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Managing Runoff: A Tool to Evaluate Potential Impacts of Climate and Land Change on Pathogen and Nutrient Concentrations in Weeks Bay

Glynis C. Lough, Ph.D.
Battelle

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CAST AND SCHEDULE

- New award under NASA ROSES A.40, Earth Science For Decision Making: Gulf of Mexico Region
- Expected start: October 2010
- Collaboration between Battelle and USRA (NASA MSFC)
  - Battelle
    - Dr. Glynis Lough
    - Dr. Doug Mooney
    - Dr. Cynthia Cooper
    - Dr. Norm Richardson
  - USRA (NASA MSFC)
    - Dr. Mohammad Al-Hamdan
    - Mr. Maury Estes
    - Dr. Ashutosh Limaye

OBJECTIVE

- Create a software DSS tool to evaluate and visualize the impacts of potential future climate and land use changes on runoff and concentrations of total suspended solids, nutrients, and pathogens in Weeks Bay, AL
  - Focus on end user needs
  - Allow evaluation the potential impacts of a variety of future scenarios
  - Provide new decision support for planning, anticipating vulnerabilities, and understanding uncertainty associated with future scenarios.

DECISION-MAKING ACTIVITY

- Four end user organizations:
  - Weeks Bay Foundation
  - Weeks Bay National Estuarine Research Reserve (NERR)
  - Alabama Coastal Foundation
  - Baldwin County (AL) Soil and Water Conservation District

- End user group
  - Focuses on research, conservation, outreach, and policy
  - Gave input to the proposal
  - Will participate throughout the project to advise on tool development

WEEKS BAY, AL


Mobile
Mobile
Baldwin
10
MOBILE BAY
WEEKS BAY
Dauphin Island
GULF OF MEXICO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Google
Image U.S. Geological Survey
Image © 2010 TerraMetrics
30°25'44.04" N 87°52'03.25" W
elev 6 m
Feb 2008
Eye alt 72.49 km

THE BAY

- Weeks Bay, AL
  - National Estuarine Research Reserve
  - Long-term sets of *in situ* data
  - Small estuarine embayment (3 mi^2 open water) off of Mobile Bay
  - Average 4.5 ft depth
  - Rapid development in recent years
- The primary concerns in the bay are nutrients and pathogens
- No regulations address runoff or water quality at the planning stage (state, county, or municipal)
  - Most of Baldwin County is unincorporated and has no zoning laws
  - Housing developers have basic regulations (lot size), but developers of business and agricultural projects have zero requirements
  - Development decisions are often based on the judgment of volunteer planning boards

NEW DSS GOALS

- End users requested a tool to allow resource managers and planning boards in the area to input scenarios and understand the potential impacts on the character of runoff and concentrations of nutrients and pathogens in the bay
- Example scenarios:
  - A new development of a certain size with 35% impervious surface
  - An increase in average summer temperature
  - Increased hydroperiod or precipitation strength

NEW DSS GOALS

- Provide a tool that allows simple assessment of potential changes, vulnerabilities, and uncertainties

- **Key point: translation of important concepts into something that is real, accessible, and useful**
  - Partner end users indicated disappointment with past projects that delivered static future predictions

METHOD

1) Collect and evaluate existing data sets (satellite and in-situ)

2) Detailed watershed and hydrologic modeling for historical dates and future scenarios

3) Statistical analysis of the existing data sets and modeled water properties to develop associations and patterns

4) Develop a DSS visualization tool to permit end-users to interact with the statistical model and scenarios

TASK 1: EARTH SCIENCE PRODUCTS

- Landsat-derived NLCD (1992 and 2001)
- Watershed and Hydrodynamic models
- Projected LCLU
- Landsat Data Continuity Mission (LDCM)
- Surface Reflectance (MOD09GQ)
- Chlorophyll-a (SeaWiFS, MOD21)
- Diffuse Attenuation Coefficient (MODIS, SeaWiFS)
- Organic Matter concentration (MOD24)
- In-Situ data
  - Weather (NERR)
  - Water quality (NERR)
  - Atmospheric deposition (NADP)
  - Atmospheric PM and nutrients (EPA)

TASK 2: MODELING

- Conduct watershed and hydrodynamic modeling to simulate water flow, TSS, salinity and temperature
- Use LCLU and climate conditions for two historical years (1992 and 2001) and for 2030
- Watershed model
  - Predicts changes in water runoff and total suspended solids (TSS)
  - Models multiple discharge points around Mobile Bay and Weeks Bay
- Hydrodynamic model
  - Uses watershed model results
  - Generates forecasted TSS values
  - Results are gridded with four vertical profiles throughout the Bay's aquatic ecosystems

LCLU MAPS for 1992, 2001, 2030

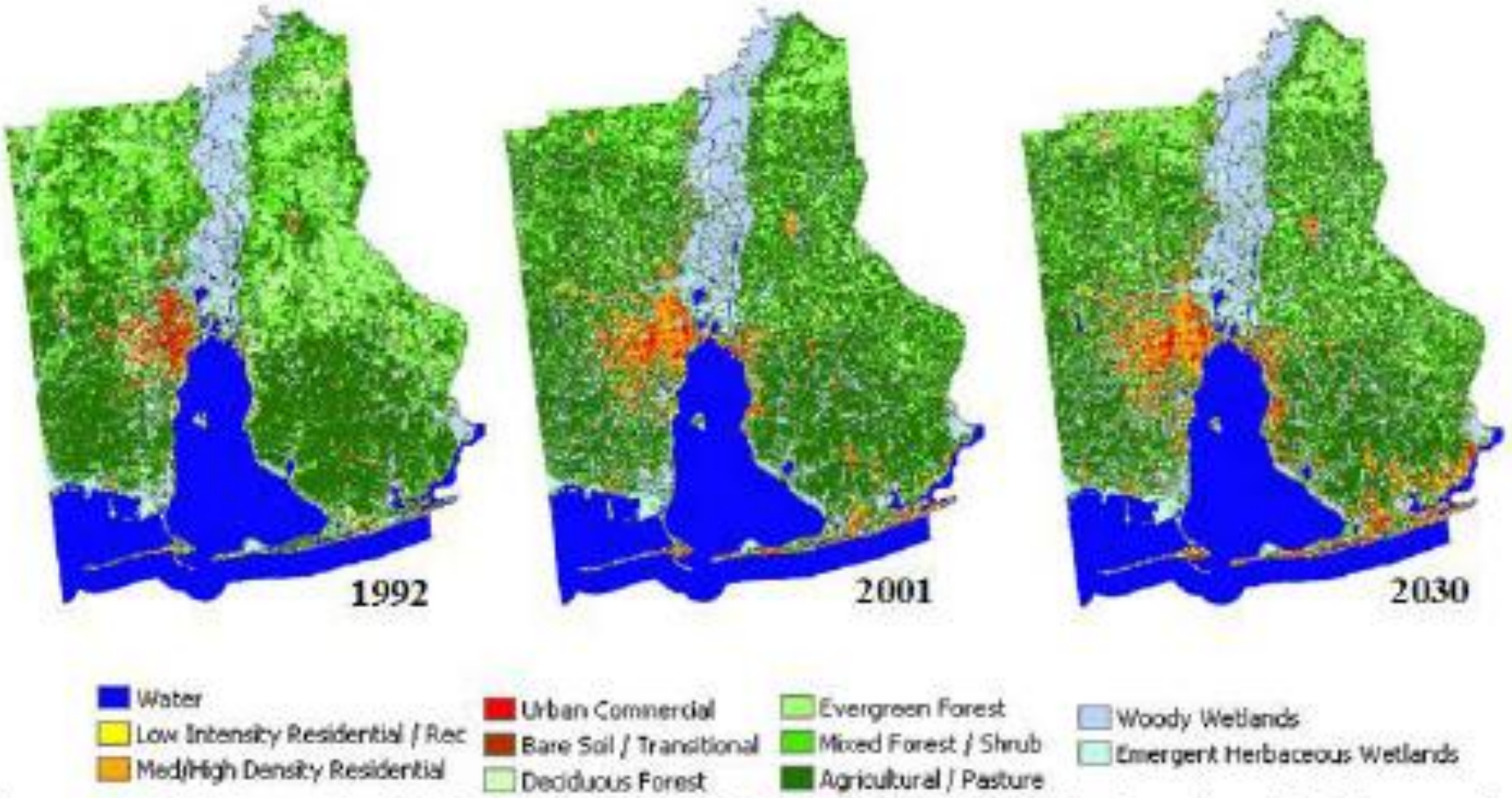


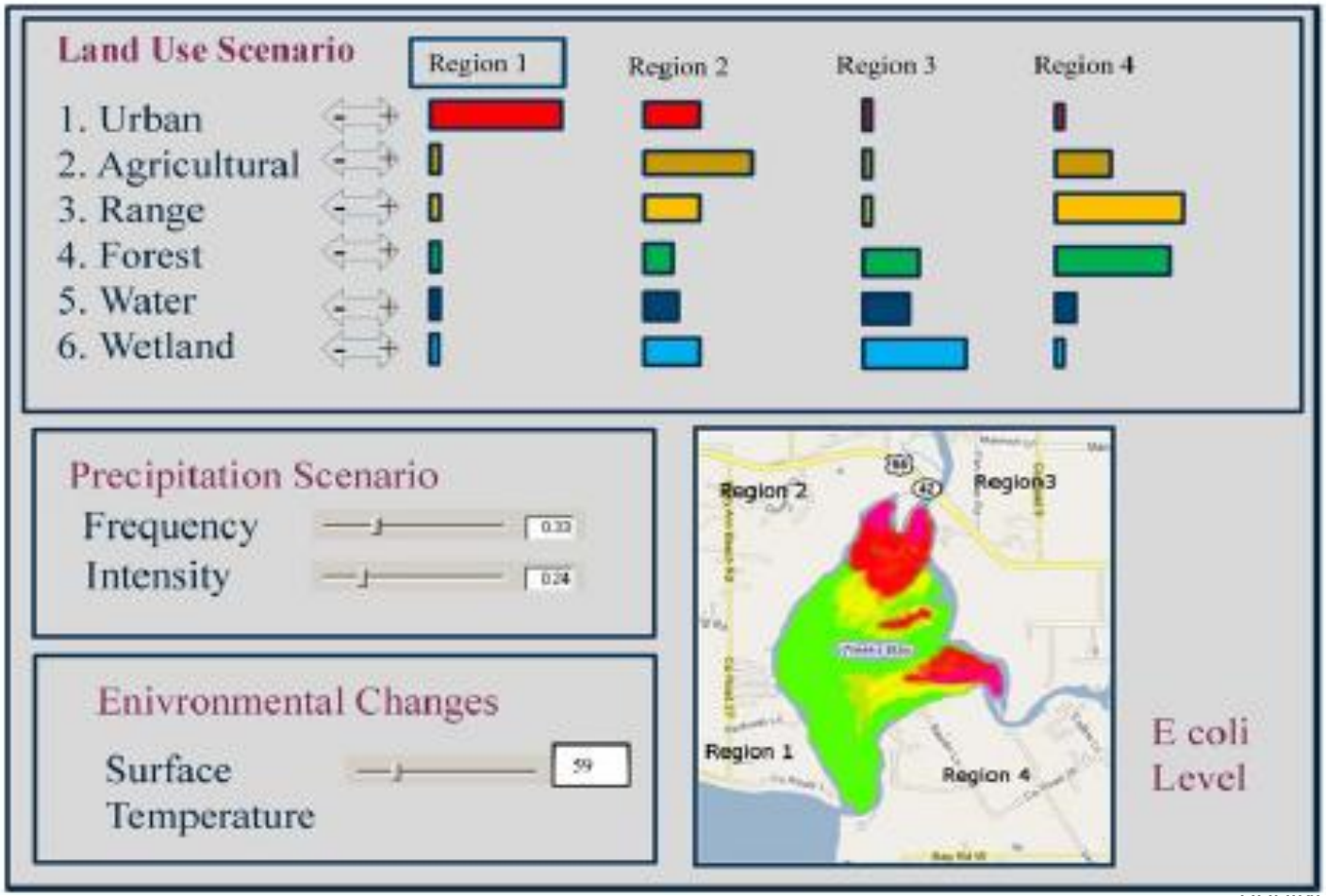
Figure 2. LCLU maps for 1992, 2001, and 2030 in Mobile and Baldwin Counties, AL (Estes et al., 2007).

TASK 3: STATISTICAL MODEL

- Develop a statistical model to relate changes in watershed and climate characteristics to water conditions
- Methods include multivariate regression and spatial analysis
- 2-3 layers in the statistical approach
  - First layer: relates watershed conditions and meteorological conditions
  - Second layer: addresses water conditions at numerous locations within the bay waters over time
  - Third layer (exploratory): ecological outcomes (e.g., algal blooms, fish kills) that may be associated with changes in water conditions
- "To associate the layers, consider that some combination of factors constitute latent conditions throughout the layer for which a particular set of conditions or outcomes at the next layer would be expected to occur"
  - Little or no attempt to develop a parametric model to mimic the behavior of physical processes, nor to have a physical interpretation.

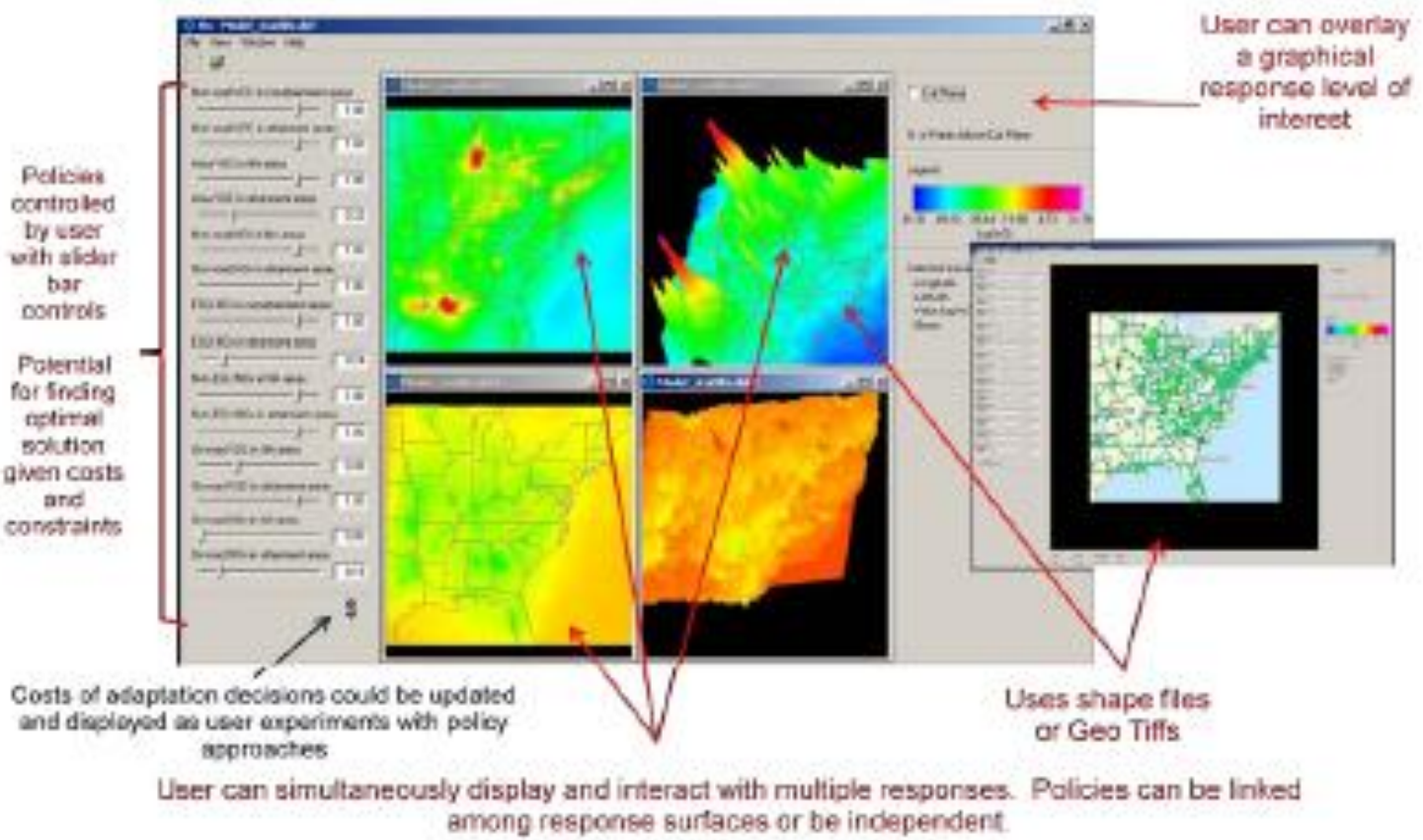
TASK 4: TOOL DEVELOPMENT

- Work with end user group to identify their information needs
- Develop a simple software interface to interact with the model

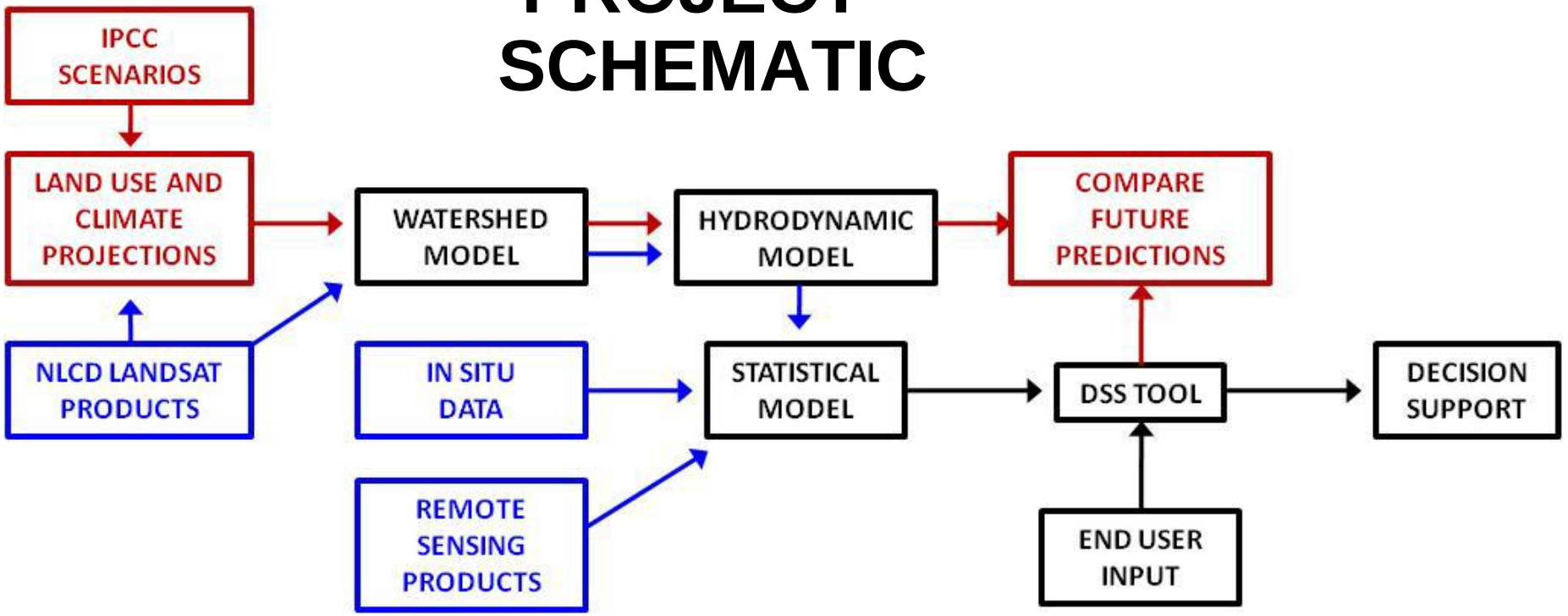


TASK 4: TOOL DEVELOPMENT

- Tool will be similar to a previous tool, the Visual Policy Analyzer (VPA), developed for EPA
- VPA allows interaction with a complex set of model outputs simply assess predicted outcomes of an action



PROJECT SCHEMATIC



DATA | PROJECTIONS | THIS PROJECT

Glynis C. Lough, Ph.D.
loughg@battelle.org

Mohammad Z. Al-Hamdan, Ph.D.
mohammad.alhamdan@nasa.gov