

## **EBEI-2: Observation System for Changes in Coastal Areas**

### **Option Description**

The Chesapeake Bay is the largest inner-coastal estuary in the Nation, covering over 166 thousand square kilometers, with more than 150 rivers and streams draining into the watershed, and home to about 15 million people. Most of Maryland's communities and economic activities in this low-lying coastal region are particularly vulnerable to storm surges and flooding, events that will be likely be intensified due to rising sea level associated with climate change. Maryland relies upon its coastal areas along the Chesapeake Bay and its Atlantic coast for healthy fisheries, and reliable transport and navigation. Its dependence on infrastructure networks (roads, power grids, etc) intensifies the potential vulnerability of these areas to impacts from climate change-induced natural disasters.

An enhanced ability to observe sea level rise induced changing along Maryland's coastal areas will provide key benefits to the state. Under climate change, managing resources in these areas is more important than ever and will require accurate information from an integrated observation system to allow for detection and prediction of the causes and consequences of changes in coastal systems, watersheds and infrastructural resources. This option aims to support, enhance and integrate observation systems already in place in Maryland. Specifically, the option aims to strengthen such systems to enable the comprehensive surveillance, monitoring, documentation, and dissemination of rates and locations of sea-level rise in Maryland. This includes the installation of surveillance equipment in coastal sites where current public/private infrastructure is potentially vulnerable to small increases in sea level, the incorporation of long-term coastal monitoring aspects into existing protocols, and the integration of observation activities in regional efforts.

This policy option aims to enhance statewide monitoring programs to detect biological, physical and chemical responses due to direct and indirect effects of climate change. This option will be facilitated through the observation, analysis, and interpretation of trends in coastal water levels, elevation (subsidence rates, if any), shoreline change, wetland loss, and tidal influence on estuaries and water supplies. The observation systems will enable the state to assess the responses of coastal landforms to sea level rise as well as the effects of an increase in storm activity. The Geographic Information System (GIS) will integrate the current elevation of the built environment with sea level, storm surge scenarios, and changes in coastal buffers that protect the built environment. Such a system will enable the identification of specific structures and infrastructure (roads, ports, etc.) that are most vulnerable to climate change.

### **Option Design**

The specific objective of this option is to assess how existing observation systems for the Chesapeake Bay region can be enhanced to better understand and address long-term sea level

rise and its impacts on the built environment. The overall option design is summarized in the bullets below.

- **Targets:** The target for this option is in the form of a detailed assessment regarding the adequacy of MD's current observation system protocols, systems, technologies, and surveillance strategy to address long-term changes in sea level rise in the Bay area. The output of the study should be a series of recommendations regarding how current observation networks could be reinforced and/or new component addressed to better address changing conditions regarding sea level rise. Observation networks are an essential component of adaptive management in low-lying coastal areas. They are also essential in planning and evaluating the effectiveness of restoration programs in Maryland's coastal zone.
- **Ideas to Explore:** 1) vertically-controlled tide gauges (there is a gap in the CO-OPS observing system at Jug Bay, and CO-OPS or someone should fund a tide gage there; and 2) Surface Elevation Tables to measure whether marsh accretion is keeping pace with erosion/inundation – there are a bunch of these at Blackwater, CBNERR-MD has them at Jug Bay and is getting them at Monie Bay
- **Timing:** The timing of the study is immediate. It is anticipated that a 3-year period will be needed to complete the study. By the end of this period, there should be a detailed recommended program regarding the additional integrated observations required, supplemental data management and distribution systems (if any), and a set of analytical products that respond to user-specific needs (i.e., commercial, management, recreational, educational, scientific, regulatory, safety, hazard protection, and restoration communities).
- **Parties Involved:** There are several parties that would be involved in the design and oversight of the study. At the state level, it would include the MD Department of Natural Resources and local national weather services offices. At the regional/national levels, it would include the National Oceanic and Atmospheric Administration, National Geodetic Survey, Chesapeake Bay Observation System, the United States Geological Survey, and the National Office for Integrated and Sustained Ocean Observations.
- **Other:** NA.

### Implementation Mechanisms

This option would be implemented by first preparing a feasibility study on the scope, issues, challenges, and likely costs associated with upgrading existing observation systems. On the basis of this study, terms of reference for the assessment would be prepared and implemented by a qualified organization/consortium. The recommendations of the study would become the input for changes to existing rules/regulations or new legislation to implement the activities identified as necessary to adequately monitor sea level rise and the effectiveness of Maryland's adaptation responses to climate change.

### Related Policies/Programs in Place

There are important observation systems already in place in Maryland to monitor the Chesapeake Bay. The Chesapeake Bay Observing System (CBOS) is an organization that provides integrated data observation, management, and distribution systems and information for use by Chesapeake Bay and coastal communities. It is part of an evolving sub-regional observing system embedded in the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) and the Congressionally-mandated Integrated Ocean Observing System (IOOS).

NOAA, Center for Operational Oceanographic Products and Services (CO-OPS): *Tides and Currents*: General info – <http://tidesandcurrents.noaa.gov/index.shtml>

National Water Level Observation Network (NWLON):

- A network of 200 long-term, continuously operating water-level stations throughout the U.S., which provide tidal datums and water level observations for the US, as well as long-term sea level trends. They are also the foundation reference stations for NOAA's tide prediction products, and serve as controls in determining tidal datums for all short-term water-level stations.
  - Routine real-time automated and event-driven data acquisition.
  - Data can be used to estimate relative sea level trends (long-term sea level variation, monthly mean sea level).
  - Working on the ability to model long-term events (50 to 100 years) and inundation. The exceedance probability product will be available online soon.
  - Tie tide gauge stations to Continuously Operating Reference Stations (CORS) in order to tease out local land movements from sea level trends.
- More info – <http://tidesandcurrents.noaa.gov/nwlon.html>

VDatum:

- Software tool designed to transfer between 28 different vertical datums consisting of tidal, orthometric, and ellipsoidal datums.
- more info – <http://www.nauticalcharts.noaa.gov/csdl/vdatum.htm>

Climate Change Science Program (CCSP):

- NOAA is a lead author on Synthesis and Assessment Product 4.1: *Coastal Elevations and Sensitivity to Sea Level Rise*
  - Estimated start of 45-day public review of draft report 9/2007.
- more info – <http://www.climatescience.gov/Library/sap/sap4-1/default.php>

**National Geodetic Survey (NGS):** General info – <http://www.ngs.noaa.gov/>

National Spatial Reference System

- NGS responsible for [National Spatial Reference System](#). Need land and water levels tied together for local impacts of sea level rise. LIDAR must be tied to good geodetic control for it to be accurate.

Continuously Operating Reference Stations (CORS):

- CORS network – Over 1,200 Global Positioning System (GPS) stations that run 24/7 and get adjusted daily. CORS system enables positioning accuracies that approach a few centimeters relative to the National Spatial Reference System, both horizontally and vertically.
  - NGS is working with CO-OPS to co-locate CORS with NWLON stations. This has already been done at several coastal sites, including Charleston, SC and Key West, FL. This enables local land elevation changes to be accounted for within local sea level measurements.
- more info – <http://www.ngs.noaa.gov/CORS/>

Height Modernization Program:

- Provides accurate height information by integrating GPS technology with existing survey techniques.
- Looking at ways to get good elevations in intertidal areas, particularly tidal wetlands.

- This year, for the first time, NGS was funded for a nationwide height modernization program instead of earmarks for individual States. This should allow NGS to focus on areas where heights matter the most (i.e. along the coasts).
- more info – <http://www.ngs.noaa.gov/heightmod/index.shtml>

#### Remote Sensing Division

- Responsible for collecting national shoreline information, to be fed into nautical charts.
- more info – <http://www.ngs.noaa.gov/RSD/coastal/index.shtml>

#### (NGS) State Geodetic Advisors

- NGS has agreements with many States to employ geodesists to assist with surveying and geospatial data issues.
- more info – <http://www.ngs.noaa.gov/ADVISORS/AdvisorsIndex.shtml>

#### Surface Elevation Tables (SETs)

- NGS is working on guidance documents concerning using GPS to tie SETs to local tidal and geodetic datums to enable measurement of vertical movement of coastal habitats.
- NGS is also working with USGS to quantify the errors associated with SET devices and to improve the design of the instrument.
- more info – <http://www.pwrc.usgs.gov/set/>

#### **U.S. Geological Survey – Need to add**

*Eyes on the Bay (EOTB):* A website of DNR's Tidewater Ecosystem Assessment (TEA) Division, Eyes on the Bay (EOTB), provides easy access to near real-time, mapped and historical Chesapeake and Coastal Bays water quality information and data. Available data includes water temperature, salinity, dissolved oxygen (the amount of oxygen available for aquatic life), water clarity, chlorophyll (the amount of algae in the water), and pH levels (the acidity/alkalinity of the water). Monthly, Continuous Monitoring and Water Quality Mapping data can be retrieved at EOTB.

*MDNR – MANTA-MD Biological Stream Survey:* Since 1994, Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division (MANTA) has sampled and assessed more than 2,000 freshwater, wadeable streams for biological, habitat, and chemical quality through the Maryland Biological Stream Survey (MBSS). Stream quality indicators have been developed for fish, benthic macroinvertebrates, salamanders, and physical habitat. MBSS results have been used in a variety of ways, including 1) watershed characterizations (i.e., targeting areas in need of both restoration and protection) via the Clean Water Action Plan and the resultant Watershed Restoration Action Strategies, 2) listing impaired streams for MDE's 303d list, 3) evaluation of stressors to aquatic fauna, and 4) determining geographic ranges of rare, threatened, or endangered aquatic species.

*MANTA's Sentinel Site Network:* To track natural variability in stream chemical, physical, and biological conditions, the Maryland Biological Stream Survey (MBSS) established a long-term monitoring component, the Sentinel Site Network, in 2000. The Network consisted of 26 of the highest quality, minimally disturbed streams in Maryland based on physical, chemical, and

biological data collected by the MBSS from 1995-1997. In addition, MANTA has developed a Proposed Monitoring Program for Tidal Freshwater Ecosystems

*Comprehensive Shoreline Inventory (CSI):* Maryland's Coastal Program contracted with the Virginia Institute of Marine Sciences (VIMS) to prepare a Comprehensive Shoreline Inventory that captures baseline shoreline conditions throughout the tidal portions of Maryland's coastal counties. Shoreline features and conditions were identified through a three-tiered shoreline assessment approach. The Inventory divided the shorezone into three regions: 1) immediate riparian zone (land use), 2) bank (bank characteristics such as height, bank type, etc., and shoreline buffers), and 3) shoreline features (shoreline attributes including bulkheads, riprap, marinas, boat ramps, docks, etc.). Data from the survey was processed to create three GIS coverages, displayed through reports, summary tables, and maps, which are viewable online at <http://ccrm.vims.edu/gisdatabases.html>. Uses of *CSI*, for changes in shoreline conditions due to climate change and sea level rise impacts are numerous. The *CSI* has already been used by St. Mary's County to conduct a shoreline structure damage assessment following Tropical Storm Isabel. The *CSI* was incorporated into HAZUS-MH to provide shoreline conditions to conduct the level-one analysis of flood vulnerability in Maryland. And, the *CSI* was merged with the Stream Corridor Assessment used in the development of the Watershed Restoration Action Strategy (WRAS) program to provide a watershed view of non-tidal and tidal shoreline conditions.

#### **Estimation of Adaptation Benefits and Costs**

- **Estimated Cost:** TBD.
- **Flexibility:** TBD.
- **Adaptive capacity:** TBD.
- **Other:** TBD.

#### **Documentation of Adaptation Benefits and Costs**

- **Data Sources:** TBD.
- **Quantification Methods:** TBD.
- **Key Assumptions:** TBD
- **Key Uncertainties:** TBD.

#### **Additional Benefits and Costs**

TBD.

#### **Feasibility Issues**

TBD.

#### **Status of Group Approval**

TBD.

## Barriers to Consensus

TBD.