

Potential Response To Sea Level Rise By Virginia Coastal Localities

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Overview

This project was undertaken to assess the likelihood that coastal areas in Virginia, potentially at risk from sea level rise, would be defended in some way. For purposes of this study, coastal localities along the Atlantic Ocean and Chesapeake Bay shorelines were considered. The project sought to evaluate three specific planning scenarios (Table 1).

Table 1			
Summary Description, Key Information Collection Needs, and Illustrative Examples for the Three Planning Scenarios			
	Scenario 1 Existing Policies/Practices	Scenario 2 Practical Assessment of Likely Actions	Scenario 3 Greater Protection for the Environment and Cultural Resources
General Description	Provides existing state and local policy "overlay". May bear little relation to what is practical and feasible. Assumes static land use.	Combines existing regulations with available information about future development patterns. Assume "practical" implementation of regulations and local planners' preferences.	Builds off Scenario 2 and incorporates additional information on areas with significant "public goods" values.
Key Information Needs	State, County, and perhaps Municipal regulations, policies, and history covering hard structure construction, beach nourishment, rebuild after storms.	Economic and development trends, migration/population trends, proximity and access to urban or resort areas, presence of or plans for sewer line, road access, value of property in existing or likely future use, potential cost to avoid abandonment.	Identification of areas of critical environmental concern, wetlands maps, migratory bird areas, endangered species habitats, communities with unique historical or cultural qualities.

Methods

The project was accomplished by working with planners from each of the twelve study localities. Project staff prepared maps, questionnaires, and conducted interviews to collect the information contained in this report.

GIS Preparation

Using Digital Ortho Quarter Quadrangles (DOQQs), a large format (~42x56 inch) color poster of

each locality or city was generated. Upon each map, the 10 foot and 20 foot contours derived from the USGS Digital Elevation Models (DEM) were depicted. These would serve as basemaps upon which local government representatives would be asked to delineate their responses to specific questions regarding shore protection under sea level rise scenarios. The use of DOQQs was preferred over traditional line maps because they provide additional visual reference information.

County Coordination

The Planning District Commissions in the region were contacted to help identify appropriate individuals from each local government or city included in this study. It was understood that participants would be asked to respond to a series of questions that encompassed disaster planning, environmental protection, cultural resources, and zoning issues. This generally included the head of a county/city Department of Planning and Development (or equivalent). The format allowed for these individuals to bring other members of their staff as they saw appropriate. It was emphasized that teams should be comprised of individuals who could address the specific questions at hand. The actual team members ranged from only one individual to as many as six. In addition to planning and development staff, some localities included environmental staff, city engineers, and emergency management personnel.

Five meeting forums were organized across the region. The Eastern Shore forum included Northampton and Accomack Counties, and two members of the Planning District Commission. Lancaster County and Northumberland County met along with a representative from the Northern Neck Planning District Commission. The Middle Peninsula Planning District Commission hosted the counties of Gloucester, Mathews, and Middlesex. The Hampton Roads Planning District Commission hosted the Cities of Virginia Beach, Hampton, Poquoson, and Newport News. Since the City of Norfolk was unable to meet at this time, a separate meeting was held for Norfolk staff. Appendix 1 lists participants. Each meeting commenced in the morning. There was ample time for discussion to occur between the groups, however, county teams generally worked within their own groups for the mapping exercise. Average meeting time was 3 hours.

Meeting Format

Meetings began with a brief introduction about the project. Project purpose, goals, and milestones were described. A brief history of sea level rise in the Chesapeake Bay region was explained. Some basic justification for the project as it pertains to sea level rise and municipal planning was discussed. Following the introduction participants were asked to complete a written questionnaire designed to survey them about current planning activities within their locality. Survey questions were derived from products received from Industrial Economics, Inc., during the early phases of this project. Appendix 2 is a sample questionnaire. This particular exercise was in part intended to address Scenario One. Since current Virginia law allows for all public or private lands to be protected, under this scenario there was little reason to request the local governments to delineate these zones. The questionnaire moved the project closer to understanding their current planning efforts regarding sea level rise.

The remainder of the session was spent on the mapping exercise. Participants broke into workgroups by locality. Each group was given one copy of the DOQQ poster basemap, a piece of mylar cut to overlay the poster, and a set of pens and markers. The map exercise was divided into a series of steps which were presented incrementally to the entire group. Each step had a specific task and desired outcome which could be related back to the remaining two Scenarios defined by Industrial Economics.

Step One was experimental. It was included to determine if the decision making process would be effected by land ownership. Planners were asked to use colored pens to delineate property owned by federal, state, and local governments (road right-of-ways were excluded from this exercise). Areas not delineated were assumed to be private lands. On final analysis, ownership was determined not to be a factor in the planners' responses to subsequent scenarios.

Step Two asked planners to delineate on the basemap areas of cultural or environmental significance. This designation was intended to address Scenario 3. Planners were reminded that these lands could be under any ownership. Additionally the designation of significance was to be at the discretion of the planners. Areas indicated did not need to be formally recognized by the locality or some other authority. Culturally significant sites need not be on the National Register of Historic Places, and did not necessarily have to be historic in nature. All that was required was the planner's sense of importance to the community. Areas of environmental significance did not have to be an officially designated reserve, refuge, or sanctuary. For example, the Nature Conservancy owns nearly all the land area incorporating the barrier island system off the Eastern Shore in Virginia. These islands, as private holding, have no official state or federal protection status, nor are they under state or local management. Access to many of them is prohibited without permission by the Nature Conservancy. Nevertheless, they represent important environmental habitat, and both Accomack and Northampton Counties recognized their significance.

For Steps Three and Four, the mylar sheet was placed over the basemap. Tick marks were made on both so the two maps could be rejoined. Step Three was prefaced with an explanation about sea level rise scenarios. The 20 foot contour elevation was designated by Industrial Economics as the impact zone for this project. Planners were asked to assume that everything below 20 feet in elevation might be at risk from increasing sea level through either direct inundation or storm surge. The planning horizon presented was 100 years. Under Scenario 2, each locality was asked to delineate on the mylar sheet areas currently below the 20 foot contour with a probable or high likelihood for protection from rising sea level. Areas not delineated were assumed to be abandoned. Planners were told to assume a gradual inundation over a 100 year period, to frame potential responses. Since topographic gradients are very low over most of the study area, the 10 foot contour was also illustrated on the base map to provide some additional reference for participants.

In order to understand some of the rationales for designation of protection areas, planners were asked to select from a short list of potential reasons for each area selected. Six choices were offered: (1) cost effectiveness (i.e. protection would be relatively cheap), (2) too costly to abandon due to existing infrastructure, (3) large tax base, (4) political pressure, (5) high percentage of private ownership (i.e. very dense population and private investment), and (6) other

(i.e. anything else). Corresponding numbers were placed inside the polygons marking boundaries for protection. More than one reason per area was allowed.

To complete Scenario 3, participants were reminded to look at the delineated protection boundaries with respect to the location of cultural and ecologically significant areas delineated in Step two. For this final step, participants were asked to reevaluate the possible protection of these areas, using their best professional judgement about the probable interest and will of the locality, state, or federal government to provide protection from rising sea level. With this perspective, participants were allowed to add or delete areas from the protection areas.

This concluded the mapping component of the workshop session. In addition to the questionnaire and mapping exercise, a break with lunch was scheduled to engage participants in discussion regarding the reality of such a scenario, the planning implications, and the nature of decision-making at the local level.

GIS Analysis

In preparation for map development, the boundaries delineated by the local planners were digitized using the GIS software ArcInfo[®]. Frequency analyses were run to develop study data. Maps were generated in ArcInfo[®] for each locality participating in this study.

Results

Participants in the project meetings are identified in Appendix 1.

The questionnaire used for the project was comprised of twelve questions based on a suggested list prepared by Industrial Economics staff, and discussions with other researchers in the field. The questionnaire is presented in Appendix 2.

Responses to the questionnaire were collated and summarized by project staff. The resulting findings are summarized in Appendix 3 by locality and planning district.

The maps resulting from the GIS analysis are contained in Appendix 4. There are 4 maps for each locality.

1. General Topography: These maps show three contour bands for the locality. Contour lines derived from DEMs were grouped together to form three categories; 0 - 10 feet, 10 - 20 feet, and greater than 20 feet.
2. Scenario 1 (shoreline and wetlands): These maps use the tidal marsh inventory polygons and the shoreline developed in-house (VIMS) from USGS maps. The wetland polygons were associated with the shoreline arcs using GIS techniques. Shoreline arcs without

adjacent wetlands are shown as a black line. These arcs show the shoreline that can be currently protected.

3. Scenario 2 (protection zones): The protection zone maps show the areas that the locality's planners thought might be protected should the sea level rise. This includes high and probable likelihood of protection area.
4. Scenario 3 (cultural and ecological areas within protection zones): These maps show the intersection of culturally significant and/or ecologically significant areas with the locations planners predict might be protected. Planners identified cultural and ecological significant areas within their locality. Many of these locations did not fall within a designated protection zone.

The results of the map analysis are presented in Table 2.

Discussion

The coastal localities in Virginia used for this study have very little vertical relief. Only 42% of the total land area within the study localities is above 20 feet in elevation. Even this statistic overstates the condition in many of the localities. Almost 99% of Poquoson lies below the 10 foot contour. Mathews, Hampton, Norfolk, and Virginia Beach all have less than 10% of their landmass at an elevation above 20 feet. This condition means that protection of significant areas from the threat of rising sea level is improbable in the estimation of area planners, simply because the challenge is potentially overwhelming.

The study localities include both very rural areas (Accomack, Northampton, Northumberland, Lancaster, Middlesex, Mathews, and Gloucester) and highly developed areas (Poquoson, Hampton, Newport News, Norfolk, and Virginia Beach). All operate with locally elected governments (city councils or county boards of supervisors). Local zoning ordinances are the predominate planning and landuse regulatory mechanisms.

Virginia enacted the Chesapeake Bay Preservation Act over ten years ago. The act requires designation of riparian buffers known as Resource Protection Areas (RPAs). RPAs are designated in local ordinances as 100 foot setbacks from tidal shorelines or wetlands. Property owners may still construct shoreline defense structures within the RPA if desired. State and federal regulations allow revetments at or above the mean high water line along unvegetated shorelines, or landward of vegetated tidal wetlands (where the upland boundary is defined as 1.5 times the tide range above mean low water). The type of shoreline defense installed is not regulated (beyond certain engineering considerations). This means that hard structures can be installed anywhere along Virginia's shoreline as long as they are either permitted or positioned just outside of jurisdictional boundaries.

Questionnaire

The differences among local planners' responses to the questionnaire used in this study can be attributed to variations in local conditions and variable knowledge/opinions about state and federal programs. Despite the variation in responses, there are several general conclusions that can be drawn. Most importantly, none of the local governments in the study area undertake any planning or regulation based on sea level rise. The state operates a public beach management program that affects several localities, but the goal is maintenance of the amenity, not protection of adjacent fastlands. There are also state and local efforts to educate, and in some cases support, private shoreline protection efforts. These programs are aimed at the private property owner, and are not typically based on a large-scale, long-term plan for shoreline management.

When planners looked to the future, few anticipated rapid changes in population or development patterns. Local zoning ordinances are used to direct development to lower risk areas (higher elevation, better soils, existing infrastructure), but zoning is never immutable. Failing septic systems are not typically sufficient to force relocation of development. Instead, alternative technologies (e.g. mound or peat systems, package treatment systems) are typically employed to avoid or circumvent the problem.

Mapping exercise

Planners generally were pessimistic about the likelihood significant areas would be protected from rising sea level. In most cases, this was simply because topography made the effort impractical. Planners from the localities with the least elevation, agonized for extended periods before concluding that there was little or no chance that significant areas of existing or future development could be protected in the face of a ten or twenty foot rise in sea level. Most concluded that the rate of change in sea level would ultimately determine how much defense would be undertaken. Slower rates of change would result in greater protection efforts. This relationship was not quantified, but was based on the planners' assumption that the state and localities would be slower to abandon roads under scenarios of slowly increasing risk. Roads were viewed as critical infrastructure for maintaining occupation of lands at risk.

Cultural and environmental resources did not create much impetus for protection in the opinion of local planners. Over the entire study area, planners believed only about 17% of the land below 20 feet in elevation would ultimately be protected. Planners believed there were relatively few culturally significant areas within the risk zone. Most of the designated areas were existing town or city centers with potentially defensible road connections to higher ground. There were many more areas identified as ecologically significant. The vast majority of these areas were tidal wetlands in the Nature Conservancy's barrier island reserves along Virginia's Eastern Shore. The next largest block is the tidal wetlands of the federal wildlife reserve in Poquoson. Planners did not believe any of these areas would be defended against rising sea level.

Thus, despite the current and potential intense development within Virginia coastal lands below 20 feet in elevation, planners did not believe there was much reason to believe much of this land would ultimately be defended from rising sea level. Most of the area would simply be abandoned, to become the new shoal tidal waters of the Commonwealth.

**Table 2. Summary of mapping exercise with local planners
(area in acres)**

	Accomack	Northampton	Mathews	Middlesex	Gloucester	Lancaster	Northumberland	Hampton	Newport News	Poquoson	Norfolk	Virginia Beach
Total area of locality*	374645	231742	80132	117226	184210	119966	145901	38623	76600	13954	42582	197012
Total land area	285877	135023	54743	83625	140069	85040	123537	33065	44024	9660	34752	161961
Area of land 0' to +10'	150746	59967	28961	7568	34781	11107	17604	15007	8179	9542	10869	94632
Area of land +10' to +20'	35813	26706	20543	10153	14266	8889	23819	15664	6999	117	23204	58962
Designated for protection	11455	1810	366	3559	20198	847	15514	9261	5078	1872	11083	39068
<i>Reasons:</i>												
<i>Cost effectiveness</i>	0	1306	366	0	4300	100	200	46	0	0	11083	0
<i>Too costly to abandon</i>	4052	0	366	0	3111	0	7897	1994	4908	194	11070	21248
<i>Large tax base</i>	6872	1306	366	1956	17959	675	15313	3046	2765	194	603	30549
<i>Political pressure</i>	11455	0	0	3559	16575	0	0	4185	2313	0	11029	27148
<i>High percentage of private ownership</i>	5033	1373	0	3426	7998	847	15313	3613	5070	1162	603	21079
<i>Other reasons</i>	0	183	0	0	0	0	0	92	0	516	4983	1327
Culturally significant land	752	1076	121	1067	65	0	58	415	301	0	770	23
Ecologically significant land	69055	31880	177	1343	6998	0	395	1317	0	4596	147	57108
Culturally significant land within zone of protection	0	373	2	1060	60	0	58	389	244	0	225	8
Ecological significant land within zone of protection	3875	0	0	0	1968	0	0	31	0	0	5	46

* includes land and water within locality boundary

Appendices

Appendix 1. List of participants in project meetings.

Appendix 2. Sea-Level Rise Assessment Project Questionnaire.

Appendix 3. Summary of questionnaire responses by locality and planning district staff.

Appendix 4. Maps

Appendix 1. List of participants in project meetings.

First Name	Last Name	County/City
David	Fluhart	Accomack County
Sandy	Manter	Accomack County
Jennifer	Coughlin	NASA – Accomack County
Beverly	Harper	Northampton County
Jack	Larson	Lancaster County
Luttrell	Tadlock	Northumberland County
Jay	Scudder	Gloucester County
Rodney	Rhodes	Mathews County
Tim	Wilson	Middlesex County
Greg	Goetz	City of Hampton
Kathy	James-Webb	City of Newport News
Brian	Townsend	City of Norfolk
Susan	Pollock	City of Norfolk
Lee	Rosenberg	City of Norfolk
Seamus	McCarthy	City of Norfolk
Paige	Weiss	City of Norfolk
Jeff	Raliski	City of Norfolk
Stephanie	Mertig	City of Poquoson
Mark	Marchbank	Virginia Beach
Hugo	Valverde	Hampton Roads PDC
Eric	Walberg	Hampton Roads PDC
Lewis	Lawrence	Middle Peninsula PDC
Stuart	McKenzie	Northern Neck PDC
Jim	McGowan	Eastern Shore PDC
Allen	Teasley	Eastern Shore PDC

Appendix 2.

SEA-LEVEL RISE ASSESSMENT PROJECT QUESTIONNAIRE

Scenario 1

1. Does the state/county have any policies that take into consideration sea-level rise (e.g., setbacks that are based on sea-level rise -- or erosion -- rates)?
2. Does the state/county fund or construct any protection measures/nourishment projects? If so, what are the policies that dictate where state/county efforts are targeted?
3. Are there any ongoing federal projects/programs significantly impacting coastal protection efforts (e.g., Coastal Barrier Resources Act, FEMA's Community Rating System project)?
4. Do any setback provisions exist in the state/county? Are property owners required to keep protective structures a set distance from open water, wetlands, or the property edge?
5. Are there any policies (state/county/municipal) that direct whether public lands (e.g., parks, wildlife refuges) are to be protected? For example, are there policies prohibiting (or requiring) the state/county from funding the construction of seawalls?
6. Have any public areas been protected (via structures or nourishment) from erosion, flooding, or sea-level rise?
7. Does the state/county have any policies regarding the maintenance of roads along the coast? (hurricane evacuation routes/ allowing only private roads)?

Scenario 2

8. What are the current population trends throughout the area of interest? For example, is the population expected to rapidly increase?
9. Has the state/county developed any policies directing development toward certain areas and away from others? Do any priority planning areas exist? Are there strict zoning policies in place?
10. What happens in cases where property owners can no longer meet septic tank regulations (e.g., percolation tests)?
11. Are current rural areas likely to be sufficiently developed in the future to make protection practical? Do you think they would be protected?
12. Have any agricultural land owners attempted to protect their lands in the past? If so what was the outcome? Do you expect that agriculture areas will be protected in the future? If not, will the land likely be developed and protected?

Appendix 3. Summary of questionnaire responses by locality and planning district staff.

County/City	Question #									
	1	2	3	4	5	6	7	8	9	
Accomack	No	No	FEMA	100' RPA	No	Yes	No	No	No	Alt
Northampton	No	No	Yes	100' RPA	No	Yes	No	No	No	Alt
Lancaster	No	Yes	No	100' RPA	No	Yes	Yes	No	Yes	Alt
Northumberland	No	No	No	No	No	Yes	No	No	Yes	Alt
Gloucester	No	No	Local	100' RPA	No	No	No	No	Yes	
Mathews	No	Yes	No	100' RPA	No		No	No	Higher Elevation	Ab:
Middlesex	No	No	No	No	No	No	No	No	Yes	Ab:
Hampton	No	Yes	USFW	Local	No	Yes	No	Aging	Yes	Ab:
Newport News	No	Yes	No	100' RPA	No	Yes	Yes	No	No	Put
Norfolk	No	Yes	CRS	100' RPA	Yes	Yes		No	Yes	Put
Poquoson	No	No	FEMA	No	Yes	No	No	No	Higher Elevation	Put
Virginia Beach	No	Yes	Corps			Yes	No	No		
Planning Districts										
Hampton Roads	No	Yes	Corps	100' RPA	No	Yes	DK	No	Yes	Put
Northern Neck	No	No	No	100' RPA	Yes	No	No	No	Yes	Alt
Eastern Shore	No	Yes	Yes	DK	No	Yes	No	Toll Change	Yes	Alt

Terms:

FEMA = Federal Emergency Management Agency

USFW = US Fish and Wildlife Service

CRS = FEMA's Community Rating System

Corps = US Army Corps of Engineers

RPA = Resource Protection Areas, 100' riparian buffers required as part of the Chesapeake Bay Preservation Act

DK = don't know

Toll Change = potential reduction/elimination of cost to cross Bay Bridge-Tunnel from Hampton Roads to Virginia's Eastern Shore

Appendix 4. Maps

Accomack County
Contour Map
Scenario 1
Scenario 2
Scenario 3

Gloucester County
Contour Map
Scenario 1
Scenario 2
Scenario 3

City of Hampton
Contour Map
Scenario 1
Scenario 2
Scenario 3

Lancaster County
Contour Map
Scenario 1
Scenario 2
Scenario 3

Mathews County
Contour Map
Scenario 1
Scenario 2
Scenario 3

Middlesex County
Contour Map
Scenario 1
Scenario 2
Scenario 3

Northampton County
Contour Map
Scenario 1
Scenario 2
Scenario 3

City of Newport News

Contour Map

Scenario 1

Scenario 2

Scenario 3

City of Norfolk

Contour Map

Scenario 1

Scenario 2

Scenario 3

Northumberland County

Contour Map

Scenario 1

Scenario 2

Scenario 3

City of Poquoson

Contour Map

Scenario 1

Scenario 2

Scenario 3

City of Virginia Beach

Contour Map

Scenario 1

Scenario 2

Scenario 3