

# **NDVI-Based Change Detection**

## **1. Background**

The purpose of this practical is to introduce to you the NDVI-based change detection technique that can be applied to detect and monitor land surface change. For this purpose you will use Landsat TM imagery although any other EO dataset with similar characteristics can be used.

The Landsat TM data you are provided cover the Virunga National Park, a World Heritage Site, situated in the Democratic Republic of the Congo. The park was established for its spectacular landscapes, including active volcanoes and the Ruwenzori mountains, as well as its amazing richness in biodiversity, including one of the remaining populations of the rare mountain gorilla. You can read about the park at the UNESCO website - [http://whc.unesco.org/pg.cfm?cid=31&id\\_site=63](http://whc.unesco.org/pg.cfm?cid=31&id_site=63).

**The purpose of this practical is to investigate whether the park has suffered habitat loss during the 16 year period between 1987 and 2003. In addition you will see how the studied area and your final change detection map can be visualised as a 2D image, creating an added value product that can be used to support your interpretation.**

For this purpose you will be using two Landsat TM images which were acquired in 1987 (8<sup>th</sup> July) and 2003 (31<sup>st</sup> January). In addition to these data you will also utilise a Digital Elevation Model (DEM) produced using the Shuttle Radar Topography Mission (SRTM) dataset. For your reference the Landsat data used in this practical have been downloaded from the Earth Sciences Data Interface (ESDI) website at the Global Landcover Facility.

The Landsat TM data consist of 7 wavebands (listed in the table below) at a spatial resolution of 30m (solar reflective wavebands) and 60m for the thermal waveband. However, in the datasets used in this practical the thermal waveband has been resampled to 30m. The resampling of the thermal IR waveband has not improved its spatial resolution (you will notice this waveband appears blurry) but has just increased the number of pixels in the image. This is necessary so that it can be stored and displayed with the other wavebands (i.e. in 1 image file).

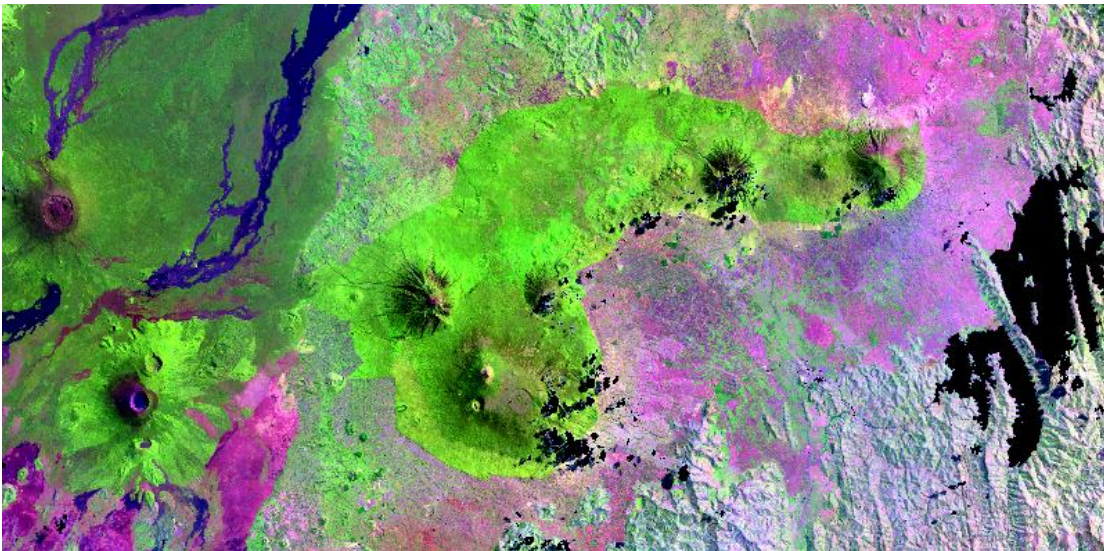
### *Landsat TM spectral characteristics*

<b>Band Number</b>	<b>Spectral Range (Microns)</b>	<b>EM Region</b>	<b>Generalised Application Details (many other applications exist)</b>
1	0.45 - 0.52	Visible Blue	Coastal water mapping
2	0.52 - 0.60	Visible Green	Assessment of vegetation status
3	0.63 - 0.69	Visible Red	Chlorophyll absorption for vegetation differentiation
4	0.76 - 0.90	Near Infrared	Biomass surveys and delineation of water bodies
5	1.55 - 1.75	Middle Infrared	Vegetation and soil moisture measurements; differentiation between snow and cloud
6	10.40-12.50	Thermal Infrared	Thermal mapping, soil moisture studies and plant heat stress measurement
7	2.08 - 2.35	Middle Infrared	Mineral mapping. Hydrothermal alteration makes many different clay minerals that absorb at 2.2 microns (which is TM Band 7).

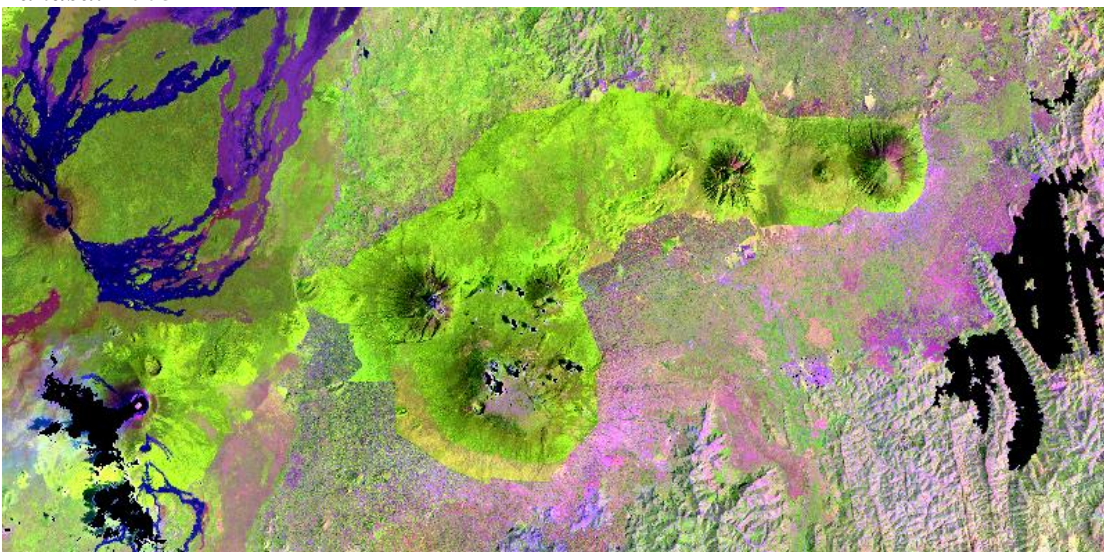
The DEM was produced using a technique called **radar interferometry**. In radar interferometry, two radar images are taken from slightly different locations. Differences between the two images allow for the calculation of surface elevation. The DEM has a spatial resolution of 90m and a vertical accuracy of less than 10m. As with the Landsat thermal IR waveband, the DEM has been resampled to 30m so that the DEM has the same number of pixels as the Landsat images. This allows the DEM and Landsat images to be overlaid together (i.e. each pixel in the Landsat image has a corresponding pixel in the DEM – a height value).

Some data pre-processing has been carried out. All datasets have been co-registered together so that comparisons can be made between images. In the Landsat images, attempts have been made to mask out clouds, volcanic plumes and water bodies. These areas have a value (digital number) of zero. It is necessary to remove these features since they occur at different spatial locations in each image and would therefore be interpreted as a change in the land surface if not accounted for. ). The water bodies have been removed since they are not required in the image classification. Note that the 'edges' around some of the clouds remain.

*Landsat 1987*



*Landsat 2003*



*SRTM Digital Elevation Model*



## **Practical methodology**

### **Starting ENVI**

Start ENVI from the START/PROGRAMS menu at the bottom of the screen – or (if one exists) by double clicking on the ENVI shortcut on the WINDOWS desktop. A three-button mouse can be used, but if you are using a two-button mouse you can simulate a "middle" mouse button press by holding down the **Ctrl** key on your keyboard (bottom left) and pressing the left mouse button.

### **Opening an Image file**

- *Select File -> Open Image File.*

An Enter Input Data File file selection dialog appears.

- Navigate to the directory where your data are held, just as you would in any other application.
- The images are called
  - Landsat\_1987masked.img
  - Landsat\_2003masked.img
  - SRTM\_filled.img
  - ChangeDetectionMask.img

***Remember these files are quite large so can you delete them at the end of the practical.***

Open the 2003 Landsat image for visual inspection either as a True Colour Composite (TCC) or a False Colour Composite (FCC). The park is centrally located in the Landsat images and is clearly identifiable. Within the park are a number of active volcano's. This is reflected by the recent lava flows on the left hand side of the image. In the 2003 Landsat image the volcano in the lower left of the image is erupting (clearly visible in the thermal infrared waveband – band 6). It is also important to note the time of year that the images were captured. The 1987 image was acquired in the dry season, where the vegetation is senescing, whereas the 2003 image was acquired in the wet season where the vegetation is greener. This can have implications for detecting surface change.

## Land cover change detection

A number of methods exist for detecting land surface change which vary in terms of complexity. In this practical we will examine two methods of detecting surface change.

### Classification based approach

The first approach to detecting land surface change will make use of the two classified images we created earlier. From the ENVI toolbar select **Basic Tools -> Change Detection -> Compute Difference Map**. Select the 1987 *classified image* as the 'initial' state and the 2003 *classified image* as the 'final' state. Select **three** classes and leave the remaining options as they are. Choose a filename for the output image.

Before interpreting the resulting change detection image it is necessary to mask out the regions where a mask (cloud and water) has been applied in either of the Landsat images. If this was not carried out the region which were masked in one image and not in the other would be detected as a change. To mask the change detection image, open the mask image (*ChangeDetectionMask.img*). This is a binary image where areas which have been masked in either Landsat images are 0 and all other areas 1. To mask the image we are going to use ENVI's **Band Math** function. This is accessed through **Basic Tools -> Band Math**. This allows you to implement an equation which will be applied to the image data. The equation can be entered in the '*Enter an Expression*' box. The we need to apply is a simple multiplication :

$b1 * b2$

where  $b1$  is the **change detection image** waveband and  $b2$  is the **change detection mask** (*ChangeDetectionMask.img*). This expression will mask out all regions which have been masked in either Landsat image by replacing the values in the change detection image with a zero. Enter a name for the output image and apply the expression.

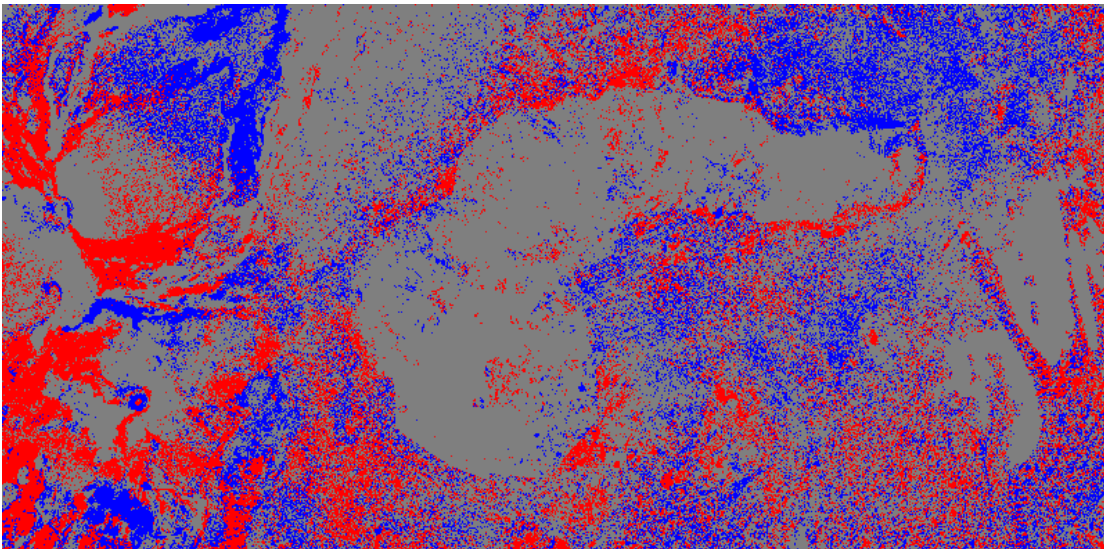
The resulting image will contain 3 different classes (and the masked regions) : positive change, no change and negative change. A positive change identifies pixels that became brighter (final state brightness was greater than the initial state brightness) – i.e. an increase in vegetation, while a negative change identifies pixels that became dimmer (final state brightness was less than initial state brightness) – i.e. a loss of vegetation. The area of change which we are interested in is around the park boundary. This will indicate whether there has been any loss of park habitat over the past 16 years.

***Q: Has there been any lose of park habitat ?***

***Q Where are the main areas of change and why?***

*Change detection image (NOT masked out – notice the water bodies have been assigned a class)*





If you would like to quantify the degree of change you can from the main ENVI menu **Basic Tools -> Change Detection -> Change Detection Statistics**. Again select the 1987 image as the ‘initial’ state and the 2003 image as the ‘final’ state. In the next window pair-up each region/land cover type so that land cover type 1 in the 1987 image is paired with the equivalent land cover type in the 2003 image. In the next window you have to choose how to output the results. Leave the top three boxes ticked and don’t choose to out put any images. This will output the statistics of the change which has taken place for each land cover type in a table format. This is illustrated below.

Change Detection Statistics (Initial State: Landsat_1987_7_maxi.img, Final State: Landsat_200...				
File Options Help				
Pixel Count Percentage Area (Square Meters) Reference				
Initial State				
	Region #1 [Red] 73278 points	Region #2 [Green] 11390 points	Region #3 [Blue] 26754 points	
Unclassified	0	0	0	
Region #1 [Red] 51052 points	843264	40482	109161	
Region #2 [Green] 26439 points	63880	95618	63516	
Region #3 [Blue] 65466 points	186531	57202	495830	
Region #4 [Yellow] 108498 points	77346	23633	170387	
Class Total	1171021	216935	838894	
Class Changes	327757	121317	343064	
Image Difference	-95644	11075	172064	

### Vegetation Index (VI) based approach

Another method for monitoring land cover change which is more readily applied than the classification approach is through the use of vegetation indices such as the Normalised Difference Vegetation Index (NDVI). This uses a ratio of red and NIR data to enhance the presence of vegetation whilst minimising ‘background’ information.

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

There are two methods of deriving the NDVI using satellite image data in ENVI. The first (and more straight forward method) is to select **Transform -> NDVI** from the ENVI toolbar. Select one of the Landsat images this will be detected as being a Landsat image by the software. The red waveband will be detected as being band 3 and the NIR waveband detected as being band 4 (which is correct). Simply choose an appropriate output filename. The resulting image will have values ranging between -1 (dark) and 1 (bright). Negative values are typically non-organic materials

(where the red reflectance is higher than the NIR) and the positive values indicate increasingly 'green' vegetation (where the NIR reflectance is higher than the red reflectance).

Apply this process to each of the Landsat images.



To determine the degree of land surface change use the *Change Detection* algorithm approach which was discussed in the classification section (**ENVI Toolbar -> Basic Tools -> Change Detection -> Compute Difference Map**). *How well do the two approaches agree?*

Another method of deriving the NDVI from image data in ENVI is by using the *Band Math* function which is accessed through **Basic Tools -> Band Math**. This allows you to implement an equation which might not be available in the software. The equation (above) can be typed in the 'Enter an Expression' box. In the case of the NDVI type the following into the box:

$(\text{float}(\text{b1}) - \text{b2}) / (\text{float}(\text{b1}) + \text{b2})$

where b1 is the NIR waveband and b2 is the red waveband. Once you have implemented the expression, the next window will enable you to select which Landsat band is represented by b1 (in this case **waveband 4**) and which band is represented by b2 (**waveband 3**). Finally choose the name of the output image. You only need to apply this to one image as the result will be the same as the other NDVI method. *The importance of the Band Math function is that it allows you to apply your own expressions to the image data and not to simply rely on those provided with the software.*

**Important note:** ENVI and IDL do NOT perform mathematical operations using floating point (FP) arithmetic (i.e. with decimal numbers) by default – rather they have to be told to use FP arithmetic (since it requires more memory to store a decimal number such as 1.000 as compared to simply 1). This means that by default the result of mathematical operations involving non-floating point numbers (i.e. whole numbers – or integers) will also be integers. In the case of the NDVI calculation, our input numbers are non-floating point (whole) numbers since they are simply the image DN's in the NIR and RED spectral channels. This means that the output NDVI value will also be a whole number by default, but this is not what we want as we know that NDVI (being a normalised ratio) should be a floating point value between -1.0, 0 and +1.0. The output of the NDVI calculation, truncated to integers only will only have three values, 1, 0 and -1 – not a very precise discriminator! Therefore we must force the calculation to be carried out with floating point numbers – and one simple way to do this is to make the input variables floating point numbers by encasing them within the command float() [since when one or more of the input variables is a

floating point number, the output of the calculation is automatically stored as a floating point number also]. As you can see with the NDVI equation, we have encased one of the numerator variables and one of the denominator variables in the float() command, just to be certain. Remember this trick when using BAND MATH to input your own mathematical expressions, and if you are expecting a floating point output but get whole numbers this is the first area to check for faults.

## 2. Creating a 3D surface view

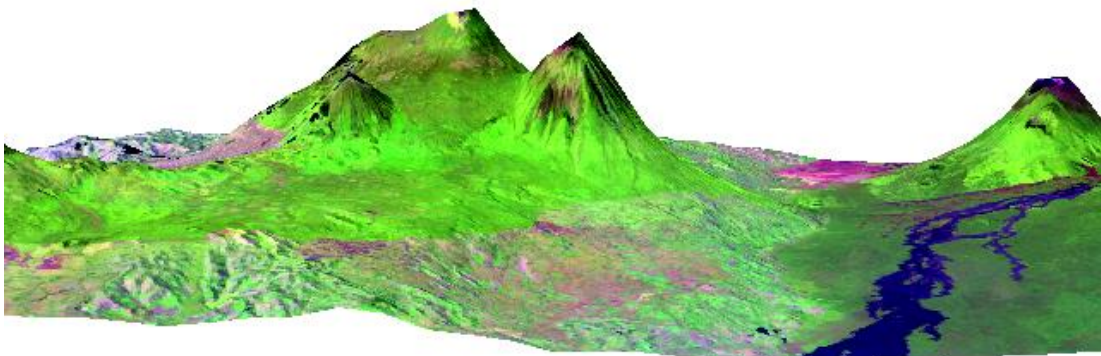
To create a 3D surface view we will use the SRTM digital elevation model (DEM) and one of the Landsat images (either 1987 or 2003). Open a Landsat image as a colour composite (i.e. 3 wavebands) into an image viewer. From the ENVI toolbar select **Topographic -> 3D Surface View**. In the following window select the SRTM image as the associated DEM. The next window allows you to select the DEM parameters, such as resolution. Select **512** as the **DEM resolution** (this process takes quite a lot of memory so high resolution DEMs need more powerful machines) and **1024** as the **image resolution**.

A 3D surface view will be created where the Landsat image is ‘draped’ over the DEM. The controls of 3D surface view are as follows (and take some getting used to) :

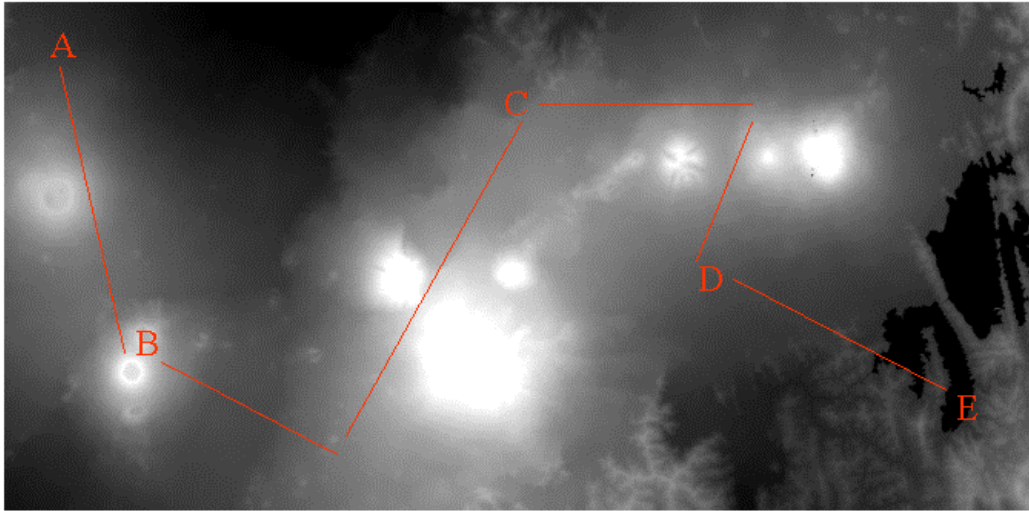
- 1) Use the **left mouse button** AND **move the mouse** to **rotate** the view
- 2) Use the **left mouse button** AND **Ctrl** (left+Ctrl) to **alter** the position of the DEM in the viewer window
- 3) Use the **right mouse button** AND **move the mouse** left/right to zoom in/out of the DEM

You can save a particular view as a graphics (bmp, jpeg etc) file from the menu **File -> Save surface As**.

*3D surface view*



**It is visually attractive to** create a ‘Fly-by’, whereby you “fly” around the DEM. From the 3D surface window menu, select **Options -> Motion Control**. Using the mouse controls detailed above select a starting position (view) and press the **add** button. This will be the view where the fly-by will start. Again using the mouse controls (e.g. zoom), position the view at a different location and press **add**. This will be the second view – don’t worry if its some distance from the start position as the software will interpolate between the two points. Continue this process until you have 5-10 views. This is illustrated below where each letter signifies a new view (i.e. where you press the **Add** button). The distance between two points will be interpolated by the software.



To view the full sequence press **play**.



## PRACTICAL

### INTRODUCTION TO ENVI AND SIMPLE IMAGE MANIPULATION

#### INTRODUCTION

Your task is to work through the following instructions. You should be able to get a significant way through these during the practical session, but may need to complete the final parts of the practical work after class. The purpose of this session is to introduce you to the basics of remote sensing data analysis and image processing software functionality.

For this practical you will be using ENVI 5.0 software. ENVI is a highly advanced but also easy to use piece of software. It allows examination, analysis and processing of remote sensing imagery and spectra, along with some GIS functionality. ENVI uses a graphical user interface (GUI) to provide point-and-click access to image processing functions. ENVI is written in the IDL programming language, and all the commands you can use in ENVI can also be accessed from within IDL programmes.

#### Landsat Imagery

The practical is focused on the use of **multispectral imagery** from the **Landsat satellite**. Landsat was first launched in 1972 and has since provided a near- continuous record of Earth Observation.

NOTE: Multispectral sensors have 10 bands or less covering the Electromagnetic spectrum. The alternative in remote sensing is the use of hyperspectral sensors which divides the spectrum into hundreds of narrow bands (i.e. these sensors have a higher spectral resolution)

There have so far been 8 Landsat satellites (although Landsat 6 failed on launch). Landsat 8 is the latest and launched successfully on 11<sup>th</sup> February 2013. For this practical we will be using data from the Landsat ETM+ mission (Enhanced Landsat Thematic Mapper+), the predecessor to Landsat 8.

ETM+ provides 30 m spatial resolution in 6 spectral bands that record solar reflected radiation between 0.45 and 2.35  $\mu\text{m}$ . It also has a spectral band in the thermal infrared region with a spatial resolution of 60 m (120 m for the previous TM instruments) and a broadband (panchromatic) spectral channel. The panchromatic band allows for measurements at higher spatial resolution (15 m), but across the entire visible channel range, rather than in individual spectral bands.

The following table provides a breakdown of the wavebands of the ETM+ sensor, in addition to the panchromatic band (normally termed band 8).

Table 1. Landsat ETM+ waveband properties

Band Number	Spectral Range (Microns)	EM Region	Generalised Application Details
1	0.45 - 0.52	Visible Blue	Coastal water mapping
2	0.52 - 0.60	Visible Green	Assessment of vegetation status
3	0.63 - 0.69	Visible Red	Chlorophyll absorption for vegetation differentiation
4	0.76 - 0.90	Near Infrared (NIR)	Biomass surveys and delineation of water bodies
5	1.55 - 1.75	Shortwave Infrared (SWIR1)	Vegetation and soil moisture measurements; differentiation between snow and cloud
6	10.40 - 12.50	Thermal Infrared	Thermal mapping. Soil moisture studies and plant heat stress measurement
7	2.08 - 2.35	Shortwave Infrared (SWIR2)	Mineral mapping. Hydrothermal alteration makes many different clay minerals that absorb at 2.2 microns

For this practical you will only be using BLUE, GREEN, RED, NIR, SWIR1 and SWIR2 bands (**designated as bands 1 to 6 respectively**). The image you will be using is a subset of a Landsat ETM+ scene covering the area of Dongola, Sudan.

## DISPLAYING AN IMAGE

1. Identify the image "Landsat\_SudanSubset" from your data folder save it to an appropriate location and open ENVI 5.
2. The following user interface should appear:

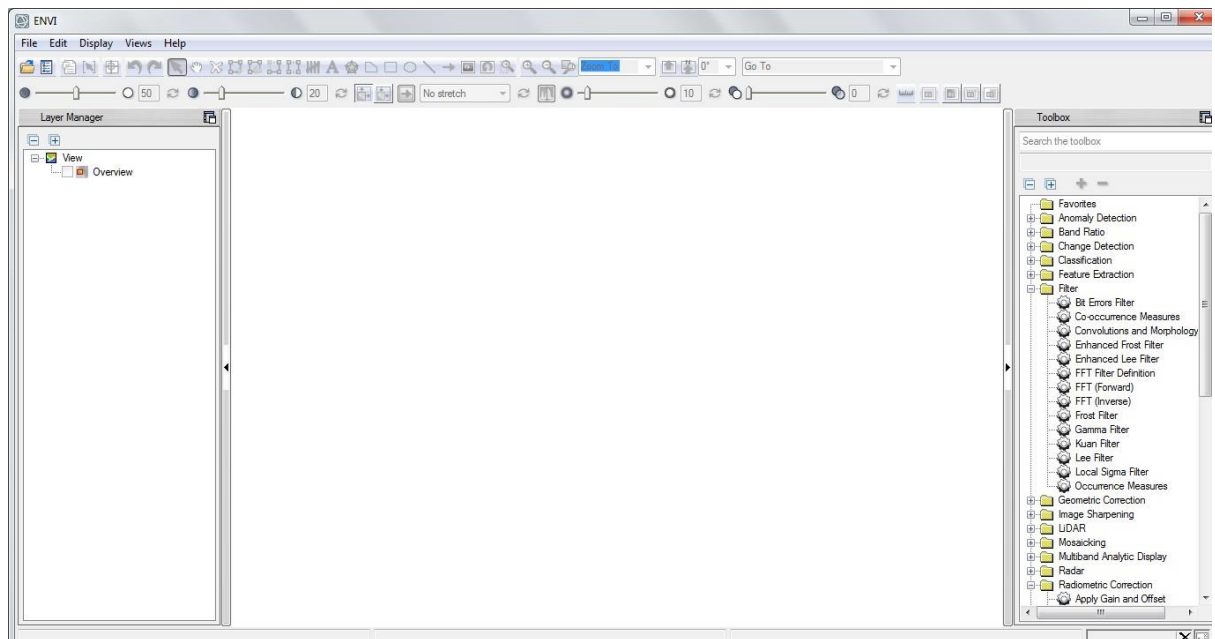




Figure 1. ENVI 5 User Interface

3. Using the  icon, load the **"Landsat\_SudanSubset"** image .

The image will load as a single band file, you will need to alter the image setup to be able to display it as a 3-band RGB composite. To do this, go to the **"Data Manager"** icon .

Select the band combination to be R = 6, G = 4, B = 5 as indicated in Figure 2 and select "Load data".

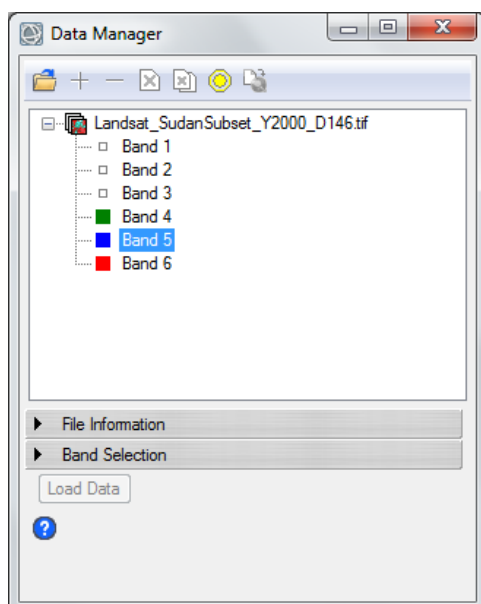


Figure 2. Displaying a composite image

This band combination is used because it incorporates NIR and SWIR 1 and 2 wavelengths. This allows vegetation to be clearly discriminated from the surrounding landscape due to the high reflectance of NIR radiation.

Vegetation near the river should now be displayed in a greenish colour.

Right-click on the image in the “**Layer Manager**” and select “**Change RGB Bands**”. Try changing the band combination to a true colour composite: R = 3, G = 2, B = 1 (reflecting how the human eye would see the image). Notice how it is more difficult to identify vegetation from the surrounding landscape.

NOTE: Any band combination which does not exclusively use the RED, GREEN, BLUE visible wavelengths (i.e. is not a **true colour composite**) is generally referred to as a **false colour composite**.

Using Table 1 as a guide, try experimenting with other band combinations to see the effect of reflectance at different wavelengths on landscape representation. When you have finished, return the image to the R = 6, G = 4, B = 5 false-colour combination.

NOTE: In the image, the river remains dark regardless of the band combination used, why do you think this is?

## CONTRAST STRETCHING

4. Now you will need to alter the histogram stretch of the image. This will help to increase the definition of the image you are viewing by altering the range and distribution of Digital Number (DN) values within an image.

NOTE: Multispectral sensors initially record measurements of the interaction of EM radiation with terrestrial surfaces in the form of **brightness values**. These values are known as **Digital Numbers** (DN) and normally range from 0 to 255. Each pixel within an image has a unique DN.

Image DNs are stored within a histogram. To view the histogram of your image, type “**Statistics**” into the “**Toolbox**” interface on the right of your screen and select “**Compute Statistics**” from the list that appears.

Select the image and click “**OK**” in the window that appears. The following display should appear:



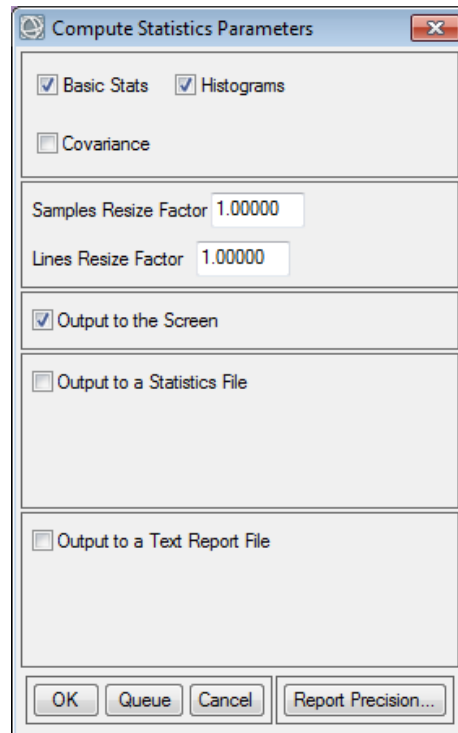


Figure 3. Displaying the image histogram

As Figure 3 shows, ensure the **"Histogram"** box is ticked and click **"OK"**

Figure 4 shows an example of the histogram for Band 4. Notice that the majority of pixels within the image have a DN value between 90 and 150 in Band 4 (NIR). Use the **"Select Plot"** icon to view the DN histograms for all 6 bands of the image.

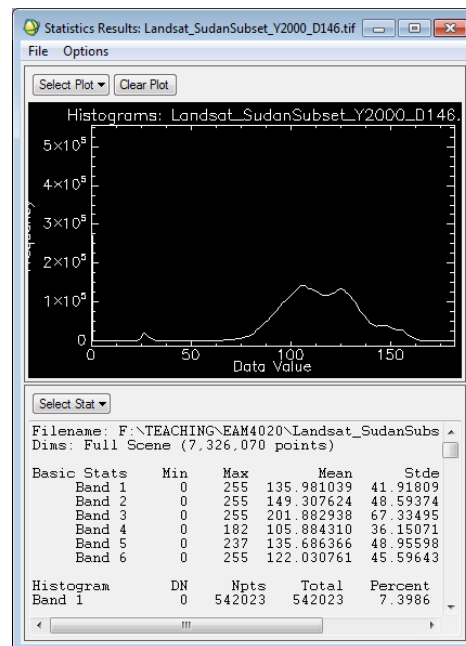


Figure 4. Histogram for Band 4 (NIR)

Contrast stretch is a form of image enhancement where the range and distribution of DN (Digital Number) values within an image is altered by stretching the histogram.

The most common type of histogram stretch is the **linear stretch**. Say, for example, that all pixels within your image had DN values within the range of 15 to 65. Linear stretch modifies the histogram so that 15 becomes 0 and 65 becomes 255 with all other values distributed proportionally in between the minimum and maximum values.

Image data can contain outliers / anomalies (i.e. extreme values). To ensure that the stretch is not affected by outliers, a 2% linear stretch is often applied. This only uses 96% of the pixels (96% of pixels closest to the median DN) within the histogram therefore excluding extreme values.

Try applying a linear 2% stretch to your image using Figure 5 as a guide:

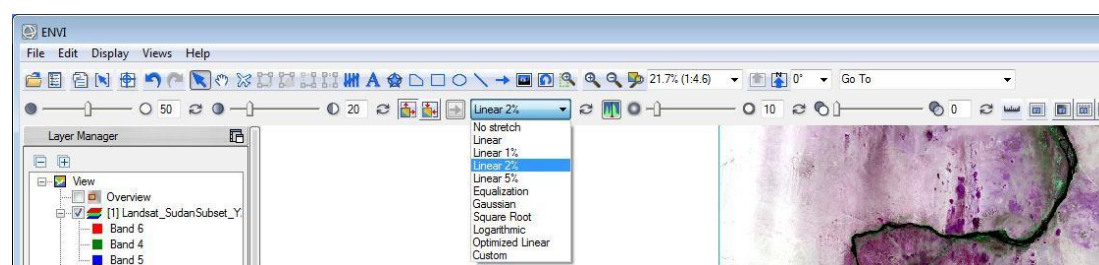


Figure 5. Applying a 2% linear stretch

Notice how the image appears to be much brighter now and how different land cover types are now far more distinct. The result of your stretch should be similar to Figure 6:

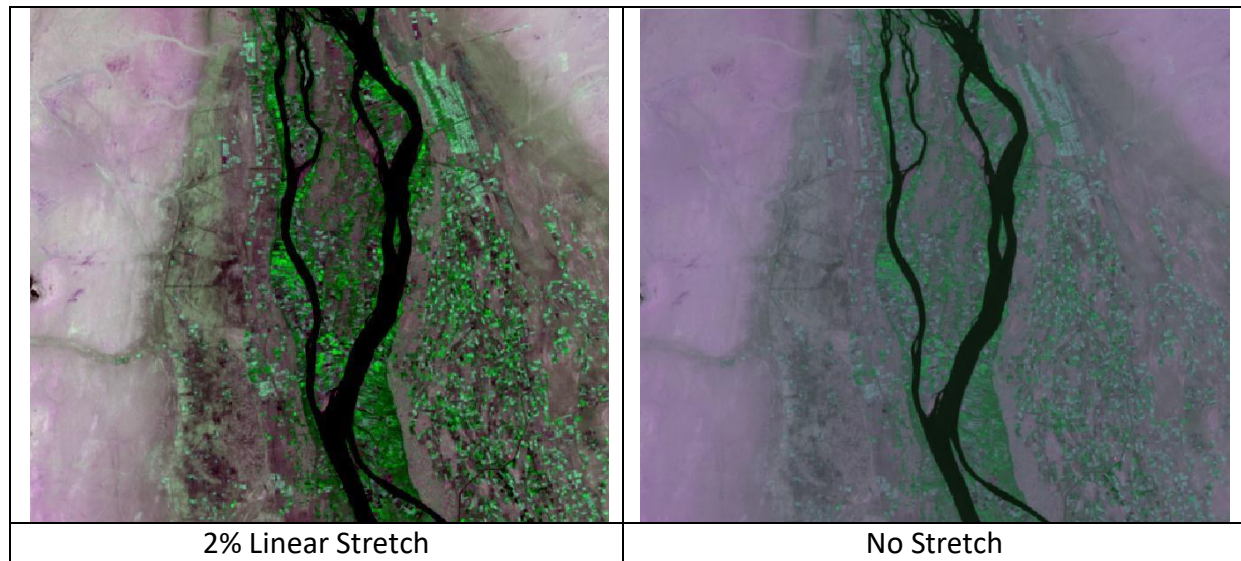


Figure 6. Contrast stretching

Try using some of the other histogram stretch types from the drop-down list (Figure 5) and see how they differ from linear 2%. It is recommended that you research the different types of contrast stretching to gain a good understanding of what is available and when it is appropriate to apply these enhancements.

### USING LOCATION TOOLS

5. To move around the image and focus on a particular area it is simply a case of using the icons outlined in Figure 7, contained within the main user interface.

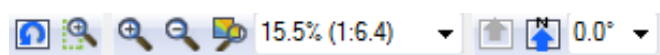



Figure 7. Location tools

Experiment with these tools by zooming-in to an area of your choice and rotating the imagery. When you have finished, return the image to its original position by selecting **“Zoom to Full-Extent”** and **“North Up”**.

NOTE: You can also use the   icons to pan quickly across an image

6. To display data for an individual pixel or location use the “Crosshairs” icon  on the main user interface.

This will bring up the following window:

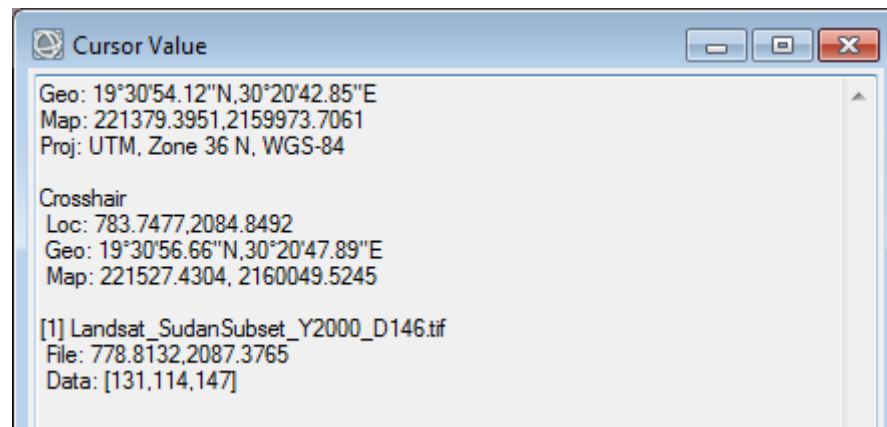


Figure 8. Displaying pixel information

Click anywhere within the image to display the data for a specific pixel. As Figure 8 shows, the crosshair displays:

**Loc:** This is the pixel-based **location** of the area which you have selected. Imagine if your grid of pixels which make up the image were in a table of rows and columns. The pixel displayed here would be in column **783** and row **2084**.

**Geo:** This is **geographical coordinates** of the pixel in relation to the UTM, Zone 36 N, WGS-84 projection of the image. The units displayed here are in **degrees, minutes, seconds**.


**Map:** This is the **map coordinates** with a unit of measurement in **metres**.

**Data:** This displays the DN value for your pixel for each band within the image composite. For example, this pixel has DN numbers of **131** for Band 6, **114** for Band 4 and **147** for Band 5.


## LINKING DISPLAYS

It is often helpful to display your image or 2 different images with the same spatial extent and geographic projection side-by-side to compare differences during data analysis.

7. In the main user interface go to **“Views” > “Two Horizontal Views”**

Ensure that the duplicated window which currently has no data is selected by clicking once on the screen using the  icon. The duplicated window should now be selected and highlighted.



You will now need to reload your image for the duplicated view by going to: 

Your screen should now look similar to Figure 9:

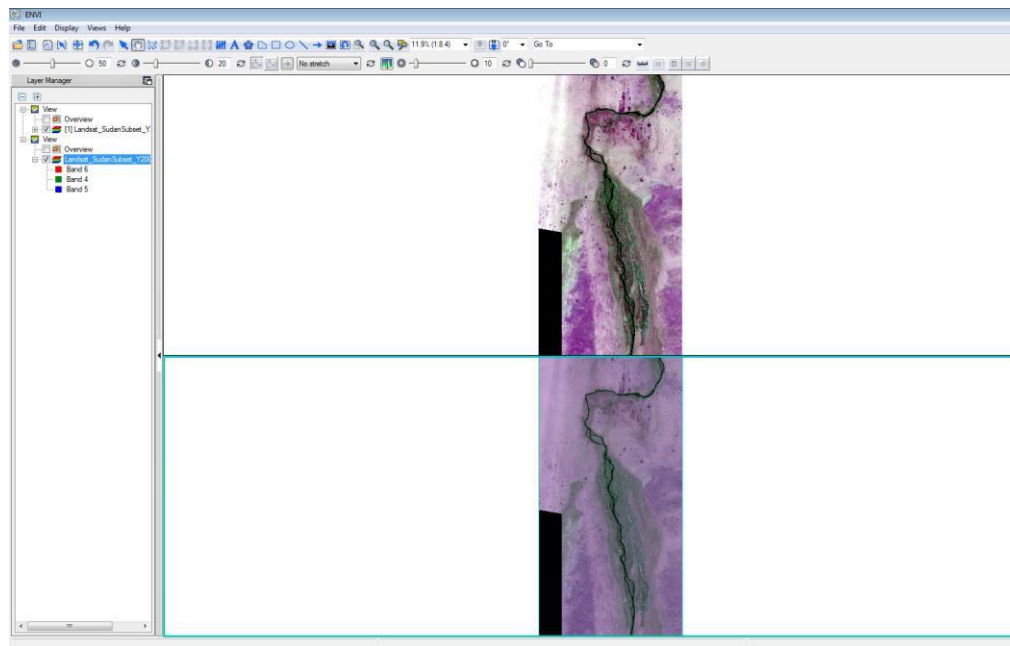


Figure 9. Duplicating the view window

8. However, the images will still move independently of each other. You should now link your displays so that the images move simultaneously.

Do this by going to **“View” > “Geo Link View”**

In the following window, left-click on both images. An anchor icon should appear indicating that the displays are now geographically linked. Select **“OK”**.

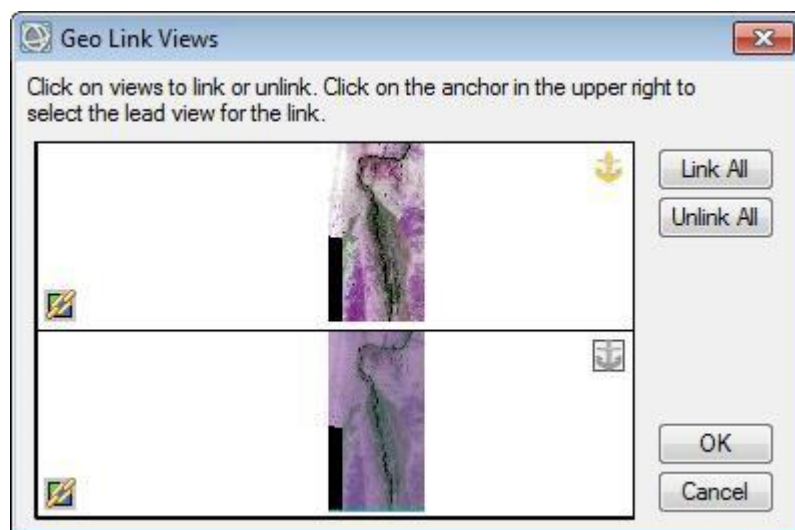



Figure 10. Linking the display

Now try moving the one of the images using the  icon. You will notice that the images move simultaneously.


Try experimenting with the other options within **“View”**. You can have up to **16** separate viewing windows if necessary! This is very useful, for example, when comparing time series data to identify land cover change over time.

NOTE: You can unlink displays by going back to the **“Geo Link View”** window and selecting **“Unlink”**

## DATA PLOTS

You can view the spectral signature of a pixel in the form of a spectral profile using all 6 bands

9. Go to **“Display”** and select **“Spectral Profile”**.

Using the select icon , left-click at random locations across the image and observe how the spectral profile of each pixel is different.

Try and find a pixel which closely resembles the spectral profile of vegetation (Figure 11) and the spectral profile of water (Figure 12)

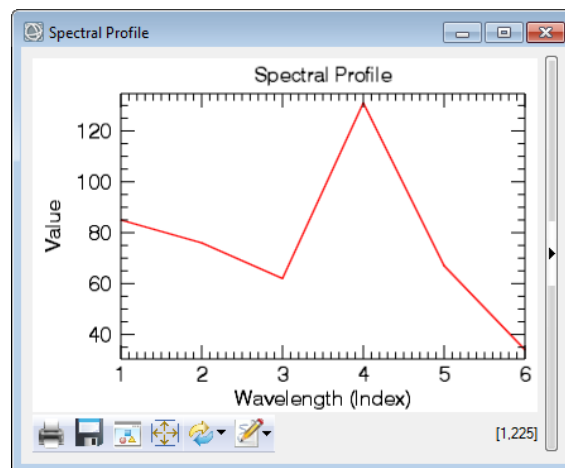


Figure 11. Spectral profile of vegetation

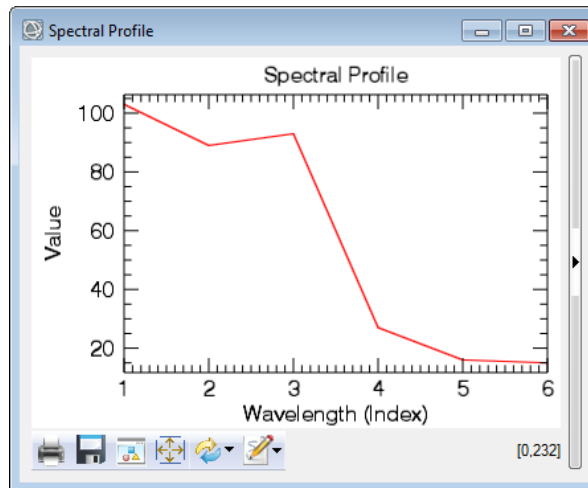


Figure 12 Spectral profile of water

These profiles are quite distinct. What major differences can you see? Suggest why this may be the case.

- Now try displaying multiple pixel profiles within the same window. Do this by holding the **"SHIFT"** key and left-clicking on the pixels you wish to view.

This allows the direct comparison of spectral profiles for the discrimination of land cover types (Figure 13). Click on the arrow to the right of the window to reveal the plot key for your individual profiles. Right-click on a profile within the plot key to delete it from your display.



Figure 13 Comparing profiles

11. You may notice that the x-axis of your display is inaccurately titled as **“Wavelength”** when in fact it is displaying discrete band numbers. To edit your profile, double-left-click on the axis and change the appropriate property to **“Band”**.

You may also wish to have a play around with the other profile properties to alter the overall style of your profile.

NOTE: You can save your profile as a jpeg or other image type by clicking on the “Save As” icon at the bottom of the screen

## SCATTER PLOTS

Another type of data display is the 2D scatter plot using 2 spectral bands.

12. Go to **“Display” > “2D Scatter Plot”**

Change the display to match Figure 14:

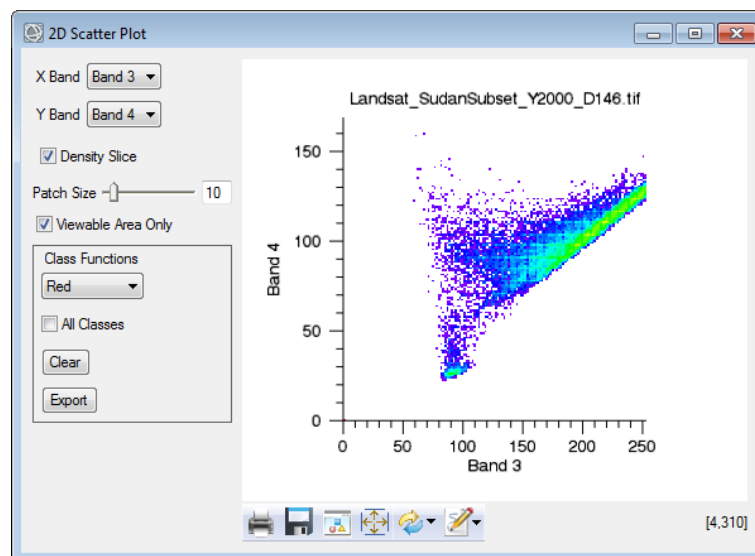


Figure 14. The 2D Scatter Plot

This particular scatter plot shows a comparison of RED and NIR spectral bands. You’ll notice the profile forms a triangular shape. Tick the **“Density Slice”** option to identify where the greatest concentration of pixels lie. For this profile, the greatest concentration of pixels occurs to the right of the profile.

On the plot, hold the left-mouse button to draw a polygon around the pixels at the top-right area of the profile triangle. Right-click to finish the polygon, this will select the contained pixels. In **“Class Functions”** change the colour of your polygon selection and repeat the process for the other two corners of the profile triangle as shown in Figure 15



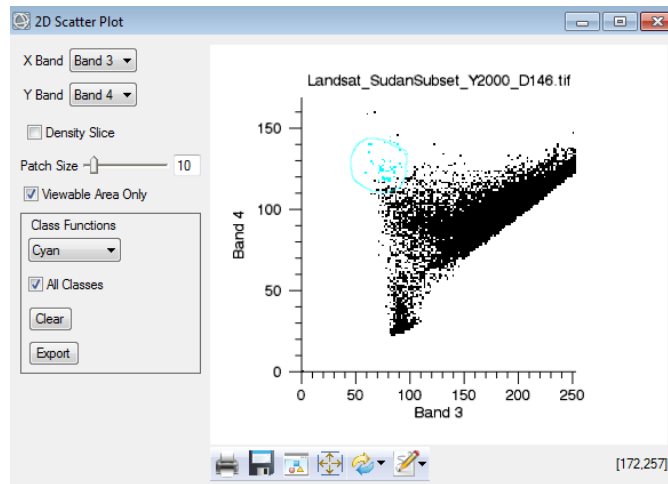


Figure 15. Selecting pixels from the scatter plot

Once you have done this try to answer the following questions (you don't need to write anything down for this):

What land cover type do pixels in the top-right corner of the profile represent?

What land cover type do pixels in the top-left corner of the profile represent?

What land cover type do pixels in the bottom-left corner of the profile represent?

13. **“Export”** your selections as **“Regions of Interest”**. These regions will now be displayed in the **“Layer Manager”**.

NOTE: Try dragging the cursor along the image to see where the respective pixels lie in the scatter plot.



# Ushtrime praktike ne laborator

**Permbajtia: Siperfaqet e interpolimit  
hapsinor ne mjedisin e ArcMap**

**Udhezime Praktike**



Në praktikën e sotme do të përdorim të dhëna të mbledhura nga një mjedis fushor i përmbatur. Të dhënat përmbajnë informacion mbi përbërjen e tokave dhe % e argjilës brenda atyre tokave. Ne kemi matje aktuale të fituara në 153 dhe 350 lokacione mostrash të shpërndara në atë terren.

Na janë dhënë gjithashtu shapefile elumit dhe asaj të sipërfaqes së tokës për atë vend.

## **Te dhenat**

**1.Agrinio\_153.shp**

**2.Agrinio\_350.shp**

**3.Agrinio\_soils.shp**

**4.Axeloos\_river.shp**

**Te dhenat e nevojshme**



Qellimi i ushtrimit eshte:

1. Krijoni sipërfaqe të vazhdueshme (për variablat që lidhen me përbërjen mekanike) me metodën e interpolimit hapësinor Pesha e Anasjelltë e Distancës (IDW) nga skedari i dhënë ne formatin shapefile (153 pikë)
2. Kryeni **një vlerësim të hartave tona të perftuara të interpolimit** në mënyrë që të identifikoni se cila po prodhon rezultate më reale.
3. Vlerësoni efektin e (a) parameterizimit të algoritmit dhe (b) karakteristikat e mostrës (madhësia / dendësia) për saktësinë e hartave të ndërfutura.

E gjitha do te behet me programin ArcMap.

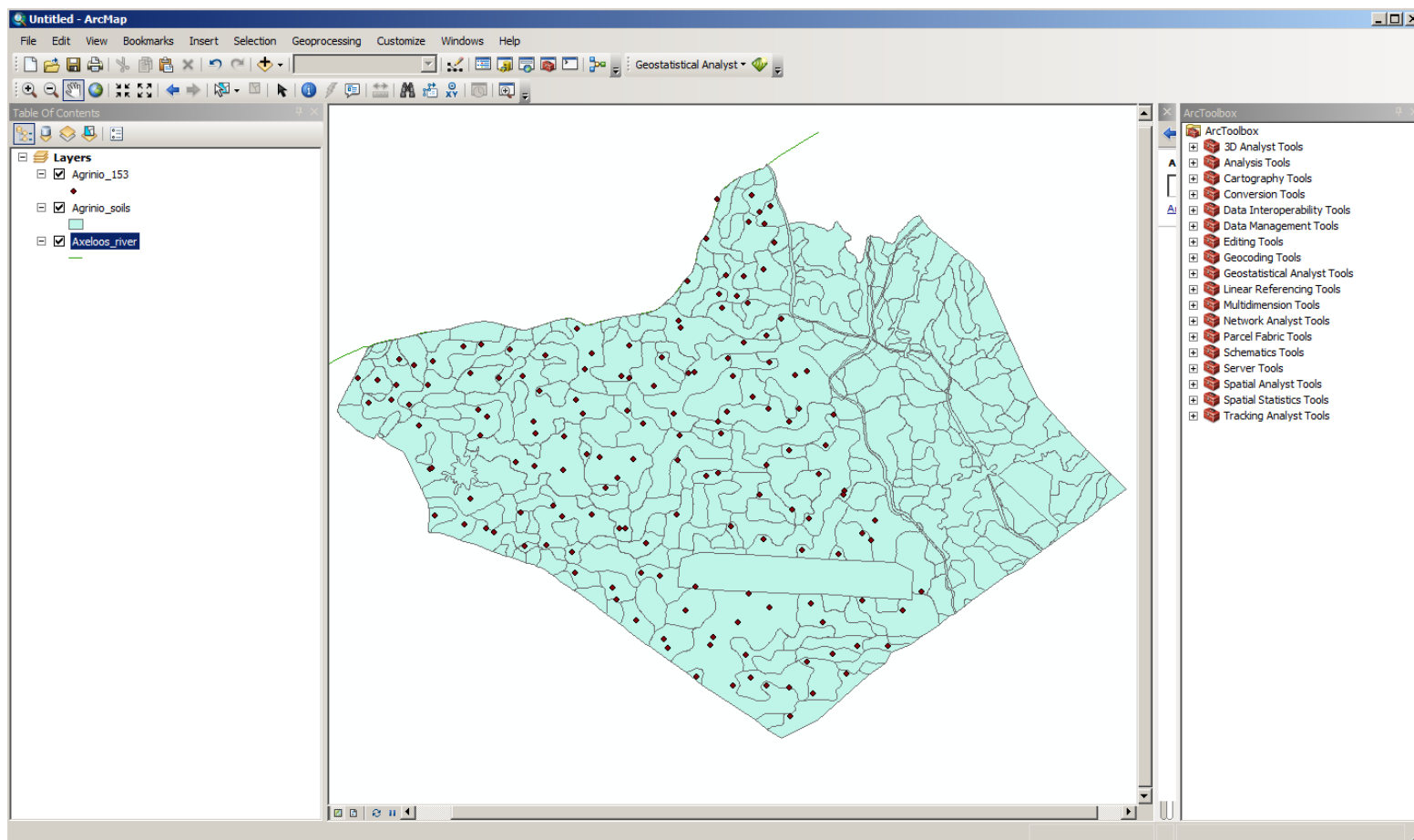
Metoda IDW bazohet në supozimin se vlera e një prone në një vend ku nuk ka asnjë matje, është vlera mesatare e ponderuar (në lidhje me distancën) e pronës, e pikave prove që rrethojnë pikën nën hetim.

Si hap i pare, importo skedaret e meposhtem ne ArcMap:

**1.Agrinio\_153.shp**

**2.Agrinio\_soils.shp**

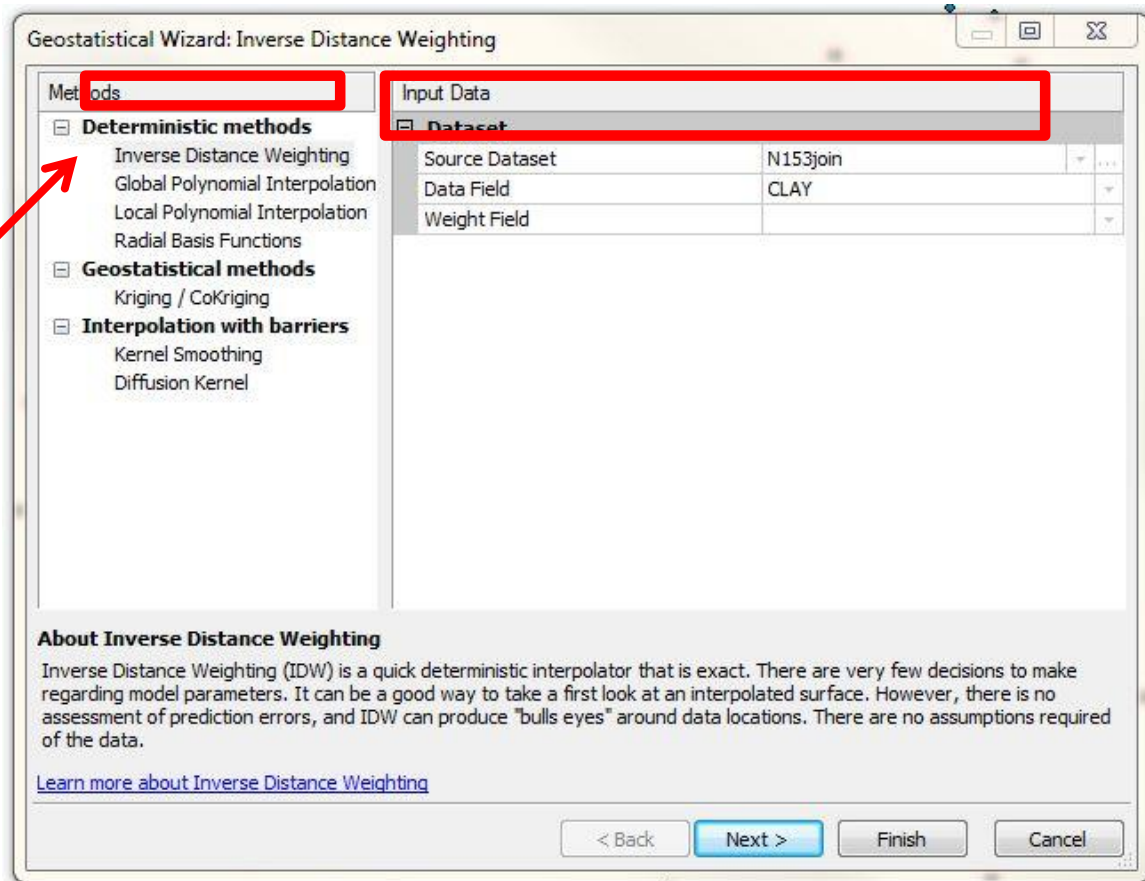
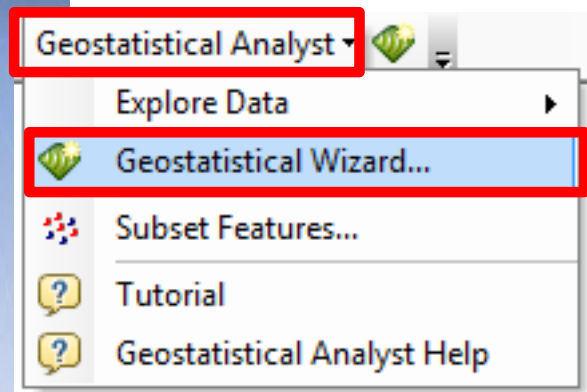
**3.Axeloos\_river.shp**



Filet e importuar ne ArcMap



Ne hapin tjetër, fillo me toolbarin e Analizes gjerostatike “**Geostatistical Analyst**” dhe me pas zgjidh “**Geostatistical Wizard**”. Nga opsionet e algoritmave te interpolimit qe jane zgjidh “**Inverse Distance Weighting**” siç tregohet me poshte:



Ne hapin tjetër ju duhet të parametrizoni algoritmin e interpolimit si më poshtë:

Untitled - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

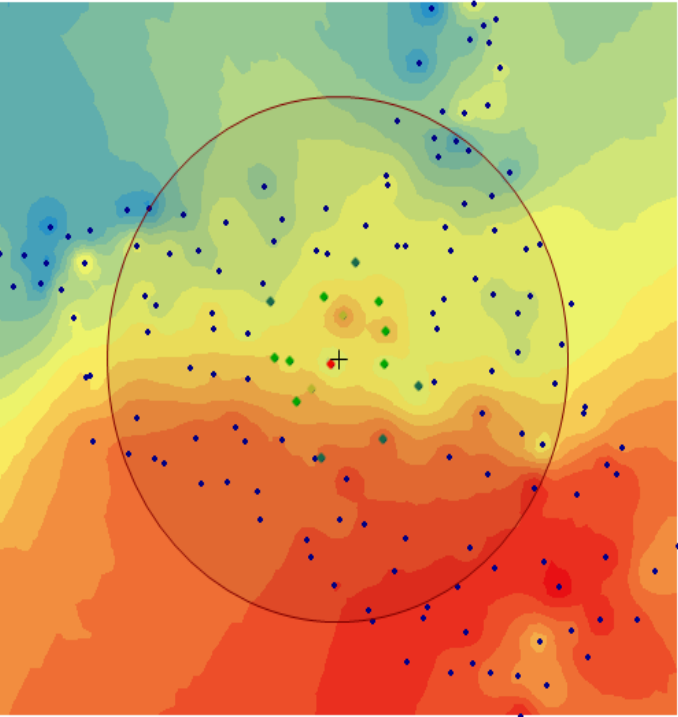
Geostatistical Analyst

Table Of Contents

Layers

- ☒ Agrinio\_153
- ☒ Agrinio\_soils
- ☒ Axeloos\_river

Geostatistical wizard - Inverse Distance Weighting step 2 of 3 - Method Properties



**General Properties**

Power	2
-------	---

**Search Neighborhood**

Neighborhood type	Standard
Maximum neighbors	15
Minimum neighbors	10
Sector type	1 Sector
Angle	0
Major semiaxis	2994.394
Minor semiaxis	2994.394
Anisotropy factor	1

**Predicted Value**

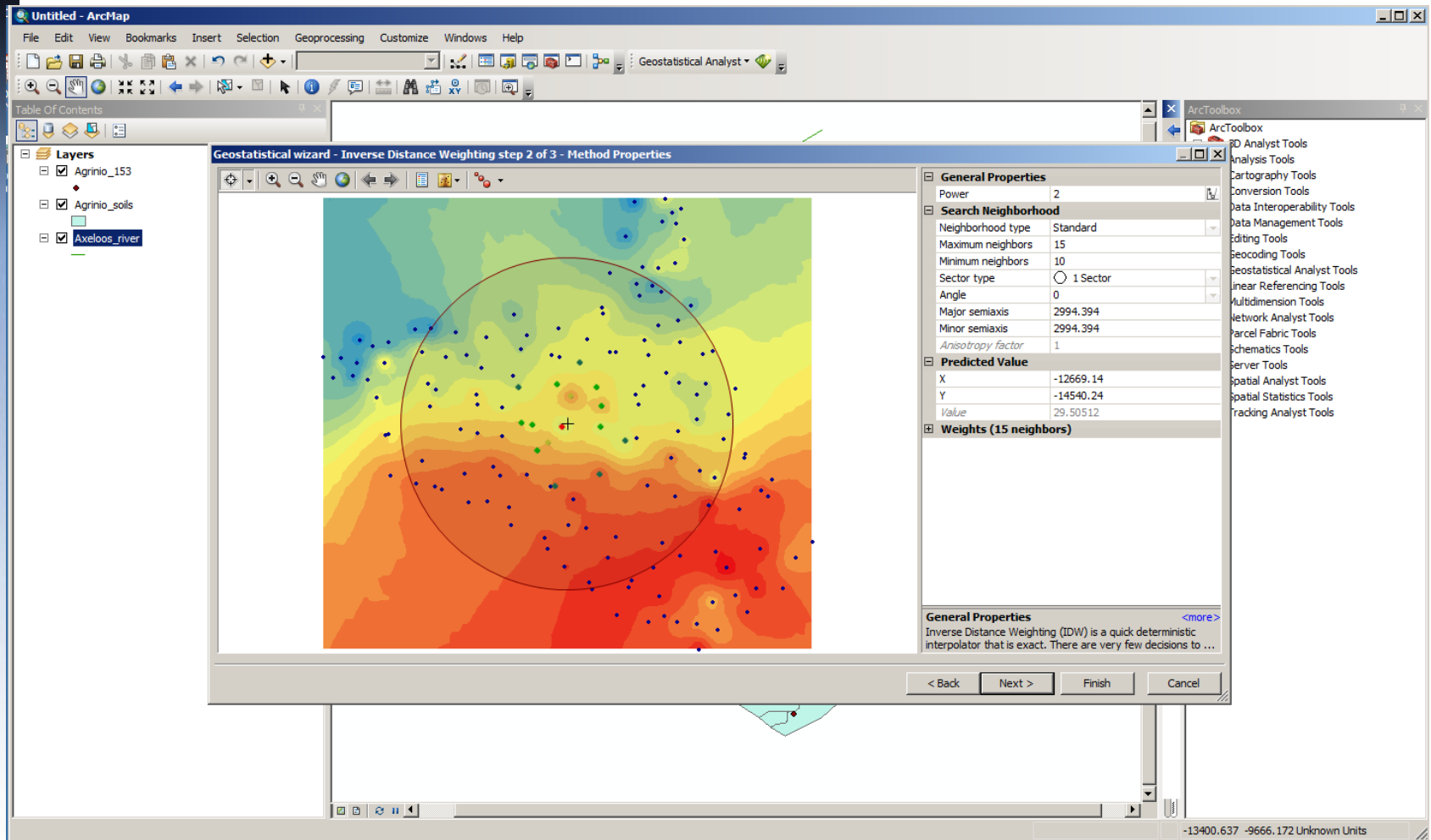
X	-12669.14
Y	-14540.24
Value	29.50512

**Weights (15 neighbors)**

**General Properties** [<more>](#)  
Inverse Distance Weighting (IDW) is a quick deterministic interpolator that is exact. There are very few decisions to ...

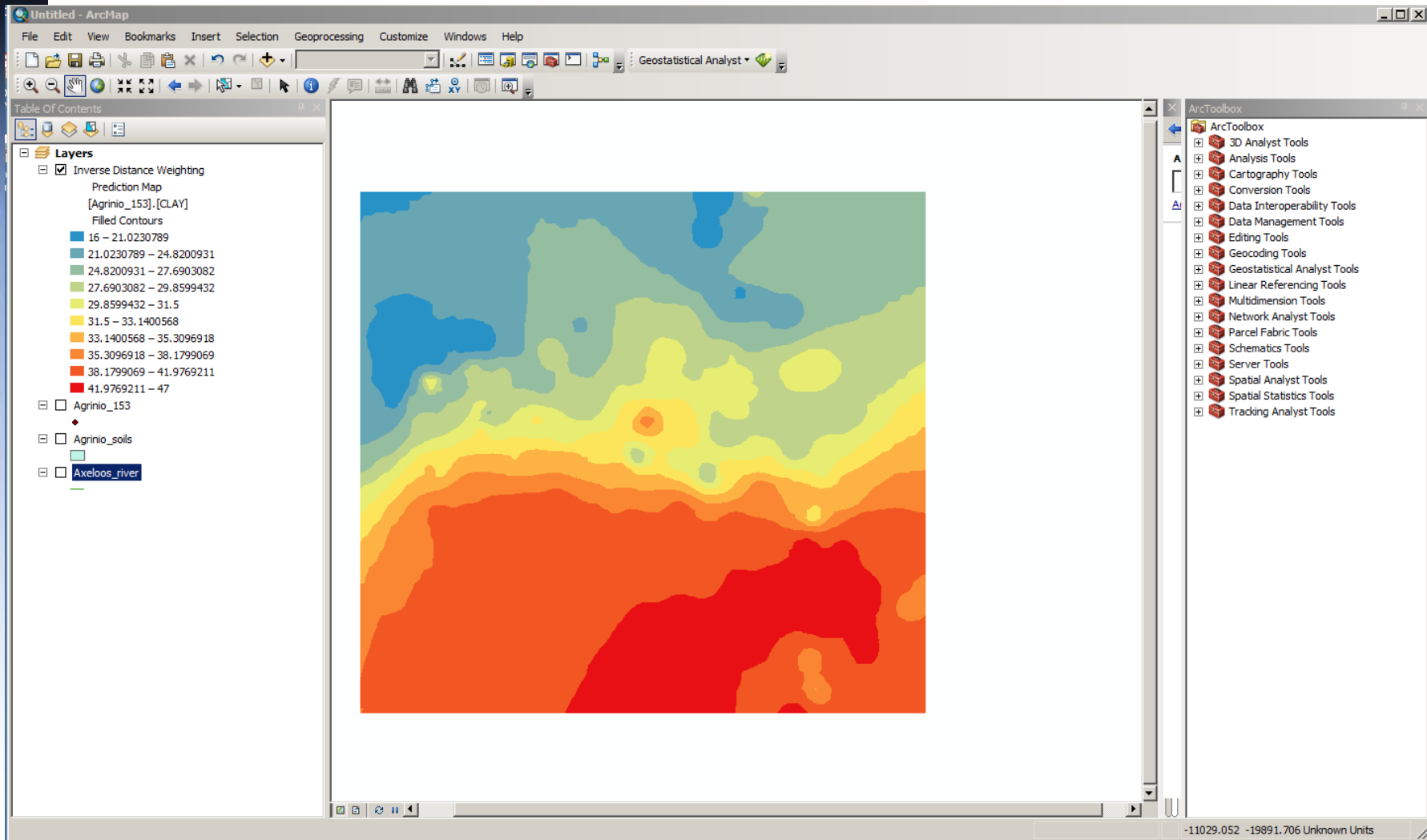
< Back Next > Finish Cancel

Fillimisht zbatoni metoden einterpolimit duke perdorur opsionet e parametrave dhe me pas zgjidhni “Finish”.

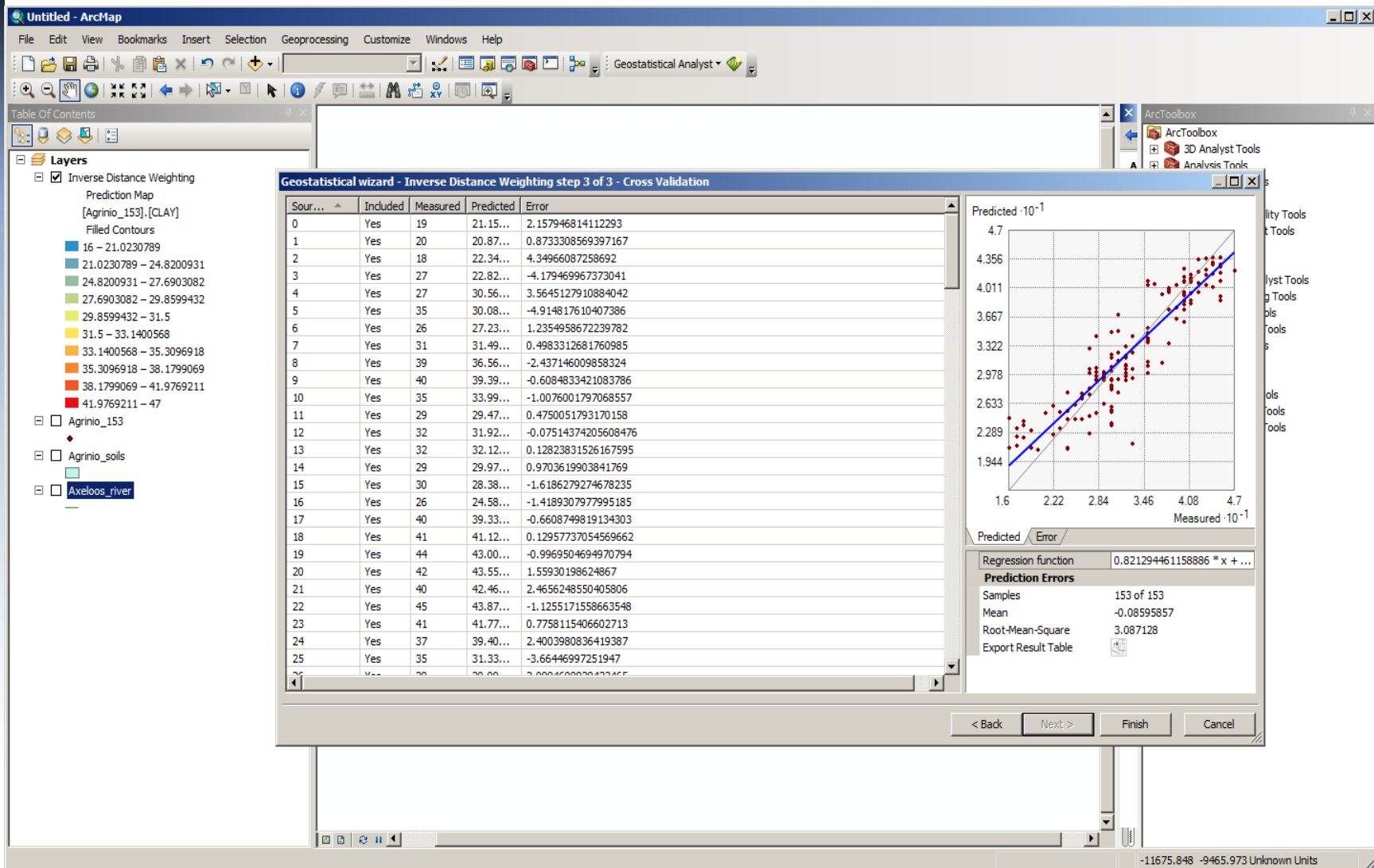


Kjo do t'ju lejojë të shihni hartën tuaj të parë të interpolimit për zonën.

**... Mire deri ketu!!!**



Ne gjithashtu mund të shohim rezultatet e vlerësimit të kryqëzuar në lidhje me hartën që sapo prodhuam, siç tregohet më poshtë dhe gjithashtu mund të ruajmë rezultatet tona nëse dëshirojmë.







Tani një ushtrim për ju: Kthehuni tek **Geostatistical Wizard** dhe:

- Duke ndryshuar vlerat **e fuqisë** (1,2 dhe 5 dhe Optimizoni fuqinë) dhe për **pikat fqinje** të përdorura (5 dhe 10 pika) plotësoni tabelën e mëposhtme (të ndryshme për secilën variabël) me vlerat e rrënjës katrore te gabim mesatar për kombinimet e ndryshme të vlerave të dhëna për fuqinë - numri i pikave fqinje..

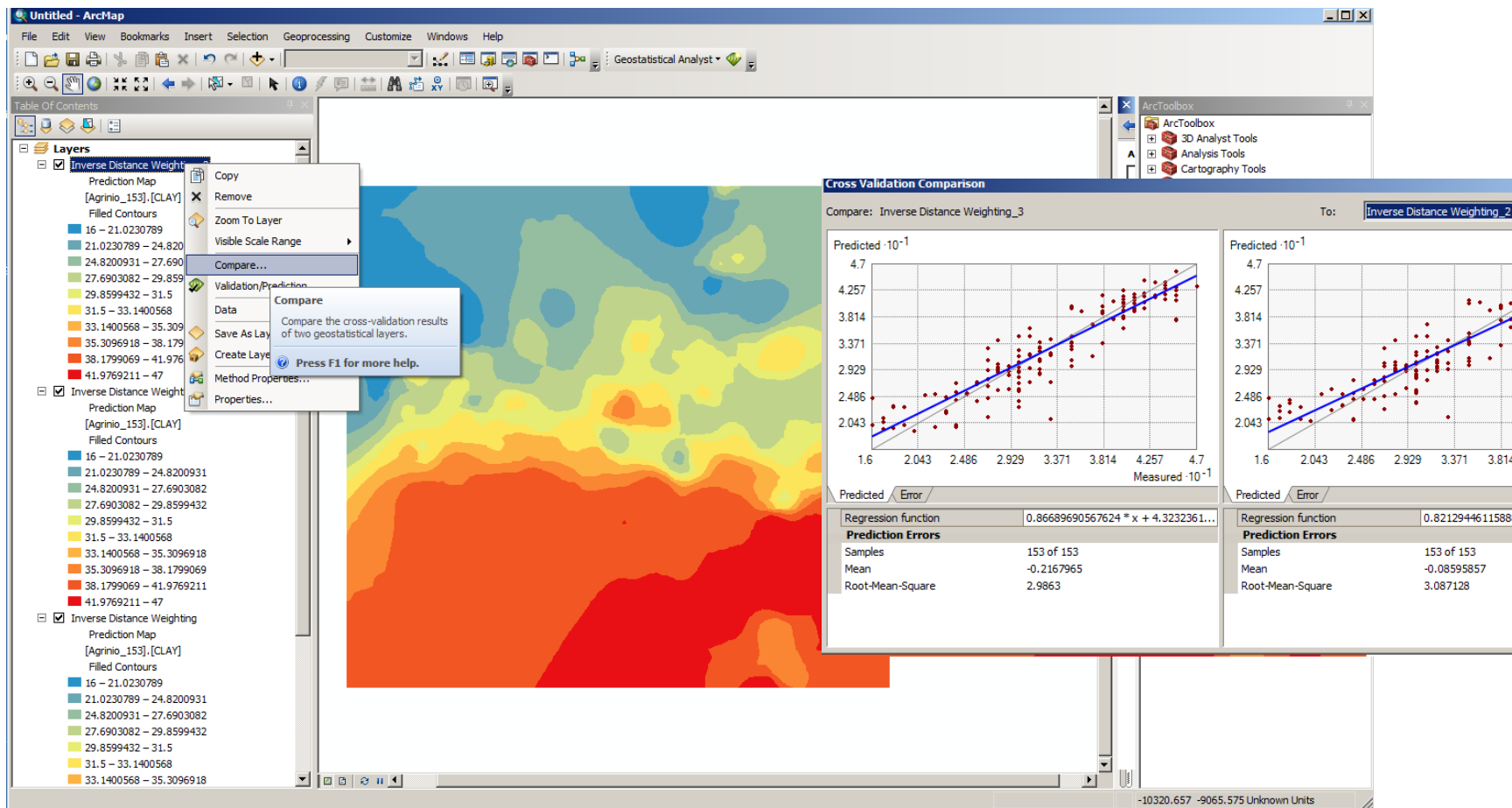
Për secilën pikë të vlerësuar, përdorni gjithmonë vlera nga pikat fqinje të vendosura në çdo pozicion rreth saj dhe jo vetëm në një drejtim - pjesë e zonës fqinje.

Kjo do t'ju lejojë të identifikoni se cila skemë e parametrave të interpolimit po prodhon rezultate më të afërta me veçorite e mostrës suaj.

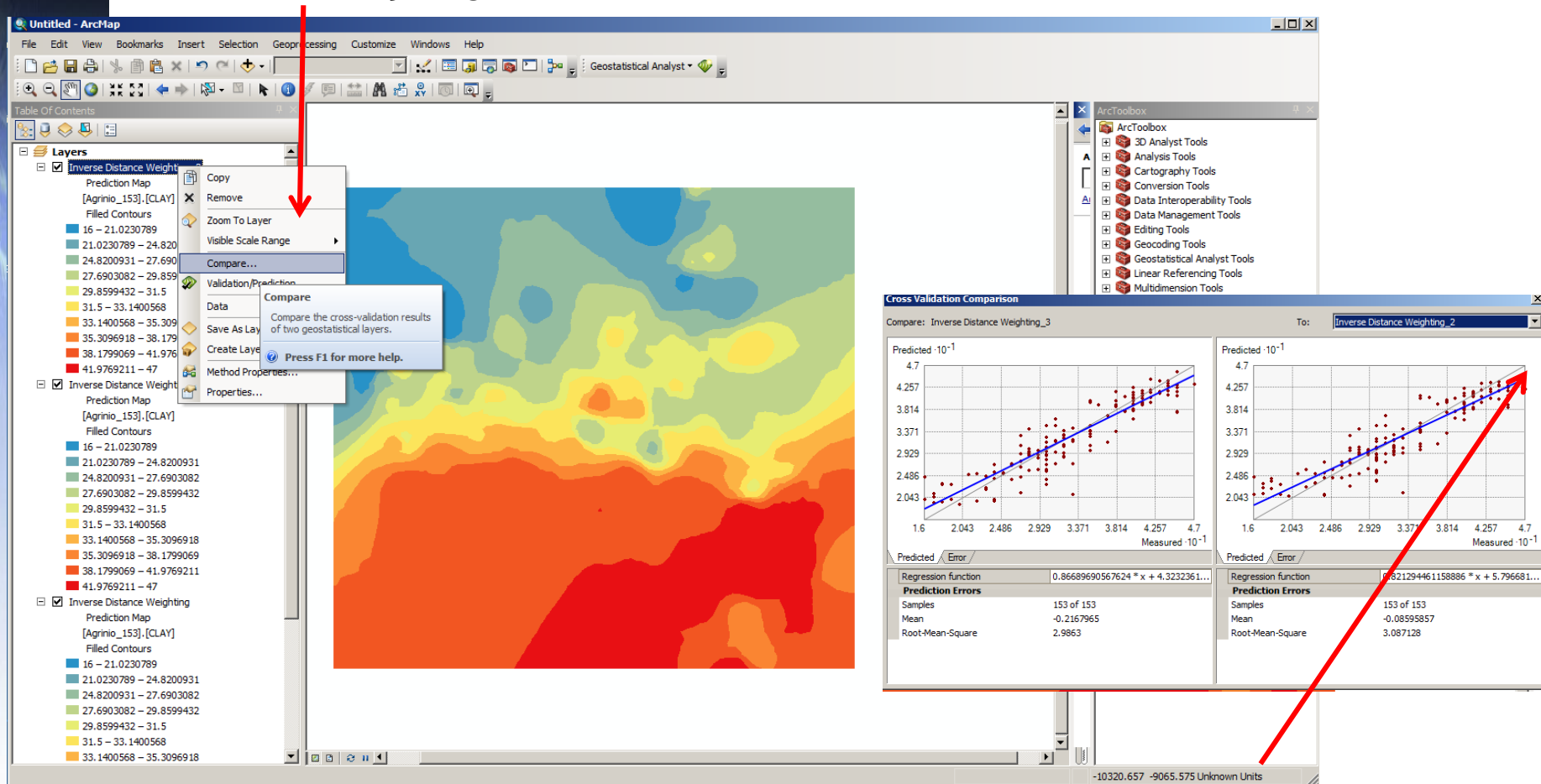
Fuqia	Fqinjet	RMS Gabimi
1	5	
1	10	
2	5	
2	10	
5	5	
5	10	
Fuqia Optimizuese	5	
Fuqia Optimizuese	10	

Tani do të shihni se si mund të krahasojmë rezultatet e dy hartave të interpolimit në një mënyrë të ndryshme

Shkoni në një nga hartat tuaja të interpolimit të prodhuar dhe bëni një klikim me të djathtën dhe zgjidhni “Compare” siç tregohet më poshtë:



Tani do të shihni se si mund të krahasojmë rezultatet e dy hartave të interpolimit në një mënyrë të ndryshme. Shkoni në një nga hartat tuaja të interpolimit të prodhuar dhe bëni një klikim me të djathtën dhe zgjidhni "Compare" siç tregohet më poshtë :



Tani nga e djathta e dritares që del, zgjidhni një hartë tjetër interpolimi që keni prodhuar dhe do të jeni në gjendje të shihni statistikën e përmbledhura në lidhje me dy grupet e të dhënave.



Tani edhe një ushtrim më shumë për ju...:

Importoni kampionin tjetër që ju është siguruar, i cili përmban 350 pikë dhe përsëritni procesin që keni zbatuar deri më tani, por duke përdorur këtë herë këto (350 pika prove) si te dhenat hyrese kryesore për të krijuar hartat tuaja të interpolimit.

- Kjo do t'ju lejojë të shihni efektin e madhësisë së mostrës në rezultatet e interpolimit.
- Ç'fare shikoni ne lidhje me kete ?
  - Cili kombinim i kushteve të parametrave dhe madhësisë së mostrës duket se po jep rezultate më realiste?

# Ju faleminderit

**Ndonje Pyetje?**

