

Option Description

Maryland has thousands of miles of developed waterfront property along the Chesapeake Bay and its tributaries and less than one hundred of miles bordered by the Atlantic Ocean. Much of this area contains public and private sector infrastructure, and historically has enjoyed higher market value compared to inland properties because of its proximity to the water especially in more recent times.

Much essential public sector as well as private sector infrastructure located within Bay waterfront and coastal areas will be adversely impacted by sea level rise (SLR) and increased climatic severity (storms and wind driven tides) caused by climate change and subsidence. Public sector infrastructure includes roads, bridges, airports, wastewater treatment facilities, municipal water systems, landfills, administrative buildings, marinas, etc. Private sector infrastructure includes residential properties, boating facilities, retail & office buildings, manufacturing facilities, power stations, utility transmission lines, farms, etc. Comprehensive research and planning is needed to provide efficient and less disruptive strategies to achieve adaptation while minimizing negative impacts of abandonment and inundation. While a range of adaptation options are possible to protect vulnerable infrastructure, there is a current lack of information which impedes successful action; extensive research is needed.

In order to plan and ascertain priorities, there needs to be differentiation between properties that can adapt to SLR and those which may need to be abandoned and/or relocated. In the case of public infrastructure, one important factor in this determination can be made by comparing the impact of projected SLR and the projected useful life of the facility. Coordinated plans need to be developed between the private sector, local, state, and federal authorities for how adaptation can best be accomplished. Existing laws and regulations, processes, and practices need to be re-visited and possibly changed, eliminated, and/or supplemented so that they facilitate positive potential results from adaptation in recognition of the changing climate and environment.

Option Design

The objectives of this option are to identify and assess Maryland's SLR impacted public and private sector infrastructure, examine all the options available, formulate strategies to adapt to climate changes and SLR that meet our needs, and to implement those strategies. By following this course, opportunities can be realized and disruptions and costs of abandonment and/or relocation can be minimized. This should be accomplished so that the resultant is a prosperous, productive, and where possible, an improved environment in Maryland.

• Targets:

Adaptation of Vulnerable Public and Private Sector Infrastructure should be accomplished via the following phases:

1. Raise the awareness that we are traveling down a road that has not been traveled previously by mankind, and that creative thinking is required now.
2. Identify and Assess
 - a. Use newly produced topographic data to identify impacted areas based on projected SLR
 - b. Assess vulnerable public and private sector infrastructure in these areas for adaptation vs. abandonment.
3. Research & Formulation
 - a. Initiate an aggressive, creative, innovative engineering and technology focused study to minimize the negative impacts of SLR and maximize potential positive results. This should include review and evaluation of efforts to adapt that have been implemented in other countries such as the Netherlands.
 - b. Recognize difficulties to be faced including:
 - i. Determining the rate and extent of the change in sea level is extremely complex and therefore subject to variance in “expert” opinion.
 - ii. Some of our applicable laws and regulations are rooted on the traditional wisdom of constant sea level.
 - iii. Convincing some to not be in denial about the problem.
 - c. Identify feasible option strategies that best meet needs
 - d. Formulate and prioritize strategies
4. Facilitate implementation by providing incentives to the private sector and by creating enabling legislation, regulations, and/or changes in processes and practices to reduce anticipated damage from SLR and increased climatic variability to enhance Maryland’s adaptive response capability.
5. Execute the plan

• **Timing:**

Phase	Start / Completion
1. Raise the awareness:	2008 / ongoing
2. Identify & Assess:	2010 / 2011
3. Research & Formulation:	2012 / ongoing
4. Facilitate implementation:	2014 / 2013 (initial phase)
5. Execute plan:	2015 / ongoing

• **Parties Involved:**

Coordinated involvement will be needed from property owners, local town/city governments, county governments, Maryland agencies including DNR, MDOT, MDE, MDP (Maryland Department of Planning, Maryland Utilities Commission, federal agencies including USDA, US Army Corps of Engineers, and xxx.

• **Other:**

The research phase can determine plausible option strategies that preserve the ecology and environment while creating opportunities. Examples of opportunities from adapting to SLR to help visualize potential solutions are as follows:

1. For existing waterfront properties that are currently productively used, changes in processes, practices, or hard/soft protection structures should be considered to facilitate protecting these properties to avoid abandonment where feasible. For instance, it would be feasible to elevate and/or protect certain waterfront properties to adapt to SLR rather than abandon them. This would depend on many factors including continued access to the location after SLR has progressed, environmental impact, resulting benefit of project, etc.

The town of Oxford on Maryland's Eastern Shore is an excellent example of this situation. Oxford is sited on a peninsula and some of the valuable, developed, waterfront land is relatively low (currently approximately 2-3 feet above mean high water (MHW)) and is contiguous to the centerline of the peninsula which is approximately 10 feet above MHW. If projected SLR is 2-3 feet by the end of the century, some of the waterfront land could become inundated and thus abandoned if adaptation measures were not implemented. Adaptation would involve simply elevating and protecting the low areas eliminating financial loss and disruption.

Oxford's proximity to the water and varying elevations are commonplace for towns along the Chesapeake Bay and tributaries.

2. For existing marshlands that will become lost because of progressing SLR, changes in processes, practices, or hard/soft protection structures should be considered. These adaptive strategies could facilitate such things as no net loss of marshes, creating opportunities in aquaculture, and replacement of developable land lost to SLR. Research may reveal that opportunity exists to create ecologically and financially productive and beneficial properties as SLR progresses while minimizing or eliminating net loss of marshes in those areas.

This could be accomplished by creating new marshes to replace those projected to be lost to SLR by excavating low lying pre-SLR-upland earth forming new tidal marsh and/or tidal ponds suitable for aquaculture. The excavated material could be used to form wide, elevated barriers (barrier peninsulas) bordering the seaward edge of current marshes. Ample water flow would be provided through the barrier peninsulas.

The new water-land interface in exposed areas could be protected by ecologically designed, reinforced dikes that encourage the growth of sea grasses (engineered living shorelines) on the waterside. Traditional living shorelines could be created on unexposed areas and on the marsh side of the new, elevated land. These could serve to provide higher land buffers that would survive SLR, protect against storm damage, be used to relocate adversely impacted residential or

commercial properties or future development while sheltering and protecting new marsh, habitat, aquaculture, or agriculture.

Implementation Mechanisms

Identification and assessment of impacted properties, research, determining strategies, and creating incentives and enabling legislation and/or changes in processes, practices are needed before widespread adaptive measures can be successfully implemented.

Related Policies/Programs in Place

Maryland Department of Planning?

Coordination and reinforcement for this option should be with the following other options in this report:

- Assessment of Coastal Zone Adaptation Options and Evaluation of Shoreline Protection Structures
- Integrated Planning for SLR and Associated Coastal Hazards
- State Agency Reporting on Response to CCC Findings
- Preserve Undeveloped, Vulnerable Lands
- Integrated geographic information systems, monitoring, and modeling
- New Criteria for Identifying Priority Protection Areas
- Forest and Wetland Protection
- Modify Environmental Protection Regulations to Promote
- Sustainable Shoreline and Buffer Area Management Practices

Estimation of Adaptation Benefits and Costs

- Environmental and ecological benefits will accrue from creating new marsh and wetlands to replace those that are lost to SLR.
- One for the ecological costs will the fact that currently existing marshes will be eliminated as SLR progresses while there will be a benefit from new marshes to be created both naturally and purposefully.
- Innovative incentives can be made available to the private sector to stimulate opportunities.
- There will be a considerable financial cost to local governments, the state of Maryland, and the federal government because of replacing or relocating impacted public infrastructure that become inundated.

Estimated Cost: The cost of adapting, relocating or abandoning & replacing public infrastructure can be estimated after the assessment and identification of impacted properties is complete. Some of these will be able to serve out their useful life before the need to replace them. In the meantime, care should be taken to not site new public sector infrastructure in impacted areas.

Flexibility: Adaptation following this model will be site specific driven by local conditions and situation.

- **Adaptive capacity:** TBD.
- **Other:** TBD.

Documentation of Adaptation Benefits and Costs

Data Sources:

- Town of Oxford, Maryland Flood Insurance Rate Map, Community panel number 240068-001 A, effective September 28 1984
- Earth From Space.
http://earthfromspace.photoglobe.info/spc_netherlands_dikes.html
- The Tyee. <http://thetyee.ca/News/2007/05/28/FloodControl/>
- MSN Encarta.
http://encarta.msn.com/encyclopedia_761572410/netherlands_the.html
- Maryland Shorelines Online: <http://shorelines.dnr.state.md.us/living.asp>
- Chesapeake Bay Funders Network:
http://www.campbellfoundation.com/html/related_projects.html
- Coastal defence solutions (approach of ComCoast)
 - **Henk Jan Verhagen and Paul J. Visser:**
www.citg.tudelft.nl/.../doc/EFRM2007_ComCoast.pdf
- Intergovernmental Panel on Climate Change: <http://www.ipcc-wg2.org/index.html>

Quantification Methods:

- TBD.

Key Assumptions: It has been assumed that

- The strategies and priorities from research depends on accurate projections of SLR
- funding for strategies developed can be justified and become available because both short term and long term ecological, environmental, and financial benefit

Key Uncertainties:

- It is uncertain what the rate and extent of SLR will actually be because of all the complex factors involved.
- The relative impact of subsidence and SLR is uncertain. How much increased inundation is caused by subsidence vs. SLR? What is causing subsidence? Can this be minimized?
- How to achieve continuity of protection between multiple property owners if one or more does not wish to participate thus interrupting protection?
- The failure of our federal government to demonstrate leadership to this country and to the rest of the world by taking immediate and decisive actions to reduce and minimize the man-made causes of climate change must be changed. It is uncertain if this will happen throughout the world thus climate change could continue exceeding projections.

Additional Benefits and Costs

TBD.

Feasibility Issues

TBD.

Status of Group Approval

TBD.

Barriers to Consensus

TBD.