife species. Such system could serve early warning, and is based on GEONETCast global data dissemination and open geospatial data analysis technology. It supports development of rangeland management options and scenarios by efficient data pre-processing required.

Currently large amounts of environmental data are delivered through "GEONETCast-EUMETCast". ILWIS plug-ins are developed to import various data types delivered via these telecommunication based systems. These systems disseminate real and near real-time environmental data which can be received using a low cost ground receiving station. On the other hand, various environmental data resources, especially time series of data, are currently available through the internet. The "**MaMaSe Toolbox**" is developed to easily ingest selected data from both sources. The generic RS and GIS capability offered by ILWIS can be used for further processing of the data.

The toolbox is identical in design as compared to the other toolbox plug-ins, like the GEONETCast and ISOD Toolboxes. This document is providing a description where to download the freeware utilities used, how to install and configure them. The MAMASE Toolbox developed is an open utility. It can be easily modified and tuned to fit the specific user needs without programming skills. Next to this description also an overview is presented on the various data resources that can be automatically retrieved and processed. Finally the document provides hands-on exercises how to use the utilities offered. The exercises provided are focusing on the selected vegetation and precipitation (including forecasting) information relevant for the MaMaSe project. Further information on the MaMaSe project can be obtained from <http://www.MaMaSe.org/>.

The utilities provided are extensively tested using various operating systems, such as Windows 7/8/10 and have found to be performing in a stable manner. The toolbox currently does not work under LINUX. In case unexpected behaviour or bugs are observed, additions to the functionality are required or if you have developed new utilities which you want to share, please contact the EO Community Contact (<http://52north.org/communities/earth-observation/community-contact>).

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LIST OF ACRONYMS AND ABBREVIATIONS

52North-----	52°North Initiative for Geospatial Open Source Software
ARC-----	Africa Rainfall estimate Climatology
CHIRPS-----	Climate Hazard Group InfraRed Precipitation with Station (data archive)
CMORPH-----	Prediction Centre Morphing Technique for rainfall estimation
CPC-----	Climate Prediction Centre
EO-----	Earth Observation
ECMWF-----	European Centre for Medium-Range Weather Forecast
eMODIS-----	Expedited MODIS
ESA-----	European Space Agency
EUMETCast-----	Telecommunication based data dissemination system
EUMETSAT-----	European Organisation for the Exploitation of Meteorological Satellites
FTP-----	File Transfer Protocol
FEWSNET-----	United States Agency for International Development (USAID) Famine Early Warning System
GDAL-----	Geospatial Data Abstraction Library
GDEM-----	Global Digital Elevation Model
GFS-----	CPC Global Forecasting System
GMTED-----	Global Multi-resolution Terrain Elevation Data
GRIB-----	GRIdded Binary
GSOD-----	Global Summary of Day Data
GTS-----	Global Telecommunication System
HDF-----	Hierarchical Data Format
ILWIS-----	Integrated Land and Water Information System (GIS-RS software)
MaMaSe-----	Mau Mara Serengeti Sustainable Water (MaMaSe) Initiative
MOD13-----	MODIS Vegetation product
MODIS-----	Moderate Resolution Imaging Spectrometer
MPE-----	Multi sensor Precipitation Estimate
NCEP-----	National Centers for Environmental Prediction
NDVI-----	Normalized Difference Vegetation Index
NASA-----	National Aeronautics and Space Administration
NetCDF-----	Network Common Data Form
NOAA-----	National Oceanic and Atmospheric Administration
RFE-----	Rainfall Estimate
SRTM-----	Shuttle Radar Topographic Mission
TAMSAT-----	Tropical Applications of Meteorology using Satellite data and ground-based observations
UTC-----	Universal Time Coordinated
XML-----	Extensible Markup Language

RELEASE NOTES

Following comments have to be taken into consideration with respect to the release of this MaMaSe Toolbox, XML version 1.0:

1. This is the third release and utmost care was taken to ensure appropriate operation of the routines developed but at this stage some defects might still be included and should be reported to the corresponding author to be included in a new release;
2. For the release of this toolbox version all data sources used have been checked. For some data sources the data format or naming conventions have changed. It was also noted some data has been re-processed. Furthermore Internet has a transient nature; some links might not be active after some time. If any of such a problems are encountered please report these to the corresponding author;
3. No liability can be accepted for use of the MaMaSa Toolbox by the toolbox developers;
4. When using ILWIS 3.8 Open or higher some functionality has changed and is not downwards compatible. When not familiar with ILWIS it is advised to use the latest version of ILWIS 372 for the purpose of learning how to apply this toolbox in conjunction with other ILWIS functionality. When running the toolbox under ILWIS 372 and you want to use ILWIS 38 for visualization – animation, copy the ILWIS service objects, available under your ILWIS 372 sub-directory “\Extensions\MAMASE-Toolbox\System” into the ILWIS 38 sub-directory “\system”;
5. When using the MaMaSa-Toolbox you agree and comply with the conditions of the software utilities used as well as the terms and conditions stipulated by various online data providers for the use or references to the source of the data;
6. Further license notes are described in the files ‘52N_EO_license.txt’, ‘CC-BY-NC-3.0.txt’ and ‘Readme.txt’, situated in the root folder of the MaMaSe toolbox.

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1. GENERAL INSTALLATION AND CONFIGURATION INSTRUCTIONS

1.1 INTRODUCTION

Follow the instructions provided below to install the latest ILWIS Version 3.7.2, the MaMaSe Toolbox and a number of other free software utilities, in order to work with the data provided via open internet resources. Read the instructions provided below carefully and proceed with the installation of the various utilities. In case you want to use the MaMaSe Toolbox, be aware that at this moment it is not running under LINUX-Ubuntu. Furthermore this MaMaSe Toolbox version is not downwards compatible; you need to use at least ILWIS Version 3.7.2.

1.2 DOWNLOAD ILWIS

Available from: <http://52north.org/>

From this location select the navigation tab: “Downloads” or directly select “<http://52North.org/downloads/ILWIS>”. Select the latest (multiple file) ILWIS372 version (“ILWIS 3.07.02”) and download the ZIP file(s), save the file(s) in a temporary directory on your hard disk. Unzip the file and run the ILWIS setup. When you intend to use the MaMaSe Toolbox **do not install ILWIS372 under the default installation directory “C:\Program Files”** as this might cause problems with respect to administration rights (especially under Windows 7) when creating temporary files and because the toolbox is utilizing DOS batch routines, which can be affected by the space in the directory file name “Program Files”. Select as your installation “drive:\directory” a location where you have the proper administrative rights (e.g. “D:\ILWIS372”). In the “ILWIS372” directory a shortcut to the “ILWIS.exe” can be created, you can copy this shortcut to the desktop of your system.

Please take into consideration, straight from the start, the following golden rules when using ILWIS:

- Don't use spaces in directory or file names, instead use underscores;
- Do not only use numbers as file names;
- Do not work in multiple output directories;
- Start ILWIS, navigate to your working directory and close ILWIS. Open ILWIS again to ensure that your current working directory is also the actual ILWIS working directory.

1.3 DOWNLOAD THE MAMASE TOOLBOX

Available from: <http://52north.org/>

To download the MAMASE Toolbox from the 52North website: Select from the 52north.org website the navigation tab: “Earth Observation”. Additional information is provided over there as well as the link to the download area. You can also directly download the Toolbox from <http://52north.org/downloads/earth-observation>, select “MaMaSe”. Download the Zip file: “52n-eo-MaMaSe-toolbox-1.0” available over there and store it in a temporary directory. Eventually download other resources provided over there.

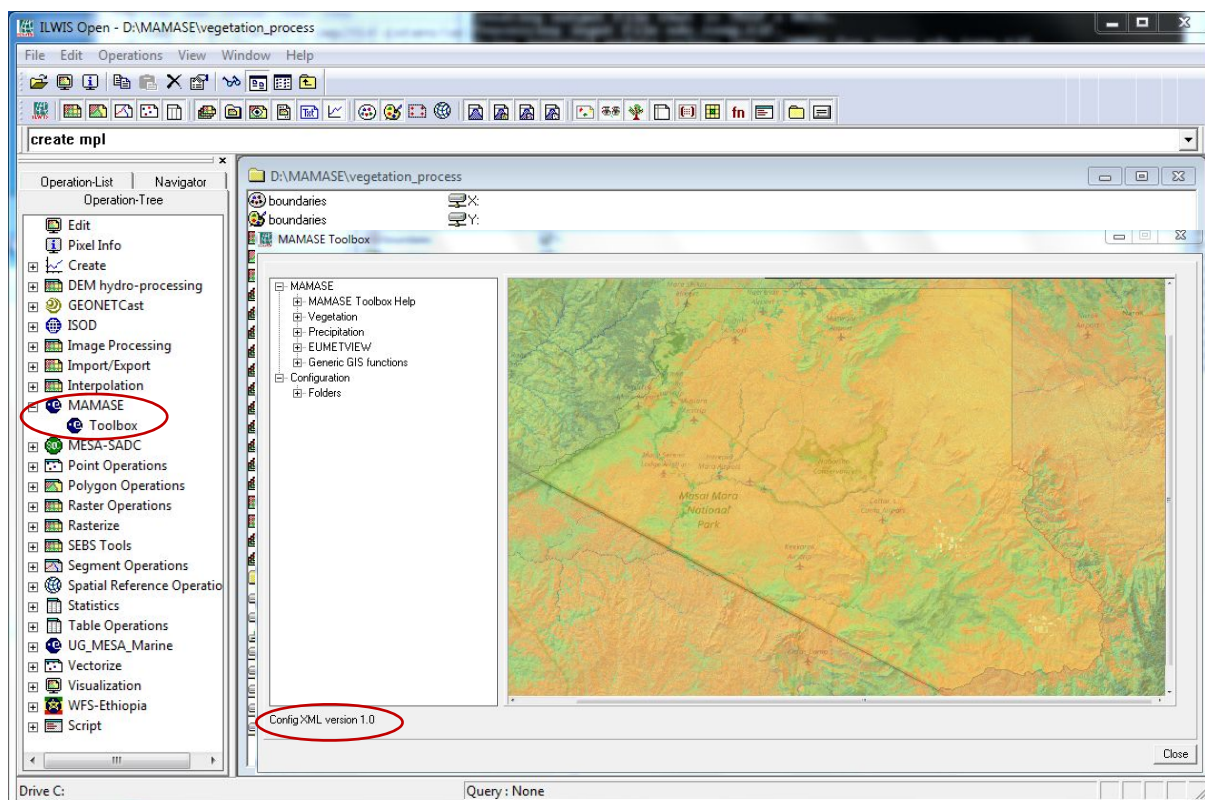
After the download is completed, copy this ZIP file in the ILWIS sub-directory “\Extensions”. There is no need to unzip the file! ILWIS automatically detects the ZIP file in this directory then unzips the file and installs the plug-in when a new instance of ILWIS is started. Afterwards the ZIP file is deleted in this “\Extensions” sub-directory!

If an ILWIS 37 version is used, start ILWIS and in the Operation-Tree of ILWIS the “MAMASE” tab will appear (see also figure 1.1). Double click the “MAMASE” tab and the subsequent “Toolbox” tab and various (sub) menus are now at your disposal. These options can be used to import open internet environmental and EUMETCast selected data sets.

If an ILWIS 38 version is used, use your file browser, navigate to the ILWIS sub-directory \extensions\geonetcast-toolbox, copy the two files with the extensions *.DLL and paste these in the sub-directory \extensions\MaMaSe-toolbox and start a new instance of ILWIS. Now the “MAMASE” tab will appear (see also figure 1.1). Double click the “MAMASE” tab and the subsequent “Toolbox” tab and various (sub) menus are now at your disposal.

Keep checking the “*Earth Observation*” community web pages (<http://52north.org/communities/earth-observation/>) for new (toolbox) developments. Modifications and added functionality for the MAMASE Toolbox are made available on these websites on an ad hoc basis, so check if you are working with the latest version. The XML configuration number, currently 1.0, is given on the lower left hand portion of the MAMASE Toolbox opening screen.

Figure 1.1: The MAMASE main and sub menu structure under ILWIS372



Close ILWIS as you might need to install additional utilities. Check if you have already installed IrfanView. If this is not case use the link below and follow the additional installation instructions.

1.4 DOWNLOAD IRFANVIEW

Available from: <http://www.irfanview.com/>

For some data visualizations and animation that do not require import into an ILWIS data format, use is made of IrfanView. Download the setup executable and save it in a temporary directory on your hard disk.

After the download has been completed run the setup, there is no need to create shortcuts, use the option: “For all users” and select the default Installation folder. Click “Next” three times, just use the default settings, “Don’t install Google Desktop Search”, click “Next” two times and after the installation has been completed, press “Done”.

An instance of IrfanView can be started to check if the installation has been successful, the program can be stopped. Eventually the slide advancement, available under the Slideshow icon, can be changed, e.g. “Automatic after 0.85 seconds”. For good visualization of the animations a “Play in Window mode option can be selected, the window size is 800 by 620 (width by height) respectively.

1.5 CONCLUDING REMARKS

With ILWIS, the MaMaSe Toolbox plug-in and the other necessary utility-software installed you still need to continue with the MaMaSe Toolbox configuration settings which are further described in the next chapter, next to additional information with regard to the overall toolbox architecture.

Some routines use "Powershell". If you are working on a system and do not have full administrative rights it is required to set the "Execution Policy" to "Unrestricted". Also this is described further below.

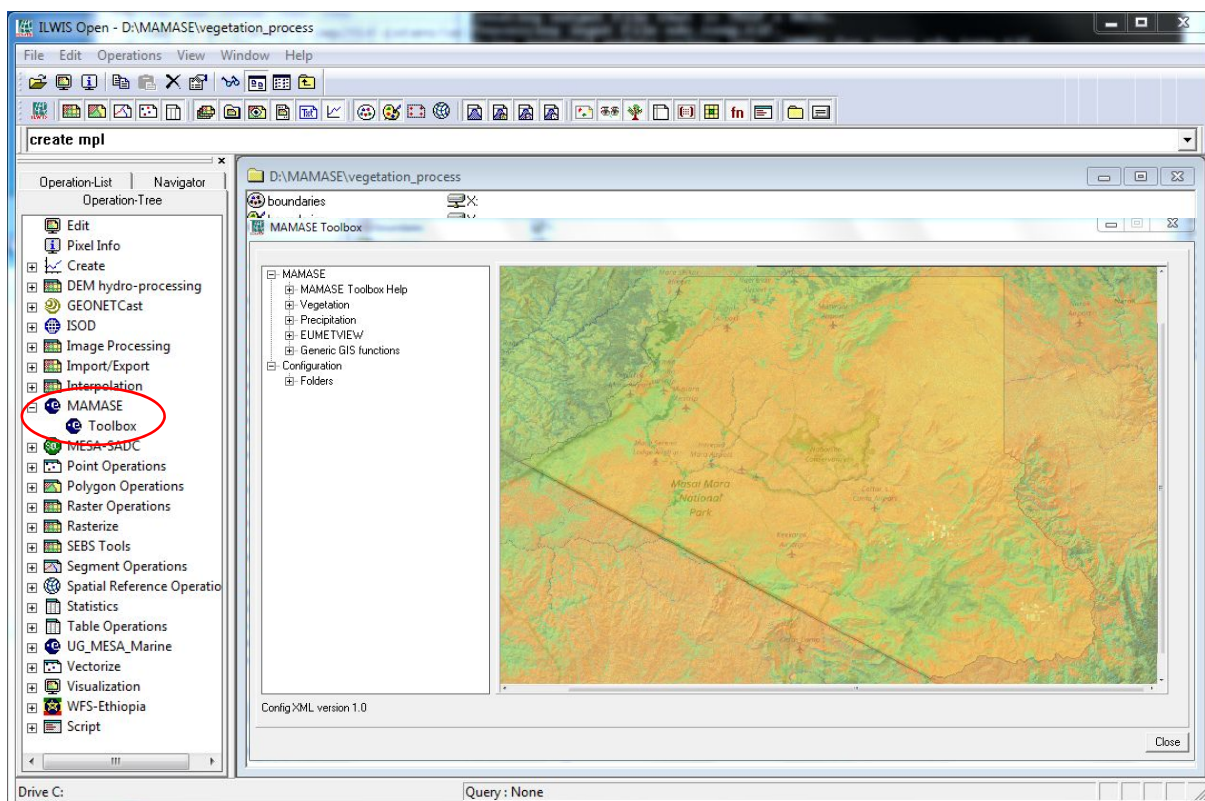
This page is empty

2. OVERVIEW OF THE MAMASE TOOLBOX ARCHITECTURE

2.1 INTRODUCTION

The MAMASE Toolbox Config XML version 1.0 allows import of various web based environmental data resources and data delivered via a GEONETCast-EUMETCast ground reception station through a Graphical User Interface (GUI). Here the toolbox architecture is described into more detail. Once the toolbox is installed and ILWIS is newly started the “MAMASE Toolbox” should appear as a menu item under the ILWIS Operation Tree (see figure 2.1).

Figure 2.1: The MAMASE Toolbox plug-in Graphical User Interface



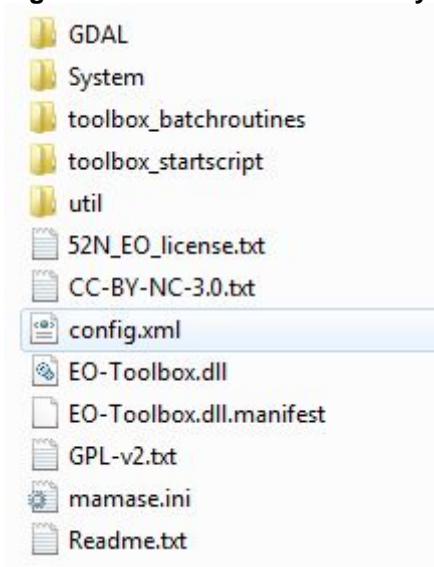
2.2 STRUCTURE OF THE MAMASE TOOLBOX

To operate the MAMASE toolbox, the Zip file “52n-eo-MaMaSe-toolbox-1.0” is copied under the ILWIS sub-directory “\Extensions”. Once a new event of ILWIS372 is started this ZIP file is extracted and the content is stored in the sub-directory “MAMASE-Toolbox” within the same “\Extensions” sub-directory. Within the “MAMASE-Toolbox” sub-directory a number of other sub-directories appear (see figure 2.2).

The folder “\GDAL” (Geospatial Data Abstraction Library) contains a translator library for raster geospatial data formats that is released under an X/MIT style Open Source license by the Open Source Geospatial Foundation (<http://www.gdal.org>).

The folder “\System” is storing the ILWIS service objects. Service objects are used by data objects; they contain accessories required by data objects besides the data itself. Upon installation of the toolbox, these objects are copied to the main ILWIS directory \System.

Figure 2.2: Toolbox sub-directory structure



The folder “*Toolbox_batchroutines*” provides the batch files that are used to execute most of the actual operations. These files can be opened and modified using a text editor like notepad. Further information is provided in chapter 2.6. Before you modify a routine, first make a backup!

The folder “*Toolbox_startscript*” contains a number of sub-directories which contain the ILWIS scripts. Upon selection of an import routine, from the MAMASE Toolbox User Interface a script is called and this script subsequently calls a batch file which executes the operation. The scripts can also be opened and modified using ILWIS. Further information is provided in chapter 2.5.

In the root of the “*Util*” folder ILWIS service objects are stored, like lookup tables, georeferences, domains, etc. Furthermore a number of executables are stored here that are used by various toolbox batch routines, such as the “*joinmsg*” executable. The sub-directory “*7Z*” is containing the 7Z unzip utility. The sub-directory “*Maps*” is containing segment-polygon files of the countries and for MAMASE project area. The sub-directory “*lgrep_wget*” is storing the wget utility used to extract the selected data from the internet http or ftp locations and the grep utility handles string manipulations / replacements in command line mode. The sub-directory “*manuals*” contains a number of files that provide ancillary information describing the nature of the data to be retrieved and this manual. The folder *ilwis_O* contains the new ILWIS open command line version which is used for the temporal filtering routine.

The file “*config.xml*” contains the MAMASE Toolbox GUI menu structure. This file can be edited using a text editor. In case the user wants to add new routines, this XML file can be adapted and modified. The resulting menu will be adapted accordingly when a new instance of the Toolbox is started. This allows users without programming experiences to adapt the toolbox to their own preferences. A more detailed description is provided below in chapter 2.3.

The file “*MaMaSe.ini*” contains the settings of the input and output directories for each “*folderid*” that is defined in the “*Config.xml*”. This file is storing the settings as defined from the Toolbox menu options “*Configuration*” >> “*Folders*”. Further information on the folder settings is provided in chapter 2.4.

The file “*EO-Toolbox.dll*” contains the layout of the User Interface of the MAMASE Toolbox and generates the full ILWIS command string that executes the script, batch file, defines and passes the parameters that are used, like the time stamp, input drive, input directory, output drive, output directory, ILWIS directory, etc. Up to 9 parameters are used to execute a Toolbox operation.

The file “*EO-Toolbox.dll.manifest*” is used by the operating system for certification of the appropriate DLL.

Furthermore included are a ‘*Readme.txt*’ and the ‘*52N_EO_license.txt*’, which can be opened using a text editor. These files provide relevant license and additional information on this toolbox release. The files ‘*CC-BY-NC-3.0.txt*’ and ‘*GLP-v2.txt*’ provide further details on the Creative Commons and GNU General Public License information applicable respectively.

NOTE: As from ILWIS38 a new version of the “*EO-Toolbox.dll*” has to be used. This file can also be downloaded from the “Earth Observation Downloads Area” (<http://52north.org/communities/earth-observation/>). When using ILWIS38, copy this file into the ILWIS directory “*Extensions\MAMASE-Toolbox*”. Eventually overwrite the existing “*EO-Toolbox.dll*”. The MAMASE Toolbox plug-in should now appear in the Operation-Tree, identical to figure 2.1 when activating ILWIS38.

2.3 STRUCTURE OF THE CONFIG XML

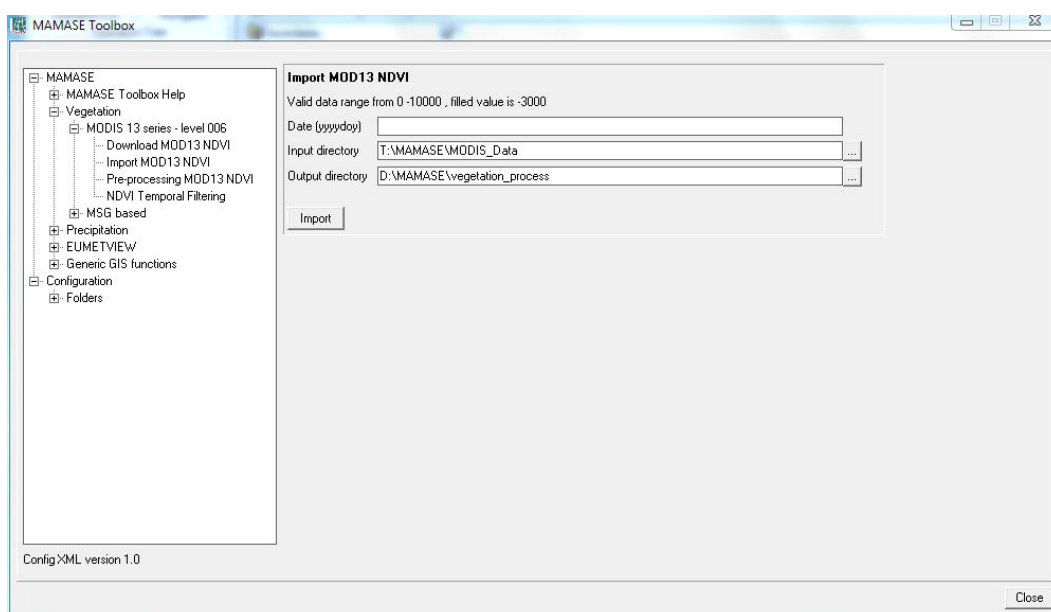
One of the main criteria during the development of this utility was to make the toolbox as open as possible, allowing users with no programming experiences to make modifications. As indicated before, all scripts and batch routines used can be adapted by the user. Next to this, the user can also modify the menu of the Toolbox GUI. The file that generates the user interface, “*Config.xml*”, can be opened using a text editor.

The structure of the file is kept as simple as possible. The “Level” is defining the main (Level1) and sub menu structure (Level2 – Level “N”). For the “Level value=” a menu name can be defined. Within a certain Level a “Product value=” can be specified, which will generate the name of the respective (sub) menu.

The string starting with “Product value=” contains mostly a number of other items, like “script”, “format”, “type”, “folderid” and “comment”.

- Script: The item script defines the sub-directory where the respective ILWIS script is located and the name of the script that should be executed;
- Format: The text string that can be entered here will appear in the popup window when importing a certain image or product. It is used to ensure that e.g. the appropriate “time stamp” is entered on the user interface (see the “Date” on figure 2.3). For the various data sets these can have different formats, in the example of figure 2.3 the “Date” stamp expected should have the format “yyyymmday” (yyyy=year, mm=month, doy= day of year). Also dd=day, pen=pentad, dek=Dekade are used, e.g. “yyyymmdek”;
- Type: This is the only part of the toolbox that does not allow user modification without programming experiences. Various forms, that generate the pop-up windows are available within the “EO-ToolboxUI.dll” and are called by their specific names given. These forms generate the appearance of the popup windows when importing a specific product. The popup menu that is given in figure 2.3 is generated from a “type” called: “ymdhm”;
- Folderid: This item generates a folder item in the “*MaMaSe.ini*” file. From the main Toolbox menu, “*Configuration*” and “*Folders*” option, this Folder item is now available and can now be further specified by defining the appropriate input and output directories.
- Comment: Additional information (one line of text) can be provided in the popup menu to notify the user on any specific information that might be relevant. In figure 2.3 a comment string is added showing the “Date” format expected (yyyymmday) and some information on the values of the imported ndvi.

Figure 2.3: Popup menu for import MOD13 NDVI product



Other syntax used in the config.xml is:

- < Start of a new line
- /> End of a line
- <Level... Start of a new level
- </Level"n"> End of level "n"

Note that all the text should be entered between quotation marks "".

The first few lines of the config.xml are:

- 1: < MAMASE >
- 2: <Version id="1.0" finder="false"/>
- 3: <UIInfo icon="ESA" menu="MAMASE..Toolbox" title="MASESE"/>
- 4: <Path value="Extensions\MAMASE-Toolbox" infile="MaMaSe.ini"/>

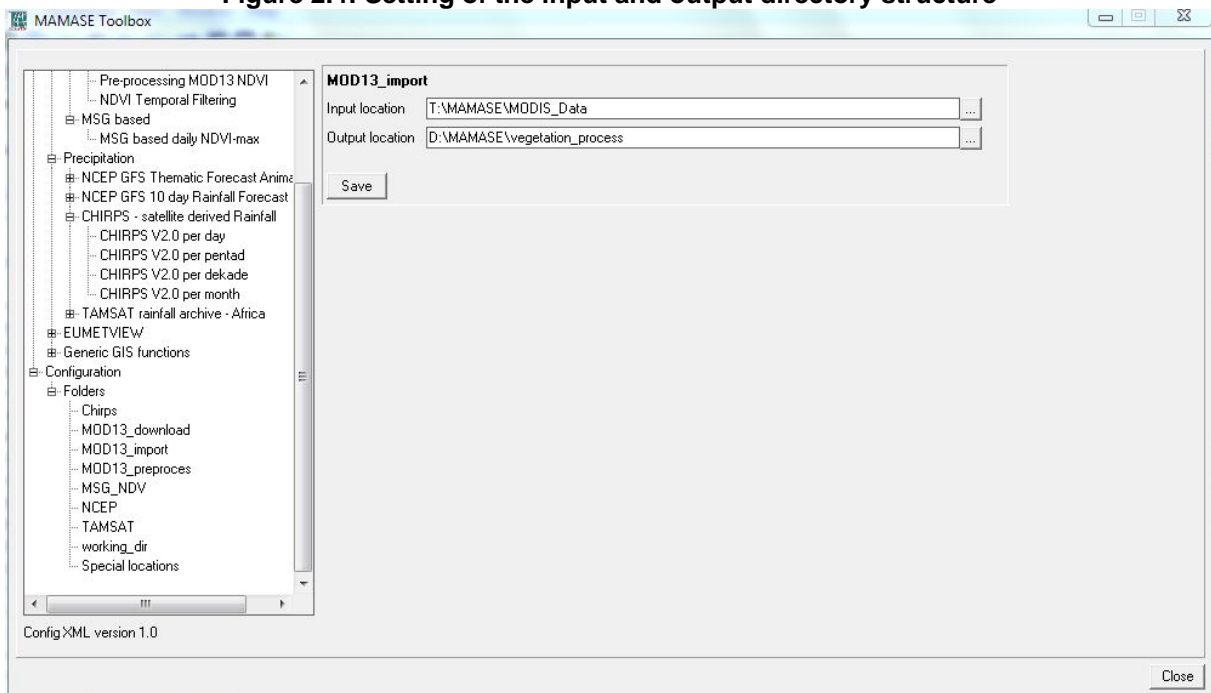
Line 1 provides the link to the plug-in and the menu name, note that this is also the last line of the XML. Line 2 provides the opportunity to indicate a version number, useful if modifications are done to the original XML. The version number is also shown in the main MAMASE Toolbox menu, in the lower left hand corner. The "Finder" is a utility under development, allowing a search using keywords. The "UIInfo Icon" in line 3 refers to the toolbox logo used in the ILWIS Operation Tree, the "menu" provides the name, the ".." indicates that the menu consists of two levels, and the heading used in the toolbox user interface is defined by the "title". In Line 4 the "path" defines the location of the toolbox in ILWIS and the "infile" here refers to the "MaMaSe.ini" file, which provides the links to the input and output directories.

After changes are made to the config.xml the file should be saved and a new instance of the Toolbox should be started, showing the adaptations. Before modifying the file first make a backup!

2.4 GENERAL MAMASE TOOLBOX CONFIGURATION - FOLDER SETTINGS

To conveniently work with the MAMASE Toolbox the local system output (working) directories need to be defined. From the main MAMASE Toolbox menu, select "Configuration" and the sub-menu "Folders". In figure 2.4 below the output directory for the MOD13 Import is used as example ("D" and T" are the local system hard disk and mapped network drive respectively). If the folders are correctly specified the "Save" button should be pressed to store the 'drive:\folder' settings.

Figure 2.4: Setting of the input and output directory structure



The “MAMASE.in” file can also be edited using a text editor to change using the “find and replace” option e.g. the drive for all directory entries in the file. Also the full directory settings can be specified, as example a “folderid” of “MOD13_import” is given. When opening the “MaMaSe.in” file, using a text editor, an item “[MOD13_import]” is given and the output folder can now be changed by providing the relevant directory names, like:

```
[MOD13_import]
InputFolder=T:\MAMASE\MODIS_Data
OutputFolder=D:\MAMASE\vegetation_process
```

There is a “Special locations” folder to select the location of an executable. Currently the location of “IrfanView” and “i_view32.exe” (or newer version) needs to be specified. This freeware utility is used for visualization and animation of pictures that are not transformed into an ILWIS data format. Make sure that this folder and executable are always correctly specified. Installation instructions are given in chapter 1.4.

2.5 STRUCTURE OF THE MAMASE TOOLBOX SCRIPTS

Most of the ILWIS scripts, situated within the sub-directories within the folder “\Toolbox_startscripts\” directory contain a single line having an identical structure. Below an example is given of the extraction of the “TAMSAT Dekadal Rainfall” script “TAMSATRFE_importnc”, located in the folder “\Toolbox_startscripts\Precipitation”:

```
!%7\Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_importnc.bat
%1 %2 %3 %4 %5 %6 %7 %8
```

The command line starts with: ! This syntax (!) instructs ILWIS to start an external application. The application that should be started is situated in “%7\Extensions\MAMASE-Toolbox\toolbox_batchroutines” and calls “TAMSATRFE_importnc.bat”. This is a DOS batch routine which should be executed. The parameters required to execute the batch routine are given as %1 to %8:

%1 Longfilename	remark: the lower left corner coordinates for the specific elevation tile
%2 InputDrive	remark: input data drive, not used here
%3 InputDir	remark: input data directory, not used here
%4 OutputDrive	remark: output data drive
%5 OutputDir	remark: output data directory
%6 gdalDir	remark: location of GDAL directory within the toolbox
%7 llwDir	remark: location of the ILWIS directory
%8 UtilDir	remark: location of the Util directory within the toolbox

A number of these parameters are generated by the “EO-Toolbox.dll”, such as gdalDir, llwDir and UtilDir as these are fixed locations within the toolbox. Other parameters require user interaction, such as longfilename, InputDrive, InputDir, OutputDrive, OutputDir, as these change based on the user preferences. These parameters can be interactively provided in the popup menu when importing an image or product, see e.g. figure 2.3 above. The “Date” field provides the “Longfilename”, input and output drive and directory for the “InputDrive”, “InputDir”, “OutputDrive” and “OutputDir” respectively.

When pressing the “Import” button of the popup menu (see again figure 2.3) an ILWIS command line is generated which is executed. Using the script example above for import of a TAMSAT Dekadal Rainfall product, the following command line is generated and executed:

```
!D:\Ilwis372 \Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_
importnc.bat 2017011 x x D:\MAMASE\precipitation_process D:\Ilwis372
\Extensions\MAMASE-Toolbox\GDAL\bin D:\Ilwis372 D:\Ilwis372 \Extensions\MAMASE-
Toolbox\util
```

The parameters are now defined as follows:

%1 Longfilename	2017011 (the “Date” stamp, retrieval 1 st dekade of January 2017)
%2 InputDrive	x (not used here)
%3 InputDir	x (not used here)

%4 OutputDrive	D:
%5 OutputDir	MAMASE\precipitation_process
%6 gdalDir	C:\Ilwis372\Extensions\MAMASE-Toolbox\GDAL\bin
%7 IlwDir	C:\Ilwis372
%8 UtilDir	C:\Ilwis372\Extensions\MAMASE-Toolbox\util

Now with all parameters set the batch file "**TAMSTRFE_importnc.bat**", situated in the ILWIS subdirectory "*\Extensions\MAMASE-Toolbox\toolbox_batchroutines*" can be executed. Starting the command with the "!", ILWIS knows it has to execute an external command, given the fact that the extension is ".bat", the Windows operating system knows it has to execute this file using the Windows Command Line Processor (CMD.exe).

For a number of visualization and animation routines to view picture products (in png, gif or jpg formats) "*IrfanView*" is used. In these cases an additional parameter is defined as %9, called "*IrfanViewDir*". This parameter defines the location of the IrfanView directory and executable. It can be specified under "*Configuration*" >> "*Folders*" and "*Special locations*" options from the MAMASE Toolbox User Interface.

2.6 STRUCTURE OF THE MAMASE TOOLBOX BATCH ROUTINES

As is the case with the ILWIS scripts, also most of the batch files follow a similar structure. As an example a retrieval of the "TAMSTR Dekadal Rainfall" import routine is given below. The first 6 lines (see line numbers) are giving some general remarks and these are shown in the command line window, see figure 2.5. The command "echo." results in an empty line in the command line window, which is used to improve the readability of the text given in the command line window.

From line 7 to line 17 in the batch file the "Date" stamp, here defined as "*longfilename*" is passed, originating from the ILWIS script, to the batch file using the "SET" command. This command displays, sets or removes Windows Environment Variables.

When starting this import operation for the Date field the appropriate RFE map date should be entered, here defined as "*yyyymmdek*" (total of 7 characters), the first 4 digits for the year are subsequently defined as *shortfilename1* (in line 8, first 4 characters of the input string), the month is defined as *shortfilename2* (in line 9, for characters 5 and 6 of the input string) and the dekade is assigned as *shortfilename3* (in line10, as character 7 of the input string).

From lines 11 to 17 the other parameters are passed, originating from the ILWIS script, to the batch file. Once all these parameters are known the actual import routine can start. Lines 18 to 20 ensures that the application moves to the appropriate output directory. Lines 21 to 22 show in the command line window the full date stamp which is used and shows the output directory defined (see figure 2.5). The items "echo." in lines 23 and 24 creates two empty lines in the command line window.

Once in the output directory line 25 starts the "Wget" utility which retrieves the requested input data from the specified internet location, using the appropriate file name, created based on the *longfilename* string entered, as derived from the "Date" stamp, note "*rfe%shortfilename1%_%shortfilename2%-dk%shortfilename3%.nc*". Line 27 sets the display of subsequent messages off.

In line 28 a check is performed if the input file exists, if this file does not exist the batch routine jumps to the section starting with "MESSAGE". If the input file exists line 29 is displayed in the command line window, followed by 2 empty lines and then jumps to the start of the actual import routine, which begins at the "START" section (line 42).

If the input file does not exist (in line 28) the batch routine jumps to line 33 "MESSAGE", the section below (lines 34 to 39) are displayed, see also figure 2.5. In line 40 a "pause" command is used and the user has to press <enter> in order to continue. Once this is done the "GOTO END" command in line 41 causes the routine to jump to line 57.

If the data is located in the specified input drive-directory, the retrieved file is renamed in line 43, and imported into ILWIS format in line 44, using GDAL.

Ancillary data, in this case a mask, only providing the African continent land area, is copied from the toolbox utility directory (in line 45) and the data is unzipped in line 46.

Once the file is in ILWIS format, a second instance of ILWIS is executed from the command prompt in line 47 and the georeferenced is set. In line 48 the routine checks for no data and is assigning this to a value of "0" in a new output map with the suffix "b". In line 49 a conditional statement is used, if the land mask = 1 (for land only) and the map with suffix "b" = 0, then assign 0, else use the RFE map (with suffix "b") values. In line 50 the georeferenced is set once more.

Lines 51 – 56 are deleting the files that have become obsolete. Line 57 marks the ":END" section. With or without the required input data line 58 is always executed, this line closes instances of ILWIS which have started using this batch routine.

Start of batch file listing: *TAMSATRFE_importnc.bat*

```
1: @echo off
2: echo TAMSAT RFE product 10 day rainfall in mm
3: echo From archive
4: echo File name convention rfe2011_03-dk3.nc
5: echo.
6: echo.

7: set longfilename=%1
8: set shortfilename1=%longfilename:~0,4%
9: set shortfilename2=%longfilename:~4,2%
10: set shortfilename3=%longfilename:~6,1%
11: set InputDrive=%2
12: set InputDir=%3
13: set OutputDrive=%4
14: set OutputDir=%5
15: set gdalDir=%6
16: set llwDir=%7
17: set UtilDir=%8

18: cd\
19: %OutputDrive%
20: cd %OutputDir%

21: echo rfe%shortfilename1%_%shortfilename2%-dk%shortfilename3%
22: echo your current working directory = %OutputDrive%\%OutputDir%
23: echo.
24: echo.

25: "%UtilDir%\grep_wget\wget.exe"
26: http://tamsat.org.uk/public_data/%shortfilename1%/rfe%shortfilename1%_%shortfilename2%-
   dk%shortfilename3%.nc

27: echo off
28: if not exist "%OutputDrive%\%OutputDir%\rfe%shortfilename1%_%shortfilename2%-dk%shortfilename3%.nc" goto
   MESSAGE
29: echo The file(s) "rfe%shortfilename1%_%shortfilename2%-dk%shortfilename3%.nc" has been retrieved and transferred to
   your current working directory
30: echo.
31: echo.

32: GOTO START

33: :MESSAGE
34: echo The input file was not found in the archive.
35: echo Check your Date stamp settings
36: echo Your current Date stamp used is %longfilename%
37: echo Data is retrieved from http://tamsat.org.uk/public_data/
38: echo Check also manually if the data exists on ftp archive (see link above)
39: echo Internet has a transient nature - addresses might not be valid or has changed after some time!

40: pause

41: GOTO END

42: :START
```

```

43: rename rfe%shortfilename1%_shortfilename2%-dk%shortfilename3%.nc
    rfe%shortfilename1%%shortfilename2%%shortfilename3%.nc

44: "%GdalDir%\gdal_translate.exe" -of ilwis
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%.nc
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%.mpr

45: copy "%utildir%\maps\rfeland_mask1.zip"

46: "%utildir%\7z\7z" e rfeland_mask1.zip
47: "%llwDir%\ilwis.exe" -C setgrf
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%.mpr %Utildir%\rfe_nc
48: "%llwDir%\ilwis.exe" -C
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%b:=ifundef(%OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%a,0)
49: "%llwDir%\ilwis.exe" -C
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%:=iff(%OutputDrive%\%OutputDir%\africaland_mask1=1 and
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%b=0,0,%OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%b.mpr)
50: "%llwDir%\ilwis.exe" -C setgrf
    %OutputDrive%\%OutputDir%\rfe%shortfilename1%%shortfilename2%%shortfilename3%.mpr %utildir%\rfe_nc

51: del rfe%shortfilename1%%shortfilename2%%shortfilename3%.nc
52: del rfe%shortfilename1%%shortfilename2%%shortfilename3%.mpr.aux.xml
53: del rfe%shortfilename1%%shortfilename2%%shortfilename3%.mp*
54: del rfe%shortfilename1%%shortfilename2%%shortfilename3%.b.mpr*
55: del rfeland_mask1.*
56: del africaland_mask1.*

57: :END
58: "%llwDir%\ilwis.exe" -C closeall

```

End of Batch file listing

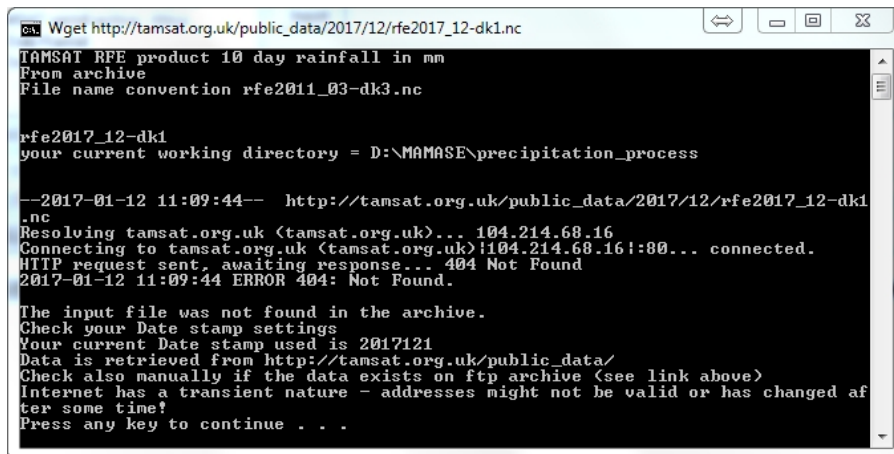
Although the content of the batch files can vary significantly, the sequence of activities is mostly the same:

- Some remarks are given at the start of the batch file
- Setting of the environment variables, passing over the parameters from the ILWIS scripts to be used by the batch routine executed
- Check if input data is available, if not go to the end of the batch routine
- Retrieve or copy the original data to the local working directory specified
- Import of the data into ILWIS format
- Execute various ILWIS routines from the command prompt
- Delete obsolete files
- Close ILWIS tasks created during the batch routine execution

Note that all batch routines show a command line window. Relevant information is contained in these windows. It is advised that the content of these windows is critically checked while waiting for the batch routine to finish. The batch files can be opened using a text editor. The name of the batch file executed can be obtained from the ILWIS command line, a sample string is given in chapter 2.5. Some import routines download time series of data (e.g. dekadal or monthly climatology rainfall data). Upon extraction of the file all data contained is imported using a batch looping procedure. For further information on how these procedures operate see also the reference given in chapter 2.7. Some files are large so adequate bandwidth is required for smooth operations, e.g. as is the case with the MOD13 Vegetation product files.

In the example given in the batch file listing given above a date stamp should have been entered as "2017011". The actual time stamp erroneously provided is "2017121" which is resulting in the fact that the input data cannot be found (as it is not available at this moment!) and the routine, after pressing <Enter> is aborted. Carefully inspect the date stamp and directory settings as indicated in the command line interpreter window as given in the figure below.

Figure 2.5: Resulting message when entering wrong date-time stamp



```
Wget http://tamsat.org.uk/public_data/2017/12/rfe2017_12-dk1.nc
TAMSAT RFE product 10 day rainfall in mm
From archive
File name convention rfe2011_03-dk3.nc

rfe2017_12-dk1
your current working directory = D:\MAMASE\precipitation_process

--2017-01-12 11:09:44-- http://tamsat.org.uk/public_data/2017/12/rfe2017_12-dk1
.nc
Resolving tamsat.org.uk (tamsat.org.uk)... 104.214.68.16
Connecting to tamsat.org.uk (tamsat.org.uk):104.214.68.16:80... connected.
HTTP request sent, awaiting response... 404 Not Found
2017-01-12 11:09:44 ERROR 404: Not Found.

The input file was not found in the archive.
Check your Date stamp settings
Your current Date stamp used is 2017121
Data is retrieved from http://tamsat.org.uk/public_data/
Check also manually if the data exists on ftp archive (see link above)
Internet has a transient nature - addresses might not be valid or has changed af
ter some time!
Press any key to continue . . .
```

When appropriate, “quotation marks” are used to specify the location of a ‘directory\executable’ as well as for the input original file names to ensure that batch routines keep working if encountered spaces in (sub-) directory names and to process input files with complex file names. To ensure proper operation of the batch routines stick to the golden rules as given in chapter 1.2.

Some routines also use PowerShell scripts. This utility is used to create interactive pop-up menus for easy data entry. The PowerShell *.ps1 is activated through the batch file and is creating, based on the user input a text file, which is subsequently called by the next line in the batch routine. This text file contains the user entries and these are set as environment variables. To prevent issues running powershell scripts, ensure that the Execution Policy is set to “Unrestricted”, see also: <https://msdn.microsoft.com/en-us/powershell/reference/5.1/microsoft.powershell.security/set-executionpolicy>.

Open an instance of powershell and type the following commands:

```
get-ExecutionPolicy
set-ExecutionPolicy -ExecutionPolicy Unrestricted
```

The “get” command shows the actual settings, if required these can be modified using the “set” statement.

2.7 ADVANCED USE

If certain operations have to be repeated on a continuous basis, e.g. import of certain products for which basically only the time stamp has to be modified the use of the MAMASE toolbox menu might be cumbersome. From the main menu of ILWIS, the command line history can be checked. Select the appropriate string generated through the graphical user interface, modify the time stamp and execute the expression again by pressing <Enter>.

It is advised however, to copy the command line string that is generated through the graphical user interface, available from the command line in the main menu of ILWIS, to the WINDOWS command line processor (CMD.exe). Delete the “!” from the start of the string and execute the expression. Within the string the date stamp can be easily modified. Eventually this line can be copied into a new text file and the file can be given an extension “.bat”. Add at the beginning of each line the command “cmd /c” to ensure that after execution of a line the routine jumps to the next line within the batch file. This file can then be executed from the DOS Command prompt. With multiple lines in such a batch file only having different “Date” stamps, time series can be created very efficiently. Additional information on how to conduct these procedures is described in the “GEONETCast – DevCoCast Application Manual”, online available at: <http://www.itc.nl/Pub/WRS/WRS-GEONETCast/Application-manual.html>. Also within this document an example demonstrating automated data retrieval and processing is presented (see chapter 4.2.4).

2.8 CONCLUDING REMARK

With all the configuration settings provided you are now ready to utilize the MAMASE Toolbox and explore the selected data that is freely available from the Internet / GEONETCast-EUMETCast Environmental data stream. The main objective of this toolbox is to integrate these resources in an efficient manner into the Geographic Information System ILWIS, relevant for the MaMaSe Project.

This document is providing links to various online metadata and background reference resources, next to the data archives itself (indicated within the toolbox pop-up menu). It should be noted that due to the transient nature of the internet some of these links might not be up to date anymore. In case this is noted please provide your observations to the EO Community contact available at: <http://52north.org/communities/earth-observation/community-contact>.

3. EXPLORING SELECTED RESOURCES USING THE MAMASE TOOLBOX

3.1 INTRODUCTION

Various environmental (time series) data resources are currently available on the internet and GEONETCast-EUMETCAST Environmental data stream relevant for a multitude of applications. Users are often not aware of these resources and if so, they might find it difficult to import the (multi-temporal) data into a GIS. In order to overcome these bottlenecks, the “MAMASE” Toolbox has been developed. When operating the toolbox, the data is in most cases automatically retrieved (when possible!) and ingested into an ILWIS format. The data exchange library within ILWIS allows the user to export the data to other formats; furthermore the extensive image, vector and thematic data processing capability of ILWIS can be used for further data analysis.

Within this chapter attention is given to the various data resources which can be retrieved using the toolbox. Additional relevant background information is presented here to obtain a better understanding of the data which is needed if further analysis is envisaged. References to (online) documentation are provided as well. In the following chapter a number of practical exercises are presented using the toolbox to become familiar with its functionality.

The toolbox menu (XML Version 1.0) as presented in figure 2.1 has a number of main menu items. This menu sequence is followed below as well to present the relevant background details.

3.2 MAMASE TOOLBOX HELP

The HELP submenu provides additional information on the software and license information in the Readme. It has a link to this manual and additional information is provided on the MOD13 and MSG Vegetation Index User's / Product Guide as well as the temporal filtering schedule implemented to process the full time series of the NDVI as from 2000 onwards. To retrieve the various documents available press the “Import” button.

3.3 VEGETATION

Routines have been developed to integrate the online (satellite derived) Vegetation products from MOD13 Version 006 for Index number h21 v09 and from METEOSAT 2nd generation geostationary (MSG) satellites. The MOD13 tile is covering the MaMaSe region. The data is retrieved from https://e4ftl01.cr.usgs.gov//MODV6_Cmp_C/MOLT/MOD13Q1.006/. The current routines implemented allow the user to download the data files for MOD13 and MSG and to import them into an ILWIS format for a given geographical sub window.

For the MOD13 NDVI the user can conduct some additional preprocessing (remove the fill values) and create an ndv map with values from -1 to 1 as well as a ndv byte map, with values from 0 to 255. The time series extracted can be used in a temporal filter to remove noise.

The MSG derived NDVI is a daily product and is disseminated through EUMETCast every day at approximately 00:15 UTC the next day. The NDVI daily product is generated by incremental update at each repeat cycle of 15 minutes during daytime, every time a new clear-sky observation is available for a given pixel. Here the maximum NDVI value obtained over the day is used. Data is resampled to the georeference used for MOD13 NDV.

The MOD 13 NDV is a 16 day product, using a maximum value compositing method. Data becomes available online about 20 days after each 16 day cycle. To fill the gap between availability of a new MOD13 NDV product, the MSG derived daily NDV can be used.

The online data (in HDF format) is stored under dated folders, according to calendar date. The HDF files have as date string in their filenames the day of year (doy) notation. The table below provides an overview of the structure of the webpage and corresponding data provision for normal and leap years.

Table 3.1: MOD13 Q1 level 006 Series data provision details

Day of year (doy)	Calendar date normal year (mm-dd)	Calendar date leap year (mm-dd)
001	01-01	01-01
017	01-17	01-17
033	02-02	02-02
049	02-18	02-18
065	03-06	03-05
081	03-22	03-21
097	04-07	04-06
113	04-23	04-22
129	05-09	05-08
145	05-25	05-24
161	06-10	06-09
177	06-26	06-25
193	07-12	07-11
209	07-28	07-27
225	08-13	08-12
241	08-29	08-28
257	09-14	09-13
273	09-30	09-29
289	10-16	10-15
305	11-01	10-31
321	11-17	11-16
337	12-03	12-02
353	12-19	12-18

File name convention used is "MOD13Q1.A2000049.h21v09.006.2015136104747.hdf". In this example the date provided is 2000049, corresponding to calendar date 18 February 2000, note the shift in calendar dates for normal and leap years as from day of year 65 onwards. The date string, for production date, at the end of the filename is not used.

Under the Help menu the product guides are provided for the MOD13 and MSG derived NDVI products. Additional information on MOD13 can be obtained from https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mod13q1. For MSG consult <http://www.eumetsat.int/website/home/Data/Products/Land/index.html> and look under Vegetation Products for 'Normalised Difference Vegetation Index - MSG - 0 degree'.

3.4 Precipitation

The Global Forecast System (GFS) is a weather forecast model produced by the National Centers for Environmental Prediction (NCEP). Dozens of atmospheric and land-soil variables are available through this dataset, from temperatures, winds, and precipitation to soil moisture and atmospheric ozone concentration (source: <https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-forecast-system-gfs>).

Routines implemented allow the user to view an animated sequence of a 6 day - daily forecast for Africa, produced by the NCEP, of rainfall and an 850Mb level forecast of temperature, relative humidity and streamlines (winds). For visualization of the animations IrfanView is used (see also chapter 1.4). This utility should be installed by the user, see installation instructions (chapter 1.4), and the special location folder should be correctly specified (see also chapter 2.4).

The next routine allows the extraction of the 10 day – daily precipitation forecast for Africa. Daily forecasts are retrieved (pre-processed at ITC and provided in ILWIS format) from the ITC FTP. New forecasts are available at approximately 07:00 UTC each day.

It is also possible to retrieve three different satellite derived rainfall products, one created by the University of Reading, TAMSAT (<http://www.tamsat.org.uk/cgi-bin/data/index.cgi>) including daily,

dekadal and monthly rainfall and a rainfall climatology. The other one is from the Climate Hazard Group, called CHIRPS (<http://chg.geog.ucsb.edu/data/chirps/>). Data can be retrieved for daily rainfall, per pentad, dekade and on monthly basis. Due to the fact that ground observations are used, the lead time is longer compared to TAMSAT, about 2 months. TAMSAT products are available directly after each dekade. For further details on each of these products use the links indicated above.

The final rainfall product retrieval function implemented is extracting the MSG based multi sensor precipitation estimate (MPE). Each 15 minutes the satellite records the area and the rainfall is retrieved. The product is aggregated from a 15 minutes temporal interval to a daily interval (from 00:00 – 23:45 UTC) and this final product is stored on the ITC FTP. Further information on this product can be obtained from http://oiswww.eumetsat.int/~idders/html/doc/IPWG_2002_MPE.pdf.

3.5 EUMETVIEW

EUMETView is a visualisation service that allows users to view EUMETSAT imagery in a more interactive way through an online map viewer or Web Map Service (WMS). It is currently a pilot service and is providing near real time geostationary satellite images in different spectral regions and derived products, such as satellite derived rainfall. The link to the WMS is <http://eumetview.eumetsat.int/mapviewer/>.

3.6 GENERIC GIS Functions

A routine is implemented here ensuring that all final products are using the same projection and map dimensions / resolution. The final georeference used is “*MaMaSe_23m.grf*”. For sake of completeness also the details are provided in the table below of the MOD13 NDV georeference and projection parameters.

Table 3.2: the main georeference and projection parameters used

	MAMASE grf/csy	MOD13 NDV grf/csy
Corners of Corners	Yes	Yes
Min-X	678090.376176589870	0.00
Min-Y	9790238.35396559160	97500777.42
Max-X	826952.751994465830	174903.30
Max-Y	9900043.46778083410	9950000.00
Projection	UTM	UTM
Datum	WGS 1984	User Defined
Zone	36 Southern Hemisphere	37 Southern Hemisphere
No. Lines	4740	863
No. Columns	6426	755
Pixel Size	23.166	231.66

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4. MOD13 NDV ARCHIVE AND PROCESSED DATA

4.1 INTRODUCTION

For the MaMaSe Project all MOD13-Q1 Vegetation Indices 16-Day L3 Global 250m for Index number h21 / v09 are retrieved locally and are processed from start of product generation (doy=2000049) till the end of 2016 (doy=2016353) at the moment of writing. Global MOD13-Q1 data are provided every 16 days at 250-meter spatial resolution as a gridded level-3 product in the Sinusoidal projection. New data becomes available about 20 days after the integration period is completed and is available at the NASA's Land Processes Distributed Active Archive Center (LP DAAC) located at the USGS Earth Resources Observation and Science (EROS) Center.

Downloading these data requires a NASA Earthdata Login username and password. For the purpose of the project this was done and is provided internally within the appropriate routines. A new user account can be created at: <https://urs.earthdata.nasa.gov/users/new>. For modification of the settings contact the corresponding author. For more information about the data, including documentation and how to properly cite the data, see: <https://lpdaac.usgs.gov/>.

4.2 TRANSFER MOD13 DATA TO LOCAL ARCHIVE

All available original HDF files have been downloaded and are provided in the MAMASE folder, sub-directory is \MODIS_Data. New datasets, for 2017 (20170101) onwards have to be downloaded using the routine provided. This archive is stored at an appropriate location and available internally for project purposes.

The 250m VI product contains the Science Data Set "250m 16 days NDVI", data type is "int16", valid range is "-2000 to 10000" and the scaling factor is "0.0001". Missing data has been assigned to a value of -3000. Only the NDVI layer is retrieved from the HDF file and processed. A GDAL-Warp routine is implemented to change from Sinusoidal to UTM projection.

4.3 ARCHIVE DATA PROCESSING AND TEMPORAL FILTERING

All downloaded data has been imported in ILWIS format and pre-processed. All data is available in the MAMASE folder, sub-directory is \Vegetation_process. For all files the doy notation is used, e.g. ndv_200049. Files have a suffix _b and _r for byte range and data range from -1 to 1 respectively. To obtain the _r ndv maps the scaling factor has been applied. For the _b map conversion (to byte range 0-255) the following formula was applied: $ndv_inmap * 0.02125 + 42.5$. This is resulting in a value of 85 where vegetation starts (source: Kees de Bie, Department of Natural Resources, ITC).

The Representation to be used for the _b maps is "ndv_byte" and for the _r files is "NDVI1".

Based on the time series imported a climatology was constructed for each 16 day period for the byte range maps. For each year a maplist was created for both types of ndv's. All data was visually inspected to check if all preprocessing was conducted appropriate using animated sequences. Maplists have also been created containing the given time steps over the total period, e.g. for timestep 049 all layers from 2000 to 2016 for this time step have been selected (ndvb_clim_***, ***=doy). Subsequently the median value was derived and stored as climatology for this time step. A final maplist was created "clim_stmed", containing the 23 time steps "clim_ndvb****" (***=doy). These climatologies are required for the temporal filtering routine of the most recent ndv time steps.

All ndv byte maps and the climatologies are copied into the folder "\MAMASE\Filter_process" for further processing.

For the filtering procedure use is made of the modified adaptive Savitzky-Golay filter (http://www.itc.nl/library/papers_2009/msc/gem/beltran-abauanza.pdf) to reduce noise in the NDVI time series data and forcing an upper envelope. It is a modification of the filter in TIMESAT 2.3 (<http://web.nateko.lu.se/timesat/timesat.asp>). The code is developed by Willem Nieuwenhuis (w.nieuwenhuis@utwente.nl), ITC-NRS, and implemented under ILWIS Objects. The input data is

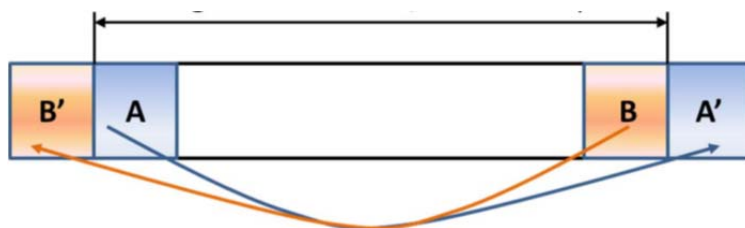
expected as byte values (domain IMAGE) and the output data will also be byte data (domain IMAGE for ILWIS 3 output). Also the filter assumes 16 day data (23 images per year).

For proper operation at least one year of data is recommended. A number of options are set. The filter iterates using different filter window sizes as this aids in filtering without losing too much detail. By specifying the number of iterations, automatically the window sizes are calculated. For example 4 iterations will generate window sizes of 3, 5, 7 and 9. The filter always starts with the smallest window size. The window size is calculated as $\langle \text{current iteration} \rangle * 2 + 1$. Here “4” is applied. With these 4 iterations specified 9 time steps are considered, four before the actual time step and 4 future time steps.

The “*upperenvelop*” is set to true and the filter will use the original value in favor of the fitted value if the fitted value is lower than the original value. The “*fitlastiteration*” is set to true and therefore the filter will force the upper envelope for all filter window sizes except for the last.

The “*extendwindow*” is set to true and the input maplist is extended with data from the front appended to the end, and data from the end appended to the beginning to account for the filter window size. The figure below shows the way time steps are added to the time series using the extendwindow “true” option, adding additional data, depending on the filter size, to the start and end of the time series. This is why 23 steps are required to ensure that the “yearly cycle” is maintained.

Figure 4.1: Extension of the time series temporal window



The overall filter schedule applied is given in appendix 3. For the filter input a maplist is required, specifying the 23 layers to be used during the filter procedure. As input maplist convention a consecutive maplist number was provided (e.g. ndv_in001, ndv_in002, etc.), resulting in a similar output maplist number (e.g. ndv_out001, ndv_out002, etc.). For the first three 16 day periods (in 2000) no actual data is available, therefore the climatology calculated for these time steps is used.

The output maplist layers are having as filename convention “ndv_out***_mpl_band_0.mpr” to “ndv_out***_mpl_band_22.mpr” (note ***=maplist number). Given the fact that 4 iterations are used within the filter, output map layer 17 is not going to be changed during subsequent filter operations. This layer is regarded as final. From each of the ndv_out maplists this layer is copied into a new folder “\MAMASE\Ndv_final”, currently until ndv_out369. See also the red column in the filter schedule.

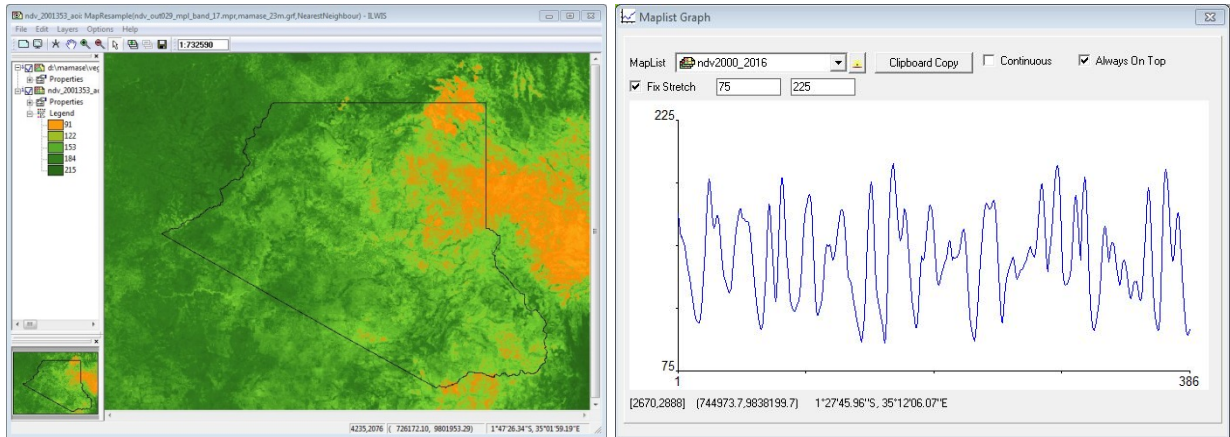
For processing of current ndv maps the climatology is used for the future time steps, e.g. for ‘ndv_in370’ the input ndv for time step 2017001 is not available. This time step is now replaced by the map “clim_ndvb001”. For ‘ndv_in371’ the input ndv for time step 2017001 and 2017017 are not available, these time steps are now replaced by the maps “clim_ndvb001” and “clim_ndvb017”. For ‘ndv_in372’ the input ndv for time step 2017001, 2017017 and 2017033 are not available, these time steps are now replaced by the maps “clim_ndvb001”, “clim_ndvb017” and “clim_ndvb033”. For ‘ndv_in373’ the input ndv for time step 2017001, 2017017, 2017033 and 2017049 are not available, these time steps are now replaced by the maps “clim_ndvb001”, “clim_ndvb017”, “clim_ndvb033” and “clim_ndvb049”.

After the actual data becomes available the respective climatology time steps are replaced with the actual ndv maps in the map list and the map list is filtered again. Each time the value of layer 17 in the filtered output map list is containing more actual data and the final value is more based on actual observations compared to the climatology. Therefore the last 4 time steps need to be filtered a number of times to get the final values.

4.4 FINAL NDV PREPARATIONS

As indicated above the final NDV filtered time steps (layer 17 from an output map list created by the filter) is copied into a folder 'MAMASE\ndv_final'. All maps are resampled to the mamase georeference and the initial files are deleted. The resampled files have as suffix *_aoi. Some of the results are presented in the figure below.

Figure 4.2: Filtered ndv time series map for the Mamase region for a selected pixel



Note that the x-axis is showing the time, e.g. from 1 to 386 represents 2000001 to 2016257 (16 years of 23 maps each and 18 maps for the year 2016)

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5. PRACTICAL EXERCISES USING THE MAMASE TOOLBOX

5.1 VEGETATION

5.1.1 Introduction

After installation of ILWIS and the MAMASE Toolbox (XML version 1.0), start ILWIS and open the “MAMASE” > “Toolbox” options from the left hand menu tree. Inspect the menu strings of the Toolbox and open the item “Configuration” > “Folders” (see also figure 2.1 and chapter 2.4). Note that here the assumption is made that you have created on your local system, using drive “C”, a directory called “Vegetation_process”. For the Folder items under MOD13_download, MOD13_filter, MOD13_import, MOD13_preprocess and MSG_NDV, specify the appropriate directory and press “Save” to store the drive:\directory settings. For the purpose of these exercise the same output directory can be used. It should be noted that as input folder for the MSG_NDV the user should have acces to a EUMETCast ground reception station archive. Note the local settings. At ITC a network mapping can be made to the EUMETCast file server at [\\csyn009.utsp.utwente.nl/other](http://csyn009.utsp.utwente.nl/other) and the data is in the folder MPEF_DayDec. Close the Toolbox and use the ILWIS Navigator to move to the directory “C:\Vegetation_process”. Close ILWIS and start ILWIS again, ensure that the location of your catalogue is now “C:\Vegetation_process”. Select from the menu the “MAMASE” and “Toolbox” options and you are ready to start the exercises. Note that if you have changed working directory during an active ILWIS session, it is advised to close ILWIS and start it again. The catalogue should now open in the correct working directory. Also note the other “golden rules” when working with ILWIS (see also Chapter 1.2).

From the “MAMASE” and “Toolbox” main menu select the “MAMASE Toolbox Help” menu item, inspect the help files provided.

5.1.2 Download of MOD13 Vegetation products

Within the MaMaSe project use is made of the MODIS derived NDVI. These datasets are available online, registration is required. If not registered, first conduct the registration. Subsequently check the batch file “MOD13_ndv_download.bat” and look for the strings user=XXXXX and password=XXXXX, replace the XXXXX with obtained username and password respectively. Save the batch file.

From the “MAMASE” and “Toolbox” main menu select the “Vegetation” > “MODIS 13 Series – level 006” > “Download MOD13 NDVI”. Note that the “Output Directory” correctly specified and enter the appropriate date stamp, see also table 3.1, here a date stamp (yyyymmdd) of “20000321” is used (note the leap year!) and press “Import”.

After the routine has finished downloading the vegetation product, navigate using your Windows browser to the output directory specified and check the file and note the file name convention used. Check the index number and the year, day of year (doy) time notation used (in this example 081).

5.1.3 Import MOD13 NDVI

From the “MAMASE” and “Toolbox” main menu select the menu options “Vegetation” > “MODIS 13 Series – level 006” > “Import MOD13 NDVI”. Note that the “Input Directory” and “Output Directory” are correctly specified and enter the appropriate date stamp in day of year format, see also table 3.1, here a date stamp of 2000081 is used and press “Import”.

Display the imported map using the default settings and note the data values. The map still has the original values, e.g. from -3000 to 10000. Display the vector file “boundary_23m”, select from the map window menu the option “Add Data Layer”, navigate to the folder in your ILWIS directory \Extensions\MAMASE-Toolbox\util\maps and select this vector file, use under the display options “display boundary only”, as colour “black” can be selected. Note the map dimensions, the area extracted is much larger than the Mamase project area. Open also the histogram and check the values of the map. Subsequently open the georeference and the coordinate system service objects for the imported map and check their content.

5.1.4 **Pre-processing MOD13 NDVI**

From the “MAMASE” and “Toolbox” main menu select the the menu options “Vegetation” > “MODIS 13 Series – level 006” > “Pre-processing MOD13 NDVI”. Note that the “Input Directory” and “Output Directory” are correctly specified and enter the appropriate date stamp in day of year format, see also table 3.1, here a date stamp of “2000081” is used and press “Import”.

Display the newly create map “ndv_2000081_b” using as Representation “ndv_byte” and note the data values by pressing the left mouse button when scrolling the mouse over the map window. Repeat this procedure also for the map “ndv_2000081_r”, now use as representation “NDVI1”. Also check the map values.

5.1.5 **NDV Temporal Filtering**

From the “MAMASE” and “Toolbox” main menu select the menu options “Vegetation” > “MODIS 13 Series – level 006” > “NDVI Temporal Filtering”. Note that the “Input Directory” and “Output Directory” are correctly specified. Check the settings under the “MAMASE” > “Toolbox” options from the left hand menu tree. Inspect the menu strings of the Toolbox and open the item “Configuration” > “Folders” and look for MOD13_filter. It is advised to use the same input and output directory.

The routine requires as input a maplist containing 23 time steps, e.g. a full yearly sequence. This maplist has to be created manually, from the main ILWIS menu, select the option “File” > “Create” > “MapList”. Adhere to the conventions as given in the appendix showing the filtering schedule.

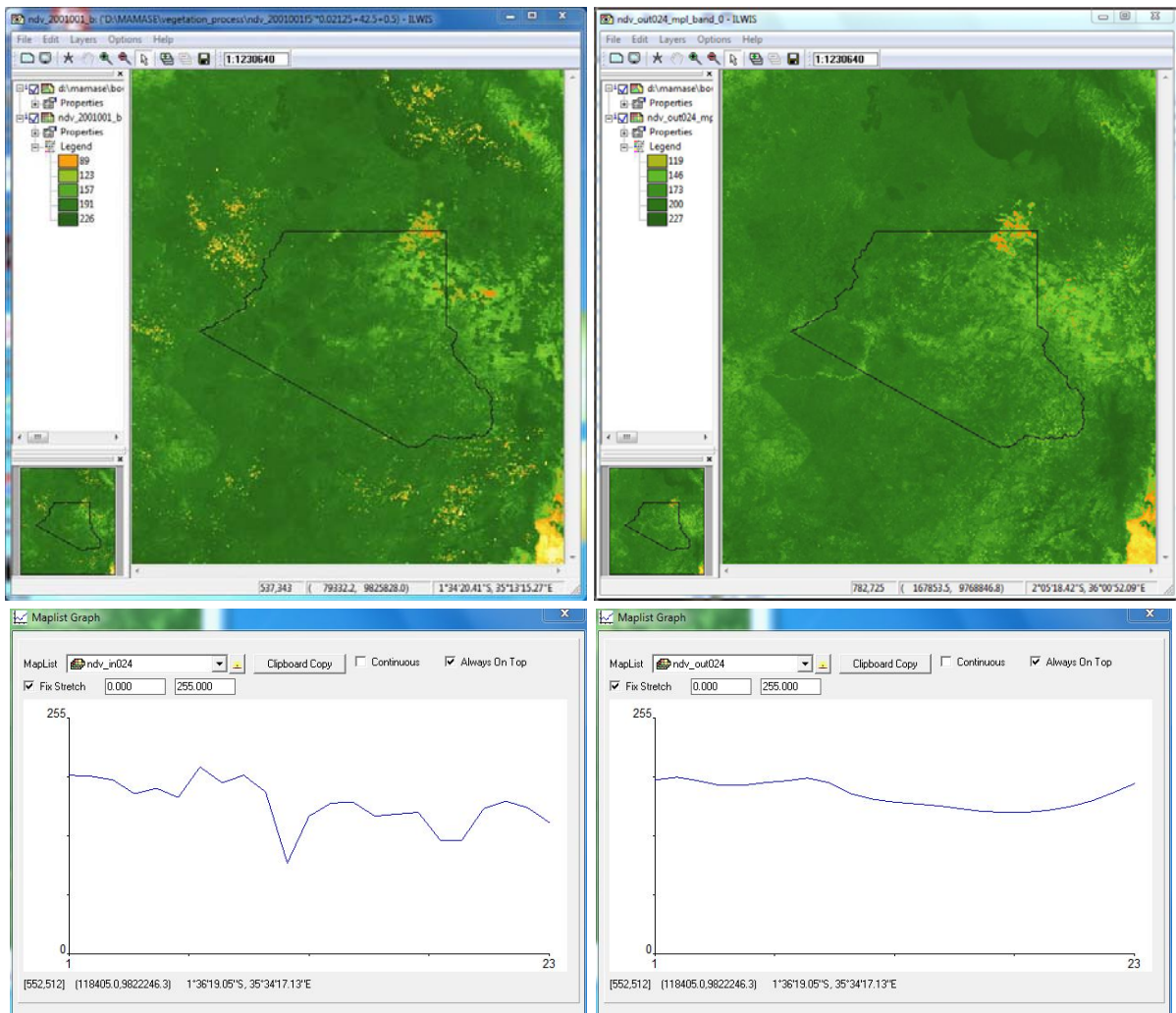
If you want to execute a filter operation, use the year 2001, download and pre-process all 23 time steps. Create a maplist and as Map List name enter “ndv_in024” (see filter schedule), select all “ndv_2001***_b” maps (23 in total) in the left hand maplist window (selected maps are indicated by a blue colour), press the “>” sign to add them to the right hand Create MapList window and press “OK” to save the new maplist . Double click with the mouse the newly created Maplist “ndv_in024”. In the MapList window select as display option “Open as Slide Show”, as Representation select “ndv_byte” and press “OK” twice, add the “boundary_23m” (no Info, boundaries only) and using the mouse with the left button pressed, inspect the map values. Close the animation window when finished.

With the maplist created, open once more from the “MAMASE” and “Toolbox” main menu the menu options “Vegetation” > “MODIS 13 Series – level 006” > “NDVI Temporal Filtering”. Note that the “Input Directory” and “Output Directory” are correctly specified and enter the name of the maplist, here “ndv_in024” is used. Execute the operation.

Once more open the maplist “ndv_in024” and display the map “ndv_2001001_b” and use as Representation “ndv_byte”. Add to this map the vector layer showing the project region boundary and use the option boundaries only for display of this vector layer. Now from the main ILWIS menu, select “Operations” > “Statistics” > “MapList” > “MapList Graph”. In the maplist graph window, select as MapList “ndv_in024”, use a fixed stretch of “0 to 255”, activate the option “Always on top”. Activate the map window showing the previously opened map layer “ndv_2001001_b”. Browse with the mouse cursor over the map. Note the precipitation time series values in the graph window, the X-axis shows the time (from the first 16 day time step of January 2001 as time step 1 to the last 16 day time step of December 2001 as time step 23) and the Y-Axis the ndvi byte value during each 16 day period for the respective pixel. See also figure 5.1. The left hand map and graph below are representing the input maps / values, the right hand map and graph show the result of the filter operation. Note the more gradual appearance of the map / graph.

Click on a number of pixels to see the temporal behaviour of the ndv for the given year for these pixels. Now replace the maplist with “ndv_out024”. Note the change in the values and the graph. Eventually copy the values of the input and output maplist, using the option “Clipboard Copy” to a spreadsheet and add the two curves to a graph.

Figure 5.1: NDV time series filter impact for run ndv_in024



5.1.6 Last 5 time steps reprocessing

Each 16 days a new NDVI map is becoming available. Given the fact that for the filter 4 iterations are used, also the four previous time steps have to be updated based on this new input for proper temporal reconstruction – fitting of the curve.

For the new ndvi map a new maplist has to be created manually. This maplist should contain the previous 19 layers, including the latest received ndvi map and the four temporal consecutive ndvi maps containing the median climatology values, based on the short term median value derived from the overall data archive (from 2000 to 2016).

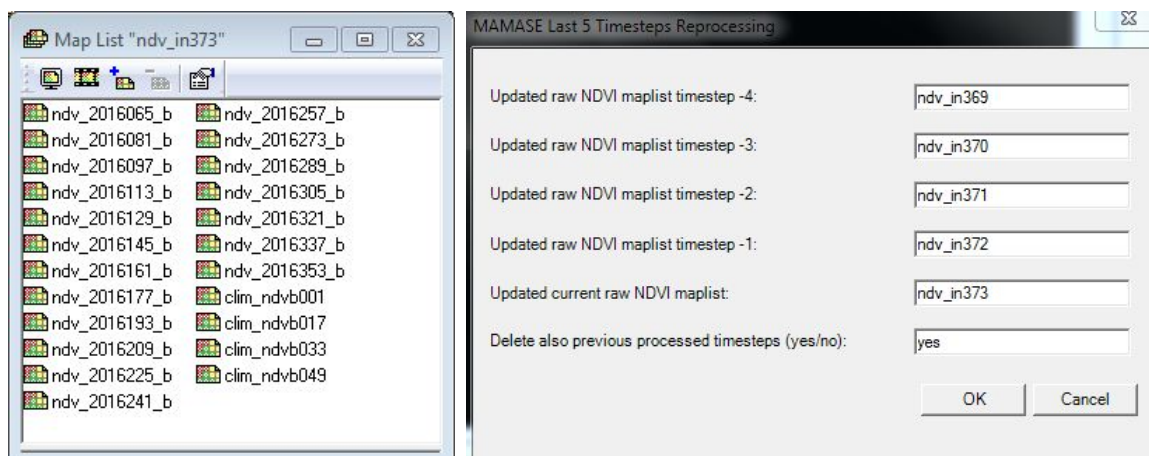
Next, the maplists of the four previous time steps have to be updated manually as well, substituting the median map of the given time step represented by the climatology by the newly received NDVI representing this time step. The maps should be aligned according to their temporal sequence in a proper manner. The modified map list should also contain 23 time steps.

Here an example is given of run 373, ndv_in373. Till now the latest ndv time step available is from 2016353, the other (future) time steps required are based on climatology, e.g. for the first 4 time steps representing time step 001, 017, 033 and 049, see the filter schedule and note the time steps required. These are not available at this moment and are replaced by the climatology.

Note that the “*Input Directory*” and “*Output Directory*” are correctly specified. Check the settings under the “*MAMASE*” > “*Toolbox*” options from the left hand menu tree. Inspect the menu strings of the *Toolbox* and open the item “*Configuration*” > “*Folders*” and look for “*filter_auto*”. It is advised to use the same input and output directory. From the “*MAMASE*” and “*Toolbox*” main menu select the menu options “*Vegetation*” > “*MODIS 13 Series – level 006*” > “*Last 5 timesteps reprocessing*”.

A new pop-up window appears, here you have to enter the different map lists of the current and previous map lists. Note that all map lists used have to be updated, to include the most recent ndv map time step! This involves for map list ndv_in369 that for clim_ndvb353 the layer ndv_2016353_b is now used, for ndv_in370, the future layer (ndv_2017001_b) is now represented by clim_ndvb001, for ndv_in371, ndv_2017001_b and ndv_2017017_b are now represented by clim_ndvb001 and clim_ndvb017 and for ndv_in372, ndv_2017001_b, ndv_2017017_b and ndv_2017033_b are now represented by clim_ndvb001 and clim_ndvb017 and clim_ndvb033. For ndv_in373, ndv_2017001_b, ndv_2017017_b, ndv_2017033_b and ndv_2017049_b are now represented by clim_ndvb001, clim_ndvb017, clim_ndvb033 and clim_ndvb049. Also the previous time steps of the maplists created can be deleted.

Figure 5.2: Filtering using climatology to represent future time steps



Due to the iterative nature of the temporal filter and the number of iterations used, 4 in this case, the last 4 time steps are reprocessed on a continuous basis. It is therefore advised to adhere to the naming conventions used to ensure that no errors are made as provided in appendix 3! The filter sequence to be applied for 2017 is given as well.

5.1.7 MSG based NDVI

From the “*MAMASE*” and “*Toolbox*” main menu select the menu options “*Vegetation*” > “*MSG-based*” > “*MSG based daily NDVI*”. Note that the “*Input Directory*” and “*Output Directory*” are correctly specified and enter the appropriate date stamp in daymonthday (yyyymmdd) format. Here a date stamp of 20170105 is used and press “*Import*”.

Display the newly create map “*GNC_NDVI_{max}_201701051200*” using as Representation “*NDVI1*” and note the data values by pressing the left mouse button when scrolling on the map. Note that the window selected is identical to the MOD13 NDV’s, but the data is having a data range of -1 to 1. Drag and drop the ndv map “*ndv_2000081_r*” on the map window displaying the MSG derived NDVI, use also the “*NDVI1*” Representation. In the map window switch the top layer on and off to see the difference in resolution, as MOD13 has a spatial resolution of 231 meters and MSG is 3 kilometres. Note furthermore that even having a temporal acquisition rate of 15 minutes, persistently cloud covered regions cannot be assigned an NDVI value, therefore these pixels do not have a data value. Close all open map windows before you continue.

5.2 PRECIPITATION

5.2.1 Introduction

Routines have been developed to integrate the online (satellite derived) precipitation products from CHIRPS, TAMSAT and MSG for Africa. Also forecasting information from the National Centers for Environmental Prediction (NCEP) can be retrieved and visualized / processed. A number of exercises are presented below on the various products that can be retrieved and visualized.

After installation of ILWIS and the MAMASE Toolbox (XML version 1.0), start ILWIS and open the "MAMASE" > "Toolbox" options from the left hand Operation-Tree (see also figure 2.1). Inspect the menu items of the Toolbox and open the item "Configuration" > "Folders". Note that here the assumption is made that you have created on your local system, using drive "C", a directory called "Precipitation_process". For the Folder items under Chirps, TAMSAT, MSG_MPE and NCEP specify the appropriate directory and press "Save" to store the output drive:\directory settings. Use the ILWIS Navigator to move to the specific working directory, close ILWIS and open it again. ILWIS should now open using the selected directory. Furthermore check if IrfanView has been correctly configured, see also chapter 1.4 and 2.4.

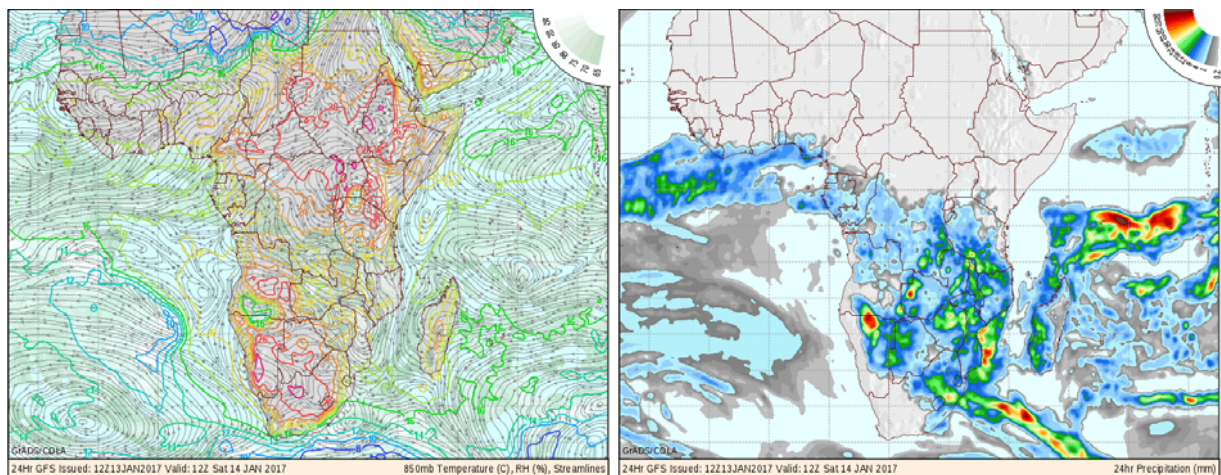
5.2.2 NCEP GFS Thematic Forecast Animation

Latest forecasts for Africa, issued by the National Centers for Environmental Prediction and presented as a set of seven panels for each 24 hour interval from 0 (analysis) to 144 hours are available at <http://wxmaps.org/pix/af.vv.html> and <http://wxmaps.org/pix/af.850.html>. The routine select the relevant thematic panels and creates an animation for the precipitation forecast and a forecast showing a number of parameter, like temperature, relative humidity and stream lines for the 850 Mb pressure level.

To import the NCEP issued precipitation forecast for Africa select from the "MAMASE" > "Toolbox" main menu the item "NCEP GFS Thematic Forecast Animation" > "Latest NCEP GFS Precipitation Forecast" sub menu. In this case only the "Output Directory" need to be correctly specified as some temporary data is stored here. To execute the route press "Import". If you want to interrupt the animation press the <esc> button on the keyboard.

To import the NCEP issued 850 Mb forecast for Africa select from the "MAMASE" > "Toolbox" main menu the item "NCEP GFS Thematic Forecast Animation" > "Latest NCEP GFS 850 Mb Forecast" sub menu. In this case only the "Output Directory" need to be correctly specified as some temporary data is stored here. To execute the route press "Import". If you want to interrupt the animation press the <esc> button on the keyboard. Note that you are looking at an animated sequence of pictures, not providing the actual data!

Figure 5.3: NCEP latest forecast examples



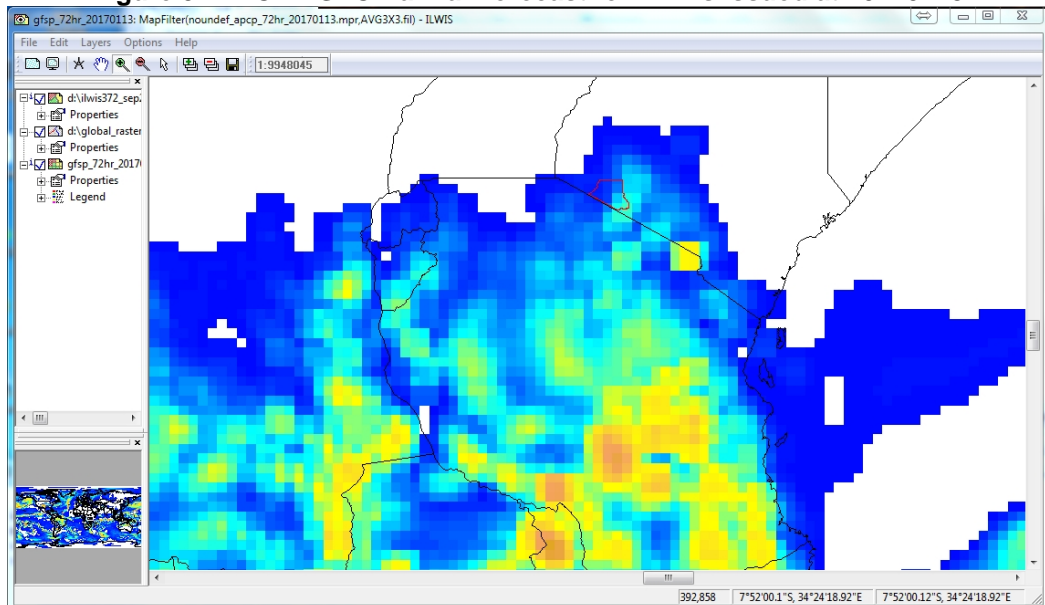
5.2.3 NCEP GFS 10 day Precipitation forecasts

At ITC a routine is executed on a daily basis to retrieve the NCEP GFS Precipitation forecasts. The actual 6 hourly forecasts are aggregated to 24 hours and the forecast data for 10 days is processed in this way. Finally the data is put on the ftp for external use. The data is provided in ILWIS format.

To import the NCEP issued precipitation forecast for Africa select from the "MAMASE" > "Toolbox" main menu the item "NCEP GFS 10 day Rainfall Forecast" > "GFS 10 day Rainfall Forecasts" sub menu. In this case the "Output Directory" need to be correctly specified and a date stamp used, here for date (yyyymmdd) "20170113" is used. To execute the route press "Import".

Upon completion of the import open the maplist "gfsp_acc10d_20170113" and display it as an animated sequence, using as Representation "mpe_sum". As it is a global product add the country boundaries. Select from the map window menu the option "Add Data Layer", navigate to the folder in your ILWIS directory \Extensions\MAMASE-Toolbox\util\maps and select the vector file "countryboundaries", use under the display options and as colour "black" can be selected. You can zoom in to the region of interest. Note the map values by keeping the left mouse button pressed and scrolling your mouse over the map window. The unit is in mm/day. Close all maps before you continue.

Figure 5.4: NCEP GFC Rainfall forecast for 72 hrs issued at 20170113



5.2.4 CHIRPS Satellite derived Rainfall product

The Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a 30+ year quasi-global rainfall dataset. Spanning 50°S-50°N (and all longitudes), starting in 1981 to near-present, CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series (see also: <http://www.nature.com/articles/sdata201566>). To import the daily rainfall data from the CHIRPS precipitation data set select from the "MAMASE" > "Toolbox" main menu the item "Precipitation" > "CHIRPS V2.0 per day" sub-menu. In this case only the "Date" field and the "Output Directory" need to be specified. As Date stamp (in yyyymmdd format) select "20160101" and press "Import". Note that the lead time is at least 2 months!

After the import has been completed, display the newly created map "chirps_Africa_20160101", using as Representation "MPE_single". Add the country boundaries (no Info, boundaries only) and use pixel information to inspect the values.

To import the data from the CHIRPS pentad precipitation data (aggregated to 5 days) select from the "MAMASE" > "Toolbox" main menu the item "Precipitation" > "CHIRPS V2.0 per pentad" sub-menu. In

this case only the "Date" field and the "Output Directory" need to be specified. As Date stamp select "2016016" (for the last pentad of this month!) and press "Import".

After the import has been completed, display the newly created map "chirps_Africa_201601p6", using as Representation "MPE_sum". Add the country boundaries (no Info, boundaries only) and use pixel information to inspect the values.

Compare both rainfall maps and close them when ready. The procedure can be repeated importing the other temporal interval precipitation maps from CHIRPS, like the dekadal and the monthly rainfall maps. Note the date stamp required, for the dekadal map as date stamp "1016011", for the first decade of January 2016 is required, for the month date stamp "201601" would be required. The output maps created are "chirps_Africa_201601d1" and "chirps_Africa_201601" for dekadal and monthly rainfall respectively. As Representation "MPE_sum" or "Pseudo" can be applied for visualization of the rainfall maps.

5.2.5 TAMSAT Satellite derived Rainfall product and climatology

Dekadal and monthly rainfall estimates and anomalies derived from Meteosat Thermal Infra-Red (TIR) channels are based on the recognition of storm clouds and calibration against ground-based rain gauge data. This rainfall estimate is produced by the University of Reading, Meteorology Department, UK. Dekadal and daily data is available one or two days after the actual dekadal period is completed, and therefore the lead time is shorter compared to the CHIRPS data set. For the monthly data, the data is available directly after the first decade of the next month.

A number of products are available, like the daily, dekadal and monthly accumulated rainfall products for Africa, the dekadal and monthly accumulated rainfall anomaly products for Africa. Select "MAMASE" > "Toolbox" > "Precipitation" > "TAMSAT rainfall archive - Africa" > "Daily Rainfall" > "Daily Rainfall from 1983 onwards". As date stamp specify: "20170101". Upon completion of the import display the map "rfe20170101" and as Representation use "rfe_dec". Add the country boundaries (no Info, boundaries only) and using the mouse with the left button pressed note the map values.

To import the dekadal accumulated rainfall map of the first decade of January 2016, select the menu options Select "MAMASE" > "Toolbox" > "Precipitation" > "TAMSAT rainfall archive - Africa" > "Dekadal Rainfall" > "Dekadal Rainfall from 1983 onwards" and specify as date stamp "2016011". Upon completion of the import display the map "rfe2016011" and as Representation use "rfe_dec". Add the country boundaries (no Info, boundaries only) and using the mouse with the left button pressed inspect the map values.

To import the dekadal rainfall anomaly map of the first decade of January 2016, select the menu options Select "MAMASE" > "Toolbox" > "Precipitation" > "TAMSAT rainfall archive - Africa" > "Dekadal Rainfall" > "Dekadal Rainfall anomaly from 1983 onwards" and specify as date stamp "2016011". Upon completion of the import display the map "rfe2016011_anom" and as Representation use "rfe_anom_dec". Add the country boundaries (no Info, boundaries only) and using the mouse with the left button pressed inspect the map values.

To import the monthly accumulated rainfall map of January 2016, select the menu options "MAMASE" > "Toolbox" > "Precipitation" > "TAMSAT rainfall archive - Africa" > "Monthly Rainfall" > "Monthly Rainfall from 1983 onwards" and specify as date stamp "201601". Upon completion of the import display the map "rfe201601" and as Representation use "rfe_month". Add the country boundaries (no Info, boundaries only) and using the mouse with the left button pressed inspect the map values.

Also import the monthly rainfall anomalies for January 2016 and use as Representation "rfe_anom_month" for the imported "rfe201601_anom" map created. Add the country boundaries (no Info, boundaries only) and using the mouse with the left button pressed, inspect the map values.

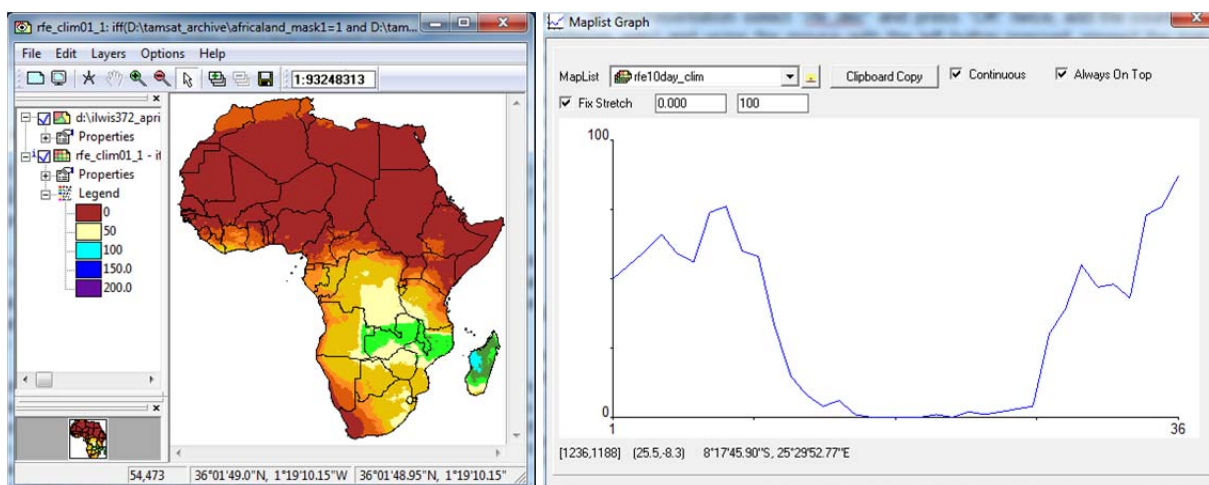
To get an idea of the distribution of the rainfall over a longer time period the rainfall climatology (derived from 1983-2012) can be used. To import the Dekadal Climatology rainfall, select the menu options > "Precipitation" > "TAMSAT rainfall archive - Africa" > "Rainfall Climatology" > "Dekadal

Rainfall from 1983 onwards”, note the output directory and press the “Import” button. After extraction of the file a looping routine imports all 36 dekades. From the main ILWIS menu, select “Window” > “Refresh” to see the updated content of the catalogue.

After the import of all 36 rainfall climatology maps (rfe_clim01_1 up to rfe_clim12_3) has been completed, select from the main ILWIS menu “File” > “Create” > “Map List”, as Map List name enter “RFE10day_clim”, select all rfe_clim_month_dekade maps (36 in total) in the left hand maplist window (selected maps are indicated by a blue colour), press the “>” sign to add them to the right hand Create MapList window and press “OK” to save the new maplist. Double click with the mouse the newly created Maplist “RFE10day_clim”. In the MapList window select as display option “Open as Slide Show”, as Representation select “rfe_dec” and press “OK” twice, add the country boundaries (no Info, boundaries only) and using the mouse with the left button pressed, inspect the map values. Close the animation window when finished.

Once more open the maplist “RFE10day_clim” and display the map “rfe_clim01_1”. Add to this map the vector layer showing the country boundaries and use the option boundaries only for display of this vector layer. Now from the main ILWIS menu, select “Operations” > “Statistics” > “MapList” > “MapList Graph”. In the maplist graph window, select as MapList “RFE10day_clim”, use a fixed stretch of “0 to 100”, activate the options “Continuous” and “Always on top”. Activate the map window showing the previously opened map layer “rfe_clim01_1”. Browse with the mouse cursor over the map. Note the precipitation time series values in the graph window, the X-axis shows the time (from the first decade of January as time step 1 to the last decade of December as time step 36) and the Y-Axis the average amount of precipitation (in mm) during each 10 day period for the respective pixel. See also figure 5.5.

Figure 5.5: TAMSAT time series rainfall climatology over Africa



Eventually import the monthly climatology. The procedure is identical as for the dekadal climatology import routine. Also display it as an animated sequence and use the graph display to check the values of your imported time series.

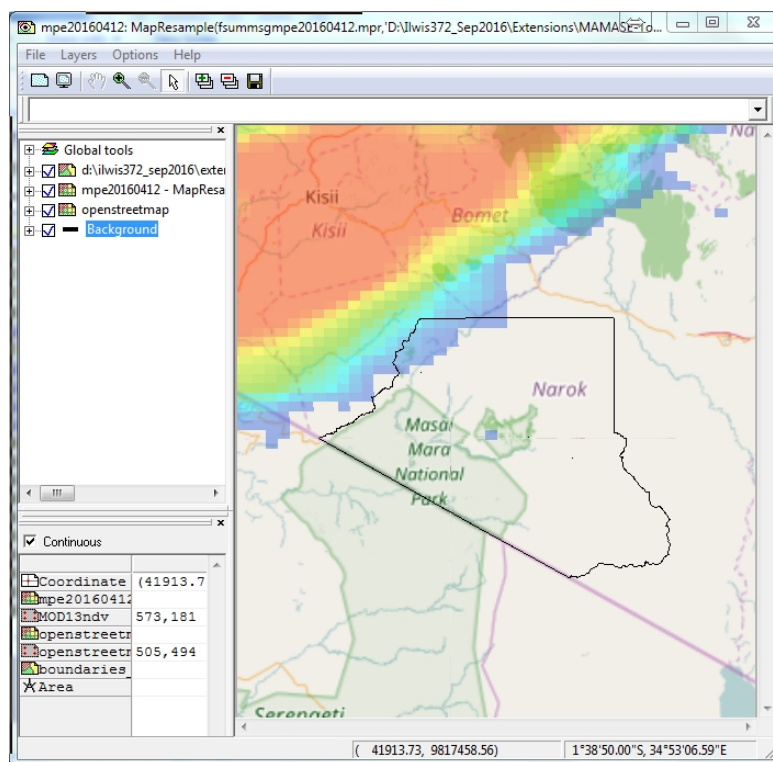
5.2.6 MSG based multi sensor precipitation estimate

In order to overcome the gap in satellite rainfall estimates of CHIRPS and TAMSAT, another rainfall product can be used. The aggregated Multi Sensor Precipitation estimate is available the next day, after 11:00 UTC. It is produced, based on an aggregation of each 15 minutes time step of the previous day (from 00:00 to 23:45 UTC). An automated aggregation procedure is implemented at ITC to create this product and transfer it to public FTP for external use.

Select “MAMASE” > “Toolbox” > “Precipitation” > “Daily MSG Multi Sensor Precipitation Estimate” > “MSG MPE Daily Rainfall Product”. As date stamp specify: “20160401”. Upon completion of the import display the map “mpe20160412” and as Representation use “mpe_sum”. Add the project area vector file “boundary_23” (no Info, boundaries only) and using the mouse with the left button pressed note the map values. See also Figure 5.6. Note that the map is resampled to the same georeference

as the MODIS NDV maps. It can be that for certain time steps imported there is no rainfall in the extracted window!

Figure 5.6: Example of the daily precipitation estimate over the area of interest



Note that visualization is made in ILWIS38, as here Openstreets map is used as backdrop image.

5.3 EUMETVIEW

EUMETView is a visualisation service that allows users to view near real time EUMETSAT imagery in a more interactive way through an online map viewer or Web Map Service (WMS), available from <http://eumetview.eumetsat.int/mapviewer/>. It is currently a pilot service. EUMETView has been designed to be easy in usage:

- Choose the layer to display from the list;
- Select the date and time;
- Choose region of interest;
- Download selected images;
- Animate images if required.

Some video tutorials to help you use EUMETView can be accessed from http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=VID_EUMETVIEW_BRIEF_TUTORIAL&RevisionSelectionMethod=LatestReleased&Rendition=Web. It covers how to connect to EUMETView, how to add a layer and how to display a layer.

5.4 GENERIC GIS FUNCTIONS

In order to ensure that no errors are made during certain pre-processing routines this menu item offers GIS procedures which are repeatedly required. At this moment a resampling routine has been added, ensuring that all final maps are resampled using a nearest neighbour resampling option to the same georeference, here “boundary_23m” is used. The output map is having as suffix “_aoi”, so the user can immediately identify the new map created. Additional functions will be added later on.

Inspect the menu items of the Toolbox and open the item "*Configuration*" > "*Folders*". Note that here the assumption is made that you have created on your local system, using drive "C", a directory called "*Working_dir*". For the Folder items under *Working_dir* specify the appropriate directory and press "Save" to store the output drive:\directory settings.

Click in the ILWIS catalog on a map you want to resample, subsequently from the main ILWIS menu select the options "Edit" > "Copy Object to", select the option copy object to "new Directory", now specify the directory, here "*working_dir*" and press "OK" to execute the operation and accept other default settings. Note that when using the ILWIS copy command also the related service objects are copied as well!

Navigate using the Navigator button in ILWIS to the new folder, here "*Working_dir*". Specify the map name and execute the resampling routine. Display the new map created with the suffix "*_ao*", use the appropriate Representation and eventually add the vector layer "*boundary_32m*".

6. DATA EXTRACTION AND IMPORT AUTOMATION FOR GENERATION OF TIME SERIES PRECIPITATION DATA

In the previous exercises you have imported a variety of precipitation products using the MAMASE Toolbox menu. You can keep using this procedure to import the other events from the same products by changing the Date stamp, e.g. each time selecting the next temporal interval. This is a cumbersome activity that needs user intervention. This procedure can be easily automated by copying the ILWIS command line string that is created each time you conduct an MAMASE toolbox routine.

From the Main ILWIS menu, press the “drop down” button on the right hand side of the command line. You will now see the “history”. A typical command line string that is generated when using the MAMASE Toolbox is given below using as example the import routine used for the ‘TAMSAT 10 day RFE’-import (note that the command line string is given as a single line, the location of your ILWIS directory might be different!):

```
!D:\lw372\Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_importnc.bat 2016011 x x D:
MAMASE\precipitation_process D:\lw372\Extensions\MAMASE-Toolbox\GDAL\bin D:\lw372
D:\lw372\Extensions\MAMASE-Toolbox\util
```

Have a look at the command line above and note that “!” is used in ILWIS to call an external routine, in this case “*fews_rfe2_10day.bat*”. This batch file is executed for the time stamp “2016011” (for the 1st decade of January 2016). The “x” indicates that here no input drive and input directory is used. All other strings define the parameters that specify the locations of the required software utilities to conduct the operation. In your case the location of ILWIS might be in a different ‘drive:\directory’ and therefore your command line string might look different, but the string will have the same number of “items / parameters”. See also chapter 2.6 for further details.

Once more execute this operation from the toolbox menu and subsequently copy this command line to clipboard, open ‘Notepad’ and paste the command line string as a single line into Notepad (Check from the Notepad menu > Format > Word Wrap off!). Delete the “!” at the start of the line and add the following syntax: cmd /c instead. The line now becomes:

```
cmd /c D:\lw372\Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_importnc.bat 2016011
x x D: MAMASE\precipitation_process D:\lw372\Extensions\MAMASE-Toolbox\GDAL\bin D:\lw372
D:\lw372\Extensions\MAMASE-Toolbox\util
```

Now copy this modified line and paste it 2 more times. Modify for the 3 lines the date stamp, instead of “2016011”, enter as new date stamps: “2016021”, “2016022” and “2016023” respectively. Your final results (as 3 lines) should look like the example below:

```
-----
cmd /c D:\lw372\Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_importnc.bat 2016021
x x D: MAMASE\precipitation_process D:\lw372\Extensions\MAMASE-Toolbox\GDAL\bin D:\lw372
D:\lw372\Extensions\MAMASE-Toolbox\util

cmd /c D:\lw372\Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_importnc.bat 2016022
x x D: MAMASE\precipitation_process D:\lw372\Extensions\MAMASE-Toolbox\GDAL\bin D:\lw372
D:\lw372\Extensions\MAMASE-Toolbox\util

cmd /c D:\lw372\Extensions\MAMASE-Toolbox\toolbox_batchroutines\TAMSATRFE_importnc.bat 2016023
x x D: MAMASE\precipitation_process D:\lw372\Extensions\MAMASE-Toolbox\GDAL\bin D:\lw372
D:\lw372\Extensions\MAMASE-Toolbox\util
-----
```

Save this file in your active working directory, use as file name “*rftamsat_feb16_import.bat*”.

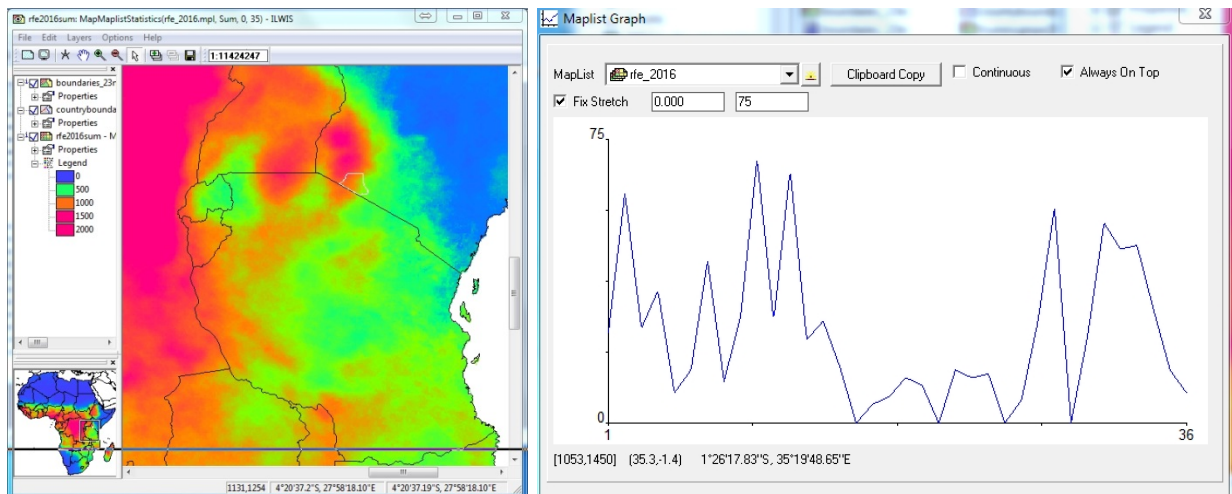
Now use the Windows Explorer, browse to your active working directory and double click with the mouse on the new batch file created “*rftamsat_feb16_import.bat*”. The RFE maps are now automatically retrieved and processed in ILWIS. When the operation has been completed, click with the mouse on the ILWIS catalogue and press “F5” or select from the ILWIS main menu “Window” > “Refresh”. Now create a maplist of the 3 imported dekadal images and show this as an animation. Also use maplist statistics, and the “sum” option, to calculate the monthly precipitation of February 2016. Display the map using as Representation “*rfe_month*”. Add the country and project area

boundaries (no Info, boundaries only) and use pixel information to inspect the values, eventually use the option “MapList Graph” to see the rainfall characteristics over the whole year.

Repeat this procedure, now prepare a batch file to import all RFE 10 day rainfall products for 2016 (36 events) and calculate the sum, min, max and mean yearly precipitation for 2016.

Your final results (for the sum) should resemble those provided in figure 6.1, using a “Pseudo” Representation and a stretch from 0 to 1500. Note that more advanced batch procedures can be developed, using a so called “looping” procedure, identical to the import of the TAMSAT Climatology products. You can find examples of these files in the “*toolbox_batchroutines*” sub-directory.

Figure 6.1: RFE from TAMSAT based total precipitation over Africa for 2016



7. CONCLUSIONS

This manual is mainly focussing on data retrieval and visualization of the various free environmental data sources residing on the internet and disseminated through GEONETCast-EUMETCast. Within the MaMaSe project the focus is firstly on NDVI and rainfall retrieval. For the NDVI it was decided to use the MOD13 product time series. As these have a lead time and become available 20 days later for the most recent period the NDVI derived from the SEVIRI instrument on Meteosat Second Generation is used as a proxy. These products are disseminated through GEONETCast-EUMETCast the next day.

For rainfall data from CHIRPS can be used. Here the situation is identical as with respect to the NDVI. The CHIRPS products become available at least two months later. To fill the gap use can be made of the TAMSAT rainfall products. As these also become available with a short time delay the last 10 days can be covered by the Multi Sensor Precipitation Estimate, these products are available the next day.

For rainfall, as it is a quickly changing and important parameter, also forecasting information can be retrieved, based on the Global Forecasting System, a numerical global weather prediction model.

The toolbox has been used to process the NDV time series and an archive of processed data has been created during development of this utility. A structured method is proposed and provided in the appendix, showing the user how to continue processing the data. The same archive was also used to calculate the short term climatology, which is used within the temporal filtering routine to parameterize the future time steps.

A method is shown to quickly generate rainfall time series. For further automation additional effort is required, which is outside of the scope of providing a generic toolbox.

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APPENDICES

Appendix 1: Other utilities available at the EO Community web pages at 52North.org

Various other software utilities have been developed over time are released via the 52North.org web portal, through the Earth Observation Community, available at: <http://52north.org/communities/earth-observation/overview>. A short overview of the freely available ILWIS plug-ins is presented below. Also dedicated ILWIS scripts are available to import the Culture MERIS, MERIS Reduced Resolution S10 and METOP AVHRR-S10 data (under data bases) as well as various documents and useful links.

ILWIS plug-ins to handle free Environmental data sources

Current data dissemination systems, like GEONETCast, provide free, near real-time Environmental and Earth Observation data together with derived products to a worldwide user community. The environmental data is delivered on a global scale via communication satellites. Next to this, a multitude of environmental relevant data is residing in online archives. To integrate this information toolbox plug-ins have been developed, also dealing with specific geographic regions only upon user request, like the AMESD-SADC Toolbox and the Water and Food Security Toolbox for Ethiopia.

The toolbox plug-ins, coupled with the existing ILWIS processing utilities, facilitate easy integration of large amounts of environmental data into various applications related to weather, atmosphere, oceans, land, vegetation, water and environment.



General Key Features:

- open design and easy user configuration
- GEONETCast automated data management system for dedicated storage of data

Features GEONETCast Toolbox Version 1.7

- import routines for various satellites, Meteorological Product Extraction facility (MPEF), Satellite Application Facilities (SAF's), Chinese Meteorological Administration and 3rd party data providers such as TAMSAT, DevCoCast, MODIS, SPOT Vegetation
- integration of METOP-AVHRR and JASON-2 data
- export routines to BILKO and R
- calculation of solar and MSG zenith and azimuth angles
- real time METEOSAT Second Generation visualization

Features Water and Food Security-Ethiopia Toolbox Version 1.3

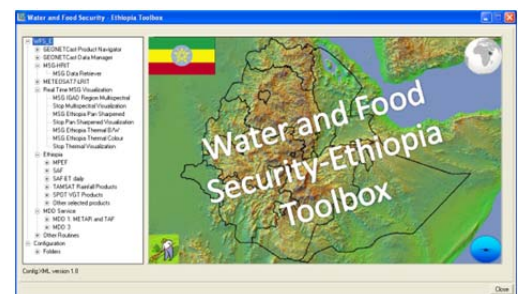
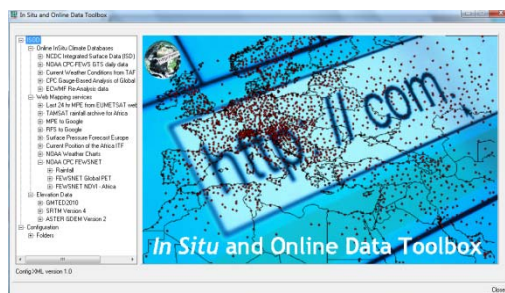
- processing selected GEONETCast data relevant for water and food security monitoring and analysis for Ethiopia, including Meteorological Data Dissemination Service routines

Features ISOD Toolbox Version 1.4

- retrieval and import of data from various free online archives related to in situ climatological observations, gauge and satellite derived rainfall estimates, weather and pressure forecasts, potential evapotranspiration, normalized difference vegetation indices, ocean and elevation information

Features MESA-SADC Toolbox Version 1.0

- import and pre-processing of all products disseminated by the MESA-SADC program for southern Africa, related to agriculture, drought and fire



Appendix 2: Utilities available at the ITC GEONETCast web pages

For access to the Capacity Building utilities use can be made of the information and documents posted on: <http://www.itc.nl/Pub/WRS/WRS-GEONETCast>. Various documents are presented here providing further information on data dissemination systems providing a multitude of free environmental information, without the need for internet access but using a local ground receiving station for reception of the data.

For more advanced use of the environmental information in ILWIS use can be made of the so-called "GEONETCast-DevCoCast Application manual", providing various exercises, including description, exercise data and powerpoint presentation. Also other training materials are available from the ILWIS community at <http://52North.org> as well as from <http://www.itc.nl/ilwis/downloads/ilwis33.asp>, check the left hand "*Documentation*" and "*Applications*" tabs.

Also a Moodle based Capacity Building portal, the "Earth Observation Capacity Building Portal" is under construction, providing a lot course materials provided during various workshops conducted. The link to this resource is <http://eocbportal.itc.utwente.nl/>. It does not require a password, you can login as guest.

Finally various resources, like scripts, base maps, sample data, etc. are also posted at <ftp://ftp.itc.nl/pub/52n/> for easy access by the user community.

Appendix 3: Filtering schedule

Below the details on the filtering schedule are provided. Note that the last data downloaded for ndv filter processing is "ndv_2016353". The first time steps of the filtering table are not available in the source data, therefore time steps 2000001 – 2000033 are replaced by the climatology calculated for the time series (from 2000-2016).

Filter schedule MOD13 Time Series

384	ndv_in384	2016241	2016257	2016273	2016289	2016305	2016321	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	ndv_out384
385	ndv_in385	2016257	2016273	2016289	2016305	2016321	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	ndv_out385
386	ndv_in386	2016273	2016289	2016305	2016321	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	2017257	ndv_out386
387	ndv_in387	2016289	2016305	2016321	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	2017257	2017273	ndv_out387
388	ndv_in388	2016305	2016321	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	2017257	2017273	2017289	ndv_out388
389	ndv_in389	2016321	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	2017257	2017273	2017289	2017305	ndv_out389
390	ndv_in390	2016337	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	2017257	2017273	2017289	2017305	2017321	ndv_out390
391	ndv_in391	2016353	2017001	2017017	2017033	2017049	2017065	2017081	2017097	2017113	2017129	2017145	2017161	2017177	2017193	2017209	2017225	2017241	2017257	2017273	2017289	2017305	2017321	2017337	ndv_out391