Digitalization of Coastal Management and Decision Making Supported by Multi-Dimensional Geospatial Information and Analysis

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This paper presents the status and outcomes of the third year of an NSF-funded Digital Government Program project. The goal of the three-year project is to investigate and develop technologies to enhance the operational capabilities of federal, state, and local agencies responsible for coastal management and decision making. During this three-year period, successful collaborations have been established among research laboratories and government agencies such as NGS/NOAA, COOPS/NOAA, NIMA, ODNR, and the Lake County (OH) Planning Commission, in the areas of data collection and analysis, hydrodynamic modeling, development of web-based systems, and real-life application of research results.

The project has made significant progress. We have achieved coastal spatio-temporal data collection, set up a spatial data inventory system, and conducted multi-source spatial data integration. To facilitate the administrative processes of state and local government agencies, we have developed a web-based system for coastal management and decision making. Based on advanced web service technology, we have implemented a distributed spatial data infrastructure upon which spatial data can be effectively and efficiently managed, shared, and integrated in different data servers. At the same time, the requirements for data storage and computation intensity have been significantly reduced.

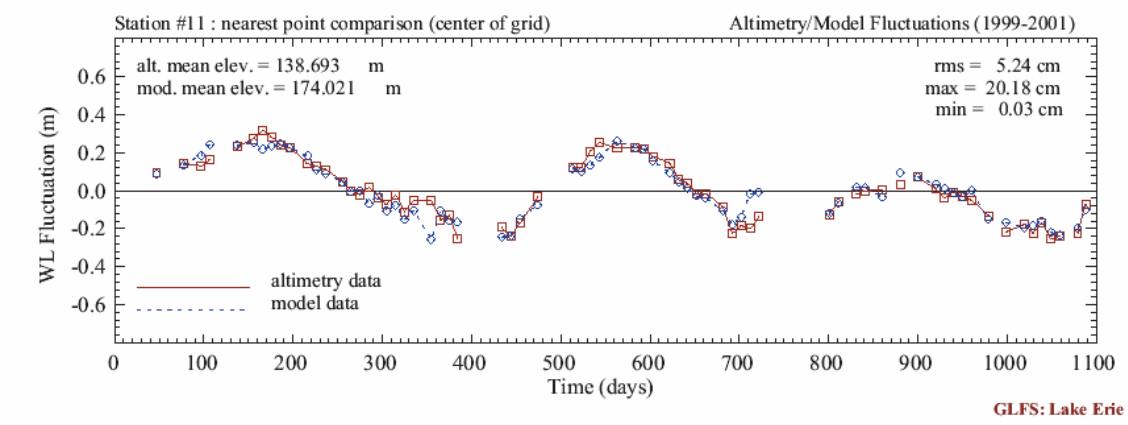

Figure 1. Comparison between satellite altimetric data and hydrodynamic model

In multi-source spatial data integration, three-year (1999-2001) satellite altimetric data, water-gauge data, and hydrodynamic model hindcast results are compared with the goal of improving operational lake and coastal circulation nowcast and forecasting capabilities. Figure 1 shows the comparison between satellite altimetric data and the hydrodynamic model hindcast in Lake Erie, Ohio. The 5.24 centimeter RMS result indicates that the hindcast is well matched to actual observations made by satellite altimetry and thus can be used directly (along with high-resolution DEM) for digital shoreline generation.

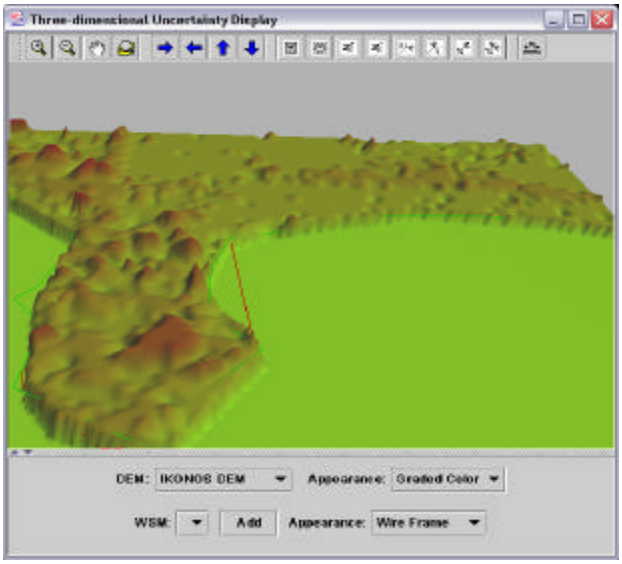

Figure 2. 3-D Uncertainty Visualization System

Figure 3. 3-D Shoreline in Tampa Bay

To provide a good understanding of spatial data integration and uncertainty analysis, a 3D uncertainty visualization system (Figure 2) was developed using Java3D techniques. The 3D relationship between satellite altimetric data, water-gauge data, the hydrodynamic model, and high-resolution DEM can be analyzed visually.

Sub-meter high-resolution QuickBird satellite stereo imagery was also acquired for the southern Tampa Bay area. Applying four different adjustment methods, geo-positioning accuracy of the QuickBird was achieved at a level of 71 cm in the horizontal and 65 cm in the vertical directions. A 3-D shoreline (yellow line in Figure 3) and a high-resolution coastal DEM were also derived.

A web-based coastal management and decision making system was developed. Modules of the system include a Shoreline Erosion Awareness System, a Coastal Structure Permitting System, and an On-Site Mobile Wireless Spatial System. The system will be put into use by the Ohio Department of Natural Resources and the Lake County (OH) Planning Commission. A shoreline prediction model has also been designed at The Ohio State University Digital Mapping and GIS Laboratory. Based on historic shorelines, future shorelines are predicted and published in the shoreline erosion awareness subsystem. This prediction model will help end users, especially coastal residents living in erosion areas, assisting them in making such decisions as building property protection constructions, property purchasing/selling, and small community planning activities.

Web service technology was applied to implementation of our distributed spatial data infrastructure. Through the help of web services, this infrastructure provides users with a means to establish communications between different kinds of data servers. It also provides the functionalities of data management, data processing, and data publication. Multiple resources of these servers such as storage space, and CPUs, are fully utilized. We are currently developing methods to produce a tide-coordinated digital shoreline from periodic instantaneous observations. The uncertainty of linear features and the analytical uncertainty model are also studied.

The project is proceeding very well.