Climate Change and Extreme Weather Adaptation Options for Transportation Assets

Alameda County in the San Francisco Bay Area contains valuable transportation and community assets for the region, including major connecting bridges, freeways, a port and airport, homes and businesses. The Metropolitan Transportation Commission, Bay Area Rapid Transit, Bay Conservation and Development Commission and the California Department of Transportation partnered on a project to assess adaptation options for a subset of key transportation assets vulnerable sea level rise. As part of the project inundation maps showing 6 different sea level rise scenarios were developed, as well as a detailed asset inventory, 125 potential adaptation strategies to reduce the vulnerabilities of these assets to flooding, and 5 more detailed concept designs including living levees, a breakwater, and governance strategy.

RISK	ACTION	IMPACT	OUTPUT
The San Francisco Bay Area (Bay Area) is at risk from sea level rise and extreme tide events. Sea levels have risen eight inches over the past century and are projected to rise between 36-66 inches by the end of 2100. Already parts of the Bay Area flood during extreme high tides, such as King Tides. During the 2015-2016 El Nino season, this flooding has been more pronounced, inundating roads and properties.	Sea level inundation scenarios were developed showing different levels of sea level rise onto the elevation of the existing daily high tide level – 12, 24, 36, 49, 72 and 96 inches. The upper levels were included to evaluate important extreme flooding scenarios during storm surge events with lesser sea level rise. Critical inundation pathways were also identified to understand how shoreline inundation areas were connected to the inland inundation areas. Using these maps a vulnerability and risk assessment was carried out, and a suite of adaptation strategies developed.	Through the development of the six scenarios the three transportation authorities were better able to understand the vulnerability of their assets. Weak points in the shoreline were identified through over topping analysis. The authorities developed an understanding of the range of physical, information and governance strategies that could be employed for the different asset types to reduce their vulnerability. The outputs from the project were shared with stakeholders in the three focus areas of the project to get feedback, strengthening the partnerships with the community	A detailed technical report was produced at the end of the project, detailing the project methodology, the evaluation criteria and methodology, and the 5 detailed adaptation strategies. Detailed memos were produced including the inundation maps, inundation pathway details. The physical adaptation strategy concept designs included sketches, high level costs, regulatory considerations, operations and maintenance considerations to enable the agencies to include these options in their upcoming planning documents.

Example of a sea level rise inundation map of the Bay Bridge touchdown area (showing Oakland and Emeryville)

Lessons Learned

It can be hard to find detailed asset information that can be useful to inform a vulnerability assessment (such as condition, previous failure, usage) and time can be wasted trying to locate it. There is a balance between collecting sufficient data at an early stage to help decide which assets are most vulnerable and at risk, and then once those assets are identified, collecting further data to help develop appropriate adaptation strategies.

BUSINESS CASE

This project will help the three transportation partner agencies to make better, more informed investment decisions regarding investment in their assets that are most vulnerable to sea level rise. The outputs will help to inform the next update to Bay Plan Area, the region's sustainable community strategy. The inundation maps are being used by other agencies and jurisdictions in the area to help them understand their vulnerabilities.

REPLICATION OPPORTUNITIES

The compendium of 125 strategies has been included as an appendix to the technical report, and is a useful resource for other transportation agencies with similar asset types. The evaluation methodology developed to help select the most appropriate strategy, considering economic, social, environmental and governance issues could also be used for other projects to help with prioritization. The five strategies developed with more detail could also be leveraged by other agencies, particularly the guidance for mainstreaming climate change into transportation agency management.

How does the project support the implementation of the Sendai Framework targets?

1	*Reduce disaster mortality by 2030*		The project provides five adaptation strategies for three areas in the San Francisco Bay that, if implemented, will reduce periodic flooding and long term sea level rise affecting critical transportation assets, homes and businesses. Assets to be protected include the Bay Bridge serving thousands of vehicles daily, the San Mateo Bridge and a heavy and light rail station. This will reduce the number of vulnerable people in the Bay Area, reduce potential economic losses and reduce disruption and loss fro infrastructure damage.
2	*Reduce number of affected people by 2030*	X	
3	*Reduce economic loss by 2030*	X	
4	*Reduce infrastructure damage and disruption of services by 2030*	X	
5	*Increase countries with DRR national/ local strategies by 2020*		
6	*Enhance international cooperation to developing countries*		
7	*Increase the availability of and access to EWS* and DR information to people by 2030*		

How does the project contribute to the ARISE Themes?

1	*Disaster Risk Management Strategies*	X	Provides governance strategies for mainstreaming consideration of sea level rise into every element of an agency. Provides best practice concept designs, including cost of inaction and capital cost estimations that can solve short terming periodic flooding and long term sea level rise. Provides a methodology for carrying out a detailed vulnerability and risk assessment.
2	*Investment metrics*	X	
3	*Benchmarking and Standards*		
4	*Education and Training*		
5	*Legal and Regulatory*		
6	*Urban Risk Reduction and Resilience*	X	
7	*Insurance*		

For More Information

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