**GEOM066**
**Remote Sensing and Image Analysis**
**Fall Semester**

- **Image Filtering**
  - **High Pass**
  - **Low Pass**
  - **Relation between high and low Pass Filtering**
  - **High Pass Differential Image (Sharpening)**

**Imagery Provided.**

The imagery provided here is a SPOT Panchromatic Image acquired June 4, 1985, an ERS1 radar image acquired May 8, 1992, and a Landsat derived Land Cover map, derived from Landsat TM imagery acquired April 29, 1985. The raw Landsat imagery was acquired at 28 metres resolution but resampled to 10 metre resolution to match the resolution of the SPOT image. The main town in this image area is Stouffville, in southern Ontario.

**Imagery/Data Provided**

File Name: OakRidges.pix

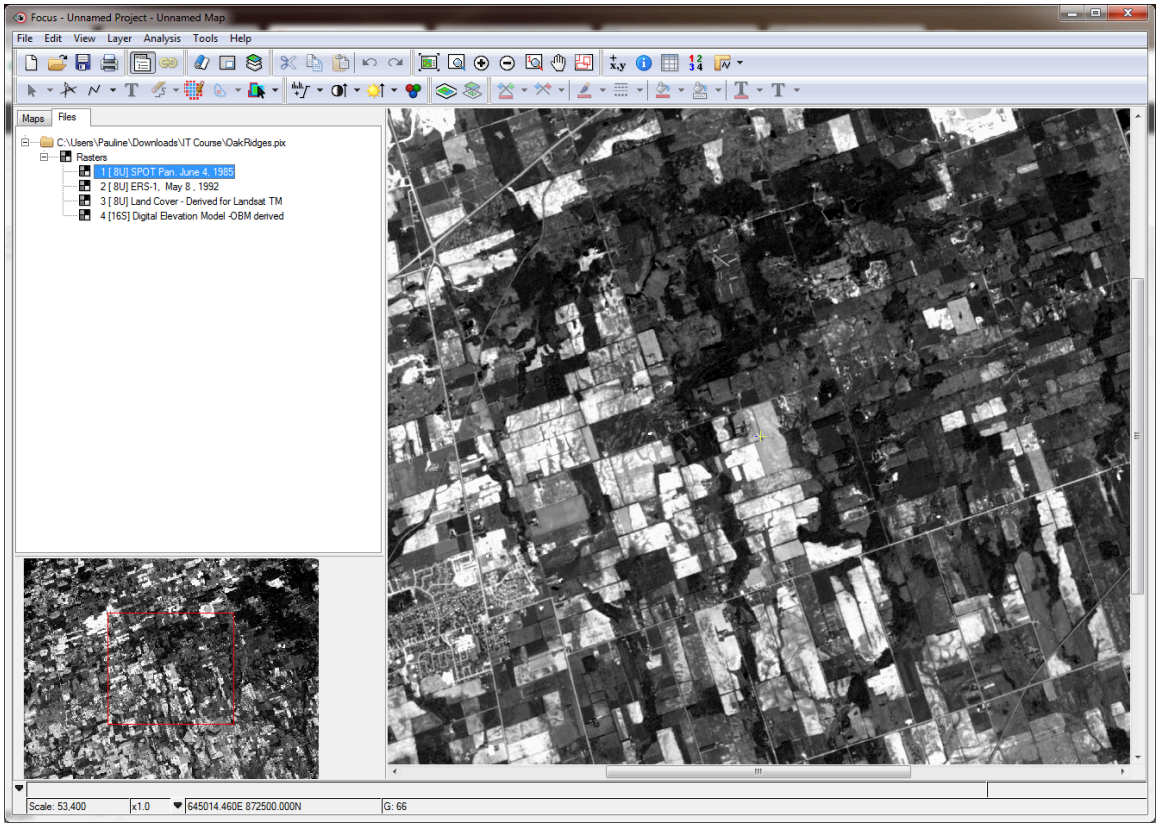
| **Channel** | **Description** |
|---|---|
| 1 | - SPOT Panchromatic - Acquired June 4, 1985 |
| 2 | - An ERS1 Radar image - Acquired May 8, 1992 |
| 3 | - Land Cover derived from Landsat TM imagery acquired April 29 1985 |

---

**1) Low Pass Filtering and Filter Size**

We will examine the effects of low pass filter size. We will use the SPOT Panchromatic Image (OakRidges.pix, Channel 1) for our analysis.

1.1 Initiate a Focus window. Load and view the SPOT Panchromatic band. Go to the Files tab and right-click channel 1 (then View and greyscale).




1.2 From under the **Layer** pull down menu, select **Filter**. This will initiate the **Filter** dialog box (see figure 1). Filters are divided into three main types, Low Pass, High Pass and Custom. In this exercise, we will use all three types. Note, you can also select the filter size. (because filters typically have a central operating pixel, the filter sizes are typically odd size (ie. 3 by 3, 5 by 5, 3 by 5, 21 by 21 etc). From the options presented under **Low Pass**, select **Average Filter.** Finally specify a **Filter Size** of 3 by 3.

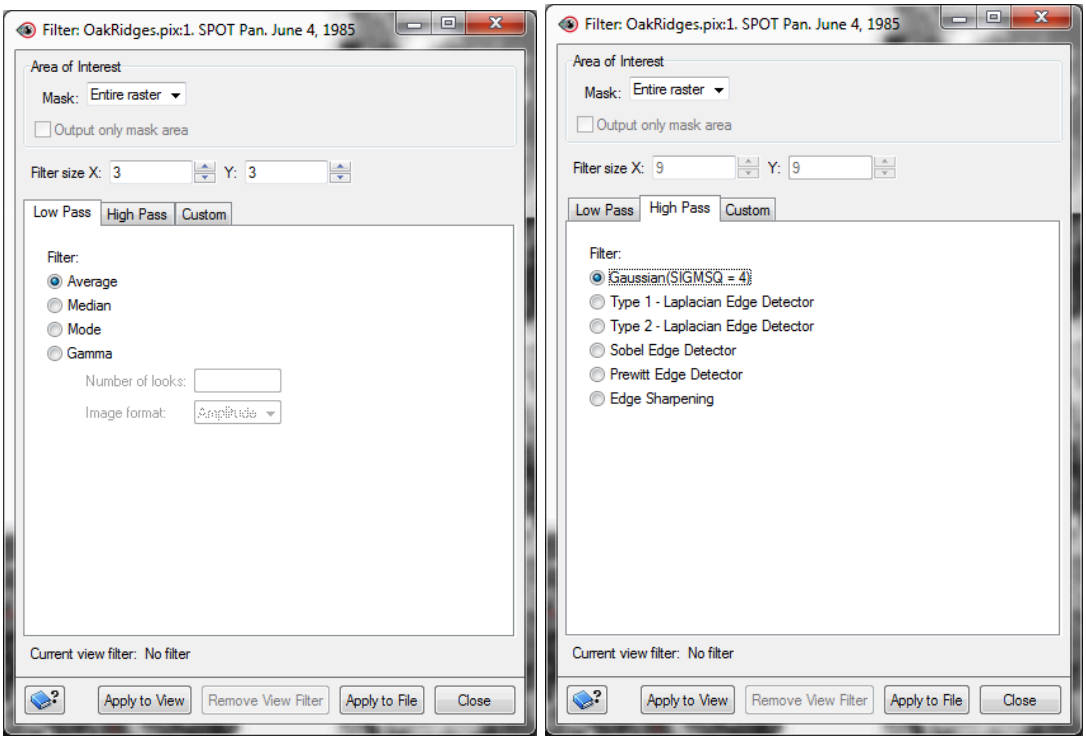



*Figure 1. Main Filtering options.*

1.3 To run this filter, select the **Apply to View** option. You will see the results nearly instantaneous in your Focus window. Note these changes have only occurred in in the map view (and not to the original file) To remove this filter from the active layer, select the **Remove View Filter** option.

1.4 To generate a filtered image on your hard drive, select the **Apply to File** option. This will bring up the **Save New Filtered Image Layer** dialog box (figure 2). You will note that for **File** the program defaults to your current working file. For the Layer, you have the option of specify an existing layer (careful not to overwrite an existing needed layer) or to create a new layer. Select the New Layer option.

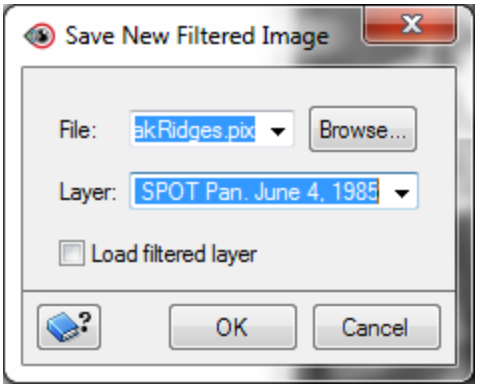
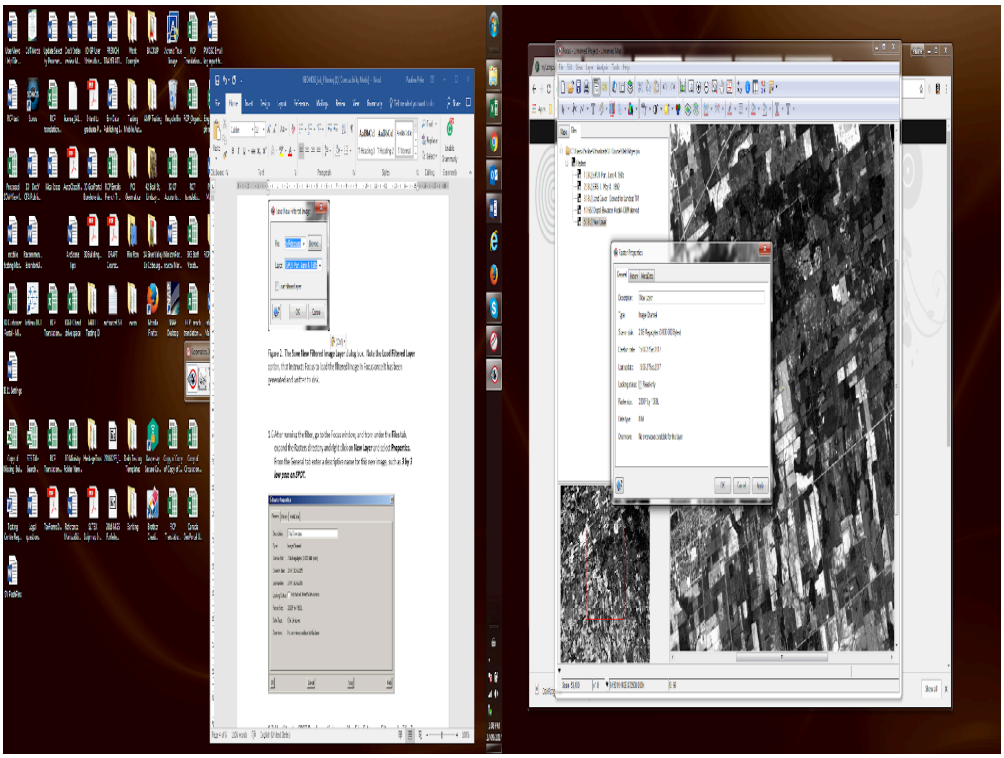



*Figure 2. Saving New image Layer.*

**Figure 2. The Save New Filtered Image Layer dialog box. Note the Load Filtered Layer option, that instructs Focus to load the filtered image in Focus once it has been generated and written to disk.**

1.5 After running the filter, go to the Focus window, and from under the **Files** tab, expand the Rasters directory and right click on **New Layer** and select **Properties**. From the General tab enter a descriptive name for this new image, such as ***3 by 3 low pass on SPOT.***



1.6 Next filter the SPOT Panchromatic Image with a 5 by 5 Average Filter, and a 7 by 7 average filter. Save the results obtained from each of these filters as new layers. Also update the description of these new layers.

1.7 View each of these filtered files in Focus as a greyscale.

Question 1) What has been the effect of increasing filter size? (provide screen captures)

The filtering size will affect the smoothing in image. i.e. BLUR. The smoothing effect of a low-pass filter becomes more evident with increased kernel size.

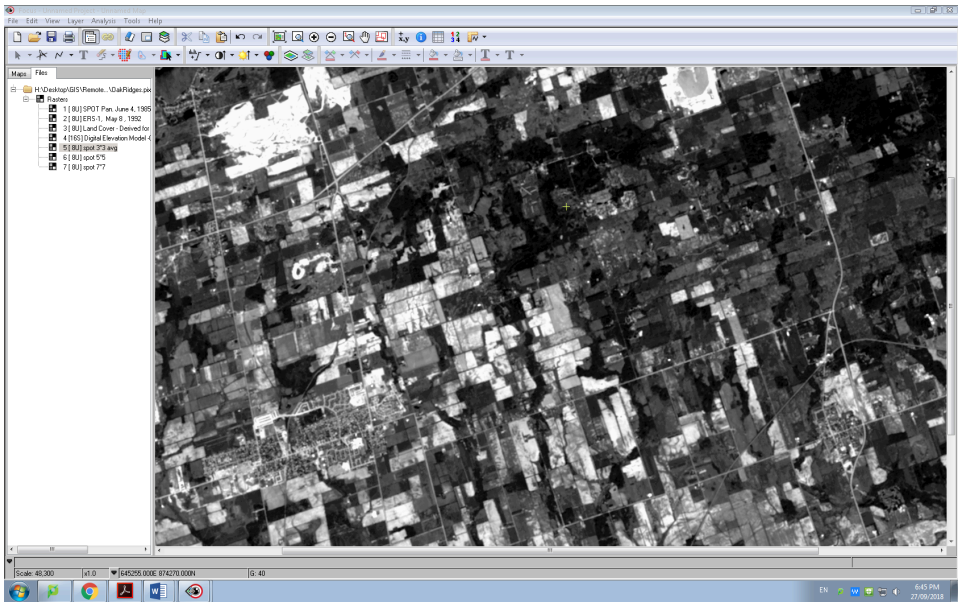


**Figure 1:3*3 low pass filter**

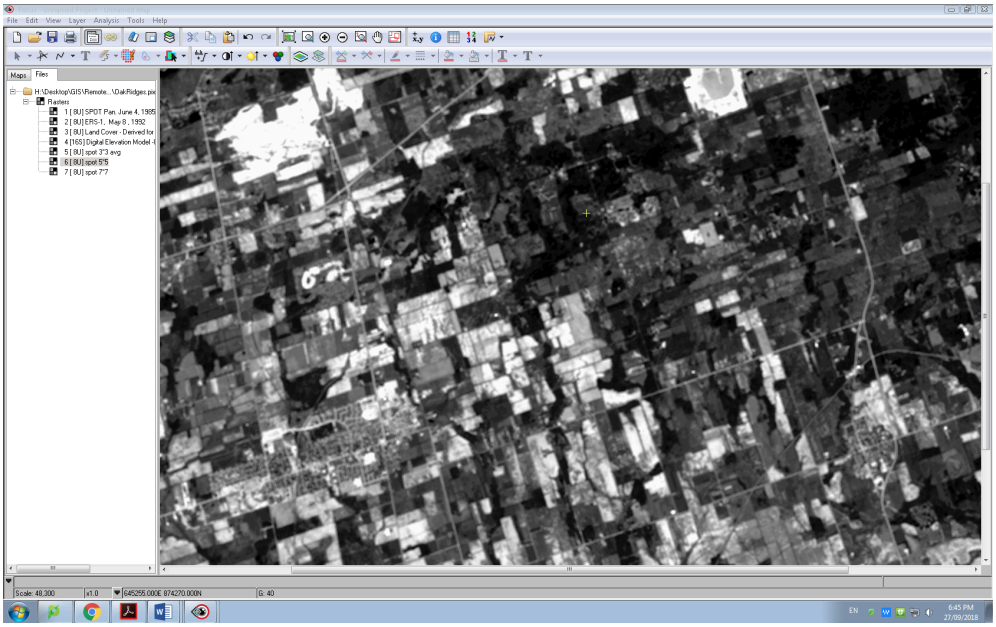


**Figure 2: 5*5 low pass filter**

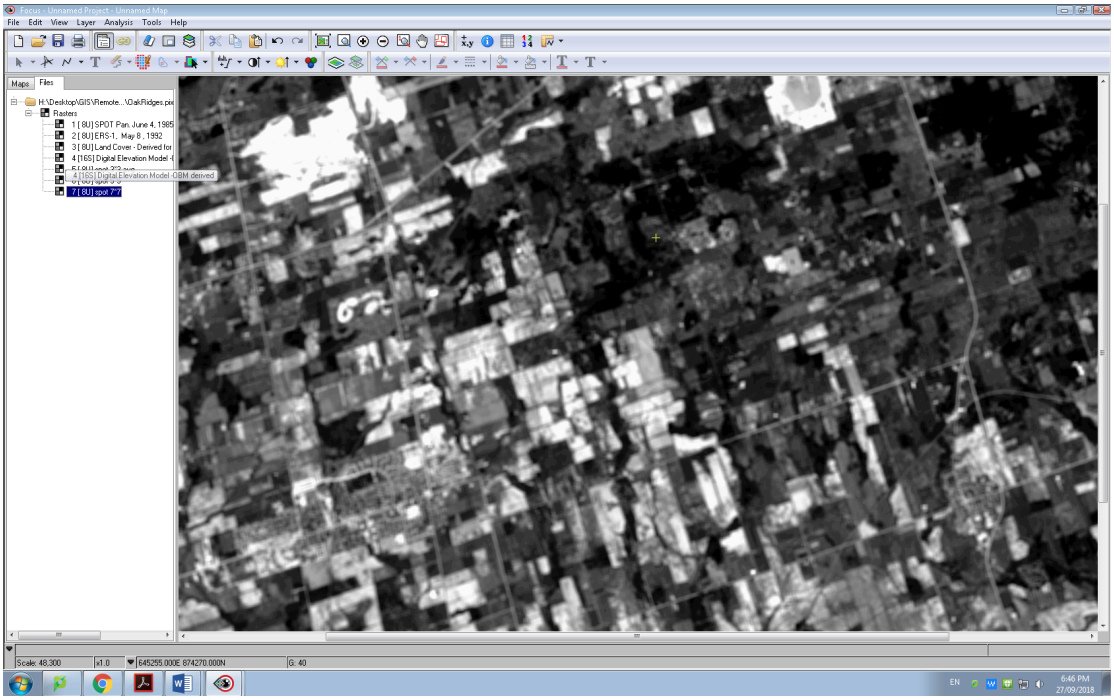


**Figure 3:7*7 low pass filter**

2) **High Pass Filtering and Filter Size**

In this exercise, we will examine the effect of filter size on High Pass Filtering. Using the same process as above…

2.1 Run a 3 by 3, **Type 2 - Laplace Edge Detector Filter** (under the **High Pass** tab) on your SPOT Panchromatic channel. Save your output to disk.

2.2 Run a 5 by 5, **Type 2 - Laplace Edge Detector Filter** (under the **High Pass** tab) on your SPOT Panchromatic channel. Save your output to disk.

2.3 Run a 7 by 7, **Type 2 - Laplace Edge Detector Filter** (under the **High Pass** tab) on your SPOT Panchromatic channel. Save your output to disk.

2.4 In Focus view the results obtained as greyscale.

Question 2) What is the effect of increasing High Pass filter size? (provide screen captures)

The sharpening effect of a high-pass filter becomes more evident with increased kernel size.

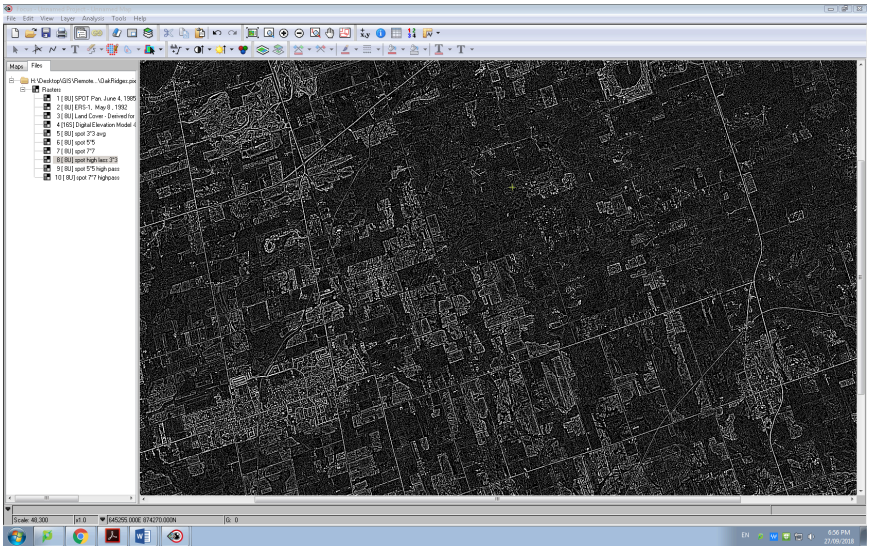


**Figure 4:3*3 High Pass Filter**

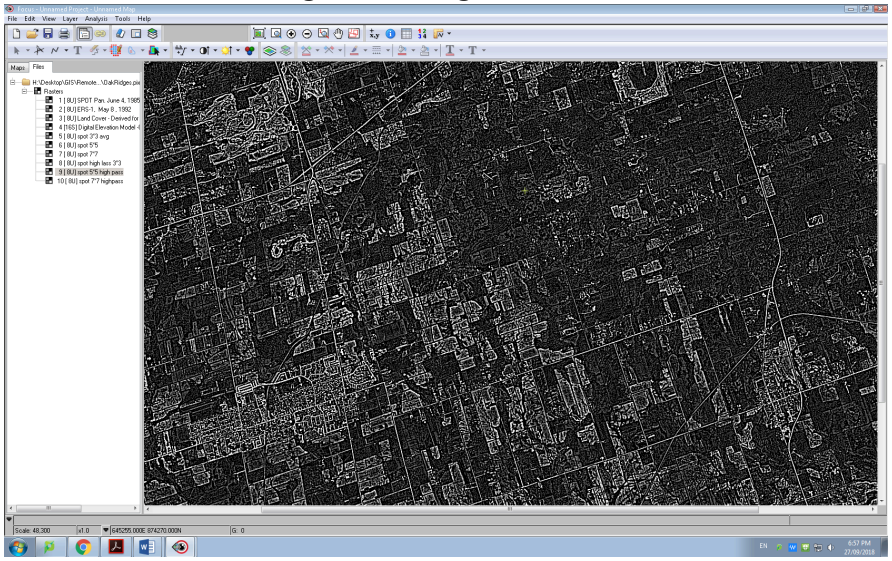


**Figure 5:5*5 High Pass Filter**

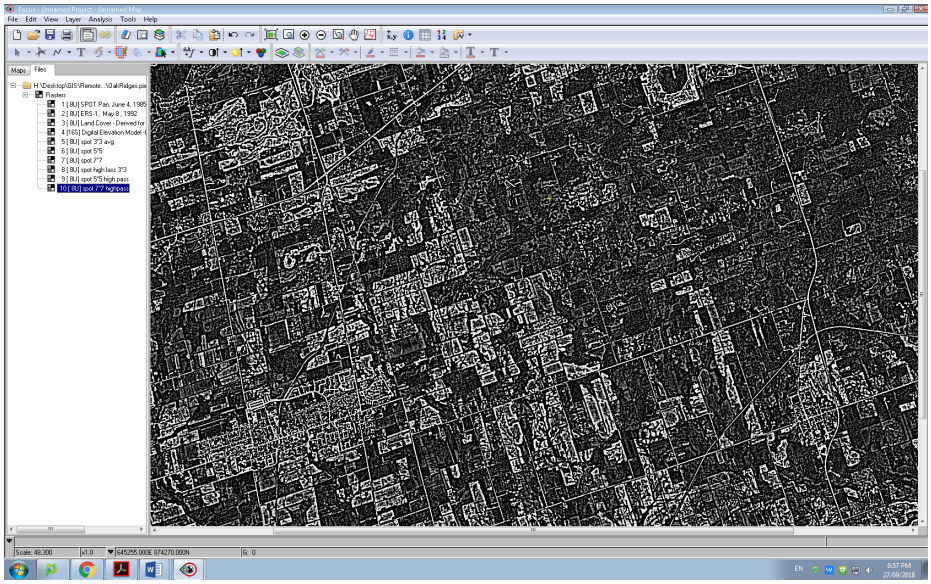
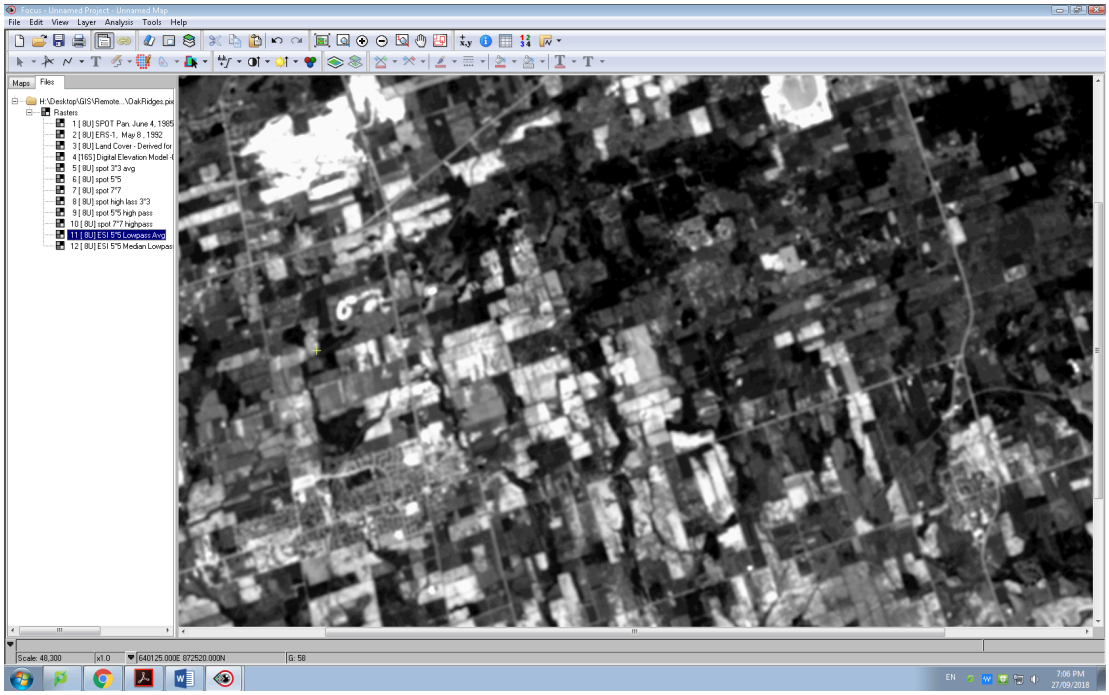


**Figure 6:7*7 High Pass Filter**

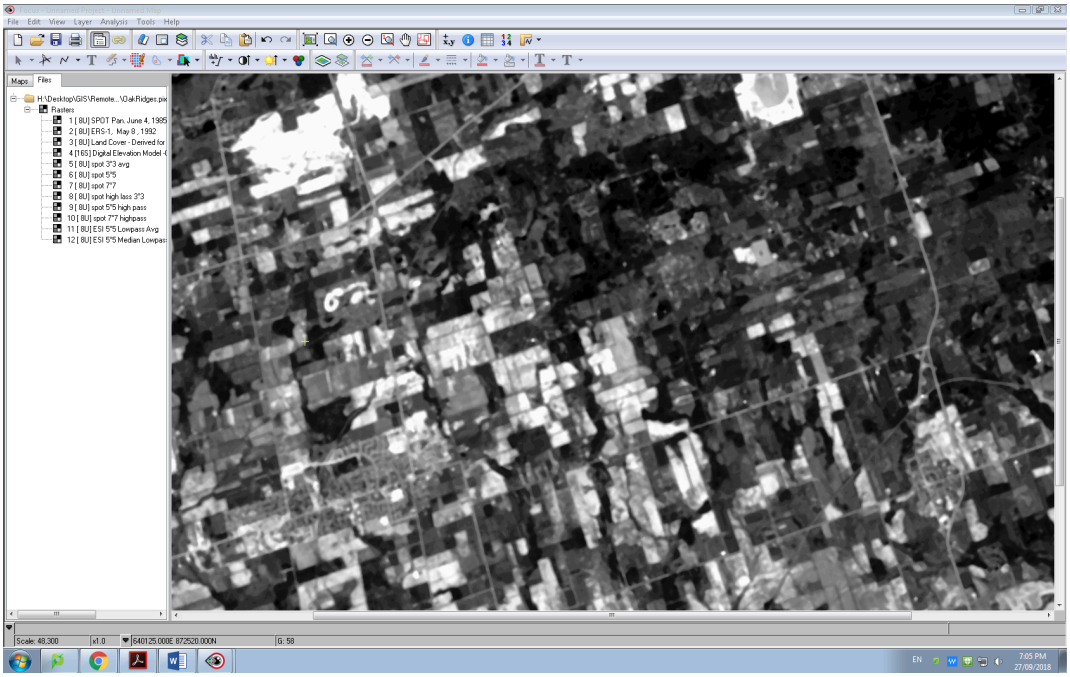
## 3) Low Pass Versus Median Filter

Radar Imagery is noted for its speckled appearance, and although these speckles or bright/dark areas on the imagery are valid radar information it has the effect of visually masking underlying broader patterns (ie low frequency). There are many strategies to filter out the speckle from radar imagery two of which we will do here.

3.1 Run a 5 by 5 **Average Filter** (**Low Pass)** filter over the original ERS-1 Radar image. Save your result to a new channel.



3.2 Now run a **5 by 5 Median Filter (Low Pass)** over the original ERS-1 radar image. Save your output to a new channel.

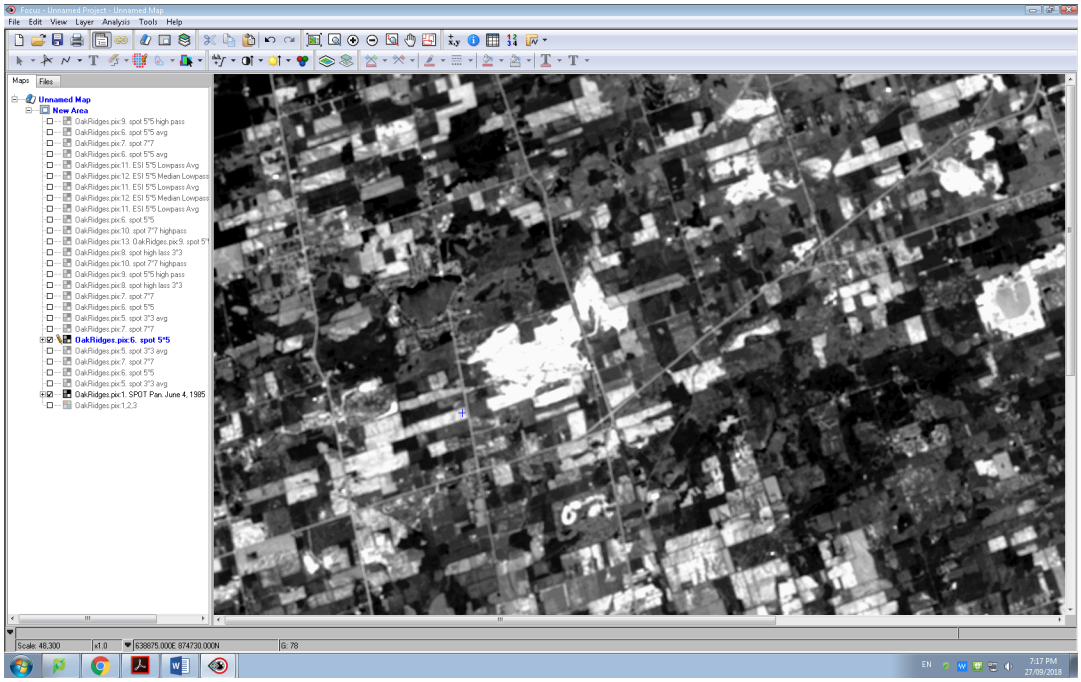


3.3 View the original ERS-1 radar and the two filtered images you created. Note how both the filtered images effectively removed the "speckle" and additionally how the median filter preserved much of the spatial character (edges) of the image. The low pass (or mean filter) tends to "blur" an image by averaging the results over the filter size.

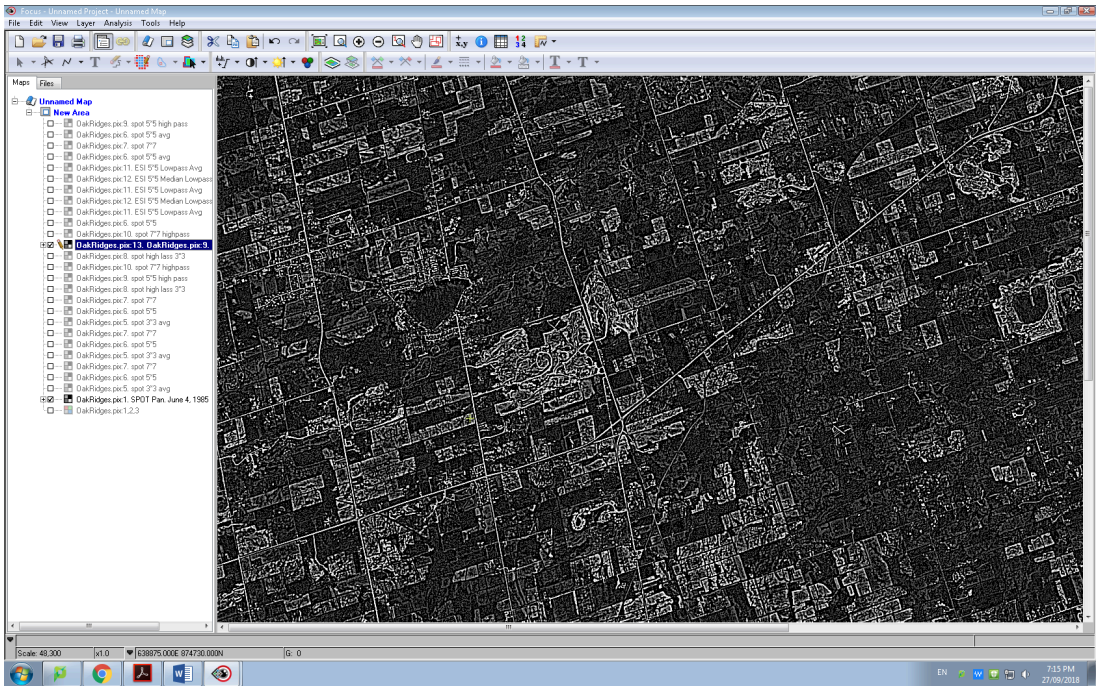
**4) Relation between High Pass and Low Pass Filtering.**

In the next steps, you will see the relationship between the results of low pass (average) filtering and high pass filtering. Low pass filtering enhances the broader or low frequency changes in an image, whereas high pass filtering enhances the rapidly changing, or high frequency areas in an image. An example of low frequency features would be a mono-cropped field and an example of a high frequency feature would be an urban area.

4.1 Run a 5 by 5 **Average** filter over the SPOT Panchromatic Channel. Save your result. Update the raster description.



4.2 Run a 5 by 5 Type 2 – Laplace Edge Detector Filter over the SPOT Channel. Save your result. Update the raster description.



4.3 From under the **Tools**, pull-down menu select **Algorithm Librarian.** Use the 'Find' function to search for **ARI as an algorithm name**. It should return ' ARI: Image Channel Arithmetic'.

Double-click the ARI icon to open the tool.

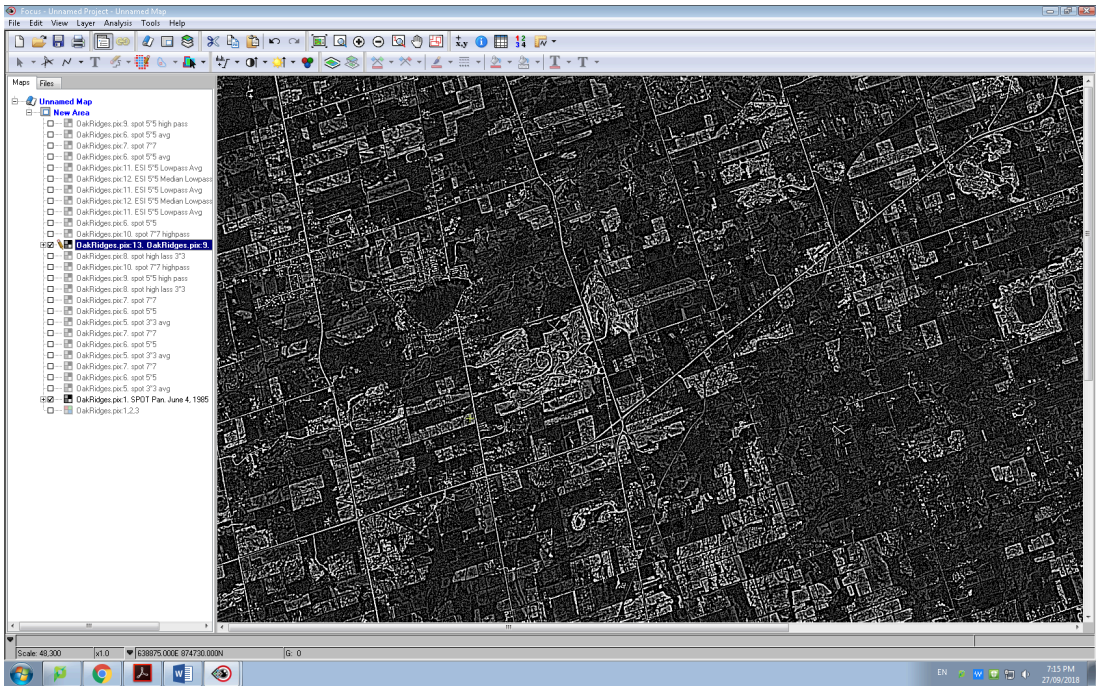
What we want to do is subtract the result of the Low Pass filter from the Original Image.

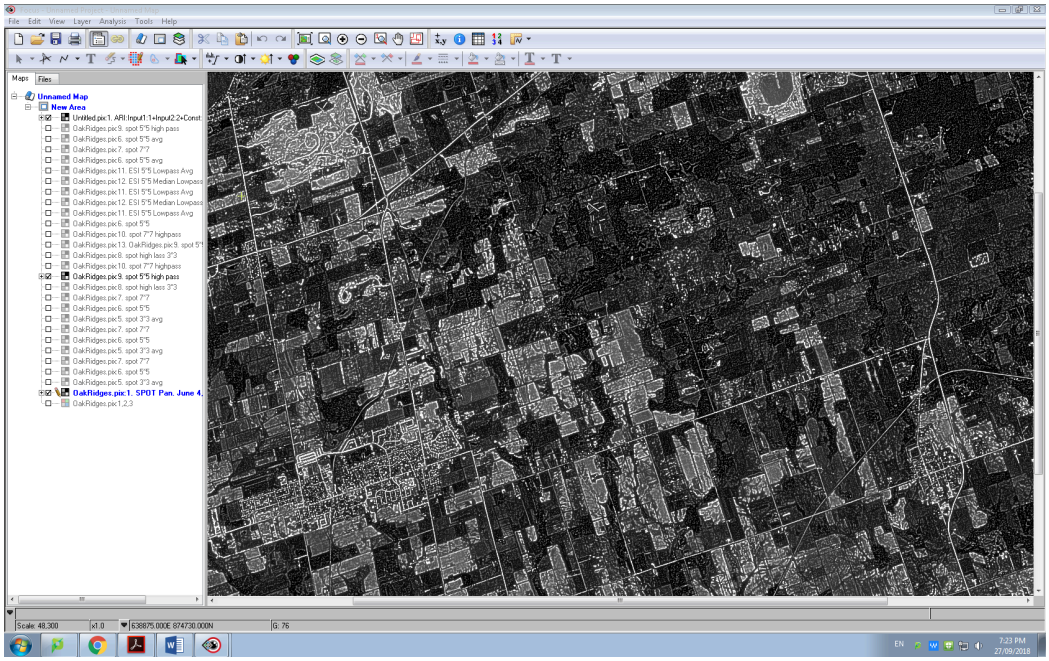
4.4 Note steps 4.2 and 4.3 yield similar results.

Question 3) Explain why the results of 4.2 and 4.3 are similar and include screen captures.

Original = High pass +Low pass

Now, if we will subtract the low pass filter effect the original image will look like high pass filter image.





5) **Generating a "Sharpened" Image**

5.1 Run a 5 by 5 **Sharpening** filter over the SPOT Panchromatic band. Save you output.

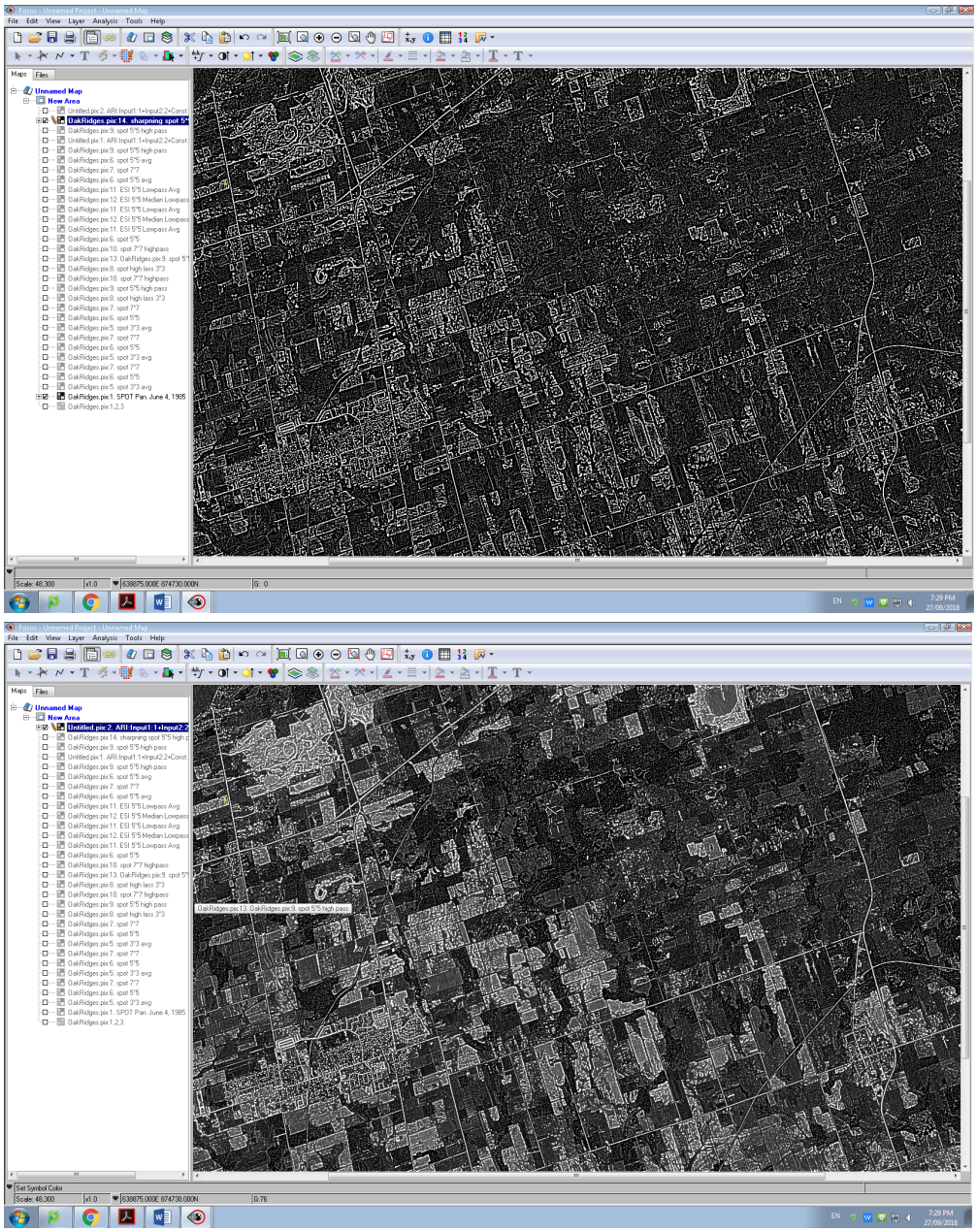
5.2 Now, from the algorithm library select task ARI. This time add the High pass (Leplace Edge Detector) filter from step 4.2 to the original SPOT image. Review the result.

Question 4) Compare these two images (from 5.1 and 5.2) and note how they are similar.

**High Pass Differential (HPD) Image or Sharpening Filter**

HPD = Original Image+ High Pass

Now, if we will add the High pass filter effect the original image will look like high pass diffrencial image.



Submission:
Please save your Answers in a word document. Including headings and figure descriptions for your images/screen captures so it is clear which answers match the images. Please reference the lecture notes to explain what is happening to the raster when the filters or ARI tool is applied. Submit in the dropbox when complete.