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Environmental and Disaster Management System in the Valles Altos Region in Carabobo / NW-Venezuela

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1. Introduction

2. Methods and Workflow
Digital Image Processing of Satellite Data
Digital Processing of Digital Elevation Data

3. Results of the GIS integrated Evaluations of Satellite Data

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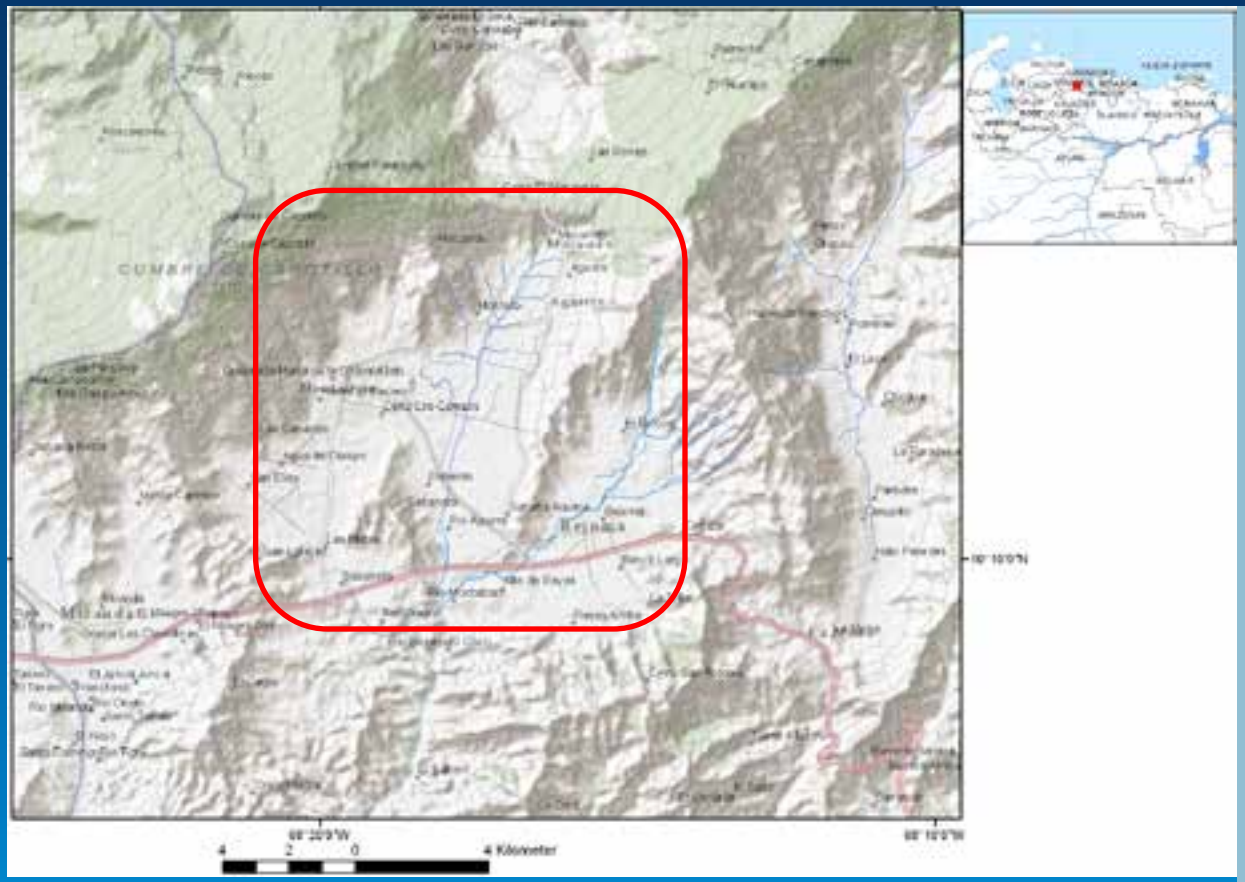
Position of the Investigation Area



Objectives

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- Development of an internet-integrated information system (WebGIS) as a decision support tool for land management with focus on risk areas in the region of Carabobo;
- Detection, analysis, identification and classification of the different risk areas (landslide, flooding soil erosion and earthquakes), and definition of the degree of their vulnerability;.
- Development of a methodology for risk survey and elaboration of the main modules for a warning system;
- Raising local public awareness on environmental issues;

Natural Hazards in Carabobo, Venezuela

Tsunamis

Earthquakes

Uplift, Subsidence

Aguirre

Fire

Flooding

Flash Floods

Drought

Active Faults

Soil erosion, degradation

Mass Movements

Environmental Situation in the Aguirre Area

Image: Daniel Nesic, 30.08.2012

Methods and Workflow using Spatial Analyst, 3D-Analyst and Image Processing Tools of ArcGIS and ENVI

Digital Image Processing of LANDSAT.Data

- RGB
- NDWI-Wasser-Index for soil moisture detection
- NDVI-Vegetationsindex for vegetation anomaly detection
- Principal Component, classifications
- Filter techniques (Morphologic Convolution)

GIS integrated Evaluation of Satellite Data

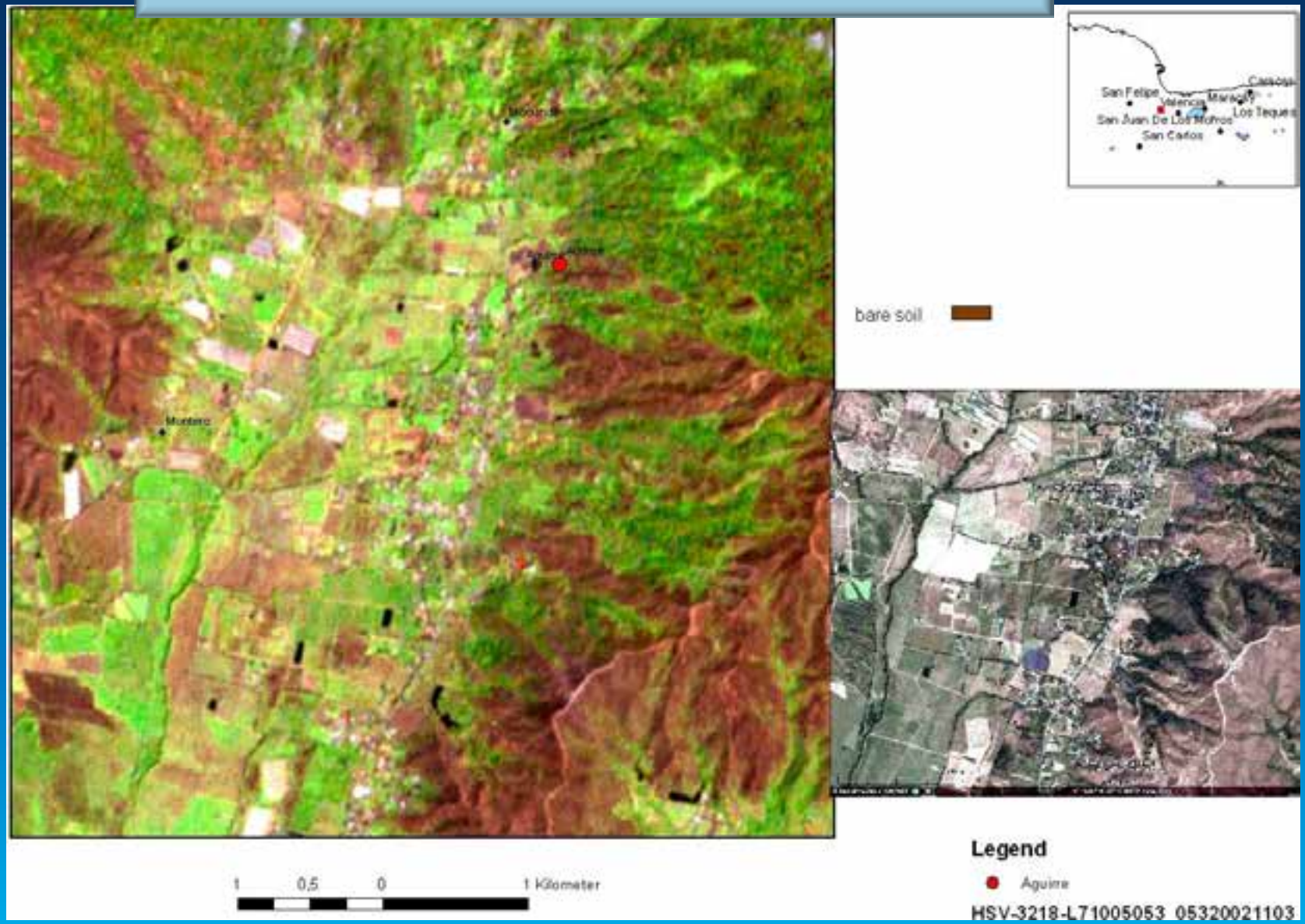
- Extraction of areas with higher soil moisture
- Lineament analysis
- Change detection
- Weighted Overlay

Integration and Combination of Geodata

- Integration of geophysic, geologic, geomorphologic, pedologicand and vegetation data
  - Digital Elevation Data (DEM)
  - Land use, infrastructure

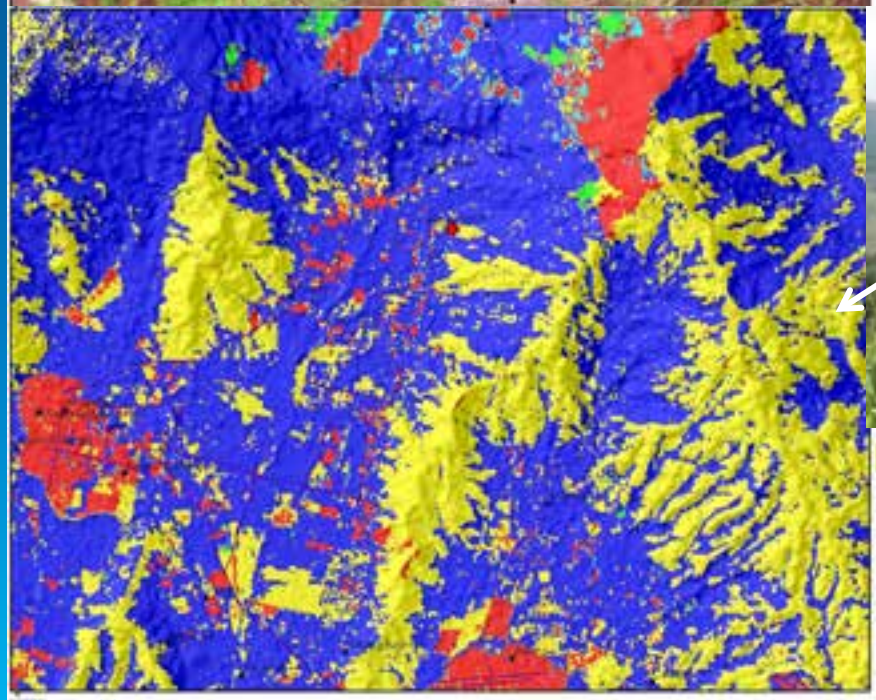
Data Mining

Evaluations of LANDSAT and IKONOS Imageries

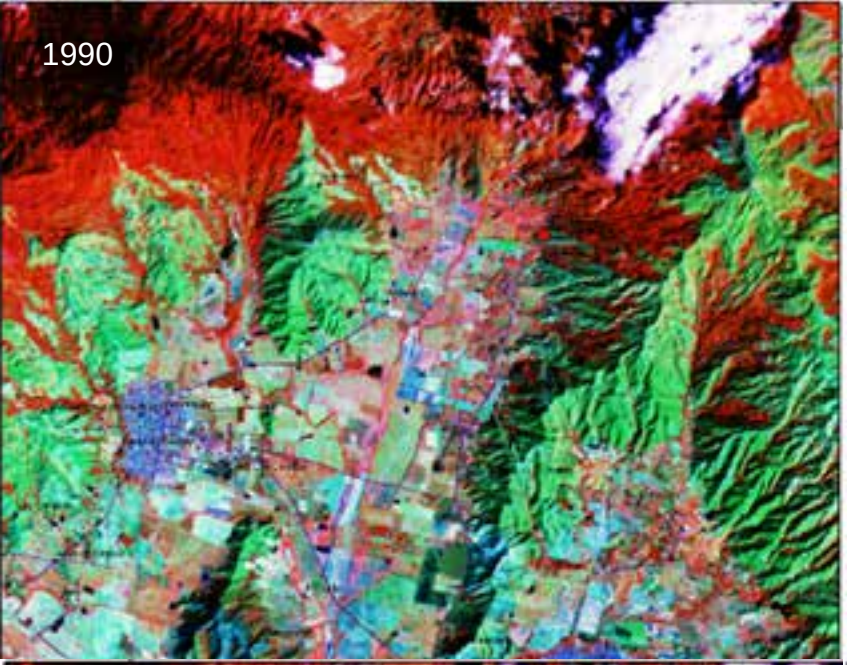


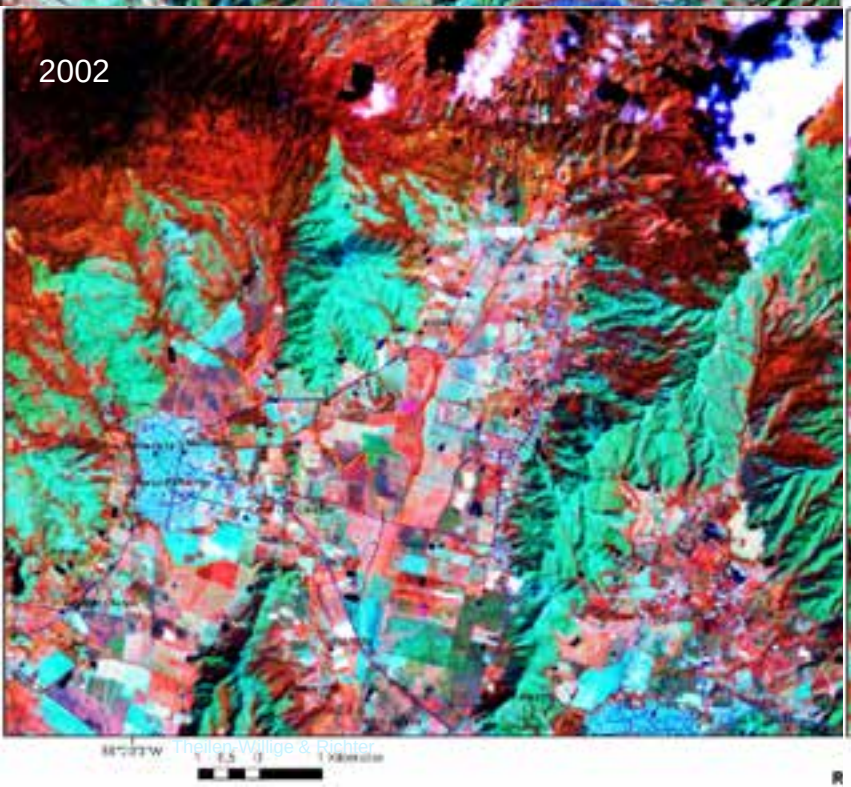
LANDSAT ETM-Scene

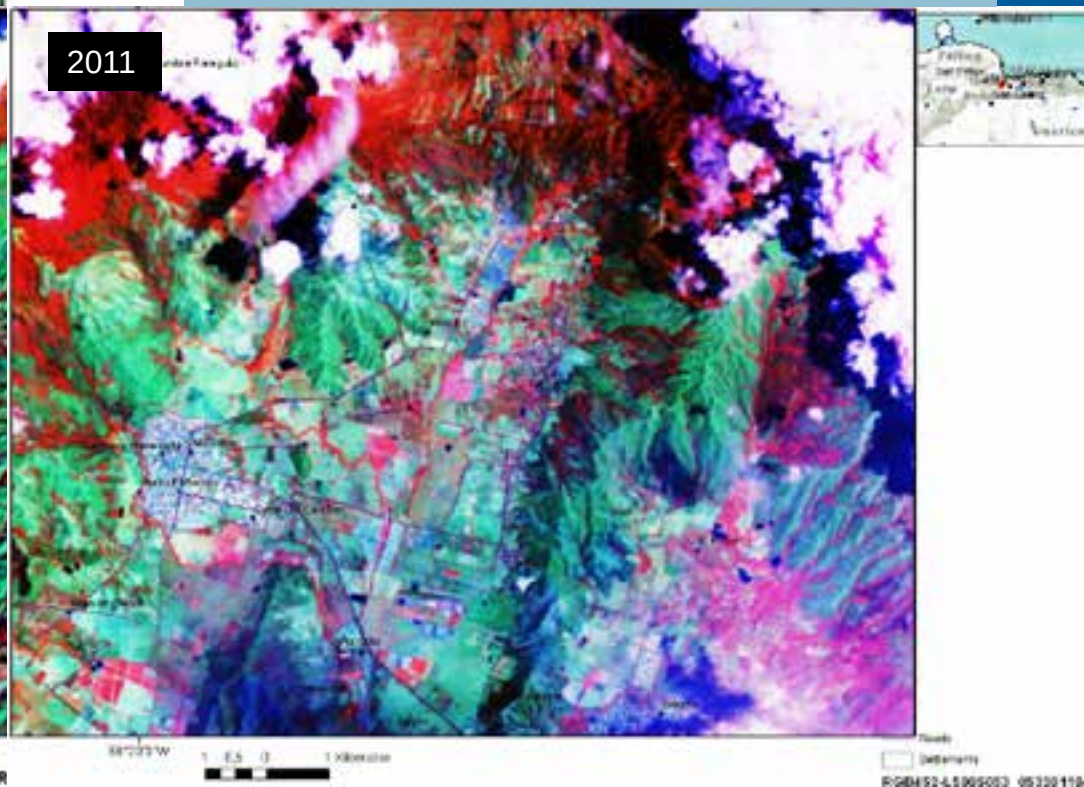
Detection of Soil Erosion and Bare Soils by LANDSAT Image Classification



LANDSAT Time Series for the Detection of Changes in the Vegetation Cover







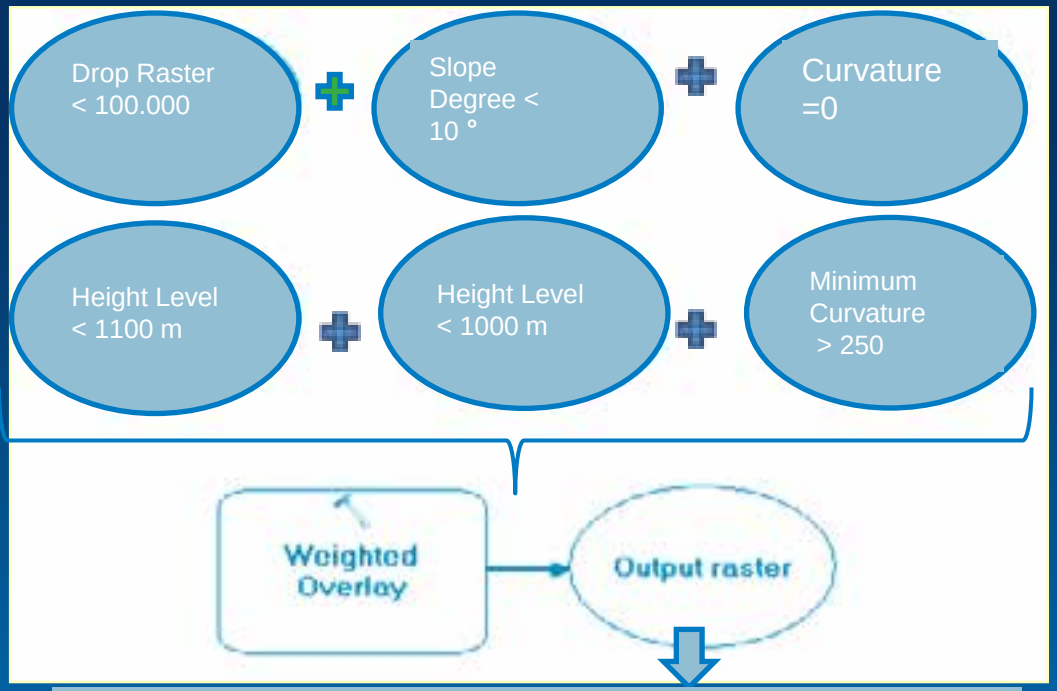
Photsynthetic activity of the vegetation is represented in red colours. (RGB , Bands 4,5 and 2)

Deriving Morphometric Properties of a Terrain from Digital Elevation Modell (DEM) Data

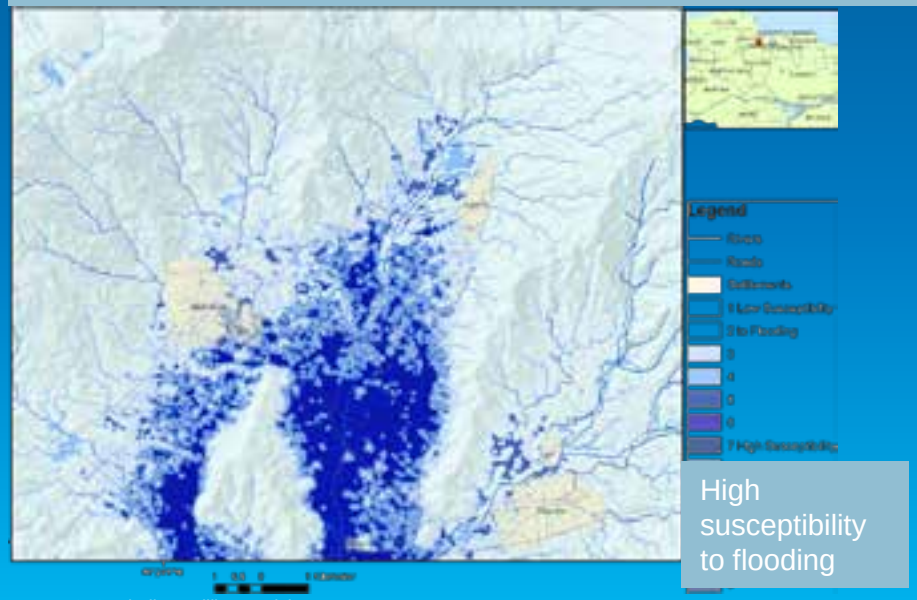
such as the

minmum curvature, *lowest slope gradient and the lowest local height level* help to detect flat accumulation zones: areas with recent, unconsolidated sediments and higher surface water input.

Recent sediments due to flash flood deposits



Aggregation of causal, morphometric factors influencing flooding susceptibility using the weighted overlay-tool in ArcGIS



High susceptibility to flooding

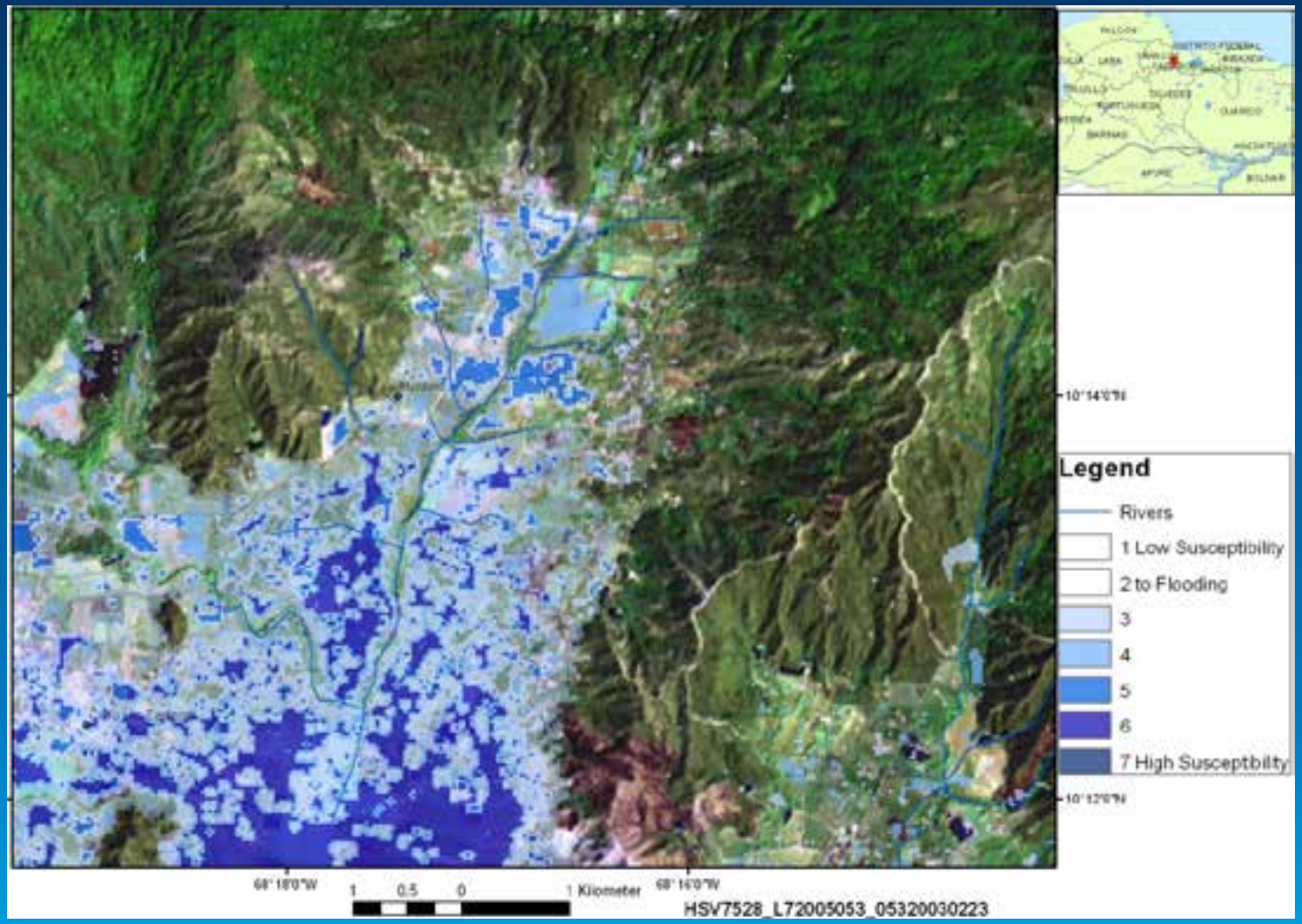
Weighted overlay of causal / preparatory factors influencing the susceptibility to flooding

The weighted overlay approach in ArcGIS can be used for the detection and identification of endangered lowland areas susceptible to flooding such as by flash floods. Based on ASTER Digital Elevation (DEM) data morphometric factors as mentioned below are extracted and then aggregated in the weighted overlay tool.

Factors influencing flooding susceptibility such as

- relatively lowest height levels ,
- flat terrain, calculating terrain curvature (curvature values=0 –, calculated in ArcMap, minimum curvature > 250 , calculated in ENVI)
- slope gradients < 10 °
- drop raster < 100.000 and
- high flow accumulation values
- watershed size.

Areas prone to Flash Floods and Sediment Accumulations



Result of the weighted overlay of causal / preparatory, morphometric factors influencing the susceptibility to flooding

Data Mining for the Earthquake Preparedness using mainly Open-Source Data and GIS-Tools

Geophysic Data

- ShakeMaps
- Macroseismic maps

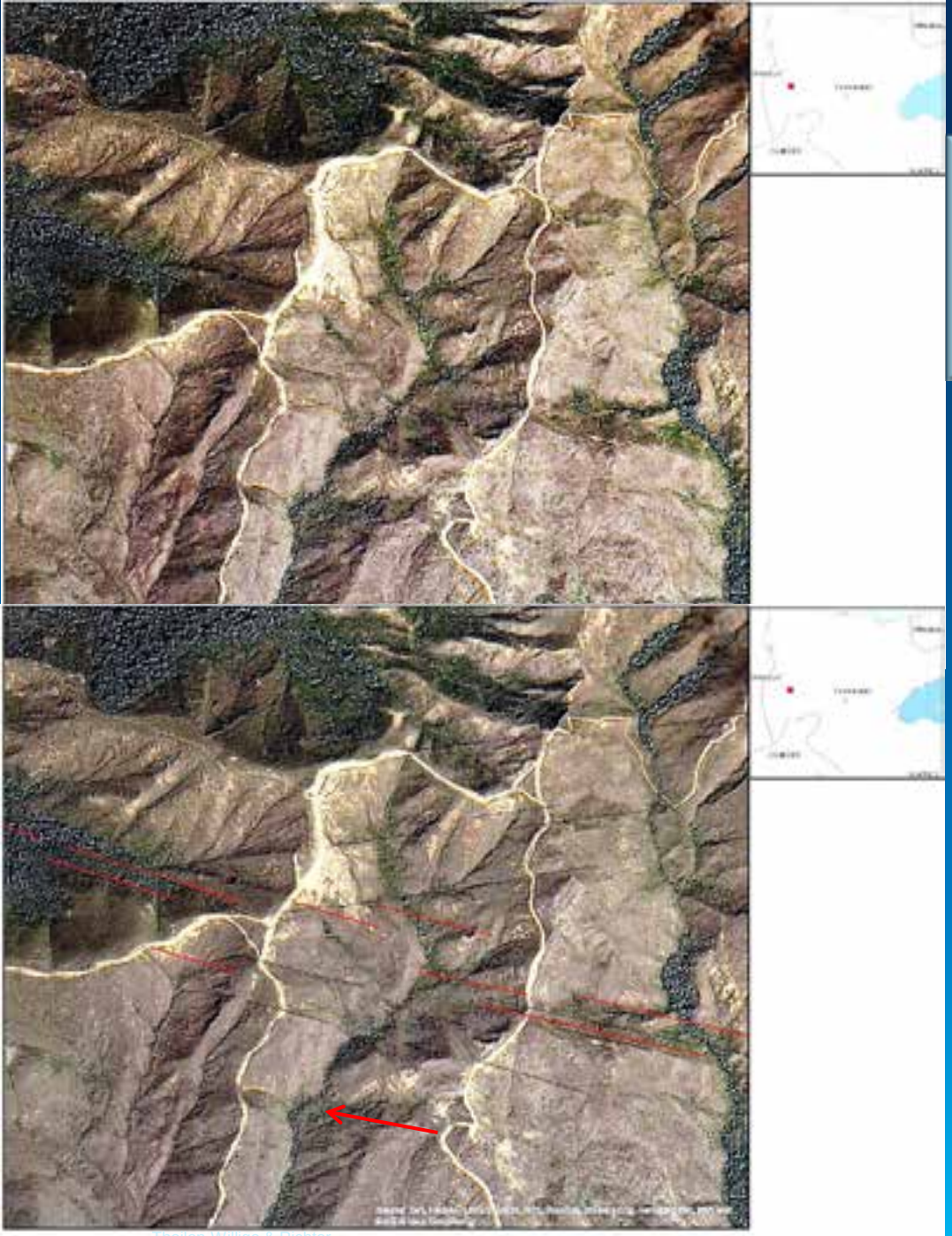
Geologic and Geophysic Data

- Shear wave velocity-data
- Geologic , pedologic and hydrogeologic maps

Satellite Data

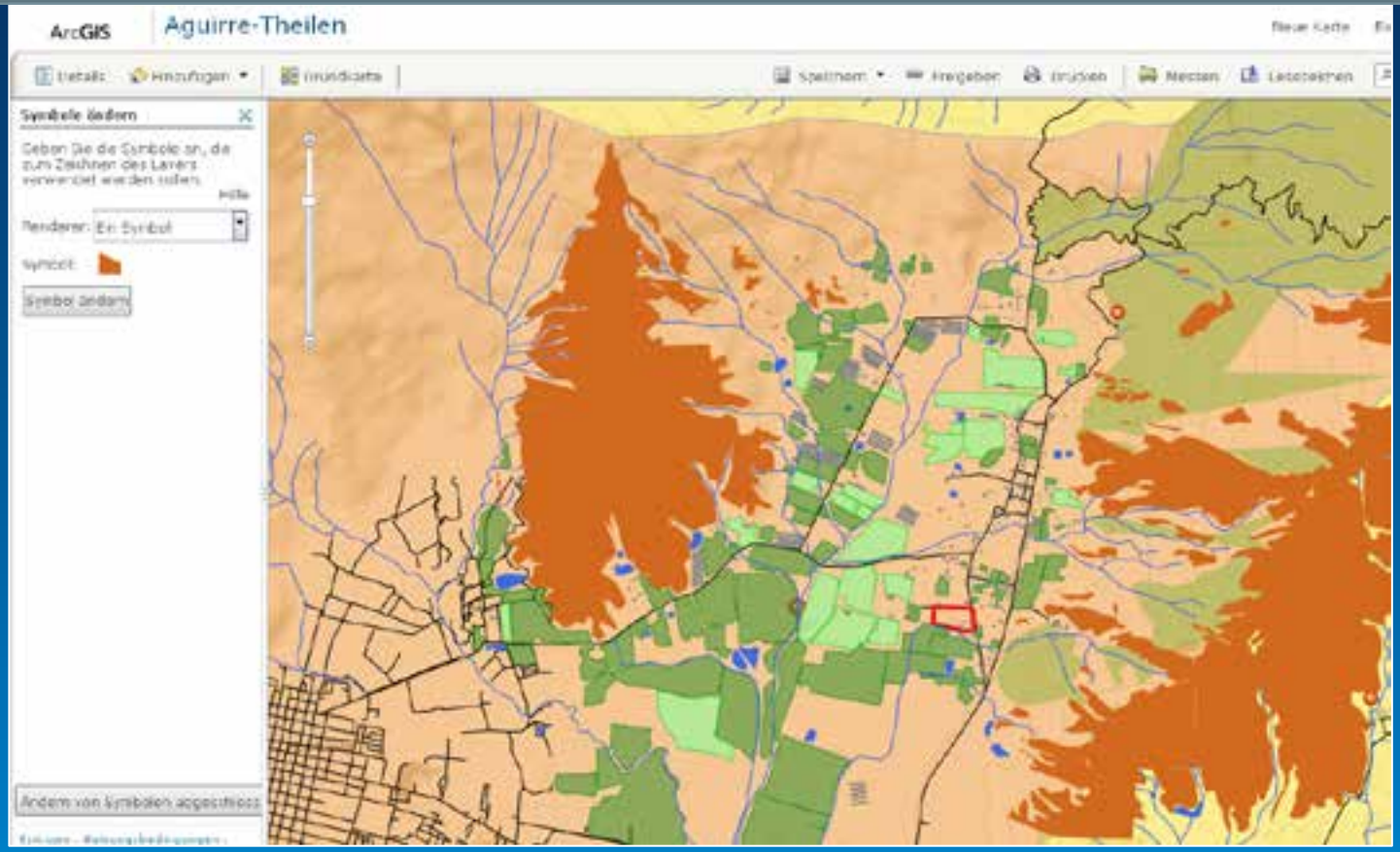
- Weighted overlay of causal / preparatory factors influencing earthquake shock using DEM based morphometric tools and analysis
- Structural analysis of satellite imageries (lineament analysis)

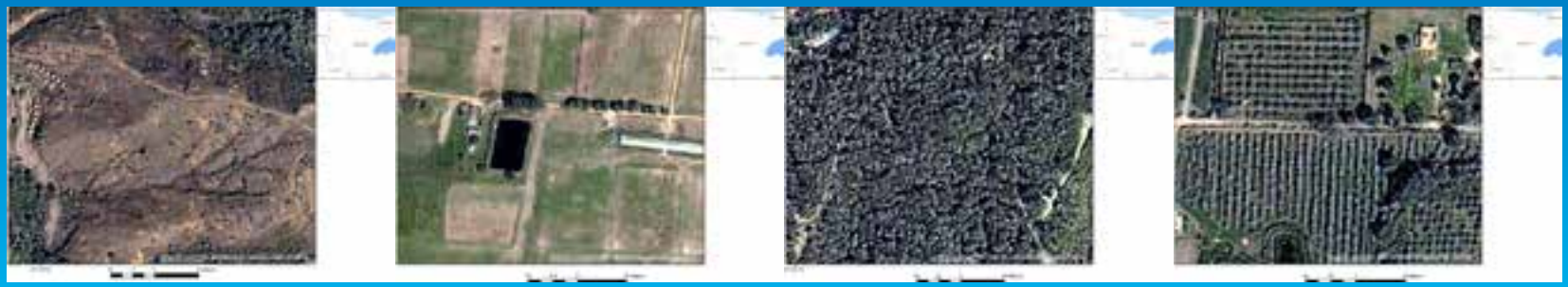
Overview of areas prone to relatively higher earthquake shock during a stronger earthquake due to the aggregation of causal / preparatory factors



Mapping of linear features on the satellite imagery for getting information of sub-surface structures such as faults and fracture zones

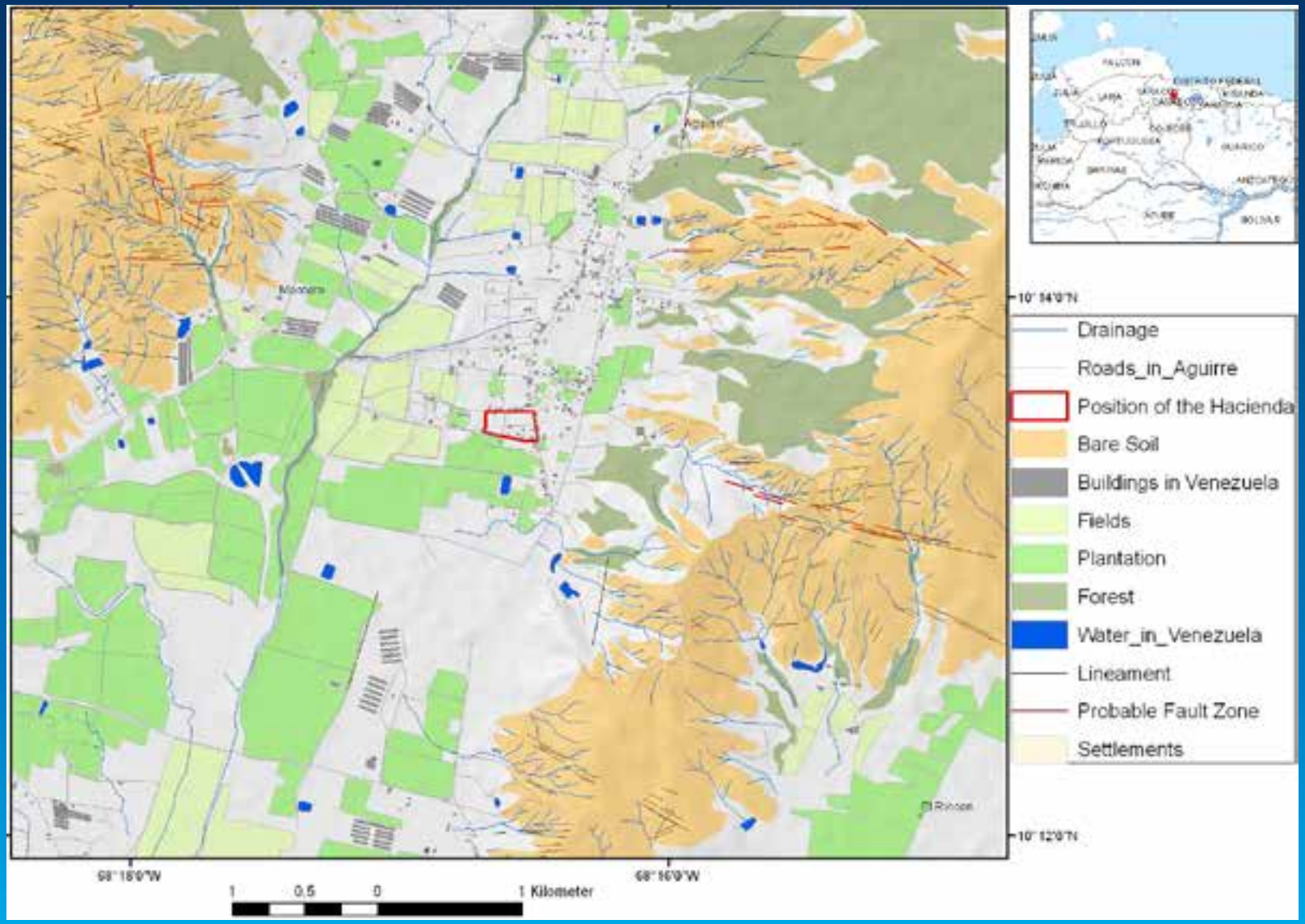
Land Use Mapping based on the World-Imagery.lyr-file of ESRI (GeoEye-Satellite data) and Distribution of the Results in the Web





Bare soil | fields, meadows and water body | forest | plantation

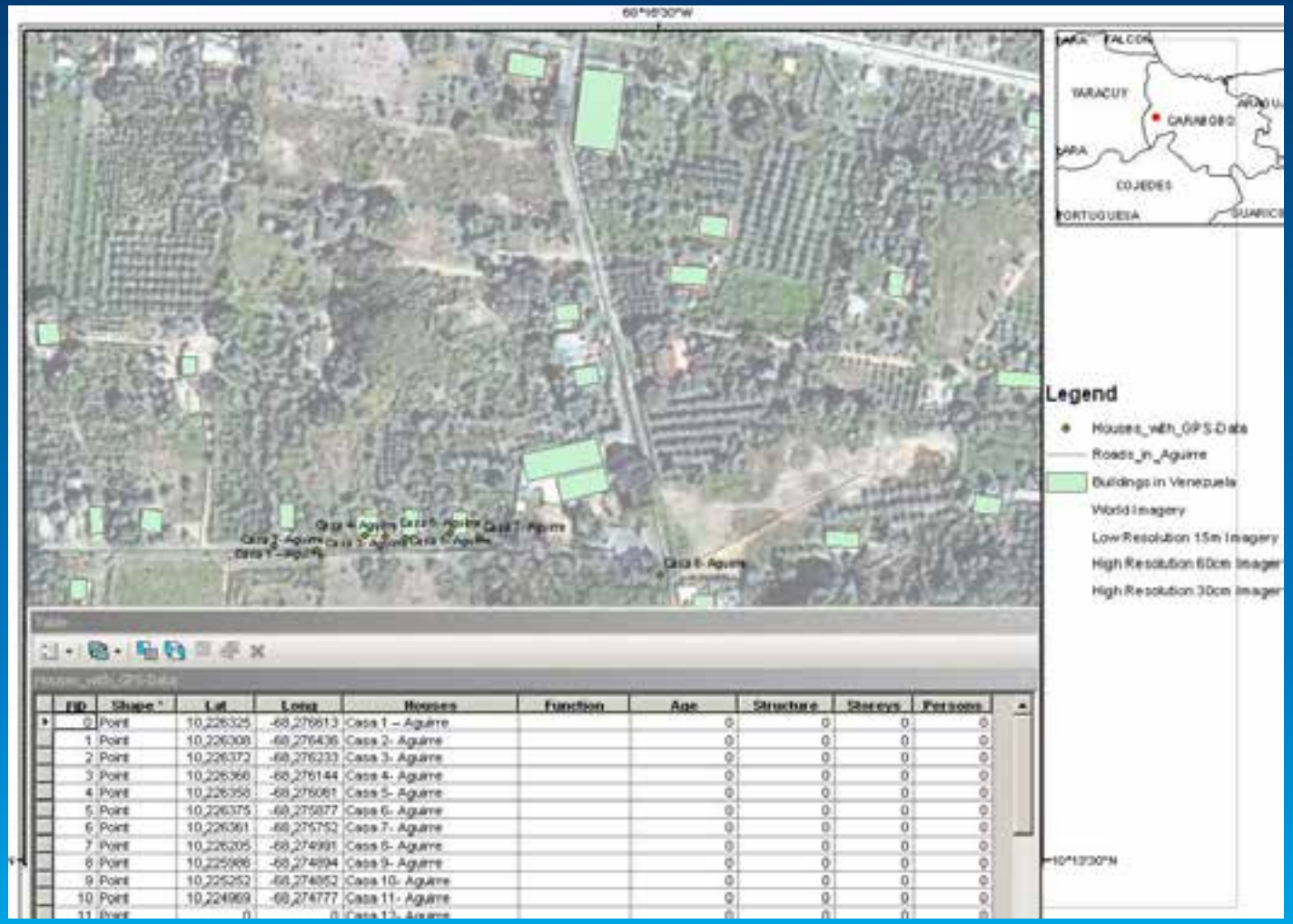
Land Use Mapping



Building Taxonomy for Cadastral Works

3D perspective view of the Aguirre area

Cadastral Inventory For Damage Loss Estimations and Vulnerabilty Analysis



FID	Shape *	Lat	Long	Houses	Function	Age	Structure	Storeys	Persons
0	Point	10,226325	-68,276813	Casa 1 – Aguirre		0	0	0	0
1	Point	10,226308	-68,276436	Casa 2- Aguirre		0	0	0	0
2	Point	10,226372	-68,276233	Casa 3- Aguirre		0	0	0	0
3	Point	10,226366	-68,276144	Casa 4- Aguirre		0	0	0	0
4	Point	10,226358	-68,276061	Casa 5- Aguirre		0	0	0	0
5	Point	10,226375	-68,275977	Casa 6- Aguirre		0	0	0	0
6	Point	10,226361	-68,275752	Casa 7- Aguirre		0	0	0	0
7	Point	10,226205	-68,274991	Casa 8- Aguirre		0	0	0	0
8	Point	10,225986	-68,274894	Casa 9- Aguirre		0	0	0	0
9	Point	10,225252	-68,274852	Casa 10- Aguirre		0	0	0	0
10	Point	10,224969	-68,274777	Casa 11- Aguirre		0	0	0	0

Conclusions

- Susceptibility maps can be created providing an overview of areas that are more susceptible to natural hazards such as earthquake shock, landslides or flooding due to regional and local site conditions following a standardized work flow by the aggregation of causal / preparatory factors.

- Merging these maps with infrastructural data vulnerability assessments can be improved and, thus, as consequence, the detection of damage susceptibility of infrastructure and resulting cascading effects.

- The presented approach, – combining different data and results of methods in a GIS-environment - , can contribute to a better understanding of the different influence on damage distribution and on secondary effects in case of natural hazards. The gained database forms an important input into an environmental and disaster management system.

Thank you for your Attention