Using 3D GIS Visualization to Communicate Flood Risk and Climate Change Information in Coastal Communities

As our climate continues to change and become more variable, flood risk and associated impacts are on the increase. Coastal communities are threatened by rising water due to sea level rise, high tides, storm surge, and heavy precipitation events. Community and sustainability planners, stormwater engineers, emergency managers, business owners, and other decision makers need meaningful and actionable information to increase their resilience and lessen their exposure. Much related data and information exists; however, it is often not presented in formats that decision makers can easily interpret.

3D GIS visualization allows anyone to virtually view potential flood impacts on coastal community infrastructure. Sea level rise and climate change scenarios, storm surge models, and other flood risk datasets are overlaid with buildings, elevated bridges and roads, and other community assets to assess varying levels of damage and destruction. Seeing these scenarios in 3D provides a sense of realism unachievable with traditional data formats. Having this knowledge can lead to better decision making by coastal community leaders when planning for future climates.

Basic Steps for Creating 3D GIS Visualizations

The 3D GIS visualization process starts with good LiDAR-based elevation data and high-resolution aerial imagery. These critical datasets form the base of the 3D visualization scene. The accuracy and resolution of the elevation data, in particular, will determine how other layers overlay onto the terrain and influence depth or other flood-related measurements. Once these layers are added to the scene, streets and other basic infrastructure can be added.

1. LiDAR Elevation Data
2. High-Resolution Imagery
3. Streets
4. 2D Building Footprints
5. Sugar-Cube 3D Buildings
6. Detailed 3D Buildings
7. Photo-Textured 3D Buildings
8. 3D Trees
9. Add Climate Stressor: Flood Overlay

Why Use 3D GIS for Climate and Flood Applications?

Historically, planners, emergency managers, and other decision makers have relied on charts, graphs, tables, and 2D maps to assess flood risk and climate change data. The reality is that many people—including these and other decision makers—have difficulty with “correctly” interpreting traditional 2D maps. Flood-related maps in particular can be very difficult to understand due to the complex information and the high amount of detail they typically display.

The next critical piece of 3D GIS data is 3D building models. In most cases, the focus of flood risk is on building infrastructure. 3D buildings can be generated at varying detail, depending on available data, costs, and other resources. They can vary from basic extruded 2D building footprints to create “sugar-cube” buildings, or they can be generated from LiDAR or stereo imagery data and then photo-textured with oblique imagery for maximum detail. After the 3D buildings are included, 3D trees and other elements can be included for added realism.

At this point, the 3D GIS visualization is ready for flood risk or climate change overlays. This could be in the form of sea level rise, storm surge, tidal flooding, or other climate stressors.
Flood Risk and Climate Change 3D Models in Southeast Florida

NEMAC has been working with municipal professionals from Broward County, Florida, over the last three years to develop 3D GIS visualization tools that will integrate new county flood modeling aimed at a better understanding of flood risk, as well as options for mitigating that risk. These new tools have enabled county staff to better communicate these issues to local elected officials and the general public. They have also allowed decision makers to assess where—and what type of—flood mitigation measures may be needed, such as possible locations for pumping stations.

More recently, NEMAC has partnered with the national engineering firm Hazen and Sawyer on a stormwater infrastructure planning project for the City of Ft. Lauderdale. Leveraging the 3D GIS visualization tools created by NEMAC for parts of Broward County, the existing work will be greatly expanded and will include new and very high-resolution LiDAR and imagery data.

NEMAC is also working directly with Esri—a global leader in developing and providing leading-edge 3D GIS software and tools—in the development of new workflows and methodologies for performing 3D GIS analysis and visualization. Recent projects in Miami, Florida, have allowed both organizations to test new tools and procedures.

Disseminating 3D GIS Information

Traditionally, the only way to effectively disseminate 3D GIS visualization scenes was through exported movie animations and 3D graphics. Both of these methods controlled what the user was able to see. Recent advancements in web technologies have allowed these 3D scenes to be shared through interactive and dynamic “web scenes.” These give the user full control and interactivity.

Screen capture of an Esri-based 3D web scene showing a neighborhood in Ft. Lauderdale modeled in 3D GIS and overlaid with FEMA floodplain data. This 3D web scene opens directly in a web browser and allows the user to navigate the scene, toggle on/off various flood overlay and other layers, and export map images.

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