GIS CASE STUDY

Application of GIS for hazard and risk assessment: Tegucigalpa, Honduras

Part 2: Data preparation

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Although this exercise doesn't deal directly with specific hazard or risk related topics, it is a good introduction to the dataset, and to some of the functionalities of GIS (ILWIS in this case) that are useful in disaster management.

We will concentrate on the following aspects:

- Georeferencing the Lidar image of Tegucigalpa
- Generation of an artificial stereopair of a part of Tegucigalpa using an orthophotoimage and a Lidar DEM for visual 3-D digital interpretation
- Accuracy checking of the Lidar DEM in comparison with a DEM derived from topomap.

Disclaimer

The material in this exercise is for training purposes only. The results should not be used in actual planning of the city of Tegucigalpa as ITC does not guarantee the accuracy and precision of the input data.

The GIS software that will be used in this exercise is the Integrated Land and Water Information System (ILWIS), version 3.12, which contains useful tools for digital stereo pair generation.

Acknowledgements

We would like to thank Gonzalo Ernesto Funes Siercke from COPECO for providing us the data.

2.1 Georeferencing base data and preparation of digital stereopair

This exercise will first deal with the application of a number of image processing tools for georeferencing the Lidar image, and for developing a digital stereopair, which you will later interpret directly on the screen.

Time requirement: 4 hours

Objectives:

- Georeference the Lidar image using a hillshading image and the detailed orthoimage for finding ground control points.
- Create an artificial stereopair from the Lidar image and the detailed orthoimage
- Compare the Lidar DEM with a DEM derived from contour interpolation.

Input data:

- Lidar data for Tegucigalpa (date : ????): **Lidar_tegu** (raster map)
- Orthophotomosaic of the northern part of Tegucigalpa: **Ortho_tegu** (raster map)
- Road map of the city: **Roads_tegu** (segment map)
- Contour map of the city, digitized from topographic maps (contour interval 2.5 meters): **Contour_map** (segment map)

2.1.1 Georeferencing the Lidar image

Time requirement: 2 hours

In this first exercise you will georeference the Digital Elevation Model which is made by laser scanning (LIDAR). The image contains the raw data, which has not been corrected for artifacts, such as houses and trees.

The georeferencing will be done by finding control points, that are recoganizabel both on the Lidar image as well as on the orthophotomosaic, which has a pixelsize of 1 meter. In order to be able to see the same features we would first have to make a hillshading map of the Lidar image, from which it will be possible to see the individual buildings.

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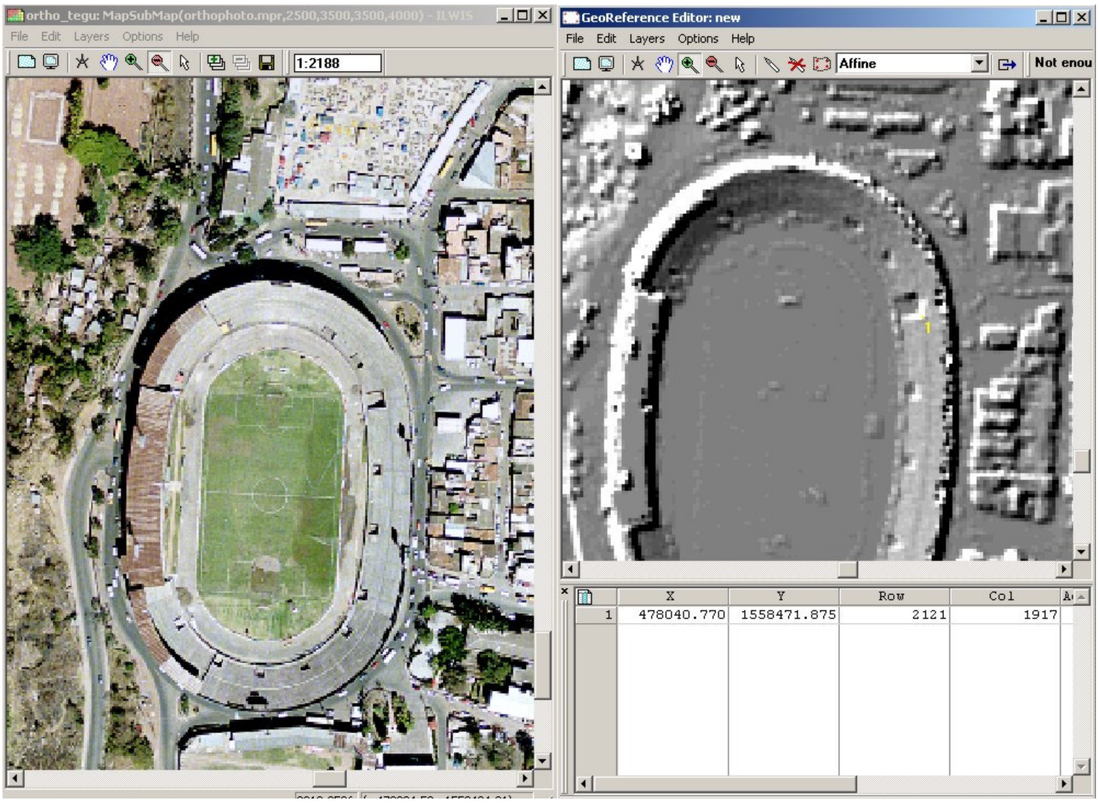
- Open the raster map **Lidar_tegu**. Display the map with a pseudo color representation. Zoom in on the center of the city. You will not be able to see individual buildings now. Change in the display options the stretch to 920 – 1000. Now you will see some of the buildings. To see all buildings you will have to make a hillshading image, by using a filter.
- Generate a hillshading image from the Lidar map. Use *Operations / Image processing / Filter*. Select the linear filter **Shadow**. Name the output map: **Shadow**.
- Display the map **Shadow**, using a grey represenation, and stretch between –25 and +25. When you zoom in you will now be able to see the individual buildings
- Open the orthophoto map: **Ortho_tegu** and compare this image with the hillshading image **Shadow**. Zoom in on the stadium in both images. You will be able to see recognize in detail the same features

- Select Operations / Image In the File menu, select *Create Georeference*. Name the georeference **New** and make sure *Tiepoints* is selected. Next click the OK button
- Position the window with the Lidar_tegu and the map Ortho_tegu next to each other, as indicated in the figure below, and zoom in on the stadium.



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- Search for the same point in the stadium visible both in the ortho_tegu and in the **Shadow** map. Zoom into this point in both maps.
- Select the arrow icon and click the first the point in the **Shadow** map. Then go to the **ortho_tegu** map, select the arrow and click on the corresponding point. Do this as exact as possible
- Repeat this procedure at least 5 times for other points. Make sure that you select points in different parts of the **Shadow** map; in other words, avoid points which are clustered together.
- Once you have digitized three control points, you can already overlay segement information. On the **Shadow**, go the *Add layer* from the *Layers* menu and select **roads_tegu**. Zoom in to observe the results of your georeferencing procedure. Also overlay the raod map on the map Ortho_tegu. This makes it easier to recognize the same points in both images.
- When you have entered at least four points, you will see a value for the Sigma (error). Try to select the points in such a way that the sigma is below 1.

- If the fit is good and the error is within acceptable limits, close the editor (special button). If you are not satisfied, entered more tiepoints. When you are finished, select *Exit Editor* from the *File* menu
- Close both map windows.

The next step is to resample the image **Lidar_tegu** so that it fits on the map **Ortho_tegu**. For that you will need to resample it according to the georeference of the map **Ortho_tegu**, which is called **Tegucigalpa**. However, the new georeference has not been made for the map **Lidar_tegu**, but for the derived map **Shadow**. We will first have to assign the georeference tiepoints: New also to the map **Lidar_tegu**, before we can resample it.

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- Right click on the map **Shadow**, and open the properties form. Find out what is the name of the Georeference. Do the same for the mpas **Ortho_tegu** and **Lidar_tegu**. Also check the number of rows and columns:

	Georeference	Pixelsize	Nr Rows	Nr Columns
Ortho_tegu				
Shadow				
Lidar_tegu				

- As you see they are all three different. We need to resample the map **Lidar_tegu** to the georeference of **Ortho_tegu**.
- In the properties form of the map **Lidar_tegu**, change the georeference to **New**. Now you can resample the image.
- Select *Operations / Image Processing / Resample* . Select Raster map: **Lidar_tegu**. Select georeference **Tegucigalpa**. Type Output map: **Lidar_dem**. Select resampling method: **nearest neighbour**. Select precision of 0.01. Click Show.

The resampling now starts. It may take some

Question: What would happen if you select Bilinear or Bicubic?

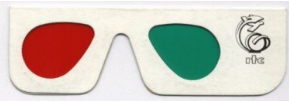
Question: What does a precision of 0.01 mean in this case?

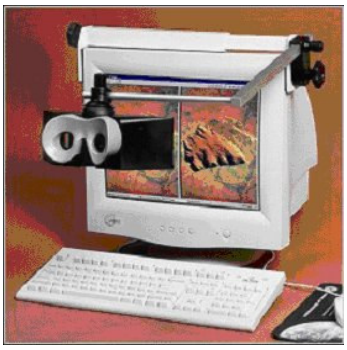
- Check the properties of the resulting map **Lidar_dem**. How many rows and columns? And which pixelsize?
- Open the resulting map **Lidar_dem** and overlay the roads and rivers on it, and check the result.

2.1.2 Creating a digital stereopair.

Time requirement: 1 hour

A stereo pair allows you to view raster maps, scanned photographs or images in stereo, using a stereoscope mounted onto your monitor or red-green or red-blue glasses (anaglyph).





A stereo pair can be calculated:

- with the *Epipolar Stereo Pair* operation which requires two raster images with overlap as input, for instance two scanned aerial photographs with overlap. In the output stereo pair, you will be able to view the area of overlap in stereo or,
- with the *Stereo Pair From DTM* operation with a *single raster map* as input, for instance a scanned photograph or an image, and a Digital Terrain Model (DTM). In the output stereo pair, you will be able to view the whole area of the input map displayed over the DTM in stereo.

A stereo pair can be displayed:

- in a stereoscope window (a stereoscope is required) or
- as an anaglyph in a map window (red-green or red-blue glasses is required).

Objectives:

- Create an artificial stereopair from the Lidar image and the detailed orthoimage

Input data:

- The resampled Lidar image for Tegucigalpa which was made in the previous exercise: **Lidar_dem** (raster map) If you did not make this map you can copy it from the subdirectory /results.
- Orthophotomosaic of the northern part of Tegucigalpa: **Ortho_tegu** (raster map)

We will first generate a stereoimage from a colour image and a DEM.

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- Select *Operations / Image Processing / Stereo Pair from DTM*. In the form enter the following information:

  Raster Map = **Otho_tegu**

  DTM = **Lidar_dem**

  Look angle and reference height: keep as they are. (for more information on them check the ILWIS help)

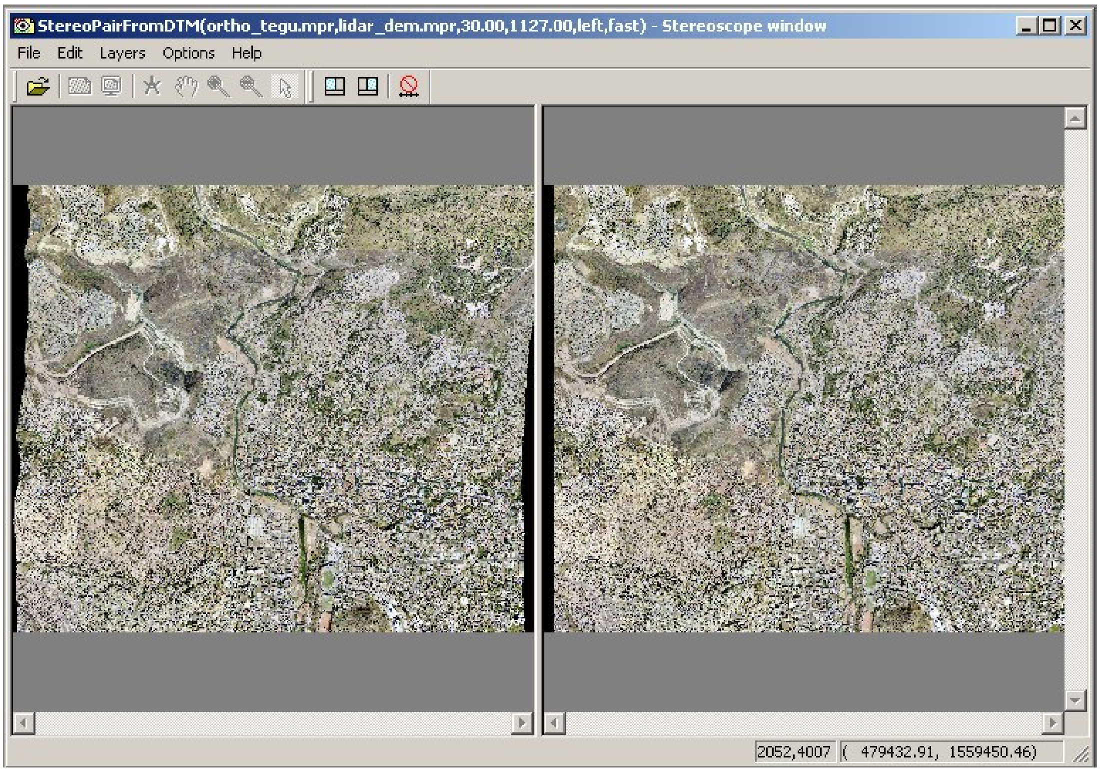
  Look modus: Left

  Resample modus: fast

  Output map: **Ortho_stereo**

- Click Show. The calculation will take some time.

The following window will now open:



In order to see the images in stereo, you will need a screen stereoscope. The use of the screen stereoscope will be demonstrated. The following part can only be done if you have a screen stereoscope mounted on your system.

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- Maximize the window, and adjust the screen stereoscope so that you can see in stereo.
- Zoom in so that you can see individual buildings. You might have to unlock the image using the red traffic light symbol, and move one of the two windows until you see stereo. Than lock it again.
- Use the hand to browse through the window.
- Make sure that you have the right window (which is georeferenced) is selected.
- Overlay the polygon map Flood_Mitch on the right image (select the transparency button and use 50% transparency). Now you can also evaluate the buildings that were affected during the Mitch flood event.

In a later exercise we will use this image for the interpretation of elements at risk.

It is also possible to make a stereoimage that you can see using anaglyph glasses. That is however only possible for black and white images, since the anaglyph technique uses its own colour scheme. In the next exercise we will make a stereo pair using a black and white version of the map **Ortho_tegu**.

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- Select *Operations / Image processing / Colour separation.*

- Select Raster map: **Ortho_tegu**, and select gray. Name the output map: **Ortho_tegu_BW**. Click Show.
- Next repeat the operation *Stereopair from DTM*. But now select the map **Ortho_tegu_bw** as raster map, **Lidar_dem** as DTM, and also select Left look modus and fast resampling. Name the output map: **Ortho_stereo_bw**
- When the calculation is finished the steropair will open in a dual-window. Close the window.
- Display the resulting image now as an anaglyph. Select *Operations / Visualization / Show stereo Pair / as analgyph*. Select the map **Ortho_stereo_bw**.
- In the display options dialogue box, select a pixelshift of –70 (see below for explanation).
- Use the analglyph glasses to evaluate the resulting image.

The resulting anaglyph will look like the one below. You might have some problems seeing stereo when zooming in too much. It may be that the red and green elements are spaced too far away from each other in order to see stereo without straining your eyes. This can be solved by introducing different values for the pixel shift in the display options dialogue box. These value might be different for different altitudes. For example, the houses in the area near the stadium can best be viewed stereo when using a pixelshift of –70.

In the next exercise we use the images for elements at risk mapping.