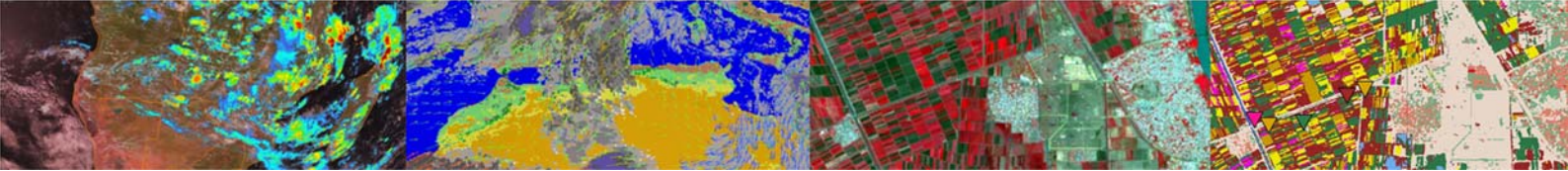


ILWIS 386 - Tutorial

Bas Retsios, Ben Maathuis and Martin Schouwenburg, 20-11-2019

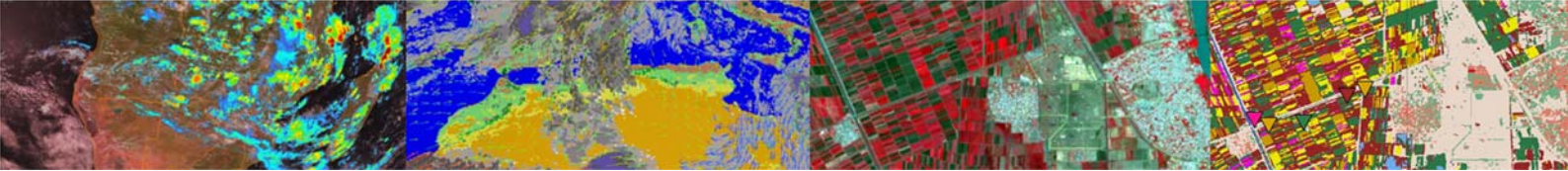
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1 Introduction

During these exercises you will get familiar with the ILWIS GIS software, and perform some basic tasks. First you will download and install ILWIS, and some data files for this exercise. Then you will get familiar with the ILWIS Main Window and the ILWIS Map Window, and then use the ILWIS command-line to perform some operations.

1.1 Overall learning objectives

After these exercises you will be able to:

- Use ILWIS to open and display raster and vector maps
- Compose several layers and change the visualization
- Hide data from the catalog that you consider unimportant, and show it again
- Find and execute operations on raster and vector data using the menu
- Use the help function
- Animate time series data
- Execute operations on raster and vector data using the ILWIS command-line

2 Download and Installation

2.1 Downloading and Installing ILWIS

ILWIS (the Integrated Land and Water Information system) is free and open source GIS software that is developed at ITC and 52north to support education and research in geo-sciences. The software is optimized to also perform smoothly on computers that are a bit older. It works on 32 and 64 bits Windows 7 and newer.

ILWIS is freely available at:

<http://52north.org>

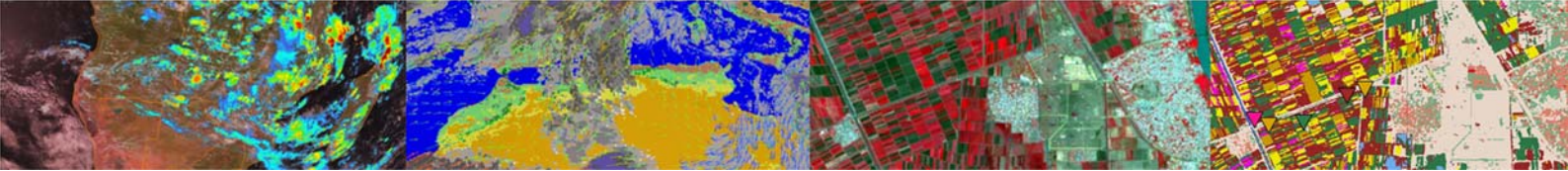
The latest version at the time of writing this document is 3.8.6 and can be downloaded by using the following link:

<http://52north.org/software/software-projects/ilwis/ilwis-3/>

If this link is unavailable, there is an alternative download link:

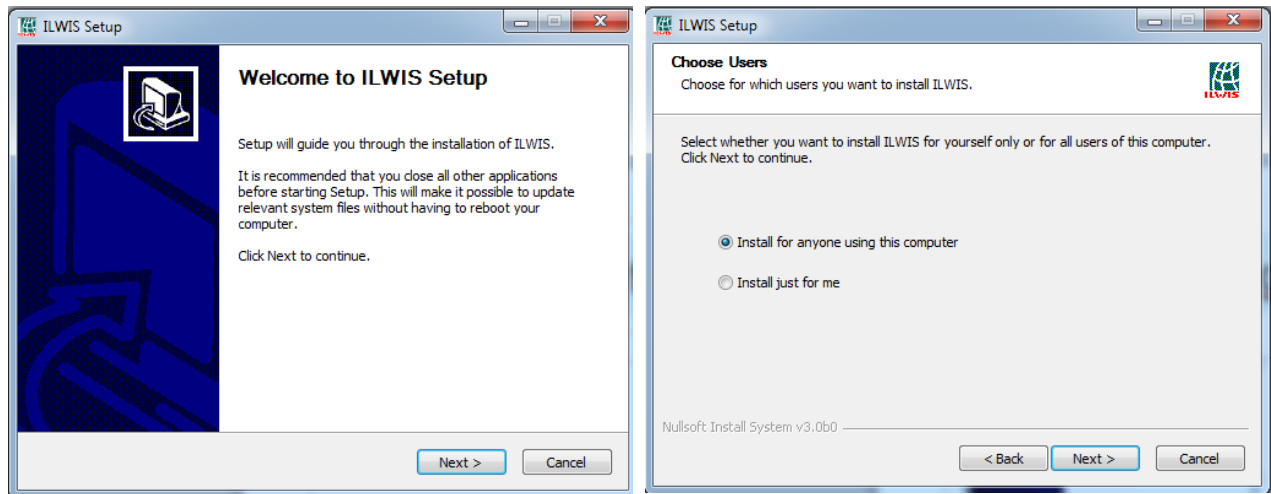
<https://filetransfer.itc.nl/pub/52n/ILWIS386/Software/>

To start the installation, unzip the downloaded zipfile, and double-click setup.exe



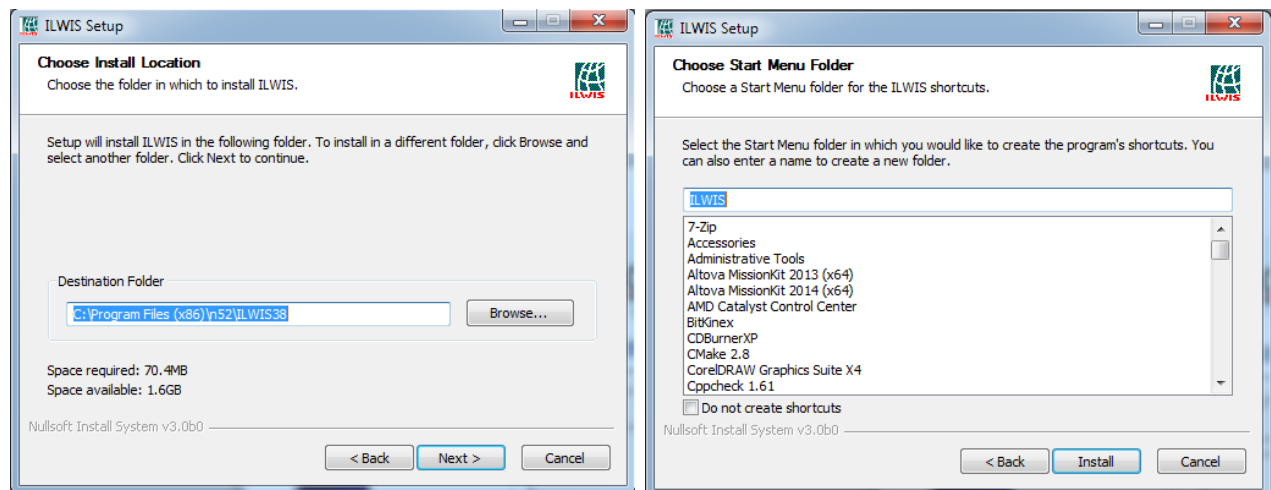
The first screen is a welcome screen. Press next.

The second screen offers you the option that the program is available for all users or only for the current logged in user (you). Leave this at the default (all). Press next.



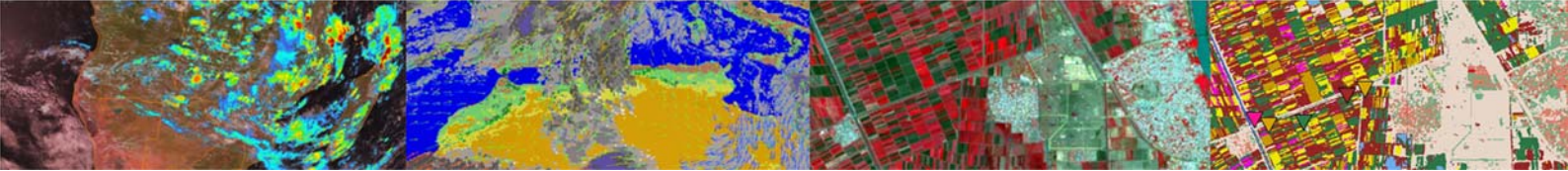
The third screen is the place on your hard disk where ILWIS 3.8.6 will be installed. To accept the default, press next, otherwise use the “Browse...” button to navigate to an appropriate location and then press next. For use with the Geonetcast Toolbox¹, the default destination folder is not appropriate. You have to select a folder with no spaces in it. For example you can use “C:\ilwis386”.

The last screen offers you options on how ILWIS will be available in the Start Menu. To accept the default press “Install”.



After this, the installation will start. Press “Next” and “Finish” when it is done.

¹ The Geonetcast Toolbox is an optionally downloadable extension/plugin for ILWIS, and is a large library of routines for converting and preprocessing more than 500 satellite image file formats, i.e. the ones that are received from [Geonetcast](#). Learning and using the Geonetcast Toolbox is out of the scope of this document.



2.2 Downloading and copying the Tutorial Data

Download a zip file with sample data named “tutorial_data.zip” from here:

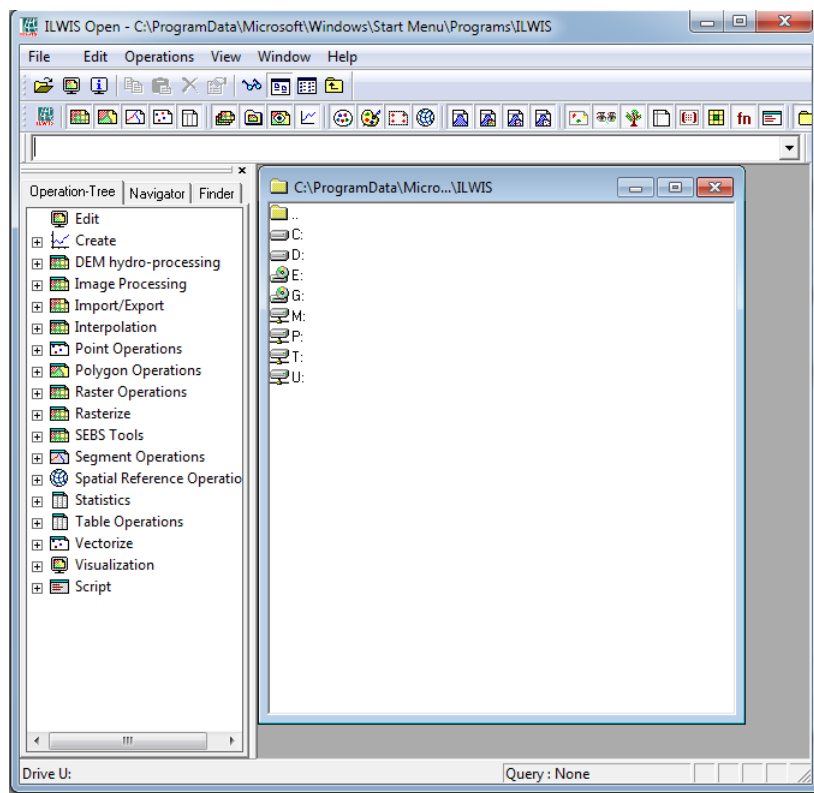
<http://filetransfer.itc.nl/pub/52n/ILWIS386/Data/>

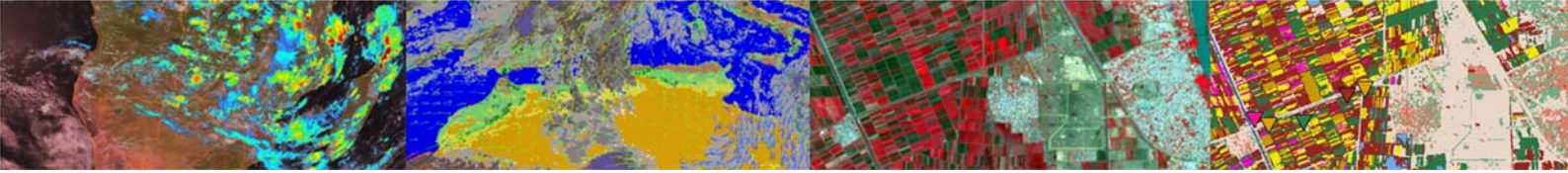
This file contains the data needed for this exercise. After downloading, select a location on your hard disk to unzip the data (e.g. into D:\Data\). A new folder, “tutorial_data”, will be created at that location.

3 Starting ILWIS

The shortcut that starts ILWIS can be found in the Start Menu under “All Programs” at “ILWIS”. Click on the ILWIS icon and ILWIS will start.

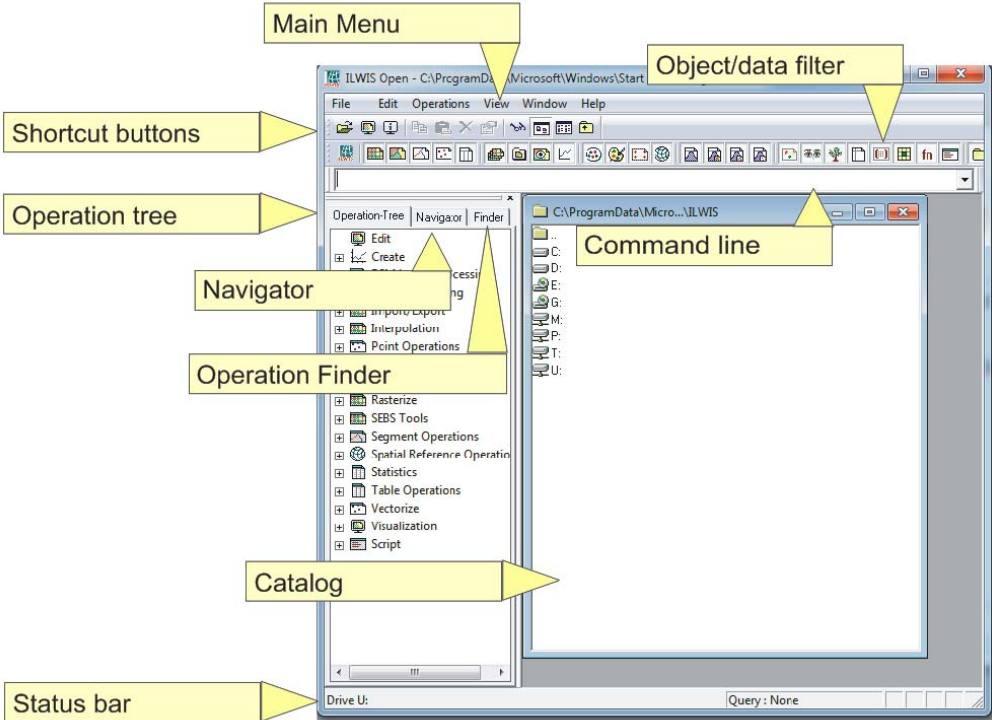
You will see a screen similar to this. This is the ILWIS Main Window.

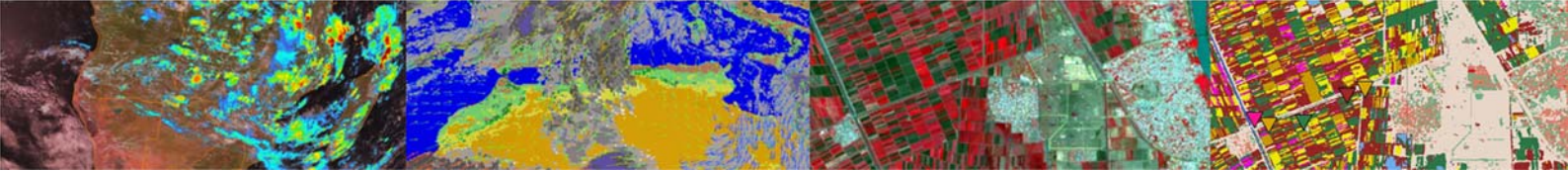




4 Exploring the ILWIS Main Window

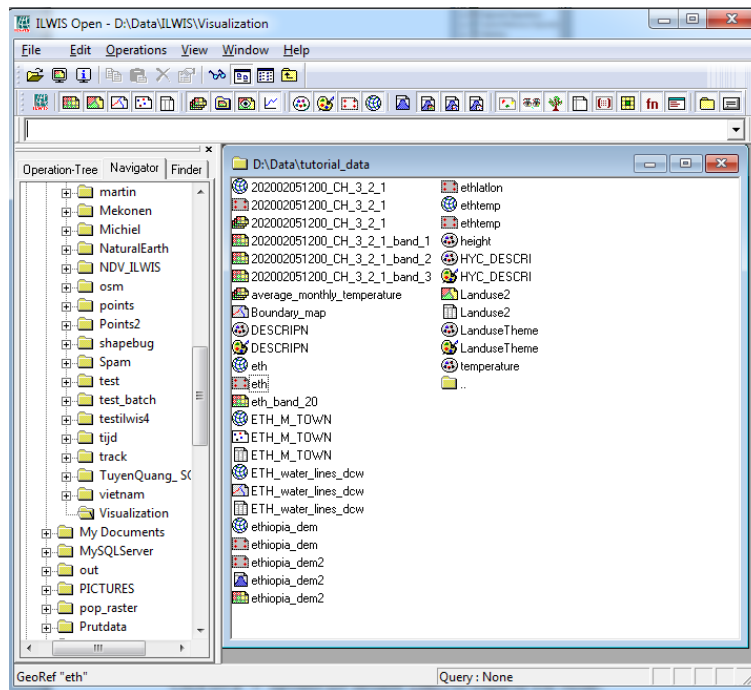
The ILWIS Main Window consist of several components





4.1 Navigator

The left part of the window has 3 tabs, named Operation Tree, Navigator and Finder. Click on the tab Navigator. This shows a folder navigator which you can use to navigate to your data.



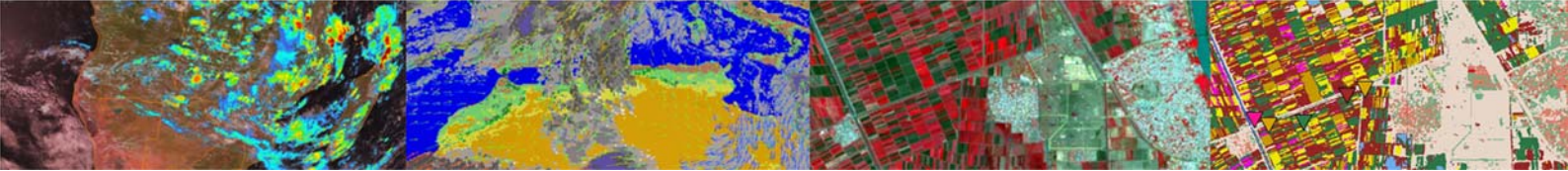
Click on a '+' symbol (or double click) to expand the folder and see its subfolders.

Selecting a folder or drive will show its content in the current active catalog, which is on the right side of the ILWIS Main Window.

The so-called context menu of the Navigator, which appears when clicking the right mouse button on one of the folders in the Navigator, gives access to a small menu to open a new catalog at the selected folder (instead of replacing the currently active catalog with that folder), or create a new folder (directory) and open it in a new catalog.

- 1) Use the navigator to go to location where you unzipped your data.

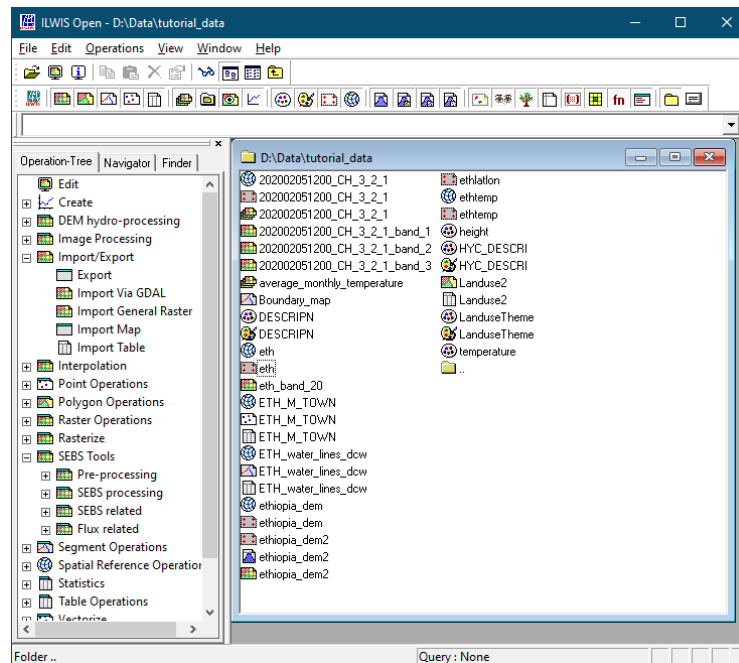
This will be your working directory for the rest of the exercise.



4.2 Operation Tree and Operation Finder

ILWIS has a large list of operations available for spatial data. The operations can be found under the Operation Tree tab, and also in the Finder tab (which is a searchable alphabetic list of all operations). The Operation Tree and the Finder are two views on the same set of operations.

In the Operation Tree the operations are organized in a number of categories.



Under each category operations can be found that operate in the same field.

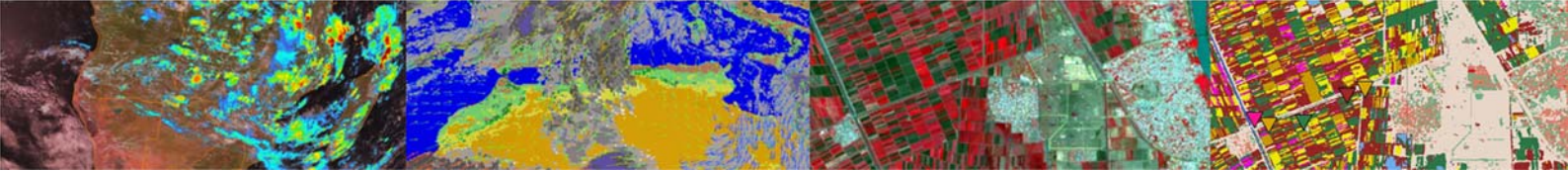
The Finder represents all operations as a long list which can be reduced in size by typing a few letters of the name of the operation.

4.3 Catalog

The Catalog is the subwindow on the right part of the ILWIS Main Window. It offers a view on a folder on your hard disk. It shows only the objects / data sources that are understood by ILWIS. Multiple catalogs can be open at the same time, however only one of them can be active at a time (the so-called currently active catalog), which is the front-most catalog. Use the mouse to make another catalog active. The active catalog is the default output location of operations.

There are two ways to create extra catalogs

- 1) In the Navigator use the context menu (right mouse button) on a folder, and select the "New Catalog" option. A new catalog will open that shows the content of this folder.
- 2) Use the menu on the top of the ILWIS Main Window: Go to the menu item named "Window", and select the option "New Catalog". A form will open where you can select the folder to open in this new catalog.



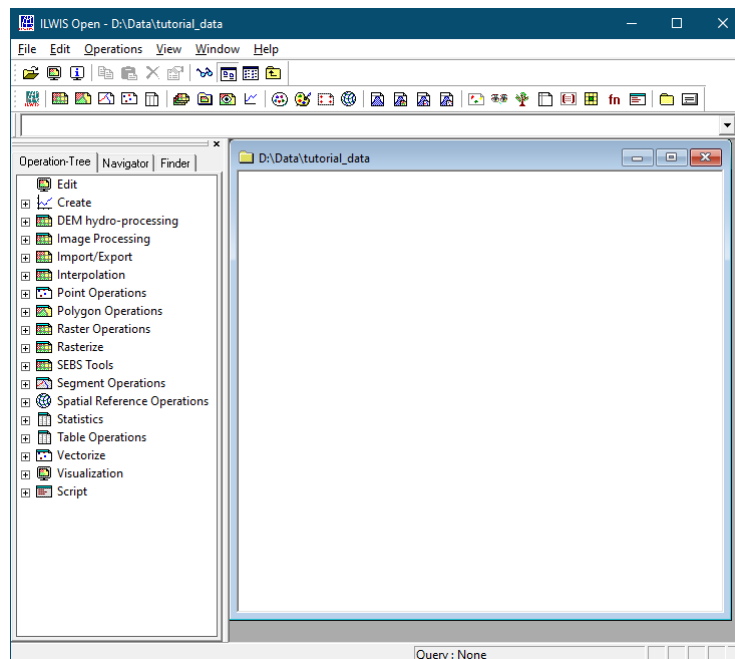
4.4 Data Filter

The catalog shows all objects that can be used by ILWIS (that are understood by ILWIS). These include raster images, vector images, but also georeferences², coordinate systems, domains, representations; all items seen in the catalog are an actual file on your hard disk. This large list of items can be, at times, a bit overwhelming, as many objects with many different icons are shown. You can use the data filter to reduce clutter.

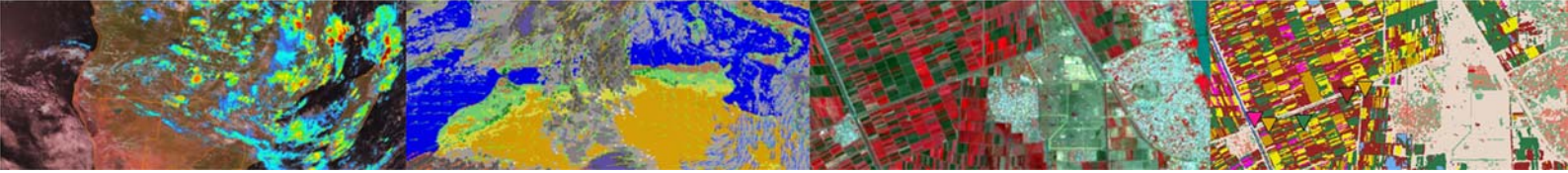
The data filter is the so-called button-bar with the long list of buttons/icons on the top of the ILWIS Main Window, each representing a type of object that you may want to show or hide from the catalog. The leftmost button, the ILWIS icon, is a toggle to switch on or off the filter for all data objects.




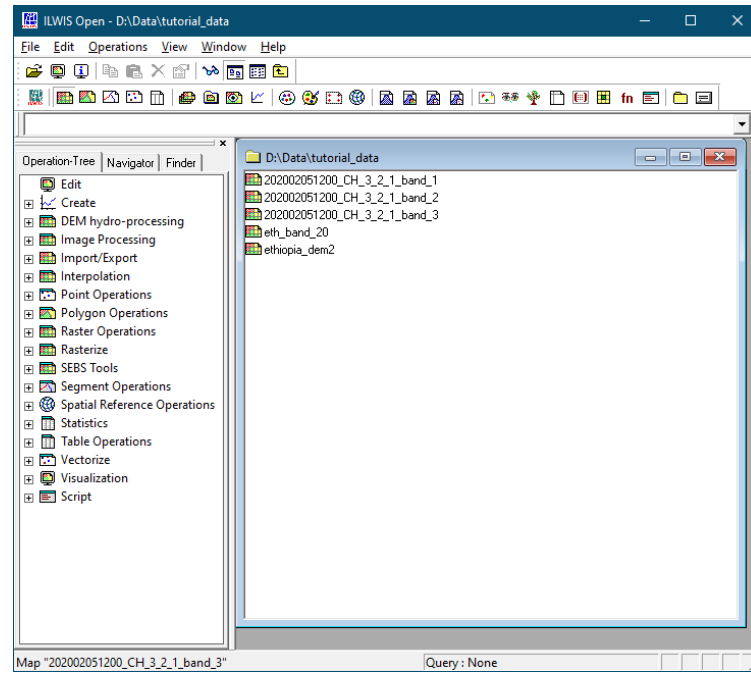
- 1) Press the ILWIS icon in the data filter. All other buttons will toggle to “unselected”, and the catalog should then look empty:



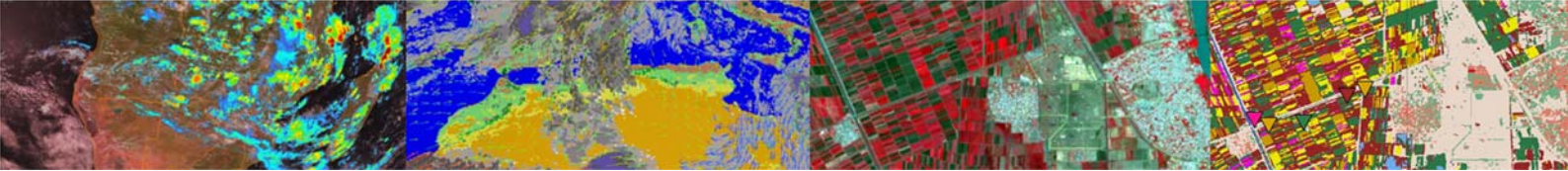
² In ILWIS, the Georeference (the assignment of real-world coordinates to a raster image's pixels, e.g. by providing its corner coordinates), the Coordinate System (the projection, ellipsoid and datum in which the image's coordinates are expressed) and the Domain (the unit of the image's values, e.g. integer, floating point with a specific precision, {true,false}, or {city,forest,lake,river}) are explicitly stored as files on disk, so that they can be shared between images.



2) Press the raster map icon (). The catalog should then look like below, showing only files that are raster maps.



Play around by pressing the various filter buttons.

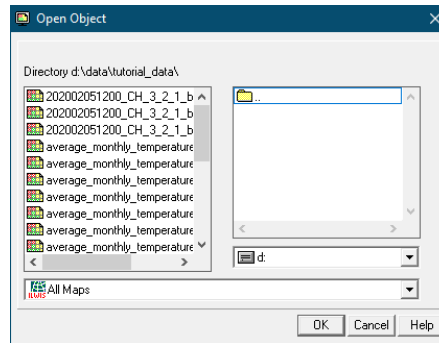


5 Exploring the Map Window

5.1 Basic map viewing

The Map Window is where spatial data is visualized. One can open a new Map Window by either

- Double-clicking on a raster or vector map in a catalog
- Using the menu on the top of the ILWIS Main Window. Go to the menu item named “File”, and select the option “Open...”. You will then get the “Open Object” form:

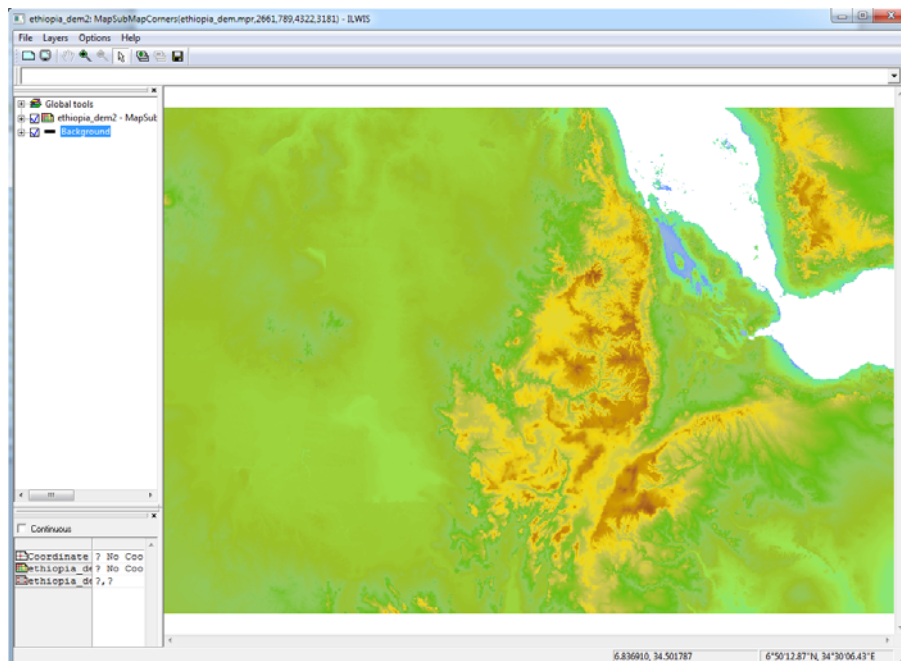


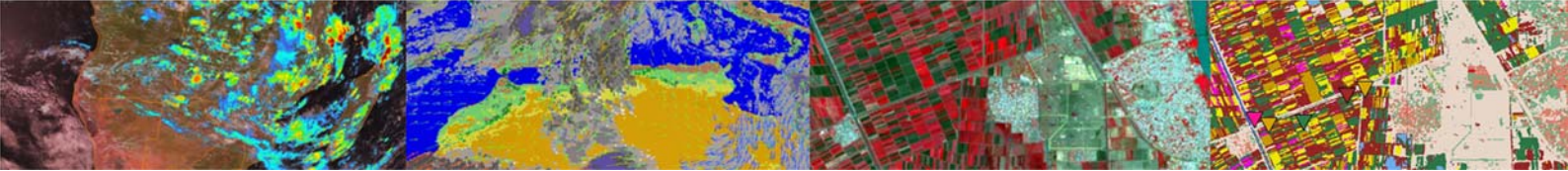
where you can select the map you want to open in a new Map Window.

- Using the context menu (right mouse button) on a raster or vector map, and select the option “Open”.

Note: the three options mentioned will always open the item in a new Map Window. Multiple Map Windows can be open at the same time. Adding layers in an already opened Map Window is described a few paragraphs later.

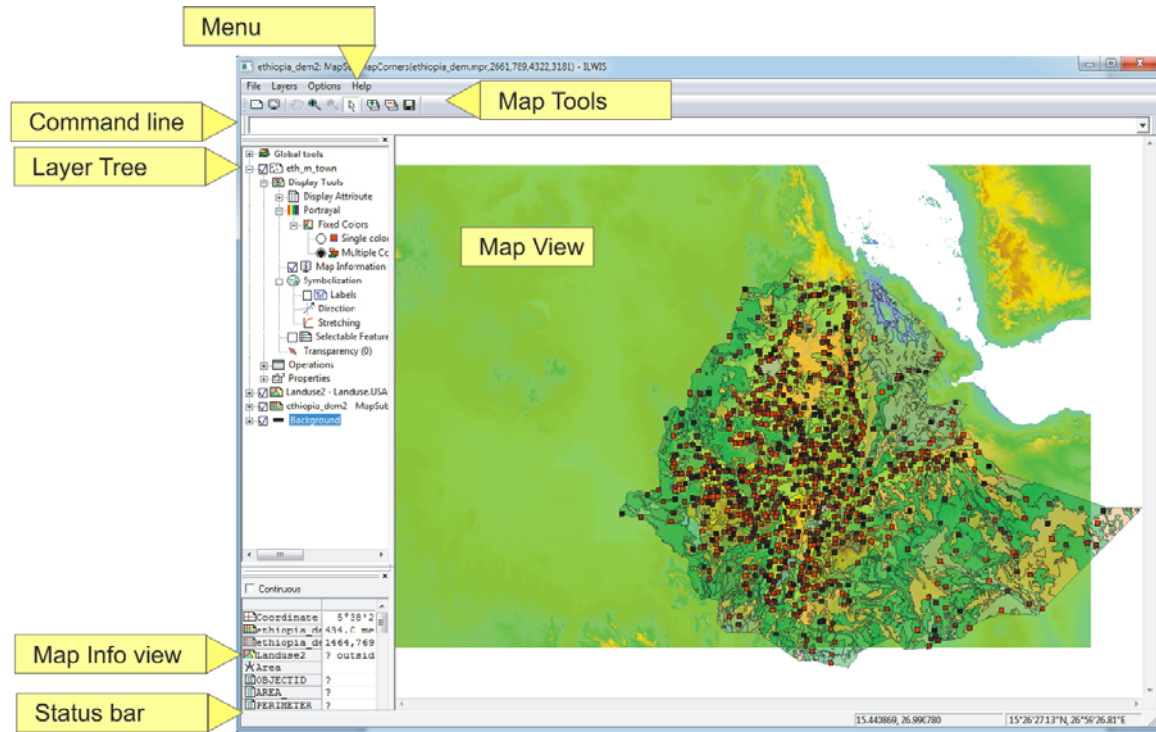
- 1) Double click on the raster “ethiopia_dem2”.
- 2) You should then see:





In the screen below, the layers named “Landuse2” and “eth_m_town” were added. As mentioned, adding a second layer will be described later.

There are several components in the Map Window:



A detailed description of all the functionality of the Map Window can be found in a document with title “ILWIS 3.8 Map Visualization”. This document can be downloaded at the following two alternative download links:

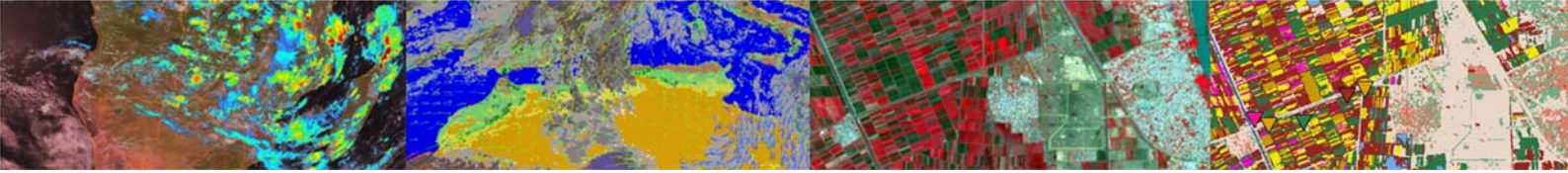
- https://52north.org/files/ilwis/ILWIS_3.8_Map_Visualization.pdf
- https://filetransfer.itc.nl/pub/52n/ILWIS386/Tutorial/ILWIS_3.8_Map_Visualization.pdf

5.2 Basic Functionality

The basic functionality of the Map Window is the following:


- 1) Zoom
- 2) Panning
- 3) Info
- 4) Adding extra layers, reordering and removing them


Much more functionality is available, but this is described elsewhere in this tutorial.



5.3 Zoom

Zooming changes the visible extent of the map window

- 1) Go to the button bar and click the zoom icon ()
- 2) Move over the map. The mouse-pointer changes from an arrow-pointer to a magnifier glass with a “+” sign.
- 3) Press (and keep pressed) the left mouse button and draw a rectangle.
- 4) Release the left mouse button when you are satisfied with the rectangle. The map zooms-in to the selected area.


Zoom out by changing the mouse-function to zoom-out. To do so, press the zoom out icon ()

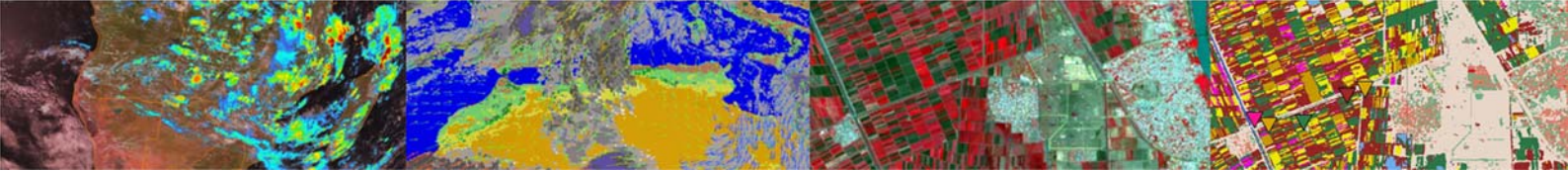
Drawing a rectangle on the map then centers the zoom out on the center of the rectangle. A single-click (no rectangle) will zoom-out the map with a fixed factor.

If your mouse has a mouse-wheel, you can also zoom in/out by turning the wheel. To do this, you do not need to change the mouse-function to zoom-in or zoom-out.

5.4 Pan

Panning changes the location of the visible extent of the Map Window.

- 1) Zoom in on the map (panning is not possible when you haven't zoomed-in first)
- 2) Click on the pan icon in the button bar ()
- 3) The mouse-cursor changes to a hand. Click with the left mouse button on the map and keep the button pressed
- 4) Move the mouse around and the map will follow



5.5 Info

With the “info” tool, one gets information of all the layers beneath the location of the mouse cursor. To use the “info” tool, set the mouse-function back to “normal” mode (the default). Thus not in zoom-in, zoom-out, or pan mode.

- 1) Go to a location on the map and press the left mouse button.
- 2) Keep it pressed and move the mouse around.
- 3) Next to the mouse-pointer you will see the current attributes/pixel values of all the layers below the mouse. The values change as you move the mouse.

More detailed attribute information can be found in the Map Info view, on the bottom-left of the Map Window.

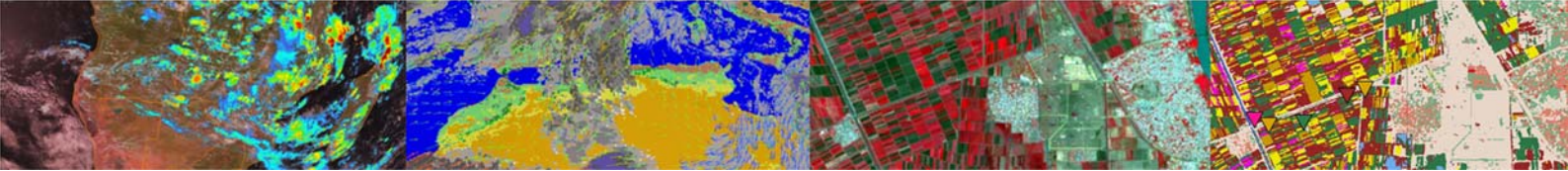
5.6 Adding Layers

The Map Window can show multiple layers with different geometries and data types simultaneously. Adding a layer is done in one of the following ways.

- Drag and drop a map from the catalog of the ILWIS Main Window to the Map Window. If the new map and the old map are roughly in the same area (they overlap somewhere), the new layer will be added on top of the already present layer(s). Select the “Landuse2” polygon map and drag & drop it to the Map Window.
- Go to the “Layers” menu of the Map Window and select the “Add layer...” option. A form will open where you can select the layer to be added. Select the polygon map “Landuse2” and add it to the Map Window. Note that here you are offered the option to specify how the layer is added (e.g. as a color composite, and extending or not the boundaries of the existing map composition), which are not available in the drag & drop add-layer operation.
- In the Map Window, open a context menu under the Layer Tree, by clicking the right mouse button in the white area below the Layer Tree. Then select the option “Add Layer...”. It is similar to the previous option. Select the polygon map “Landuse2” and add it to the Map Window.

Removing a layer can be done by using the context menu of the item in the Layer tree. The “Remove Layer” option will remove the layer from the Map Window.

The order of the layers can be changed by dragging the icon of the layer whose order you want to change in between the layers were you want it to be positioned (or at the end).

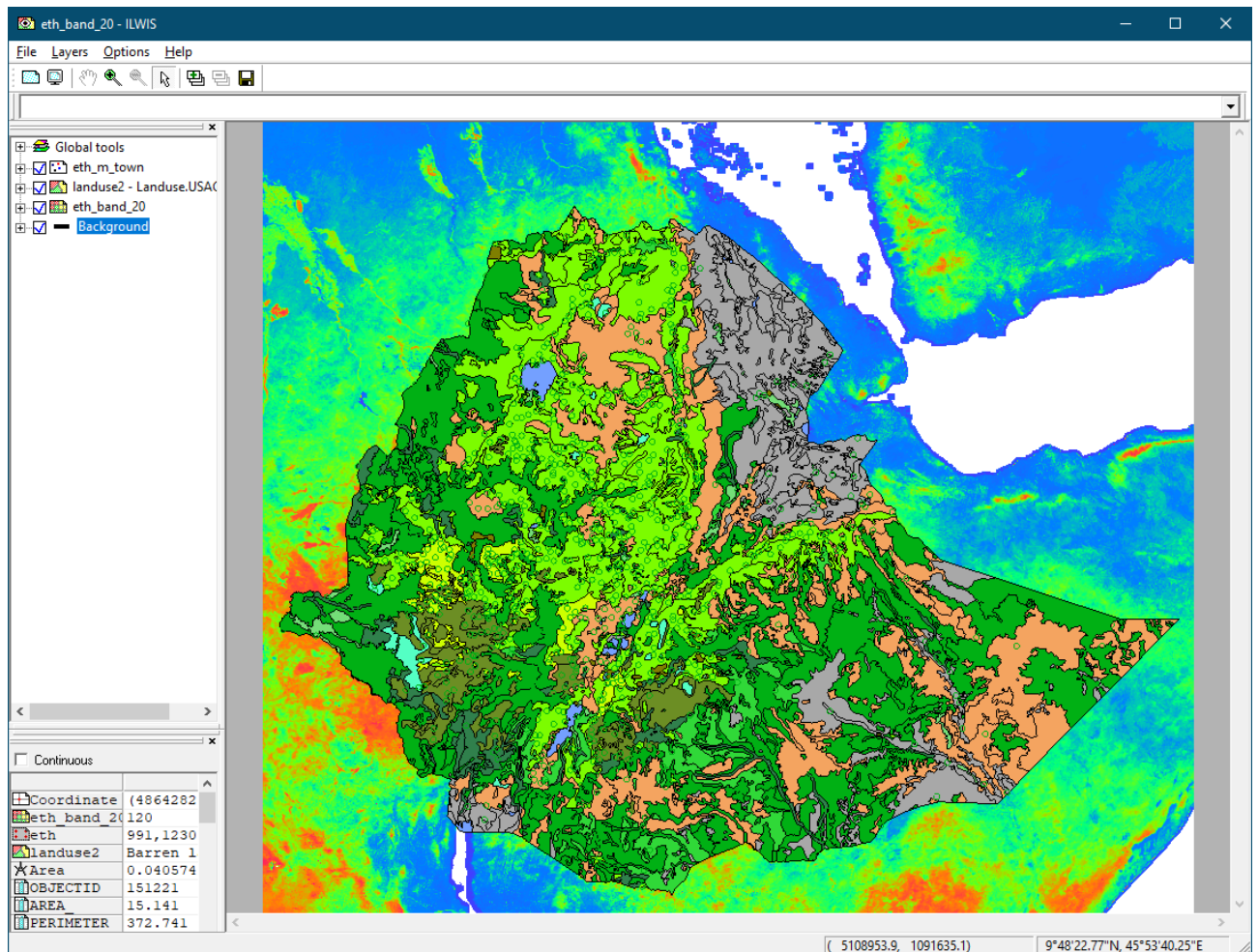


5.7 Changing Visualization Options

Though a full description of all the options in the map window can be found in the “ILWIS 3.8 Map Visualization” document, in this section we will construct a view which contains several layers and then we will use some of the Visualization tools to change its appearance and analyze its content.

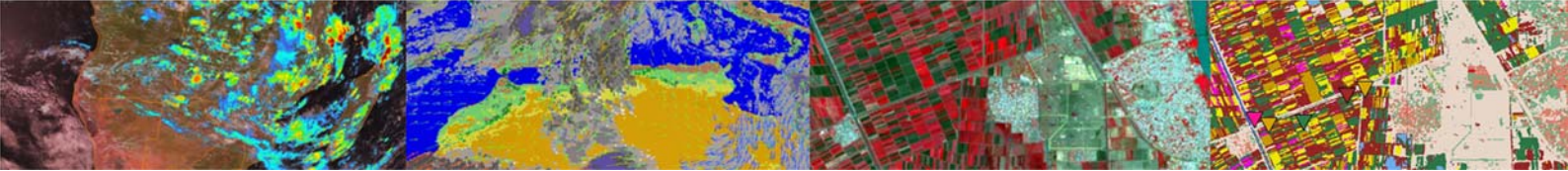
- Open the raster “eth_band_20” in a Map Window
- Add the polygon file “Landuse2” to it.
- Add the point map “eth_m_town” to it.

You should get something similar to this:

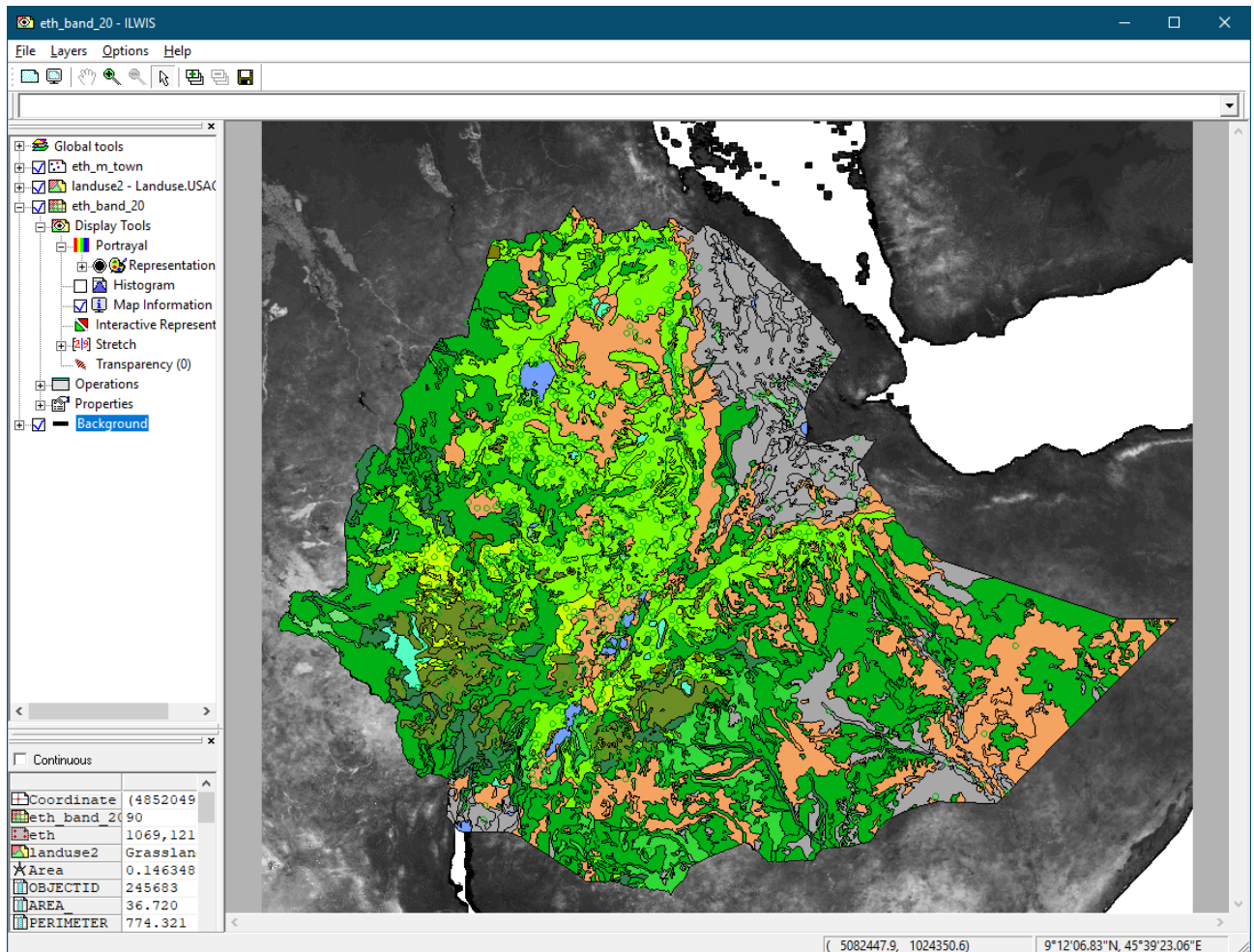


Now we are going to change the appearance of some of the layers. First the raster layer “eth_band_20”.

- 1) In the Layer Tree on the left of the Map Window, click on the “+” sign before the layer’s name “eth_band_20”. It will then expand and show three sub-nodes. Click on the ‘+’ of “Display Tools”. The display tools contain all the tools for manipulating and analyzing the visualization of the layer. In this case we want to alter the coloring of the raster layer from its current coloring to a grayscale-based coloring.
- 2) To proceed doing so, click on the ‘+’ of “Portrayal” to expand it as well, and then double-click on the “Representation” node (instead of clicking the ‘+’ before it). This will open a small form named “Set Representation”. The current Representation is PSEUDO. Click on it to get a list of possible representations. Find and select “GRAY” and press Apply and then Close. Note that you

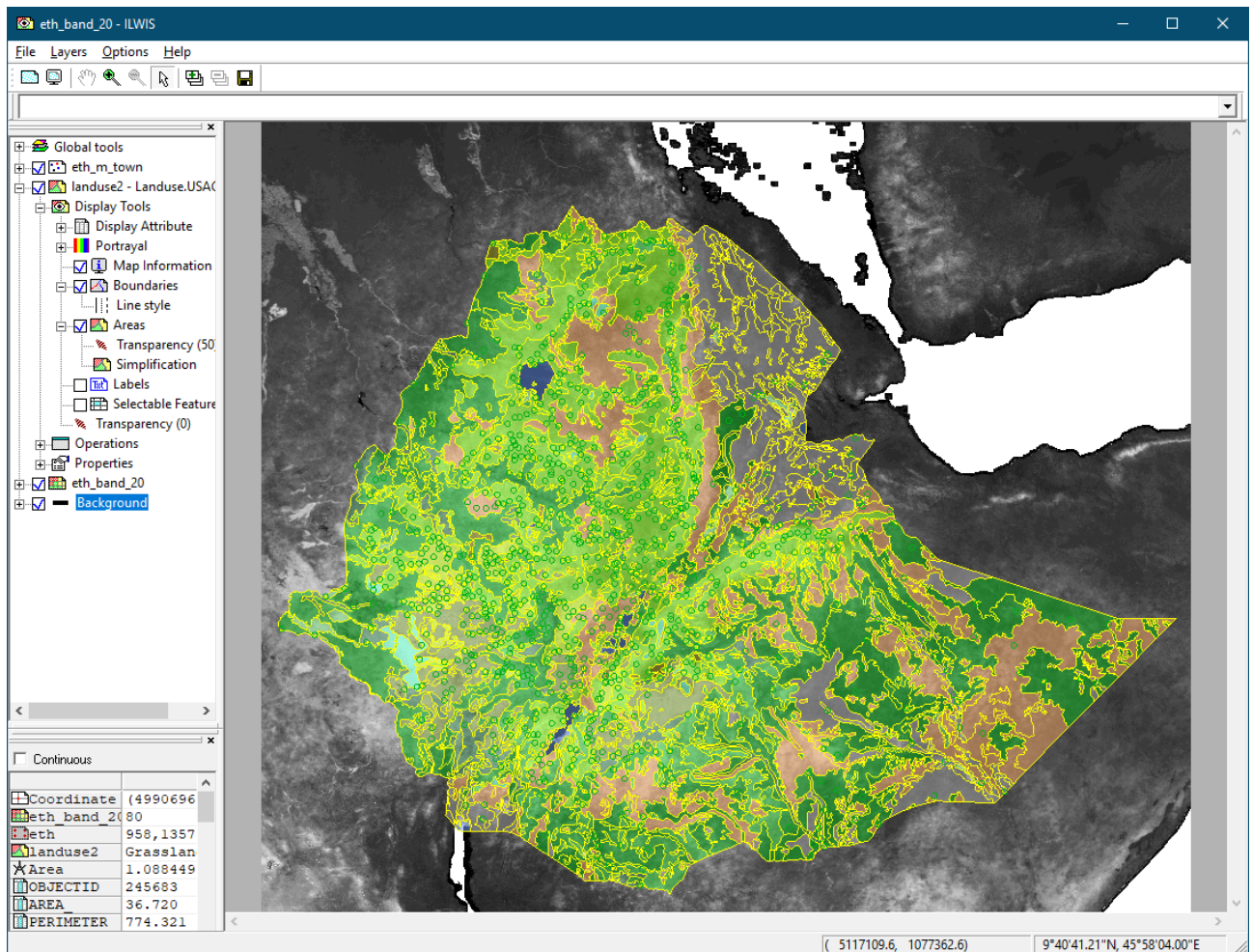
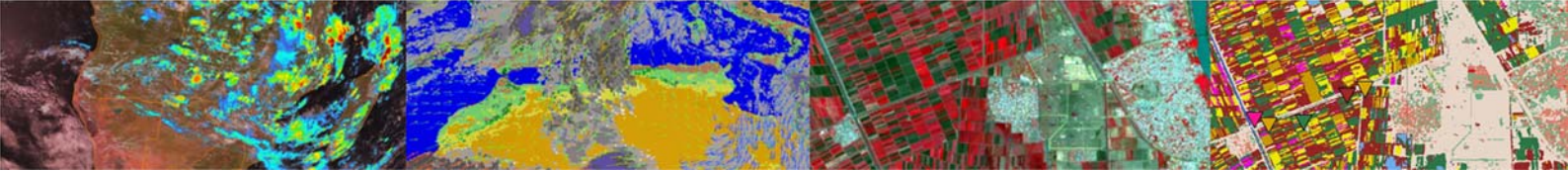


will also see representations named similarly, like “GREYS” and “GREYS_INV”. When choosing “GRAY”, the result will look like this:



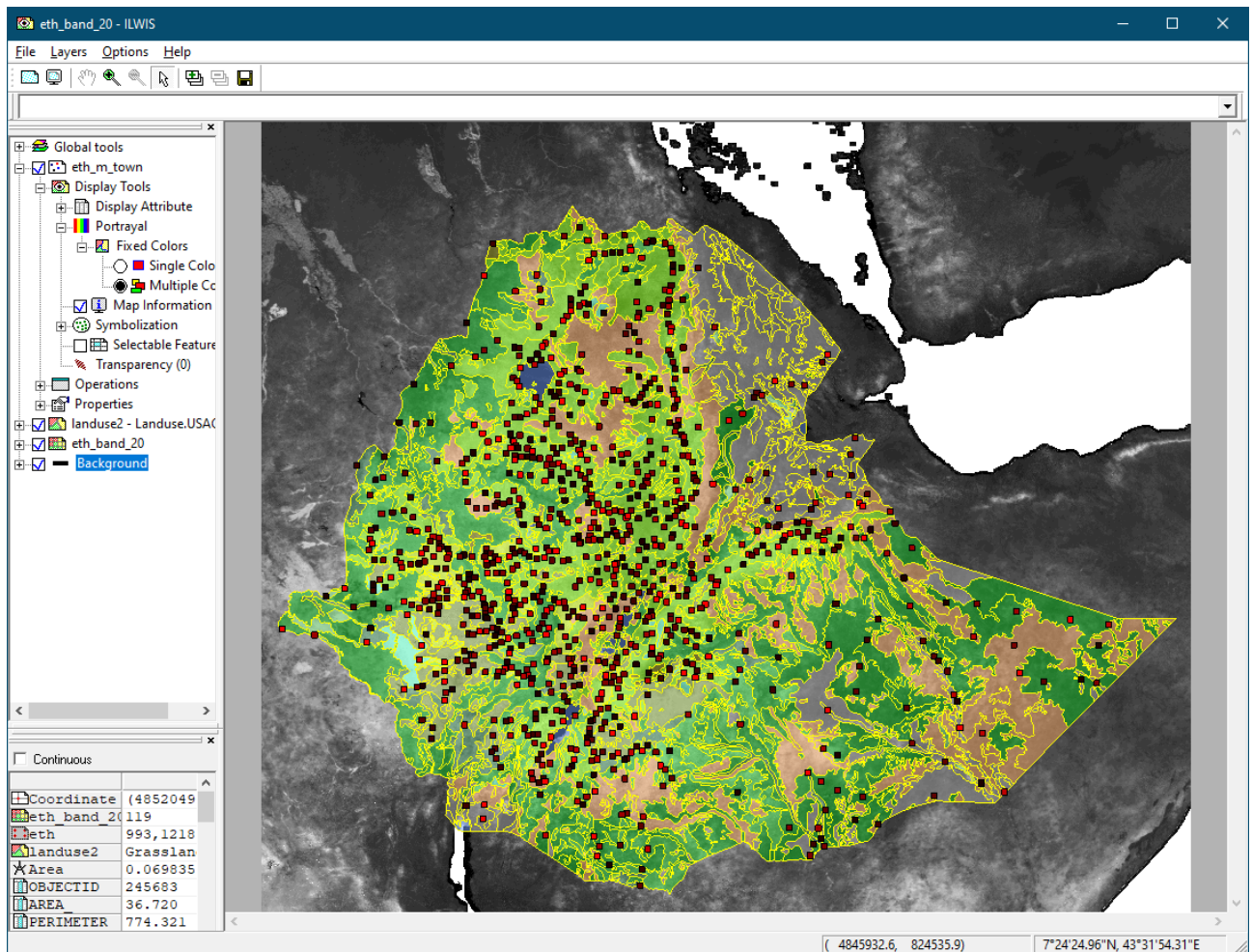
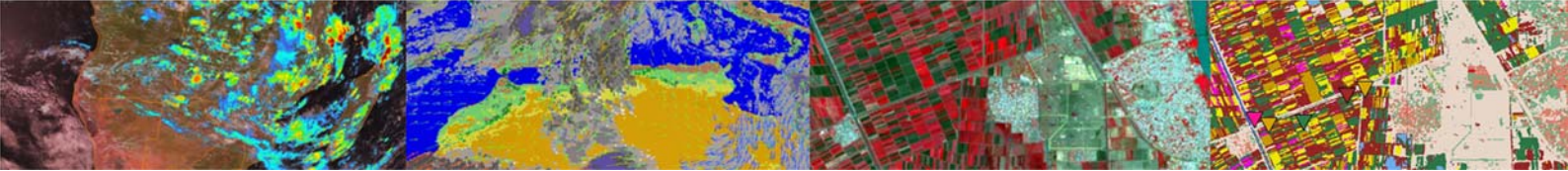
Next we are going to change the transparency of the areas and the color of the boundaries of the polygon map

- 1) Like in the previous example, go to the “Display Tools” of the layer “Landuse2”.
- 2) After expanding Display Tools, click on the ‘+’ before Areas. One of the nodes that is shown then will be the “Transparency”. Double-click on it. Note: distinguish the Transparency of the Areas from the Transparency of the Display Tools; the second one is the overall transparency of this layer, thus also influences the polygon boundaries.
- 3) After double-clicking “Transparency”, a small form will open named “Transparency”. Here you can either type in the new transparency value (between 0-100) or move the slider. Set it to 50, click Apply and Close.
- 4) Next we are going to change to color of the boundaries of the polygons.
- 5) Back in the “Display Tools” of layer “Landuse2”, click the ‘+’ before “Boundaries” and double-click the item “Line style”. This will open the “Line Style” form, where you can change properties of the boundaries. In our case we are only interested in the color. Use the Line Color selector to select “Yellow” and click Apply and then Close.
- 6) You should have something that looks like this:



Next we are going to change the appearance of the point map “eth_m_town”

- 1) Like in the previous example, go to the “Display Tools” of the layer “eth_m_town”.
- 2) First we are going to change the symbol that is used for the points (the default is “open-circle”, which is a bit hard to see on the green background).
- 3) Under the “Display Tools”, double click on “Symbolization”.
- 4) This will open a form named “Symbolization”, with which we can change the properties of the point-symbols of this layer. In this case we want to change the symbol type. Use the “Symbols” selector and select “filled-rectangle”.
- 5) Press Apply and then Close to close the form.
- 6) Next we are going to change to coloring
- 7) Go to the “Portrayal” node of the “Display Tools” of “eth_m_town”, click on the “+” before it to expand it, and then click the “+” before the “Fixed Colors” node that appeared, to expand it as well.
- 8) Change the option from “Single color” to “Multiple Colors” by clicking on “Multiple Colors”. The colors of the rectangle-symbols will change.
- 9) Double click on the “Multiple Colors” node. You will now get a form named “Color Scheme”, with which you can change the color-list used for the (multiple) colors of the points. Use the “Color Schemes” selector to select the color scheme named “red” and press “Apply” and then “Close”. You should get a result that looks like this:



There is much more to say about all the visualization properties that can be manipulated (again, see the document “ILWIS 3.8 Map Visualization”) but we leave it to the user to be creative and experiment with the Display Tools. The general principles are the same for all tools: expand nodes with a “+” before them to find more specific tools; the tools can be double-clicked to get a form for changing visualization properties.

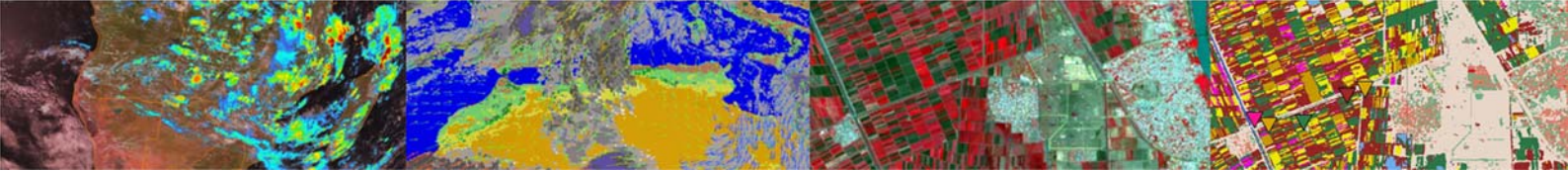
The available tools for each layer depend on the type of layer (raster, polygon, segment, point), and also on the type of data (numerical values, classes, boolean). Only tools that are applicable for that layer are available in the Display Tools list.

Also note that the Display Tools do not change the actual data files that are composing this map’s layers (in this case “eth_band_20”, “Landuse2” and “eth_m_town”), so they are only a temporary manipulation of the visualization. Close the Map Window if you want a fresh start. However a few paragraphs later, in “Saving the view”, we will see how to store the visualizations as well.

5.8 Annotations

With “adding annotations” we mean decorating the view with metadata (additional figures that apply to a specific layer, like a legend, or apply to all layers, like a north-arrow, a scale bar, grid lines, a border around the view) to enhance the communicative value of the view when it is included in other documents or presentations. We are going to add a legend for one of the layers, and also map borders, a grid, a north arrow and a scale bar (which apply to the view as a whole).

Although we can place the legend, the north arrow and the scale bar anywhere on the view (e.g. even



on top of the layers), we will make some room for them, so that we can place them on empty space so that they are clearly distinguishable. For this we will use the white space annotation.

- 1) In the Layer Tree on the left of the Map Window, click the “+” before “Global tools” to expand it. Also click the “+” before “Annotations” to expand those as well.
- 2) Double-click the item named “White space”. This will open the “White Space” form, with which you can add white space around the view.
- 3) Type “30” in the “Percentage at Bottom”, click “Apply” and then “Close”. This will add 30% of white space to the bottom of the view, which can be used to place annotations. Space will be added to other sides of the map as well, in order to keep the map-geometry the same (the map will “shrink”, while maintaining the geographical area and the x/y ratio).

Next we will add a legend:

- 1) Go to the Display Tools of layer “eth_band_20”.
- 2) Click with the right-mouse button on Display Tools, to get a context-menu. You will see a menu with all the (display) tools that are currently activated, and also some tools that are not activated by default (the tools that are not activated are intended “for Experts that want more”; they are hidden by default to not bother the casual ILWIS user). One of the tools that is not activated is “Annotations”.
- 3) Activate “Annotations” by selecting it in this context-menu.
- 4) Now under the Display Tools of layer “eth_band_20” a new item appeared, called “Annotations”. Expand this item by clicking the “+” before it. Then an item named “Legend” appears. Enable the “Legend” by clicking in the empty square before it. A checkmark will appear in the square, to confirm that it is now enabled.
- 5) Now expand the “Legend” by clicking the “+” before it, and then double click on “Appearance”. This will open a form named “Appearance of Legend”.
- 6) Change the “Title” to “Legend of eth_band_20”, and change the Min, Max and Step values to resp. 0, 300, 50. Press Apply and then Close to close the form.
- 7) Now double-click the “Size & Position” of the “Legend”. This will open a form named “Position of Legend”. Change the orientation to Horizontal, and position the legend on x = 15 and Y=9 (those are percentages of the view). Press OK to close the form. Note that the Legend’s size is automatically adjusted to match the map.

To add the map border:

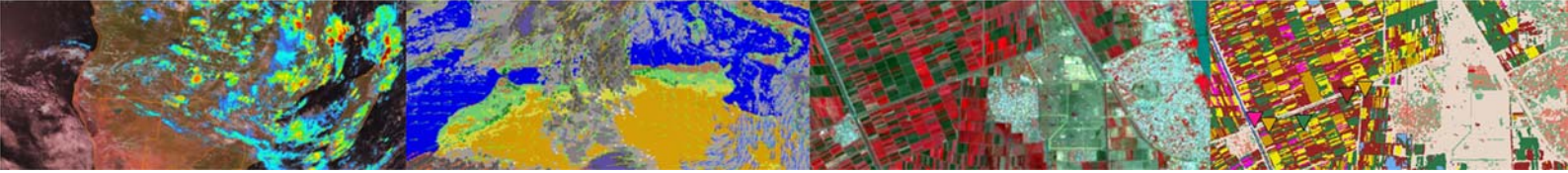
- 1) Go to the “Global tools” in the Layer Tree and expand it.
- 2) Under that, expand the “Annotations”.
- 3) Enable the item named “Border”.

Similarly add the north arrow:

- 1) Enable the item named “North Arrow”.
- 2) Double-click “North Arrow” to get the form named “Properties of the North Arrow”.
- 3) In this form, select the arrow named “Compass16”, change the scale to 200, the x-position to 94 and the y-position to 90 .
- 4) Press Apply and then Close to close the form.

To add a scale bar:

- 1) Enable the item named “ScaleBar”, by clicking on the empty square before it.

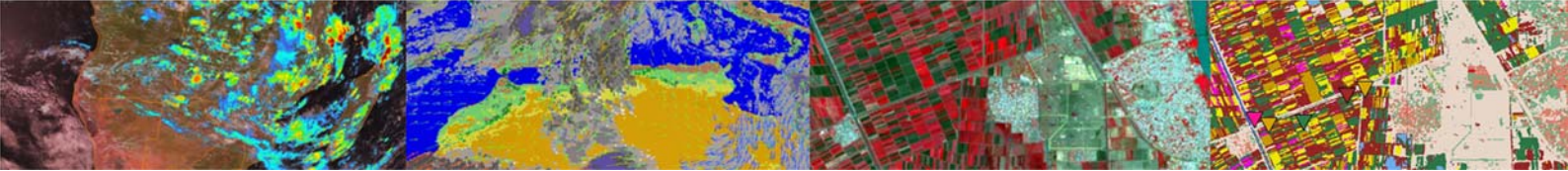


2) A scale bar will appear but it is not at the correct position. Double-click the “ScaleBar” item, to get the form named “Properties of the ScaleBar”. In this form, change the position to x=15 and y = 9. Furthermore change the “Interval Length” (which is the ticksize) to 200000. Note that if the scale bar does not fit in the window, it will be automatically adjusted to fit (the interval length will be re-computed).

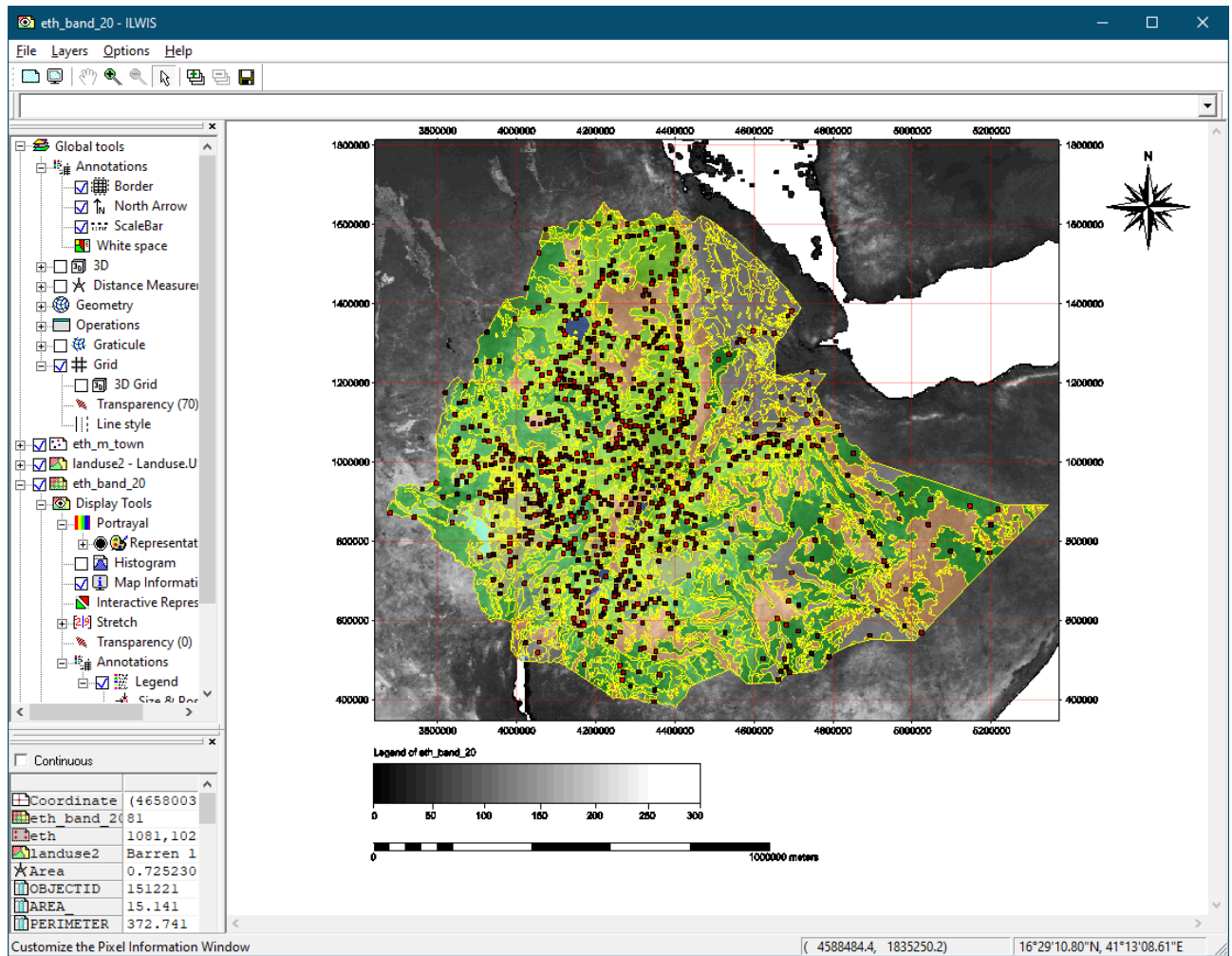
3) Press Apply and then Close to close the form.

To add a grid:

- 1) Under the “Global tools”, find the item named “Grid”. This is not under “Annotations”, it is a bit lower.
- 2) Enable the item named “Grid”. Then click the “+” before Grid to expand it.
- 3) Change the transparency to 70 and the line color (under “Line style”) to red.



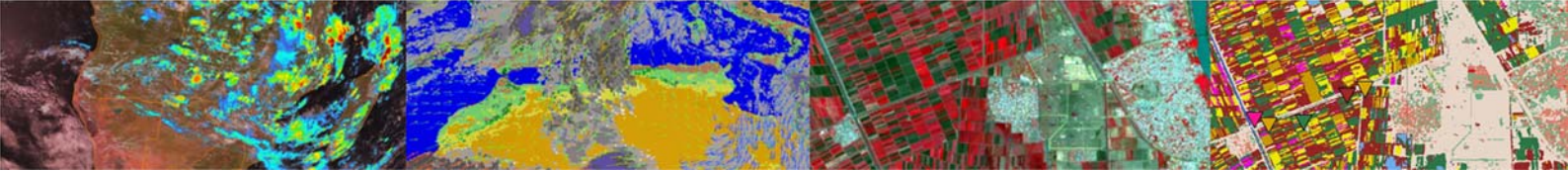
Now you should have a view that looks like this:



5.9 Saving the view

Since composing the layers and adjusting all visualizations to get a nice result may be time-consuming, the composition can be saved, to be re-opened at a later time. In ILWIS, the composition of the view (all layers with all their visualization options and the zoom position) is called Map View. To save the Map View, use the “Save View As...” option of the “File” menu of the Map Window.

- 1) Use the menu on the top of the Map Window. Go to the menu item named “File”, and select the option “Save View As...”.
- 2) In “Map View Name”, enter a filename for the map view.
- 3) Optionally, in “Title”, enter a short description for the map view. The title can be left empty, but if available, it will be shown in the title-bar of the Map Window.
- 4) Click OK to save the map view. It is saved in the currently active catalog.
- 5) Close the Map Window.
- 6) In the currently active catalog of the ILWIS Main Window, find the map view that was just saved (with the filename chosen in step 2).
- 7) Double-click the map view. A Map Window is opened, with everything as it was when you saved it. Note that the layers, their visualization options and the zoom position are part of the map view, but the window size isn’t (the Map Window is opened in its default size).



5.10 Adding Internet Maps as a background layer (OpenStreetMap)

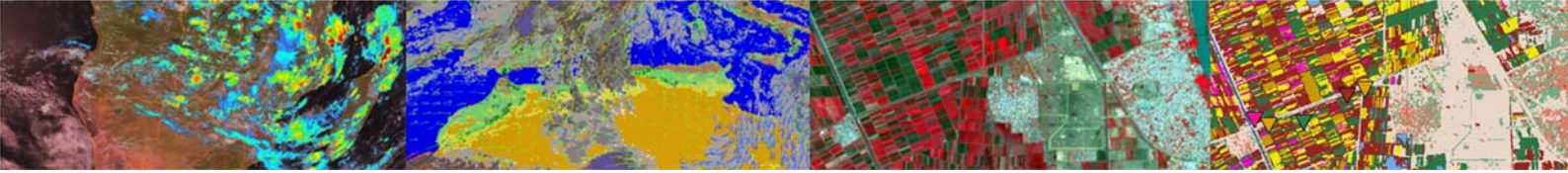
ILWIS comes with a small number of free maps (the “Base maps”) that can be used as background maps to your data, or to confirm the location of your layers. Those maps can be found when using the option “Add Layer...”, and in the “Add Data Layer” form that opens, changing the Filter from “all” to “Base maps”. In this list you will find a segment map named “country_boundaries”, having the contours of all countries in the world, a segment map named “rivers”, which is also a worldwide map of rivers, and a point map named “cities”, with all cities in the world (including attributes such as population). Those maps are in the ILWIS “basemaps” folder; they do not need an internet connection.

However there is one special map in that list, named “openstreetmap”. This is a worldwide raster of (almost) infinite resolution. When you add this as a layer, the image data will be downloaded on-demand from the Internet. The resolution and the styling is pre-determined by the data-provider, which is <https://www.openstreetmap.org/>. Due to the high accuracy of this layer’s geo-location, this layer is very suitable to verify that your own data layers are geo-located correctly. Or otherwise, it makes a nice background layer as well.

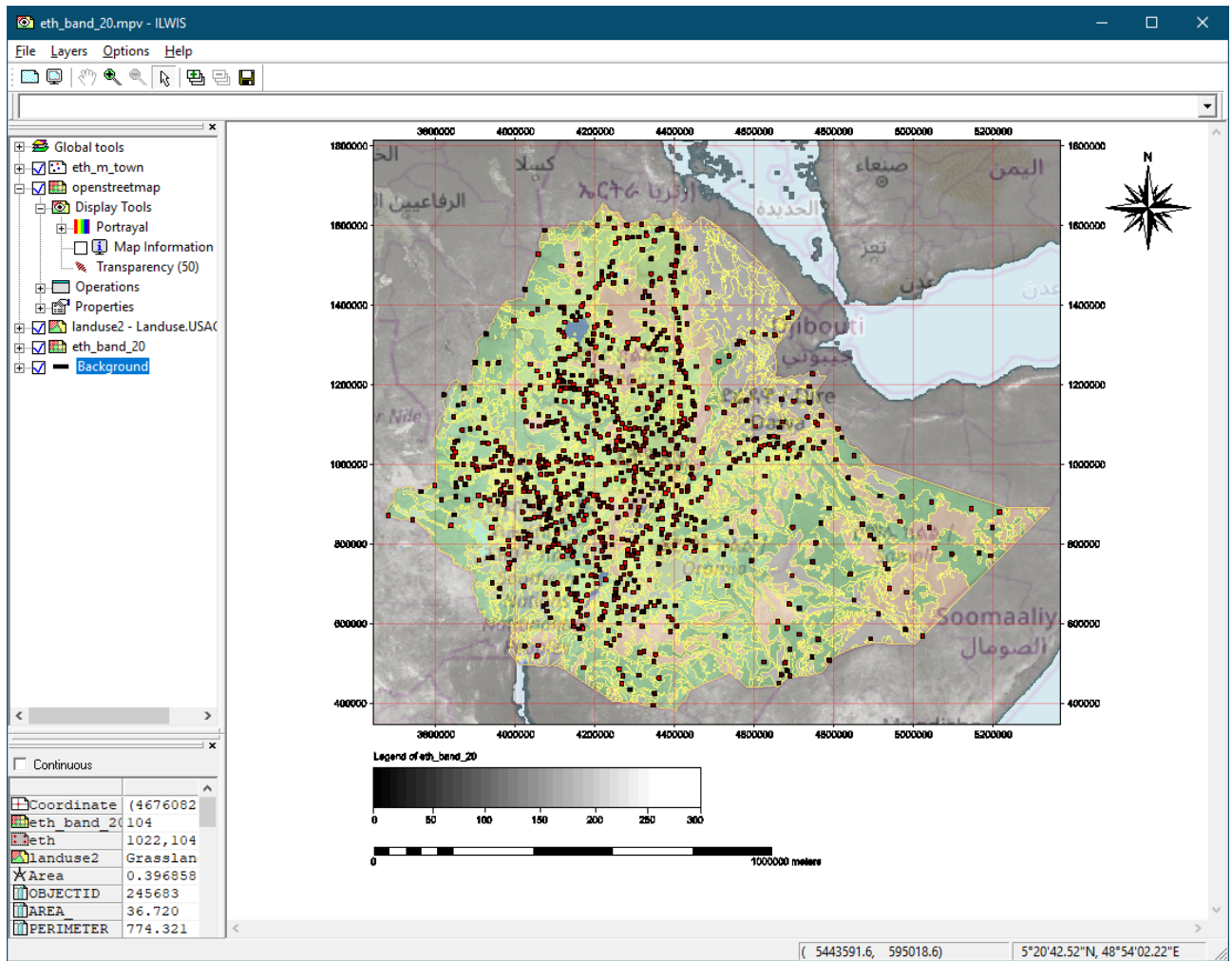
Note that the maps in “Base maps” cannot be opened directly. You will first have to open your own layers, after which you can add one or more of the “Base maps” as additional layers.

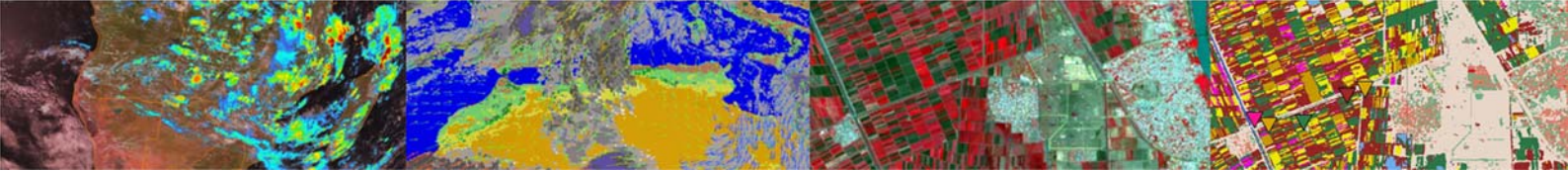
Note also that the “openstreetmap” layer requires your computer to have an internet connection. If the internet connection is slow, be patient as the map downloads. If there is no internet connection, this layer will remain empty.

- 1) Open the Map View from the previous paragraph (if you have closed it)
- 2) In the Map Window, use your preferred method to add a new layer. E.g. open a context menu under the Layer Tree, by clicking the right mouse button in the white area below the Layer Tree. Then select the option “Add Layer...”.
- 3) The “Add Data Layer” form will open. Change the Filter from “all” to “Base maps”.
- 4) You will now see four Base maps: cities, country_boundaries, openstreetmap, rivers.
- 5) Select “openstreetmap”, then click OK.
- 6) The new layer will be added on-top, hiding all other layers below it. Use the Layer Tree to change the order of the layers. Move the openstreetmap to below eth_m_town but above Landuse2 (thus not all the way to the bottom). If you accidentally moved it too far down, just try again.
- 7) In the Layer Tree, click the “+” before openstreetmap to expand it, then click the “+” before its Display Tools to expand those as well. Then double-click the “Transparency”.
- 8) The “Transparency” form opens. Change the transparency to 50%, then click “Apply” and “Close”.

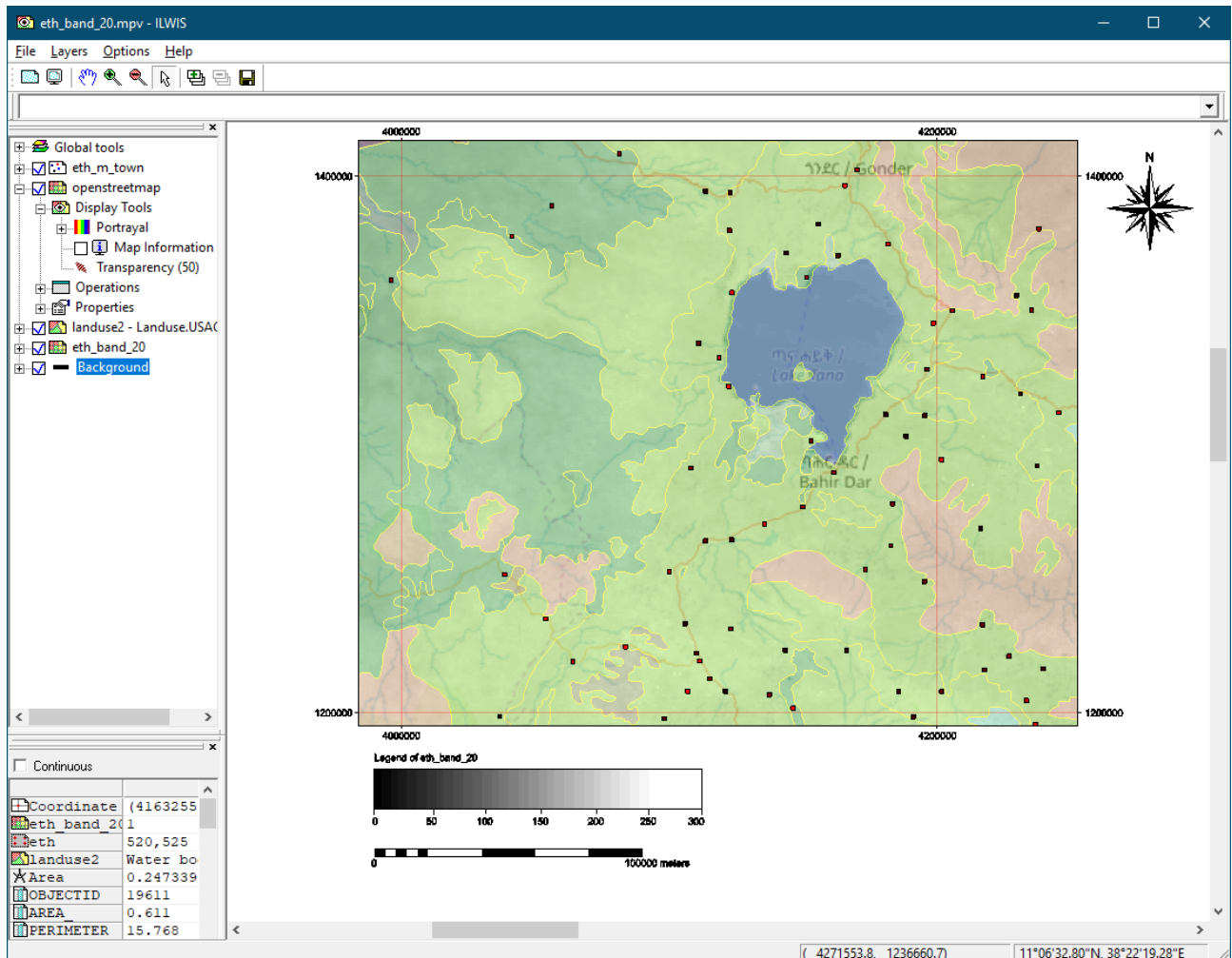


Now the view should look like this:





Zoom in, and more detailed raster data will be downloaded from openstreetmap. Note how the scalebar is automatically adjusted when zooming.



5.11 Printing

ILWIS doesn't have a means for printing maps. Instead it provides a copy/paste mechanism, with which the Map View can be copied at any resolution and then pasted in any package that accepts images and printed from there. Either as a standalone Map View or as part of a larger report.

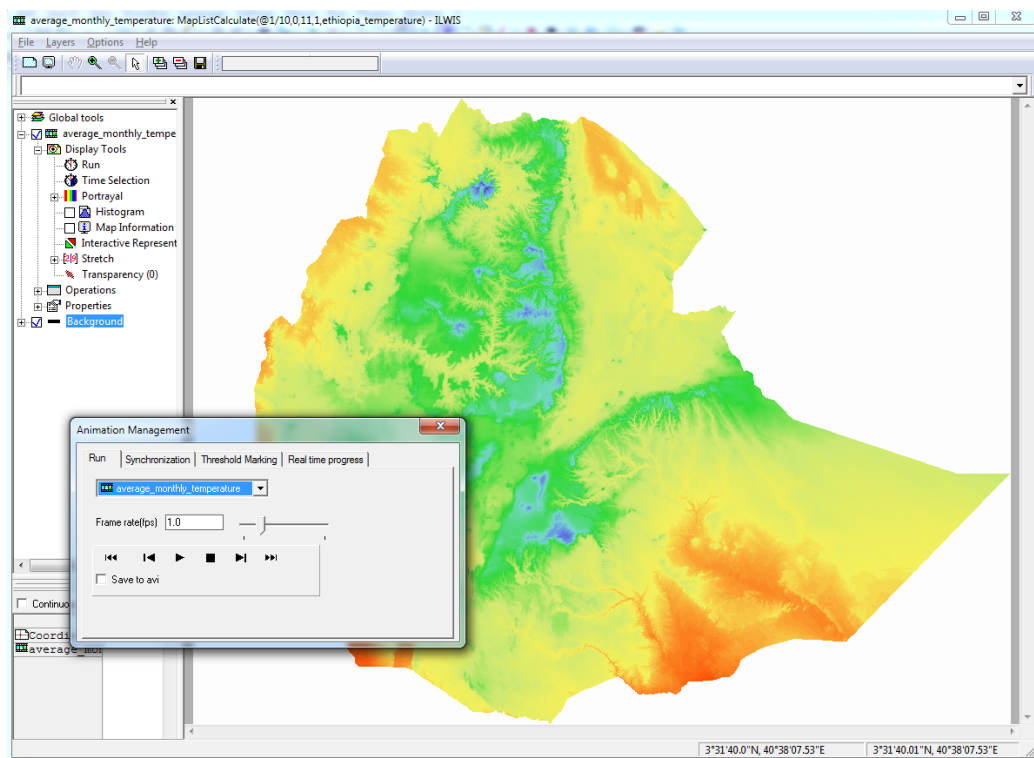
- 1) Using the menu on the top of the Map Window. Go to the menu item named "Layers", and select the option "Copy".
- 2) The "Copy image to clipboard" form will open, in which you can enter the desired size of the image in pixels. You can also set the dpi value, which is the pixels-per-inch property of the resulting image, indicating how large you intend the image to be (in inches/centimeters). The defaults should be sufficient for most purposes. Larger X-pixels or Y-pixels means a bigger image will be copied. A larger dpi value means that the pixels will be denser (and thus the picture will be smaller in inches/centimeters). Note that the dpi value only has an effect if the software in which the image will be pasted uses the dpi value to compute its physical dimensions.
- 3) Press OK. The image is now rendered in memory. Depending on the selected size and the number of layers, this may take a while. If one of the layers is openstreetmap, more detailed tiles will be downloaded from the internet, and ILWIS will say "Not Responding" for a couple of minutes but in reality the map is being rendered. Please be patient when this happens.

- 4) Open a program where you can paste images (e.g. Paint or Microsoft Word or PowerPoint or Photoshop or GIMP) and paste the image. The result should be the same as the picture above.

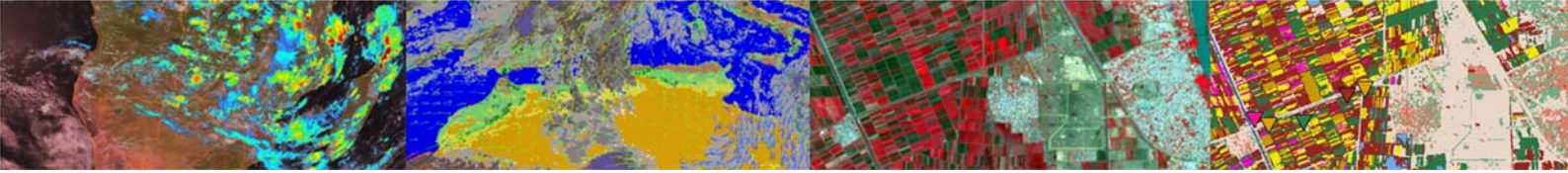
5.12 Animations of Time Series



A sequence of raster images can be assigned to a Map List. ILWIS can animate such sequences in a layer in the Map Window. One can control speed, zoom levels, display properties etc... As far as ILWIS is concerned the animated layer is a normal layer and all the tools that are applicable to a single layer (and are reasonable to expect) also work on an animation.

- 1) There are several ways to open a Map List as an animation, the easiest is through the context menu in the Catalog. In the active Catalog of the ILWIS Main Window, find the Map List named "average_monthly_temperature", click on it with the right-mouse-button to get the so-called context-menu, and from this menu, select the option "Open as Animation".
- 2) A new Map Window will open, with a layer with the same name as the Map List, and a box with the current frame number (the "index") at the top of the window, which is "1" when you start.
- 3) In the Layer Tree, click the "+" before the layer to expand it, and then click the "+" before "Display Tools" to expand those as well.
- 4) Double click on the "Run" item. A form named "Animation Management" will open, which controls the animation.



- 5) Press the "Run" button, which is the black triangle facing right (▶). The animation will now start to run at 1 frame per second (fps).
- 6) Move the "Frame rate(fps)" slider so that the fps is three. The animation will now run noticeably faster.
- 7) Press the pause button (⏸) to pause the animation.

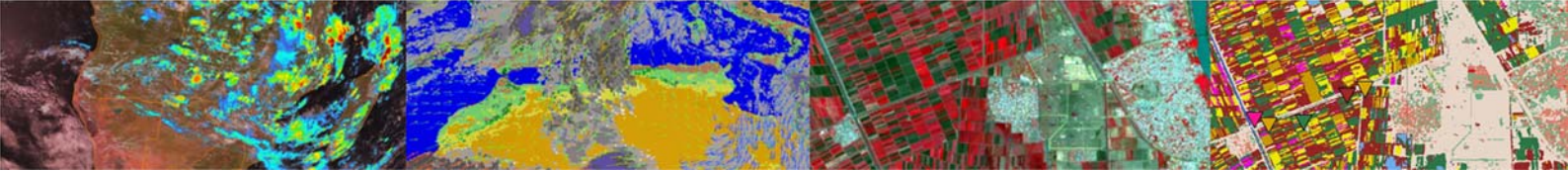


- 8) The animation can also move on a per-frame basis. To do this use the step button (forward, backward, , ) to move one frame at a time. You can do this while the animation is in the “pause” or “stop” state, but you can also do this while the animation is running.

There are many more things you can do with animations. The documentation in the addendum describes all the options.

To illustrate that the animation is just a normal layer.

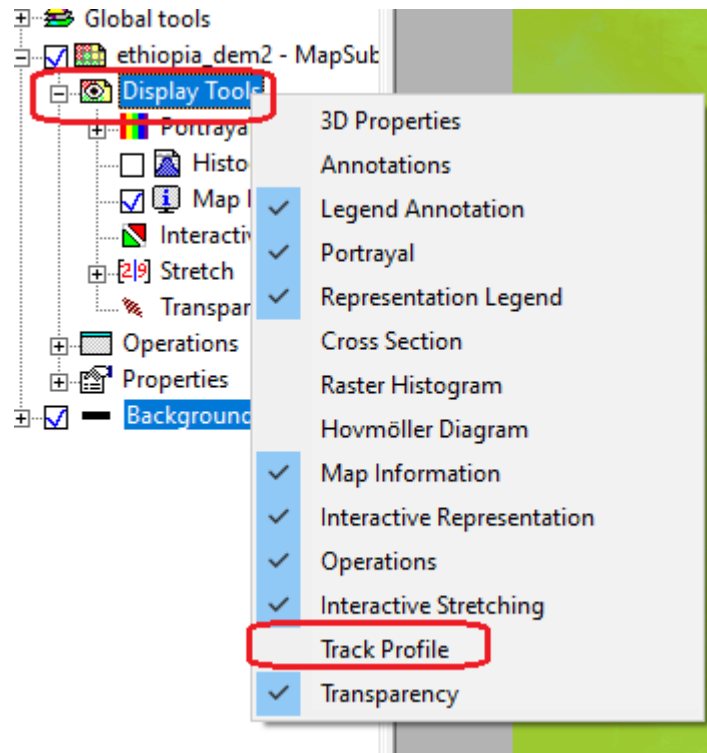
- 1) Add the layer “Eth_M_Town” on top of the animated layer “average_monthly_temperature”.
- 2) Query the information on one of the added points by moving the mouse cursor to a point and pressing the left mouse button. If the mouse is close enough to a point, the value of both the point layer and the animated raster image will be shown. While you keep the mouse-button pressed, the values shown remain constant, but if you lift the mouse button and press it again, you will see the values changing in sync with the animation.
- 3) Look also at the Map Info pane at the bottom-left side of the Map Window, and you will see the value of the animation layer changing constantly.



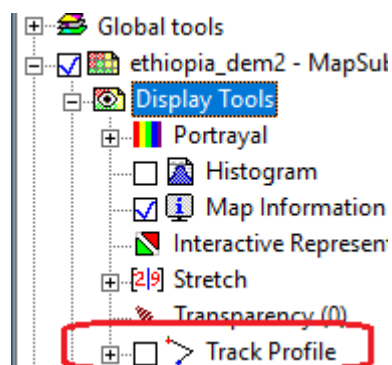
5.13 Special Visualization Tools

ILWIS has many specialized tools for visual analysis. From the earlier mentioned animation, to profile, cross sections, histogram views, interactive representation, 3D, etcetera. They are all described in the “ILWIS 3.8 Map Visualization” document. As an illustration, the “Track Profile” tool will be demonstrated here.

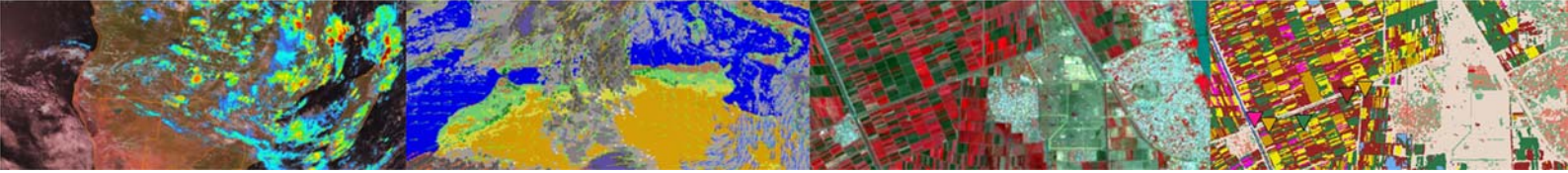
- 1) Open the “ethiopia_dem2” map.
- 2) Expand the Display Tools. Use the context menu on the Display Tools, and activate the “Track Profile” tool (which is not active by default).



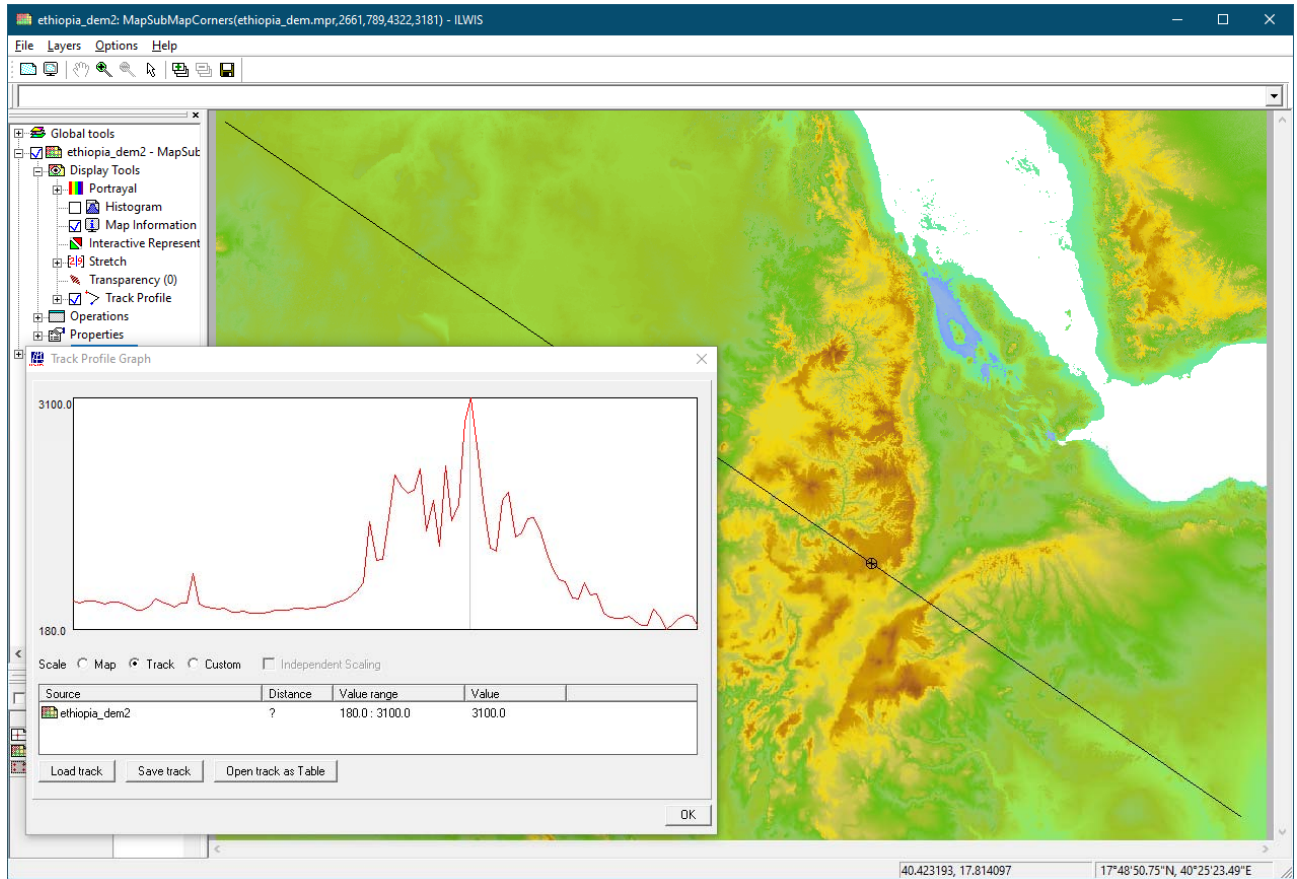
- 3) This adds the “Track Profile” tool to the Display Tools. Check the box in front of it to enable it.

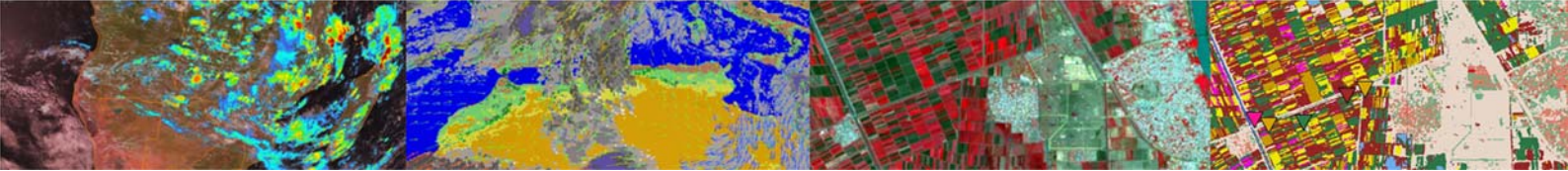


- 4) This will show a form named “Track Profile Graph”. This form has two parts. A white (empty) upper part and a list with data sources below it. Right now this list contains only the dem “ethiopia_dem2”.
- 5) Click on the map to draw a line from roughly (exact doesn’t matter) the north-west corner to the south-east corner (the “Track Profile” tool has temporarily changed the mouse-function to a line-drawer, instead of “info” or “zoom”).

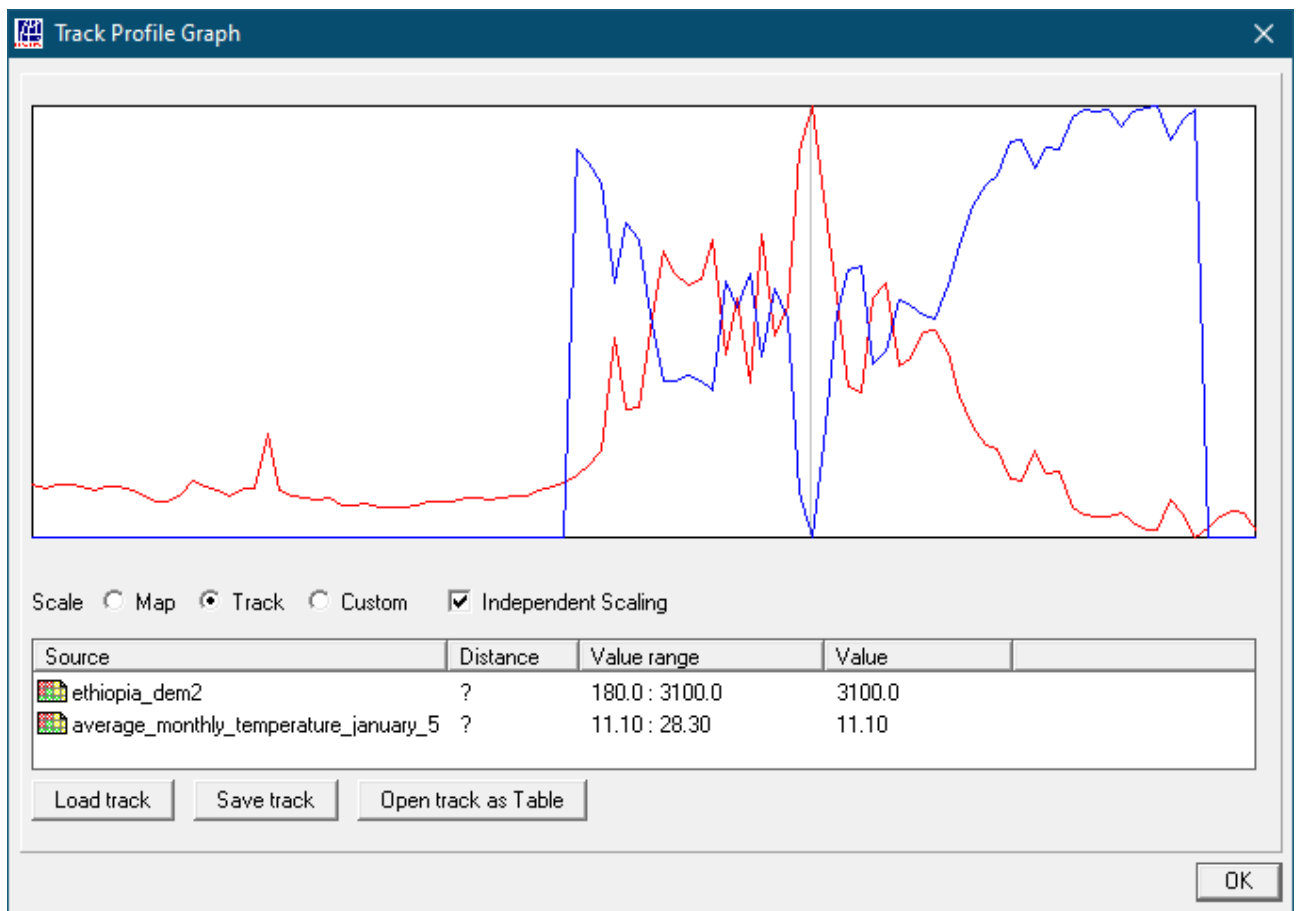


- 6) In the white area of the form a red graph will appear showing all the map-values along the line that was drawn in the previous step. The y-axis range covers all values in the map. Click the "Track" button in the "Track Profile Graph" window to change the y-axis range to the values of the line instead.
- 7) Click on the graph. For example at the maximum value.
- 8) On the map, a marker will appear, showing where that maximum value is on the map.





- 9) Go back to Layer Tree and double click on the “Track Profile” tool.
- 10) A form will appear where you can select an additional data source. Select one of the bands of the “average_monthly_temperature” to add it as a data source. Note that you may also select the entire maplist “average_monthly_temperature”. This will add all 12 bands of the maplist.
- 11) A second graph will appear showing the values of that data source on the track. If you have selected the entire maplist, instead of one of its bands, then 12 new graphs will appear. The part of the graph that is in the west is flat, because the “average_monthly_temperature” maps are smaller (in size/area) than the dem.
- 12) In the “Track Profile Graph” window, enable the option “Independent Scaling”. Each graph is now scaled independently, to fill the y-range. The y-axis range is now no longer displayed, as it doesn’t make sense anymore (multiple y-axes would be required).

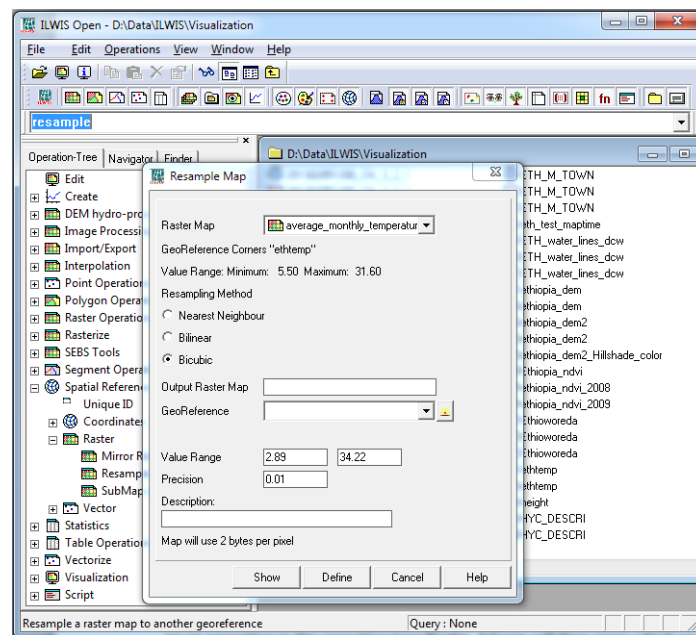


6 Performing an Operation

Up to now, we have only changed visualization options for layers, in order to compose an aesthetically beautiful or a meaningful map view. We haven't performed any operation to produce new data (the source data on the hard disk hasn't changed).

In this chapter we will learn how to perform operations that generate new data.

Though there are several ways (see below) to start performing an operation, the most common is to double click on an operation in the Operation Tree or in the Finder. A Form will then open, which you can use to enter the necessary input parameters for the operation. For example, double clicking the "Resample" operation will open the "Resample Map" form:



Each operation has its own input form for entering the corresponding parameters.

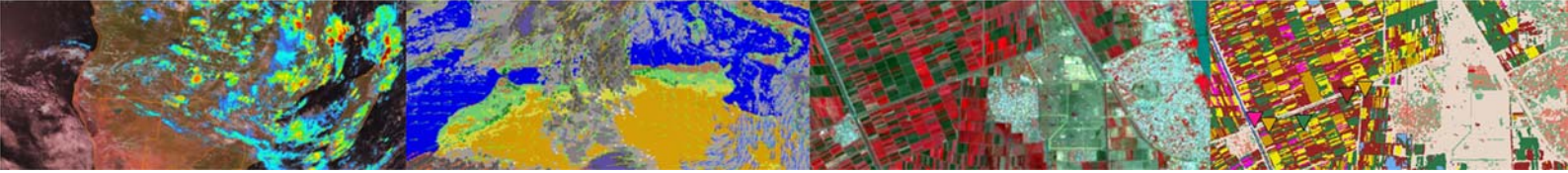
In the form one can enter the various parameters and then either press the button "Define" or the button "Show" ("Cancel" closes the form, "Help" shows the help information about this operation).

"Define" stores a definition of the to-be-created output of the operation (usually a new map) on the hard disk. The output is not calculated immediately, but any action that would require access to its data will trigger a calculation.

"Show", stores the definition, and immediately proceeds to calculate the result and then shows the result in an appropriate output window (e.g. a Map Window).

We are now going to do an example with the "Resample Map" operation.

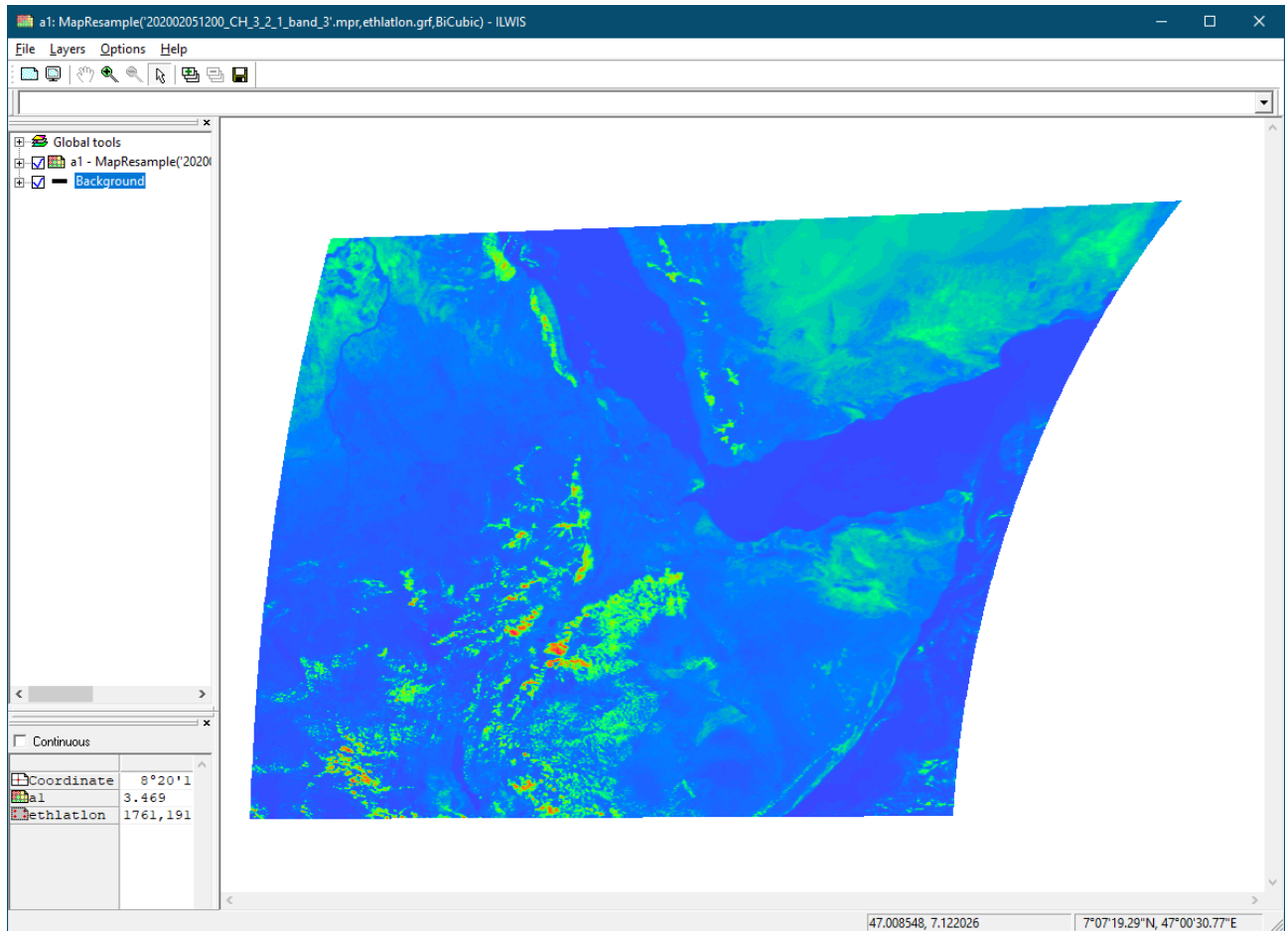
- 1) In the Operation Tree, go to Spatial Reference Operations → Raster
- 2) Double click on the "Resample" operation
- 3) A form will show similar to the one above
- 4) Click on the "Raster Map" selector, and from the list that appears, select the data file "202002051200_CH_3_2_1_band_3".
- 5) Click on the "GeoReference" selector, and from the list that appears, select "ethlatlon".
- 6) Choose an appropriate output name for the (new) raster map, and type that name in "Output

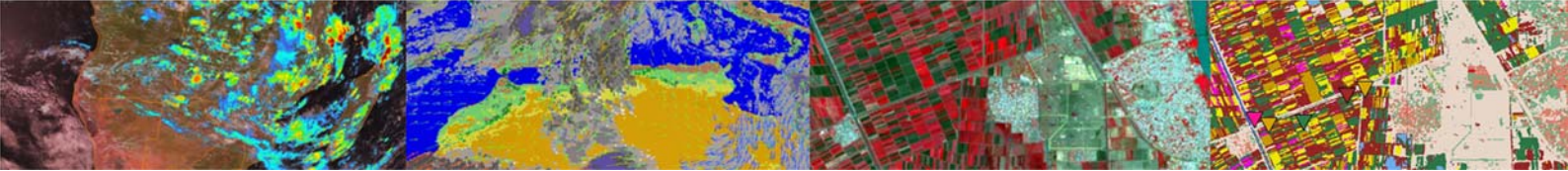


Raster Map”.

- 7) Press the “Show” button on the bottom of the form.

After the operation is performed, a new Map Window will open, with the following (raster) map:

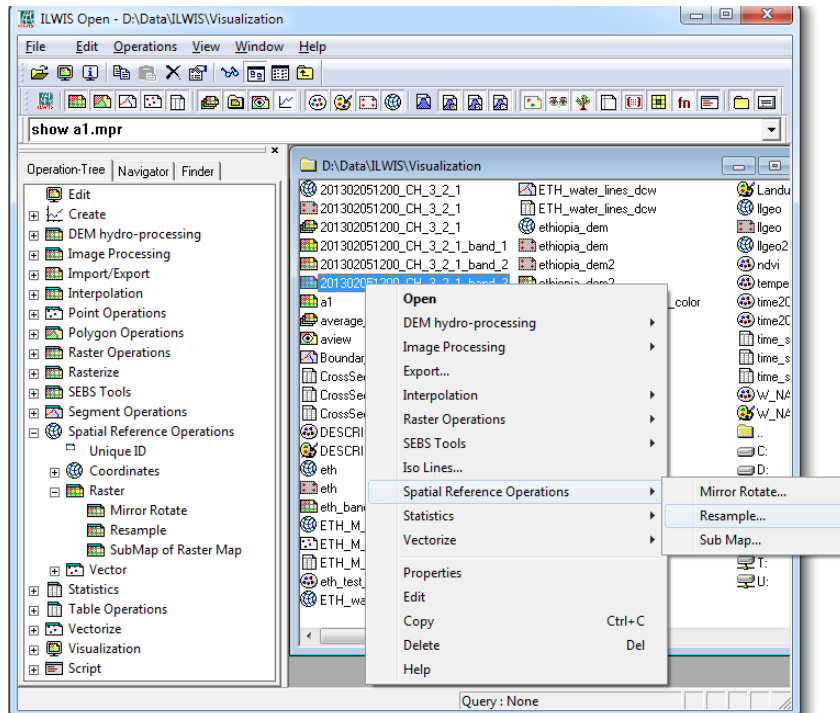




6.1 Alternative ways to start an Operation

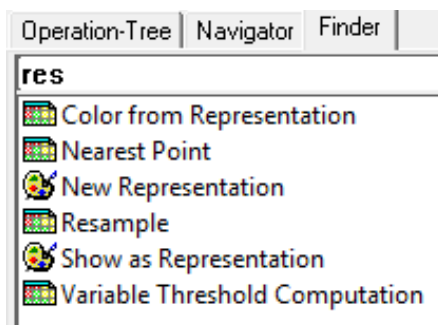
There are other ways to start an operation:

- By using the context menu of a data object in the catalog. One can use the context menu of a data-object (e.g. a raster map) to get access to operations that are suitable for that type of input data (the context-menu adjusts itself to where is clicked; hence the name “context menu”).



When you select “Resample...”, the same form will show as in the previous example, with the input map already filled-in.

- By typing “res” in the “Finder”. The list is now reduced to:

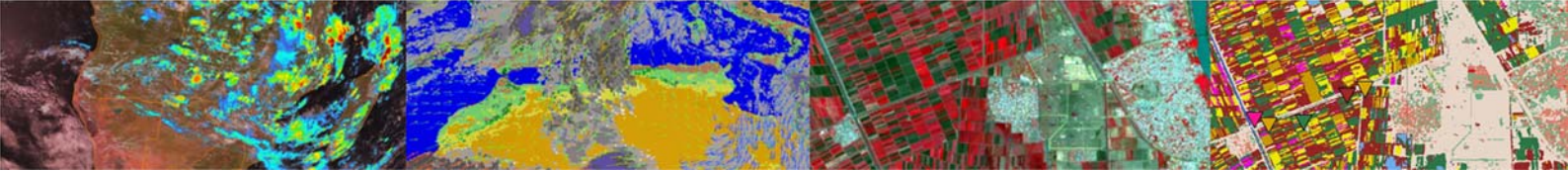


Double-clicking “Resample” in this list will open the same form.

- By typing `resample` in the ILWIS command-line and pressing return. Again the same form will open.
- When you already know exactly what to do, a special text expression, called an ILWIS statement can be used. This is a programming statement that ILWIS uses to compute maps, and is part of the ILWIS scripting language.

In the case of the resample that we have performed earlier, the statement is as follows:

```
a1.mpr { dom=value.dom; vr=-0.902:19.200:0.000 } =
```



```
MapResample('202002051200_CH_3_2_1_band_3', ethlatlon.grf, bicubic)
```

This statement is to be typed (or copy/pasted) in the ILWIS command-line. When done, press the <ENTER> key to execute the statement. You won't get the "Resample Map" form in this case, as all information is already there, but you will get a "Raster Map Definition" form confirming that you intend to execute the above operation.

6.2 The ILWIS command line

In the previous paragraph we briefly mentioned the ILWIS command-line. Most of the things you can do with ILWIS using the operation forms, have an equivalent text representation that does the same (see the "Resample" operation mentioned above). These text representations are called statements, and can be executed from the command-line or from an ILWIS script.

In ILWIS, a statement is an instruction to ILWIS to do something.

One category of statements is the assignment statement. This statement creates new objects from existing ones, and stores them on the hard disk.

The general syntax for an assignment statement is either of the following two lines:

```
OUTPUTMAP = expression
```

```
OUTPUTMAP := expression
```

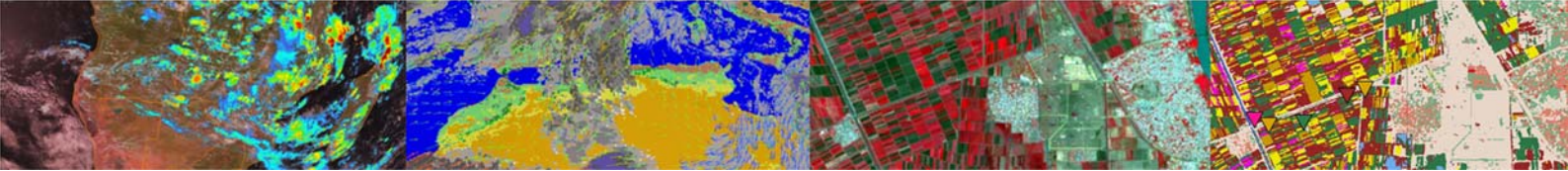
Explanation of the assignment statement:

OUTPUTMAP is the filename of the output map to be created.

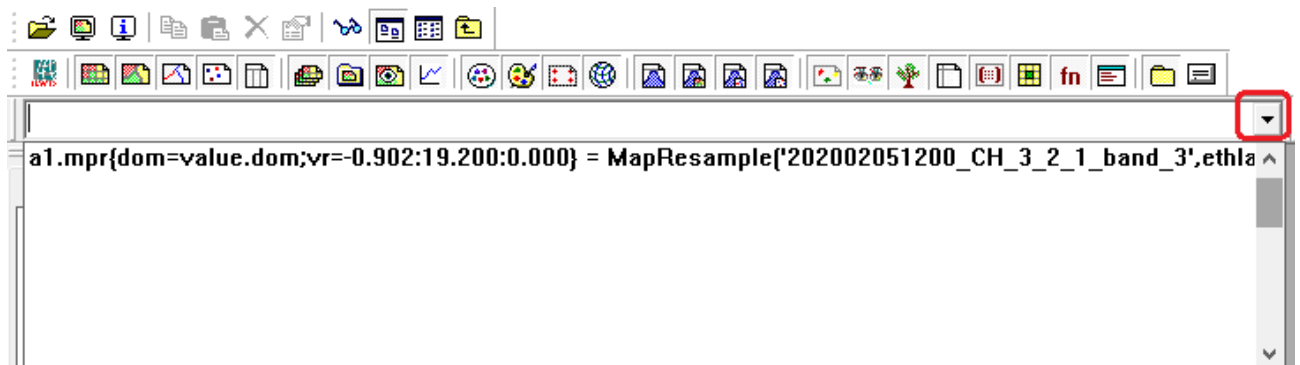
The definition symbol (=) is used to create a dependent output object. This is an object that "remembers" the expression with which it was created and the input maps that were used, so that if there is any change / update in one of the inputs, the object knows how to re-compute itself. This type of object can be used to implement a flowchart. The output is computed on-demand (when it is required). The object cannot be edited, unless the operation "break dependencies" is applied to it.

The assignment symbol (:=) is used to create an editable object. The output is computed immediately at execution of this statement, and ILWIS is no longer aware of the expression with which it was created (though for most operations, the expression that was used is in the object's description).

The expression can be any of the ILWIS operations, like Filter, Cross and Distance calculation, or it can be a so-called MapCalc expression, whereby a new map is calculated from existing ones by means of a mathematical expression that is applied to every pixel in the input raster maps. MapCalc can use any combination of mathematical operators (+, -, *, /, ^), boolean operators (=, <>, <, >, <=, >=) and functions (abs, sin, cos, tan, sqrt, iff, ifundef, not, etc.) to create the desired output result. The help files of ILWIS provide a good overview of all the expressions that are possible with MapCalc.



The recent history of executed statements is available in the command-line. Click the arrow-down on the right of the command-line to open the most-recent statements, and select a previous statement in order to execute it again. Optionally edits can be made to the statement before repeating the execution.



Note that this list only contains the most recent statements (by default 10, the number can be increased in the ILWIS Preferences). The full history (all statements executed from the first time that ILWIS was used) is stored in the ILWIS logfile (`ilwis.log`) that is specified in the ILWIS Preferences.

As an example, let's calculate the average temperature during the months June and July in Ethiopia. In the dataset there is a maplist of the average temperature per month over one year. We can use this to calculate the average over June and July. In mapcalc this would be:

```
Av_temp = (average_monthly_temperature_june_7.mpr +
average_monthly_temperature_july_6.mpr) / 2
```

A new map `Av_temp.mpr` is created. Note that this statement creates a "dependent map": `Av_temp` is aware that it was computed from `average_monthly_temperature_july_6.mpr` and `average_monthly_temperature_june_7.mpr`. If for any reason, those two maps are renewed, ILWIS will offer to renew `Av_temp.mpr` as well.

To create an "independent map", the statement should change as follows (the only difference is the `:=` assignment symbol):

```
Av_temp := (average_monthly_temperature_june_7.mpr +
average_monthly_temperature_july_6.mpr) / 2
```

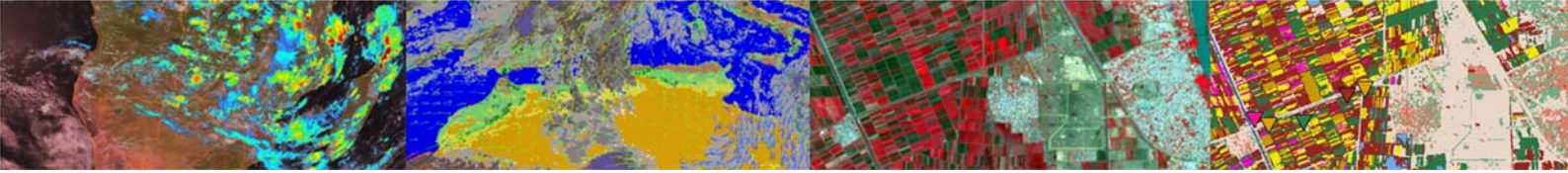
This statement will calculate the map `Av_temp.mpr` immediately after clicking OK in the Raster Map Definition form.

7 Getting Help

All buttons, operations and object types are described in-depth in the "ILWIS Help" documentation. This documentation also includes several how-to's and tutorials.

The "ILWIS Help" comes with ILWIS. There is no need for an internet connection. However the ILWIS Help system uses your browser to open the documentation. The first time you open the Help, you may be asked the question which browser to use to read the documentation (Chrome, Firefox, Edge, Internet Explorer). Simply select your preferred browser.

To start the Help, use the "Help" menu option in the ILWIS Main Window. Almost all documentation can be reached from here. Have a look at all sub-options, including "Contents", "Index" and "Search", but also the more specific options "Map and Table Calculation", "ILWIS Operations", "ILWIS Expressions", "Basic Concepts" and "How to...".



The sub-option “Help on this Window” is available in all ILWIS windows that have a menu. This option will jump directly to the documentation that is related to the window.

Several so-called forms (e.g. the form of an operation) have no menu. In this case, a Help button is available. When clicking this button, the documentation describing that form / operation will open directly.

Since the Help documentation is written after functionality is added to ILWIS, some documentation may be incomplete or missing, or referring to an older version of ILWIS. However the help-system is – just like ILWIS – Open Source. All help files are text files in the “help” subdirectory of ILWIS, so you are welcome to contribute (please send your enhancements back to us).