

Application of ArcGIS tools for Flood Risk Assessment

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ABSTRACT

The State Climate Change Action Programme of Baja California (PEACC-BC), Mexico, carried out a flood risk assessment study for Ensenada, one of the five main urban areas of Baja California. This study is a contribution to the State risk atlas that is currently being developed. Techniques and tools developed globally to diagnose hazard and risk levels faced by cities were utilized in the analysis. Specifically, the utilization of ArcGIS methodologies and tools for flood risk assessment is presented in this paper. The hydrological tools of the ArcGIS spatial analysis were combined with the Geospatial Hydrologic Modeling Extension (HEC-GeoHMS), an extension of HEC-RAS that works with ArcGIS. This paper also summarizes the data integration, modeling and analysis, and result communication processes of the flood risk assessment for the municipality of Ensenada. While HEC-GeoHMS and ArcGIS' Hydrology are tools that can be used for the same purpose, for this specific case it was found that working with ArcGIS shortened the programming time and that the utilization of LIDAR with the necessary precipitation data facilitated basin-specific analysis.

1. Data and tool requirements:

To identify the flood-prone areas, the basins and streams, along with the corresponding water flows, were determined first. The Spatial Analyst Toolbox, with the hydrologic-analysis extension in ArcGIS, was used to describe the physical characteristics of the ground's surface. A digital elevation model was used as input. Figure 1 shows the considered basins and the stream network used for the hydrological analysis. The flood assessment results for basin number 4 are presented in this paper as a representative example

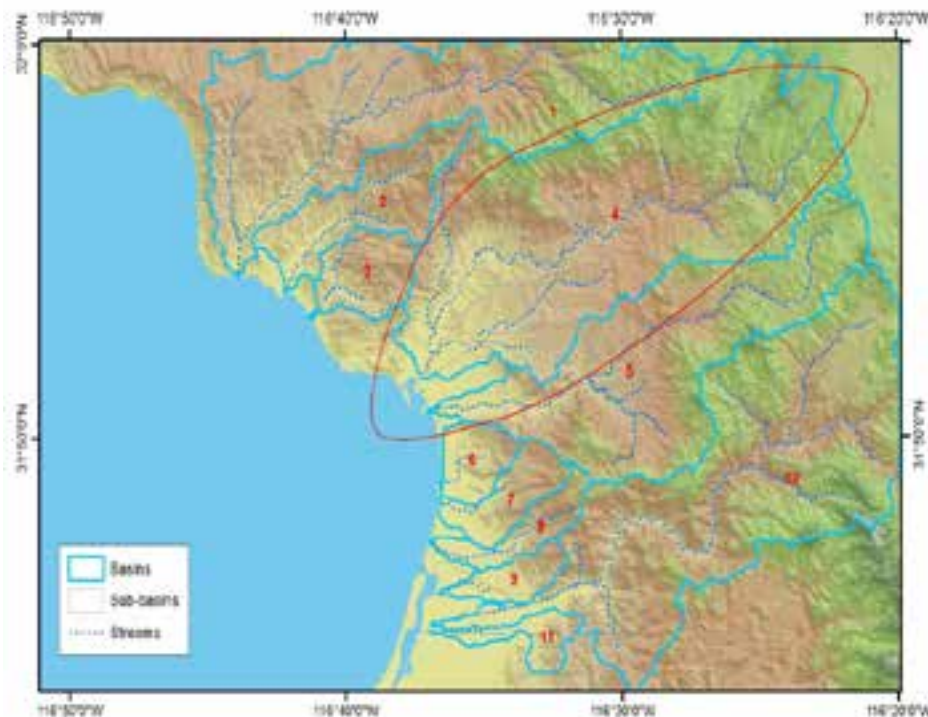


Figure 1: Basin definition and stream network representation using LIDAR in the city of Ensenada, Baja California. The red curve line shows basin 4

2. Integrating the necessary data and modeling the flooding process

After defining basins and streams, the physical characteristics of each basin were determined to calculate the corresponding flow "Q" (m^3/s). The peak flows (Q) were calculated for return periods of 5, 10, 25, 50 and 100 years. The water entering a watershed will reach the stream in different ways and at different speeds, depending on the water infiltration of the land determined by the type of rock/soil, land use and soil management. The preparation of the model for the analysis required the integration of the following data:

- Elevation and Hydraulic models – Basins, streams, cutlines, slopes
- Land-use information and soil types –Runoff coefficient (depending on slope land cover, soil type)
- Precipitation data – Semi-hourly (?) rainfall intensity, concentration time

The Hydrology extension of the Spatial Analysis tools, in combination with HEC-HMS, was utilized to integrate the necessary data. The peak flows were obtained by adding the flows estimated for small sub-basins using the rational method. Rainfall intensity was calculated with daily records taken every 10 minutes for a period of 12 years from the dataset of the Norwest of Mexico provided by PEACC-BC. HEC-RAS was used to estimate the flood-prone area and the results were visualized with ArcGIS. Figure 2 shows the integration of data and flow-estimation process utilized in the analysis of basin 4.

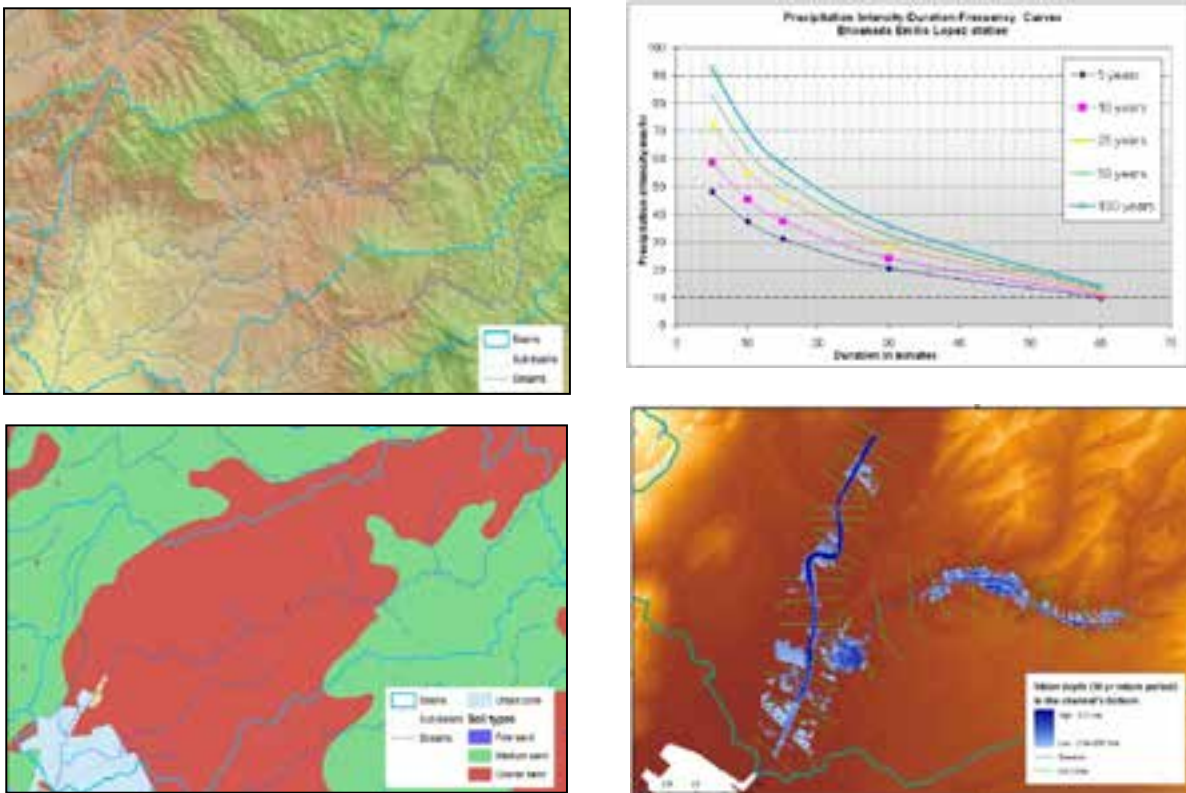


Figure 3: Base maps for the hydrological process, precipitation data used for the hydraulic model and results for 50 years return period for basin 4.

Utilization of HEC-RAS has the following advantages: low data requirements, relatively rapid computation and free software. The necessary data included: Inflow hydrographs (given by the hydrological analysis), boundary conditions (hydraulic study in function of flow regime), channels and floodplain cross sections, roughness coefficients. These simple tools have proved to be very useful to start the comprehensive flood risk assessment at State level.

3. Communicating the results: Flood risk map for Ensenada, for a 50-year return period

The HEC-GeoRAS tool of the ArcGIS' Spatial Analysis is very helpful in hydraulic modeling using a graphic interface. It estimates not only the flood-prone areas but also the associated risk of exposed infrastructure such as drains, sewage and bridges.

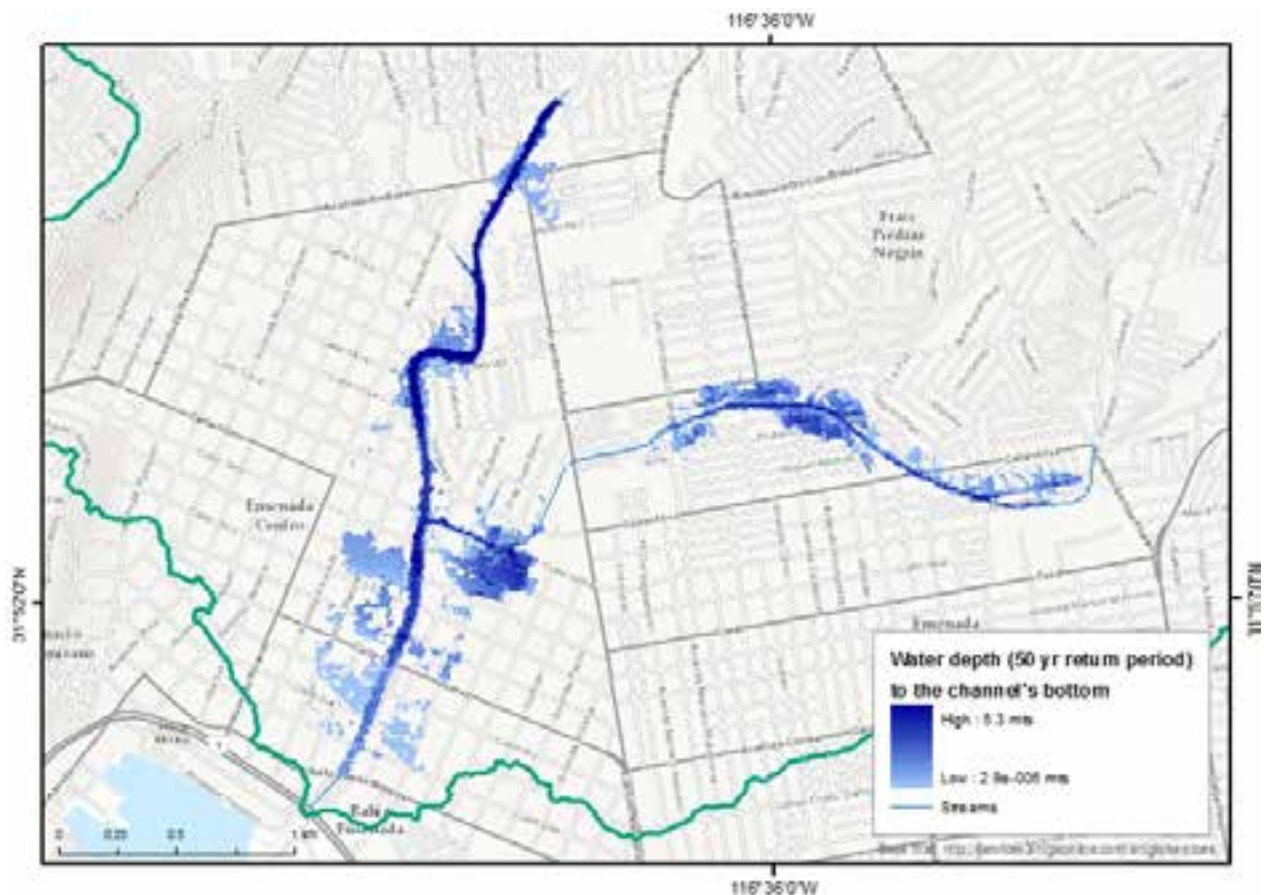


Figure 3: Flood risk results (for basin 4). The estimated flood-prone area has been compared to the effects observed in previous flood events

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<http://peac-bc.cicese.mx/datosclim/>

Global Risk Identification Programme UNDP-GRIP: <http://www.gripweb.org/gripweb/>

ESRI: <http://www.esri.com/>

HEC- GeoHMS: <http://www.hec.usace.army.mil/software/hec-geohms/>

HEC-GeoRAS: <http://www.hec.usace.army.mil/software/hec-ras/hec-georas.html>

HEC-RAS: <http://www.hec.usace.army.mil/software/hecras/>

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