Mapping Tropical Storm Susceptibility in Puerto Rico's 'Underwater City' Using NASA Earth Observations to Assist the Municipality's Intervention Effort

Led by NASA DEVELOP National Program in collaboration with:

Toa Baja

resilientSEE™

Perkins&Will

MIT Urban RISK Lab

AD&V ALVAREZ-DIAZ & VILLALÓN ARCHITECTURE | INTERIOR DESIGN

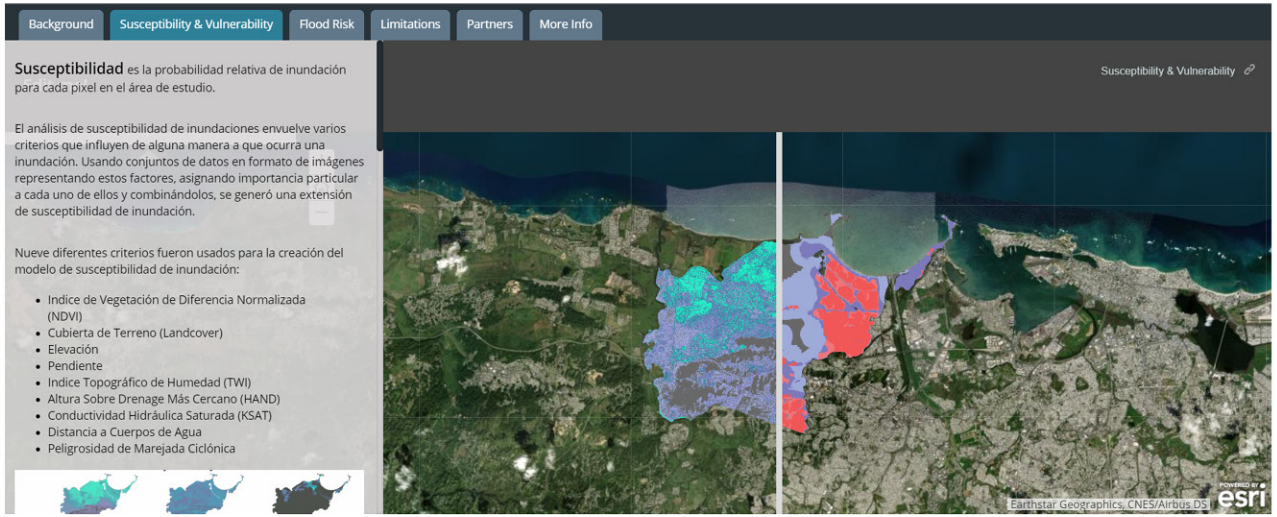
Toa Baja, Puerto Rico, is known as "the underwater city" due to its propensity to flood. Contributing to this condition is its proximity to dynamic water bodies and the low and flat topography. In the 2017 hurricane season, over 14,000 homes were flooded and damages amounted to over $1.3 billion, limiting the capacity to provide sufficient services for residents of the municipality. Changes in the global climate system are causing more intense and frequent tropical storms, making areas like Toa Baja subject to irreparable damage.

The northeast coast of Puerto Rico floods frequently due to heavy rainfall, storm surge inundations, and its unique topography (López-Marrero & Yarnal, 2010). Toa Baja specifically contains the mouth of the island's longest river, Río de la Plata, which drains into the Atlantic Ocean on the northern edge of the municipality. Proximity to these major water features and the flat, low terrain contribute to the flood-prone nature of the area.

The analysis featured here provides a high-resolution interpretation of relative flood risk using a variety of datasets representing factors that collectively influence the likelihood of flooding.

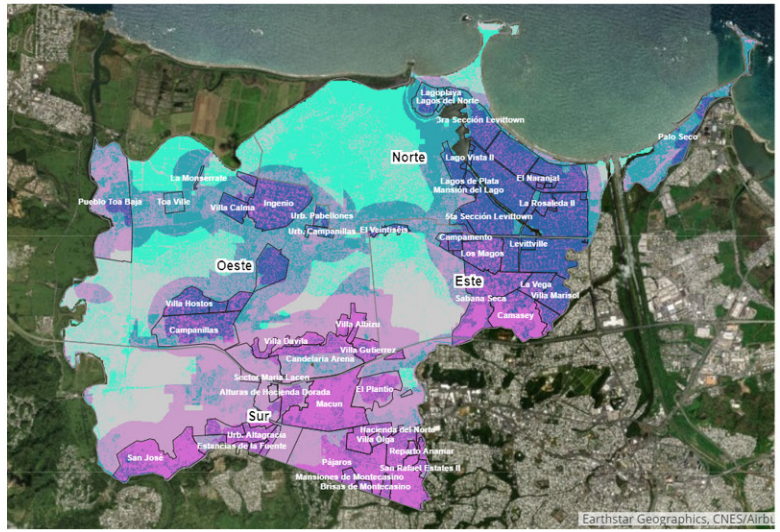
Project Goals

- Provide an interactive, scientifically explicit platform to educate the public on flood risk
- Utilize Earth observation products to model flood susceptibility
- Pair flood susceptibility with human vulnerabilities to gauge relative flood risk to strengthen their flood preparedness efforts



Snapshot from Tao Baja flood risk mapping online tool

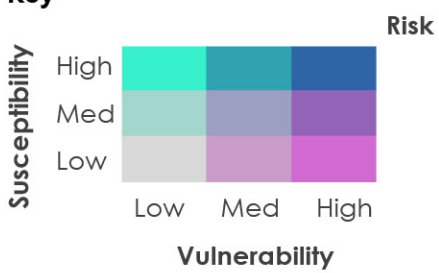
Online Tool Analysis

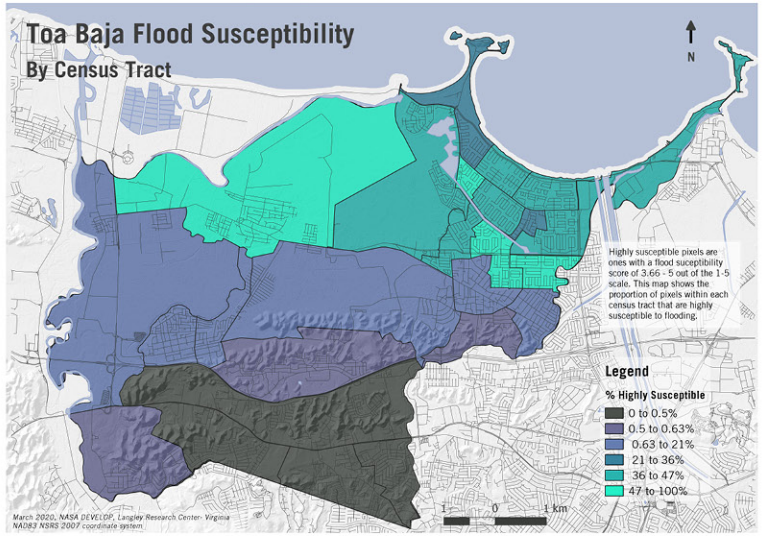


Flood Risk

The analysis of flood susceptibility, along with socioeconomic factors, account for the consequential impacts of a flood event on specific populations. The susceptibility map and vulnerability map were combined to create the flood risk model.

Key



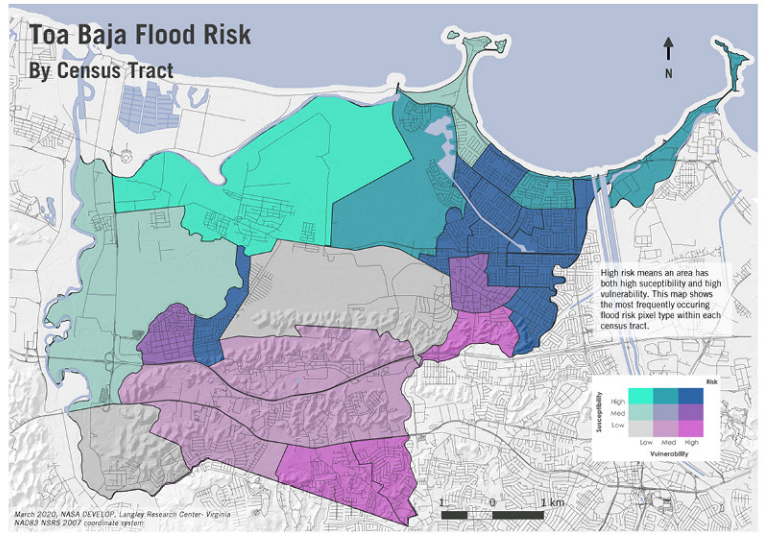


Susceptibility

Susceptibility is the relative likelihood of flooding for any given region in the study area. Flood susceptibility analysis involves various criteria that influence the likelihood of flooding. Using image datasets, we weighted and combined nine criteria to assess overall flood susceptibility. To analyze susceptibility, we used the analytical hierarchy process and multi-criterion evaluation.

We used a total of nine different criteria:

- Normalized Difference Vegetation Index (NDVI)
- Landcover
- Elevation
- Slope
- Topographic Wetness Index (TWI)
- Height Above Nearest Drainage (HAND)
- Saturated Hydraulic Conductivity (KSAT)
- Distance to Water
- Storm Surge Hazard



Vulnerability

Vulnerability analysis involves socioeconomic factors that present information about the population.

Three different criteria were added to create the vulnerability map:

- Population
- Formal & Informal Settlements
- Building Density
- Two maps are shown on this tab. The map on the left shows Susceptibility and the map on the right shows Vulnerability.