Section 17: Change Detection

Section Objective

This section is intended to guide students through a change detection workflow which first matches the histograms of two images, before co-registering and then running image difference change detection tool.

Students will then use DeltaCue to conduct advanced change detection on a number of practical real-world scenarios.

Tools Used

Hiistogram Matching	This function mathematically determines a lookup table that converts the histogram of one image to resemble the histogram of another.
AutoSync	A comprehensive tool for manually orthorectifying and geocorrecting images. They are listed here in the order in which they are listed in the Preference Editor dialog.
Image Difference	Used for change analysis with imagery that depicts the same area at different points in time.
DeltaCue	DeltaCue can distinguish significant change from insignificant change and then helps you identify changes that are of specific interest to your application

Change Detection

Objective:

Students guide their way through a change detection workflow which first matches the histograms of two images, before co-registering and then running image difference change detection tool.

Task 1: Histogram Matching

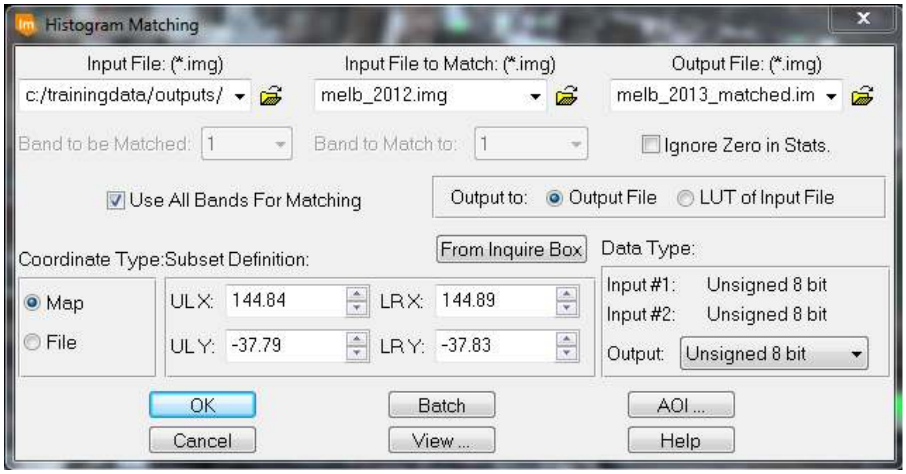
1. Go to File > Open Raster Layer.

   For this exercise we will use two Pleiades datasets captured over Melbourne. The images were captured in 2012 and 2013.

2. Open the following datasets from the TrainingData directory.
   - ***Melb_2012.img***
   - ***Melb_2013.img***
3. Using the swipe tool (accessed from the Home tab). Assess the images for changes in building construction over this period.

You may notice these images appear spectrally different. As the Image Difference Change Detection tool looks at the difference of individual pixel values, matching the histograms of the images first can assist in removing the noise of the final result.

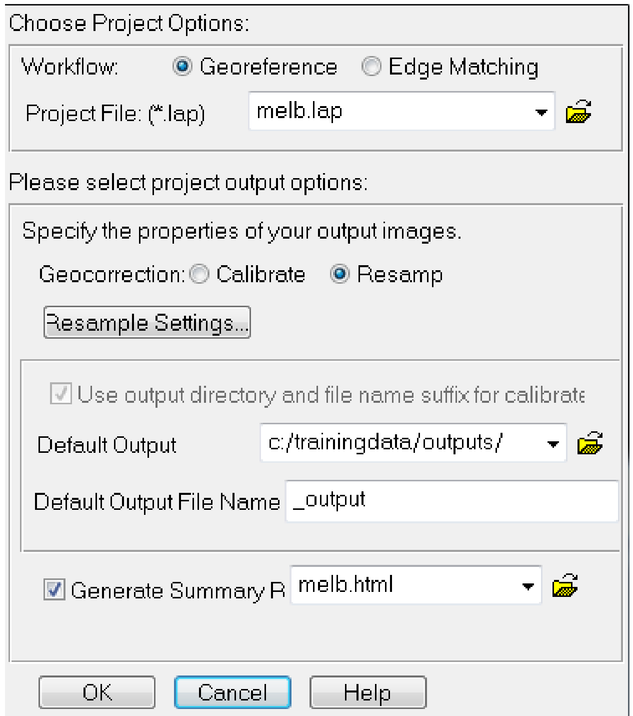
4. Assess the images for their radiometric (brightness/contrast) qualities. You should notice that **melb_2012.img** looks better than **melb_2013.img.**
5. From the **Raster** tab click **Radiometric** > **Histogram Match**.
6. This simple tool allows us to radiometrically match the histograms of two images. For the **Input File** choose ***melb_2013.img***.
7. For the **Input File to Match** choose ***melb_2012.img***. This will be the reference image.
8. Name the **Output File** ***melb_2013_matched.img.***
9. Check on **Use All Bands for Matching**.



10. Leave the rest as default and click **OK** to run the process.
11. In a **2D View** compare the difference between ***melb_2013.img*** and ***melb_2013_matched.img***.

Task 2: Co-Registration with AutoSync

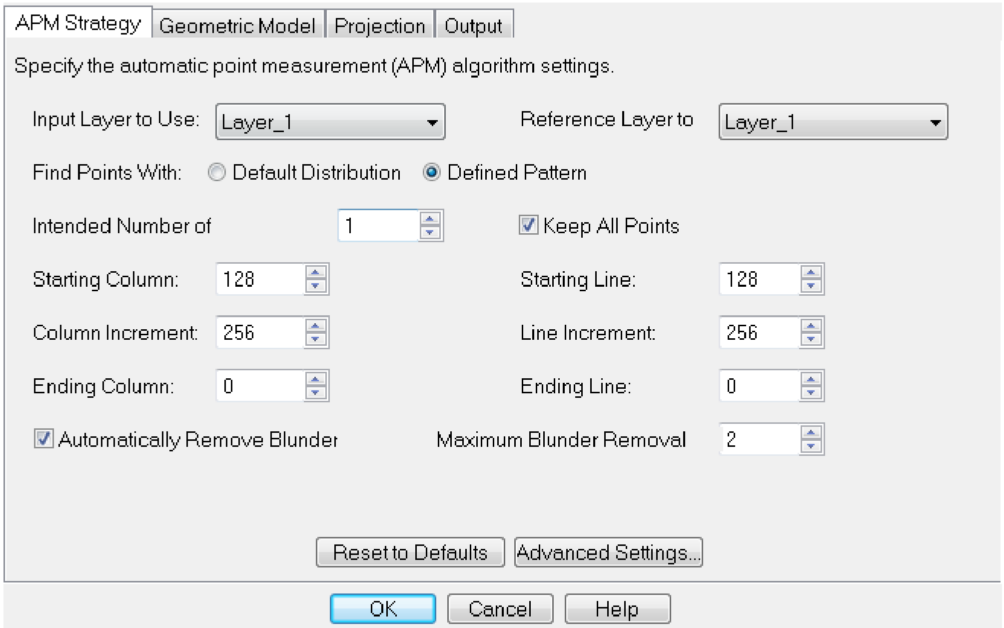
1. From the **Toolbox** tab click **AutoSync Workstation.**
2. Select **Create a New Project**.
3. Name the Project File ***melb.lap***.
4. Change Geocorrection option to **Resample**.



5. Click **OK.**

   We will now set the Reference image and the Input Image.

6. Right Click on **Reference Image** and choose ***melb_2012.img***.
7. Now Right Click on **Input Images** and select ***melb_2013_matched.img***. This is the histogram matched image that we created in the previous exercise.
8. First we will make some simple changes to the settings of the Auto Point Measuring (APM) tool.
9. Click the **Edit Project Properties** button .
10. Change Find Points With to **Defined Pattern**.
11. Turn on **Keep All Points.**

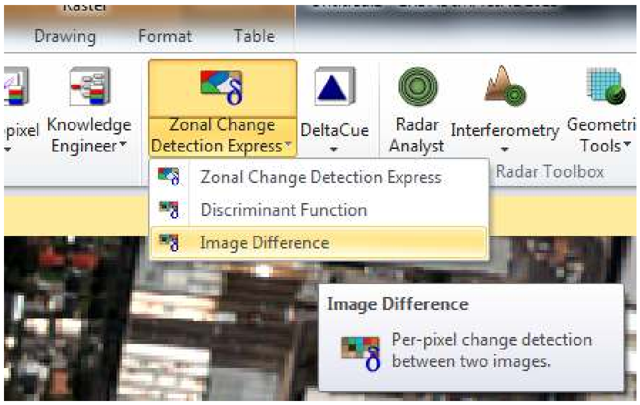


12. We will now run the APM to automatically find GCPs. From the toolbar click the **APM** icon .
13. You will see a large number of GCPs which have been automatically generated.
14. We will now run the AutoSync resample process. Go to **Process > Calibrate/Resample**.
15. There will be an image named ***melb_2013_matched_output.img*** in your Output directory.
16. Open ***melb_2013_matched_output.img*** on top of ***melb_2013_matched.img***
17. Has the new image moved significantly from the original?
18. Now compare ***melb_2013_matched_output.img*** with ***melb_2012.img***. You will notice these two images match much better, both radiometrically and spatially.

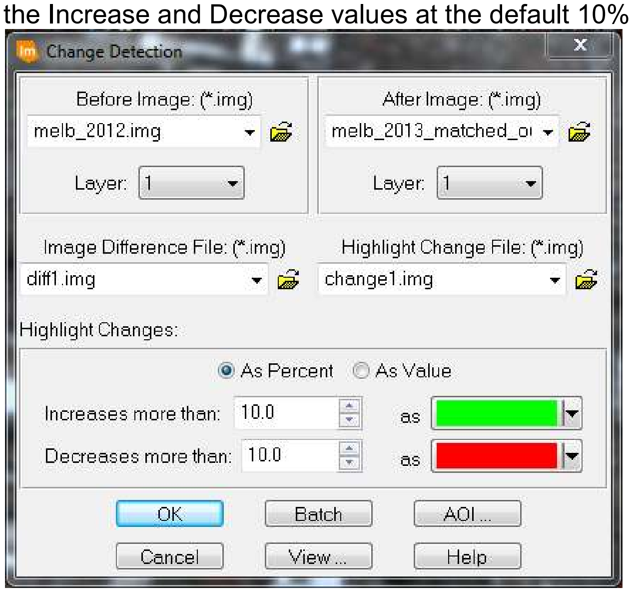
Task 3: Image Difference Change Detection

Students will now use the Image Difference Change detection tool to compare the processed 2012 and 2013 Melbourne images.

1. Ensure the only images open in the 2D View are ***melb_2012.img*** and ***melb_2013_matched_output.img***.
2. From the **Raster Tab** > **Change Detection** group select **Image Difference**.

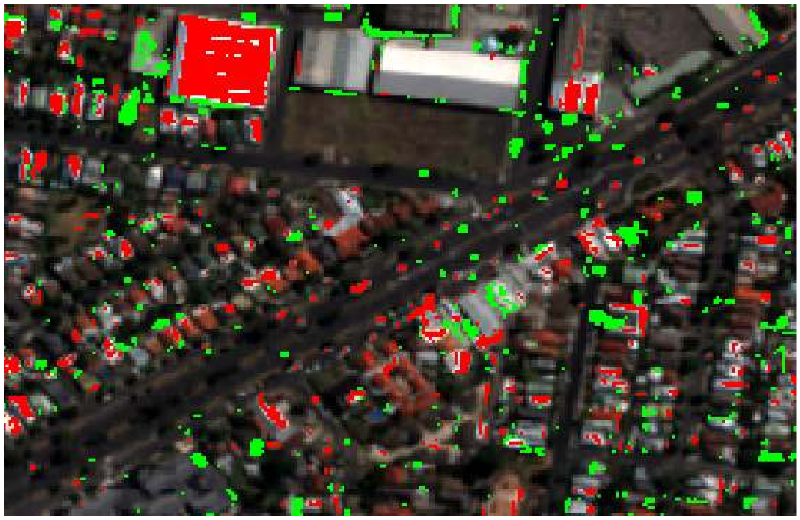


3. For the Before Image choose ***melb_2012.img***
4. For the After Image choose ***melb_2013_matched_output.img***
5. Name the Image Difference File ***diff1.img***
6. Name the Highlight Change File ***change1.img***
7. Leave the Increase and Decrease values at the default 10% for now.



8. Click OK to run the process.
9. When the Process has completed, open ***change1.img*** over the top of ***melb2012.img***.

The pixels displayed as green have increased more than 10% between the two images. The pixels displayed as red have decreased more than 10% between the two images.

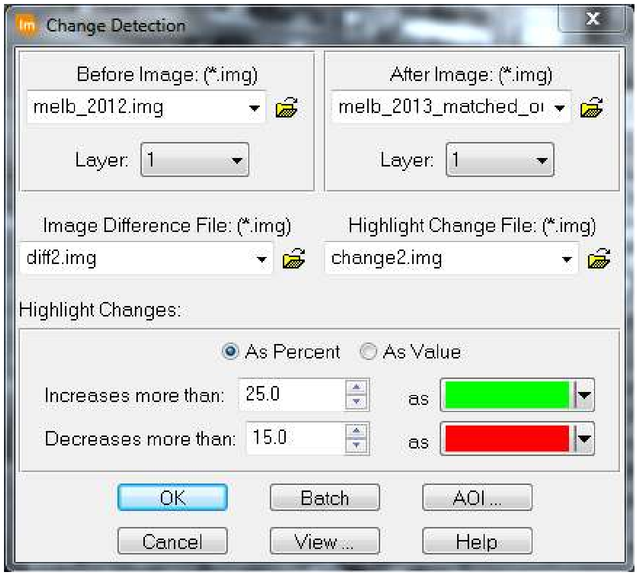


10. You may notice the image contains quite a lot of green pixels, these are considered false positives. We will adjust the settings to account for this when we run the change detection again.
11. Open ***diff1.img***

    The difference image produces a grayscale image composed of single band continuous data. This image is the direct result of subtraction of the Before Image from the After Image. Since Change Detection calculates change in brightness values over time, the Image Difference File reflects that change using the grayscale image.
12. Assess the change in ***diff1.img***.
13. Of the two methods of displaying change, which do you think is more effective?

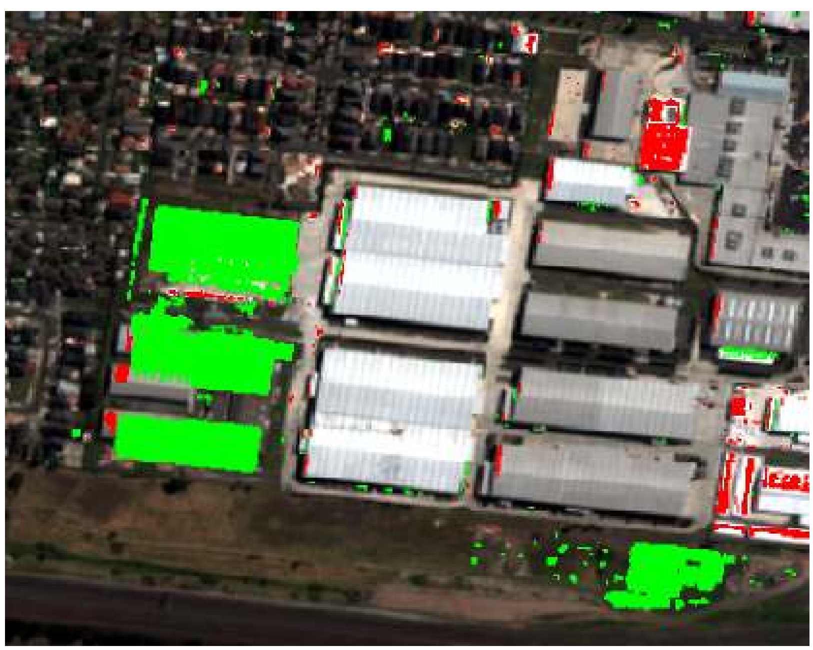
    We will now run the change detection again.
14. From the Raster tab, Change Detection group, open Image Difference
15. For the Before Image choose ***melb_2012.img***
16. For the After Image choose ***melb_2013_matched_output.img***
17. Name the Image Difference File ***diff2.img***
18. Name the Highlight Change File ***change2.img***

    As we saw a large number of false positives in the previous image we will adjust the change increase and decrease to account for this.
19. Change the Increases more than value to **25%**
20. Change the Decreases more than value to **15%.**



21. Click OK to run the process.
22. Assess the resulting ***change2.img*** image. Is it a cleaner result than ***change1.img?***

What are the limitations of this method of change detection?



Iraq BDA Change Detection with DeltaCue

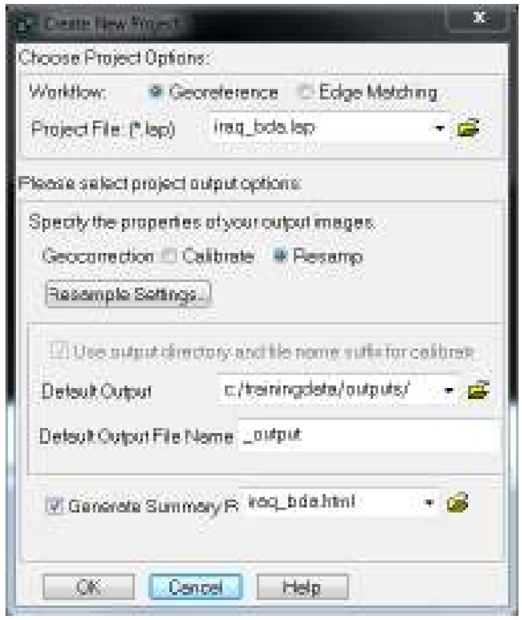
Objective:

This exercise will focus on BDA using QuickBird imagery over a location in Iraq. The imagery will first be co-registered in AutoSync before Delta Cue is used for Change Detection.

Task 4: Preparing Data Layers

1. Go to **File** > **Open Raster Layer**.
2. **Open** the following images
    - ***Iraq_qb_bda_time1.img***
    - ***Iraq_qb_bda_time2.img***
3. Assess how well the two images overlap by using the swipe tool available from the **Home** tab **> View Group**.

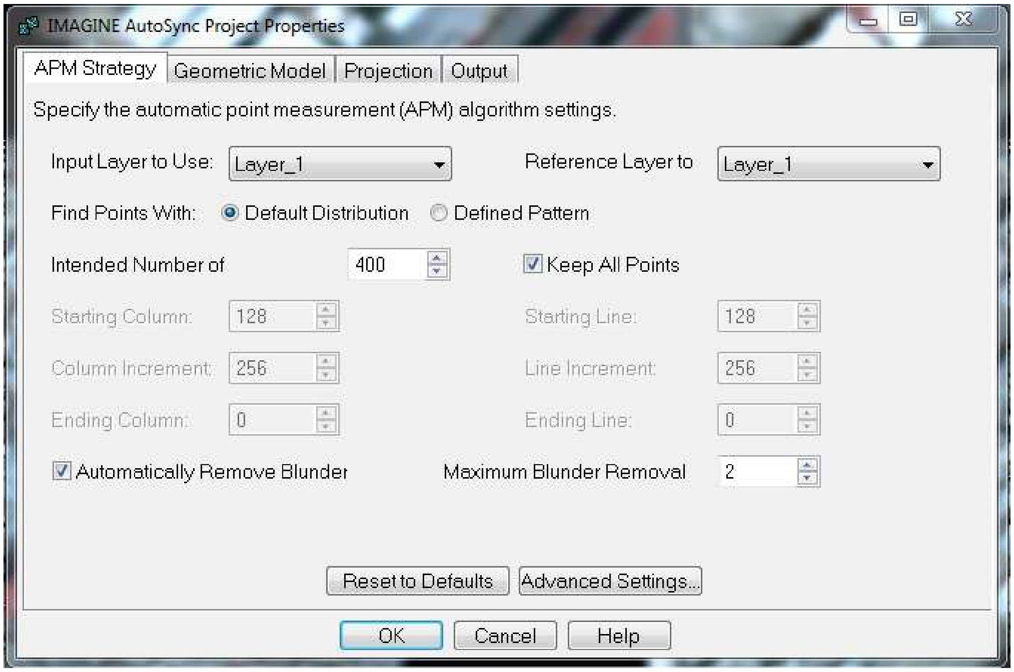
    Whilst the imagery appears to overlap quite well (within 2 – 5 pixels), change detection is conducted at pixel level accuracy. It is important to co-register change sets as closely as possible prior to running any change detection methods.
4. **Clear** the 2D View.
5. From the **Toolbox** tab open **AutoSync Workstation**
6. **Create a new project**.
7. Name the project ***Iraq_BDA.lap***
8. Set the Workflow to **Geocorrection**
9. Set the Geocorrection to **Resample.**



10. Leave the rest as default.
11. Click OK.
12. The IMAGINE AutoSync Workstation will now open.
13. From the window on the left, **Right-Click** on **Reference Image**
14. Choose ***Iraq_qb_bda_time1.img*** as the **Reference Image**
15. From the window on the left, **Right-Click** on **Input Images**
16. Choose ***Iraq_qb_bda_time2.img*** as the **Input Image**
17. Open **Project Properties** 

    We will now adjust the settings for the Automatic Point Measurement (APM) algorithm

18. Set the **Find Points With** to **Default Distribution** and **Keep All Points**



19. Click **OK.**

20. From within the AutoSync window click the **Run APM** Icon 

    You will see a large number of GCPs which have been automatically generated the APM algorithm. If we wanted to we could manually edit these points and/or remove points greater than a certain RMS Error.

21. We will now run the AutoSync process to resample the image.

22. Click **Process > Calibrate/Resample**.

    The results will display in the AutoSync window.

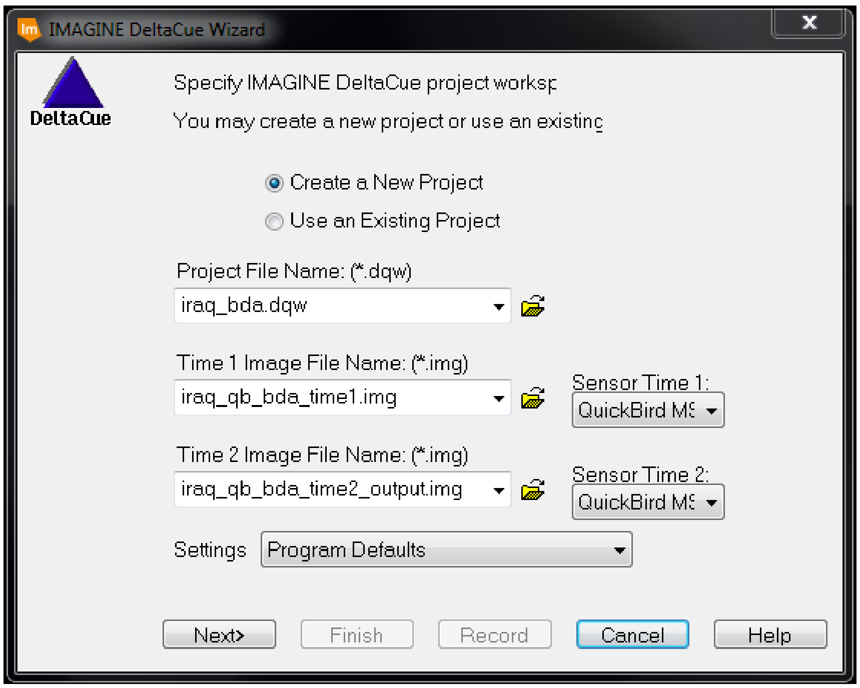
23. Use the **Swipe**  tool to assess the results. The two images should now be properly aligned.

24. **Close** the AutoSync Workstation

25. Do not save the project.

Task 5: Change Detection with DeltaCue

1. From the **Raster** tab, **Change Detection** group click **DeltaCue** > **Wizard Mode.**
2. Name to Project file ***Iraq_bda.dqw***
3. Set the **Time 1 Image** to ***Iraq_qb_bda_time1.img***
4. Set the **Time 2 Image** to ***Iraq_qb_bda_time2_output.img***. This is the image that was output from AutoSync in the previous exercise.
5. As this is QuickBird imagery, select **QuickBird MS** for both sensors.



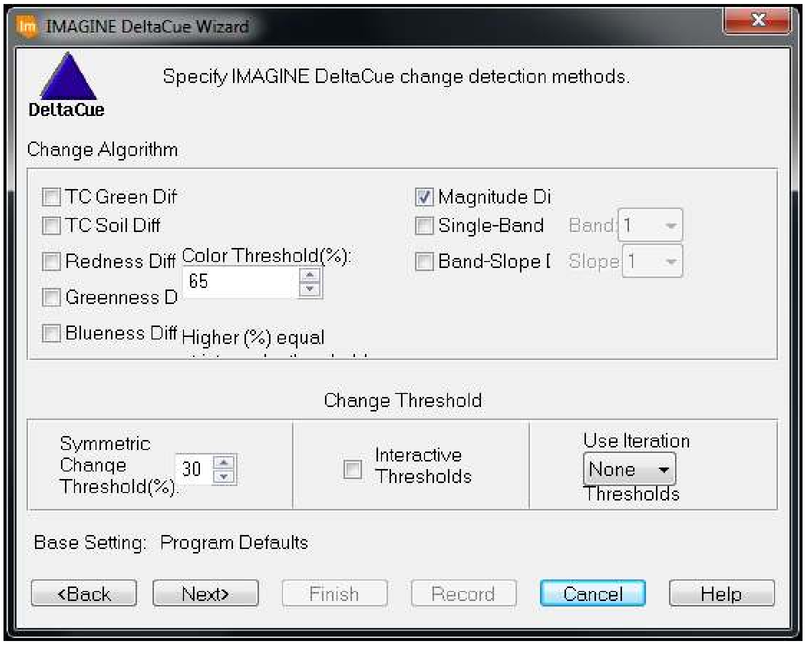
6. Click **Next**
7. As our images are the same size, we do not require copping
8. Click **Next**

The next Wizard dialog creates a normalized Time 2 image with statistics matching that of the Time 1 image. It is important during this process that clouds not skew the results.

9. As neither image has clouds, click **Next**.

This Wizard provides options for a number of different change detection algorithms. Different algorithms for better for different subjects.

10. Click **Magnitude Difference Algorithm**
11. Click **Next**



12. We can select one or more Change Filters.

Spectral Segmentation

Spectral segmentation is a process that is applied to the Time 1 and Time 2 images to classify the change pixels into spectrally similar classes. You can then filter out change pixels based on their Before or After spectral class.

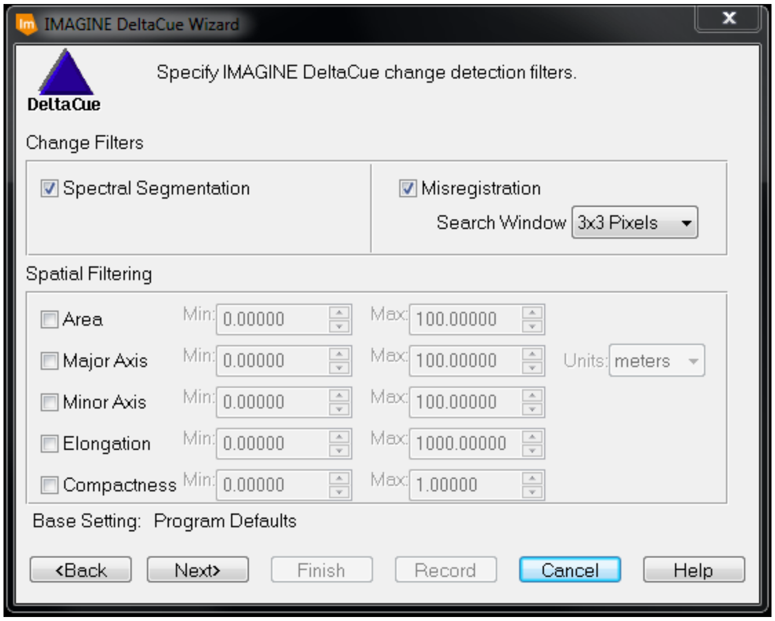
Misregistration

The misregistration filter attempts to filter out unwanted change due to local misregistration of the image pair. Such pixel misregistrations can cause apparent change differences simply because the correct pair of pixels was not differenced.

13. Enable **Spectral Segmentation** and **Misregistration.**

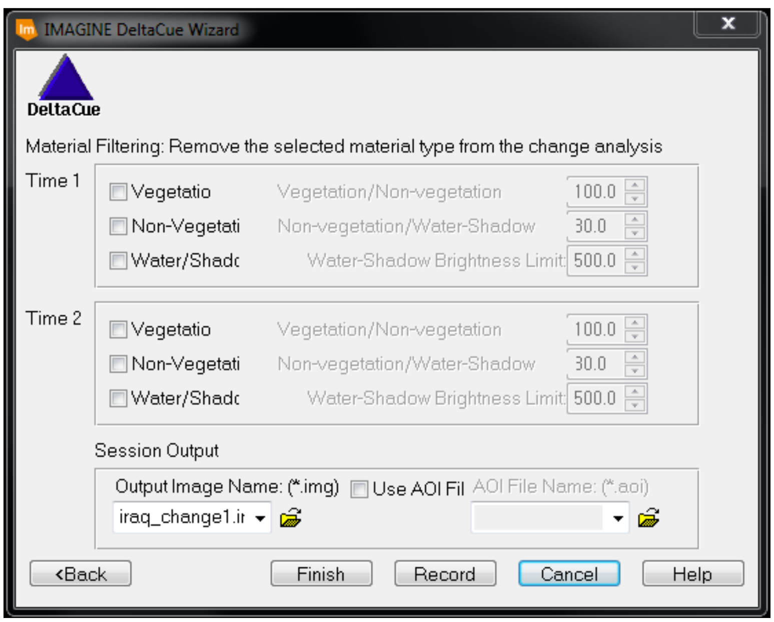
We can also apply a range of different Spatial Filters. For example we can filter out areas greater than a certain size or areas that are particularly elongated, such as roads. However it

14. We will first run the change detection without any spatial filtering



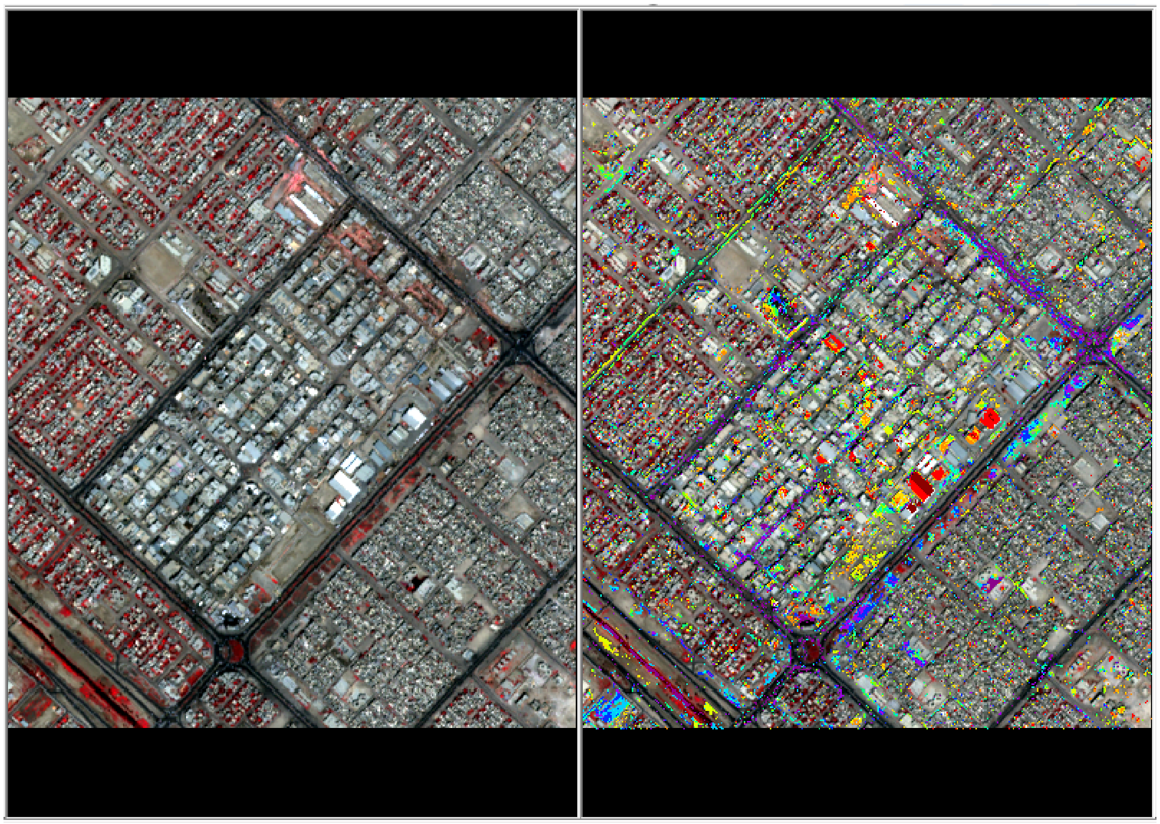
15. Click **Next**.

16. Name the output file ***Iraq_change1.img***

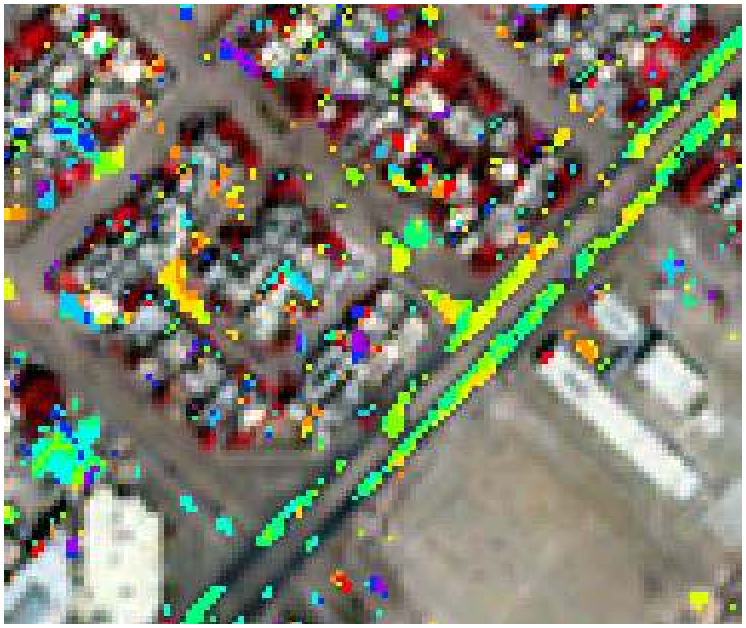


17. Click **Finish**

18. The process will take a minute or so to run, once complete the results will appear in the DeltaCue window.



19. Zoom in to the image of the right to assess the change detection signatures. You may notice a lot of noise and false-positive results.



We will now apply some spatial filters to clean up the result.

20. Click on the **Iteration**  icon from the menu.
21. Click the **Change Filters** tab.

22. Change the Output Image name to ***Iraq_change2.img.***

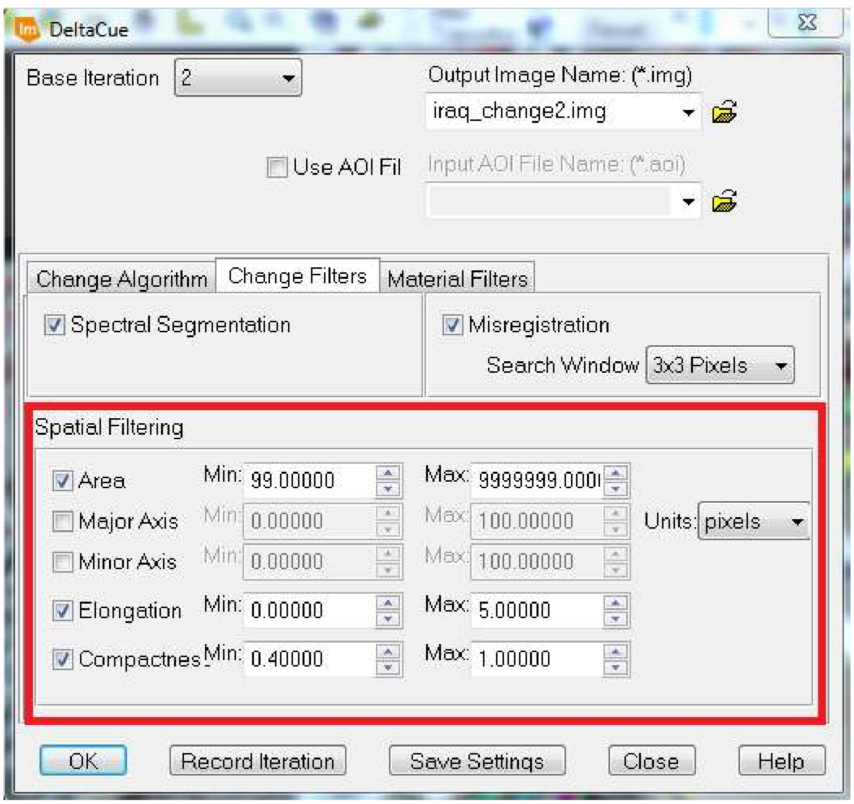
The spatial filter identifies contiguous blobs of detected change by detecting the contour of the blob. A contiguous blob is a set of pixels that are connected by at least one neighbor in any of eight directions. Two change areas are connected if they share at least one neighbor in common.

Once the spatial filter process has detected the contour of a contiguous change area, it computes several geometric properties based on the contour. The geometric properties considered are:

- Area
- Major axis length
- Minor axis length
- Compactness
- Elongation

Area and major/minor axis length have units associated with them. For example, if the units are meters, the area is in square meters and the lengths are in meters. Compactness and elongation are dimensionless quantities.

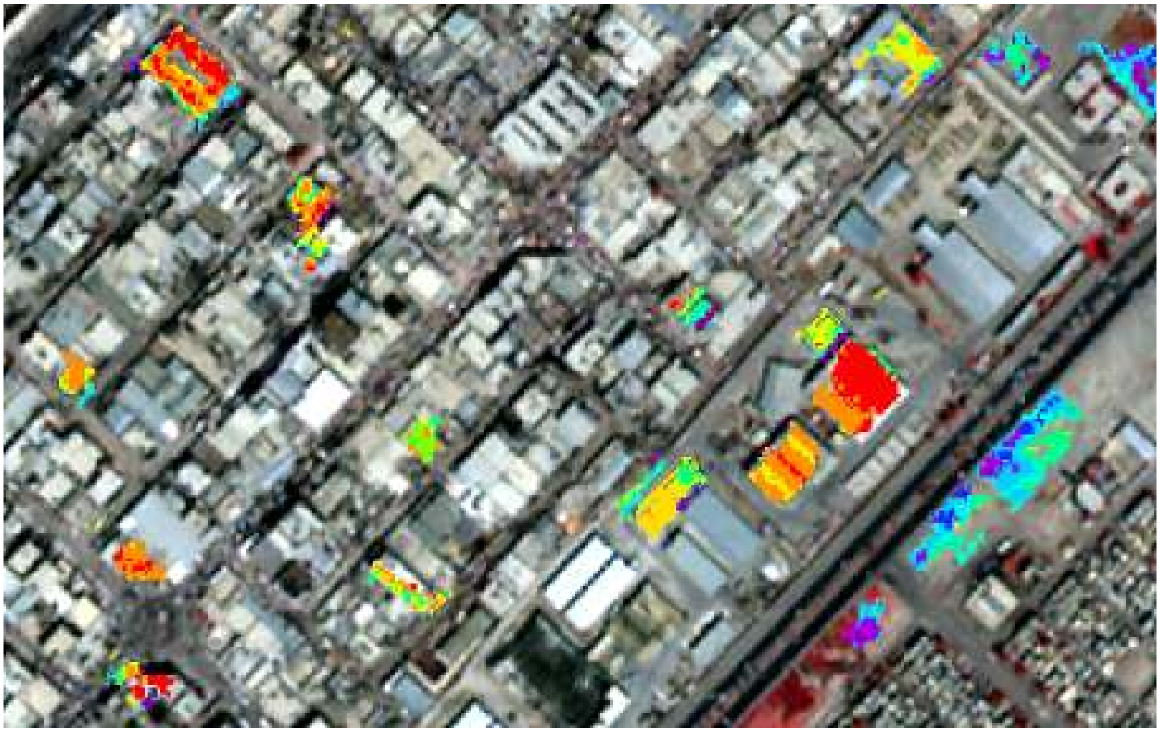
23. Apply the Spatial Filters in the following screenshot.



24. Click **OK.**

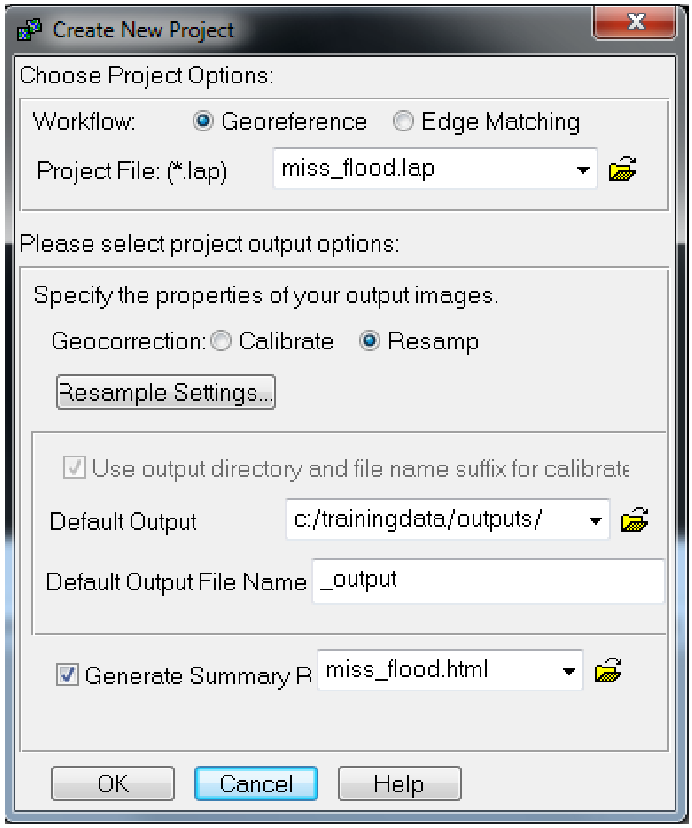
25. The process runs again.

26. Assess the final result in the 2D View on the right. The colored pixels indicate change. You may want to assess the result in the left hand window by using any of the **General Controls.**

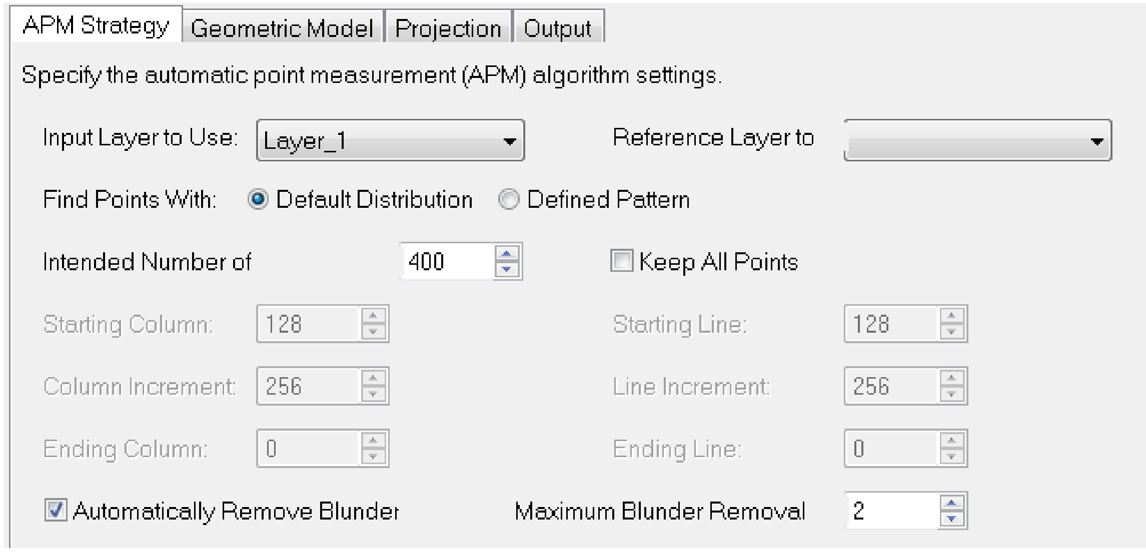


Task 6: Mississippi River Flood Change Detection

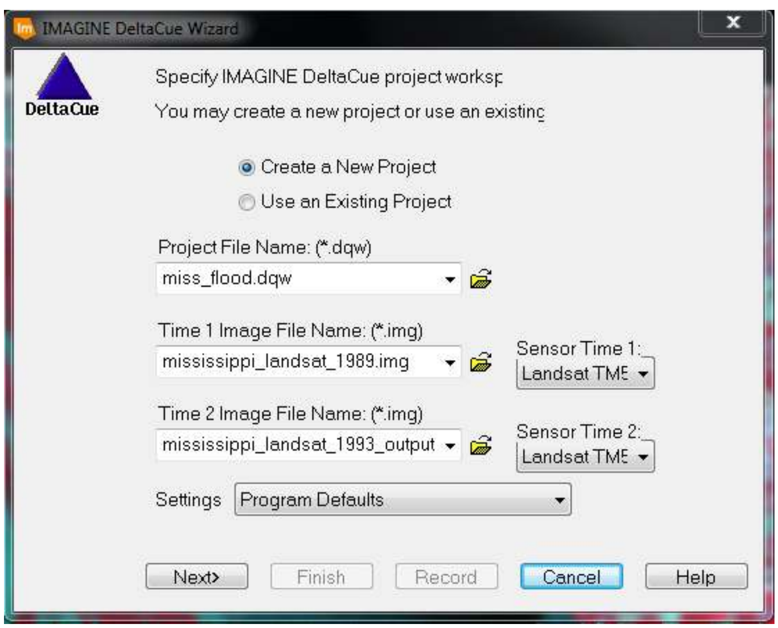
1. From the Toolbox tab launch **AutoSync Workstation**.
2. Create new project and name the new project ***miss_flood.lap***
3. Choose **Resample** as the Geocorrection method



4. Add ***Mississippi_landsat_1993.img*** as the Input Image
5. Add ***Mississippi_landsat_1989.img*** as the Reference Image
6. Click **OK.**
7. Click on the **Project Properties** icon 
8. Change the pattern is set to **Default Distribution**
9. Set the intended number of points to **400**
10. Check the **Keep All Points** option.

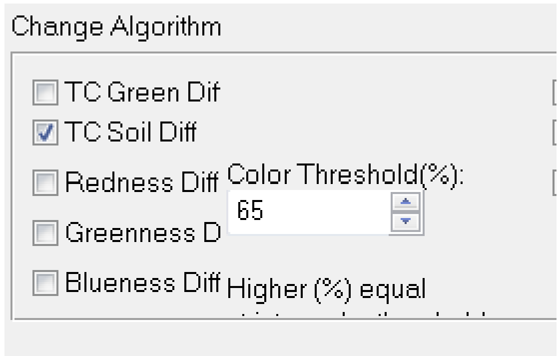


11. Click **OK**
12. Click the **Run APM**  icon
13. Click the **Run**  icon to run the resampling process
14. Once the process is complete, **Close** AutoSync. Do not save the project.
15. From the **Raster** tab, **Classification** group, Select **Delta Cue > Wizard Mode**.
16. Name the project ***miss_flood.dqw***
17. Set the **Time 1 Image** to ***Mississippi_landsat_1989.img***
18. Set the **Time 2 Image** to ***Mississippi_landsat_1993_output.img***
19. Set the Sensor Type for both images to **Landsat TM5 MS**.

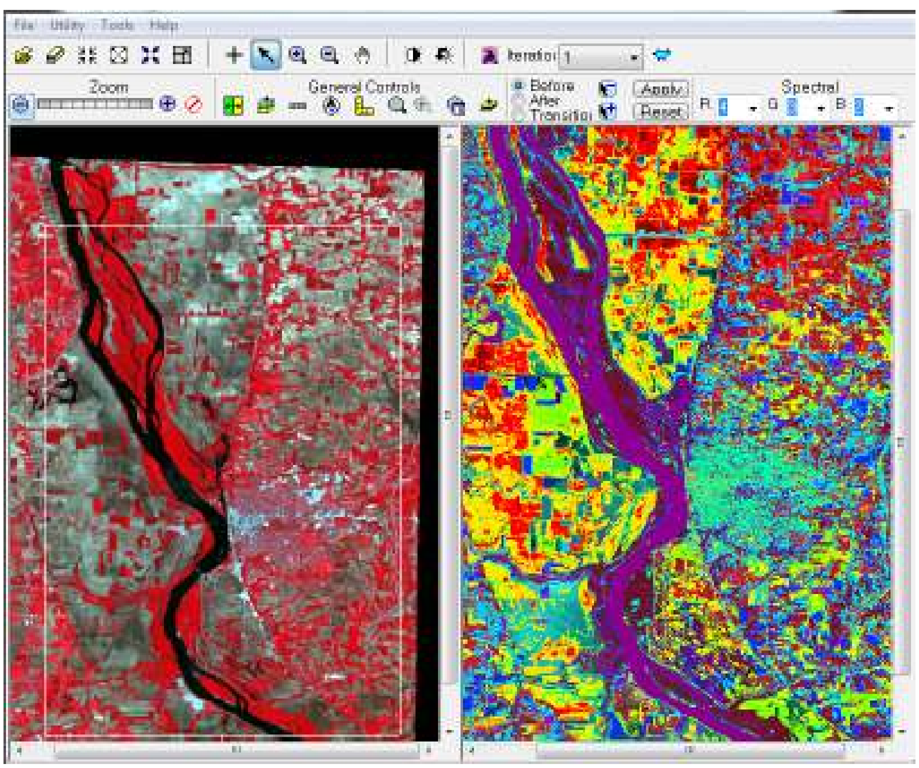


20. Click **Next**

21. At the Crop window, click **Next** again
22. At the normalization window click **Next** again
23. For the Change Detection method, select **TC Soil Difference** as the algorithm



24. Click **Next**
25. Ensure **Spectral Segmentation** is checked on and click **Next**
26. In the final window set the **Output Image Name** as ***miss_flood_change1.img***.
27. Click **Finish** to run the process.
28. The resulting Change image will open.



29. Assess the image in the window on the right, does the information make sense?
30. Click the Iteration tool 
31. Click on the **Change Filters** tab
32. Set the **minimum area to 100** and the maximum to unlimited

33. Name the output file ***miss_flood_change2.img***

34. Once the image process has finished, assess the result.

35. Click the **After** button 

36. Use the **Turn Off Segments** icon  to remove the change from the vegetation areas. You will need to turn the icon on, each time to remove more segments. Click **Apply** when finished.

37. You are now left with a thematic raster, showing the areas of flood change around the Mississippi river.

Task 7: Change Detection with using NDVI datasets

In this task we will generate two NDVI datasets from two different dates before using change detection to assess changes in vegetation health.

1. Open the following datasets

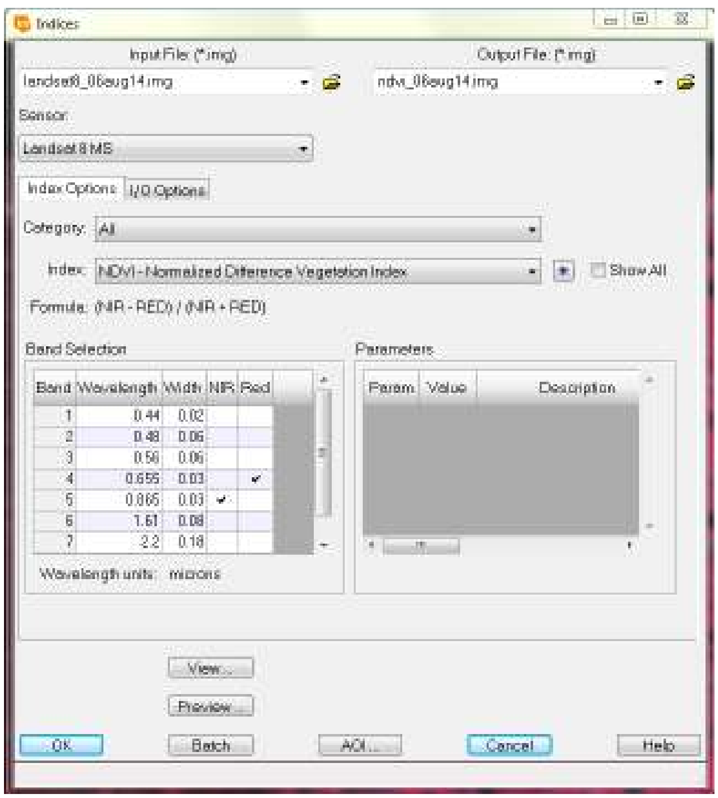
   Landsat8_06aug14.img

   Landsat8_19apr15.img

You should notice these datasets look quite different as they have been collected on different dates and the area is heavily vegetated. You may also notice some fire scarred areas.

We will now create an NDVI for each image.

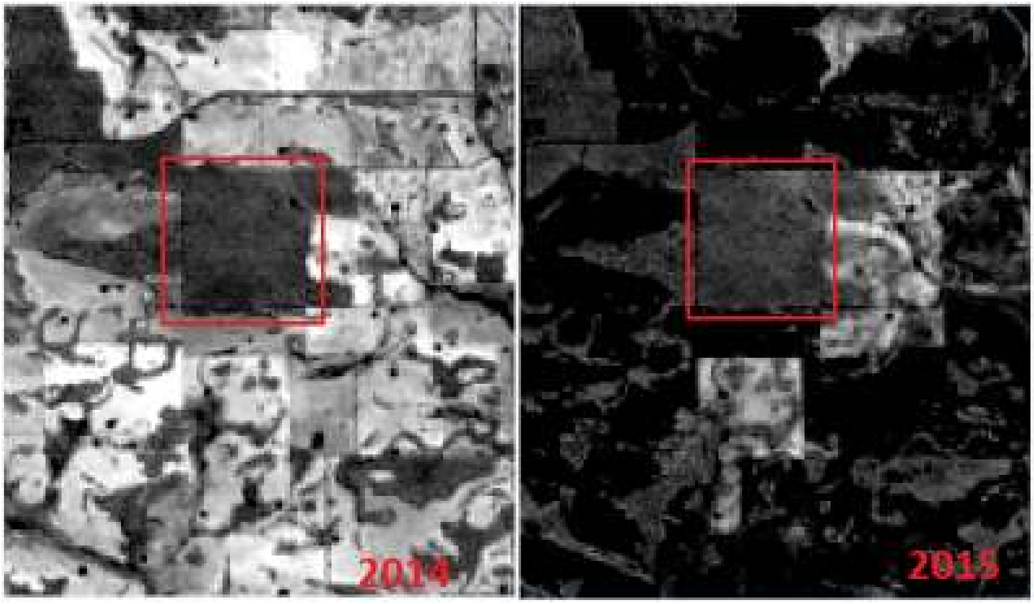
2. From the **Raster** tab, click **Unsupervised > NDVI**
3. Add **landsat8_06aug14.img** as the input image
4. Name the output image **ndvi_06aug14.img**
5. Select **Landsat 8 MS** from the Sensor drop down list



6. Click **OK** to run the process.
7. Now run the exact same process again using **landsat8_19apr15.img** as the input image and name the output image **ndvi_19apr15.img**.

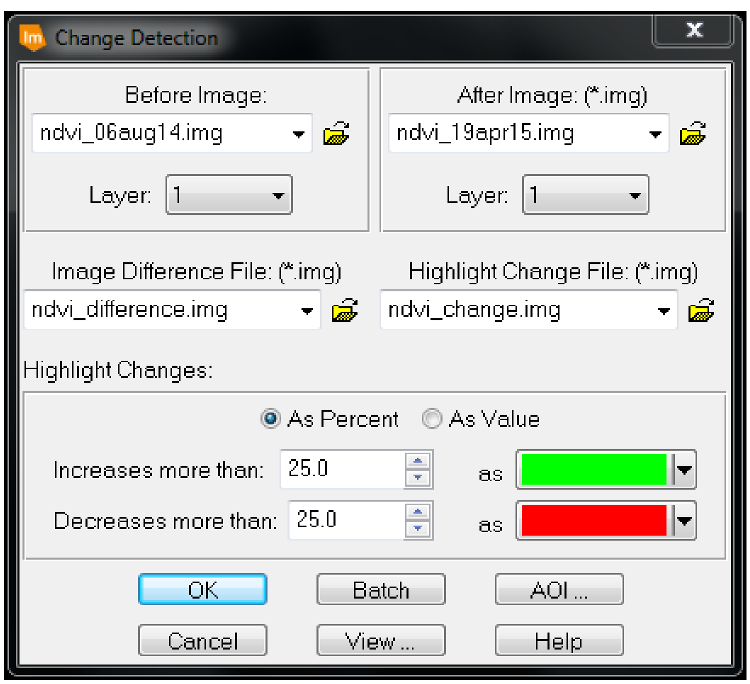
   You should now have two NDVI images. Assess the images, can you spot any initial differences between the two datasets?

   The vegetation health in these images seem very different, because in reality they are. The vegetation health may have changed due to the differences season, drought or farming, however we can still find areas where the vegetation health is similar.



The areas in red show vegetation with similar infra-red reflectance during both seasons.

8. From the Raster tab click **Zonal Change Detection Express > Image Difference.**
9. For the **Before Image** add **ndvi_06aug14.img.**
10. For the **After Image** add **ndvi_19apr15.img.**
11. Save the Image Difference as **ndvi_difference.img** and the Highlight Change File as **ndvi_change.img.**
12.



13. Assesse

14.

Class Notes