

# Image Difference Change Detection in ENVI EX using QuickBird Imagery

## Introduction

Satellite remote sensing is an ideal platform when detecting change around the globe. These changes, in turn, influence management and policy decision making. DigitalGlobe's vast archive of historical data combined with rapid collection of current imagery allow for an accurate glimpse of what has occurred on land over time therefore allow mapping of the extent and monitoring and assessment of: Environmental Analysis, Economic Analysis, Disaster Management, Political Upheaval, and any situation on the face of the earth that involves visible change.

In this tutorial, we use the Image Difference Change Detection workflow to compare two images of an area over Indonesia that was impacted by the December 26, 2004 tsunami. The first image (Fig.1) is a before image and was taken in April 2004. The second image was taken in January 2005.

Fig.1, shown below, is from tsunami\_before.tif, The Fig. 2 image shows tsunami\_after.tif in a Portal. You can see in the Portal that there are substantial differences between the two images when you adjust the Transparency sliders on the toolbar. Specifically, many vegetation areas were washed out by the tsunami.



Fig.1. Pre-Tsunami image



Fig.2. Pre and Post Tsunami (Post Tsunami in portal window)

### *References*

#### **Auto-thresholding:**

Otsu's: Otsu, N., 1979. A threshold selection method from gray-level histograms. *IEEE Trans. Systems Man Cybernet.* 9, 62–66.

Tsai's: Tsai, W., Moment-preserving thresholding. *Comput. Vision Graphics Image Process.* Vol. 29, pp. 377–393, 1985.

Kapur's: Kapur, J., Sahoo, P., Wong, A., A new method for graylevel picture thresholding using the entropy of the histogram. *Comput. Vision Graphics Image Process.* Vol. 29 (3), 273–285.

Kittler's: Kittler, J., Illingworth, J., Minimum error thresholding, *Pattern Recogn.* Vol. 19, pp. 41–47, 1986.

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### Selecting Files for Image Difference Change Detection

In the File Selection panel, choose the two images to include in image difference change detection.

1. Start ENVI EX.
2. In the Toolbox, double-click **Image Difference**. The Select **File** panel appears.
3. Click **Browse** next to the **Time 1 File** field. The Select **Time 1 Input File** dialog appears.
4. Click **Open File**. The Open dialog appears.
5. Navigate to the folder that contains the pre-tsunami image, in this example we are using a QuickBird\* image called tsunami\_before.tif. Select **tsunami\_before.tif** and then **Open**.
6. Click **OK**.
7. Click **Browse** next to the **Time 2 File** field. The Select **Time 2 Input File** dialog appears.
8. Click **Open File**. The Open dialog appears.
9. Navigate to the folder that contains the post-tsunami image, in this example we are using a QuickBird image called tsunami\_after.tif. Select **tsunami\_after.tif**, and click **Open**.
10. Click **Next**. The Image Difference panel displays.

### Image Difference Change Detection

In the Image Difference panel, set the parameters to use for the difference analysis. In this step, you perform image difference analysis based on a band or feature index. Feature index provides options to detect changes of a specific feature such as vegetation, water, built-up areas, or fire burn areas. For the QuickBird data used in this exercise, Vegetation Index (NDVI) and Water Index (NDWI) are available. Built-up Index and Burn Index are available only if an image has a shortwave infrared band, such as Landsat data,

1. In the **Difference Band** tab, **Input Band** and Band 1 were selected by default.
2. In the toolbar **Go To** field, we enter 746319.499, 585303.471 (UTM coordinates) and press the **Enter** key on the keyboard. The Image window centers over the area.
3. Enable the **Preview** check box. A Preview Portal appears. In the Preview Portal, areas that decreased in the data value of the selected band appear as red, and areas that increased appear as blue.

*\*This process is primarily suited for DigitalGlobe's multispectral satellites (QuickBird and WorldView-2) as it utilizes the spectral bands for analysis of NDVI and NDWI, etc..*

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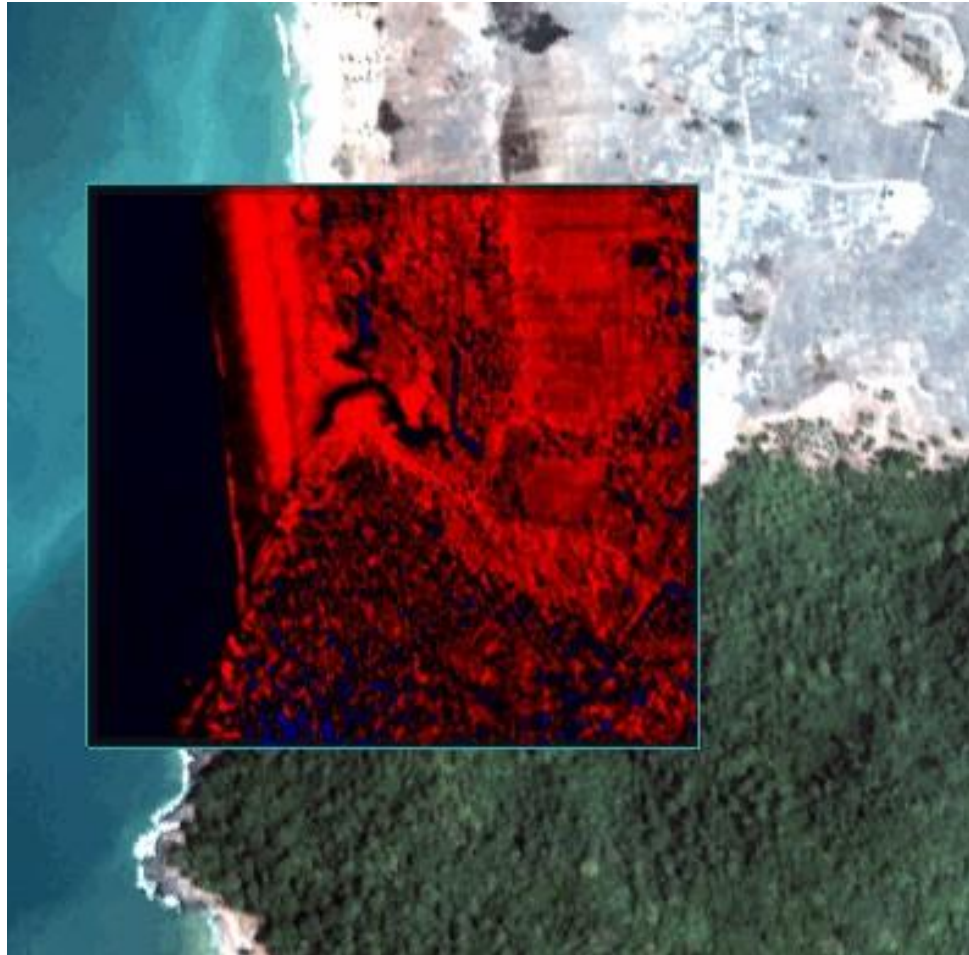


Fig.3. Preview Portal Image Difference Change Detection

4. With the Preview Portal still open, enable **Feature Index** as the difference band and keep **Vegetation Index (NDVI)** as the selected feature index.

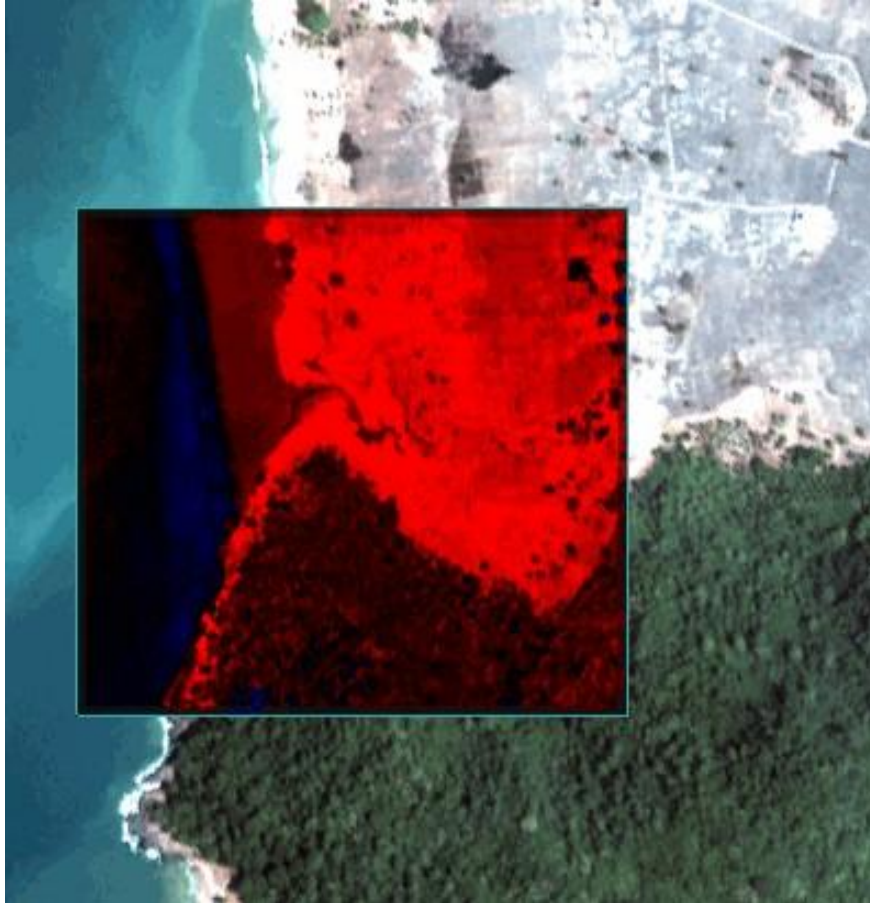


Fig.4. Image Difference

5. Disable the **Preview** check box, and then click **Next**. The difference analysis begins.
  6. When image difference processing is complete, the difference image appears in the Image window and the Thresholding or Export panel appears.
  7. Select **Apply Thresholding**. This option allows you to set parameters that help the algorithm determine which areas have big change. When you select this option, you can export multiple outputs at the end of the workflow. (If you select **Export Image Difference Only**, you will not be able to select additional processing parameters and you can only export the difference image.)
  8. Click **Next**. The Change Thresholding panel appears.
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## Change Thresholding

In the Change Thresholding step, specify change you want to show between the two images. You can use pre-set auto-thresholding techniques, and you can manually adjust thresholding.

1. In the **Auto-Thresholding** tab, select **Increase and Decrease**. This option shows areas of increase (in blue) and decrease (in red). (If you are only interested in areas of vegetation decreased by the tsunami, select **Decrease Only**.)

2. Enable the **Preview** check box. A Preview Portal opens.

3. In the **Select Auto-Thresholding Method** drop-down list, try selecting each option, one at a time, then examine the result in the Preview Portal. The auto-thresholding choices are:

**Otsu's:** A histogram shape-based method. It is based on discriminate analysis and uses the zeroth- and the first-order cumulative moments of the histogram for calculating the value of the thresholding level.

**Tsai's:** A moment-based method. It determines the threshold so that the first three moments of the input image are preserved in the output image.

**Kapur's:** An entropy-based method. It considers the thresholding image as two classes of events, with each class characterized by a Probability Density Function (PDF). The method then maximizes the sum of the entropy of the two PDFs to converge on a single threshold value.

**Kittler's:** A histogram shape-based method. It works on approximating the histogram as a bimodal Gaussian distribution and finds a cutoff point. The cost function is based on the Bayes classification rule.

*The [References](#) at the beginning of this tutorial provide additional information about the auto- thresholding methods.*

4. In this exercise, we will use the default **Otsu's** thresholding method. Below is an example of the Preview Portal with the **Otsu's** method selected.
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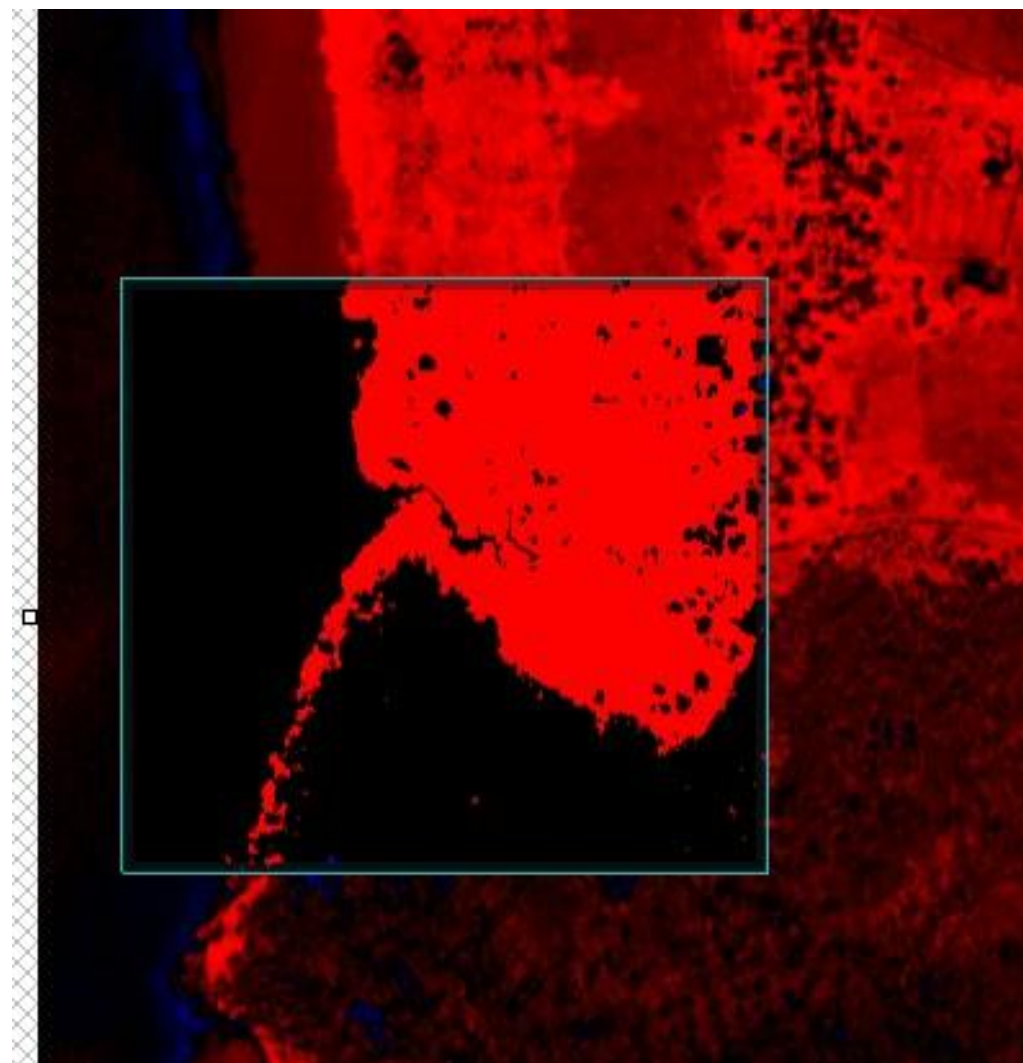



Fig.5. Preview Panel with Otsu's Threshold method

5. You can also experiment with manually adjusting the threshold settings. To do this, select the **Manual** tab.
  6. Use the slider bars to adjust the **Increase Threshold** and **Decrease Threshold** settings then view the changes in the Preview Portal.
  7. When you are done experimenting with manual adjustments, click the  **Reset** buttons to return to the default settings.
  8. Click **Next**. When you click **Next**, the difference image will be classified into **Big Increase**, **Big Decrease** and **Other**, based on the threshold values. The Cleanup panel appears.
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### *Cleaning Up Image Difference Change Detection Results*

The cleanup step refines the result. You can preview what the refinement will like look before you apply the settings.

1. Enable the check boxes for both cleanup methods:

**Enable Smoothing** removes salt and pepper noise.

**Enable Aggregation** removes small regions.

2. Enter values for the cleanup methods:

Specify the **Smooth Kernel Size** using an odd number (e.g., 3 = 3x3 pixels). The square kernel's center pixel will be replaced with the majority class value of the kernel. Keep the value at **3**.

Specify the **Aggregate Minimum Size** in pixels. Regions with a size of this value or smaller are aggregated to an adjacent, larger region. Enter a value of **100**.

3. Preview the cleanup result before processing, enable the **Preview** check box. A Preview Portal appears.

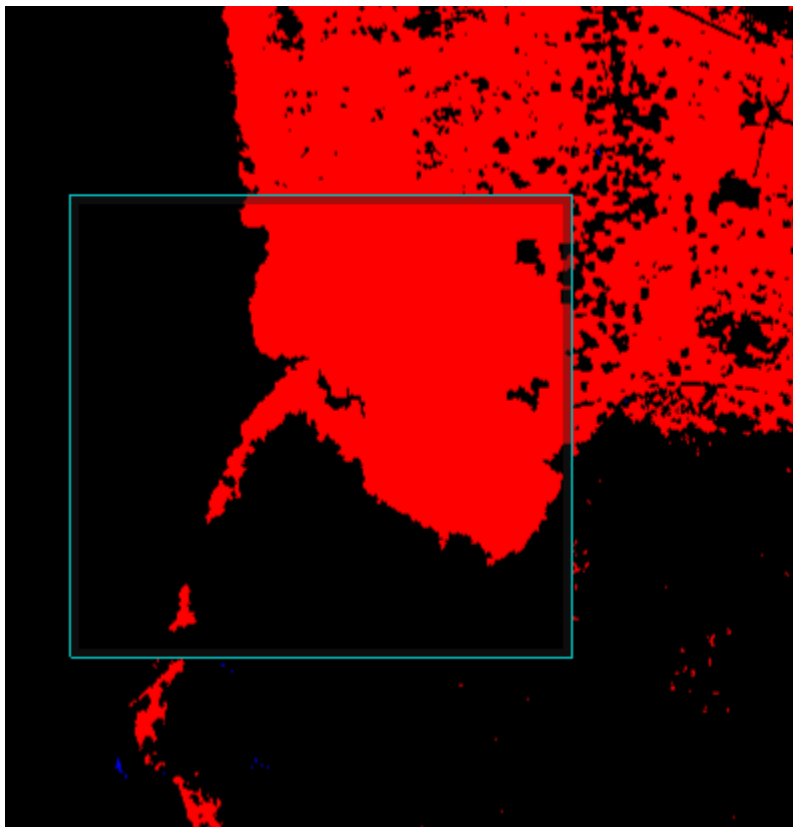


Fig.6. Preview Portal (Clean Up Stage)

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You can change the cleanup settings and preview the results again, if desired.

4. Click **Next**. The Export panel appears.

### *Exporting Image Difference Change Detection Results*

In the final step of the workflow, you will save the output from the analysis. To export results:

1. In the **Export Files** tab, enable the check boxes for the exports:
  - Export Change Class Image** saves the thresholding result to a raster file.
  - Export Change Class Vectors** saves the vectors created during thresholding to a shapefile.
2. Use the default paths and filenames.
3. In the **Additional Export** tab, enable the check boxes for the remaining exports:
  - Export Change Class Statistics** saves statistics on the thresholding image.
  - Export Difference Image** saves the difference image to a raster file.
4. Use the default paths and filenames.
5. Click **Finish**. ENVI EX creates the output, opens the layers in the Image window, and saves the files to the directory you specified.
6. Select **File > Exit** to exit ENVI EX.

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Additional Documents and Imagery Product Samples may be downloaded from here

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