

Title: Land Characterization for Hydrologic Modeling in the Everglades

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Keywords: remote sensing, topographic mapping, biomass, vegetation density, resistance to flow, NDVI, Florida Everglades

Introduction

The U.S. Geological Survey (USGS) is building hydrologic models of the Florida Everglades for use in managing South Florida surface water flows for habitat restoration and maintenance in the Everglades National Park and Water Conservation Areas. Because of the low gradients present in the Everglades, small variations in topography and differences in vegetation structural characteristics are important factors in the distribution of surface water flow. At the USGS, National Mapping Division (NMD), we are developing and applying data collection, analysis, and modeling techniques to generate spatially distributed information on topography and vegetation density.

Unfortunately, existing vegetation maps fail to meet our needs because they were created with different requirements and technologies. Therefore, we are developing our own techniques to map vegetation type on a regional scale. This effort is detailed elsewhere in this volume (see Carter et al.). Here we focus on

the generation of elevation and vegetation density information using unique collection and analysis techniques.

Methods

For the large areas of inundated wetlands, we are using two approaches to collect Global Positioning System (GPS) data and derive elevation values. In accessible areas, airboats are used to navigate predefined lines in a grid-like pattern, and the surveyors use a range pole to measure the terrain surface obscured by water and vegetation. For inaccessible areas, the USGS developed the airborne height finder (AHF) system. The AHF uses GPS to position the helicopter and then deploys a calibrated plumb bob to measure the offset distance between the antenna and terrain surface. These data are then processed to yield various elevation data products.

For the vegetation density mapping process, we collect digital multispectral videography (DMSV) over several sites just prior to field collection of vegetation data. The DMSV system captures four-spectral band images with an equivalent ground resolution of .5 meter. These images are georeferenced to the same coordinate system applied in field data collection. Linear regression is used to establish a relationship between Normalized Difference Vegetation Index (NDVI) values computed from the DMSV and biomass estimates for vegetation quadrats. This relationship is subsequently used to extrapolate vegetation biomass across space within vegetation types.

Results

The elevation data collection process lets us measure subwater surface elevation heights to greater than 15 cm accuracy relative to the North American Vertical Datum of 1988, at a horizontal spacing of 400 meters. Data visualizations are yielding insights regarding topographic controls on both surface water flows and vegetation distribution.

Initial investigations of the relationship between vegetation index and biomass produced promising results even in an area with variable and unusual substrates (like periphyton). The vegetation index has explained 78 percent of the variation in biomass across 24 vegetation quadrats of varying type and density.

Vegetation density maps generated using information about this relationship produce realistic results that can be further classified into density and (or) flow resistance categories once velocity/density relationships have been established.

Conclusions

Because elevation data are so important and such a large area influences the hydrology of the Everglades, elevation data collection will continue for some time.

Elevation/vegetation relationships may be investigated so that higher spatial resolution maps of vegetation type can be used to synthesize higher resolution elevation information.

Although the NDVI to biomass correlation seems promising for limited areas where DMSV and vegetation field data have been collected, further analysis is

necessary to determine whether similar relationships hold for several other cover types during the dry season and across the entire South Florida region. We must also determine whether NDVI to biomass relationships scale upward and regionally. If so, regional coverage with satellite data of lower spatial resolution might be used for mapping broader area vegetation density.

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John W. Jones, is a Geographer in the Science and Applications Branch (SAB) of the US Geological Survey (USGS) National Mapping Division, Reston Virginia. He investigates the application of remote sensing and Geographic Information System (GIS) technologies to process modeling in hydrology and other earth science areas. Current research projects include vegetation characterization for hydrologic modeling; spatially distributed modeling of evapotranspiration; land cover dynamics; and urban development impacts on hydrologic regime and stream morphology. He is also lecturer in the Earth Science and Public Policy Masters Program at the Johns Hopkins University.

As the NMD Land Characterization Research Coordinator from 1995 to 1997, John oversaw the NMD component of all USGS Interdisciplinary Science Initiatives and represented the USGS in numerous ad-hoc working groups, committees, and task forces where expertise in land characterization was required.

From 1990 to 1995 John worked in the USGS GIS research laboratory, conducting applications research and training research scientists in the use of GIS technology.

Prior to joining the USGS, John held research and applications specialist positions in State government (Connecticut and Nebraska) and private industry (TYDAC Technologies, Inc.).

John received the Bachelor of Arts in Geography from the University of Connecticut (1984), the Masters of Arts in Geography and Water Resource Management from the University of Nebraska (1987), and is a Ph.D. candidate in Geography at the University of Maryland.