GIS CASE STUDY

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

Part 1: Introduction

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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 3.11, developed by the International Institute for Geo-Information Science and Earth Observation (ITC). Information: www.itc.nl

Acknowledgements

We would like to thank Gonzalo Ernesto Funes Siercke from COPECO for providing us the data. Some of the data were also obtained from Sebastian Eugster (Unversity of Bern) who did his Msc study in Tegucigalpa.

1.1 Objectives:

The objectives of this initial exercise are to:

- Make you acquainted with the data set for the city of Tegucigalpa;
- These data are both GIS and RS data, and are related to both hazard, elements at risk and vulnerability;

1.2 Introduction

In late October 1998 hurricane Mitch hit Central America. It is considered the strongest hurricane in the entire Atlantic basin for 10 years and the worst natural disaster in Honduras in the last 200 years. More than 9'000 people died and 1.5 million people have lost their properties. Confirmed by official authorities the economic loss is about 3.7 billions US$, which equals approximately 70% of the annual gross national product. At least 70% of the national crop has been destroyed, including 80% of bananas, the main export product.

After landfall on the Caribbean coast, Mitch slowly moved southwards leaving a huge "highway of destruction" behind it. It produced enormous amounts of precipitation partially caused by the orographic effects of the mountains of Central America and the storm's slow movement (Hellin and Haigh 1999). Entire Honduras was affected by hurricane Mitch. Landslides and waste flooding have destroyed not only urban areas and agricultural land but also big parts of the country's infrastructure like roads and bridges. In Tegucigalpa two big landslides, El Berinche and El Reparto, have killed more than 1000 people. El Berinche blocked the main river in the capital, which lead to big flooding in the city.

It's a fact that disaster and risk management was insufficient or even absent until Mitch. After the hurricane authorities became aware of the urgent need for disaster management. Therefore a lot of recovery projects started to fill this gap, generously supported by the international community.

Tegucigalpa, the capital of Honduras, got its tongue-twisting name from the local dialect. It means "Silver Mountain", which points to the intensive mining activities since the city was founded in the 16th century. As a matter of fact, Tegucigalpa became the most important mining center in Central America during Hispanic colonial times. Today, it forms the political heart of the country, lying within the department of Franzisco Morazan in the central highlands of Honduras. "Tegus" as its inhabitants call it, is a mix of an old colonial city that has turned into the modern, busy and noisy capital of Honduras.

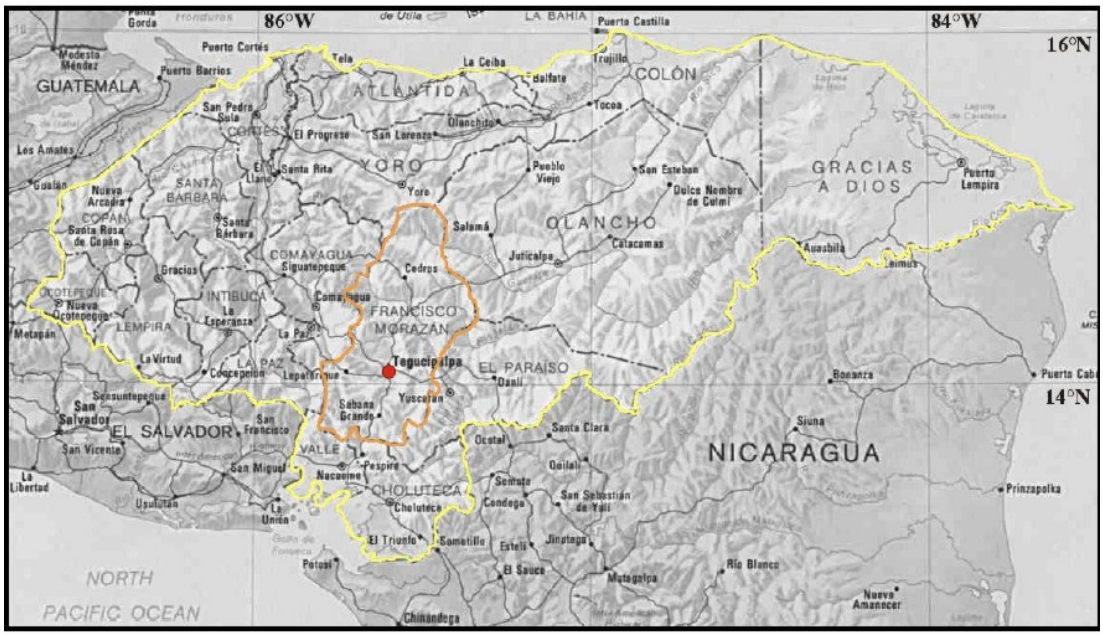

Figure 1-1 Location of the study area within Honduras: The capital Tegucigalpa lies within the Departamento Francisco Morazan, embedded in the central american mountain range

Tegucigalpa is nestled into a bowl-shaped valley within the central highlands of Honduras, at about 15°06'N/87°11'W, which corresponds to the latitude of Bangkok or Sub-Saharan Africa. The bottom of the valley floor lies at 930m above mean sea level (a.m.s.l.) with peaks (called *cerro*) around the basin rising up to 1300m a.m.s.l., like Cerro Grande and Cerro El Berinche in the Northwest or El Picacho north of the city (*See Figure 1-2*).

In the entire basin rivers play an important morphology-determining role. The Río Grande Choluteca separates Tegucigalpa from its sister city Comayagüela. The maller Rio Chiquito flows into the basin from the eastern edge, dividing the capital into the old town on the northern riverside and the modern commercial district on the south side.

Figure 1-2 gives an overview on the agglomeration of Tegucigalpa. The study area extends from Cerro El Berinche west of the old town to the northeastern edge of the capital, and from the commercial district in the south to El Picacho in the north, as m

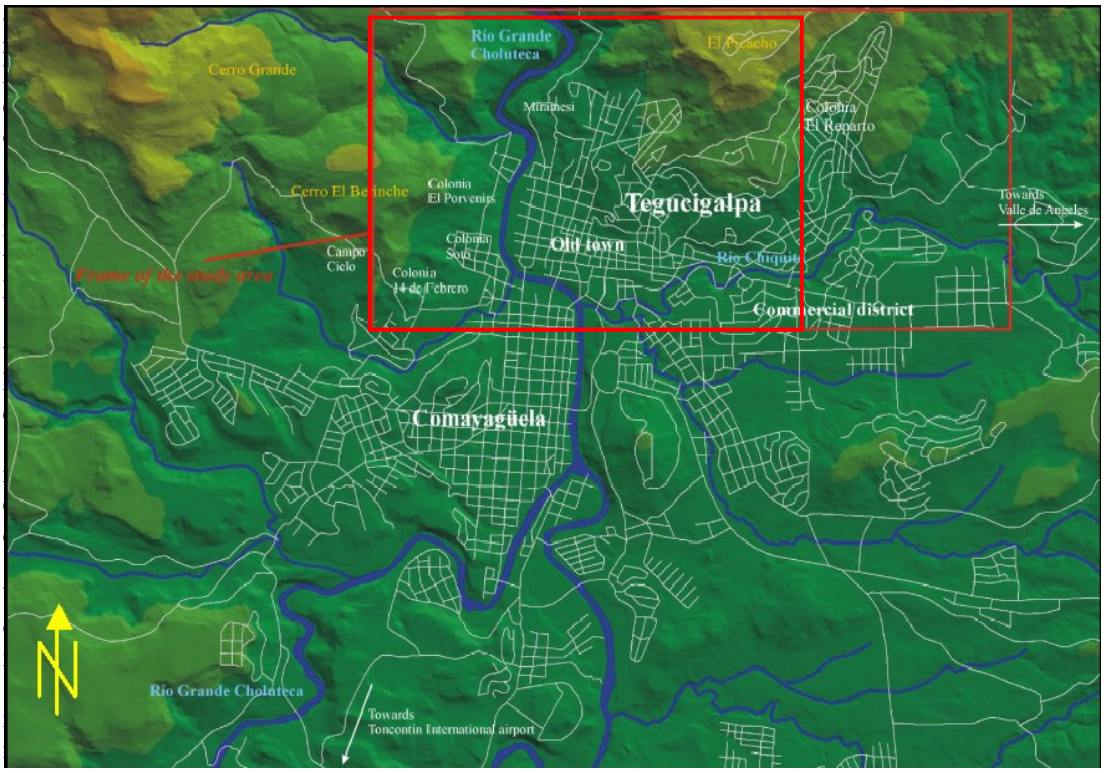

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Figure 1-2 Metropolitan area of Tegucigalpa: The red rectangle shows the frame of the study area within the basin of Tegucigalpa. It covers mainly the old centre, parts of the commercial district and adjacent hillsides. All following maps relate to the extent of this red frame. The background is based on a DEM, giving an idea on the topographic settings.

Landslides caused by Mitch in Tegucigalpa

Durante tres dias, del 29 al 31 de octubre de 1998, el total de la precipitacion pluvial de Choluteca rebaso los 900 mm. El huracan Mitch ocasionio en la ciudad capital de Tegucigalpa una precipitacion pluvial total de 281 mm;

Deslizamiento de tierra El Berrinche

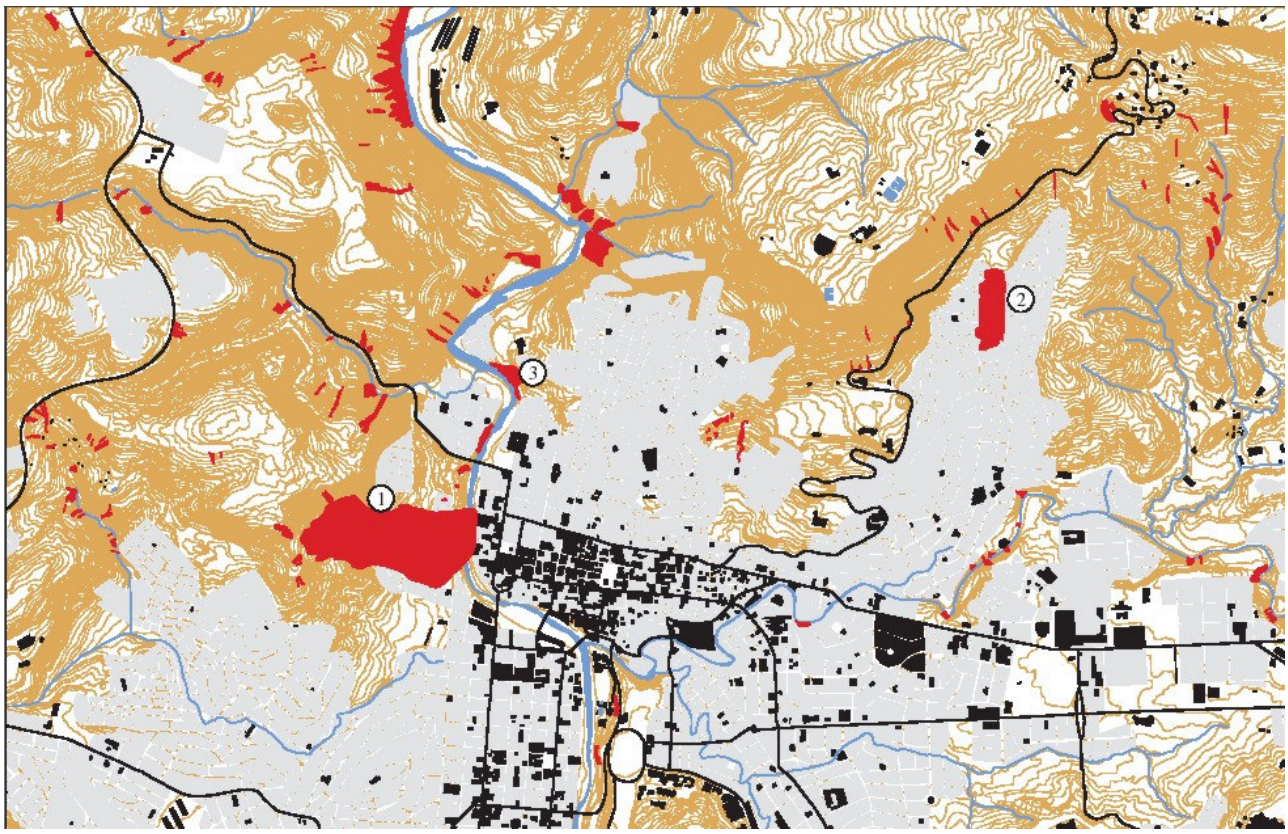
El deslizamiento de tierra El Berrinche, en Tegucigalpa, fue el mayor de los deslizamientos de tierra aislados ocasionados por el huracán Mitch en Honduras (número 1, ilustración 1). Destruyó una porción del centro de la ciudad conocida como Colonia Soto y represó al Río Choluteca, creando así una laguna de aguas residuales, corriente arriba de la presa formada por el deslizamiento de tierra (figura 2). Este hundimiento/flujo de tierra complejo tenía un volumen de aproximadamente 6 millones de metros cúbicos. Debido al lento movimiento inicial del deslizamiento de tierra durante las lluvias provocadas por el huracán, fue posible evacuar a los residentes que habitaban en la masa del deslizamiento de tierra antes de que se iniciara el rápido desplazamiento del deslizamiento y que culminara en el represamiento del río. El río quedó represado aproximadamente a las 12:30 am del 31 de octubre, aproximadamente una hora después de ocurrir el máximo caudal de inundación del Río Choluteca.

Figura 3: Vista rea del deslizamiento de tierra El Berrinche, un hundimiento/flujo de tierra complejo que represo al Rio Choluteca, en Tegucigalpa. La flecha indica la direccion del desplazamiento de la lengua del flujo de tierra. "T" denota la punta del deslizamiento de tierra que represo al rio; la "L" senala la laguna represada por la deslizamiento de tierra. punta del DT" senala a la muy deformada punta del deslizamiento de tierra, que es donde se ubicaba el centro de la Colonia Soto; "SB" senala el bloque superior del hundimiento.

Figure 4: View from the top of El Berrinche landslide

Figure 5: Part of the destroyed neighborhood el Soto. Note the backtilting.

Figure 6: Map of landslides caused by Mitch (source: USGS) 1:= El Berrinche 2 = El Reparto, 3 = Barrio Mira Mesi,



Flooding caused by Mitch in Tegucigalpa

From Mastin and Olsen (USGS)

The main river in the Tegucigalpa study area is Río Choluteca, which flows from south to north through the center of the city. In the area of Tegucigalpa known as La Bolsa, Río Guacerique flows from the west and meets with Río Grande, flowing from the south, to become Río Choluteca. About 1 kilometer (km) north of this confluence, Río Chiquito

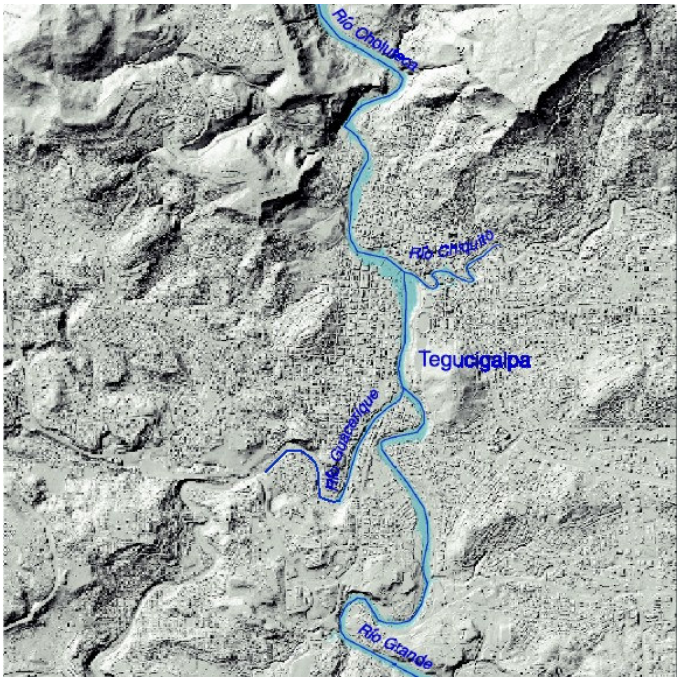
flows into Río Choluteca. The study area includes the river channel and floodplains of Río Choluteca, beginning about 2.7 km downstream of the Puente El Chile bridge and extending upstream to the confluence of Río Grande and Río Guacerique; from the mouth of Río Chiquito upstream 1.36 km; from the mouth of Río Guacerique upstream 1.27 km; and from the mouth of Río Grande upstream 4.80 km (figure 1). The headwaters for Río Guacerique and Río Grande are in the Montaña de Rincon Dolores and Montaña de Azacualpa to the south and west of Tegucigalpa, and the headwaters for Río Chiquito are in the Montaña de

San Juancito to the east of Tegucigalpa.

The streambed material of all the rivers ranges from sand and gravel to cobbles and small boulders in the main channel. The overbank areas are city streets and

buildings in most areas. The slope of the river reaches varies from 0.0091 on the steepest section of the upper end of Río Chiquito to 0.0034 on the flattest section of the upper Río Choluteca.

River	Drainage area (km^2)	Mean annual precipitation for the basin (mm)	Estimated 50-year-flood discharge from equation 1 (m^3/s)
Río Chiquito	77	1,481	254
Río Guacerique	251	1,402	475
Río Grande	453	1,402	663
Río Choluteca at confluence with Río Chiquito	715	1,402	859
Río Choluteca at downstream end of study area	804	1,409	922



1.3 Evaluating the input data

Time required: 1 hour

The input data consists of a series of raster and vector maps.

Base data

- Digital contour lines: **`Contour_map`** (segment map)
- Digital Elevation Model generated from Lidar: **Lidar_tegu** (Raster map)
- Digital orthophoto mosaic: **`Ortho_tegu`** (raster map)
- River map: **river_tegu** (segment map)

Hazard data

- Flood hazard map for 5 year return period: **Flood_5year** (polygon map)
- Flood hazard map for 10 year return period: **Flood_10year** (polygon map)
- Flood hazard map for 25 year return period: **Flood_25year** (polygon map)
- Flood hazard map for 50 year return period: **Flood_50year** (polygon map)
- Area of the extent of Mitch flooding: **Flood_Mitch** (Polygon map)
- Cross sections with waterheight for a 50 year flood event. File: **Cross_sections** (segment map)
- Map with landslide boundaries from 3 different sources: Landslide_map (segment map)
- Lithology map: **Lithology** (polygon map)
- Cross sections used for flood hazard assessment: cross_sections (segment map)

Elements at risk data

- Map of the neighbourhoods in the city with population data: **colonia_tegu** (polygon map).
- Road map: **roads_tegu** (segment map)

- Display the image Ortho_tegu. Add the various data layers available.
- Check the contents of the maps by reading the various maps using the Pixel Information window.

- Check information on the internet related to Tegucigalpa and Mitch. Use a search with keywords: Tegucigalpa Mitch
- Also visit the following websites:
- http://mitchnts1.cr.usgs.gov/data/floodhazard.html
- http://pubs.usgs.gov/of/2002/ofr-02-0033/

References

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