GIS Exercise
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# INTRODUCTION TO SCANNING AND DIGITAL IMAGERY

**Requirements**

This exercise requires PC with Windows 95/98 or Windows NT, a scanner and scanner software as well as well as the GIS software ArcView 3.1 or later.

The exercise is adapted for AGFA SNAPSCAN series and the program Agfa Fotolook 3.00.09. However, any scanner with the ability to save images in TIF format can be used.

**Objectives**

The aim of this exercise is to familiarise the student with the data capturing technique scanning. Knowledge on how to import scanned (satellite) images and adapt them to a GIS by rectifying the image will also be gained. The exercise will also introduce the ArcView extension module Image Analysis.

**Task**

The exercise should result in a scanned SPOT satellite image that has been rectified and adjusted in ArcView to be used by the students in a future exercise.

## Scanning

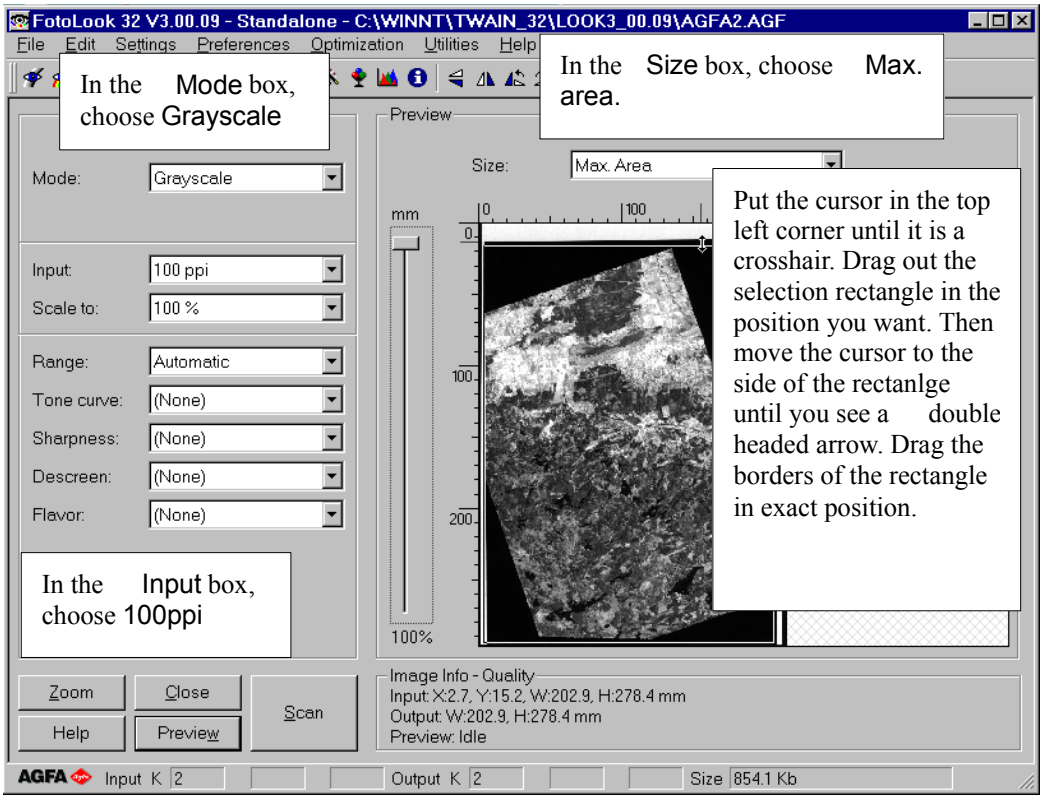
Start the scanner by pressing the button on the front. Start Agfa Fotolook by pressing the Windows Start button at the bottom of the computer screen and choose Programs and Agfa Fotolook. Put the copy of the satellite image facedown on the scanner. Before you can scan the image, you must do some adjustments. First, since the satellite image is in black and white, you should choose Greyscale in the Mode box.

Below the Mode box you find the Input box. Here, you can set the resolution at which the image will be scanned. The resolution is determined by the number of pixels (short for picture elements) that will make up the scanned image. A pixel is a square dot that is the smallest unit of a digital raster (or bitmapped) image. Digital images are composed of touching pixels, each having a specific colour or tone. A scanner (as well as most other digital image capture instruments) creates a bitmap by sampling the original and storing each sample in a pixel. The higher the resolution of a scan, the more pixels created per area of the original. The letters ppi after the number in the Input box is an abbreviation of Points Per Inch and is a

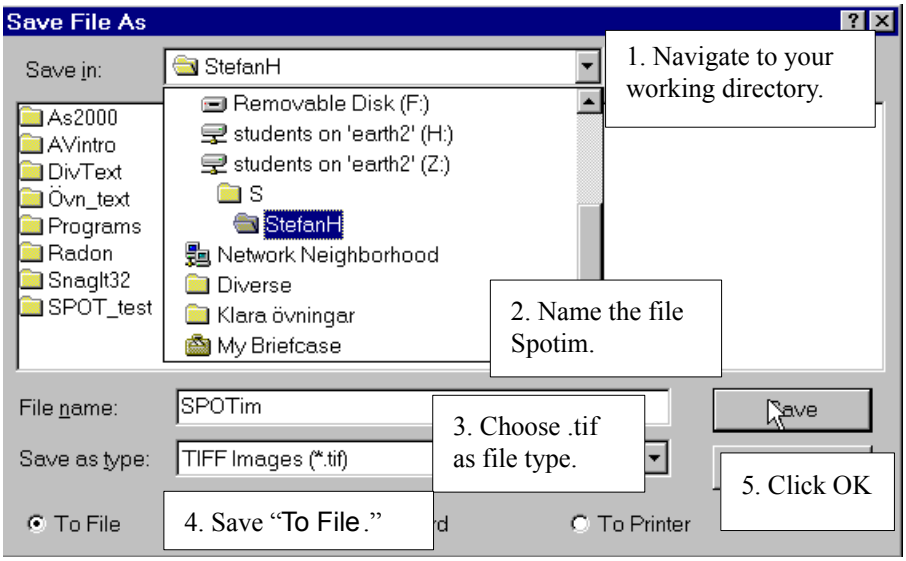
measure of resolution i.e. the higher the ppi number the more pixels per inch are recorded by the scanner.

It would then seem best to have as high resolution as possible but there are several factors to take into consideration first. A higher resolution means that there will be more data, and thus the size of the file will be larger and can be difficult for programs and computers to handle. Also many programs (or printers if you are going to print your image) does not support resolutions higher than around 300 ppi, making it pointless to scan with higher resolution. The main reason in this exercise for not choosing a very high resolution however is that the original, i.e. the SPOT image does not have higher resolution in itself. When the data is recorded on the satellite, it is also recorded in pixels and these pixels represent 10 by 10 metres on the ground. If you look closely at the copy of the image, you can actually see the individual pixels. The resolution of the original is approximately 100ppi and you should therefore choose this resolution in the Input box.

In the Preview window you find the Size box. Here, you can select a pre-set size for the preview window. Set the size to Max. Area and press the Preview button. After the Preview is complete, put the cursor in the top left corner until you see the cursor change to a crosshair. When you move the crosshair, the selection rectangle changes and you can thus decide the area yourself. When you have an approximate area, move the cursor to a side of the selection rectangle until you see a double-headed arrow. Then hold down the left mouse button and drag until you have the selection rectangle in the exact position you want i.e. all of the actual image but not the background.



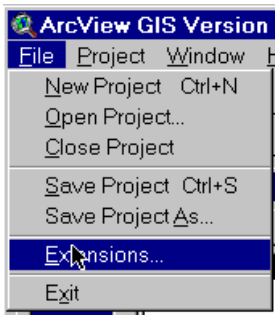
Now the adjustments are made and you can scan the image by pressing Scan. In the dialogue box that appears, navigate to your working directory and save the file in "tif" format. Hint: Write down the path to your directory the first time so you don't have to spend time browsing when you need the file the next time.



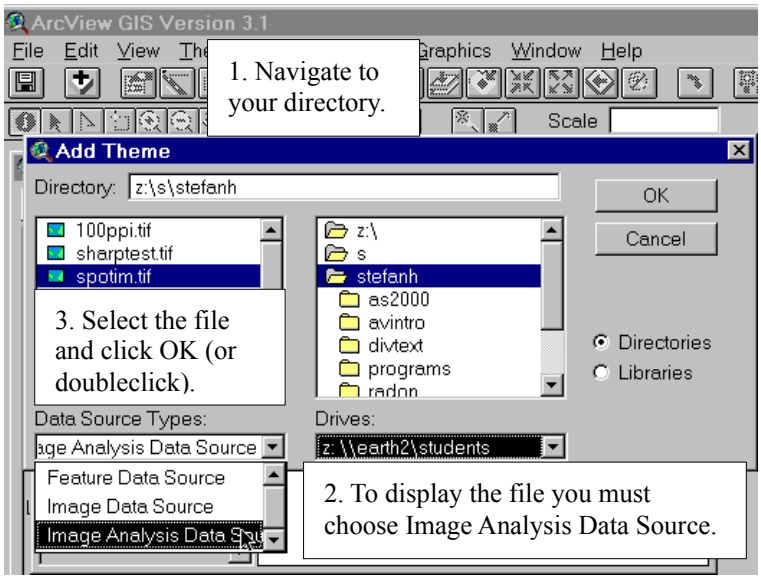

Now you are finished with the scanning part so you can close Fotolook.

**Working With The Scanned Image**

Start ArcView by using Windows Start button and navigating to Programs, ESRI and choose ArcView 3.1. When ArcView appears, open a new project with a new view (simply click OK in the Welcome box). Say "no" to add data to the view and click on the Project window (named Untitled). When the Untitled project window is active, go to the File menu and



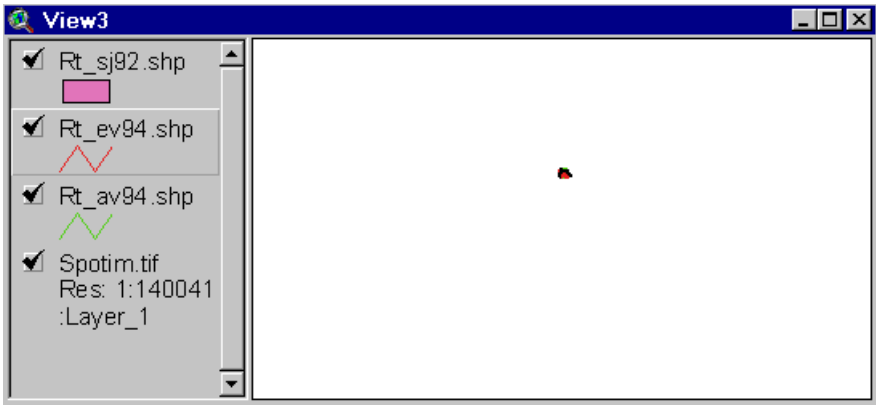

choose Extensions. In the Extension box that will appear, select Image Analysis and TIFF 6.0 Image Support. These extensions are needed to work with "raw" image features such as satellite images. Press OK to activate the extensions. Go back to the View window (called View1) either by clicking directly on it or by clicking Open in the project window. Now you should add the image you have just scanned. To add the file to the view either click the Add Theme button  or selecting Add theme under the View menu. When the Add theme box appears, navigate to your directory where you saved the image. For the file to appear, you have to choose Image Analysis Data Source as Data Source Type.




If you can not see the file in the left box you must choose Image Analysis data Source as data source type. If this option is not available (only Feature Data and Image Data appear) you have not activated the extensions. Return to the project window and do the steps as outlined above to activate extensions.

When the Theme containing the image appears, click in the check box to turn it on. If you are not satisfied with how the image looks you can double click in the legend field to activate the legend editor and use the brightness and contrast controls to change the looks of the theme.

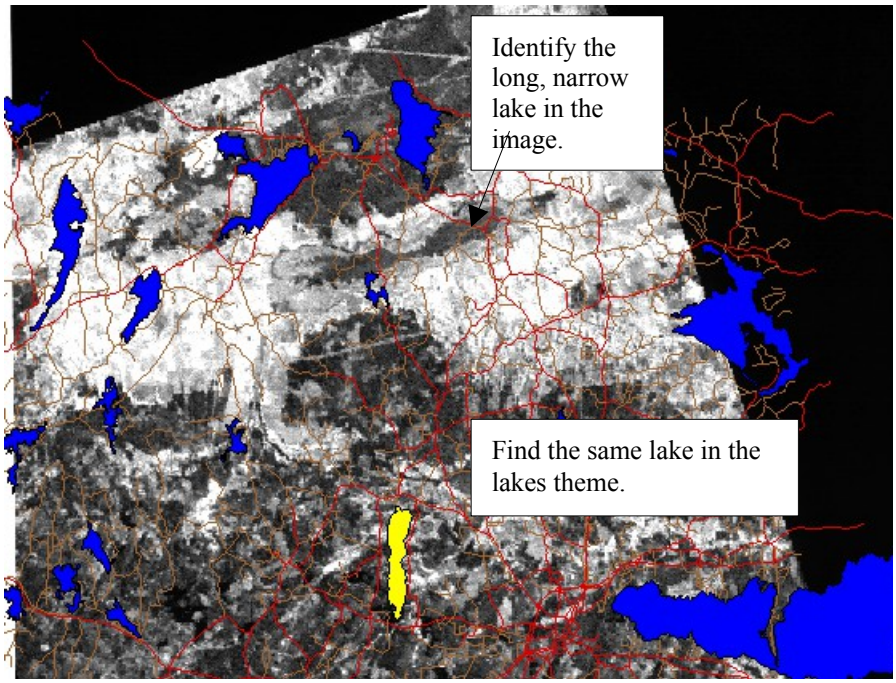
The theme with the scanned image is not a usual GIS shapefile in the sense that the program does not the co-ordinates of any points in the theme. To make the image useful for any analysis, you must therefore give the program some co-ordinates that it can recognise. In the directory earth2/_Sharedfiles/Geoinformatik/data/Arbetsstuga2000/arcview/metria/rodakartan are themes covering the same area as the SPOT image. These themes are ArcView shapefiles with geographic locations on all points stored in the data structure. You must thus add a couple of these that you will use to align the image with the known co-ordinates of the themes from röda kartan. You should choose themes with features that are possible to recognise from the image. The themes with lakes (Rt_sj92), main roads (Rt_av), minor roads (Rt_ev) and power lines (Rt_kl88) are good for this purpose. N.B. If you can't find the themes from Rodakartan in the Add theme dialogue box, you probably need to change the Data Source Type back to Feature Data Source. Use the Add theme button and navigate to the directory given above and add the themes. (You can add all themes at once by holding down the shift button as you select more than one theme.) When the themes from röda kartan are turned on in the view, click on the Zoom to Full button  . The view has only a small dot which is the themes from röda kartan and the image is not displayed anywhere.




After pressing the Zoom to Full button the View will look something like this. Don't worry, it is normal and is explained below.

The reason it only appears a small dot on the View is that the program does not know the co-ordinates of the SPOT image and thus does not know where to place it in the view. To correct this, the first thing you should do is to set the scale of the View, by going to the View menu and choose Properties. In the box that appears, set Map and Distance units to meters. This will not make the view look better but is the first step.

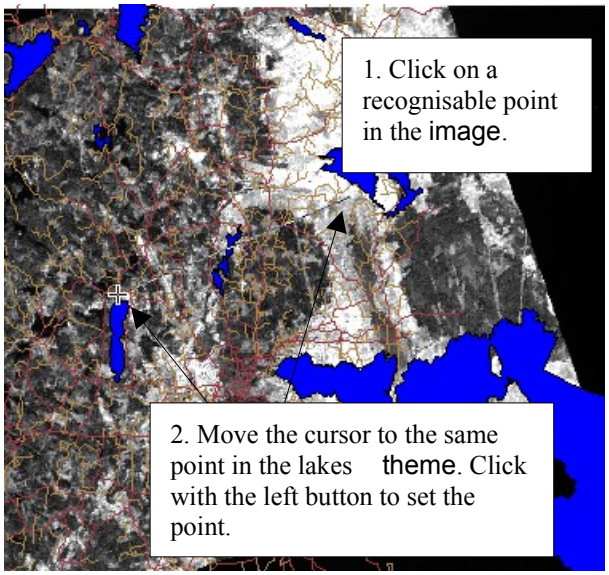
When you are now going to start the alignment process, there are a few new functions in the Image analysis extension module that you are going to use. One of them is the Align tool. Make the image theme active and click on the Align tool button  . ArcView now tries to align the separate themes and the result is that the image and the other themes are displayed in the view. However, the program still does not have any co-ordinates for the image. You are now going to use recognisable points in both themes to correlate points in the different themes. Look at the image and try to find the long, narrow lake at the top of the image and then look in the lakes theme to find the same lake.




As you can see when you have identified the lake in both themes, the two themes are approximately at a 90-degree angle to each other. Use the Rotate Image button  to adjust the position of the image (the image has to be the active theme).

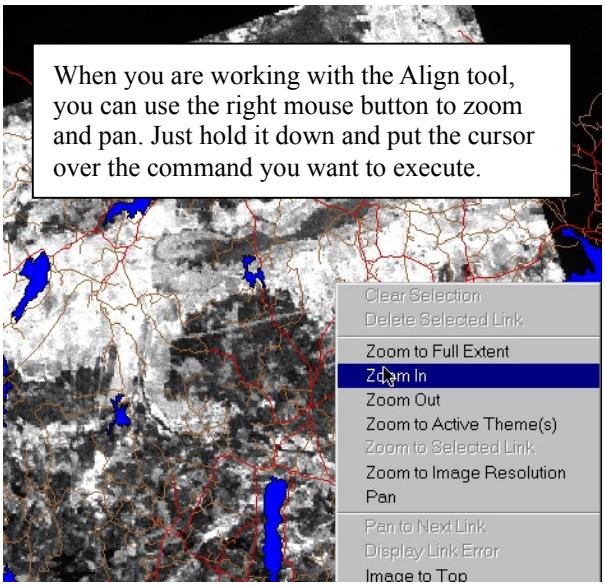
Pressing the Rotate Image button will rotate the image 90 degrees clockwise. When you have done that the image and them themes from röda kartan are roughly positioned in the same direction.

Now that the themes have approximately the same orientation, you should use the Align button to select points on the image that you will correlate to the same point on the lake theme. Hint: use easily recognisable points such as bays of the lakes. To select the points, make the image the active theme and click on the Align button. When you designate the correlation points you must first choose a point on the image and then select the corresponding point in the lake theme. Use the zoom functions to zoom in and out to help you set the control points with higher accuracy.




When you have selected the Align tool, use the left mouse button to click a point in the image theme. Then move the cursor to the same point in the lakes theme and click again in the view. Now you have told ArcView that the two selected points have the same geographical position i.e. the co-ordinates of the point in the lake shapefile is transferred to the point in the image theme.

Setting the first point will only give ArcView the location of one point on the SPOT image. The second point will give a scale between those two points and the correlation between the image and the themes from Rodakartan will be quite good near those two points. In other parts of the view, the correlation will still not be good. You must therefore set points in different parts of the map. Ideally, the control points should be spread out over the image, otherwise the area without control points will not be rectified with high accuracy. This SPOT image however, has very few recognisable points in the upper right corner. (You can try and set control points there but it is not easy!)

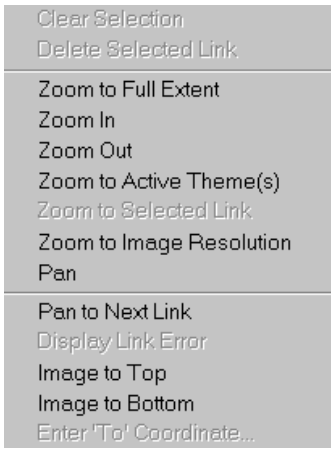



Hint: It will be easier to see some of the points in the lakes if you make the only the outline of the lakes visible. To do this, make the lakes theme active and double click on the legend symbol. In the palette toolbox that appears first click on the Bucket palette and set the colour to transparent. Then click on the colour palette (with the paintbrush symbol) and in

the Color drop down menu, choose outline. Try also to look at e.g. the intersection points of roads and see if you can use those as control points.

Select at least four control points with the method described above. After the fourth control point is set you can see how accurate your rectification has been. At the bottom of the ArcView window the RMS value (Toot Mean Square) is displayed.


This value represents the error in distance, measured in pixels, between the input location and the rectified location. A low value means a better rectification. Try to get a Total RMS value of no more than 3 (less than 2 is good). If your RMS value is high, you can delete control points with a high error. Use the pointer tool  to select a point. Hold down the mouse button and drag the point to its new position. You can also delete control points by selecting a point and pressing delete..




With the Align tool active, there are several functions available by using the right mouse button. All zoom functions can be used, which allows you to zoom while setting control points. You can also pan in the image. The Pan to Next Link function not only puts the next (in the order you created the control points) link in focus but also selects the point and displays its RMS value. In the bar showing the RMS errors, there are two values. The first represents the currently selected link and the second value the total error. The total error can be affected quite much by a single bad link. Use the Pan to Next Link button to View the RMS for the control points. When you find one point with a higher error than the total you can delete that point. If it is a high error for that single point, it is likely that you will get a much better total value.

When you are satisfied with your alignment, you can have a look at another type of image. In the METRIA folder, there is an ortophoto stored as a shapefile. Navigate to earth2/_Sharedfiles/Geoinformatik/data/Arbetsstuga2000/arcview/metria/ortofot and add the theme. (You must change the data source type to Image data source to display it.)

The theme will be placed above the other themes but will not be turned on so you must click in the checkbox to turn it on. Place the ortophoto above the SPOT image but below the other themes (the line and polygon themes will not be visible otherwise). As you can see the ortophoto covers only a small area of the SPOT image. Make the ortophoto the active theme and click on the Zoom to Active theme button  . The resolution of the ortophoto is as you can see, much higher than the SPOT image. Individual trees are actually distinguishable whereas the original SPOT image has a resolution of 20 metres and can not display individual features of less than that. Move around in the ortophoto and notice the correlation of the road network between the road theme and the ortophoto. It is not always a perfect match. Then the question is which theme is the more accurate. If you look at how the lines representing roads are drawn in the shapefile from röda kartan, you can see that they do not follow the roads exactly, e.g. the curves are not smooth. The reason being that röda kartan is made from remote sensing sources such as aerial photos and ortophotos and scanned or digitised much in the same way as you are doing now (with higher accuracy of course).

Now you are finished with the first part of the rectification. You should now set the Image Analysis Properties so that the properties of the original satellite image are stored in the shapefile. Make sure that SPOT image is the active theme. Go to the Image Analysis menu and choose Properties. In the Analysis Extent drop down menu, choose Same as Spotim. The theme's co-ordinates will then be displayed in the Left, Top, Bottom and Right boxes. In the cell Size box, type 20 to resample the image to 20meters. (you can now see the number of Rows and Columns appear below the size box.) If the letter to the right of the Size box is not "m" you must go to the View Properties menu and set Map and Distance units to metres. Click OK to finish the rectification.

You are now finished and should save the SPOT image. Go to the theme menu and choose Save Image As. When asked if you want to save the control point links to the shapefile, click No and then navigate to your working directory and save the file as RectifiedSPOT. In the next box that appears, click Yes to add the rectified image to the view. When the new theme appears, place it between the original SPOT image and the ortophoto by dragging it down.

To compare the unrectified original (Spotim) with the RectifiedSPOT theme you should zoom in to a level where you can see individual pixels. Start with the original and notice the alignment of the pixels, as you will see they are not angled slightly. Also use the measure tool to measure a single pixel. Notice that a side of the pixel is a little more than 20 metres. Now do the same thing with the RectifiedSPOT. In this theme the pixels are aligned north-south and their size is exactly 20 by 20 metres.

Now this exercise is finished. Write down the filename RectifiedSPOT and the path to it, as you will use the theme in a future exercise.