Planning for Sea Level Rise and Storm Surge Inundation: Climate Impacts in Hampton Roads

Regional Climate Change Meeting
Hampton Roads Planning District Commission
October 29, 2009

Barry Stamey
Director, Strategic Collaboration, Noblis
and Colleagues in the Chesapeake Bay Region
Noblis at a Glance

• Independent, non-profit, science, technology and strategy company
  – Work in the public interest
  – Headquarters in Falls Church, VA and offices nationwide; 750 employees
  – Over 40 years of successful support to the public sector – Mitretek Systems, Mitre Corporation

• Currently providing science and technology support to 32 federal agencies and 34 state governments
  – Impartial, conflict-free, independent counsel and support

• Transportation, Telecommunications, Healthcare, National and Homeland Security, Sustainable Energy, Oceans, Atmosphere & Space

• Climate Change
The Role of Noblis

“Government”
- Review of work
- “Directing” work
- Strong OCI requirement
- Viewed as inherently governmental & creates restrictions

Noblis
- Early Planning & Concept Development
- Research + Prototyping
- High level System Engineering + Modeling & Simulation + Analytics
- Program Management + Integration
- Acquisition Support
- Independent Verification & Validation (IV&V)

“Industry”
- Building Systems
- Large scale deployment & support
- Field Implementation
- Life Cycle Support
Project TEAL

• Greenhouse Gas Analytical Modeling
  – Noblis developed internal model to calculate and determine footprint
  – Significant interest from outside entities
  – Launched TEAL Spring 2009

• Significant work with the General Services Administration
  – GSA Integrated Technology Service requested assistance with baselining and greening their operations
  – Noblis expanded the green application to meet GSA’s needs

• The future is green
  – Currently working with GSA to expand functionality of existing application
  – Fleet, building mechanical systems, emerging technologies
  – Ensure compliance with draft public sector protocol
Assessment of the Impact of Sea Level Rise on Military Installations

Climate Change Planning for Military Installations
Climate Change Planning for Military Installations

Task Elements

- Establish Facility Selection Criteria
- Select Installations
- Visit Installations
- Current DoD Missions and Tasks
- Current and Future Missions and Tasks
- Mission / GCC Risk Management
- Observed and Predicted GCC Effects

Strategic Guidance and Evolving DoD Missions

GCC Drivers

Survey Current Tools, Methods and Research

DoD-Relevant Research Requirements

DoD-Unique Research Needs

SERDP Research Recommendations
Coarse Resolution in Global-Scale Modeling

IPCC Scenarios

GCMs (general circulation models)

Timeframe for Results:
- 1961 – 1990
- (2010 – 2030)
- 2035 - 2060
- 2070 - 2100

Hydrologic Modeling

Snow Depth

Graphics from IPCC, 2007 & USGCRP 2009
Higher Resolution Through Downscaling

GCM grids (pixels): ~150 miles

Downscaling pixels: ~10 miles
Key Attributes for Military Installations

- **Good climate change data**
  - Downscaled data
  - Significant forecasted changes
  - Diverse geographic regions

- **Includes current and future missions**
  - Full range of land, sea, air missions
  - Disaster relief/humanitarian assistance
  - Power projection operations

- **Combines major military activities**
  - Most ground forces elements
  - Many air forces elements
  - Most sea force elements

- **Have extensive and diverse training areas**
  - Land
  - Water

- **Have major infrastructure and facilities**
  - Diverse types
  - High tempo air, land, and port operations
  - Training and range areas, ports, airstrips, training, command and control, buildings

- **Have important regional relationships and concerns**
  - Water
  - Endangered species
  - Off-post/base housing
  - Transportation

- **Vulnerable to potential climate change**
  - Infrastructure (power, transportation)
  - Sea level rise
  - Hurricanes, severe storms, storminess
  - Extreme heat and humidity
Naval Base Norfolk, VA

Summary – Largest US Navy base, vulnerable location, large and imbedded active duty and civilian workforce, regional dependencies.

NAB Little Creek, VA

Summary – Critical, vulnerable, low elevation base with strong regional dependencies.
Climate Change Risk Management Framework

1. Identify DoD missions & essential functions
2. Identify activities affected by Climate Change
3. Assess likelihood of occurrence in timeframe
4. Identify full range of climate impacts that affect each activity
5. Identify worst reasonable case consequences
6. Identify necessary contributing factors
7. Assess risk response options
8. Make risk informed decision
Chesapeake Inundation Prediction System (CIPS)

From Forecasting to Climate Planning

Colleagues
Chesapeake Bay Observing System (CBOS)
Hurricane Isabel (2003)
THE POTENTIAL EXISTS FOR STORM SURGES OF 5 TO 10 FEET ALONG THE COAST FROM CURRITUCK BEACH TO CHINCOTEAGUE...4 TO 8 FEET OVER THE SOUTHERN BAY...AND 3 TO 5 FEET FOR THE CURRITUCK AND ALBEMARLE SOUND. PORTIONS OF THE WESTERN ALBEMARLE SOUND STORM SURGE VALUES FROM THE CHOWAN AND ROANOKE RIVERS. THESE SURGES WILL CAUSE COASTAL FLOODING OF LOW LYING FLOOD PRONE AREAS...ESPECIALLY AROUND TIMES OF HIGH TIDE.

SEWELLS POINT IS EXPECTED TO SEE WATER LEVELS OF 8 TO 10 FEET ABOVE MEAN LOWER LOW WATER AROUND HIGH TIDE AROUND 3:10 PM THURSDAY.

EMERGING TECHNOLOGY

• Very high resolution hydrodynamic models with inundation (wetting & drying)
• Regional scale atmospheric wind forecast model
• Very high resolution elevation data (LIDAR)
• Emerging GIS and visualization capabilities for integrated, high-resolution impacts products

CIPS
| **Storm Winds** | Prolonged intense winds with gusts of tropical strength |
| **Storm Precipitation** | Direct rainfall (1-2 feet) on bay and estuaries |
| **Storm Surge** | Ocean water (5-10 feet) pushed toward shore |
| **Storm Tide** | Storm surge and normal tide (latter, up to ~ 3 ft) |
| **Storm Waves** | Waves (3-6 feet in height) that accompany storm tide |
| **Storm Flood** | Freshwater runoff toward shore from flash and subsequent river flooding (down-channel, out-of-bank, and overland) |

**Storm Surge Inundation**  
The combination of all the above, and most severe in height if precipitation, surge, high tide, high precipitation, and flash flooding occur simultaneously, and in duration as they diverge in time.

Modified, MTK, USGS
Project Management:
• Chesapeake Bay Observing System (CBOS)/ Old Dominion University
• Chesapeake Research Consortium

Atmospheric Modeling and Validation:
• NOAA National Weather Service (NWS) Weather Forecast Offices
  – Wakefield, VA; Sterling, VA; Mt. Holly, NJ
• WeatherFlow

Hydrodynamic and Hydrologic Modeling and Validation:
• Virginia Institute of Marine Science, College of William & Mary
• University of Maryland Center for Environmental Science (UMCES) Horn Point Laboratory
• NWS Middle Atlantic River Forecast Center

Overland Inundation Validation:
• USGS Water Science Center Baltimore
• USGS Office of Surface Water Reston

Visualization and Validation:
• Noblis

Economic Valuation and User Engagement:
• UMCES Chesapeake Bay Laboratory

Data Management and Communications:
• NOAA Chesapeake Bay Office
CIPS Storyboard: 2007-2010

User Needs and Buy-In

OBSERVATIONS

VISUALIZATION

HYDRODYNAMIC MODELING

ATMOSPHERIC MODELING

AHPS

LIDAR

Emergency Management

Valuation

Health

Sea Level Rise

Structural Mitigation

Outreach

Natural Resources

Tsunami Planning?

Environmental Quality
Potential CIPS Contributions to EM Decision-Making

NWS Generated Information
- Storm location, track timing, intensity
- Local wind/flood predictions

Locally Generated Information
- Impacts of wind/flooding
- ER assets available
- ER opportunities/constraints

EM Decision Support Tools
- Visualizations
- Optimize EM asset deployment/redeployment
- Go/no go thresholds
- Risk/cost rankings
  - False positives
  - False negatives

EM Decisions
When and where to:
- Issue warnings
- Evacuate and allow returns
- Close/open roads, schools, businesses
- Initiate ‘contraflow’ traffic rules
- Turn off/on utilities
- Call for outside assistance

CIPS 1 – ‘ensemble’ provides more timely, more accurate, and more reliable predictions of water levels at local tide gauges before, during, and after storms.

CIPS 2 – employs local high resolution lidar data to provide more accurate, reliable, and timely upland inundation and related cost/risk predictions.

CIPS 3 – Improved methods of conveying NWS and local information to EMs to improve timing and reduce uncertainty related to EM decisions.

CIPS 4 – Improved EM decision support tools (e.g., GIS, visual, risk-based) and better incorporation of NWS and local information into them.
Someone marked the high water point in Old Town Alexandria, VA

Chesapeake Inundation Prediction System (CIPS)
Hurricane Isabel
September 19, 2003 (4:00 AM)

The intersection of Union and King Streets in Old Town Alexandria, VA
Hurricane Isabel (2003): Alexandria, VA
Flood Depth (10 meter pixel horizontal resolution)
CIPS Forecast Models Ensemble

PROTOTYPE EXAMPLE: NOT FOR OFFICIAL USE - FOR DEMONSTRATION ONLY
1.98 ft/100 yrs

1.12 ft/100 yrs

1.01 ft/100 yrs

http://tidesandcurrents.noaa.gov/index.shtml
20th Century Hurricanes/Tropical Storms

http://www.climate.org/topics/weather/isabel/21-storm-tracks.shtml
What if a Category 3+ went up the western side of the Bay?

http://www.climate.org/topics/weather/isabel/21-storm-tracks.shtml
1933 Atlantic hurricane 8

http://www.climate.org/topics/weather/isabel/21-storm-tracks.shtml
Hurricane Isabel – Hampton Roads
Inundation versus Sea level Rise
Hurricane Isabel - Naval Amphibious Base Little Creek
Inundation versus Sea Level Rise

Legend
- 0 cm
- 50 cm
- 100 cm
- 150 cm

PROTOTYPE EXAMPLE:
FOR DEMONSTRATION ONLY
Hurricane Isabel - Norfolk Naval Shipyard
Inundation versus Sea Level Rise

Legend
0 cm
50 cm
100 cm
150 cm

PROTOTYPE EXAMPLE:
FOR DEMONSTRATION ONLY
Peak Inundation – Hurricane Isabel
Virginia Beach, VA

Ocean Park Rescue Squad

Schools
Thank You

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