



Introduction to Filters

Using SAGA

Tutorial ID: IGET_RS_006



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Introduction to Filters using SAGA

Objective: To learn about the construction and use of image filters.

Software: SAGA (6.4.0)

Level: Intermediate

Time required: 3 Hours

Prerequisites and Geospatial Skills

1. SAGA should be installed on the computer.
2. Student must have completed exercise IGET_GIS_001.
3. Familiarity with basic operations in SAGA is preferable.

Reading



1. Image Enhancement, <http://www.nrcan.gc.ca/earth-sciences/geography-boundary/remote-sensing/fundamentals/2187>
2. Filtering, <http://eoedu.belspo.be/en/guide/filtr.asp?section=3>
3. Laplacian/ Laplacian of Gaussian, <http://homepages.inf.ed.ac.uk/rbf/HIPR2/log.htm>

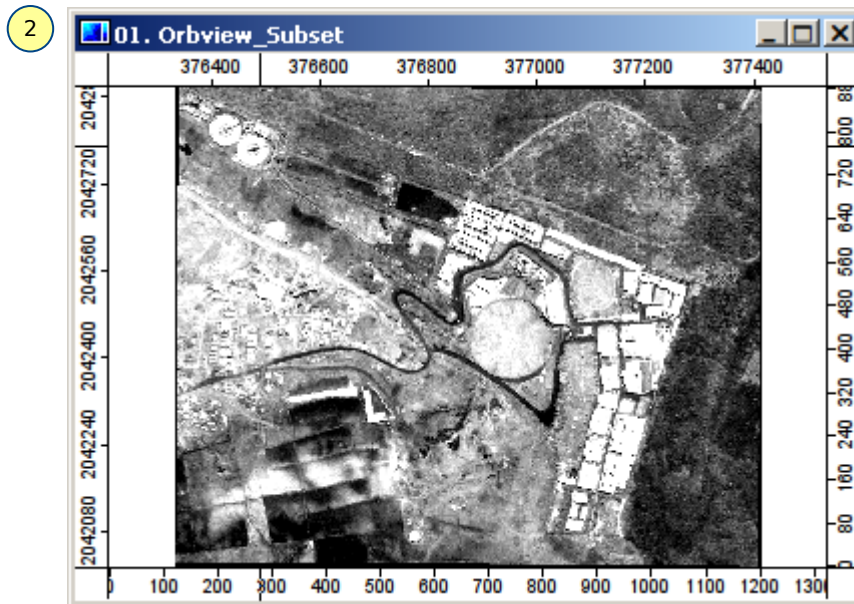
Tutorial Data: the tutorial data required for this exercise can be downloaded from [IGET_RS_006](#)

Introduction

Images come in varying levels of quality and information. Using filters we can remove the noise from an image, making it fit for analysis and interpretation. Sometimes, even having high quality images may not be enough, to glean more specific information it is necessary to process it with various algorithms. Generally, Kernel filters are used to accomplish these tasks. A kernel filter uses a moving window that processes each pixel value taking into account the values of the neighboring pixels. They may be used to highlight/suppress specific information in the image.

In this tutorial we will learn to use different filters to perform some basic enhancements on 'subset of an Orbview' and 'Land use and Land Cover Classification' images.

1. Start SAGA GIS and open the image by clicking the  **'Load'** button and navigating to the folder containing the tutorial data to open the file named **'Orbview_Subset.tif'**.
2. The image is loaded in the  **Data** tab list. Double click on it to open it.



Low-Pass (Smoothing) Filter: This filter is the most basic filter used for smoothing an image. It blurs the small features by taking the average of the center pixel and the neighboring pixels. The new value of the pixel depends not just on the original value but on the neighboring pixels as well. Thus by suppressing the starkness of the central pixel it blends in with the rest of the pixel neighbors. It is called a *'Low Pass'* filter because it passes the features of low spatial frequency while removing the high frequency features.

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

X

6	7	4
8	9	7
4	3	6

$$(6 \times 1 + 7 \times 1 + 4 \times 1 + 8 \times 1 + 9 \times 1 + 7 \times 1 + 4 \times 1 + 3 \times 1 + 6 \times 1) / 9 = 6$$

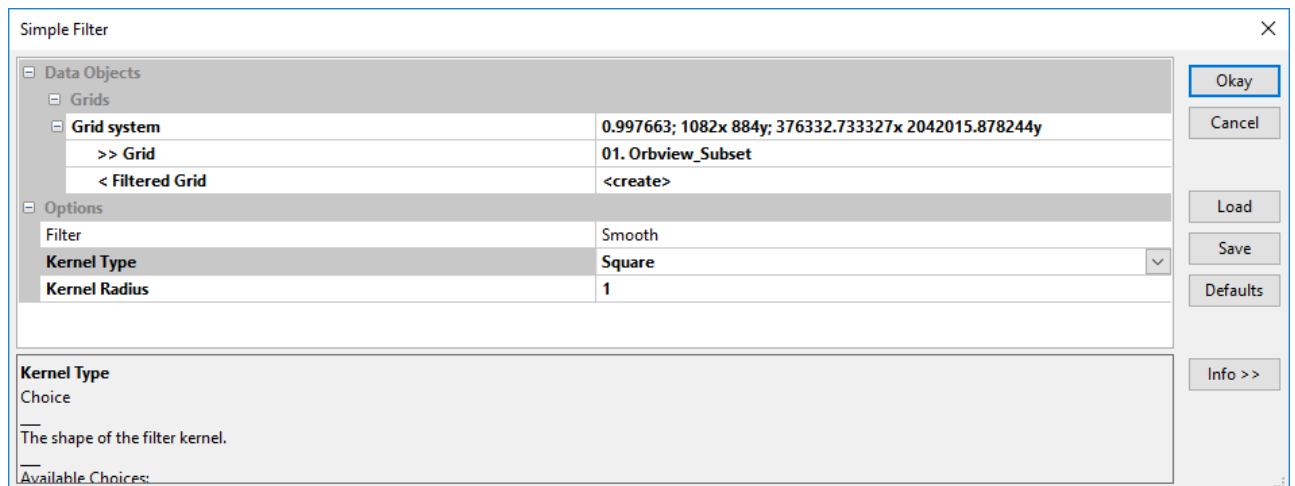
The filter is represented by 1/9 in all the cells. This indicates that while taking the mean, the cells around and including the center cell are all given equal weightage. In the above example, the 3x3 kernel is applied on the center pixel. From the calculation on the right, the new value would be 6.

- Open simple kernel filter via, *Menu → Geoprocessing → Grid → Filter → Simple Filter*. Set the 'Grid System' and '>>Grid' to the current image (i.e., *Orbview_subset*) and Change the '<Filtered' Grid output to **[create]**. If this is '[not set]' then the output would overwrite the original image. The options are explained below:

Search Mode: This is the shape of the kernel window. The default is Circle. Change it to '**Square**'.

Filter: This tells us which type of filter we are applying to the image. Since we are doing a smoothing of the image we will use the '**Smooth**' option.



Radius: The radius describes the size of the kernel window. The value **1** represents a kernel size of 3x3 pixels. If the value 2 represents 5x5 and so on. For now we will use the value **1**. Click '**Okay**'.

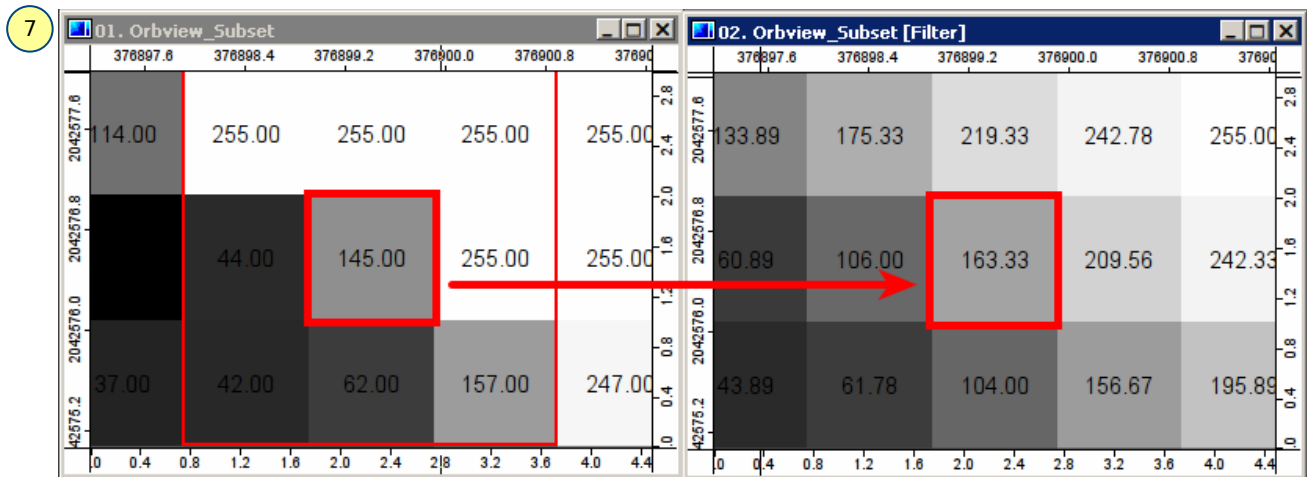


- Now change the name of the output image to 'Orbview_subset_smooth' from **Settings** tab by entering '**Orbview_subset_Smooth**' in the 'Name' section, press '**Tab**' from the key board and click '**Apply**'.

- Open the filtered image in a new map window by double-clicking on it in the list under 'Data' tab. In the popup window select 'New' and click 'OK'.
- If color ramp is not in greyscale, change the color scheme to Greyscale via, *Right-click on the filter image → Copy settings from other layer → Select Original image (i.e., Orbview_Subset)*.



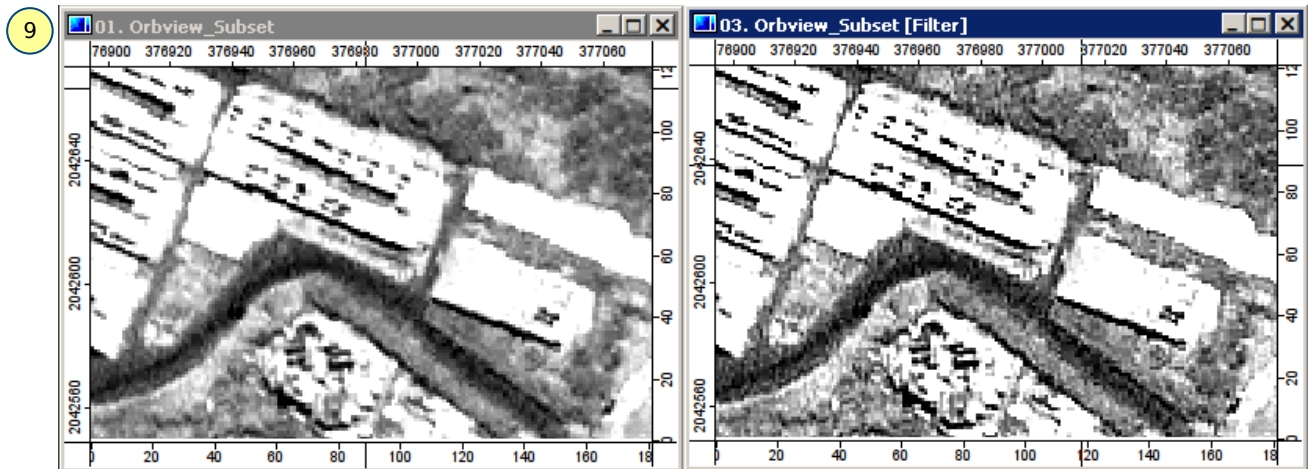
- Select the first map window and synchronize their extents via, *Menu → Map → Synchronize Map Extents*). Click the  'Action Tool' button, 'zoom in' to Individual pixel level as shown below, and select a few pixels. From the  Settings tab, check Show Cell Values and click 'Apply'.



As we see above, the central pixel on the left gets smoothed to more closely resemble its neighbors. The kernel is applied on the image on the left as calculated below:

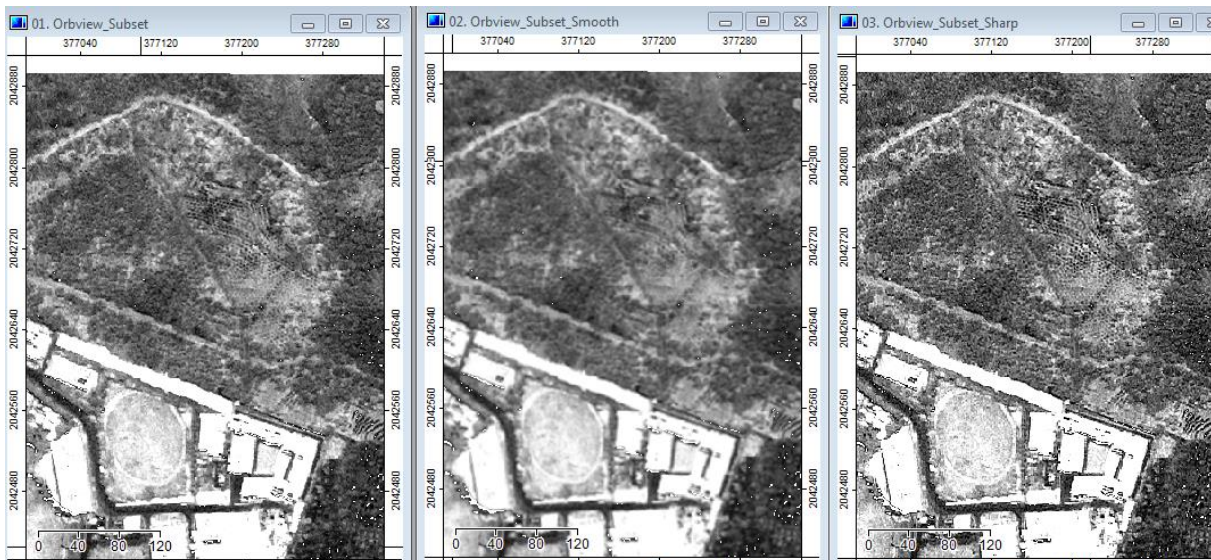
$$(255+255+255+44+145+255+157+62+42)/9 = 163.33$$

High-Pass (Sharpening) Filter: A sharpened image is one in which the smaller features are made more prominent. They appear sharper when each pixel can be differentiated from its neighbouring pixels. To do this, we must heighten the difference between a pixel and its surroundings. The High-Pass filters often treated as *Edge detection* or *Directional* filters.



- Go back to the Simple Filter module and change the 'Filter' option to '**Sharpen**'. Change the output 'Filtered Grid' to '**[create]**'. Click '**Okay**' (Refer step 4). Now change the Name of the image to '**Orbview_subset_Sharp**' (Refer step 5) and Open the image in a new window and set its color scheme to Greyscale.

Task 1: Try to interpret the following images?

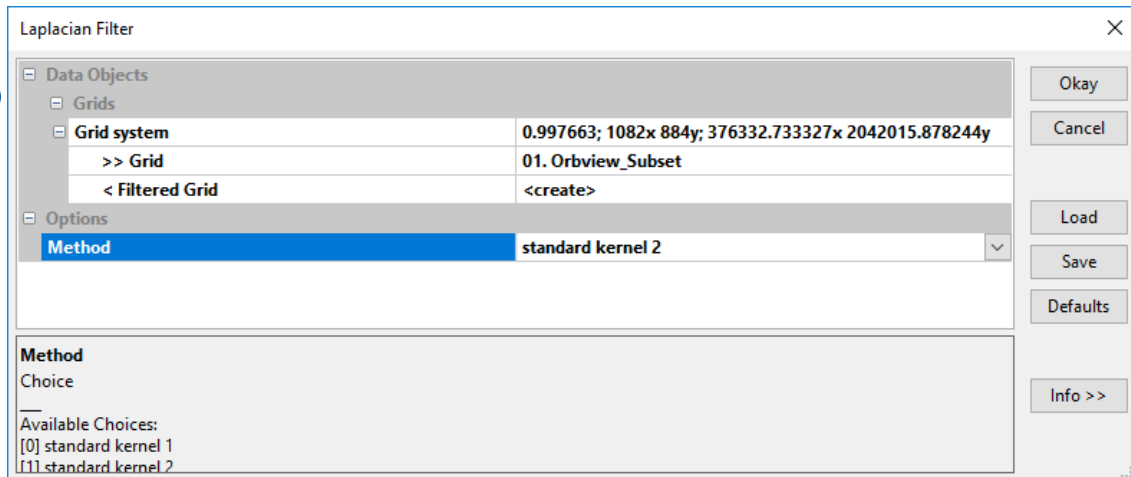


Edge Detection using the Laplacian-of-Gaussian filter combination: This combination of the Laplacian-on-Gaussian filters is used for sharpening images while preventing the amplification of noise. A Laplacian filter on its own would amplify the noise in an image.

However, if we preprocess it with a Gaussian filter, the noisy pixels get smoothed out. This reduces the chances of noise amplification.

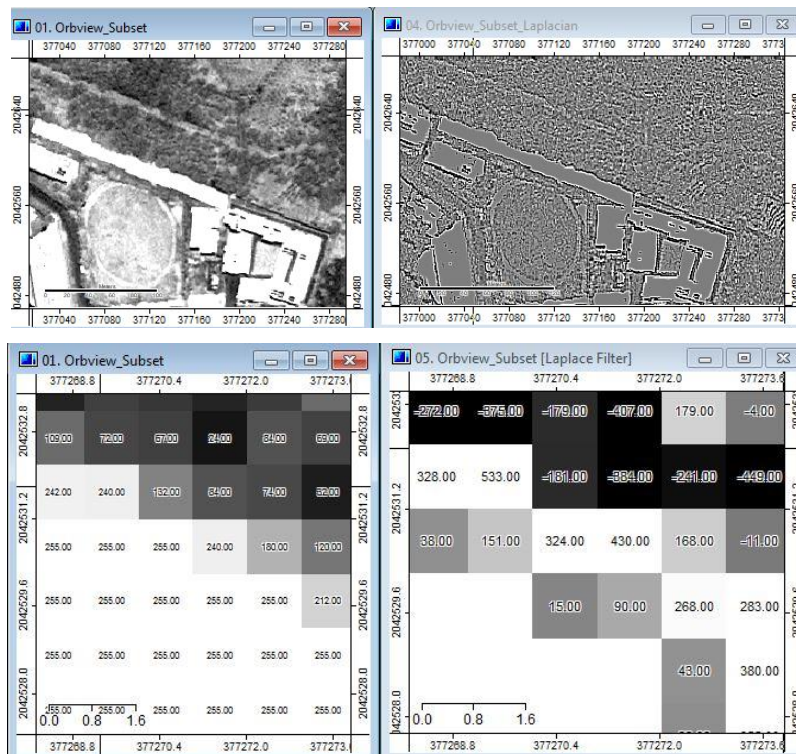
- Open the Laplacian Filter module via *Geoprocessing* → *Grid* → *Filter* → *Laplacian Filter*. Set the options as given below. Ignore the options under 'User Defined Kernel', since we are using the '**Standard Kernel 2**' and click '**Okay**'. Rename the output file to '**Orbview_subset_Laplacian**' (Refer step 5).

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- This will create an edge filter which highlights all the edges in the image. An edge is signified by an abrupt and sudden change in pixel values. This allows us to identify the boundary of features easily.

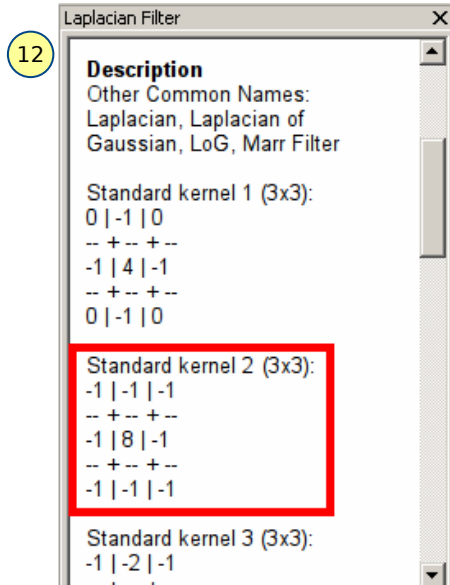
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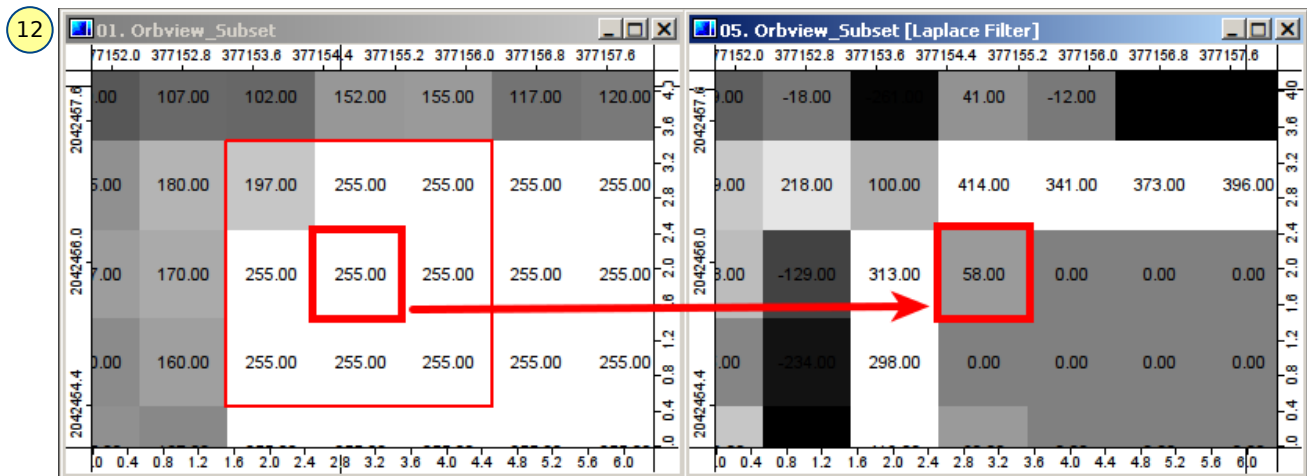
On the left is the original image and on the right is the Laplacian filtered image. As you can see, the Laplacian image only describes the rate of change of pixel values and not the

pixel value itself. So, the uniformly white portion of the image is shown with no or zero values which mean there is no change in the pixel values over that area.

- Let's look at the kernel used in the above operation. Select the *Laplacian* Filter module from the 'Tools → Grids → Filter' under *Manger* section. Then select the 'Description' tab to see the values of the kernel of 'Standard Kernel 2'.



Using the Standard Kernel 2 filter we can verify the value of the output below.

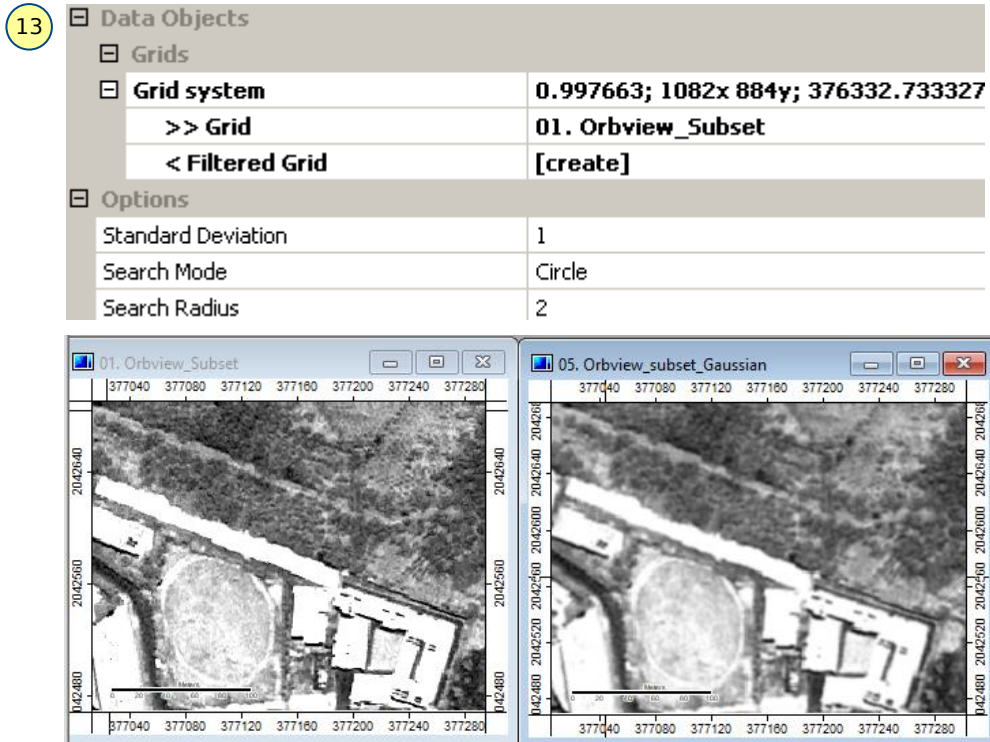


$$197x-1 + 255x-1 + 255x-1 + 255x-1 + 255x-1 + 255x-1 + 255x-1 + 255x-1 + 255x-1 = 58$$

Task 2: Try this for any other pixel.

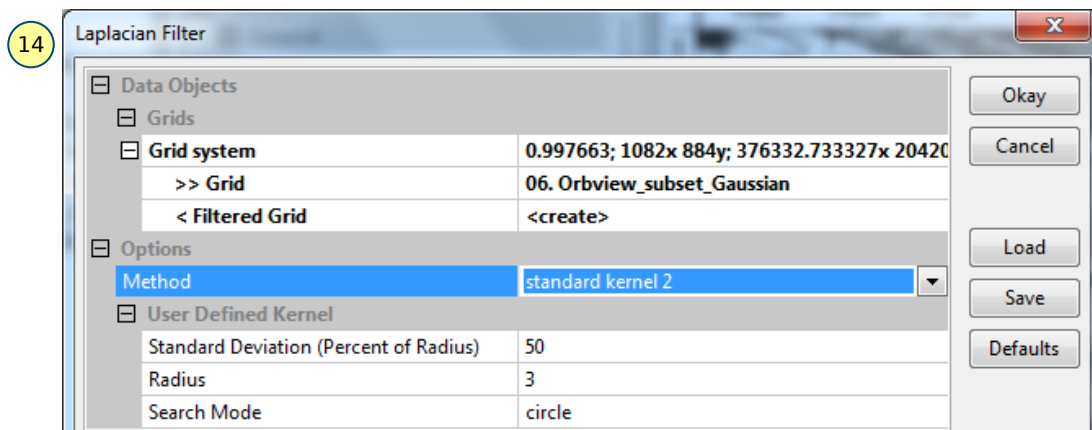
- To reduce the amplification of noise we will first pass a Gaussian filter over the image. Open the module via *Geoprocessing → Grid → Filter → Gaussian Filter*. In the filter window, set the options as shown below. For now we will use the default options. Set the

output '< Filtered Grid' to '[create]' and click 'Okay'. Rename the output file to 'Orbview_subset_Gaussian' (Refer step 5) and change the colour ramp to original image.

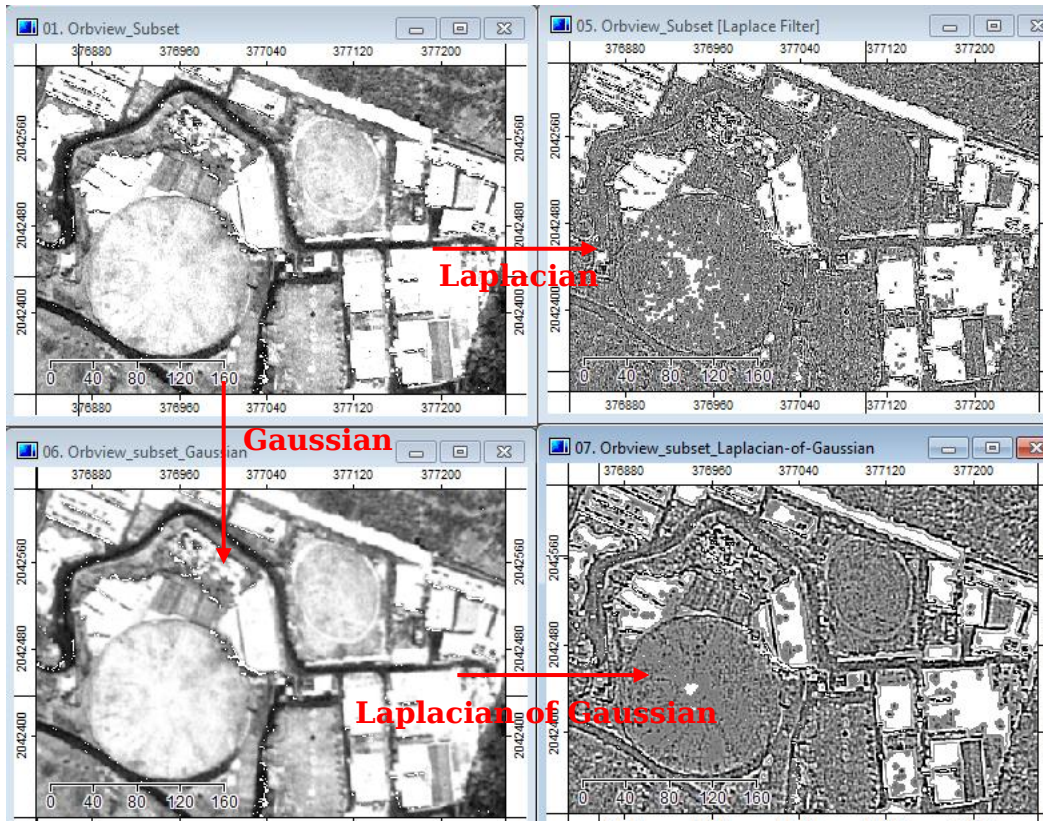


Task 3: Describe how Gaussian and Laplacian filters works and where and when you will use it?



14. Now, pass a Laplacian filter on this Gaussian smoothed image (output of step 13) referring step 10 and below figure. Rename the output file to 'Orbview_subset_Laplacian-of-Gaussian' (Refer step 5).

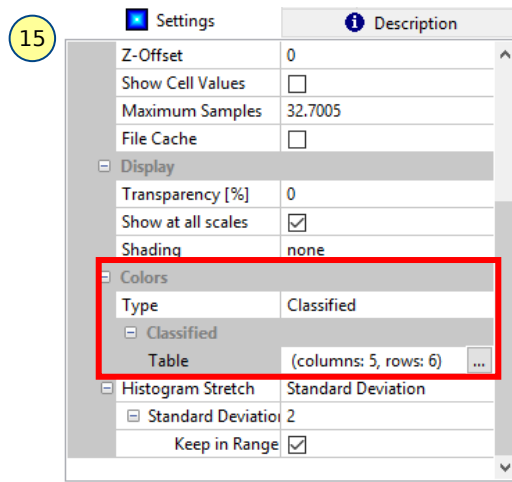


Task 4: Now open the *Laplacian of Gaussian* image and tile them as shown below. Do you see any the difference between the direct application of a *Laplacian filter* and a *Laplacian-of-Gaussian* combination?

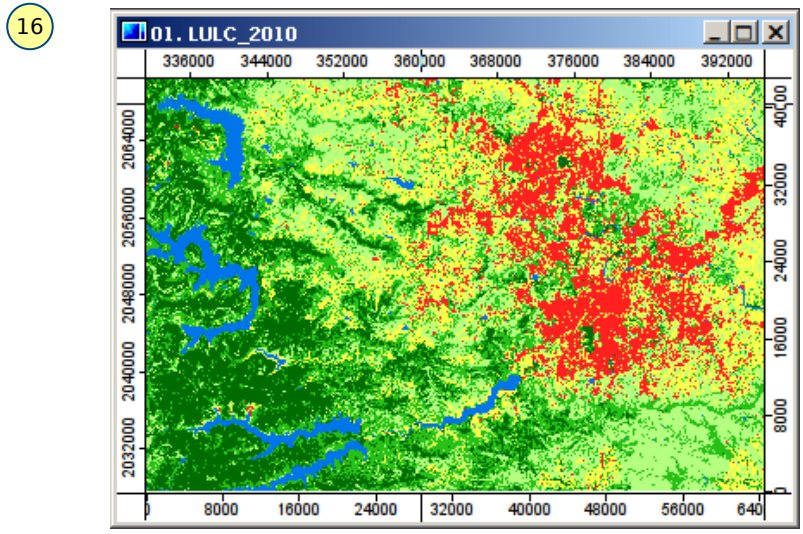


Majority filter: When dealing with the thematic images (and use classification maps), it becomes apparent that there are very tiny land use cluster within a single large land use class. To remove these counterfeit clusters and to produce a more realistic land use class map, we use the Majority Filter. This considers all the pixels in the convolution window, and assigns the most abundant land class to the central pixel. This results in an output map having smoother and more general trend.

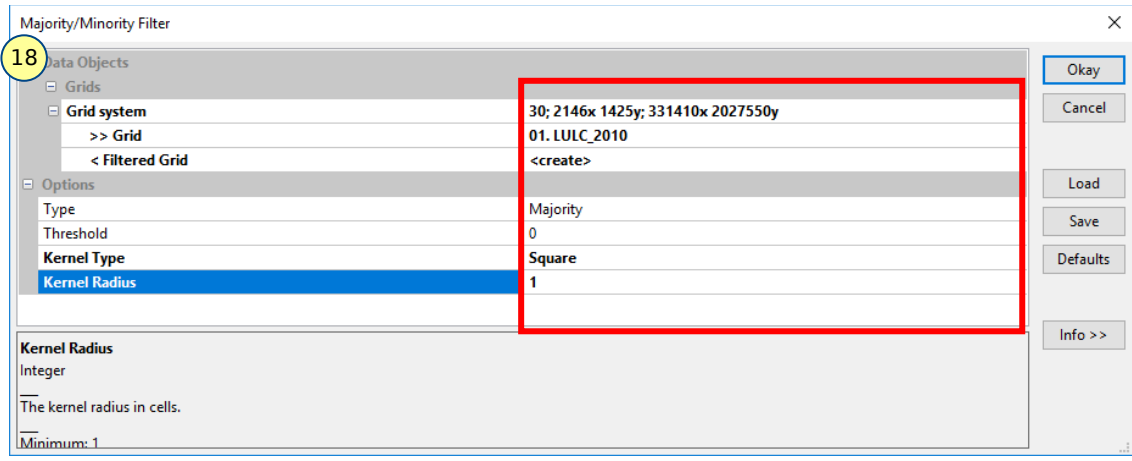
- Open the image 'LULC_2010.tif' in SAGA (Refer step 1). From the  **Settings** tab change the Colors Type to '**Classified**'. Select the 'Table' field and click the  button on the right. In the Table window, click '**Load**' and open the '**Lookup_Table.txt**' file in tutorial data. Press '**Okay**' and then '**Apply**'.



16. Now load the 'LULC_2010.tif' to a new map window. The image will look like below.

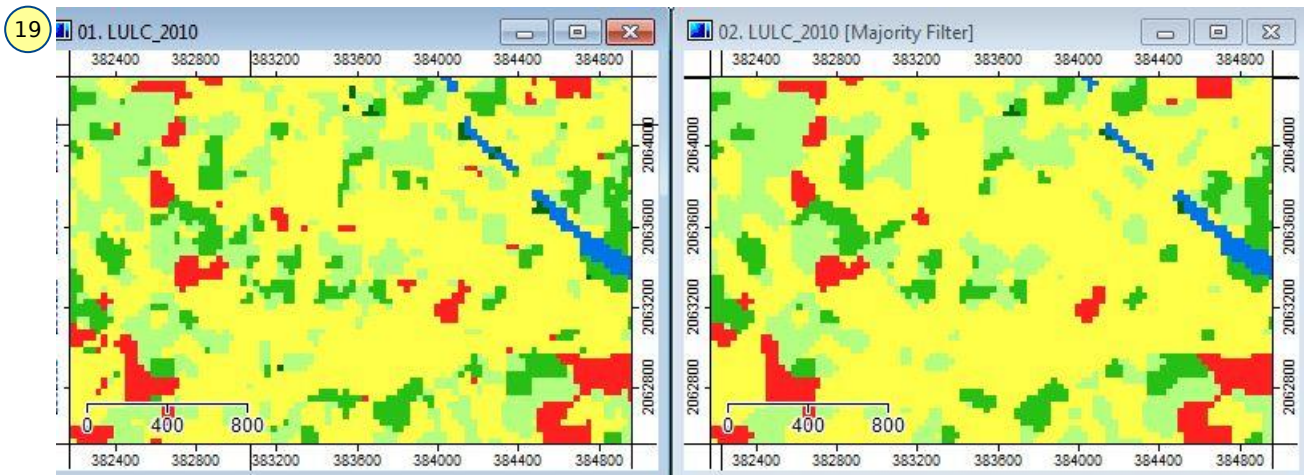


17. Open the Majority Filter via *Geoprocessing* → *Grid* → *Filter* → *Majority/Minority Filter*. In the window set the fields as given below.



18. We will set the 'Search Mode' to '**Square**' so that all the 8 neighbouring pixels are used. Change the output '<Filtered Grid' to '**[create]**' to make a new image. If it is '[not set]' it output will overwrite the original image. Keep the 'Radius' as 1. Click '**Okay**'.

19. Change the output name to 'LULC_2010_Majority'. Open the output in a new window. If color scheme of majority filter output is different from the original image, set the color scheme to by Right-click on 'LULC_2010_Majority' → *Copy setting from other layer* → *Select 'LULC_2010'* → *Click Okay*.



Task 5: What you observed in the above image after applying the Majority filter?

Task 6: Apply the Majority filter with radius 2, and then compare the output with radius 1 output?

20. Now save the project via the *File* → *Project* → *Save Project As*. In the 'Save AS' popup window browse to the desired folder to save, and enter the desired name i.e., 'IGET_RS_006' and click on 'Save'. In the popup window check the Checkbox 'Save all' and click 'Okay'.