Semi-Automatic Classification Plugin for QGIS

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Table of contents

Figures

Tables

1   Introduction

The Semi-Automatic Classification Plugin for QGIS (http://www.qgis.org/) has been developed by the 2.1 Activity of the "Adapting to Climate Change in Coastal Dar es Salaam" (ACC Dar) project, which has the following objectives: enhancing the capacity of Dar's municipalities in understanding CC issues specific to coastal areas; assessing the CC impacts on the livelihood of those dwellers, partially or totally depending on natural resources, increasing knowledge of autonomous adaptive capacity; and developing methodologies for integrating adaptation activities into strategies and plans for Urban Development and Environment Management (UDEM) in coastal unplanned and underserviced settlements.

The plugin development has the purpose of providing alternative open-source software for Land Cover monitoring through remote sensing image analysis.

The Semi-Automatic Classification Plugin allows for the semi-automatic supervised classification of remote sensing images, providing tools to expedite the classification process. This plugin requires the installation of Sextante (official plugin in QGIS repositories), Orfeo Toolbox and SAGA, and has been tested in QGIS 1.8 on Windows and Linux environment.

For Windows users, it is suggested to install QGIS and Orfeo Toolbox (http://www.orfeo-toolbox.org/otb/) through the OSGeo4W Installer (http://trac.osgeo.org/osgeo4w/). Saga can be downloaded from http://www.saga-gis.org/en/index.html, and its installation folder must be configured in the Sextante plugin.

For Linux user, all required packages should be installed through the package manager (refer to original website for repositories).

The plugin (v.1.0) can be installed using QGIS software (through the plugin repository), or downloaded from http://plugins.qgis.org/plugins/SemiAutomaticClassificationPlugin/. The installation folder of Semi-Automatic Classification Plugin must be placed under Home/User directory inside ".qgis\python\plugins".

2   Brief tutorial

This is a brief overview of plugin functionalities (Landsat imagery accessible from the USGS archive).

After enabling the plugin in QGIS, the interface displays a new icon (Figure 1) .

Figure 1: QGIS interface with plugin activated

A click on the plugin icon opens the interface, which is composed of 3 tabs (Figure 2):
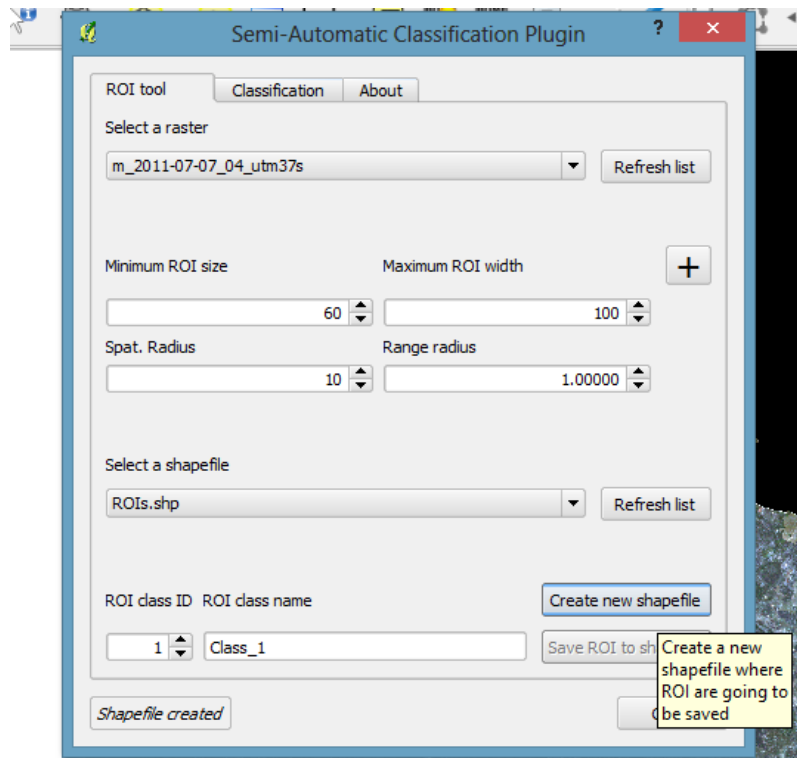- ROI tool;
- Classification;
- About;

Figure 2: Plugin interface; moving the mouse over buttons provides command descriptions

3 The ROI Tool Tab

The ROI tool tab is intended for training area collection, used in semi-automatic classifications.
Image is segmented around a seed, created by clicking on an image pixel, and a ROI (Region Of Interest) is created which contains spectrally homogeneous pixels.
Segmentation is performed using the Sextante implementation of the Mean-Shift algorithm (of Orfeo Toolbox).

Required input for ROI creation are:
- A raster image, used for calculating ROIs;
- A shapefile, used for saving created ROIs to a vector file (the combo menu displays only the shapefiles containing ID_class [integer] and Class_name [string] fields).

ROIs can be defined by setting the following variables:
- Minimum ROI size: Minimum area of ROI (in pixel unit);
- Maximum ROI width: Side length of a square, centered at the seed, which inscribes the ROI and defines the maximum width thereof (in pixel unit);
- Spatial radius: Parameter which defines the neighborhood;
- Range radius: Parameter which defines the interval in the multispectral space (in radiometry unit); this value has to be changed according to pixel values (e.g. reflectance or Digital Number).

The interface buttons are:
- [Refresh list]: refresh list of layers (needed after adding new data to QGIS);
- [+]: recall the pointer for ROI creation, by clicking on the image;
- [Create new shapefile]: create a new shapefile containing ID_class [integer] and Class_name [string] fields;
- [Save ROI to shapefile]: save the last created ROI to selected shapefile.

After selecting a raster that is the ROI target, and setting the ROI parameters, a new ROI can be created by clicking on the Pointer Activator button (Figure 3).
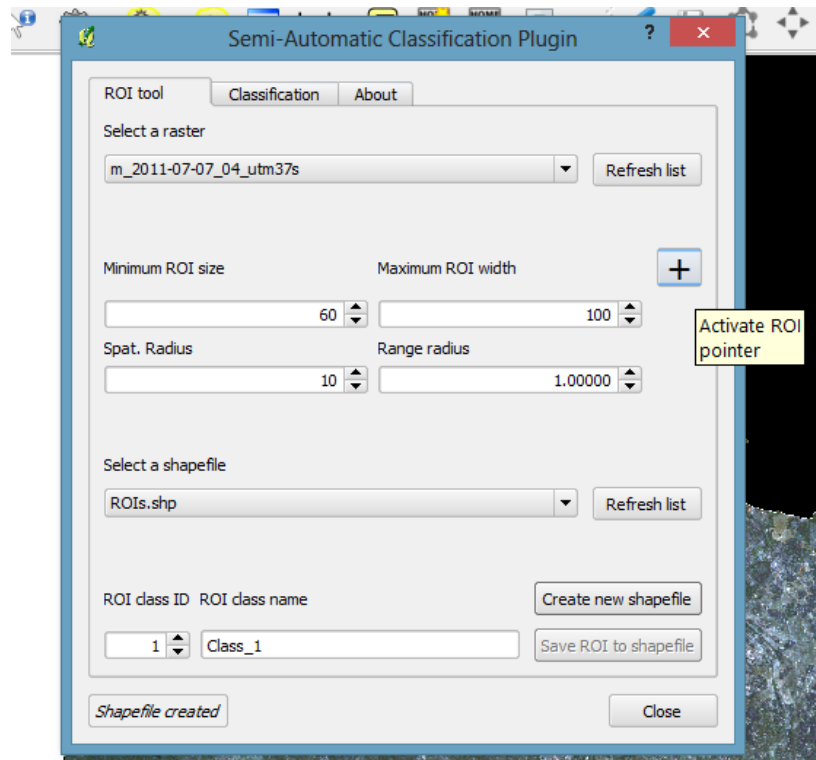

Figure 3: plugin interface; button that activates the ROI pointer

Once the pointer is active, a click on the image creates a ROI in the location of selected pixel, which comprises all spectrally similar pixels around (Figure 4).
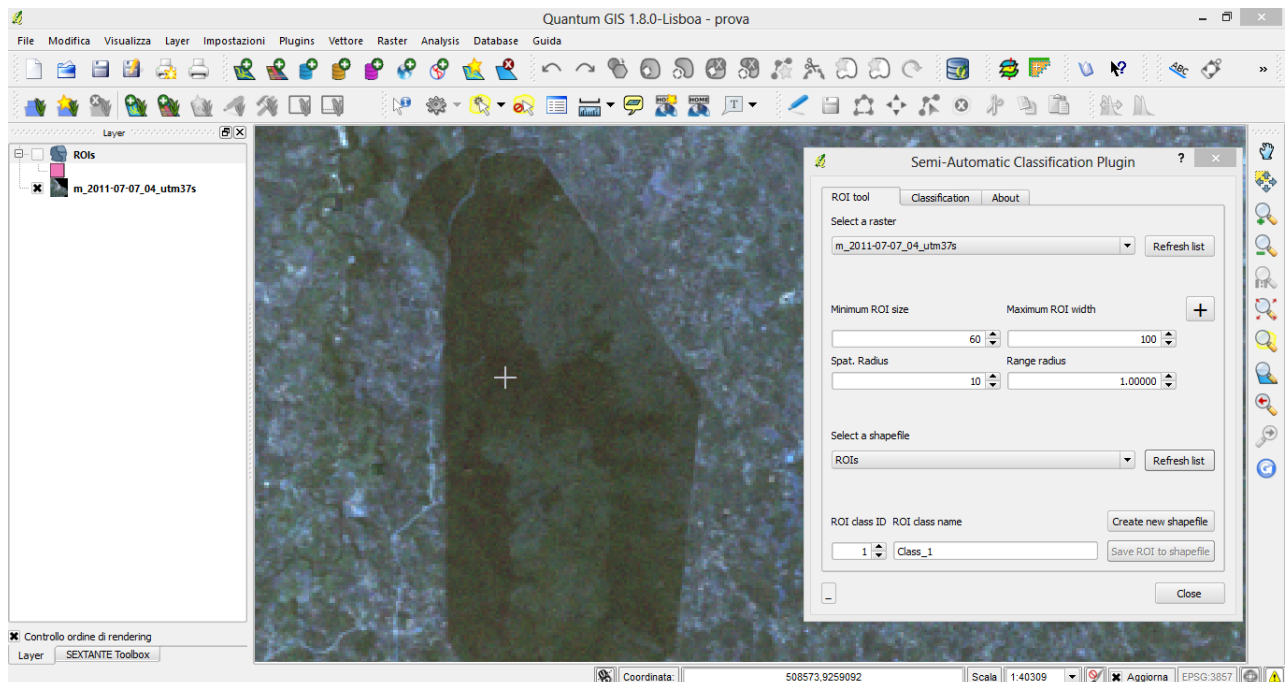

Figure 4: the ROI pointer superimposed to image

After the click. the ROI is created over the image (the required time of creation is variable from few seconds to several minutes, depending on ROI size) (Figure 5, Figure 6).
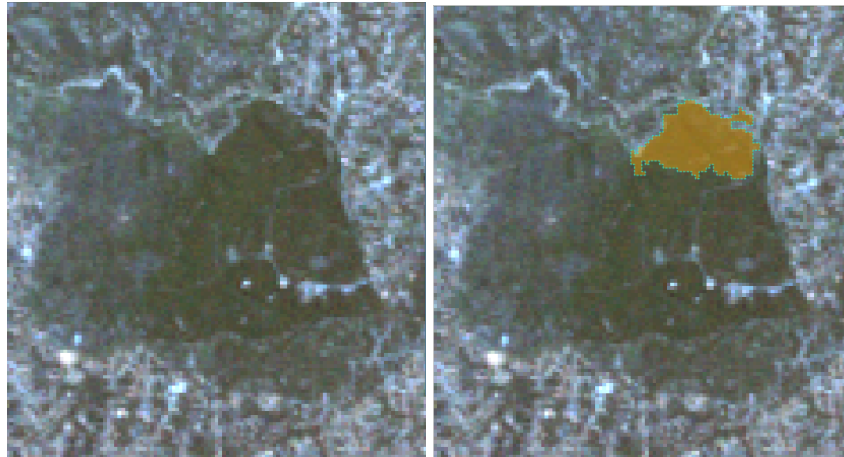

Figure 5: example of ROI creation over a vegetated area of the image(left) and the created ROI polygon (right)
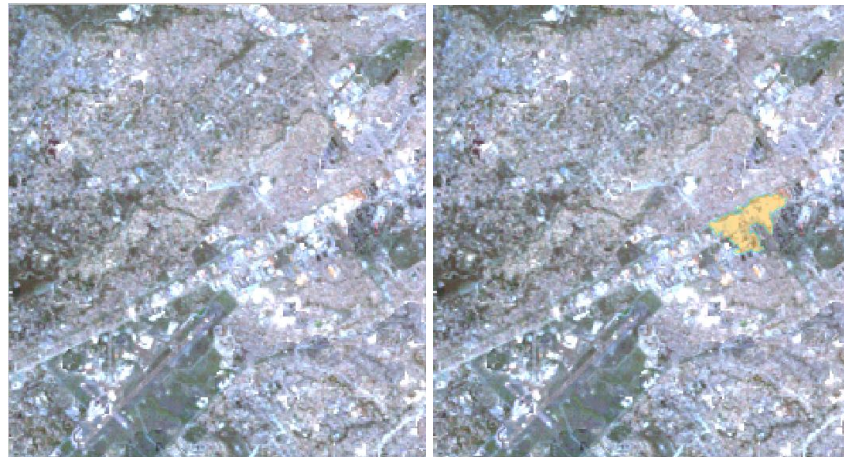

Figure 6: example of ROI creation over an urban area of the image(left) and the created ROI polygon (right)

A polygon shapefile that contains the ROI is added to layers. Created ROIs (temporarily saved in ".qgis\sextante\tempdata") are placed inside a group named "Class_temp_group", and will be automatically deleted after QGIS session is stopped (Figure 7).
A ROI can be saved in a shapefile (containing at least the ID_class [integer] and Class_name [string] fields), by defining the ID (identifier) and name of the class to which ROI belongs. After that, a click on the "Create new shapefile" button, will add the ROI to the shapefile (this shapefile can also be edited using the standard functions of QGIS for creating polygons).
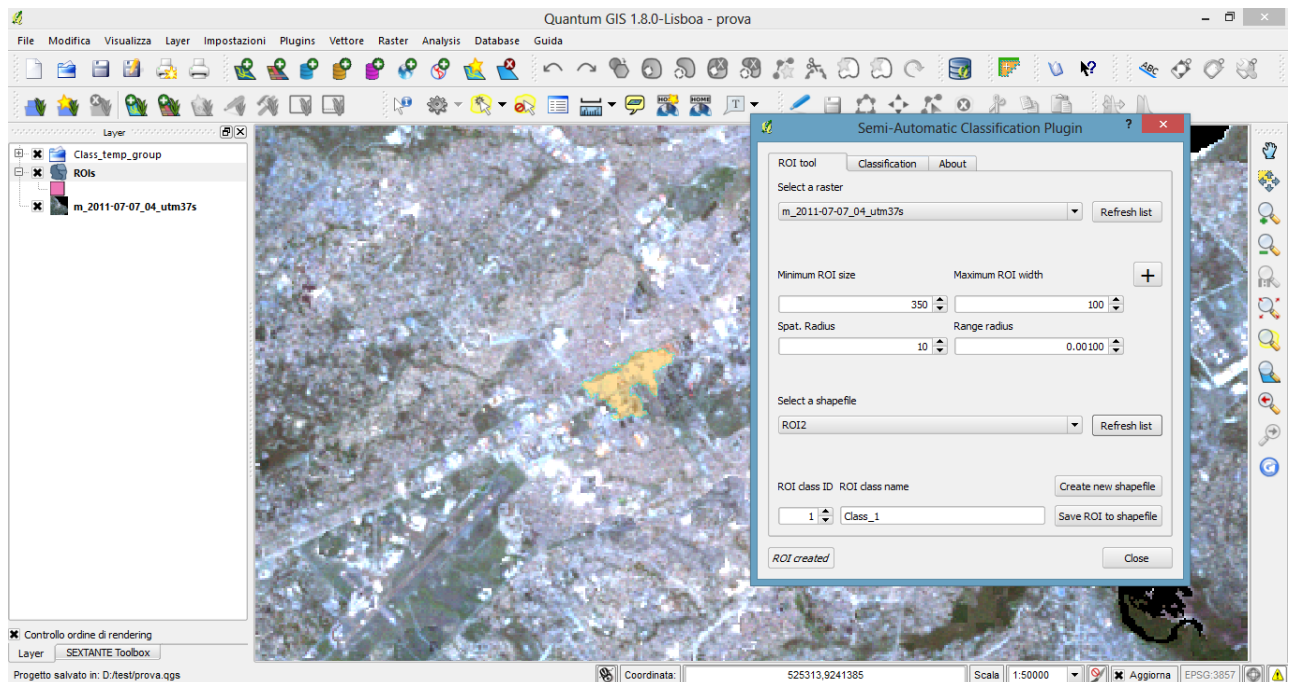
Figure 7: created ROIs are temporarily placed inside the group "Class_temp_group"

Once the collection of training areas is completed, it is possible to perform the classification, by switching to the "Classification" tab (Figure 8).

Figure 8: selected ROIs are saved inside a shapefile, which contains the required fields for classification

4   The Classification Tab

The "Classification" tab allows for the semi-automatic classification of a remote sensing image, using the Sextante implementation of supervised classification algorithms provided by SAGA (Figure 9).

Figure 9: plugin interface for classification
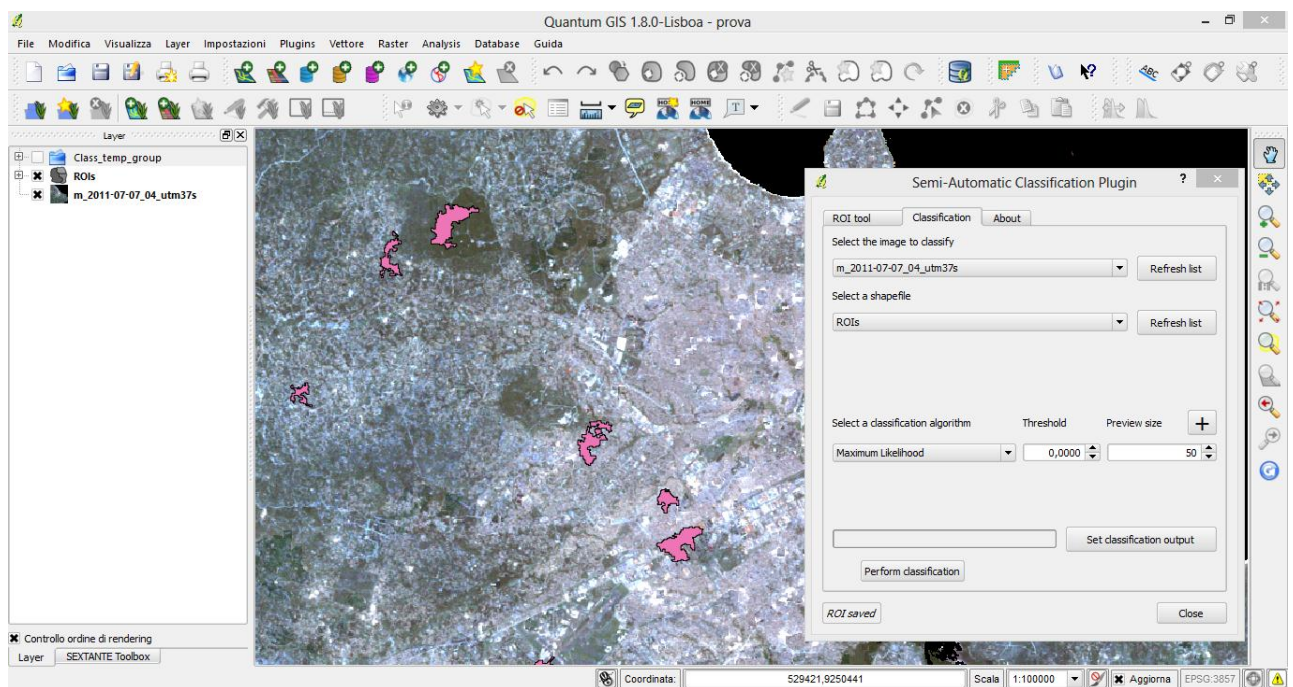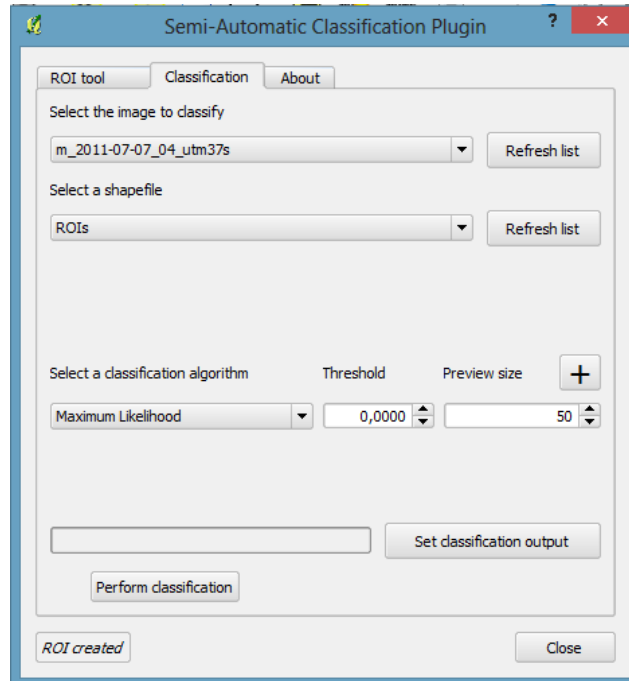
The classification process requires a shapefile containing at least an ID_class [int] field, used for the definition of classes. The classification can be performed for the entire image, or a preview can be created for a portion of it.

Required inputs are:
- A raster image, which is the classification target;
- A shapefile, which must contain at least the ID_class [int] field.

Available algorithms are:
- Maximum Likelihood;
- Minimum Distance;
- Spectral Angle Mapping.

For each algorithm, the following thresholds are available:
- for Maximum Likelihood, pixels are unclassified if probability is less than threshold (max 100);
- for Minimum Distance, pixels are unclassified if distance is greater than threshold;
- for Spectral Angle Mapping, pixels are unclassified if spectral angle distance is greater than threshold (max 90).

For the preview, it is possible to define the area by the following setting:
- Preview size (in pixel unit).

Available buttons:
- [Refresh list]: refresh list of layes;
- [+]: recall the pointer for the creation of a preview classification;
- [Set classification output]: set the classification output (.tif file);
- [Perform classification]: perform the image classification.

Preview can be useful for setting algorithm threshold, and assessing reliability of ROIs.
After the algorithm parameters are set, a classification preview can be created using the preview pointer (Figure 10).
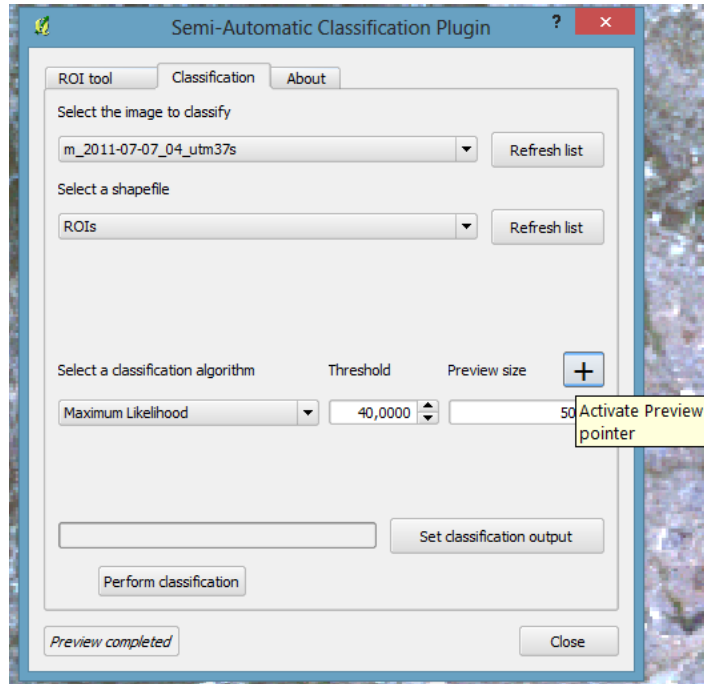
Figure 10: button for the activation of the preview pointer

By clicking on an image pixel, a classification preview is created and added to the map. The plugin automatically assigns a color to each defined class (Figure 11). The required time for preview creation is variable from few seconds to several minutes, depending on image size and selected algorithm.

Figure 11: example of image with selected ROIs (left) and preview of classification (right)

Temporarily, a .tif file is saved inside HOME/User ".qgis\sextante\tempdata" for each preview, and preview is deleted after QGIS session is stopped. Previews are loaded inside the group "Class_temp_group".

Figure 12: classification previews are placed inside the group "Class_temp_group"
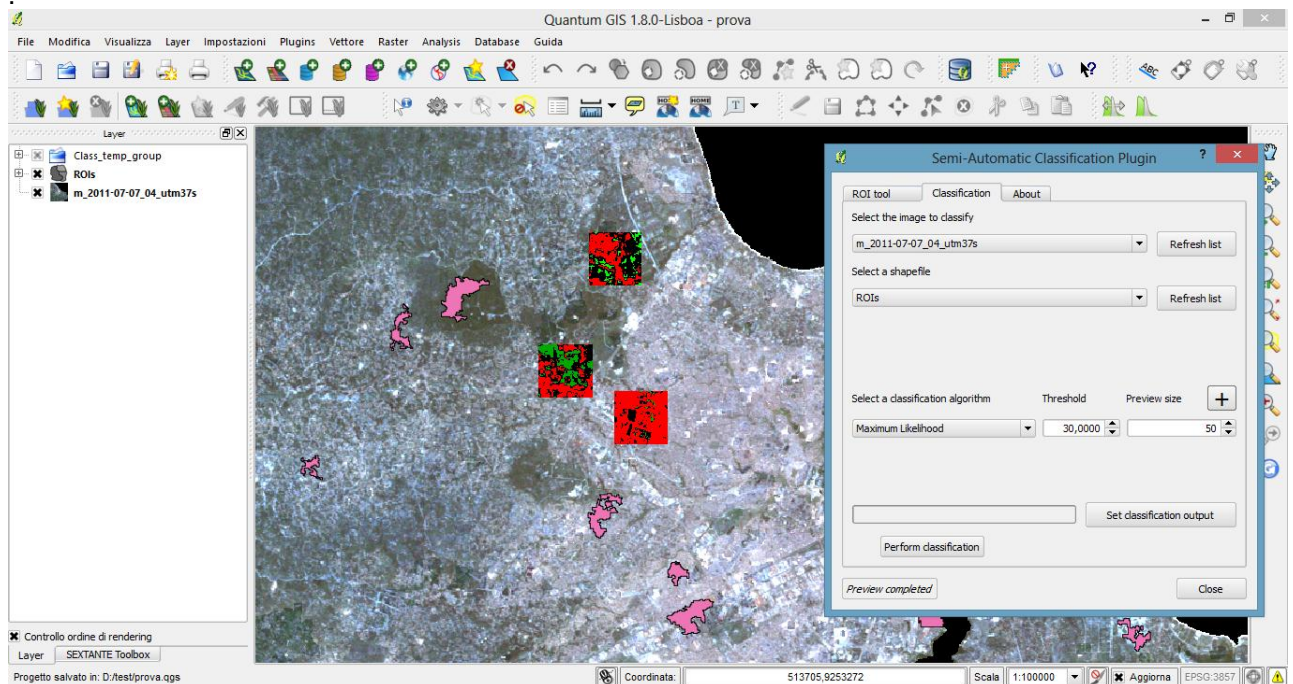
A classification for the whole image can be performed, after the selection of an output file, with a click on the "Perform classification" button. A .tif file is created for each classification, and it is automatically loaded in QGIS (Figure 13).
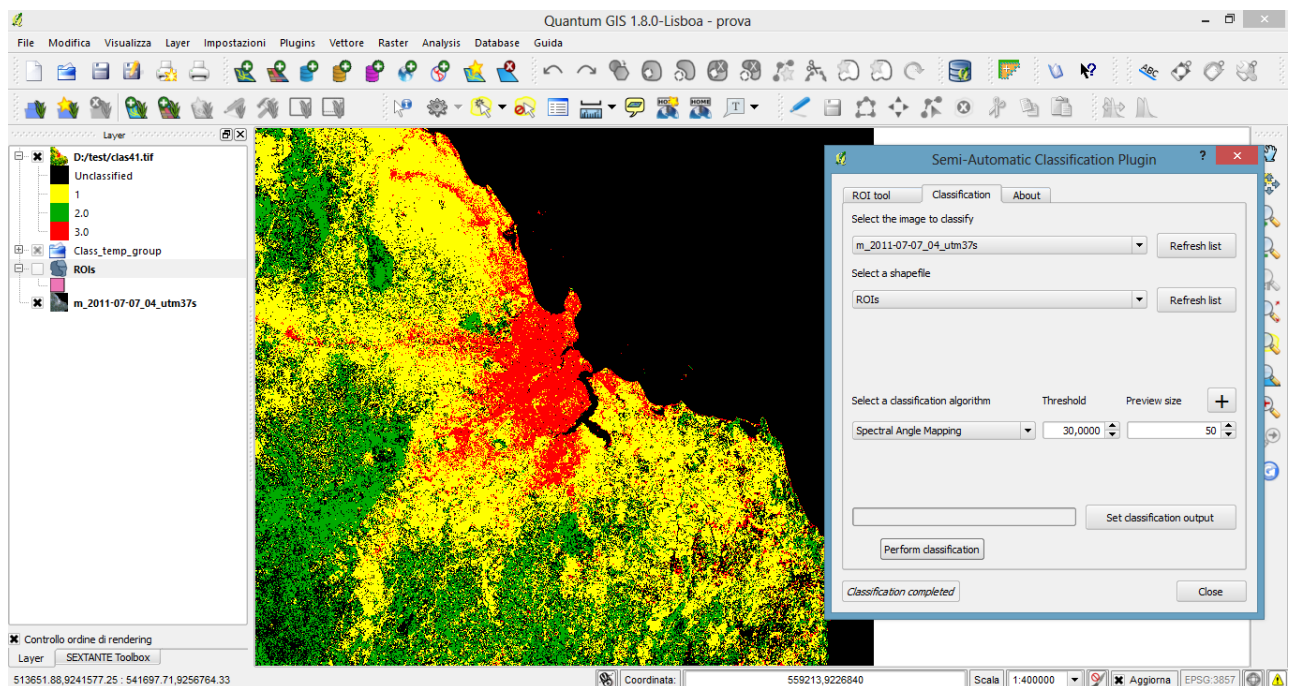

Figure 13: example of Land Cover classification

Also, a .dbf table file is created in the same output folder of the classification. This file contains the relation between ID_class values (i.e. ID column in the dbf) and classification raster values (i.e. NR column in the dbf), and several statistics about ROIs (Table 1).

Table 1: example of dbf table

NR	ID	TOT_N	ROI_N	…
1	3	1706962	2598	…
2	2	900359	7113	…
3	1	342669	4611	…
4	4	2139390	10000	…

5   The About Tab

The "About" tab contains a brief description of the plugin commands (Figure 14) and plugin license.
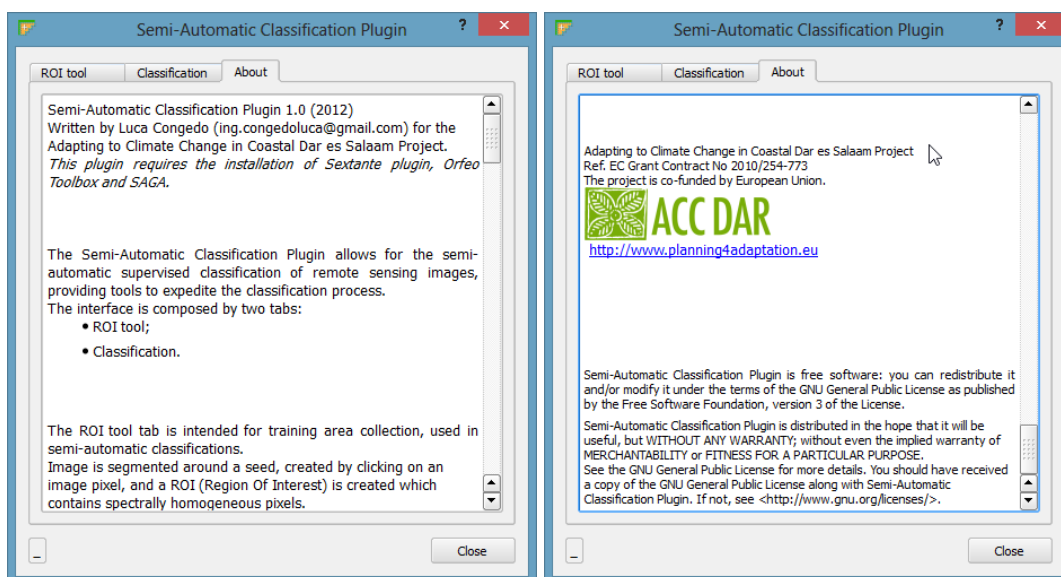

Figure 14: the "About" tab

6   License

Semi-Automatic Classification Plugin is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, version 3 of the License.
Semi-Automatic Classification Plugin is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
See the GNU General Public License for more details. You should have received a copy of the GNU General Public License along with Semi-Automatic Classification Plugin. If not, see <http://www.gnu.org/licenses/>.

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 11

Appendix 1 - Installation Guide

This is the installation guide of the "Semi-Automatic Classification Plugin" for QGIS, for several supported Operative Systems (OS):
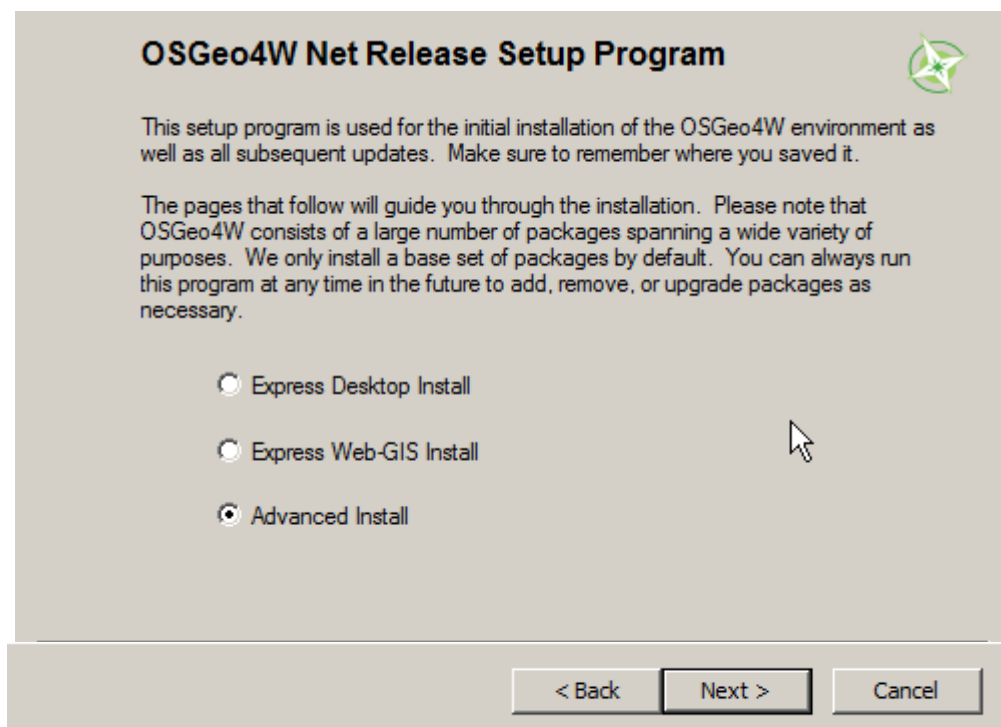
- Windows OS;
- Ubuntu Linux;
- Mac OS;
- OSGeo Virtual Machine.

Please refer to the websites of Orfeo Toolbox (http://www.orfeo-toolbox.org/otb/) and SAGA (http://www.saga-gis.org/en/index.html), for further information about their installation in other Operative Systems.

Windows OS:

Software Installation:

1) Download the OSGEO installer from http://download.osgeo.org/osgeo4w/osgeo4w-setup.exe and execute it with administrative rights;

2) Select "Advanced Install", and click "Next";

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 12

3) Select "Install from Internet", and click "Next";

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 13
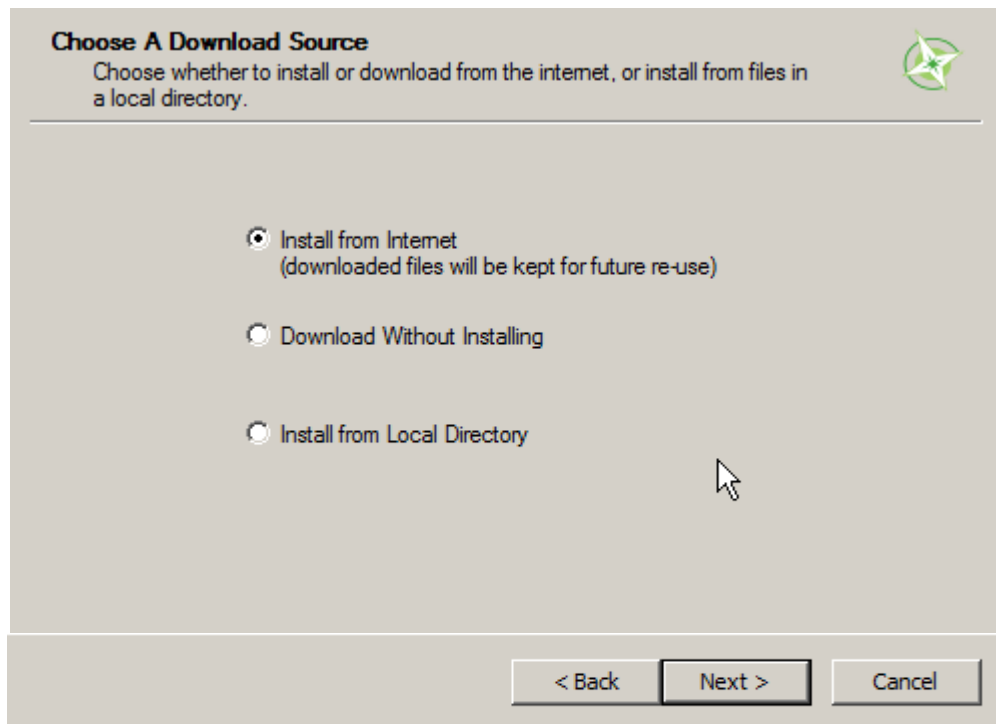
4) Leave unchanged the default "Root Directory" and click "Next";
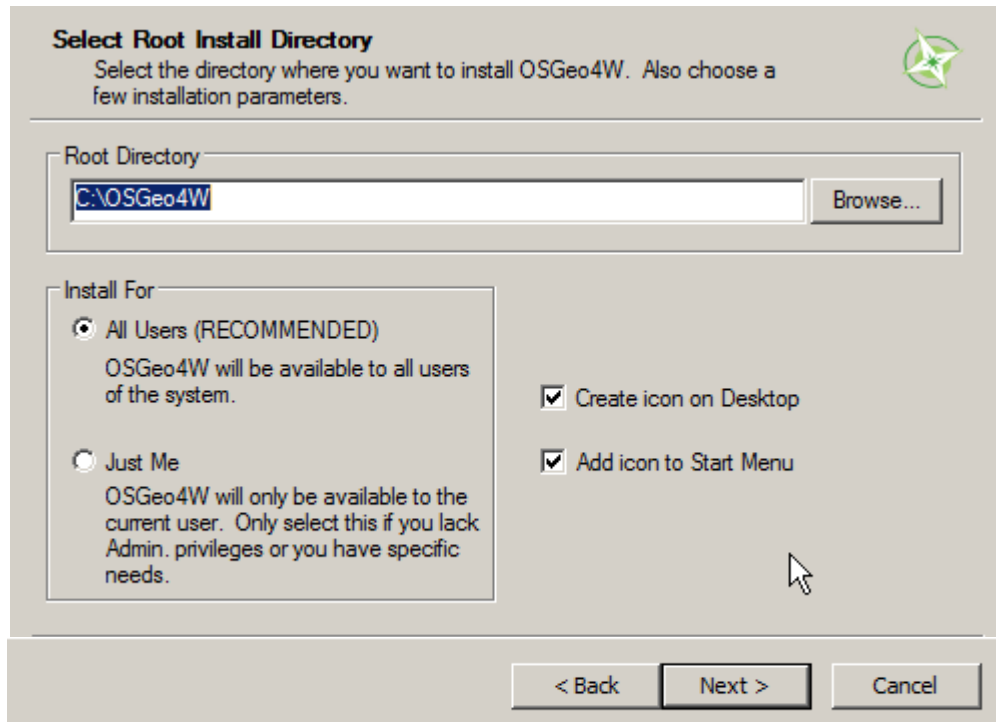
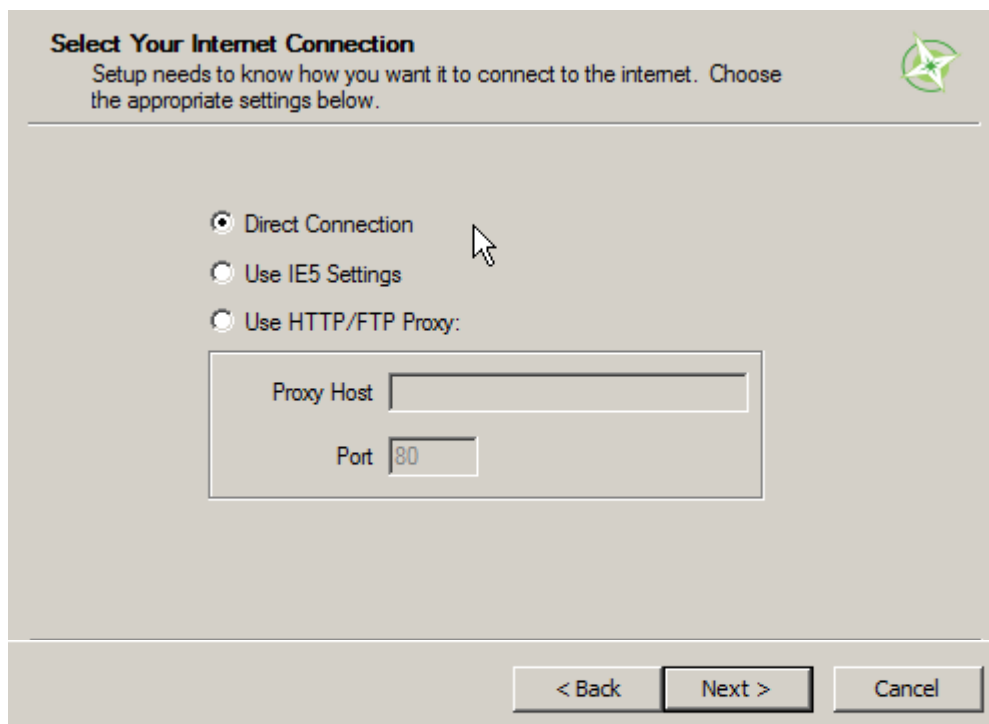5) Leave unchanged the default "Local Package Directory" and click "Next" (this folder can be deleted when installation is finished);

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 14
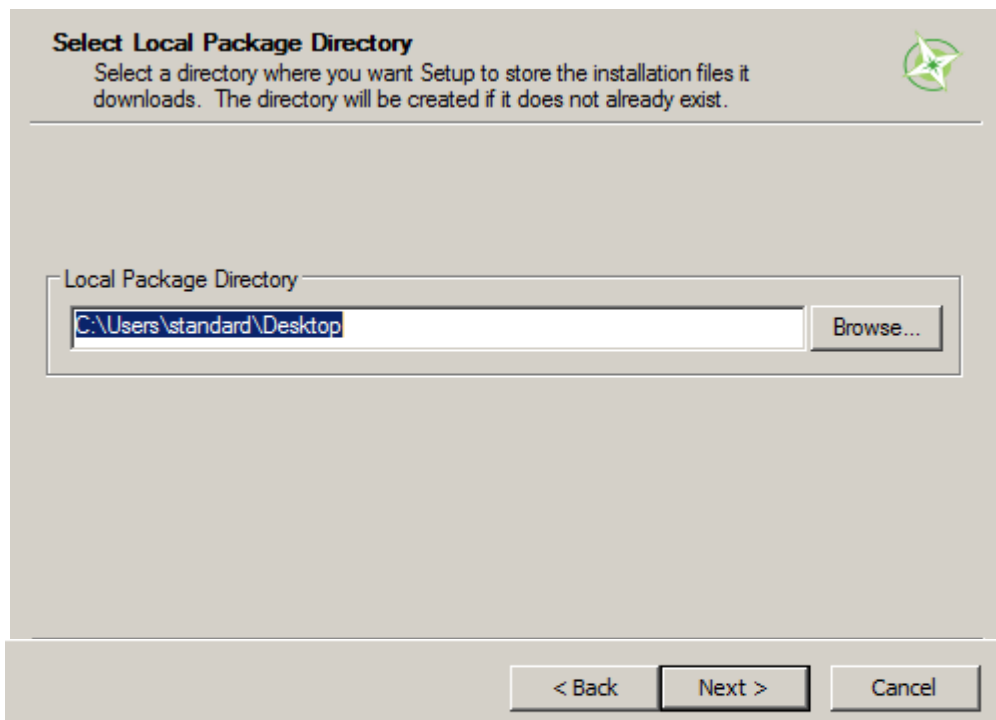
6) Select "Direct Connection", and click on "Next";

7) From the "Categories" list, click the "+" symbol, beside "Desktop";

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 15
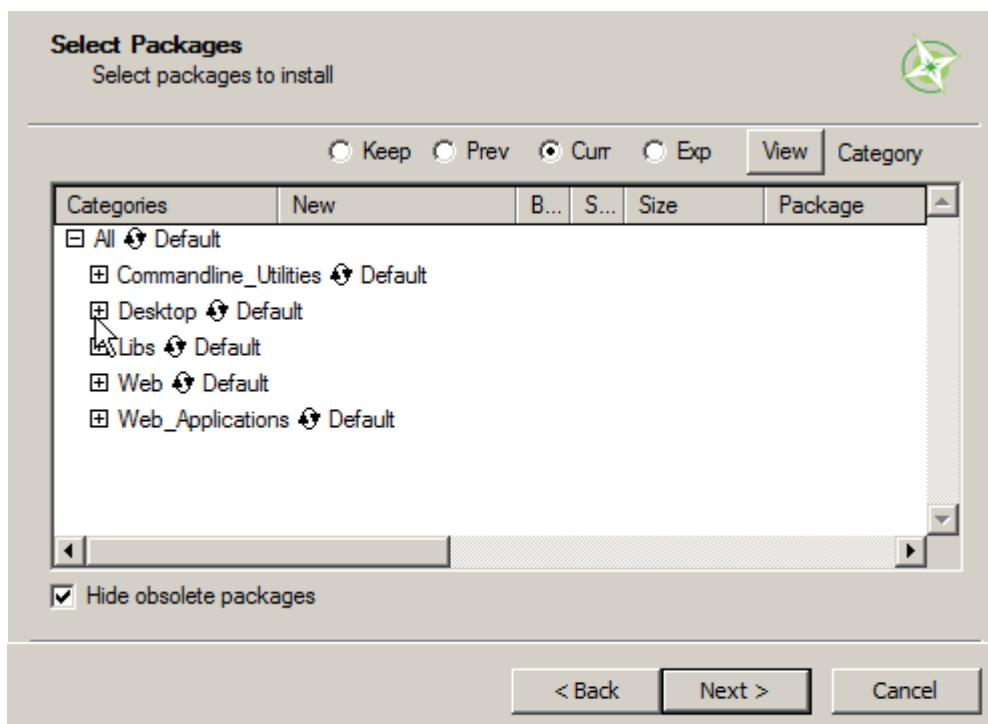
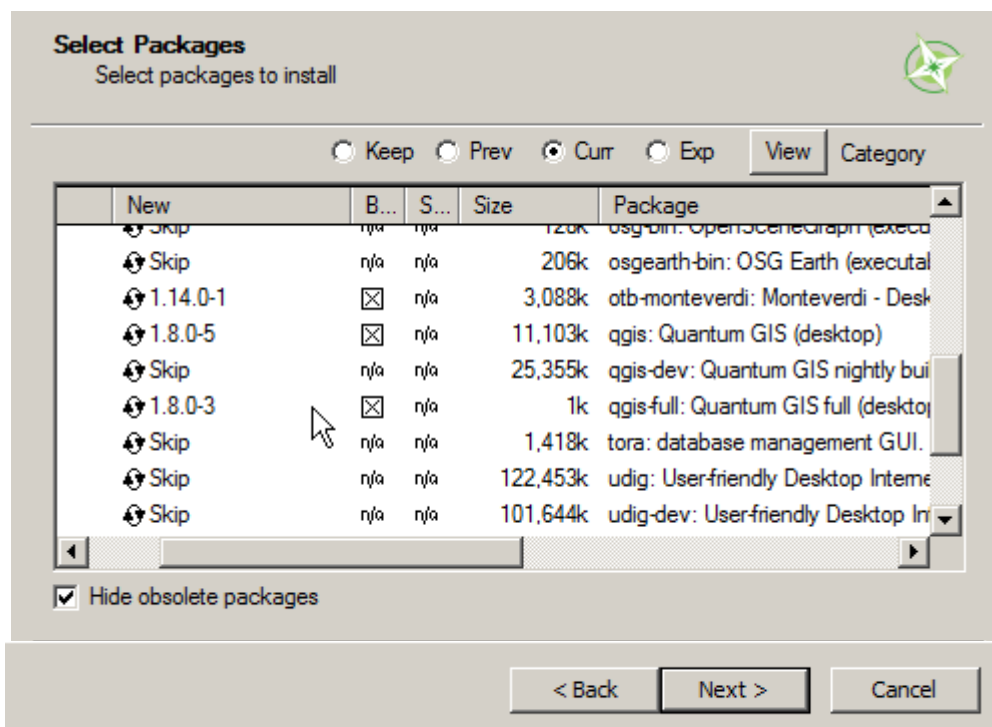8) Click the "Skip" texts beside "qgis-full" and "otb-monteverdi" (under the "New" column); a version number should appear in place of "Skip", which is the software version (for example 1.8.0 for QGIS);

9) Click "Next" and wait until the process have downloaded and installed the selected software;

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 16
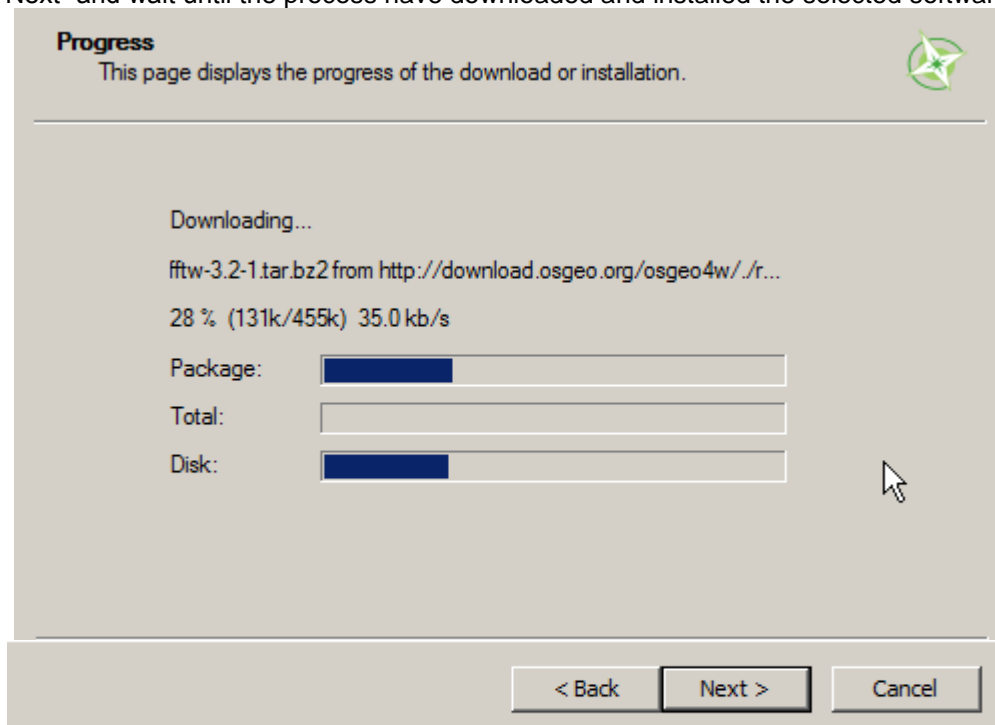
10) Download the "System for Automated Geoscientific Analyses" (SAGA) software
    1. if Windows 32bit from this link http://sourceforge.net/projects/saga-gis/files/SAGA%20-%202.0/SAGA%202.0.8/saga_2.0.8_win32_setup.exe/download ;
    2. if Windows 64bit from this link http://sourceforge.net/projects/saga-gis/files/SAGA%20-%202.0/SAGA%202.0.8/saga_2.0.8_x64_setup.exe/download ;

11) Execute the SAGA installer with administrative rights, leaving the default settings;

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
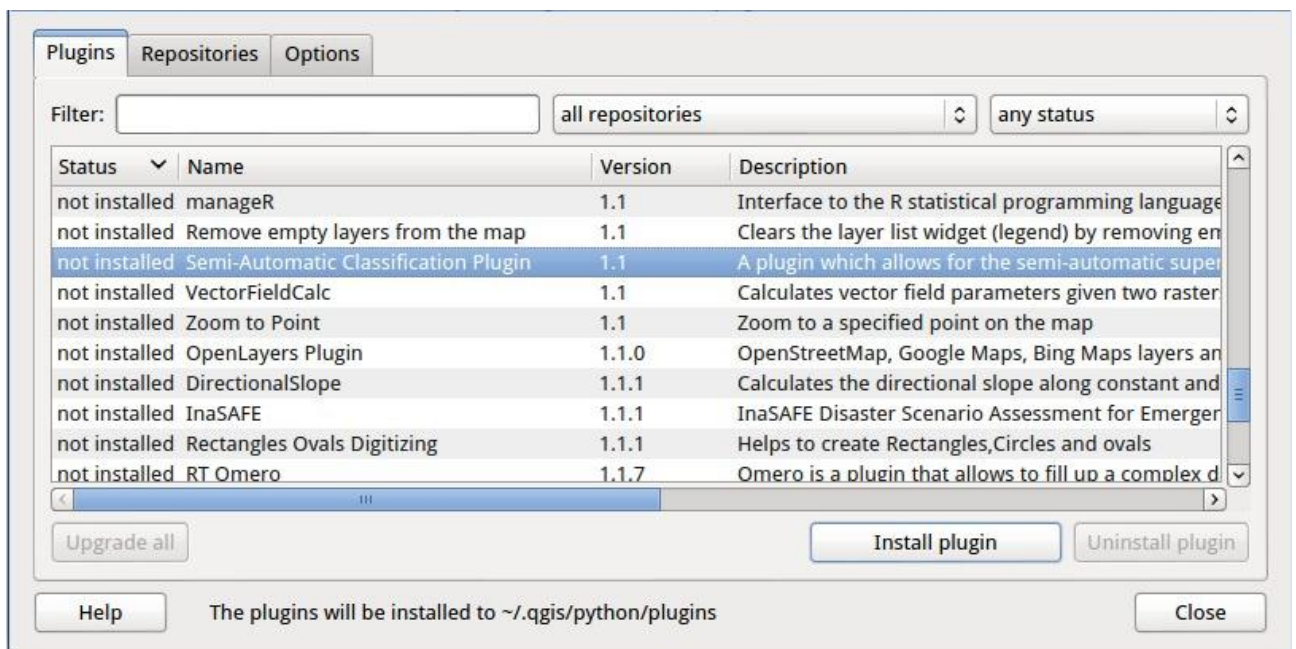8 April 2013
Luca Congedo

Pg. 17
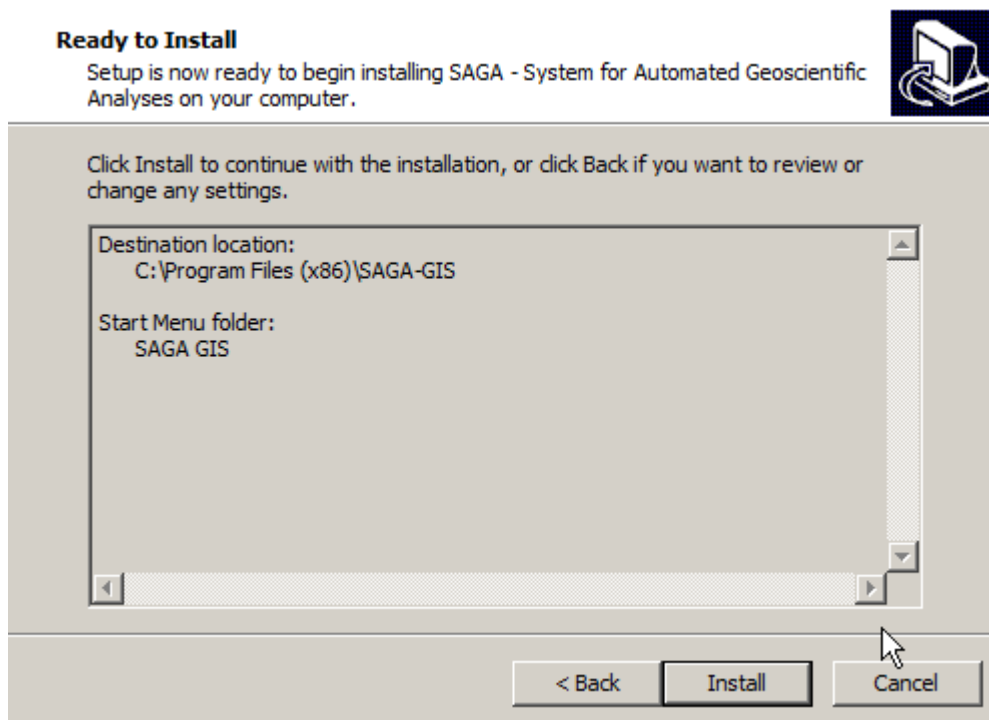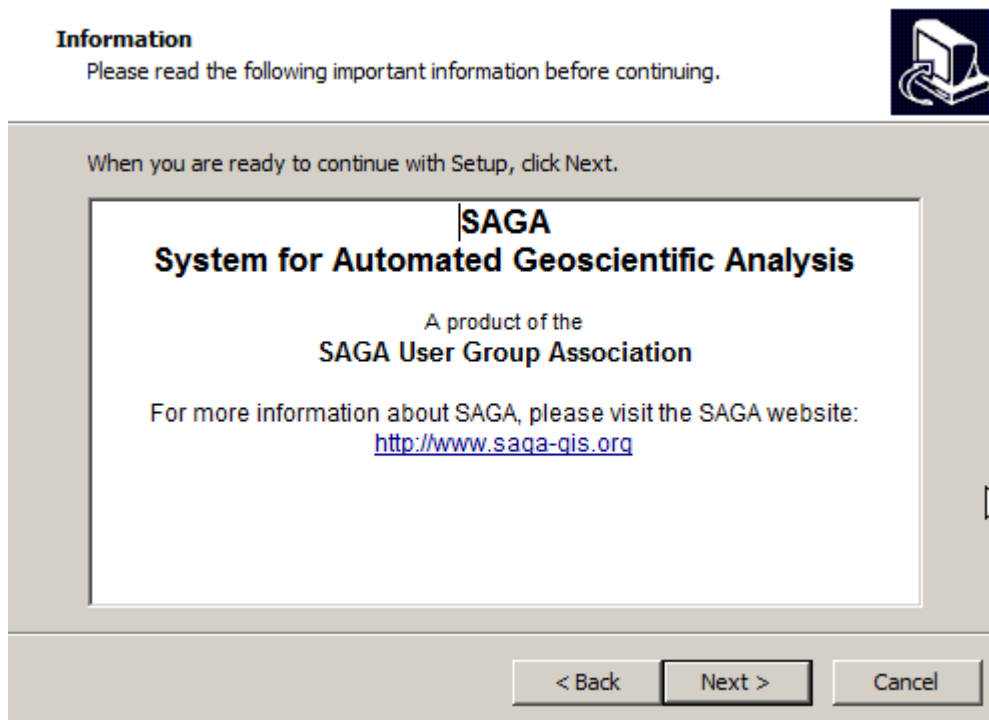
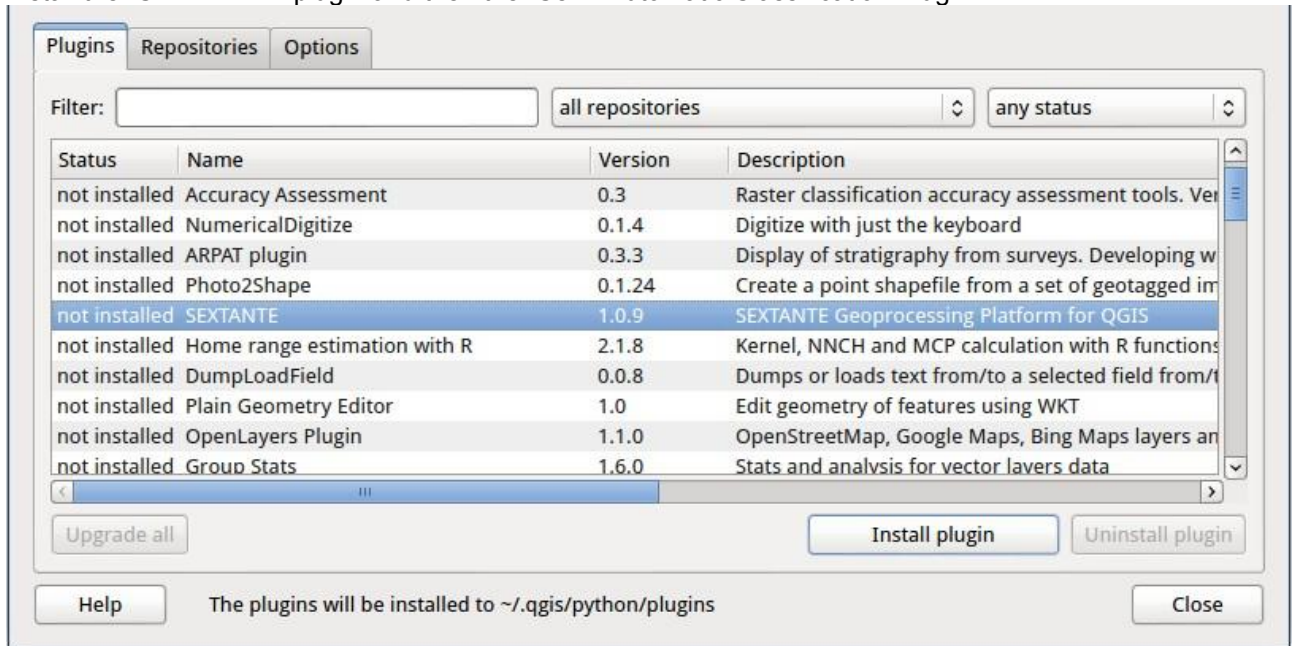*Software Configuration*

1) Run QGIS
2) Select "Fetch Python Plugins" under the "Plugins" menu

3) Install the "SEXTANTE" plugin and then the "Semi-Automatic Classification Plugin"

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 18

4) Open "Manage Plugins" under the "Plugins" menu; select the "SEXTANTE" and "Semi-Automatic Classification Plugin", and click "OK";
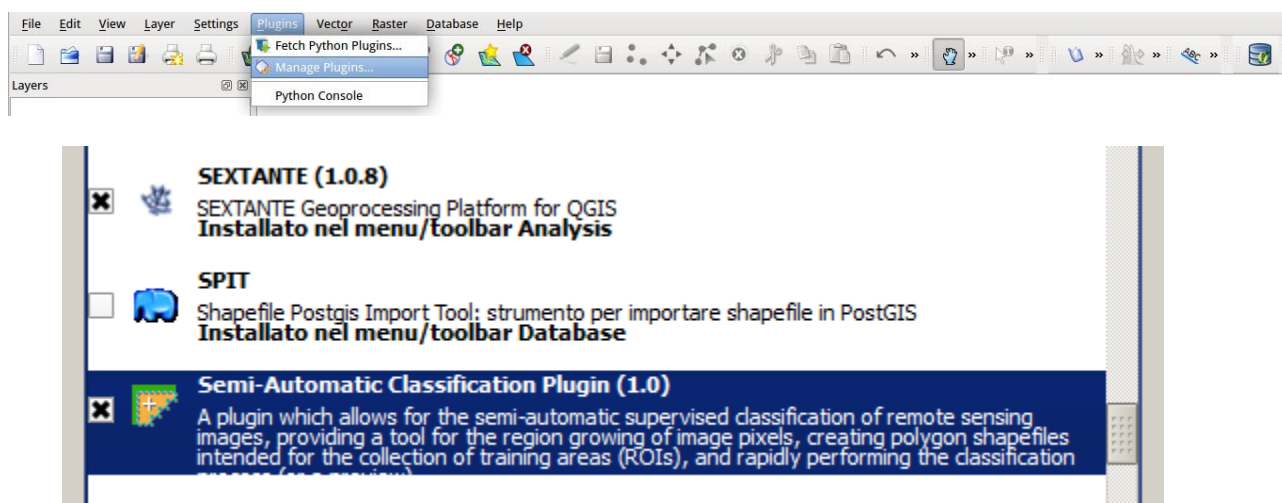
5) Select "SEXTANTE option and configuration" under the "Analysis" menu;
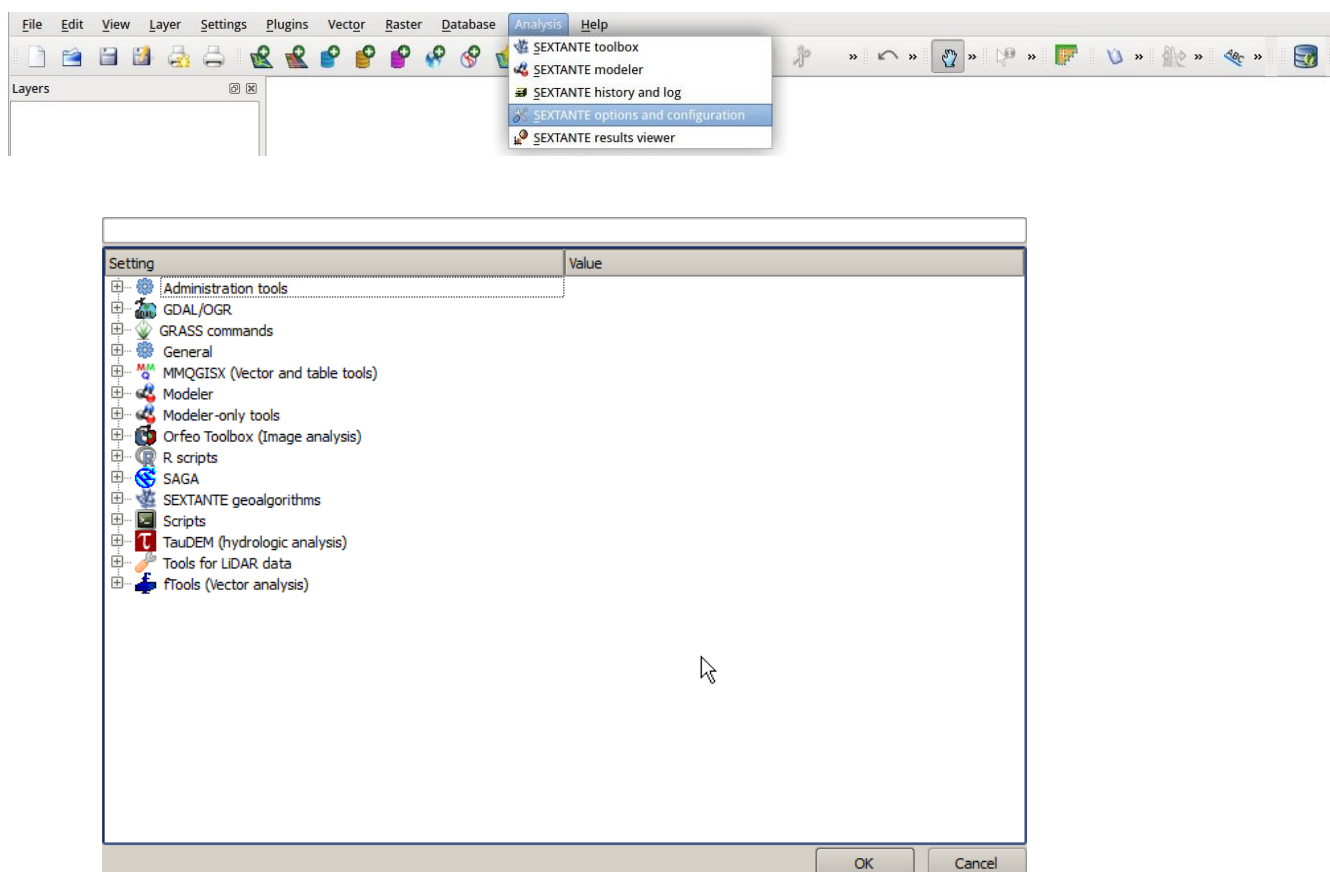
Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 19

a) In order to set "Orfeo Toolbox":
   o Click the "+" symbol beside "Orfeo Toolbox";
   o Click "Activate";
   o Copy the following path in "OTB applications folder":
       "C:\OSGeo4W\apps\orfeotoolbox\applications"
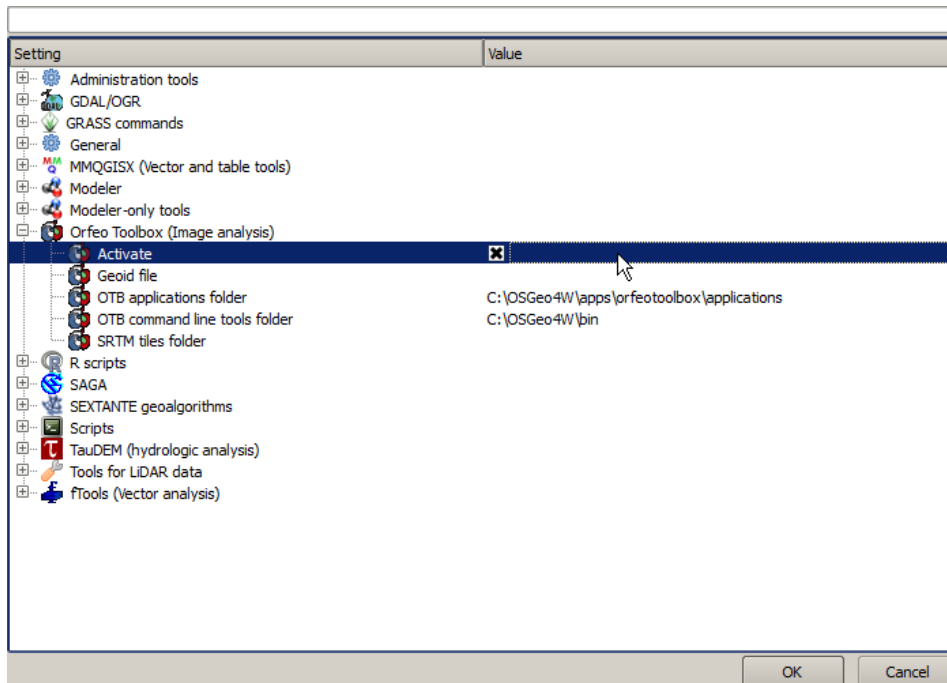   o Copy the following path in "OTB command line tools folder":
       "C:\OSGeo4W\bin"

b) In order to set "SAGA":
   o Click the "+" symbol beside "SAGA";
   o Click "Activate";
   o Copy the following path in "SAGA folder" (this path could be different, according to the version of Windows):
       "C:\Program Files (x86)\SAGA-GIS"

Setting	Value
⊞ Administration tools	
⊞ GDAL/OGR	
⊞ GRASS commands	
⊞ General	
⊞ MMQGISX (Vector and table tools)	
⊞ Modeler	
⊞ Modeler-only tools	
⊞ Orfeo Toolbox (Image analysis)	
⊞ R scripts	
⊟ SAGA	
Activate	☒
Log console output	☐
Log execution commands	☐
Resampling region cellsize	1
Resampling region max x	1000
Resampling region max y	1000
Resampling region min x	0
Resampling region min y	0
SAGA folder	C:\Program Files (x86)\SAGA-GIS
Use min covering grid system for resampling	☒
⊞ SEXTANTE geoalgorithms	
⊞ Scripts	
⊞ TauDEM (hydrologic analysis)	
⊞ Tools for LiDAR data	
⊞ fTools (Vector analysis)	

          OK   Cancel
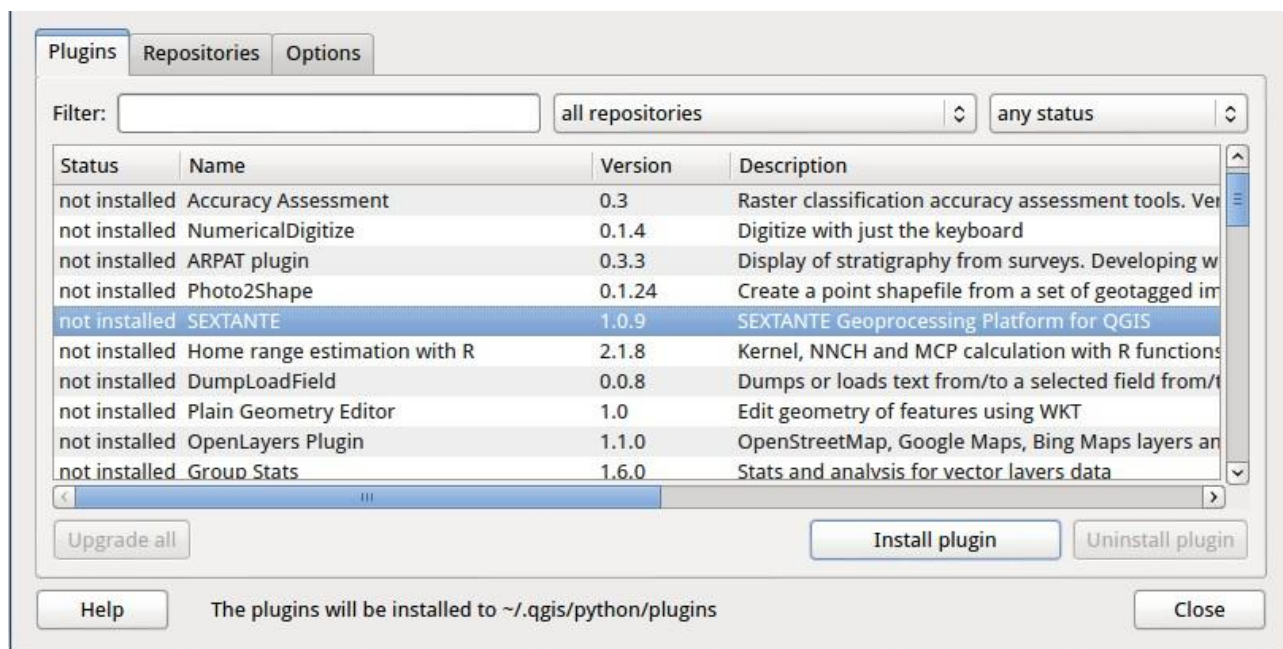
c) Click "OK".

Ubuntu Linux:

Software Installation:

1) Open a terminal and type:
   sudo apt-add-repository ppa:ubuntugis/ubuntugis-unstable
2) Press Enter and type the user password;
3) Press Enter again to confirm;
   (if Ubuntu version is lower than 12, the additional command could be required:
   sudo apt-add-repository ppa:johanvd)
4) Type in a terminal:
   sudo apt-get update
5) Press Enter;
6) Type in a terminal:
   sudo apt-get install qgis otb-bin monteverdi saga
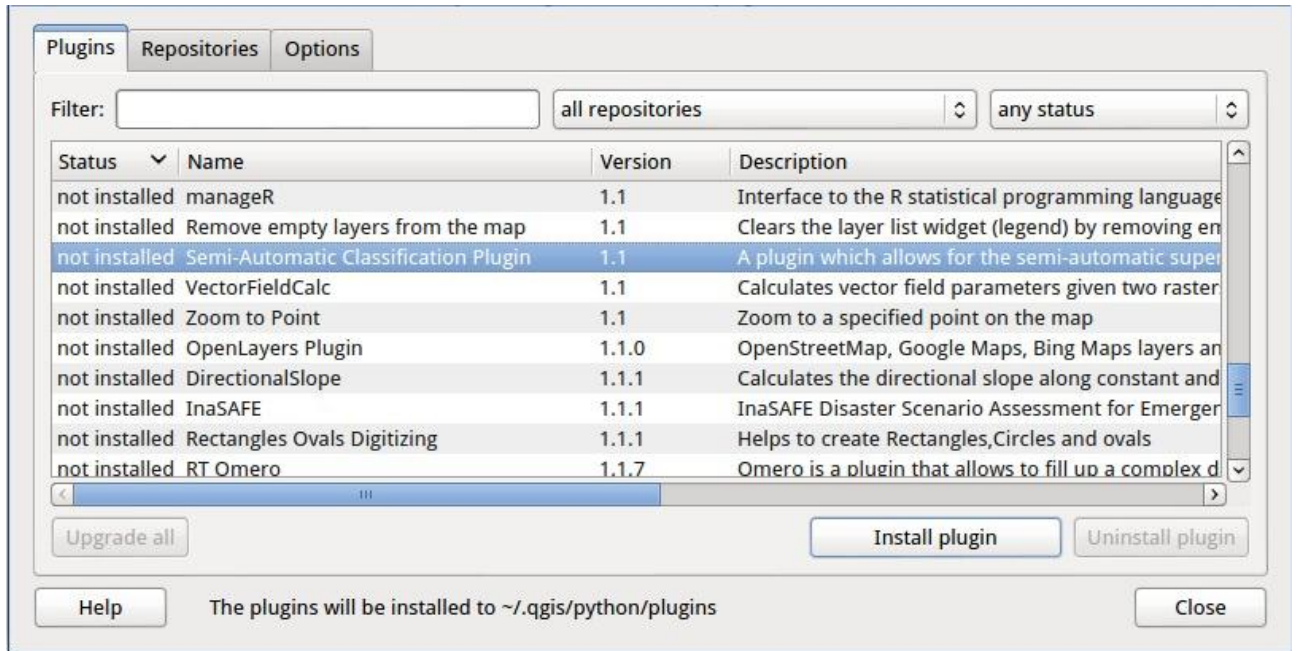7) Press Enter and wait until the software is downloaded and installed.

Software Configuration

1) Run QGIS
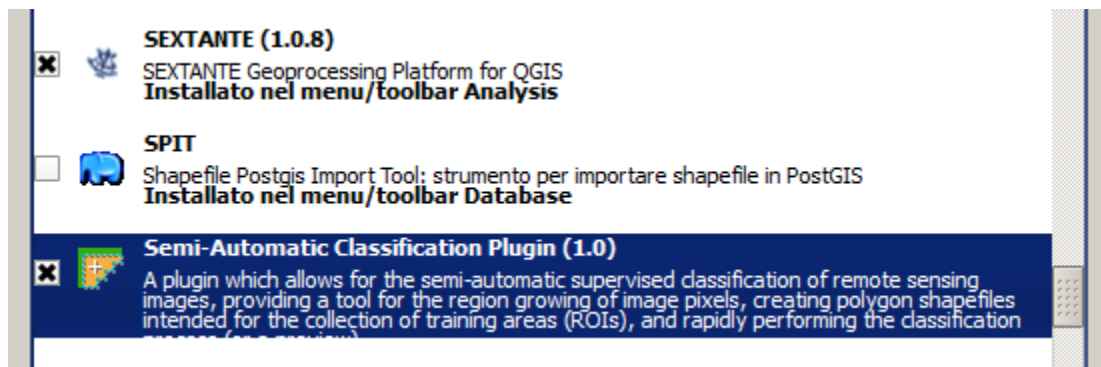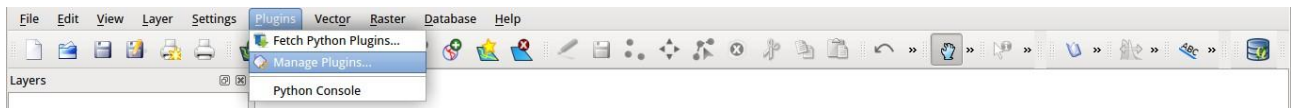2) Select "Fetch Python Plugins" under "Plugins" menu

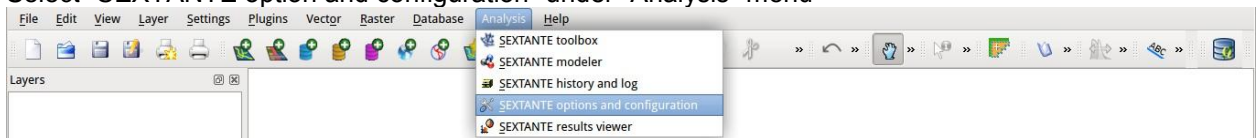3) Install first the "SEXTANTE" plugin and then the "Semi-Automatic Classification Plugin"
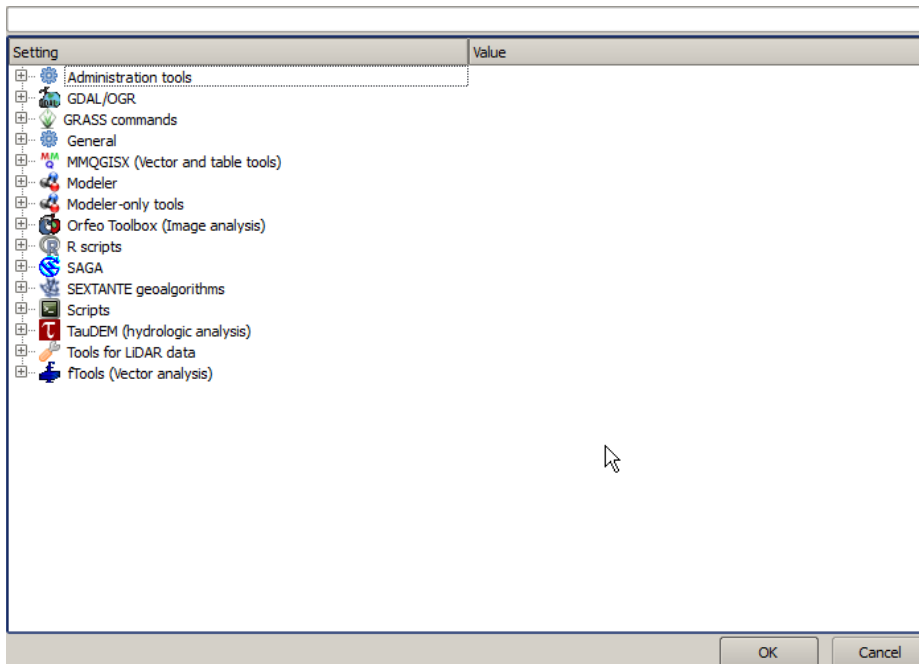
4) Open "Manage Plugins" under the "Plugins" menu; select the "SEXTANTE" and "Semi-Automatic Classification Plugin", and click "OK"

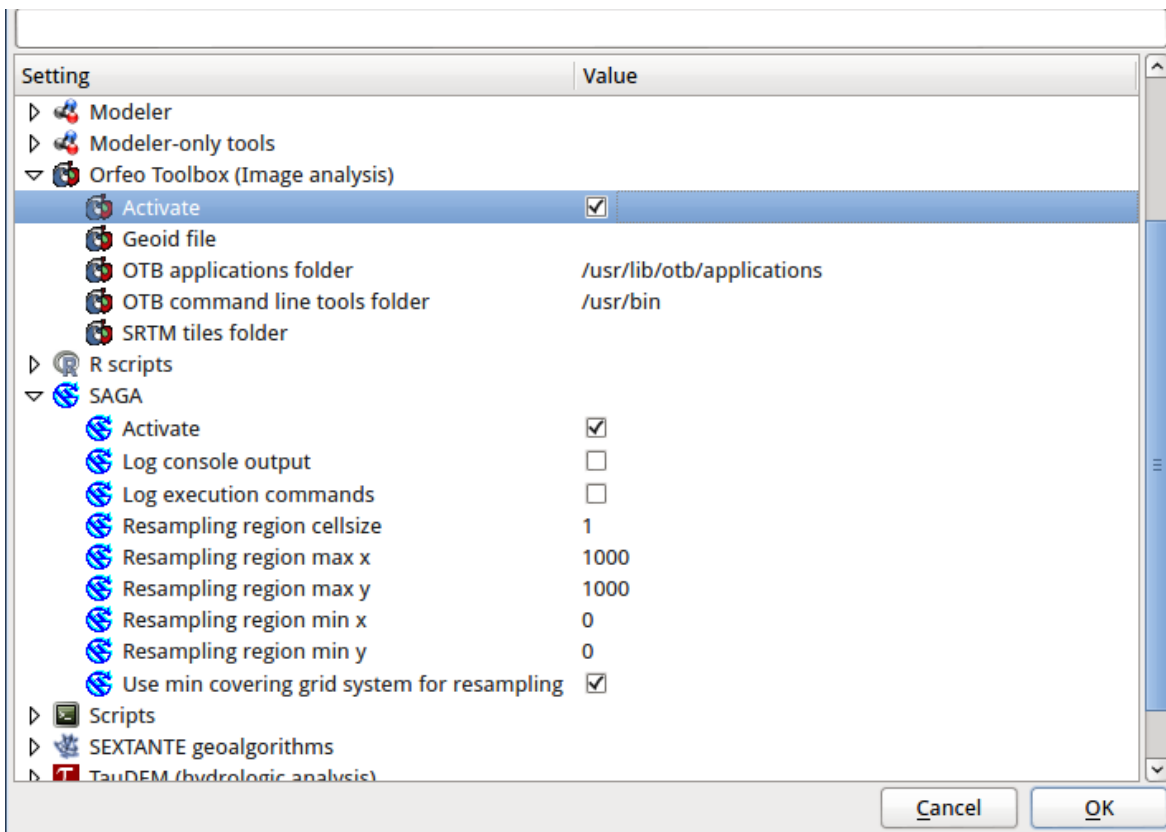5) Select "SEXTANTE option and configuration" under "Analysis" menu

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Pg. 23

a) In order to set "Orfeo Toolbox":
    o Click the "+" symbol beside "Orfeo Toolbox";
    o Click "Activate".

b) In order to set "SAGA":
    o Click the "+" symbol beside "SAGA";
    o Click "Activate".

Adapting to Climate Change in Coastal Dar es Salaam Project
Ref. EC Grant Contract No 2010/254-773
Semi-Automatic Classification Plugin for QGIS
8 April 2013
Luca Congedo

Mac OS:

To our knowledge, the "System for Automated Geoscientific Analyses" program is unavailable for Mac OS, therefore the "Semi-Automatic Classification Plugin" is unable to work.
As a solution, it is possible to use a virtual machine, which contains all the required software (see OSGeo Virtual Machine paragraph).

OSGeo Virtual Machine

Software Installation:

1) Download "VirtualBox" open source software from https://www.virtualbox.org/wiki/Downloads (select a proper version depending on the OS) and install it (at the end of the installation a system restart is required);
2) Download the virtual machine (about 3 GB) from http://live.osgeo.org/en/download.html (click "Download Virtual Machine" link);
3) Extract the virtual machine content (for example "osgeo-live-vm-6.5.7z") in a directory (the file is compressed in 7z format, and it requires about 10 GB of free space when extracted; if required download the extraction software from http://www.7-zip.org/);
4) Run "VirtualBox" and create a new "Ubuntu" virtual machine;
5) Set the virtual machine in order to use the OSGeo virtual disk;
6) Run the OSGeo virtual machine;
7) Install the VirtualBoox tools in the virtual machine;
8) Refer to the "Ubuntu Linux" paragraph for the Software Configuration.