# RiskCity

## Application of GIS for multi-hazard risk assessment in an urban environment

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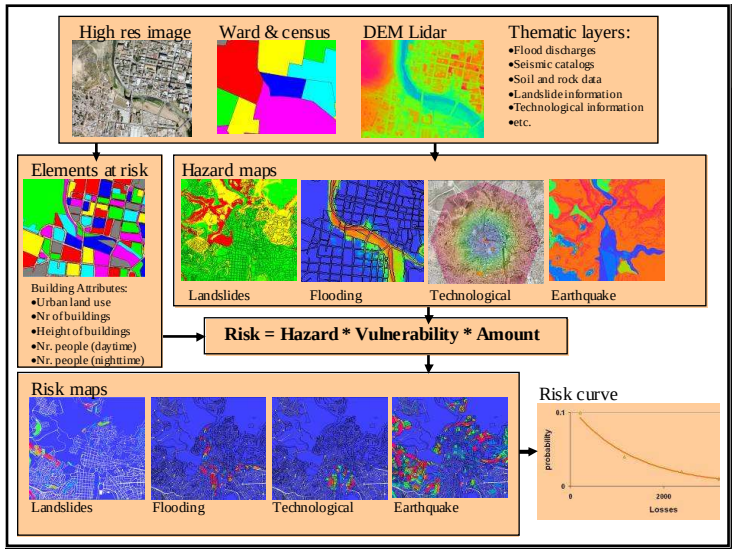
ITC

Associated Institution
UNITED NATIONS UNIVERSITY






## Objective of case study

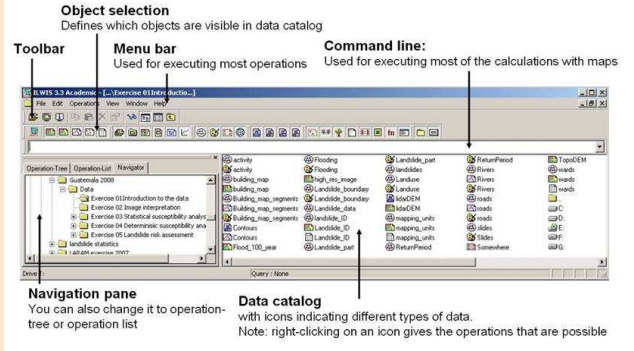
- **The objective of this exercise is to demonstrate the concepts of the use of GIS for landslide susceptibility, hazard and risk assessment in an urban setting.**
- **Risk is defined *as the probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable/capable conditions*.**
- **Risk assessment with GIS can be done on the basis of the following basic equation:**
  **Risk = Hazard * Vulnerability * Amount of elements at risk**



## ILWIS key features

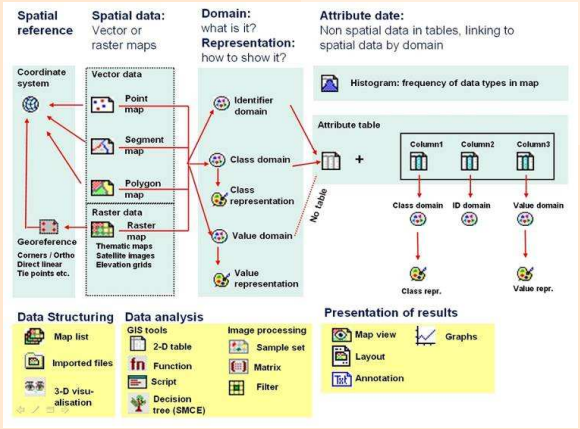
- Import and export of widely used data formats
- On-screen and tablet digitizing
- Comprehensive set of image processing tools
- Orthophoto, image georeferencing, transformation and mosaicing
- Advanced modeling and spatial data analysis
- 3D visualization with interactive editing for optimal view findings
- Rich projection and coordinate system library
- Geo-statistical analyses, with Kriging for improved interpolation
- Production and visualization of stereo image pairs
- Spatial Multiple Criteria Evaluation

# Main window






# Main structure






# Installation

**Installation instructions**

**The ILWIS binaries are very simple to install. Copy the folder in the downloaded zip file. In this folder there is an ILWIS30.EXE which is the main executable for ILWIS. Double click this file to start ILWIS.**

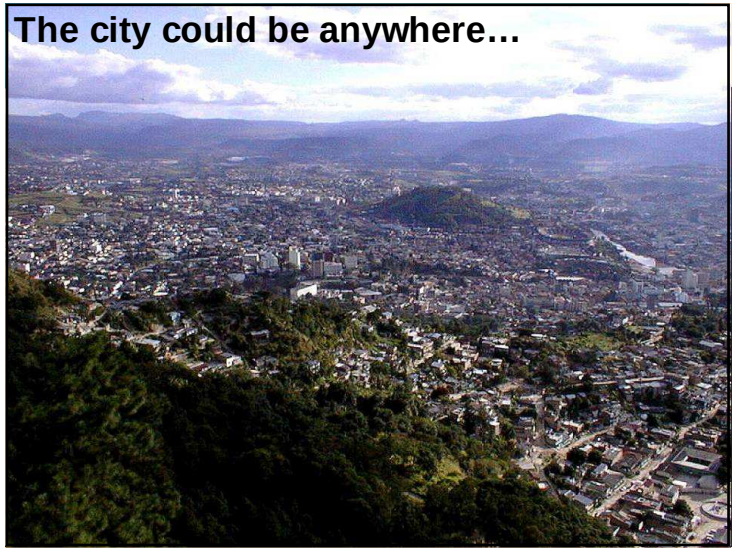
IF and ONLY IF the user wants to use the command line COM functionality of ILWIS (make the ILWIS command line available through the Windows COM functionality), the following steps must be taken. The COM registration needs two steps (assume the current directory is the directory with ILWIS30.EXE). These are started from the windows command line (via "Start|Run", or from a "Command Prompt" window).

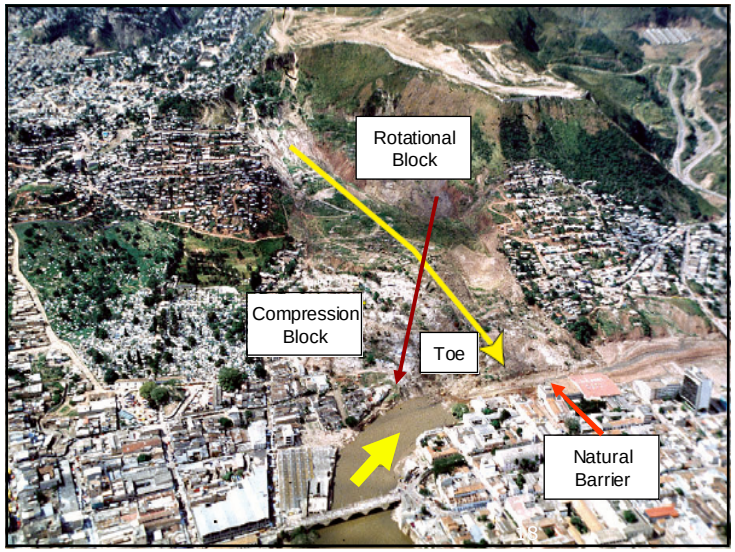
regsvr32.exe /s IlwisComProxy.dll

ilwis30.exe -RegServer

The option -RegServer needs to be typed exactly as written here. The order in which the commands are executed is not important

# The city could be anywhere…




Rotational Block
Compression Block
Toe
Natural Barrier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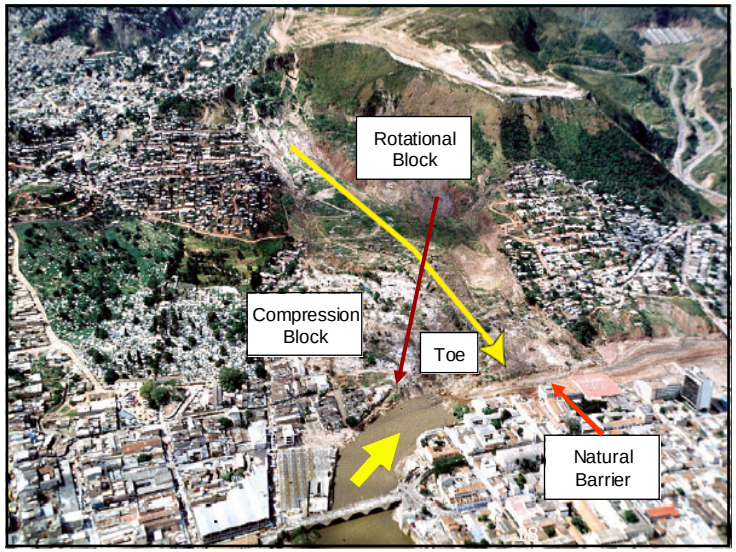
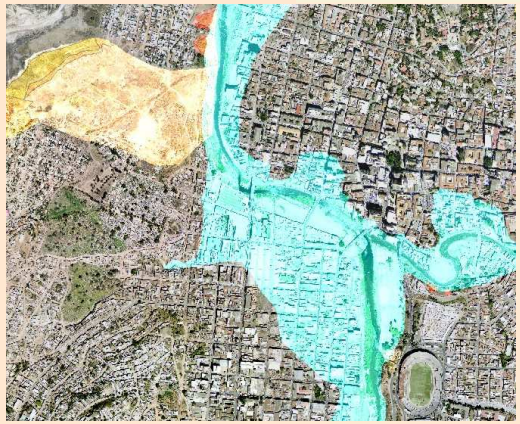
Example: Tegucigalpa, Honduras


North
Landslide
Saturday, October 31
Ponded water


Rotational Block
Compression Block
Toe
Natural Barrier

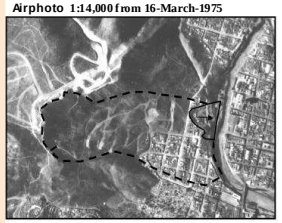
## Flood and landslide



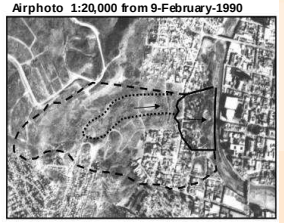


## Example: Berrinche landslide

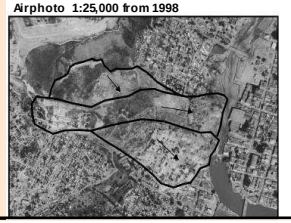
Airphoto 1:14,000 from 16-March-1975



Airphoto 1:20,000 from 9-February-1990



Airphoto 1:25,000 from 1998

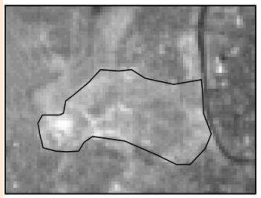


Airphoto 1:10,000 photos from May 2001

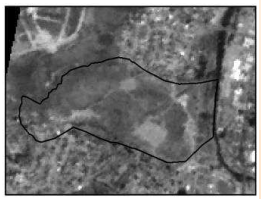


## Example: Berrinche landslide

Aster image (15 m. spatial resolution) 2005

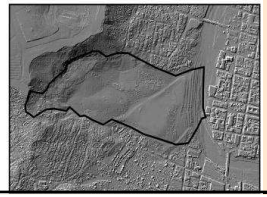


IRS-P6 (5.6 m. resolution) from 2006



Google Earth (Digital Globe image) 2007

Lidar hillshading image





## Input data

- **Image data**
- **Hazard data**
- **Elements at risk**
- **Height data**

| Name | Type |
|---|---|
| Image data | |
| High_res_image | Raster image |
| Elevation data | |
| LidarDEM | Raster map |
| Contours | Segment map |
| TopoDEM | Raster map |
| Elements at risk | |
| Wards | Polygon map |
| Mapping_units | Polygon map and table |
| Building_map | Raster map |
| Roads | Segment map |
| Hazard data | |
| Landslide_ID | Raster map |
| Flood_100_year | Polygon map |
| Rivers | Segment map |

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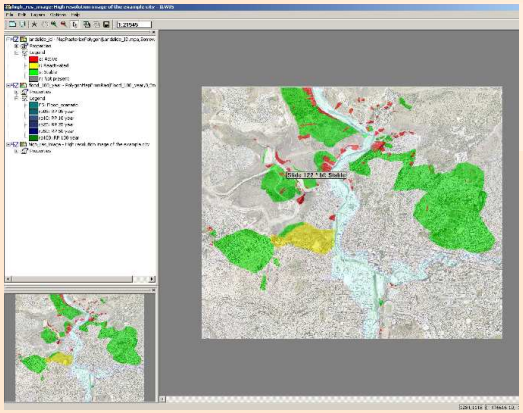
# HAZARD DATA



Landslides

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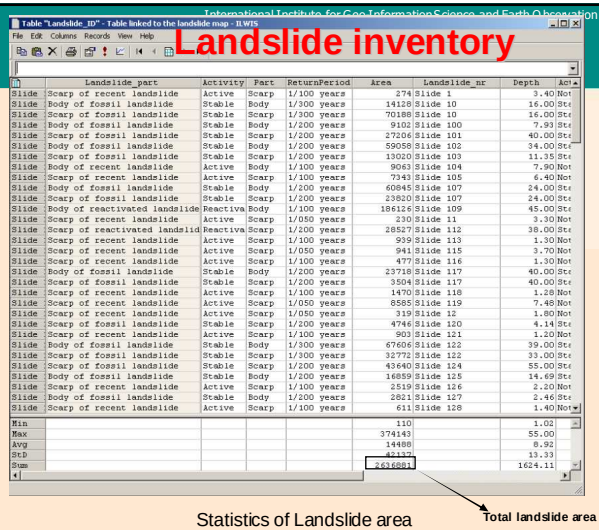
# Landslide inventory




Statistics of Landslide area

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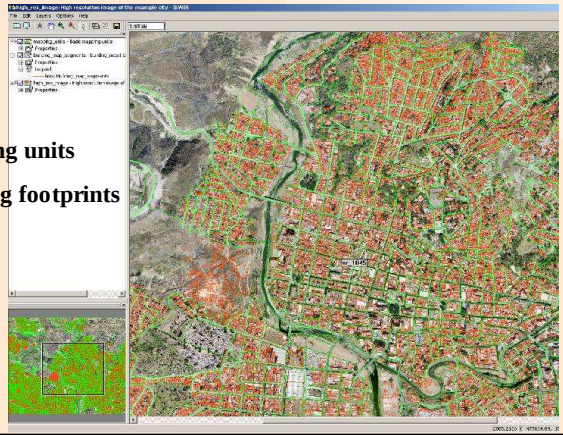
# Element at risk data

wards

mapping units

building footprints

roads



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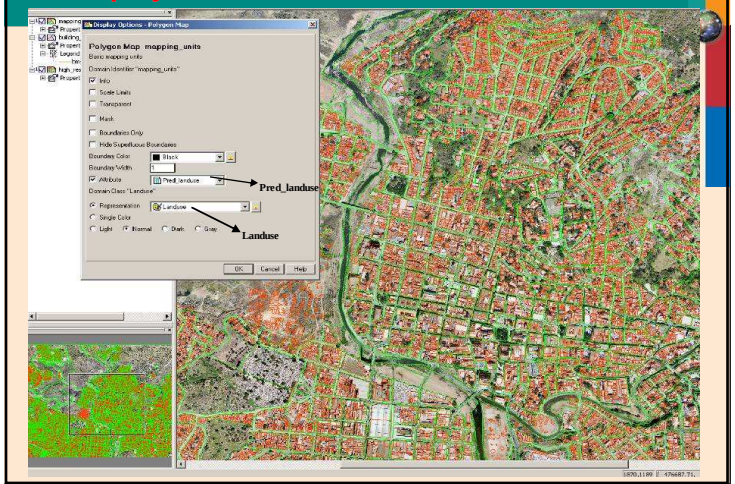
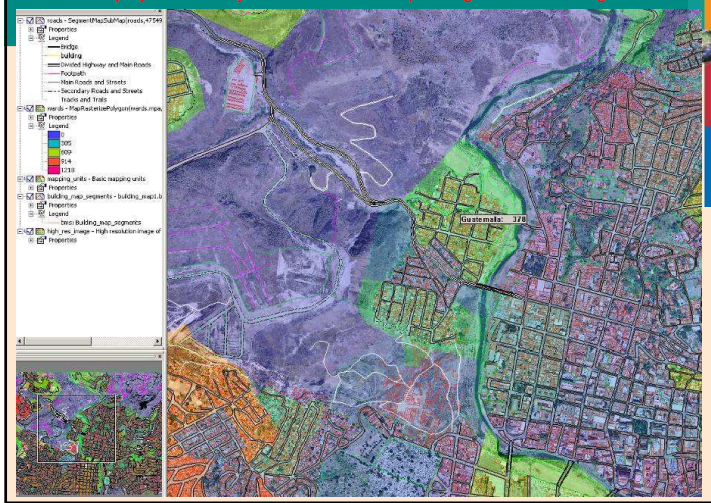
# Display the Urban Landuse as an attribute

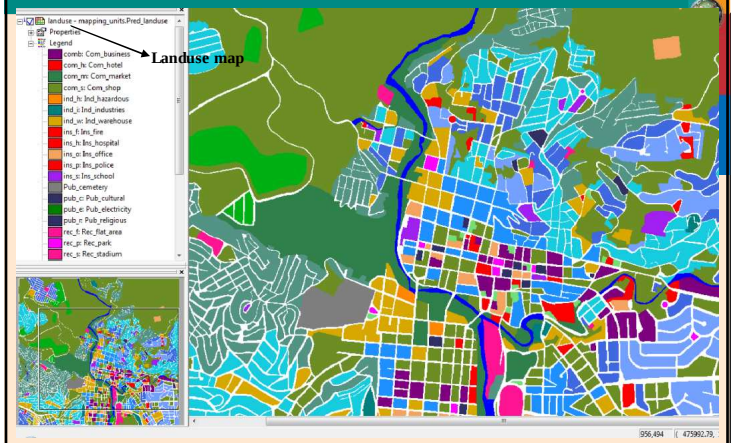


## Final Display with overlay of Ward and road map on High resolution Image





## Calculating the number of destroyed buildings






## Cross table after the cross operation with the raster maps Landuse and building map

Dependent Table "Landuse_buildings" - TableCross(landuse.mpr,building_map.mpr,IgnoreUndefs) - ILWIS

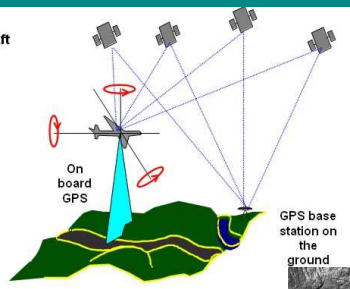
File Edit Columns Records View Help

| | landuse | building_map | NPix | Area | Vac_damaged |
|---|---|---|---|---|---|
| ind_w * B_27344 | Ind_warehouse | B_27344 | 70 | 70 | 29594 |
| ind_w * B_27368 | Ind_warehouse | B_27368 | 53 | 53 | 29594 |
| ind_w * B_27389 | Ind_warehouse | B_27389 | 67 | 67 | 29594 |
| ind_w * B_27401 | Ind_warehouse | B_27401 | 58 | 58 | 29594 |
| ind_w * B_27427 | Ind_warehouse | B_27427 | 2 | 2 | 29594 |
| ind_w * B_28484 | Ind_warehouse | B_28484 | 1352 | 1352 | 29594 |
| ind_w * B_28630 | Ind_warehouse | B_28630 | 296 | 296 | 29594 |
| ind_w * B_28694 | Ind_warehouse | B_28694 | 1469 | 1469 | 29594 |
| ind_w * B_28695 | Ind_warehouse | B_28695 | 134 | 134 | 29594 |
| ind_w * B_28792 | Ind_warehouse | B_28792 | 140 | 140 | 29594 |
| ind_w * B_28836 | Ind_warehouse | B_28836 | 126 | 126 | 29594 |
| ind_w * B_28924 | Ind_warehouse | B_28924 | 444 | 444 | 29594 |
| ind_w * B_28938 | Ind_warehouse | B_28938 | 121 | 121 | 29594 |
| ind_w * B_28940 | Ind_warehouse | B_28940 | 84 | 84 | 29594 |
| ind_w * B_28955 | Ind_warehouse | B_28955 | 172 | 172 | 29594 |
| ind_w * B_28975 | Ind_warehouse | B_28975 | 165 | 165 | 29594 |
| ind_w * B_28984 | Ind_warehouse | B_28984 | 233 | 233 | 29594 |
| ind_w * B_29091 | Ind_warehouse | B_29091 | 109 | 109 | 29594 |
| ind_w * B_29154 | Ind_warehouse | B_29154 | 200 | 200 | 29594 |
| ind_w * B_29166 | Ind_warehouse | B_29166 | 117 | 117 | 29594 |
| com_h * B_00072 | Com_hotel | B_00072 | 582 | 582 | 29594 |
| com_h * B_01108 | Com_hotel | B_01108 | 281 | 281 | 29594 |
| com_h * B_01358 | Com_hotel | B_01358 | 8 | 8 | 29594 |
| com_h * B_01369 | Com_hotel | B_01369 | 106 | 106 | 29594 |
| com_h * B_01410 | Com_hotel | B_01410 | 237 | 237 | 29594 |
| com_h * B_01541 | Com_hotel | B_01541 | 279 | 279 | 29594 |
| com_h * B_01920 | Com_hotel | B_01920 | 5 | 5 | 29594 |
| com_h * B_01950 | Com_hotel | B_01950 | 4 | 4 | 29594 |
| com_h * B_02123 | Com_hotel | B_02123 | 445 | 445 | 29594 |
| com_h * B_02217 | Com_hotel | B_02217 | 34 | 34 | 29594 |
| com_h * B_02557 | Com_hotel | B_02557 | 1 | 1 | 29594 |
| com_h * B_02738 | Com_hotel | B_02738 | 1577 | 1577 | 29594 |
| com_h * B_02880 | Com_hotel | B_02880 | 9 | 9 | 29594 |
| Min | | | 1 | 1 | 29594 |
| Max | | | 28578 | 28578 | 29594 |
| Avg | | | 108 | 108 | 29594 |
| StD | | | 231 | 231 | 0 |
| Sum | | | 3207970 | 3207970 | 875804836 |

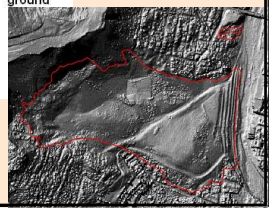


## Lidar

Position of the aircraft
+
Attitude of the aircraft
+
Distance between the aircraft and the 'ground'
+
Angle under which the distance has been measured

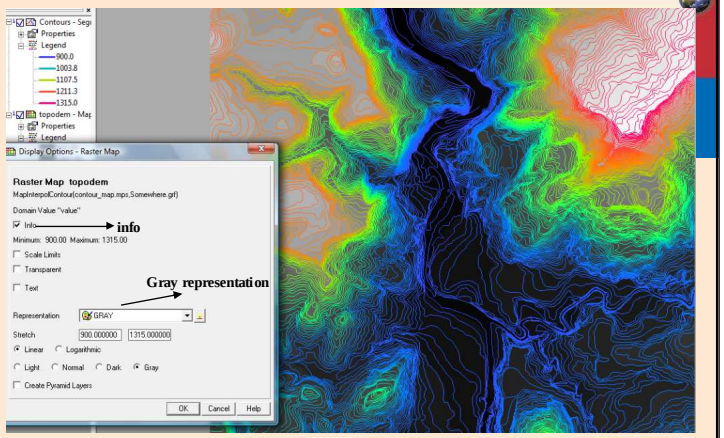



All information is required to determine the co-ordinates of the measured points and calculate the terrain elevation



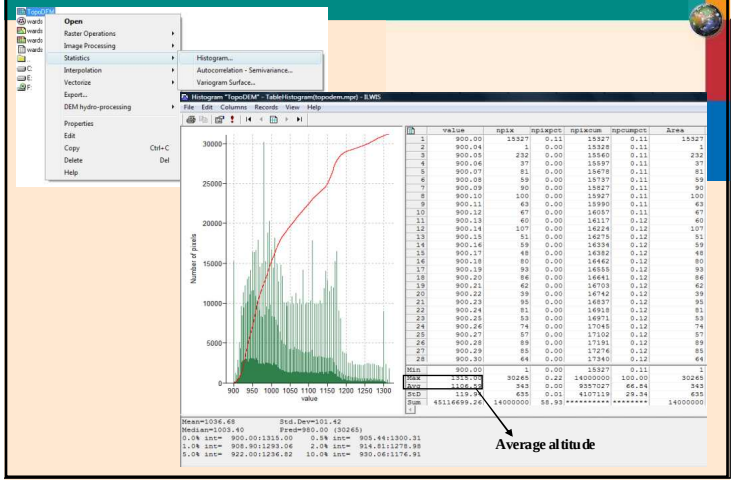
# Altitude Data & Digital Elevation Model

**After the overlay the topodem map over the contour map with gray representation**





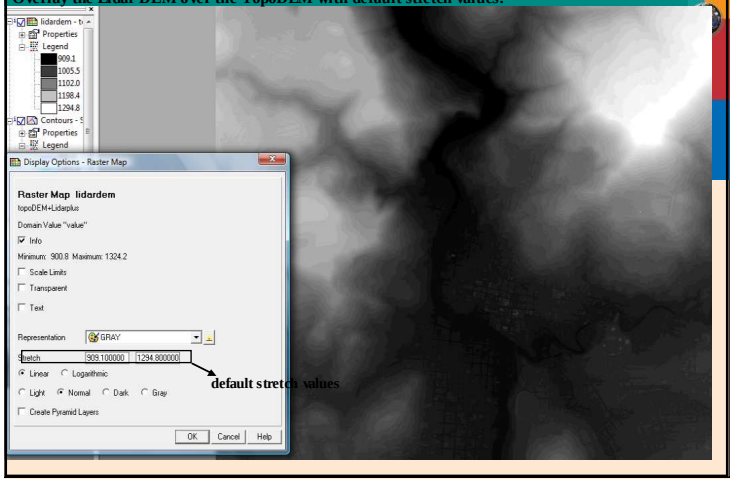

# Statistics/Histogram of Topo_DEM :





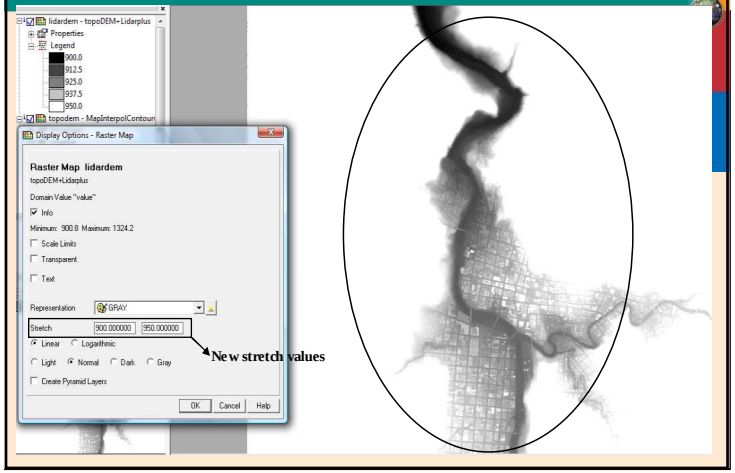

# Image Stretching

**Overlay the Lidar DEM over the TopoDEM with default stretch values:**



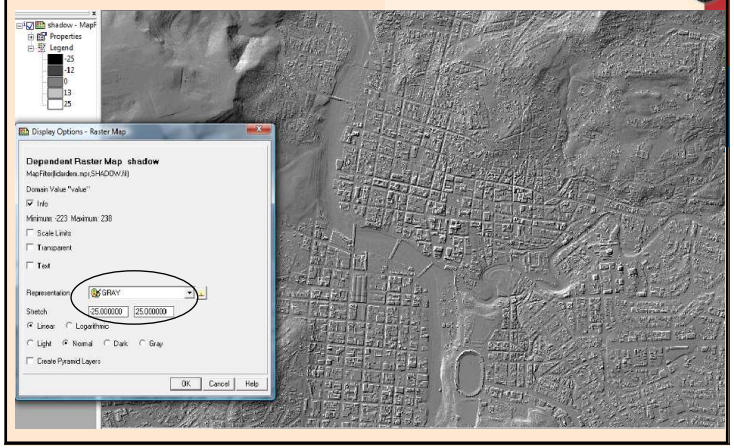



**Changes seen below after using different stretch options:**



## Filtering

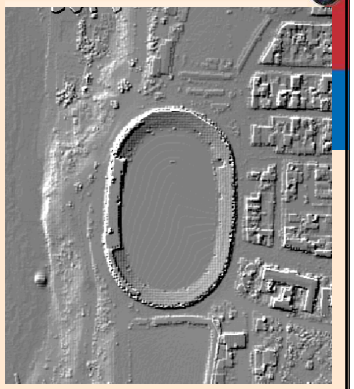
Generation of a hillshading image from Lidar map using shadow filter and different stretch value






## Comparison between High Resolution Image and Hillshading Image:

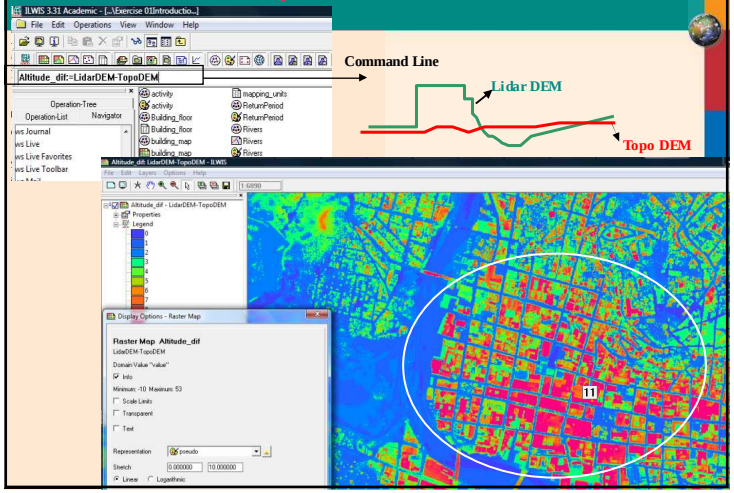
High Resolution Image



Hillshading Image



## Map Calculation






## Pixel Information