



RESEARCH BRIEF

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POINTS FOR POLICY MAKERS

- ▶ **Regional impacts from local flood protection actions are an important consideration when evaluating protection strategies in highly developed coastal areas.** Traditional sea-level rise protections like seawalls or levees can increase flooding in neighboring communities, potentially raising damages to as much as \$723 million for a single flood event. Employing strategies such as targeted flooding of less developed areas that can accommodate floodwaters can help alleviate flooding and damages along other portions of the shoreline.
- ▶ **Understanding the full regional costs of flood impacts can help enhance cost-benefit analyses.** For example, Highway 37 is susceptible to SLR-induced flooding and Caltrans is considering several adaptation options to prevent future flooding disruptions. Although building the road as a causeway would cost nearly four times as much as the alternative, the economic analysis suggests that building a barrier could lead to a net increase of \$293 million in flood damages across the bay.
- ▶ **Addressing the “governance gap” to align the scale of decision making with the scale of the threat of sea-level rise will improve coastal adaptation action.** When the scale of economic impact is matched to the scale of the threat, previously uncounted costs associated with uncoordinated adaptation actions are revealed. A regional planning perspective is critical for reducing shared risk and wisely spending adaptation resources in coastal bays such as San Francisco Bay and can be applied in other coastal estuaries with low-lying, dense development like the Chesapeake Bay.
- ▶ **Estimates of bay-wide change in economic damages due to shoreline protection provide insight into opportunities for strategic regional adaptation planning.** Planning efforts that account for the regional impacts of local shoreline actions could provide opportunities to reduce shared risk. Inclusive conversations around how best to allocate adaptation resources to benefit the most — and most vulnerable — residents as well as identifying ways to mitigate potential losses and compensate individuals will be essential to successful region-wide plans.

Local Decisions, Regional Impacts: Informing Sea-Level Rise Adaptation

Coastal cities will increasingly rely on protections such as levees and seawalls to mitigate flooding, but these strategies can increase inundation along other shorelines within the same estuary or bay. Coordinated planning efforts that account for the regional impacts of local shoreline actions could provide opportunities to reduce shared risk in coastal regions.

Background

Sea-level rise (SLR) threatens to produce more frequent and severe flooding in coastal regions and is expected to cause trillions of dollars in damages globally if action is not taken to adapt to this threat. Coastal communities around the world rely on levees and seawalls as critical protection against the effects of flooding. In the U.S. alone, \$300 billion in shoreline armoring costs are predicted to be required for protection by 2100. However, multi-layered governance and decision-making responsibilities pose a critical challenge in responding to this threat. Adaptation strategies to coastal flooding are often determined by individual communities or private entities at a scale that does not match the extent of the threat. For example, although armoring offers large potential benefits for avoiding severe flood damages at a local level, these benefits can come at a cost to neighboring shoreline communities. Seawalls can potentially exacerbate flooding and associated damages along other parts of the

shoreline — particularly in coastal bays and estuaries, where nearly 500 million people globally are now at risk from sea-level rise.

Bays and estuaries represent 21% of overall shoreline length and 54% of global population at risk from SLR and flooding. These often densely populated areas with complex jurisdictional boundaries are increasingly facing difficult and expensive decisions that demand a better understanding of shared risk along the coastline.

To better understand coastal flooding and the spillover effects resulting from shoreline modifications in these types of coastal areas, Stanford Natural Capital Project researchers analyzed specific effects on the San Francisco Bay shoreline. By employing a combination of modeling techniques, they found that accounting for the connectivity in coastal estuaries is a critical step toward identifying shoreline adaptation strategies that provide regional benefits while also mitigating unintended negative impacts. For example, installing a seawall to protect highway infrastructure along the Napa and Sonoma County shorelines would raise floodwater levels in Palo Alto as well as increase economic damages in Union City — communities which are located at opposite ends of the bay from the proposed armoring site.

This research also demonstrates that a regional planning perspective is critical for reducing shared risk and wisely spending adaptation resources in coastal bays and estuaries. Expanding the authority of existing regional planning and permitting agencies — for example, the San Francisco Bay Conservation and Development Commission — or developing a collaborative management structure comprised of multiple agencies would facilitate cooperation in implementing a more region-wide vision for coastal adaptation. Most critically, the results of this research can help decision makers in the San Francisco Bay Area pinpoint specific locations where flood protection efforts — or strategic flooding strategies — are likely to have significant impacts throughout the bay, facilitating better regional approaches.



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This brief is based on **Economic evaluation of sea-level rise adaptation strongly influenced by hydrodynamic feedbacks** published in the journal *Proceedings of the National Academy of Sciences*.



Photo courtesy of Caltrans

FOR MORE INFORMATION

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