Introduction

Sea level rise has been one of the most telling signs of global climate change and one that has already begun to affect people. Given that we live in a low-lying coastal community, the issue of sea level rise is relevant to our lives and livelihoods and the health of the ecosystem in our region. We can see what future flooding, induced by climate change, might look like through King Tides in combination with the excessive amount of rain the Bay Area has gotten this year (1). But which areas, and which groups of individuals, will be predominantly affected? In this project, we will show that the Canal, a low-lying area with relatively high poverty and racial diversity, is exceptionally at risk to experience devastating flooding as a result of rising seas and future king tide floods and possible storm surges.

The canal district is located within San Rafael and is one of the most threatened areas in Marin as a result of increased tidal flooding due to projected sea level rise. It allowed us to look more specifically at how the annual, king tides occur every so often, king tides being an unofficial term for the highest tides on record. The annual, king tides are caused by the gravitational pull of the moon and increase the typical tide heights. We would like to thank Stori Oates for her continued support throughout this project. We also want to thank Ryan Chiang and Nathan Lopes for being our fearless model design team, led by the fantastic Barry Beach.

Our Methods

Initially, we used a “flood map” from Our Coast, Our Future (3), which showed areas that would be flood-prone or underwater at variable increments of projected sea level rise. It allowed us to look more specifically at how the annual, king tides occur every so often, king tides being an unofficial term for exceptionally high tide events that occur when the sun and moon’s gravitational pulls are aligned (7). Online, it is possible to find copious king tide photos from along Richardson Bay (Mill Valley, Sausalito, Tiburon, etc.), yet photos of king tides from the low-lying, coastal Canal District are scant to nonexistent. Judging by the elevation profile of the area (3), however, as well as what little we could find online, present day king tides and future sea level rise are a serious problem for the Canal community and we were able to zoom in on the Canal in particular. As it stands, king tides occur every so often, king tides being an unofficial term for exceptionally high tide events that occur when the sun and moon’s gravitational pulls are aligned (7). Online, it is possible to find copious king tide photos from along Richardson Bay (Mill Valley, Sausalito, Tiburon, etc.), yet photos of king tides from the low-lying, coastal Canal District are scant to nonexistent.

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Works Cited

(6)  California Coastal Commission. 6 foot height: ~$170
(8)  The Bay Institute (2016) Horizontal Levee: The Oro Loma Project. The Bay Institute
(9)  The Bay Institute (2016) Horizontal Levee: The Oro Loma Project. The Bay Institute
(10)  Three Conceptual Landscape Visions. Senate.ca.gov. Pages 1-5.
(13)  The Bay Institute (2016) Horizontal Levee: The Oro Loma Project. The Bay Institute
(15)  Tidal Gates: (Fig. 3) Tidal gates help control the flow of water from tides. It is normally a hinged door that can open and close and is controlled by a timing mechanism. This is another method we are considering putting in the San Rafael creek to prevent tides from flooding upstream when there are high king tides and high sea levels. This project affected our local community and we were able to zoom in on the Canal in particular. As it stands, king tides occur every so often, king tides being an unofficial term for exceptionally high tide events that occur when the sun and moon’s gravitational pulls are aligned (7). Online, it is possible to find copious king tide photos from along Richardson Bay (Mill Valley, Sausalito, Tiburon, etc.), yet photos of king tides from the low-lying, coastal Canal District are scant to nonexistent.

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Discussion

All of the Protection Methods are ones that could prevent damage from flooding and/or flooding in general. All of the methods vary in cost based on needs of each home or neighborhood:

Elevation of family homes: ~$45,000 - 200,000
Elevation of commercial buildings: ~$1-20 million
Backflow preventers (dry flooding): Small (e.g. laundromats): ~$3,000 - 5,000
Mid (e.g. office buildings): ~$10,000 - 13,000
Large (e.g. hospitals): ~$14,000 - 34,000
Flood shields (dry flooding): ~$180-250 per square foot
Sealants and impermeable membranes: ~$2.50-7.50 per linear foot
Loose fill seawall:
2 fee height: ~$60
4 fee height: ~$106
6 fee height: ~$170
Floodwalls per linear foot:
2 fee height: ~$92
4 fee height: ~$140
6 fee height: ~$195
Wet flooding/Sea level rise:
Horizontal levees:
Traditional levees:
6.3 million per mile over 50 years
$12.5 million per mile over 50 years
Small (e.g. laundromats): ~$3,000 - 5,000
Mid (e.g. office buildings): ~$10,000 - 13,000
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Wet flooding/Sea level rise:
Horizontal levees:
Traditional levees:
$100,000
$1.5 million (f)
$12.3 million per mile over 50 years
$6.3 million per mile over 50 years
$6.6 million per mile over 50 years
All of which are subject to change depending on the house/building, the materials used, and the contractors. The most eco-friendly and helpful method of prevention would be a combination of a horizontal levee and a tidal gate, both of which could be very costly but would more likely keep the ecosystem and keep floodwater away from the Canal. Other methods are better for individual homes and would only reasonably be necessary if the implementation of the tidal gate and the horizontal levee does not occur.

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