Global sea level is rising. There will be a wide range of impacts that affect coastal communities, habitats, and the physical characteristics of the coast.

**WHY IS SEA LEVEL RISING? HOW MUCH WILL IT RISE?**

Most of the observed increase in global average temperatures over the past 50 years is very likely due primarily to human-induced emissions of heat-trapping gases. Increasing temperatures in the atmosphere cause sea level to rise by:

- Melting glaciers and ice caps.
- Dissolving polar ice shelves.
- Increased heating of the ocean.

Sea level is essentially stable at the last 2,000 to 3,000 years, and an acceleration occurred in the late nineteenth century. During the last century, global sea level rose at an average rate of 0.07 inches (0.17 centimeters) per year, or about seven inches total.

In many coastal regions, the land is also rising or sinking, so the rate of sea level rise varies from place to place. While some coastal areas will continue to be protected by water centuries into the future, there will be sea level rise of several feet over the next century:

- Submerging low-lying lands.
- Eroding beaches.
- Converting salt marshes to open water.
- Causing more severe coastal flooding.
- Increasing the salinity of estuaries and aquifers.

These effects would become more severe as sea-level rise accelerates. Some of the major findings of this Product indicate that:

- Coastal changes are caused by complex and interconnected processes. While some coastal areas will continue to be protected by water centuries into the future, there will be sea level rise of several feet over the next century:

**WHAT ARE THE EFFECTS OF SEA-LEVEL RISE?**

Today, rising sea levels affect coastal regions in many ways:

- Rising sea levels affect coastal regions in many ways:
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- Eroding beaches.
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Potential Mid-Atlantic Wetland Survival

![Image](https://example.com/image1)

- Total wetlands in the United States, such as the Blackwater River marshes in Maryland, are already being covered with water due to sea-level rise and high rates of wetland loss. In addition, many wetlands are already losing water, but, depending on the location, they may recover if the rate of sea-level rise increases by 0.28 inches (0.7 centimeters) per year.

**WHAT ARE THE IMPLICATIONS OF SEA-LEVEL RISE FOR HUMAN ACTIVITIES?**

As sea levels rise, it becomes more difficult to manage different interests effectively. Increasing population and development in coastal areas will displace many coastal species, such as beaches, barrier islands, and wetlands, and the valuable services they provide to society. Movement to the coast and development continues in the Mid-Atlantic despite the growing vulnerability to coastal hazards.

How sea-level rise affects human activities depends in part on how society responds to this change. Rising sea level increases the vulnerability of development on coastal floodplains. Higher sea level provides a higher base to build upon and ensures the rate at which low-lying areas drain. This increases the risk of flooding from heavy rains. More-eroded soils also leads to greater flood damages by removing protective dunes, beaches, and wetlands and by having some properties closer to the water. In places where the shore has structures to protect it, public access along the shore could be lost unless measures are taken to preserve that access.

The coupling of sea-level rise with storm surge is one of the most important considerations for assessing impacts of sea-level rise on infrastructure. Sea-level rise poses a risk to the ability to provide reliable and sustained transportation services in coastal regions. Disrupted transportation in these areas can lead to transportation problems across the United States.

**WHAT ARE SOME FUNDAMENTAL PATHWAYS FOR RESPONDING TO SEA-LEVEL RISE?**

As rising sea levels threaten coastal lands, people must decide whether to attempt to hold back the ocean, to move away from coastal areas, or to redevelop coastal areas:

- Retreat: Allow wetlands and beaches to reign in. This approach builds in the most sustainable areas or removes structures that are more vulnerable to sea-level rise.
- Shoreline armoring: Protect development with structures such as walls, breakwaters, and bulkheads. This approach maintains existing land use, but increases the loss of wetlands and beaches. It can also affect whether there is public access to the shoreline.
- Elevate: Raise structures and land surfaces, including beaches and possibly wetlands.

Combinations of these three approaches are also possible. Each approach will be more appropriate in some locations than others. Use storm surge protection costs, the feasibility of alternative purposes, the values of existing uses, and the time available to decide on the best course of action.
The potential impacts of sea-level rise on society, the economy, and the environment are large. Research that improves understanding of the various potential impacts would help to improve adaptation, mitigation, and avoidance-of-risk measures, and would benefit both the United States and coastal nations around the world.

The expectation that the rate of sea-level rise will increase emphasizes the need to thoroughly assess vulnerability and examine the costs and benefits of taking actions to adapt. Determining whether, what, and when specific actions are justified is not simple. The timing and size of potential impacts, and the costs and benefits of taking action, are all uncertain. The majority of people and institutions have not planned for sea-level rise. Most coastal institutions assume that sea level and shorelines do not change. Actions to prepare for the impacts can be hindered by various issues, such as policies that encourage coastal development; floodplain maps that do not account for sea-level rise; flood insurance rates that are not adjusted as sea level rises; policies that prevent building hard structures over using plants and sediments to protect the shore; and lack of plans to show which areas would or would not be protected as sea levels rise.

Opportunities to prepare for sea-level rise include:

- Developing land-use plans for the preservation of wetlands, beaches, and other coastal ecosystems.
- Specifying the location and design of new homes and infrastructure.
- Making provisions for preserving public access along the shore.
- Examining whether and how changing risk due to sea-level rise is reflected in flood insurance rates and floodplain policies.

The time, and often cultural shift, required to change federal, state, and local policies sometimes makes change difficult. In the mid-Atlantic coastal zone, only a limited number of analyses and resulting statewide policy revisions to address rising sea level have been undertaken.

Many coastal management decisions made today may affect the ultimate success of efforts to prepare for sea-level rise. Existing state policies that restrict development along the shore to reduce hazards or to protect water quality could preserve open space that may also help coastal ecosystems adapt to rising sea level. On the other hand, efforts to protect developed areas can make it less likely that those locations would be abandoned as sea levels rise.

WHAT CAN BE DONE TO BETTER ASSESS EFFECTS OF AND RESPONSES TO SEA-LEVEL RISE?

- Projecting coastal change over the next century is difficult because many factors contribute to that change. Both natural and social science research is needed to help understand, predict, and respond to the effects of sea-level rise on the environment, the economy, and society. Addressing the challenge of sea-level rise could be achieved by activities that:
  - Develop research programs that include both natural and social scientists.
  - Expand the network of basic observations and observing systems, develop data collected over time on environmental and landscape changes, and assemble data for the coastal zone that can be used as a baseline to compare with future data.
  - Use the historic and geologic record of coastal change to increase knowledge of past change, improve predictive models, identify tipping points in coastal systems, and relate past changes in climate to coastal change.
  - Improve assessment methods and combine studies of the past and present into predictive models.
  - Support decision making by providing easy access to data and resources, effectively transferring knowledge of vulnerability and risk that affect decision making, and educating the public about consequences and alternatives.

For several types of sea-level rise impacts, the cost of preparing now is small compared to the cost of reacting later. Some opportunities to prepare can be lost if action is delayed.

HOW CAN SOCIETY PREPARE FOR A RISING SEA?

The time, and often cultural shift, required to change federal, state, and local policies sometimes makes change difficult. In the mid-Atlantic coastal zone, only a limited number of analyses and resulting statewide policy revisions to address rising sea level have been undertaken.

To order Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region, please visit: http://gcrio.org/orders/sap4-1

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