Tampa Bay Integrated Science Pilot Study

Baseline mapping, land surface dynamics and predictive modeling, and hazards vulnerability studies

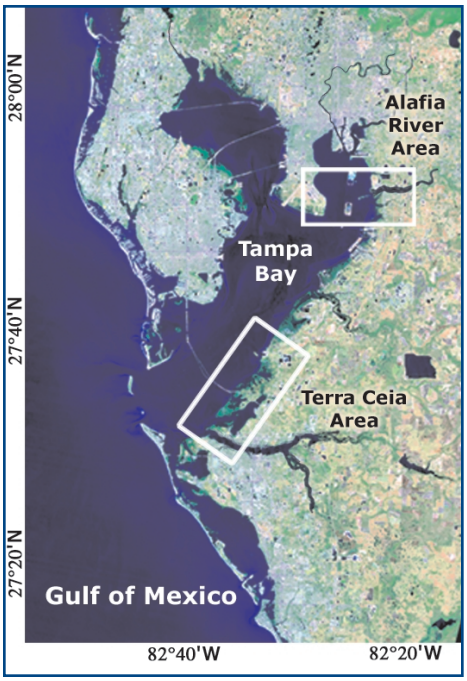

Figure 1. Landsat satellite image of Tampa Bay indicating the two initial field sites being intensively studied near the Alafia River and the Terra Ceia Area.

INTRODUCTION

Tampa Bay and its environs have experienced phenomenal urban growth and significant changes in land cover and land-use practices over the past 50 years. This trend is expected to continue, with the impact of human activity broadening geographically and intensifying throughout the region. One of the immediate impacts of urban growth is the creation of additional impervious surfaces, which in turn, generate increased urban runoff that contributes to higher levels of nutrient loading in water bodies throughout the area. To better understand these and other anthropogenic affects on the ecology of the natural environment of the region, this component of the Tampa Bay Pilot Study is taking a broad basin-wide view. This regional view is intended to provide geographic and temporal context for the smaller intensely studied sample field site locations within the estuarine environment (Fig. 1).

APPROACH

Baseline mapping

- Prepare contemporary and historical basin-wide seamless digital elevation models (DEMs).
- Create other multitemporal geospatial data layers for the Tampa Bay region.

Predictive modeling

- Prepare digital spatial data sets for use in numerical spatial modeling.
- Establish a Beowulf cluster of PC computers appropriate for performing numerical modeling.
- Run the SLEUTH Model to study urban growth from 1950 to present day, and predict urban growth patterns out to the year 2050.
- Model major categories of land use change over time and study impact to regions ecosystems.
- Integrate models to facilitate the study of anthropogenic influences on the environment.

Vulnerability to major hazards

- Investigate the current and predicted future vulnerability of the population and built environment to impacts from major natural hazards.

RESULTS/DISCUSSION

Baseline mapping:

A seamless, high-resolution, DEM has been produced for the immediate environs of Tampa Bay by merging the best currently available bathymetric and topographic data (Fig. 2). Differences in datums, formats, projections, quality, accuracy, age, and resolution associated with the two types of data were resolved by creating a common framework. This enables other high-resolution data to be integrated into the DEM as they become available. The DEM will be expanded in the near future to provide coverage of the entire drainage basin. Hydrographic charts and topographic survey maps dating from the 1800's and early 1900's will be used to create historical DEM's of the region that enable changes in the configuration of the coastline, land surface, and sea floor to be determined. Using a wide variety of sources including historical imagery, aerial photography, maps, and digital data, multitemporal data layers are also being developed for land cover and land use, areas excluded from development such as parks and cemeteries, urban land (Fig. 3), transportation features, and hill-shading, which imparts a 3-dimensional look to the terrain. The DEM's and regional geospatial data sets provide critical baseline information that support other scientific investigations being conducted under the pilot study, and support numerical modeling efforts.

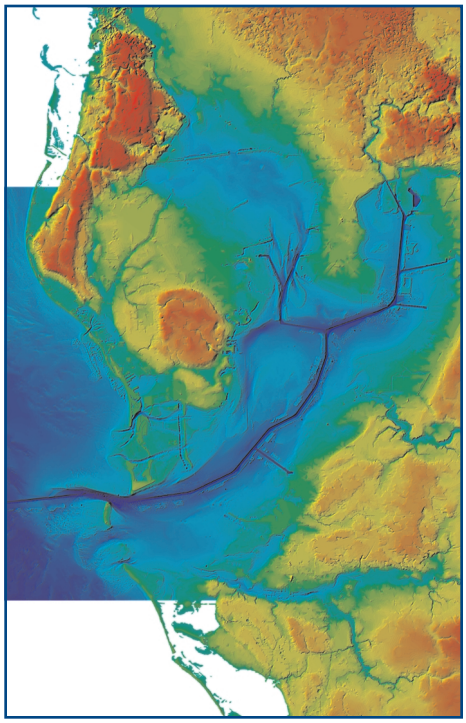

Figure 2. This DEM of the Tampa Bay area uses a combination of hill-shading and color tinting to depict relief, which ranges from a depth of 94 feet below sea level at the mouth of the Bay (dark blue) up to a height of 105 feet above sea level in Clearwater.

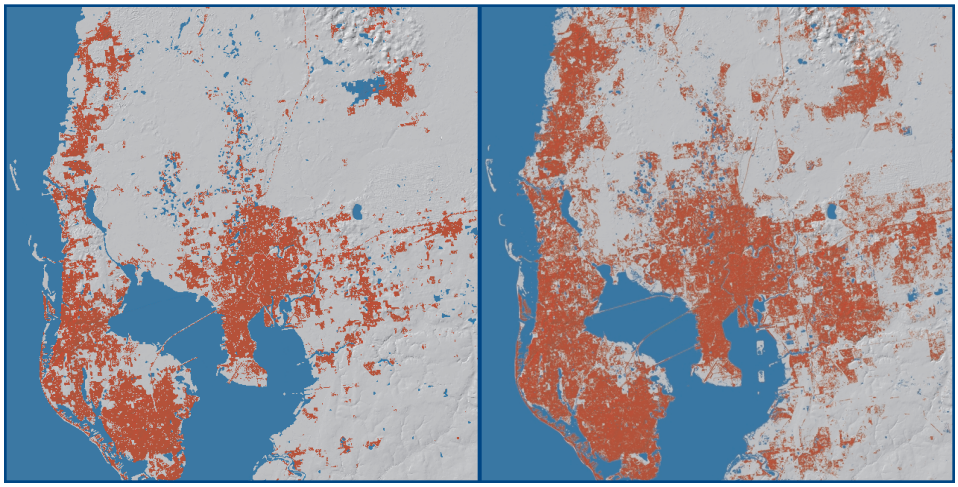

Figure 3. Urban extent for a portion of the Tampa Bay region is portrayed in red above. Note the increase in urbanization from 1972 (left) to 1992 (right).

Predictive modeling:

The baseline mapping layers described above are required input to the SLEUTH Urban Growth Model that is being used to simulate urbanization throughout the Tampa Bay drainage basin. These data have been reprocessed and prepared as input to the model. The SLEUTH Model is being run on a Beowulf cluster of PC computers that provide processing power approaching supercomputer capability (Fig. 4). The Model will be run to simulate urban growth from 1950 to the present day, and to predict urban growth patterns out to the year 2050. Similarly, major land cover categories will be modeled for the same time span to study potential impacts to ecosystems in the region. Scientists hope to couple other models with SLEUTH and investigate the relationships between land surface dynamics and the dynamics of the benthic environment.

Vulnerability to major hazards:

The rapid growth being experienced in the Tampa Bay drainage basin is placing an ever-increasing proportion of the population and attendant development at risk from the variety of natural disasters that characterize this region of the United States. Using the baseline mapping data in conjunction with other data available from Federal, State and local government agencies, and the urban growth predictions from SLEUTH, a geographical analysis is being conducted of the current and anticipated future vulnerability of the population and built environment to hurricanes, storm surges, flooding, coastal erosion, tornadoes, ground subsidence, wildfires, and high winds. The study will address historical changes that have occurred in the location and configuration of the coastline, changes in the distribution and density of the population, housing, commercial and industrial sectors, and land valuation. Socio-economic characteristics of the population will also be factored into the analysis.

SUMMARY

- The seamless DEM produced for a portion of the Tampa Bay region is available for use by other scientists at a resolution of 10 meters or 30 meters. Slope and hill-shading products have been generated from these files. The DEM data set will be expanded to cover the entire drainage basin of Tampa Bay.
- Land cover data sets have been created for the Tampa Bay drainage basin for the 1972, 1988, 1992, and 1995 timeframes. These and the other input data sets have been processed and prepared for use in initial runs of the SLEUTH Model. Data sets for the 1950's, 1960's, and 2000 will be produced in the future to improve the accuracy of SLEUTH predictions to the year 2050.
- Initial runs of the SLEUTH Model will focus on urban land growth. Later applications will model the temporal dynamics of seven land cover classes.
- South Florida has an extensive history of hurricane activity prior to the rapid growth of the past several decades. The majority of people living in the Tampa Bay region have never experienced a hurricane, and don't realize how extremely vulnerable the region is because of its low-lying topography.
- Coastal development patterns continue on barrier islands and along the coastline of the greater Tampa Bay region, placing the population and built environment at risk.

LINKS TO OTHER TAMPA BAY RESEARCH

These investigations are working closely with the other components of the Tampa Bay Pilot Project, as well as the Tampa Bay Estuary Program, Southwest Florida Water Management District, Florida Marine Research Institute, University of South Florida, and the Tampa Bay Regional Planning Council to improve our understanding of anthropogenic impacts on the Tampa Bay drainage basin.

Figure 4. Beowulf clusters such as this provide the processing power of a supercomputer at a fraction of the cost.

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