



The City of Santa Barbara Sea Level Rise Vulnerability Assessment



Prepared for the City of Santa Barbara

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Overview

The coastal areas of California are some of the most highly developed regions of the state. Coastlines are projected to be significantly impacted as a result of climate change in the coming decades by processes such as sea level rise. Consequences of sea level rise include permanent inundation, intensified storm damage, and bluff erosion. The City of Santa Barbara is addressing these hazards in an update of the City's Local Coastal Program, which guides planning and policy within the Coastal Zone. Our study identified the vulnerability of Santa Barbara to sea level rise related hazards and addressed vulnerability in terms of human populations, critical infrastructure, recreation and public access, as well as ecological resources.



Photo Credit: Laura Nicholson

Predictions of Sea Level Rise in Southern California¹

Year	Sea Level Rise	
2030z	1.8 – 11.8 in	0.05 – 0.30 m
2050	5.0 – 23.9 in	0.13 – 0.61 m
2100	17.4 – 65.6 in	0.44 – 1.67 m

Global Sea Level Rise

Average sea levels have been rising globally since the last glacial period, approximately 15,000 years ago. However, the rate of increase has accelerated dramatically in the last hundred years, from around 0.25 mm per year to **nearly 2 mm per year¹**, and has been correlated with a rise in average atmospheric temperatures globally².

The variables that cause sea level rise include:

- Thermal expansion of the ocean
- Loss of land ice
- Local tectonic processes

Project Objectives

1. Conduct a Vulnerability Assessment to determine the impacts of sea level rise on
 - Human Impacts
 - Critical Infrastructure
 - Recreation and Public Access
 - Ecological Resources
2. Identify preliminary adaptation policies that address the impacts of sea level rise hazards.



Photo Credit: Laura Nicholson

Vulnerability Assessment Components

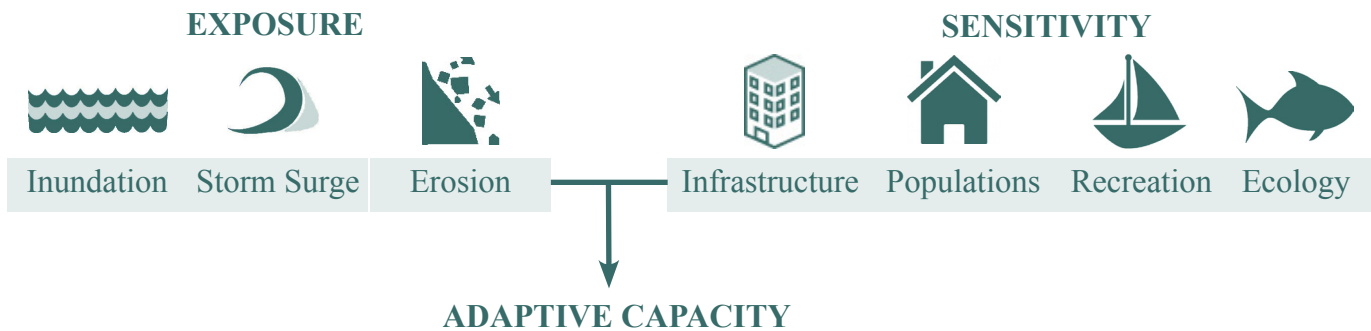
This project is organized into three parts: exposure, sensitivity, and adaptive capacity. These three measures are commonly used as a way to estimate the total vulnerability of an area to sea level rise.

Exposure refers to the projected spatial extent of sea level rise hazards on the land surface.

Sensitivity is a measure of the internal characteristics of exposed geographic features that may increase the feature's susceptibility to a sea level rise hazard.

Adaptive Capacity is the ability of the resource to maintain its function after being exposed to a hazard.

This study explored potential strategies to reduce the risk of damage caused by projected hazards.



Exposure

Permanent Inundation

We analyzed the projections of nine inundation scenarios to determine effects on human populations, critical infrastructure, recreation and public access, and ecology.

Storm Surge

Adding established Base Flood Elevations for the city³ to sea level rise values allowed us to assess overall exposure to a 100-year storm.

Erosion

We modeled bluff erosion hazards using average erosion rates for bluffs over a time horizon of 75 years, used in city planning as the economic lifetime of a building.



Sensitivity

Human Populations

The most sensitive populations of Santa Barbara are not exposed to permanent inundation until about 1 meter of sea level rise. Our sensitivity evaluation for human populations found that the coastal block groups have the highest exposure to sea level rise hazards but have low sensitivity based on demographic information. Some medium and high sensitivity populations are currently in the 100-year storm hazard zone. Bluff erosion is projected to affect populations on the Mesa, Braemar, and Clark Estate, which are considered to have low sensitivity.



Above: Population Density on the Mesa. Photo Credit: Jon Blake

Recreation and Public Access

Santa Barbara's beaches, Harbor, and Stearns Wharf are the most sensitive assets and the most exposed, making them some of the most vulnerable assets overall. Most of Santa Barbara's recreation and public access sites are located along the coastline near the downtown area. The sites that are more developed are considered to have a higher sensitivity. The resources that have a high sensitivity also happen to be most exposed to inundation, storm surge and erosion.



Above: Santa Barbara Harbor. Photo Credit: Jon Blake

Critical Infrastructure

Permanent inundation is not a big threat to most critical infrastructure in Santa Barbara, but a 100-year storm surge will become increasingly hazardous. A significant portion of Santa Barbara's critical infrastructure is located near the coast. Transportation systems such as roads and the railroad will be affected by inundation at 1 meter of sea level rise and are exposed to a 100-year storm surge today. Buildings are more likely to be affected by storm surge than by permanent inundation, which is an important consideration for future planning efforts.



Above: Cabrillo Boulevard flooding. Photo Credit: Laura Nicholson

Ecological Resources

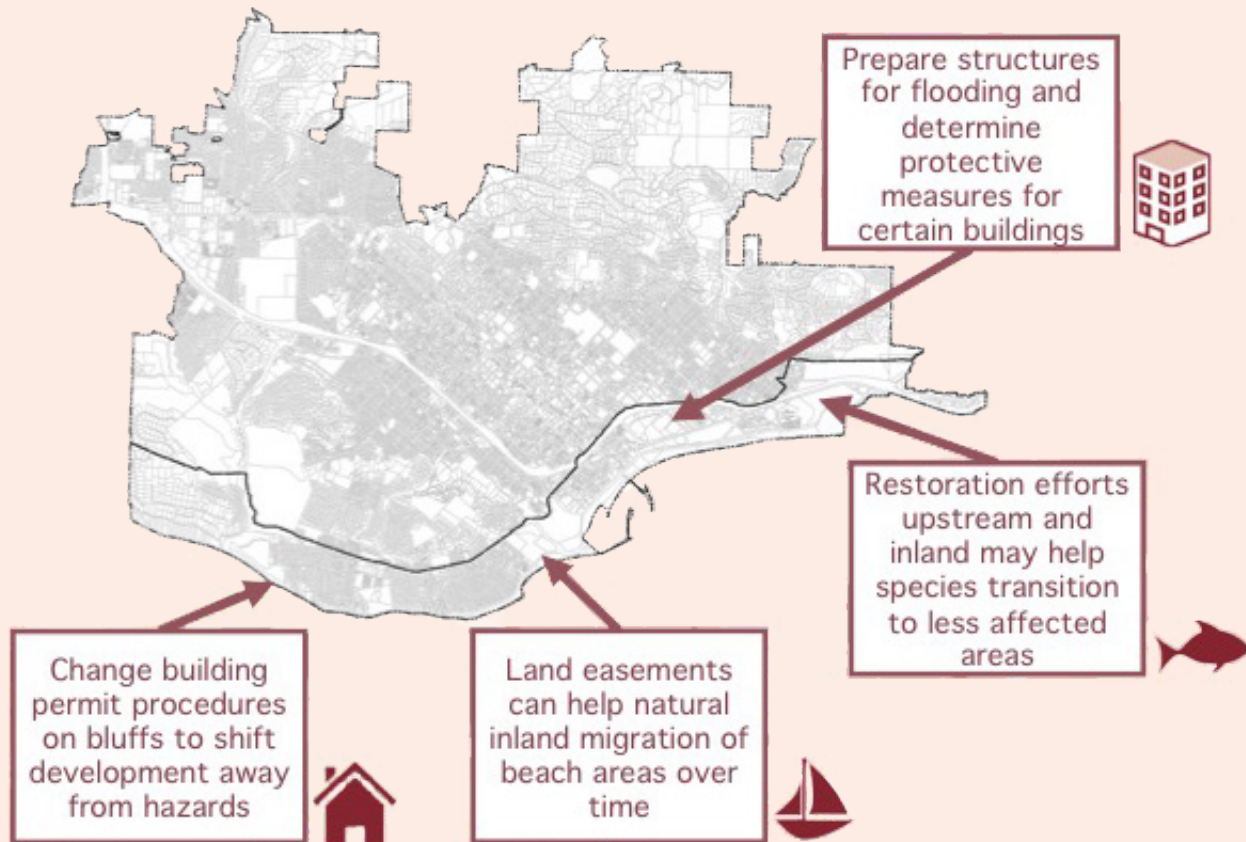
All ecological resources within the coastal area of Santa Barbara are important habitats for federally listed species. The species found to be affected by sea level rise related hazards include the tidewater goby, the California steelhead trout and the western snowy plover. Based on this analysis, Santa Barbara's coast includes high and medium sensitivity ecological resources. For ecological resources, we found that the high sensitivity resources are also the most exposed.



Above: Mission Creek Lagoon in Santa Barbara. Photo Credit: Laura Nicholson

Adaptation Capacity and Policy Options

The three major sea level rise adaptation strategies for any resource are: retreat, accommodate or protect. This study identified adaptation options for each of the four research elements.



Ultimately, it will be the responsibility of the City in conjunction with its stakeholders to determine appropriate actions, thresholds, and triggers for implementing these strategies. The City of Santa Barbara intends to include adaptation policies to address sea level rise related hazards within the Local Coastal Program. The report will both inform the City's update to the Land Use Plan of their Local Coastal Program, and help the City identify and prioritize appropriate adaptation measures.

Acknowledgements

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1. National Research Council. (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past Present, and Future*. National Academies Press.
2. Vermeer, M. & Rahmstorf, S. (2009). *Global Sea Level Linked to Global Temperature*. Proceedings of the National Academy of Sciences, 106(51).
3. FEMA (Federal Emergency Management Agency). (2012). *Flood Insurance Study: Santa Barbara County, California, and Incorporated Areas*. Flood Insurance Study Number 06083CV001C.