

# MARYLAND AT RISK

## SEA-LEVEL RISE ADAPTATION & RESPONSE

September, 2008

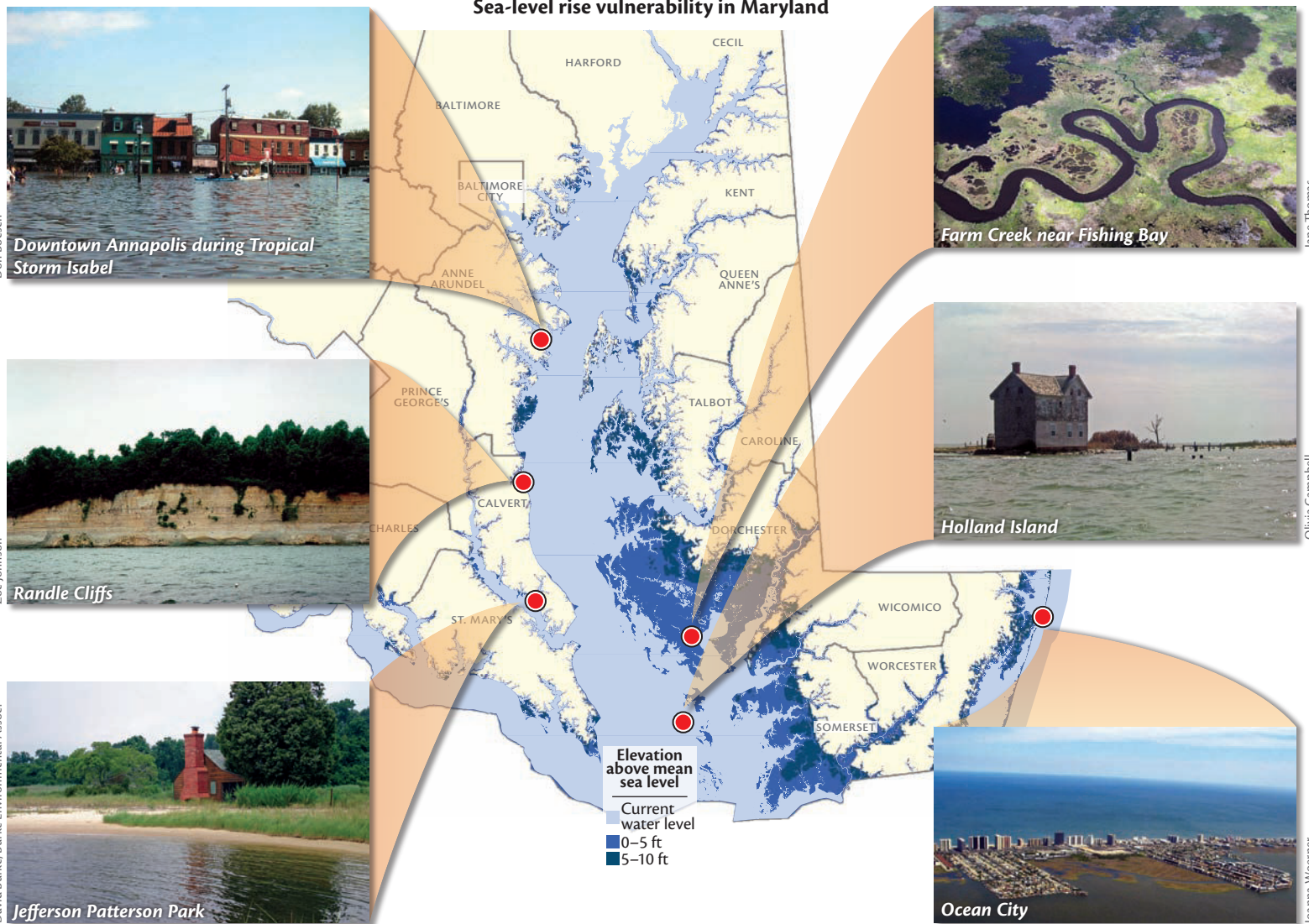
### WE MUST TAKE ACTION NOW TO PREPARE FOR THE IMPACTS OF CLIMATE CHANGE

Action is needed now to stem not only the drivers of climate change but also to prepare for the inevitable consequences. With over 3,000 miles of coastline, Maryland is extremely vulnerable to the impacts of climate change. Historic tide-gauge records show that sea levels are rising along Maryland's coast and, due to a combination of global sea-level rise and land subsidence, have risen approximately one foot within state waters over the last 100 years. As our climate changes, sea levels are expected to continue to rise—potentially twice as fast as they did during the 20th century. Maryland is at risk of experiencing another one-foot of sea-level rise by 2050 and as much as three feet of rise by 2100.

The Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change, a key component of Maryland's Climate Action Plan (August, 2008; [www.mde.state.md.us/Air/climatechange](http://www.mde.state.md.us/Air/climatechange)), sets forth the actions necessary to protect Maryland's people, property, natural resources, and public investments from the impacts of climate change. The vision for future preparedness is targeted at: 1) reducing impact to existing built environments, as well as to future growth and development; 2) shifting to sustainable investments and avoiding financial and economic impact; 3) enhancing preparedness to protect human health, safety, and welfare; and 4) restoring and protecting Maryland's natural resources and resource-based industries.

### MARYLAND'S PEOPLE, PROPERTY, NATURAL RESOURCES, AND PUBLIC INVESTMENTS ARE AT RISK

Sea-level rise vulnerability in Maryland



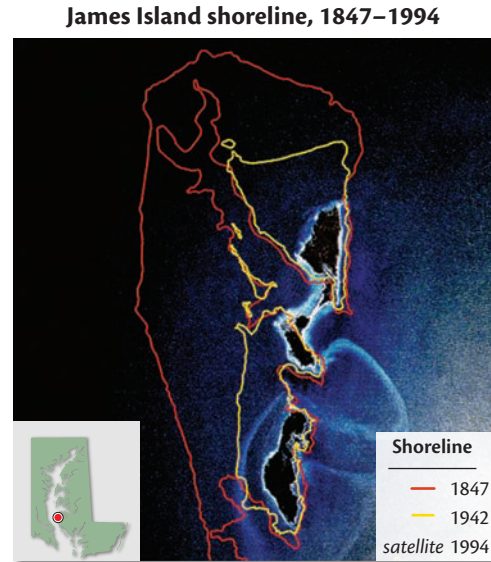


# WE MUST TAKE ACTION NOW TO PREPARE FOR THE IMPACTS OF CLIMATE CHANGE

## FLOODING

### IMPENDING RISK

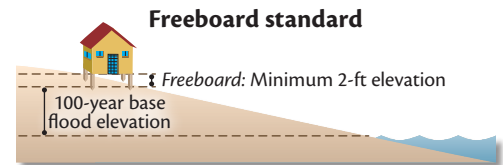
The 6–8 feet of storm surge produced by Tropical Storm Isabel in 2003 verified Maryland's extreme vulnerability to coastal flood events. Over time, sea-level rise will cause the height of storm waves to increase, enabling them to extend further inland. In low-lying coastal areas, a one-foot rise in sea level translates into a one-foot rise in flood level, intensifying the impact of coastal flood waters and storm surge. Heightened storm waves also exacerbate the processes that drive shore erosion, a chronic problem along much of Maryland's coast. Properties and infrastructure bordering the Chesapeake Bay and the Atlantic coast will be increasingly threatened as sea levels continue to rise.



James Island shoreline in 1847, 1942, and 1994 (satellite image). Thirteen Chesapeake Bay islands have disappeared due to sea-level rise over the past century.

### PREPARING FOR THE FUTURE

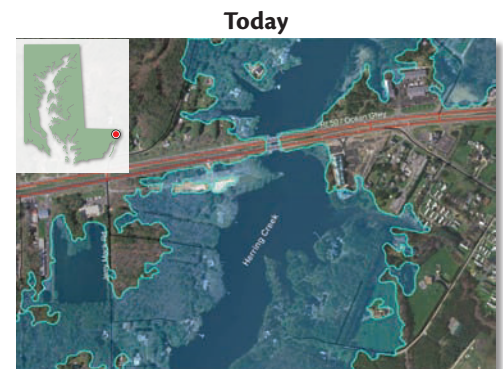
We must take action now to protect human habitat and infrastructure from future risks. This can be achieved by taking steps to effectively reduce the impact to existing-built environments by requiring that public and private structures be elevated, designed, and engineered to reduce damage; and to avoid future impact by directing new growth and development away from vulnerable coastal areas. The state's natural resources, including its tidal wetlands, marshes, vegetated buffers, and bay islands, must also be protected and restored to harness nature's inherent ability to buffer Maryland's shoreline and interior from the impacts of climate change and sea-level rise.



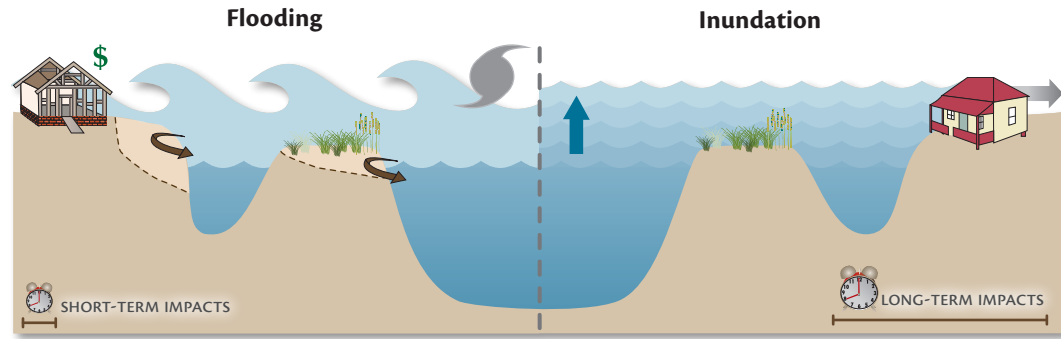
Freeboard is an elevation above a designated high water level. As sea level rises, so will the height of flood levels. The Maryland Climate Action Plan recommends that the lowest horizontal part of a structure within a tidally influenced floodplain be built to allow for two or more feet of freeboard above the 100-year base flood elevation.



Smith Island—Maryland's last inhabited Chesapeake Bay island community—is vulnerable to sea-level rise.



Areas of Ocean Pines that would be flooded by 1.5 m (4.9 ft) storm surge from a Category 2 hurricane today (left) and in 2050 after sea-level rise of 15 cm (0.5 ft), which is the current rate of sea-level rise (right).<sup>1</sup> However, the rate of sea-level rise is projected to increase above the current rate in the future, so this map likely underestimates the extent of flooding in 2050.

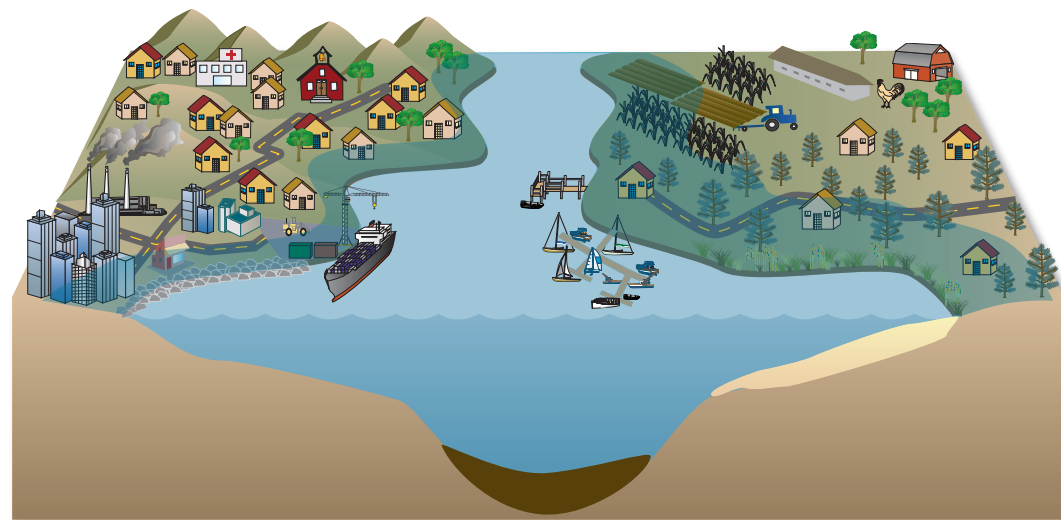


Flooding from stronger and more frequent storms results in erosion and expensive property damage. Inundation from sea-level rise, which occurs over a long period of time, includes land loss and disappearing islands. Inundation threatens buildings in coastal areas. These buildings may need to be relocated to higher elevations.

### The consequences of sea-level rise pose a serious threat to Maryland's coast.

Two to three feet of sea-level rise over the next 100 years will result in a dramatic intensification of coastal flood and storm surge events, exacerbate ongoing shoreline erosion, cause the intrusion of saltwater into freshwater aquifers, and submerge thousands of acres of tidal wetlands, low-lying lands, and the Chesapeake's last inhabited island in Maryland, Smith Island (see photo, left).

### Chesapeake Bay vulnerability to sea-level rise and storm surge



Chesapeake Bay is vulnerable to sea-level rise and storm surge. The western shore of the bay has a dense built environment, including industry and ports. The grade of slope affects shoreline movement, so areas with steep slopes, such as Calvert Cliffs, will have a slower rate of shoreline movement than flatter areas. The Eastern Shore's flat landscape contains low-lying roads, animal feeding operations, marinas, marshes, and forests.

## INUNDATION

### IMPENDING RISK

For many coastal areas, slope is the primary variable controlling the magnitude and range of sea-level rise impact over time. In areas such as Maryland's Eastern Shore where elevation may change as little as one foot per mile, gradual submergence of a large geographic area, including large expanses of tidal wetlands, is quite likely. In Dorchester County, ~25,000 acres of forest and ~60,000 acres of wetlands could be lost by 2050 if sea level rises at a rate of three feet per century.<sup>2</sup> Evidence of sea level inundation is visually apparent throughout low-lying coastal areas in Dorchester and Somerset Counties and is additionally documented by the loss of 13 chartered Chesapeake Bay islands that have disappeared beneath the water's surface.



Sea-level rise contributes to the erosion of approximately 580 acres of shoreline per year. Maryland's Living Shoreline Protection Act of 2008 requires that living shoreline or non-structural shore protection practices be used wherever technologically and ecologically appropriate. Living shorelines provide erosion control benefits while also enhancing the natural shoreline habitat. They often allow for natural coastal processes to remain through the strategic placement of plants, stone, sand fill, and other structural and organic materials.

### PREPARING FOR THE FUTURE

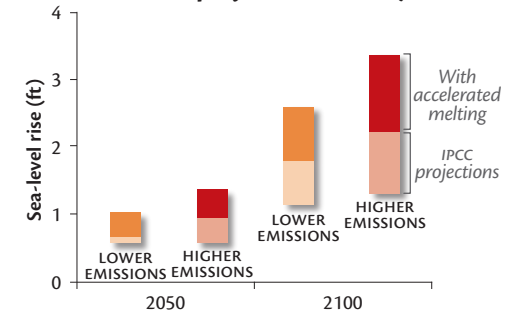
Natural resources, particularly coastal wetlands and barrier and bay islands, play a vital role in protecting Maryland's shoreline and interior by absorbing the damaging impact of coastal floods, heavy winds, and strong waves. Sea-level rise inundation poses a significant threat to these resources, as well as to the state's public and private infrastructure in low-lying areas. Transportation networks, septic systems, and coastal aquifers will all be affected as saltwater intrudes. Adaptation and response planning at both state and local levels is necessary to reduce Maryland's vulnerability. Undeveloped lands and ecologically and economically important habitats should be targeted and preserved and advance planning for the protection of vulnerable coastal infrastructure must be undertaken at all levels of government.

### Integrated sea-level rise adaptation and response



Due to the variation, range, and magnitude of sea-level rise impacts expected to occur, there is not a single means of response, nor is there one entity that can effectively implement all adaptation planning activities. Therefore, the Maryland Climate Action Plan recommends an integrated approach to adaptation and response planning whereby sea-level rise issues are incorporated into existing sector- or issue-based planning, management, and regulatory programs.

### Sea-level rise projections in Maryland



Projected relative sea-level rise in Maryland during the 21st century under higher and lower emissions scenarios. For more information, see Chapter 2 of the Climate Action Plan: Climate Change Impacts.



The loss of wetlands at the Blackwater National Wildlife Refuge, Maryland, is due in part to sea-level rise, erosion, and subsidence.



# SEA-LEVEL RISE ACTION PLAN—KEY RECOMMENDATIONS

## ► Take action now to protect human habitat and infrastructure from future risks.

**Require** the integration of coastal erosion, coastal storm, and sea-level rise adaptation and response planning strategies into existing state and local policies and programs. **Develop** and **implement** state and local adaptation policies (i.e., protect, retreat, abandon) for vulnerable infrastructure. **Strengthen** building codes and construction techniques for new infrastructure and buildings in vulnerable coastal areas.



## ► Minimize risks and shift to sustainable economies and investments.

**Develop** and **implement** long-range plans to minimize the economic impacts of sea-level rise to natural resource-based industries. **Establish** an Advisory Committee to advise the state of the risks that climate change poses to the availability and affordability of insurance. **Develop** a *Maryland Sea-Level Rise Disclosure and Advisory Statement* to inform prospective coastal property purchasers of the potential impacts of climate change. **Recruit, foster, and promote** market opportunities related to climate change adaptation and response.



## ► Guarantee the safety and well-being of Maryland's citizens in times of foreseen and unforeseen risk.

**Strengthen** coordination and management across agencies responsible for human health and safety. **Conduct** health impact assessments to evaluate the public health consequences of climate change and sea-level rise-related projects and/or policies. **Develop** a coordinated plan to assure adequacy of vector-borne surveillance and control programs.



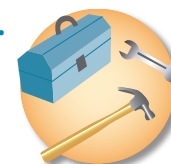
## ► Retain and expand forests, wetlands, and beaches to protect us from coastal flooding.

**Identify** high priority protection areas and strategically and cost-effectively direct protection and restoration actions. **Develop** and **implement** a package of appropriate regulations, financial incentives, and educational, outreach, and enforcement approaches to retain and expand forests and wetlands in areas suitable for long-term survival. **Promote** and **support** sustainable shoreline and buffer area management practices.



## ► Give state and local governments the right tools to anticipate and plan for sea-level rise and climate change.

**Strengthen** federal, state, local, and regional observation systems to improve the detection of biological, physical, and chemical responses to climate change and sea-level rise. **Update** and **maintain** state-wide mapping, modeling, and monitoring products. **Utilize** new and existing educational, outreach, training, and capacity-building programs to disseminate information and resources related to climate change and sea-level rise.



## ► State and local governments must commit resources and time to assure progress.

**Develop** state-wide sea-level rise planning guidance to advise adaptation and response planning at the local level. **Develop** and **implement** a system of performance measures to track Maryland's success at reducing its vulnerability to climate change and sea-level rise.



## REFERENCES

- Johnson, Z., R. Barlow, I. Clark, C. Larsen, & K. Miller. 2006. *Worcester County Sea Level Rise Inundation Model: Technical report*. Maryland Department of Natural Resources, Annapolis, Maryland.
- Carlisle, A., C. Conn, & S. Fabijanski. 2006. *Dorchester Inundation Study: Identifying natural resources vulnerable to sea level rise over the next 50 years?* Towson University Center for GIS, Towson, Maryland.



Martin O'Malley, Governor



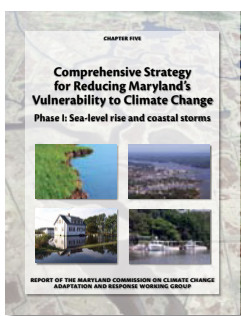
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## FURTHER INFORMATION

For more information, visit  
[www.mde.state.md.us/Air/climatechange](http://www.mde.state.md.us/Air/climatechange)



Maryland Department of Planning



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