

## **“HYDROHASARDS” PostGraduate Study Program**

### **Remote Sensing Lab Exercises**

#### **LAB 4: Georeferencing and registration - Estimation of Surface Temperature**

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#### **Image correction and registration**

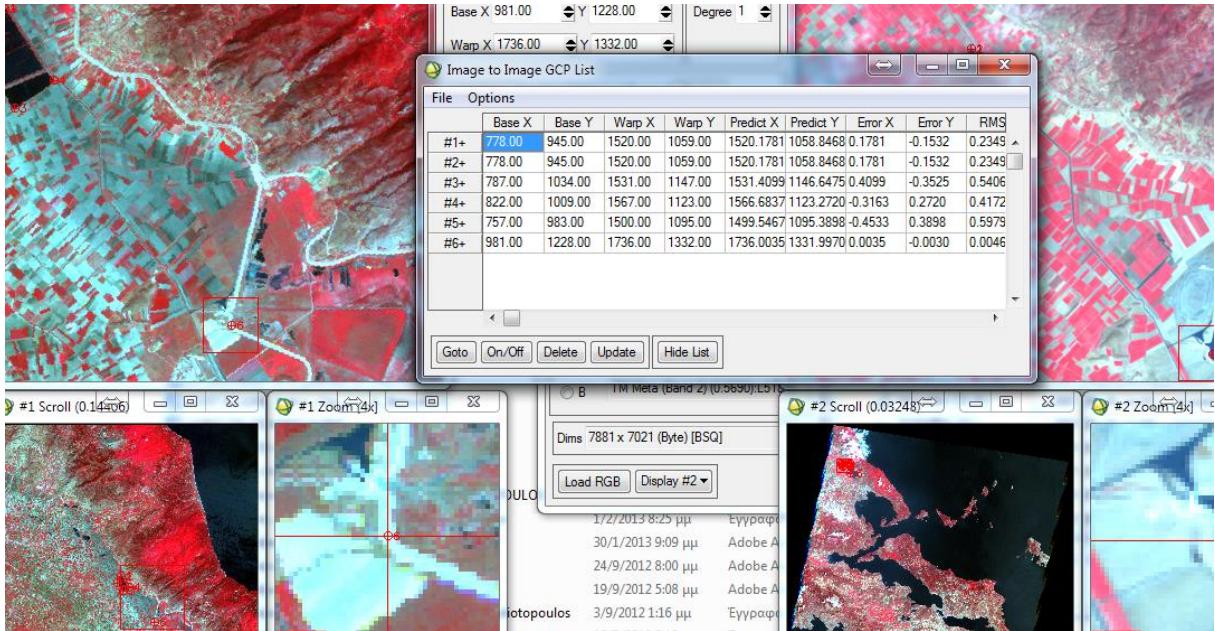
Image registration and geometric correction utilities allow you to reference pixel-based images to geographic coordinates and/or correct them to match base image geometry. Ground control points (GCPs) are selected using the full resolution (Main Image) and Zoom windows for both image-to-image and image-to-map registration. Coordinates are displayed for both base and uncorrected image GCPs, along with error terms for specific warping algorithms. Next GCP point prediction allows simplified selection of GCPs. Warping is performed using resampling, scaling and translation (RST), polynomial functions (of order 1 through n), etc. Resampling methods may include nearest-neighbor, bilinear interpolation, and cubic convolution. Comparison of the base and warped images using ENVI’s multiple Dynamic Overlay capabilities allows quick assessment of registration accuracy.

#### *Image to Image Registration*

1. Open the base image file. From the ENVI main menu bar, select Map → Registration→ Select GCPs: Image to Image. The Image to Image Registration dialog appears.
2. Click on the Base image to select it. For the Warp Image select the new given image.
3. Click OK to start the registration. This opens the Ground Control Points Selection dialog. Individual ground control points (GCPs) are added by positioning the cursor position in the two zoom images to the same ground location.
4. Navigate to a point in the base image and the warp image that show the exact same location (e.g. the end of a bridge or construction) –Hint: You can right click on any of your images and use a Geographic Link for navigating to roughly the same location in your images. You must UNLINK before you begin your fine scale navigation!
5. Examine the locations in the two Zoom windows and adjust the locations if necessary by clicking the left mouse button in each Zoom window at the desired locations. Note that sub-pixel positioning is supported in the Zoom windows. **The larger the zoom factor, the finer the positioning capabilities.**
6. In the Ground Control Points Selection dialog, click Add Point to add the GCP to the list. Click Show List to view the GCP list. Try this for a few points to get the feel of selecting GCPs. Note the list of actual and predicted points in the dialog. After you have at least 5 points, the RMS error is reported.

7. Choose up to 20 pairs of points in your warp image subset and the base image in the same manner that you chose the first pair. **In order to achieve a good registration, it is extremely important to place your GCPs evenly throughout the image.**

After selecting the 20 pairs, click on individual GCPs in the Image to Image GCP List dialog and examine the locations of the points in the two images, the actual and predicted coordinates, and the RMS error. Resize the dialog to observe the total RMS Error listed in the Ground Control Points Selection dialog. In the GCP list you can order points by error (Options→Order Points by Error) to see which GCPs are contributing the most to your RMSE

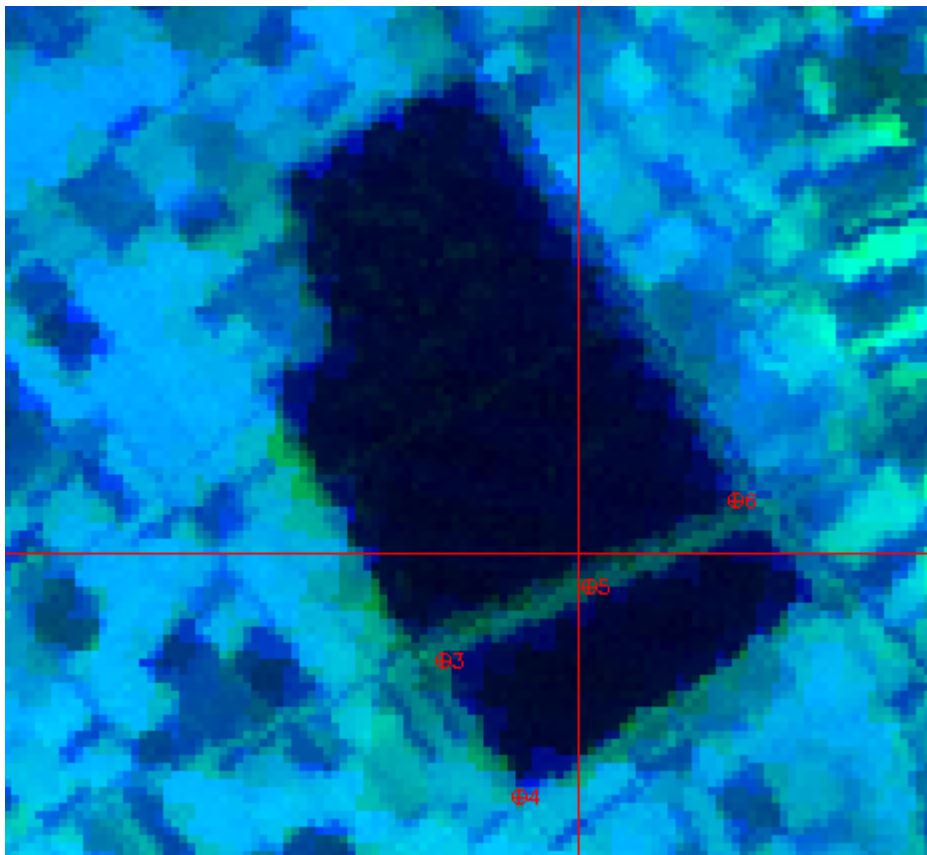


### *Working with GSPs*

The position of individual GCPs can be edited by selecting the appropriate GCP in the Image to Image GCP List dialog and editing in the Ground Control Points Selection dialog. Either enter a new pixel location, or move the position pixel-by-pixel using the direction arrows in the dialog. Clicking on the On/Off button in the Image to Image GCP List dialog removes selected GCPs from consideration in the Warp model and RMS calculations. These GCPs aren't actually deleted, just disregarded, and can be toggled back on using the On/Off button. In the Image to Image GCP List dialog, clicking on the Delete button removes a GCP from the list. Positioning the cursor location in the two Zoom windows and clicking the Update button in the Image to Image GCP List dialog updates the selected GCP to the current cursor locations. The Predict button in the Image to Image GCP List dialog allows prediction of new GCPs based on the current warp model.

1. Try positioning the cursor at a new location in the base image. Click on the Predict button and the cursor position in the warp image will be moved to match its predicted location based on the warp model.
2. The exact position can be interactively refined by moving the pixel location slightly in the warp image window.

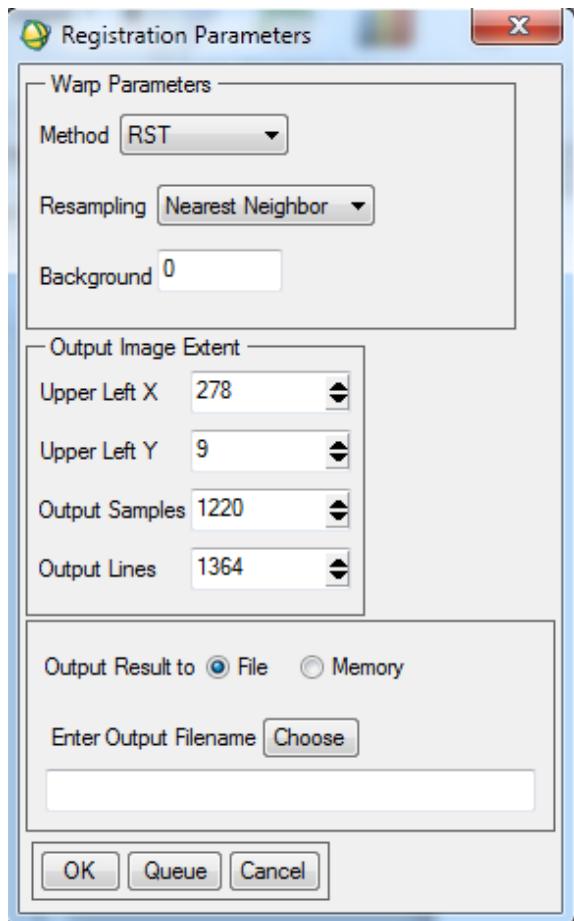
3. In the Ground Control Points Selection dialog, click Add Point to add the new GCP to the list.
4. In the Image to Image GCP list dialog, select Options → Order points by error. Click on the pairs with maximum RMS error and try to refine their positions reducing the overall RMS error.
5. Once 20 pairs are selected, save your GCP points by selecting, File → Save GCPs to ASCII. Choose your output folder and give the “desired name”.pts to the points file. Record the name of this file, where it is saved, how many points there are, as well as the related RMSE.



### *Warp Images*

Images can be warped from the displayed band, or all bands of multiband images can be warped at once.

1. In the Ground Control Points Selection dialog, select Options → Warp File
2. The Registration Parameters dialog appears. Use the Warp Method pulldown menu to select RST, and the Resampling button menu to select Nearest Neighbor resampling.
3. Make any other required settings
4. Choose your output folder, enter the desired filename and click OK. The warped image will be listed in the Available Bands List when the warp is completed.



Load the warped file to a new image window. Connect the base image, and the warped image using the geographic link (Right-click in the Main Image Window and select Geographic Link). Toggle on the cursor crosshairs in each zoom window and click around the images. With the geographic link, pixels with the same geographic coordinates should be centered in each zoom window. Do the different images all line up? Has your geo-registration improved the correspondence of the initial image to the base image?

## **Estimation of land surface temperature**

In this exercise, you can learn how to compute Land Surface Temperature. Use the previous given Landsat TM file and work with the thermal channel (band 6).

Open the file that ends with “\_MTL.TXT”.

ENVI will automatically open the Landsat image as multiple files: the 6 bands of optical data as one file, and the thermal band as another. In the case of ETM images (Landsat 7) the thermal file will have two bands and there will also be a single band file for the panchromatic band. Do the following steps:

**STEP 1.** Conversion of the digital Number (DN) to Spectral Radiance (L).

$$L = L_{\text{MIN}} + (L_{\text{MAX}} - L_{\text{MIN}}) * \text{DN} / 255$$

Where

L = Spectral radiance

$L_{\text{MIN}} = 1.238$  (Spectral radiance of DN value 1)

$L_{\text{MAX}} = 15.303$  (Spectral radiance of DN value 255)

DN = Digital Number

### **PLEASE NOTE:**

You need to change  $L_{\text{MIN}}$  and  $L_{\text{MAX}}$  for each thermal scene.

You can find these values in satellite header file.

**STEP 2.** Conversion of Spectral Radiance to Temperature in Kelvin

$$T_{B_K} = \frac{K_2}{\ln\left(\frac{K_1 * \varepsilon}{L} + 1\right)}$$

where

$K_1$ = Calibration Constant 1 (607.76)

$K_2$  = Calibration Constant 2 (1260.56)

$\varepsilon$ = emissivity (typically 0.95)

$T_{B_K}$  = Surface Temperature

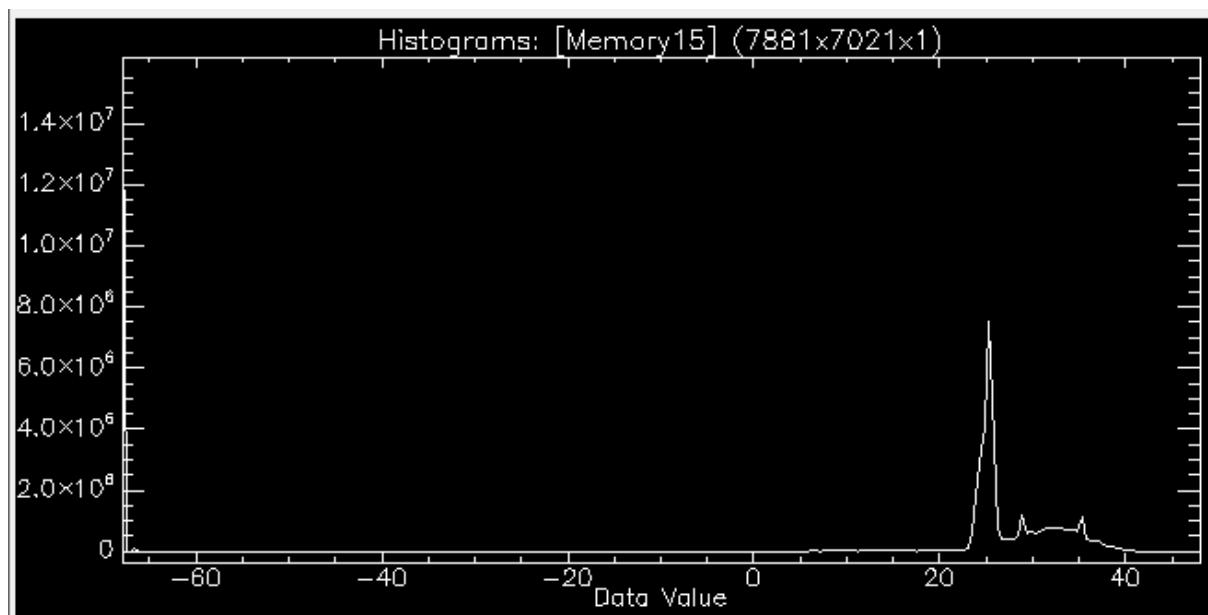
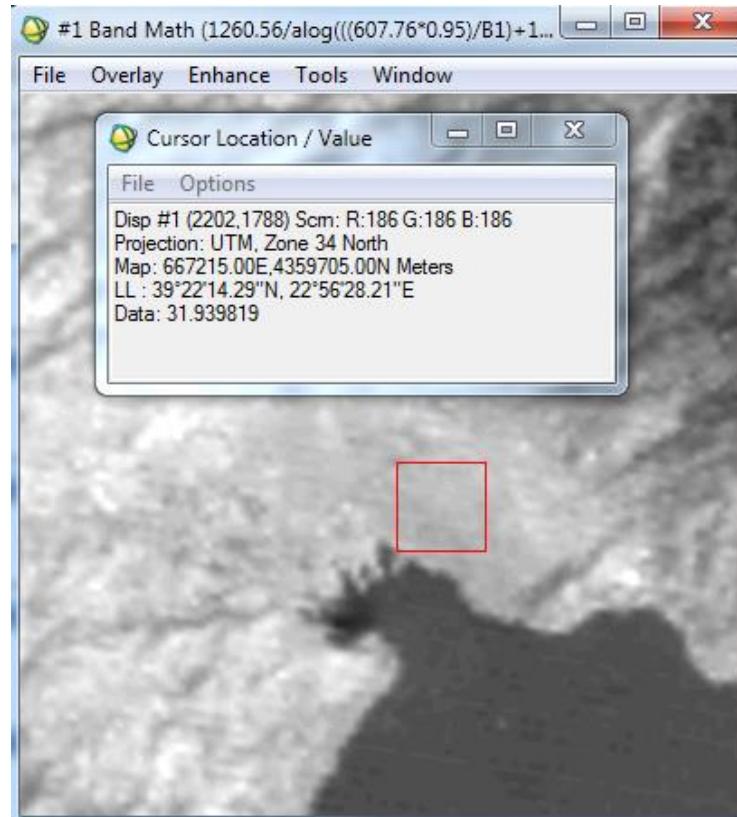
When using ENVI software, the formula in Band Math will look like  
 $1260.56 / \text{alog}(((607.76 * 0.95) / B1) + 1)$

**STEP 3.** Conversion of Kelvin to Celsius

$$T_{B_C} = T_{B_K} - 273$$

Specify the output file and open the new image. Now **check your temperature** values. Review the related histogram! From the Basic Tools sub-menu select “Compute Statistics” and then select “Histograms”.

This is it!



Then, calibrate the new image and convert it to EGSA '87 system.

**GOOD LUCK!**

Brightness  
temperature