

Sea Level Rise

Brief: Sea level is rising. This is because glaciers and ice caps are melting and warming ocean waters expand. Sea Level Rise and storm surges will increase the frequency and intensity of coastal flooding, which will impact people, public and private property, critical infrastructure, and our economy.

Problem

Increased flooding from sea level rise (SLR) could have significant impacts to our way of life. Much of the commerce to and from Washington State occurs at our Ports, the majority of which are located in the Puget Sound or on the coast. The majority of our population lives in cities and counties along these waters. And much of our water, sewer, stormwater, and transportation facilities are located in close proximity to the water's edge.

Introduction

In Washington State, the Department of Ecology and the University of Washington's Climate Impacts Group (CIG) have modeled sea level rise. Because in some portions of our state the land is still rising, while in other areas the land is subsiding, the impacts of sea level rise will not be the same in all areas.

Risks will vary by area, depending on the amount of SLR and storm surges experienced. Therefore, communities

may want to estimate these local impacts in order to be prepared. For example, a community may decide to relocate critical facilities, such as hospitals or schools. Other facilities, such as sewer outfalls, may be protected by engineered devices to prevent water from backing up into the system.

Year	Puget Sound	Northwest Olympic Peninsula	Central and Southern Outer Coast
2050	+3 to +22 inches	-5 to +14 inches	+1 to +18 inches
2100	+6 to +50 inches	-9 to +35 inches	+2 to +43 inches

Table 1. Projected sea level rise estimates for Washington. Mote et al. (2008). Adapted from: Source: Chapter 3, Oceans and Coastlines, Washington State Integrated Response Strategy

Potential Impacts

According to the Department of Ecology and CIG, levels of risk vary by location, and many specific impacts, such as the following, are possible:

- Coastal roads will be subject to more frequent closures and more frequent repairs.
- Shoreline parks will be subject to increased damages and closures. Access to the water and to natural shorelines will become more difficult as water levels rise and people construct hardened shorelines in response.
- Intrusion of seawater could damage equipment and strain the capacity of

wastewater and stormwater systems. Backflow of water through stormwater pipes could cause localized flooding in low-lying areas. Drainage of low lying areas will become more difficult, and stormwater management may require installation of tide gates, control works, and pump systems.

- Higher water tables and increased flood events may increase corrosion of underground utilities.



Source: <http://gcaptain.com/opportunity-maritime-industry/>

- Contaminated sites within shoreline areas may be affected by changes to water tables and increased flooding, spreading contaminants to Puget Sound and coastal marine waters.
- Sea level rise may affect fuel storage facilities and pipelines. Large oil handling facilities have constructed their tanks, containment areas, and pipeline conveyance systems based on current water levels. Changes to the water level could alter the stability of the ground or the flow of groundwater, increasing the chance of a spill reaching Washington waters.
- Increasing storm severity off the Pacific Northwest coast could

increase the risk of vessel incidents and oil spills.

- Puget Sound river deltas will be more vulnerable to longer duration flooding, high water tables, and increased salinity, which could affect coastal agriculture and restoration projects.

Coastal Erosion

Coastal erosion is expected to increase as a result of sea level rise. This will impact the Puget Sound communities as well as coastal communities. The state's Integrated Climate Response Strategy states:

On bluffs, which compose much of Puget Sound's shoreline, rapid erosion rates may put upland structures at risk and increase the likelihood of landslides. On spits and barrier beaches, erosion is likely to accelerate, and the potential for flooding and storm damage to low-lying areas will increase. Residential communities built on spits are common both in Puget Sound and on Washington's ocean coast.



A home balances on the remains of its foundation in Washaway Beach, WA. Photo by David Ryder/Reuters.

Source: <http://www.msnbc.com/msnbc/west-coast-hit-hard-pineapple-express-storm>

Other changes in sediment migration and deposits may occur, which could create additional challenges. These changes in sediment could affect the frequency that navigation channels and Ports need to be dredged, impact species and habitats, and impact aquaculture facilities or private property.

Sea Level Rise Viewer

NOAA, the National Oceanic and Atmospheric Administration, has developed a Sea Level Rise visualization [tool](#). Available for free online, this tool allows users to zoom in on a coastal area of the United States, select a level of sea level rise, and see how that would impact the area. It shows areas that would be inundated, as well as areas that would become low-lying areas based on the scenario selected.



Screen shot of NOAA tool, showing 3 feet of SLR in the area of Bellingham, Washington

Potential Adaptation Strategies

In the [Adaptation Tool Kit: Sea Level Rise and Coastal Communities](#), the Georgetown Climate Center considers potential adaptation strategies local governments could take to address

impacts of sea level rise. These strategies can be reactive or proactive, structural or nonstructural. They identify planning, regulatory, and spending tools to address these issues.

Planning tools identified include the use of comprehensive plans. In Washington State, the majority of cities and counties are fully planning under the Growth Management Act (Revised Code of Washington (RCW) 36.70A). All cities and counties are planning for resource lands and critical areas under the Act. Critical areas include those areas identified as frequently flooded areas.

Regulatory tools identified in the Georgetown Tool Kit include:

- Zoning and Overlay Zones
- Floodplain Regulations
- Building Codes and Resilient Design
- Setbacks/Buffers
- Conditional Development and Exactions
- Rebuilding Restrictions
- Subdivision and Cluster Development
- Hard-Armoring Permits
- Soft-Armoring Permits
- Rolling Coastal Management/ Rolling Easement Statutes

Local governments can begin discussing the issues and potential impacts with community members. Education and outreach regarding impacts and potential ways to address them can help position the government to develop the appropriate tools before impacts are experienced.

The Tool Kit also includes financial means to address impacts. These include:

- Capital Improvement Programs (CIPs)
- Acquisitions and Buyout Programs
- Conservation Easements
- Rolling Conservation Easements

Tax and Market-Based Tools identified include:

- Tax incentives
- Transfer of Development Rights
- Real Estate Disclosures

Table 1 in the Tool Kit provides a brief description of each strategy and how it could be used to address sea level rise impacts.

The Tool Kit also includes a Framework for Decision-Making, noting:

In Chapters II through V, we provide a detailed description of each tool. However, identifying the potential responses is only half the battle. To create a coherent response, decision makers will need to decide which tools to implement given their jurisdictions' unique geographic, political, and legal context.

Examples

The **City of Olympia** has considered the impacts of sea level rise on its downtown. Olympia identified some vulnerabilities that would allow seawater to backflow into the stormwater system, resulting in urban flooding in parts of the downtown. While the city considers other measures to protect its boardwalk, marinas, and port, it is also planning for the near-term and long-term strategies to prevent urban flooding from sea level

rise. Some proactive steps they are taking include:

- Continue to improve field data
- Develop better emergency responses tactics
- Incorporate sea level rise into the Comprehensive Plan and shoreline planning efforts
- Consider supplementing federal flood maps with local knowledge
- Begin considering construction needs

Seattle Public Utilities continues to consider the impacts of sea level rise. They have [mapped](#) the areas likely to be impacted by sea level rise and have identified [adaptation strategies](#), which include:

- Physical modifications to structures
- Changing the way infrastructure is operated to reflect changing conditions
- Embedding of climate information into asset management decision-making tools
- Incentivizing changes in water consumption behavior
- Developing early-warning systems for urban flooding
- Amending or implementing new codes and policies

In Kitsap County, the [Gorst Watershed Subarea Plan](#), prepared by the **City of Bremerton and Kitsap County**, “recommends adaptation measures to account for sea level rise in the design of buildings and impervious areas, as well as roadway, flood management, and utility facilities. Also, a proposed mitigation measure could require land use permit applicants along Sinclair Inlet

to conduct a sea level rise adaptation analysis.” (MRSC, Sea Level Rise: A Challenge for Washington’s Coastal Communities).

King County analyzed the potential impact sea level rise and storm surges could have on its critical wastewater facilities. As a result, they have prioritized additional analysis that is needed at certain facilities. In 2012, King County included adaptation policies in its [Climate Action Plan](#).

Additional Resources

Preparing for a Changing Climate: Washington State’s Integrated Climate Response Strategy *April 2012*
http://www.ecy.wa.gov/climatechange/ipa_responsestrategy.htm#REPORT

Adaptation Tool Kit: Sea-Level Rise and Coastal Land
Use: <http://www.georgetownclimate.org/resources/adaptation-tool-kit-sea-level-rise-and-coastal-land-use>

Sea Level Rise in the Coastal Waters of Washington State: A report by the University of Washington Climate Impacts Group and the Washington Department of Ecology. <http://www.cses.washington.edu/db/pdf/moteetalSlr579.pdf>

University of Washington Climate Impacts Group <http://cses.washington.edu/cig/>

National Oceanic and Atmospheric Administration (NOAA), 2010: Adapting to Climate Change: A Planning Guide for State Coastal

Managers <http://coastalmanagement.noaa.gov/climate/docs/adaptationguide.pdf>

NOAA Sea Level Rise Viewer <http://coast.noaa.gov/digitalcoast/tools/slr>

City of Olympia Sea Level Rise, 2012 Community Update <http://olympiawa.gov/community/sustainability/~media/Files/PublicWorks/Sustainability/Community%20Update%20SLR%2001-23-12%20AH%20final.ashx>

US Environmental Protection Agency, Adaptation Examples in the Northwest <http://www.epa.gov/climatechange/impacts-adaptation/northwest-adaptation.html>

Municipal Research Services Center (MRSC) Sea Level Rise: A Challenge for Washington’s Coastal Communities <http://mrsc.org/Home/Stay-Informed/MRSC-Insight/April-2014/Sea-Level-Rise-A-Challenge-for-Washington%E2%80%99s-Coasta.aspx>

Seattle Public Utilities Climate Change Adaptation Webpage <http://www.seattle.gov/util/EnvironmentConservation/ClimateChangeProgram/Adaptation/index.htm>