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Sea-Level Rise and U.S. Coasts

Policymakers are interested in sea-level rise because of the risk to U.S. coastal populations and infrastructure and changes to coastal ecosystems. Some coastal states and U.S. territories have a considerable share of their assets, people, economies, and water supplies vulnerable to sea-level rise. Policy choices related to sea-level rise have the potential to shape the future development and resiliency of U.S. coasts.

What Is Sea-Level Rise?

Scientists commonly use two descriptions of sea level: global sea level (GSL) and relative sea level (RSL). GSL is the average height of the Earth's oceans. RSL refers to the elevation of the sea level relative to the land surface from which it is measured. From 1901 to 2010, GSL rose an estimated 187 millimeters (mm), or 7.4 inches, averaging a 1.7 mm (0.07 inches) rise annually, according to several studies using tide gage data. Satellite measurements, available since 1992, indicate an increase in the annual rate of GSL rise to 3.2 mm (0.13 inches) through 2010. The drivers for rising GSL since 1900 are predominantly thermal expansion of the oceans due to warming ocean water and melting glaciers and ice sheets. The oceans have warmed and glaciers and ice sheets have melted due to a combination of natural variability and the influence of greenhouse gas (GHG) emissions on atmospheric temperatures.

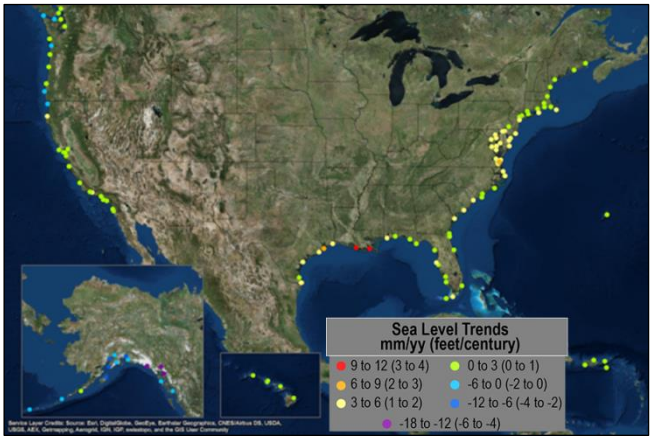
The trend and direction of RSL change varies by location. RSL is rising at a rate of 9 mm-12 mm per year along Louisiana's Mississippi Delta region near New Orleans (i.e., the land is sinking and sea level is rising). In contrast, RSL values are dropping along parts of the Pacific Northwest coastline and southern Alaska (i.e., the land is rising faster than sea level is rising). (See **Figure 1**.)

The same drivers that influence GSL change also influence RSL change, but in some cases regional or local factors are more significant than global factors. These factors can be entirely natural, such as the land rebounding upward after continental ice sheets melted at the end of the last ice age. They also can be due to human activities that may cause coastal lands to subside, such as groundwater pumping, oil and gas extraction, sediment compaction, and land management practices.

Uncertainties in Future Sea-Levels

Policymakers may contend with a pattern of sea-level rise that is very different in the 21st century compared to the past, as the longer-term trends accumulate over time and regional trends change. A number of studies indicate that the rate of sea-level rise in the 21st century is very likely to exceed the rate of sea-level rise in the 20th century. Future rates and levels of sea-level rise will be determined by a complex mix of phenomena and human activities.

Figure 1. RSL Trends for the United States (2014)



Source: National Oceanic and Atmospheric Administration, Tides & Currents, "U.S. Sea Level Trend Map." Figure modified by Congressional Research Service (CRS).

Note: Trends represent a snapshot in time for 2014 in mm per year (and calculated as feet per century using the 2014 rate).

Many scientists conclude that GSL will continue to rise for centuries even if GHG concentrations in the atmosphere are stabilized. Global sea levels may rise by 0.2 meters (8 inches) by 2100, or they could rise 10 times that amount, or even more, depending on the behavior of the Antarctic and Greenland ice sheets, according to many scientists. Estimates of the Antarctic ice sheet contributions to GSL rise between now and 2100 vary widely. A better scientific understanding of how the two large ice sheets could contribute to future sea-level rise would assist coastal communities with their coastal planning and investments.

U.S. Coasts and Their Development

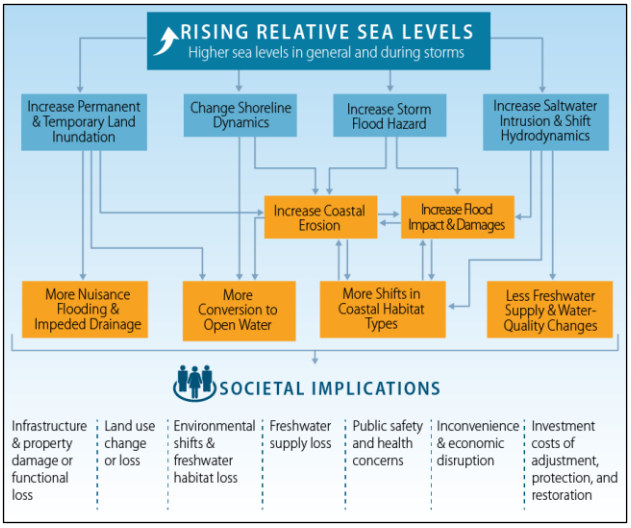
In 2010, roughly 100 million people lived in coastal shoreline counties of U.S. states and 2.9 million people resided in coastal shoreline counties of U.S. territories. Of the people who reside in coastal state shoreline counties, nearly 8 million live in the 1% coastal flood zone (i.e., area in which the annual probability of coastal flooding is 1 in 100 or greater). Some coastal areas have high property values, whereas others have populations with more limited economic means. Most decisions about coastal land development and protection are made by states, localities, and other stakeholders. Future growth in coastal areas may be shaped by the perceived risk from coastal hazards, such as sea-level rise and coastal storms, and by the efficacy of private and public responses to mitigate that risk.

Effects of Sea-Level Rise on U.S. Coasts

Some of the effects of sea-level rise on U.S. coasts can be broadly categorized as permanent or episodic flooding of low-lying lands, increased erosion and shoreline change, increased damages from coastal storms, and saltwater

intrusion of coastal freshwaters. These effects and examples of their societal impacts are shown in **Figure 2**.

Figure 2. Effects of Rising Sea Levels on Coasts



Source: CRS.

Federal Government Effects and Actions

The federal government has an interest in how coasts are developing and adjusting to sea-level rise. In a 2016 report titled *Potential Increases in Hurricane Damage in the United States: Implications for the Federal Budget*, the Congressional Budget Office estimated current annual federal spending associated with hurricanes at $18 billion on average. In addition to the demand for federal assistance associated with coastal disasters, sea-level rise could affect the federal government in other ways. Sea-level rise could affect federal facilities and lands (e.g., military installations) and federal projects (e.g., navigation improvements, coastal flood risk reduction projects). Federal programs support local and state infrastructure investments such as roads, bridges, and municipal water facilities, which may experience damage or impaired operations. Increased coastal flood risk associated with sea-level rise may increase demands on the National Flood Insurance Program. Federal agencies also are directly involved in sea-level rise science and research, coastal regulatory activities, and protection and restoration efforts in coastal areas. Federal activities under the Federal Coastal Zone Management Act (P.L. 92-583) also assist state programs for coastal zone management.

In recent years, the federal government has become increasingly involved in guiding, shaping, and informing how communities and individuals prepare for and respond to sea-level rise. These activities include efforts to reduce the impact of flooding on federally funded structures and facilities, provide more technical assistance and information on sea-level rise, and improve coastal hazard mapping.

Policy Considerations & Questions

Policymakers face several policy considerations and questions surrounding sea-level rise, including the following: What are the guiding principles for the federal role in coastal projects and activities? What are the consequences of overestimating or underestimating the risk of sea-level rise for current and future generations? How does the suite of federal programs harm or bolster coastal resilience?

General categories of policy options related to sea-level rise include the following:

- **Maintaining the Status Quo**. Current government programs, policies, and funding would continue.
- **Reducing Rise in Global Sea Level**. Policies for addressing the human activities influencing sea-level rise could include pursuing domestic and international GHG mitigation efforts.
- **Reducing Rise in Relative Sea Level**. Policies to address the local or regional drivers of sea-level rise could focus on activities that contribute to land subsidence.
- **Reducing Vulnerabilities to Sea-Level Rise**. Policies could target reducing vulnerability to the effects of sea-level rise (e.g., coastal flood risk reduction projects using dunes or storm-surge gates). Policies also could attempt to foster environmental and social resilience; these could include protection of certain coastal habitats, including those that contribute to natural coastal flood defenses.
- **Reducing Consequences of Sea-Level Rise**. Policies could promote actions that reduce the consequences of the effects of sea-level rise. These actions could include various hazard-mitigation measures, such as development restrictions, building codes, flood-proofing of structures, buyouts of vulnerable properties, and improved evacuation routes.

For all of the policy options, there are the underlying questions of their costs and benefits and who will bear the costs of not pursuing or pursuing the policies. For many of the above policy options, a challenge for federal lawmakers is how to deal with the tension between federal efforts to manage national and federal government risks (e.g., federal disaster costs, coastal ecosystem shifts) related to sea-level rise and the local and state roles in shaping coastal development and ecosystem health. Therefore, in the U.S. federalist system of shared responsibilities, who is responsible for the costs associated with adjusting to sea-level rise and the risks associated with vulnerable coastal development and infrastructure is a significant question.

For a more detailed discussion of sea-level rise and policy issues, see CRS Report R44632, *Sea-Level Rise and U.S. Coasts: Science and Policy Considerations*, by Peter Folger and Nicole T. Carter.

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