Past and Future Impacts of Sea-Level Rise on Coastal Habitats and Species in the Greater Everglades

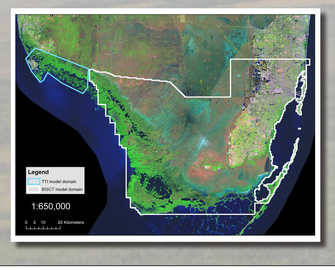
Langtimm, C. A.[1]; DeAngelis, D. L.[1]; Krohn, M. D.[2]; Smith, T. J. III[1]; Stith, B. M.[1]; Swain, E. D.[3]

[1] USGS-Southeast Ecological Science Center, [2] St. Petersburg Science Center, [3] USGS-Florida Water Center.

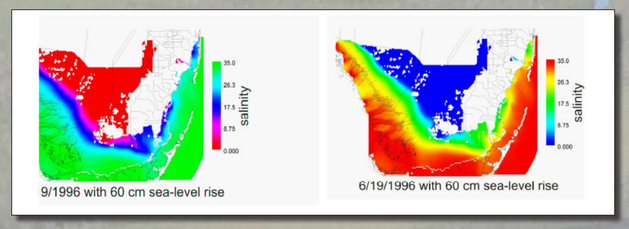
This project integrates biologic and hydrologic research components into new hindcast and predictive models to assist resource managers dealing with the consequences of rising sea level in coastal south Florida. We build on past USGS research in support of the Comprehensive Everglades Restoration Plan (CERP). (clangtimm@usgs.gov)

Component 1: The hydrodynamic model "Flow and Transport in a Linked Overland-Aquifer Density Dependent System" (FTLOADDS) simulates salinity, inundation, and water temperature. Figure A : The BISECT application (outlined in white) covers Everglades and Biscayne Bay National Parks. The TTI application (in blue) covers the Ten Thousand Islands. Figure B: An example of the application of the FTLOADDS model for BISECT; salinity is modeled with current sea-level and with a simulated 60cm rise in sea-level. (edswain@usgs.gov)

A

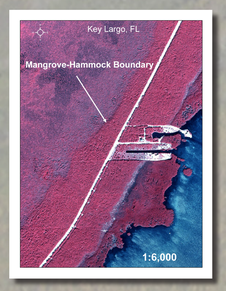


B

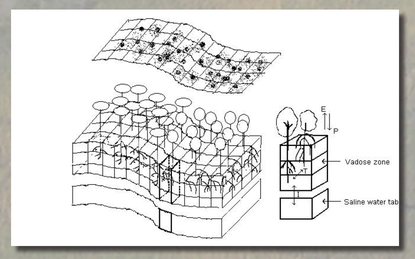


Component 2: Mangrove-hammock-marsh interaction models predict vegetation regime change due to salt-water intrusion from storm surges (or tsunamis). Vegetation types form sharp boundaries, ecotones, due to self-reinforcement to maintain salinity regimes (Figure C). The ManHam model simulates competition and predicts tipping points and lag times for regime shifts (Figure D). (don_deangelis@usgs.gov)

C

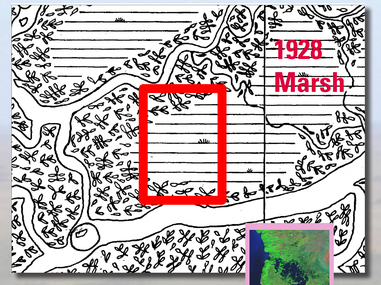


D



Component 3: Historic habitat charts and aerial photos identify hot spots of past shoreline and vegetation change in relation to historic sea-level rise (SLR) conditions. Comparing historic topographic maps (Figure E) with modern digital orthophoto quarter quadrangles (Figure F) identifies mangroves spreading along creeks and inland over time, and establishes the location of historic shorelines (Figure G) and their migration over time. (tom_j_smith@usgs.gov)

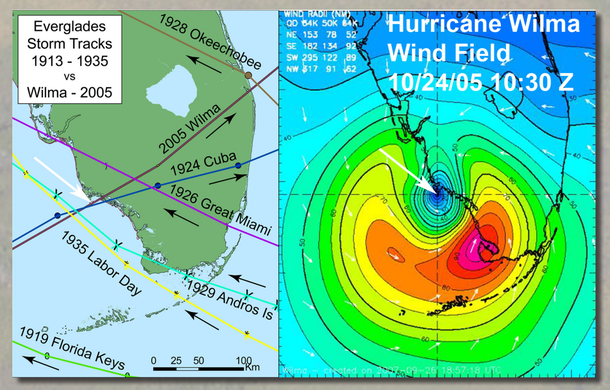
E



F

G

Component 4: Historic hurricane data test the effects of extreme hydrologic events on long-term ecological disturbances. Historic hurricane tracks from 1913-1935 (Figure H) are compared to extrapolated wind field of Hurricane Wilma in 2005 (Figure I) showing potential extent of influence from past storms. (dkrohn@usgs.gov)

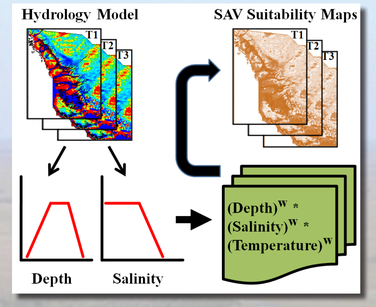


Hurricane Research Division, NOAA

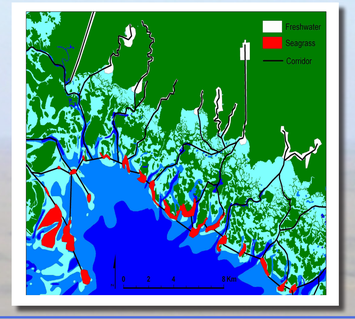
H I

Component 5: Spatially-explicit species and habitat-suitability models forecast ecologic response to hydrologic change. Submerged aquatic vegetation (SAV) suitability maps are produced from a time series of hydrology model output (Figure J). The SAV maps, along with hydrologic time-series data, will serve as input to a manatee suitability model, as well as an individual-based model (Figure K). (bstith@usgs.gov)

J



K

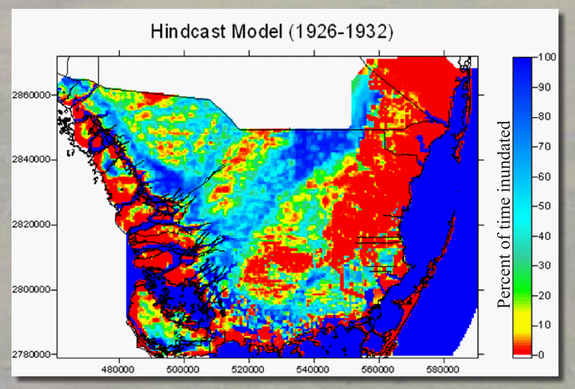


New Model Applications

{1} Hindcast

We are developing a hindcast model to assess historic hydrological conditions supporting past vegetation conditions. The initial simulation from 1926-1932 (Figure L) incorporates historic rainfall and surface-water feature data, Key West sea-level data, and input from the 1926 Miami hurricane. The simulation represents the coastal landscape prior to the construction of many canals and drainage features.

L



{2} Predictive

We will develop predictive capability from the calibrated hindcast model. The model will incorporate scenarios of projected SLR and climate parameters downscaled from global models, restoration scenarios from CERP, a selection of extreme weather events, and estimated rates of erosion and accretion to shoreline elevation. Output from the model will be used as input to a suite of spatially-explicit species models and habitat suitability models previously designed for CERP.

Acknowledgements: Jeremy Decker and Melinda Lohmann (USGS-Florida Water Science Center), Jiang Jiang (U. of Miami), Ginger Tiling-Range and Paul R. Nelson (USGS- SE Ecological Science Center) are contributing to this research.

Background photo of the Broad River by Tom J. Smith III Feb. 2006