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When Sea Level Rise Threatens: Asking Initial Questions on Behalf of the Community of Fairhaven, CA

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Asking initial questions on behalf of the community of Fairhaven, CA



Humboldt State Environmental Science and Management /Policy and Planning Option Senior Practicum

Fall 2018

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Executive Summary

The community of Fairhaven located on the North Spit of Humboldt Bay, has been identified as one of the most at risk communities to sea level rise (SLR), on the California coast. As global temperatures rise, subsequent glacier melt occurs which increases the amount of water in the oceans around the world. Low lying communities such as Fairhaven, which is about 10 feet above mean sea level, are vulnerable to flooding. Another factor that contributes to Fairhaven's specific vulnerability, is its proximity to the Cascadia Subduction Zone, which is causing Humboldt Bay to subside at a rate of .09 inches per year.

The research conducted by students in the Humboldt State University Environmental Planning Practicum Fall 2018, at the request of Trinity Associates, examines response opportunities to sea level rise for the community of Fairhaven. The unincorporated town of Fairhaven is home to 180 people with approximately 0.8 miles of natural shoreline along Humboldt Bay. This report focused on the current infrastructure, such as homes, businesses, shoreline, and utilities that are at risk as Fairhaven becomes tidally inundated, and sought to identify how long utilities and service providers can be expected to continue to maintain services, and what mitigation measures might allow the community to stay in place as long as possible before seeking a planned retreat from the shoreline. Our team compiled information from a review of the literature and from interviews with Fairhaven residents, utility and service providers, and local and state government agencies in order to provide residents of Fairhaven with up to date, relevant information to support their planning for the future of their community.

We found that the residents we spoke with highly appreciate living in Fairhaven, value its tight knit community and hope to stay in Fairhaven as long as possible. They look forward to the establishment of the Community Services District early in 2019 and were very interested in fundraising and mitigation options for their town. Utilities and service providers indicated that they plan to provide services to the industries and residential communities located on the Samoa Peninsula until they can no longer operate which is expected to be at least over the next decades. Recommendations for SLR mitigation for the immediate future include exploring and further researching the feasibility of applying sand fences, beach nourishment and a living shoreline to protect Fairhaven from coastal erosion and storm surges. We conclude with a brief mention of the longer term opportunity for a managed retreat.

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- **Aldaron Laird** who introduced us to vulnerability assessment for sea level rise, shared his expertise on Humboldt Bay and particularly Fairhaven with us, guided our research and addressed our many questions
- **Troy Nicolini** who introduced us to the community of Fairhaven, shared his expertise and perspective with us. Most importantly thank you for reminding us to stay hopeful.
- **Interview participants** who took the time to give input on their community and their concerns about sea level rise.
- **Representatives of local utilities, agencies and Humboldt County** who spoke with us and provided information regarding their organizations.
- **Jerry Rohde**, renowned local historian who shared his knowledge of Fairhaven and gave us a number of resources to gather further information from.

Introduction

Communities situated along the Humboldt Bay shoreline are some of California's most vulnerable to sea level rise (Laird, 2018). The recent Humboldt County Humboldt Bay Area Plan Sea Level Rise Vulnerability Assessment has provided a detailed assessment based on the most current information available of the levels of inundation these communities can expect over the next century (Laird, 2018). While publicly available and being presented at public meetings, there has been little visible response to this report as yet. Our goal for this project was to focus on one vulnerable community to assess how residents see their adaptation options for the future and to provide them with the best available information from service providers about expected impacts to their existing infrastructure. Our assumption was that landowners will need as much information as possible to make informed decisions as they respond to projected sea level rise. We focused this project on the community of Fairhaven, an unincorporated town on the North Spit of Humboldt Bay (Figure 1). We interviewed community members seeking to understand residents' general awareness of the issues, as well as to gain a perspective on what they believe should be done to address Fairhaven's vulnerability to sea level rise (SLR). We also interviewed representatives of Humboldt County and of utility providers to identify their current procedures and planning for SLR, and carried out additional background research to develop a list of potential responses to the unique challenges that the community of Fairhaven faces.

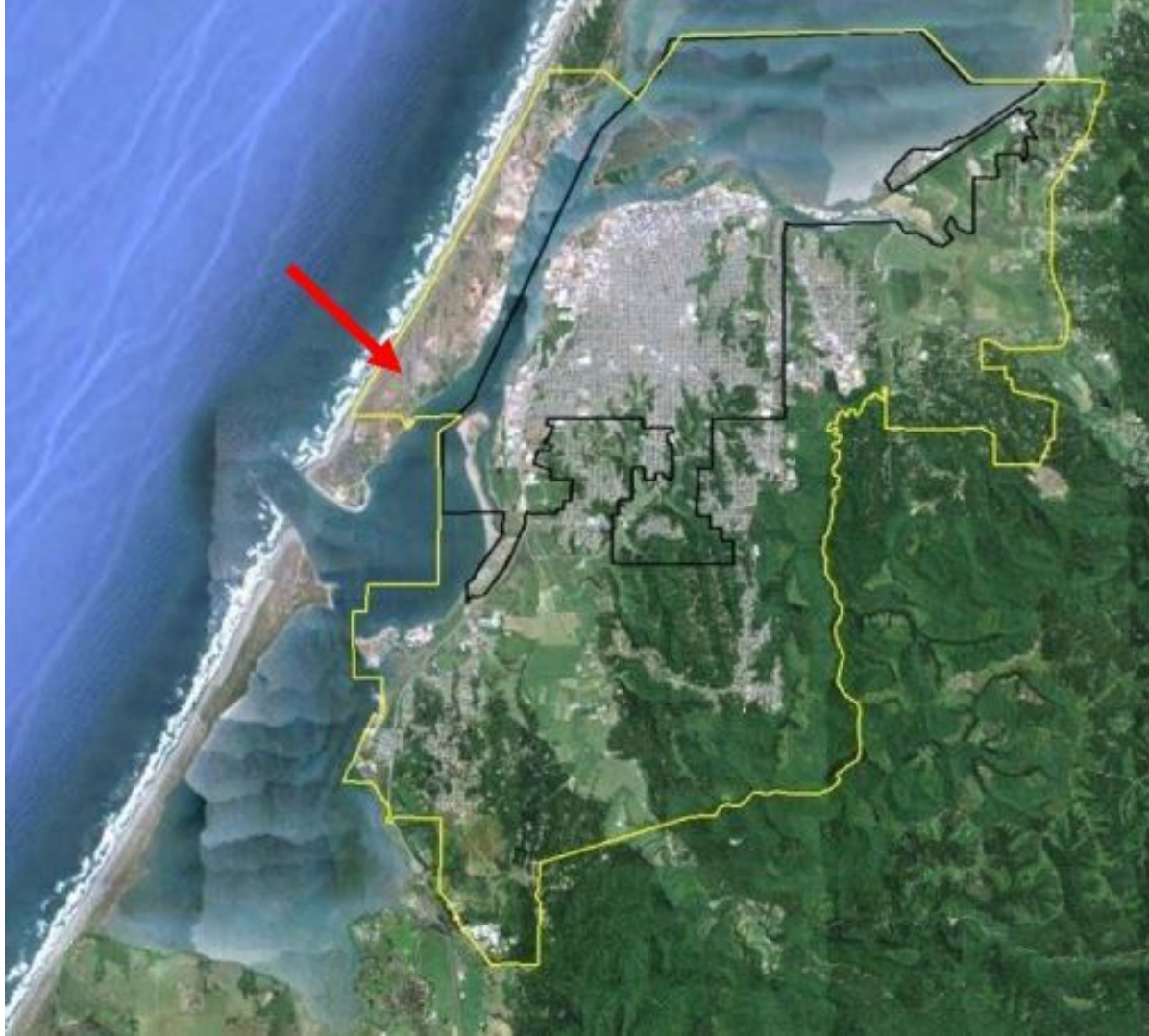


Figure 1. Spatial boundaries in Humboldt County, City of Eureka (black) and unincorporated areas of Humboldt County including Fairhaven. Source: Laird, Aldaron. Trinity Associates, 2016.

Fairhaven has approximately 180 privately owned parcels, on which a number of homes and businesses are established. The community is home to 180 people. Fairhaven has about 0.8 miles of natural shoreline along Humboldt Bay. The ecosystems in this area contains, saltwater/freshwater wetlands and dunes that host a mix of native plant species and invasive exotics (Figure 2).



Figure 2. An image taken from Google Earth shows the location of Fairhaven, and illustrates the roads residents of Fairhaven may use, New Navy Base Road and Lincoln Ave,. Source: (Graehl, Nicholas & Lori Dengler, 2008).

Fairhaven is highly susceptible to SLR. This is due to a variety of geological and topographic features that make this coastal community especially vulnerable to flooding and inundation. The mean elevation above sea level in Fairhaven is only about 10 feet and the groundwater table is also very close to the surface. As sea level rises, the denser saltwater pushes lighter groundwater up until the groundwater eventually emerges and floods the surface. As noted above, Fairhaven has been partially developed on wetlands, so groundwater is already at or very close to the surface. Rising groundwater can affect foundations of structures such as buildings and roads, as well as permanently flooding low-lying areas (Laird, 2018). Another phenomenon that is specific to this area is its location on the Cascadia Subduction Zone (CSZ). Since 1977, Humboldt Bay has been subsiding -0.09 inches/yr and its average rate of relative sea

level rise is 0.18 inches/year (18 inches per century), which is greater than anywhere else in California (Patton, 2014).



Figure 3. A locator map of Fairhaven Unincorporated Area in Humboldt County (Laird, Aldaron. Trinity Associates, 2018).



Figure 4: Coastal Zone Jurisdictions: State and County shoreline cover in Fairhaven and Finn Town under the Coastal Act. This illustrates the jurisdiction of Humboldt County, the California Coastal Commission, and other governmental agencies (Laird, A. Trinity Associates. 2018).



Figure 5: 1.6 feet **Sea Level Rise-King Tide** with **Mean Annual Maximum Water** at 10.4 ft., 0.5 meter of SLR at MAMW-4 times a year in approximately 25 years (Laird, A. Trinity Associates. 2018).



Figure 6: 3.3 feet **Sea Level Rise-King Tide** with a **mean annual maximum water=12.1 FT**, 1.0 meter of SLR at MAMW-4 times a year in approximately 50 years, inundation past Lincoln and Fay (Laird, A. Trinity Associates. 2018).

Year (High Emissions)	Medium High Projected Rise (feet)	Extreme Projected Rise (feet)
2040	1.6	2.0
2070	4	5.6
2100	7.6	10.9

Table 1. Data provided by California Ocean Protection Council new SLR Guidance 2018

The California Ocean Protection Council (OPC) recently published in 2018 New Sea Level Rise Guidance Report that provides projections on the North Spit. These new projections are different than those of Aldaron Laird's that were shared to the community. The impacts are sooner than proposed and with this new data this can allow an improved understanding of possible impacts.



Figure 7: 4.9 feet **Sea Level Rise-King Tide** with **Mean Annual Maximum Water**=13.7 FT, 1.5 meters of SLR at MAMW-4 times a year in approximately 80 years, complete inundation of Fairhaven and Finn Town (Laird, A. Trinity Associates. 2018).

SLR is a major challenge facing the community of Fairhaven in the future, and understanding what critical infrastructure the community depends on and how/when it will likely be affected by SLR may help residents develop individual and community based adaptation strategies which would allow them to stay and for Fairhaven to persist as long as possible. Funding, planning, and strategies for what Fairhaven should do are up to both the residents and the county. This project represents our efforts as students studying environmental planning and policy at Humboldt State University to begin to ask and think through some of the critical questions we would want to understand more about if we lived in Fairhaven and to make some initial recommendations based on our findings.

History of Fairhaven

The area which encompasses Fairhaven, Finntown, and Samoa lies in ancestral Wiyot territory. The Wiyot people are divided linguistically into three groups but altogether form the Soo-lah-te-luk tribes. The tribal communities where the community of Fairhaven currently exists were the Wiki or Weke tribe. Having access to Humboldt Bay, much of their transportation was by canoe and they used the bay for hunting and gathering. European settlers drove out the tribal communities in the area and quickly began to establish their own communities. According to local historian, Jerry Rohde, Fairhaven was purchased in 1875 by George Fay who established one of the first shingle sawing plants on the North Coast on Humboldt Bay. This was followed by a number of other resource industries. In 1873, the Bendixsen's shipbuilding (Figures 1 & 2) business was located in Fairhaven, which became prominently known on the Pacific Coast.

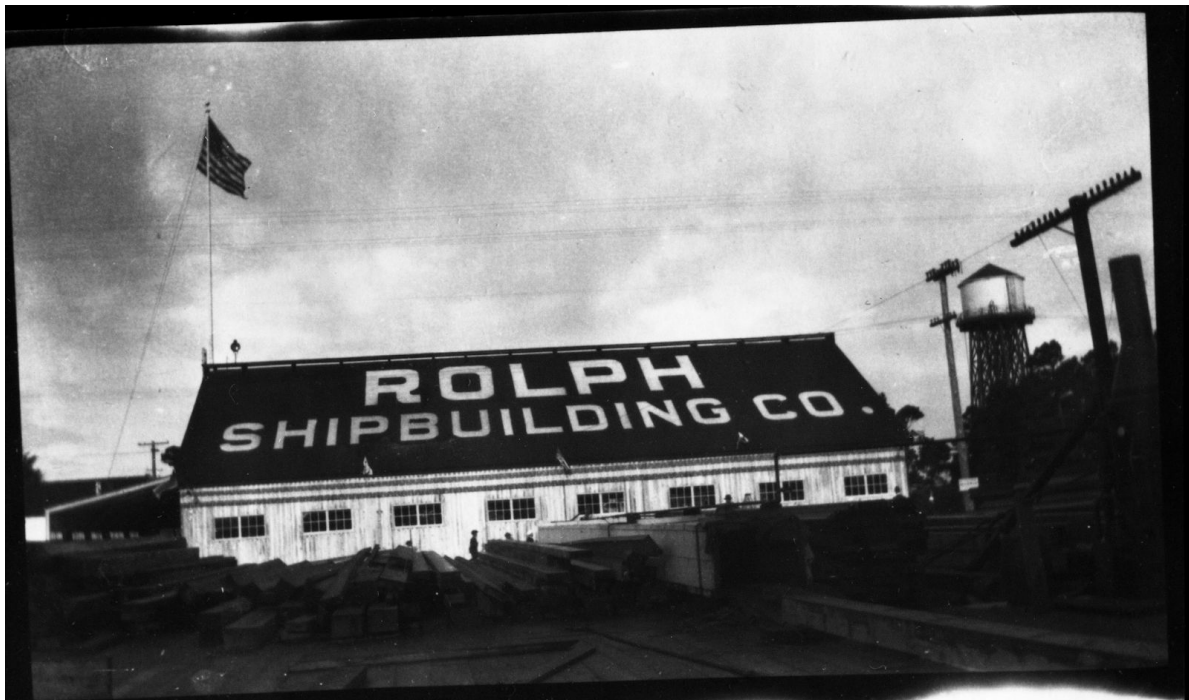


Figure 8: Rolph Shipbuilding Co (Source: Humboldt Room Photograph Collections).



Figure 9: Shipyard in Fairhaven (Source: Palmquist/Yale).

By 1887, the Fairhaven community was comprised of two dozen family settlements and a schoolhouse. Over the years, Fairhaven's industries included the shipping yard, a fishing boat servicing station, a plywood mill, a plant for timber, and a redwood pulp mill. Evidence of the many years of industrial activity in Fairhaven can be observed on the ground and through aerial photos. Today, Fairhaven is a small community of modest homes and a few businesses.

Sea Level Rise

SLR is caused by the thermal expansion of the earth's oceans and the melting of land-based ice sources (e.g. glaciers and ice sheets in regions like Greenland and Antarctica) has been scientifically measured/observed since at least 1880 (Douglas 1991). In the past twenty years, however, the rate of SLR has been roughly twice as fast as it had been in the 80 years prior (Douglas 1991). This rise in global mean sea level is creating significant environmental, social and economic effects, as storm surges and king tides reach further inland than before and flooding becomes more common. Other effects include higher rates of shoreline erosion, groundwater flooding, and saltwater intrusion into freshwater aquifers. Not all coastlines are equally affected. Due to its location along the Cascadia Subduction Zone, Humboldt Bay is subsiding at a rate of -0.09 mm yearly and is experiencing rising water levels at over twice the

rate of other locations in California, and nearly three times the rate of other locations on the West Coast (Table 2). Along Humboldt Bay, Fairhaven, located on the North Spit, is one of the most vulnerable communities with a relative sea level rise of 4.61 mm/yr (Table 2).

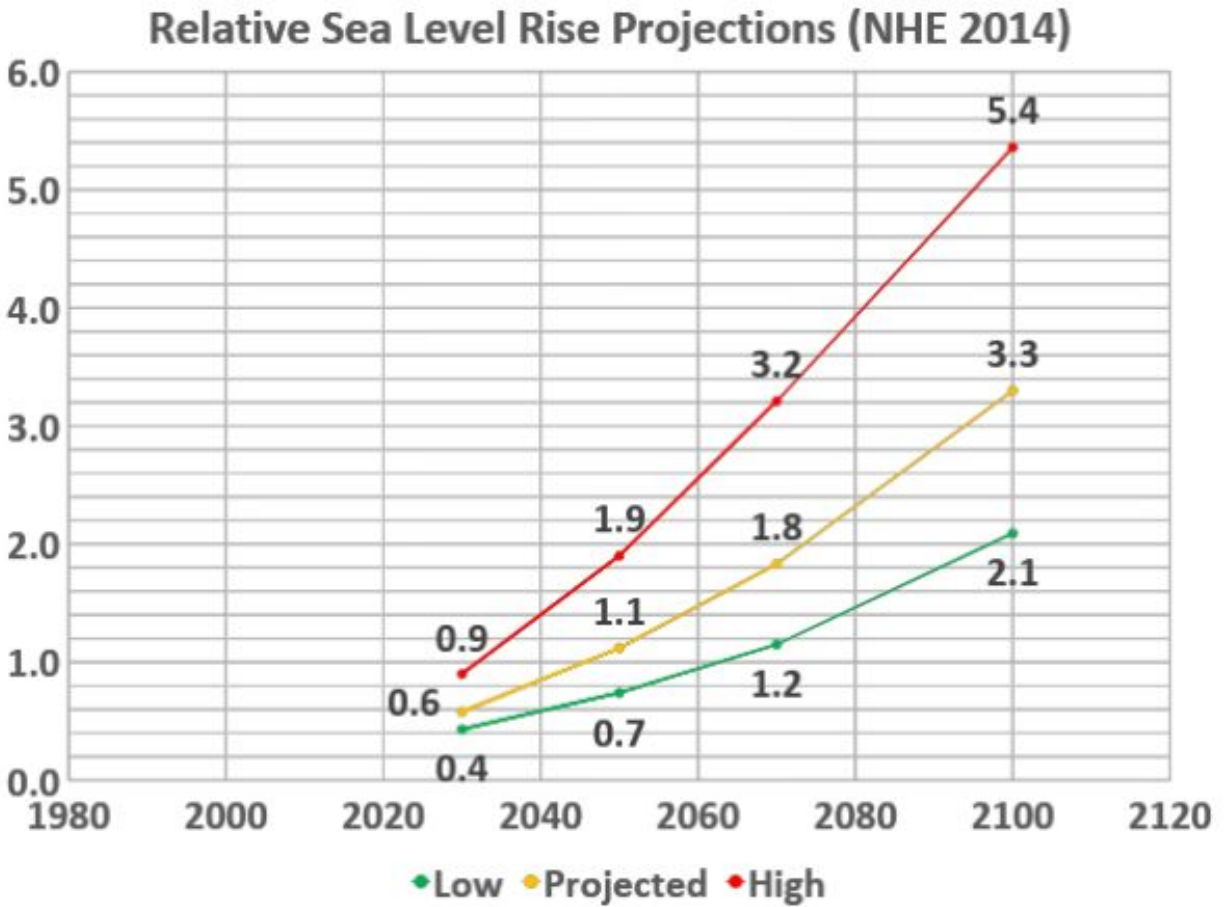


Figure 10: Projections of relative sea level rise with high to low ranges that pose a hazard to the environment of Fairhaven. (Laird, Aldaron. Trinity Associates. 2018)

Tide Gauge	Annual Rates (mm/yr)		
	ReMSL	VLM	RSL
Crescent City	2.28	3.25	-0.97
North Spit (Humboldt Bay)	2.28	-2.33	4.61
Mad River Slough (Humboldt Bay)	2.28	-1.11	3.39
Samoa (Humboldt Bay)	2.28	-0.25	2.53
Fields Landing (Humboldt Bay)	2.28	-1.48	3.76
Hookton Slough (Humboldt Bay)	2.28	-3.56	5.84

Table 2. Summary of relative sea level (RSL) rise, Regional Mean Sea Level (reMSL), and vertical land motion (VLM) rates (Patton et al., 2014). Note the annual rates of the North Spit located approximately a mile from Fairhaven. Measuring vertical land motion is key to understanding coastal subsidence and the impacts of sea level rise. Positive rates indicate upward motion, and negative rates indicate downward motion (Northern Hydrology & Engineering, 2015).

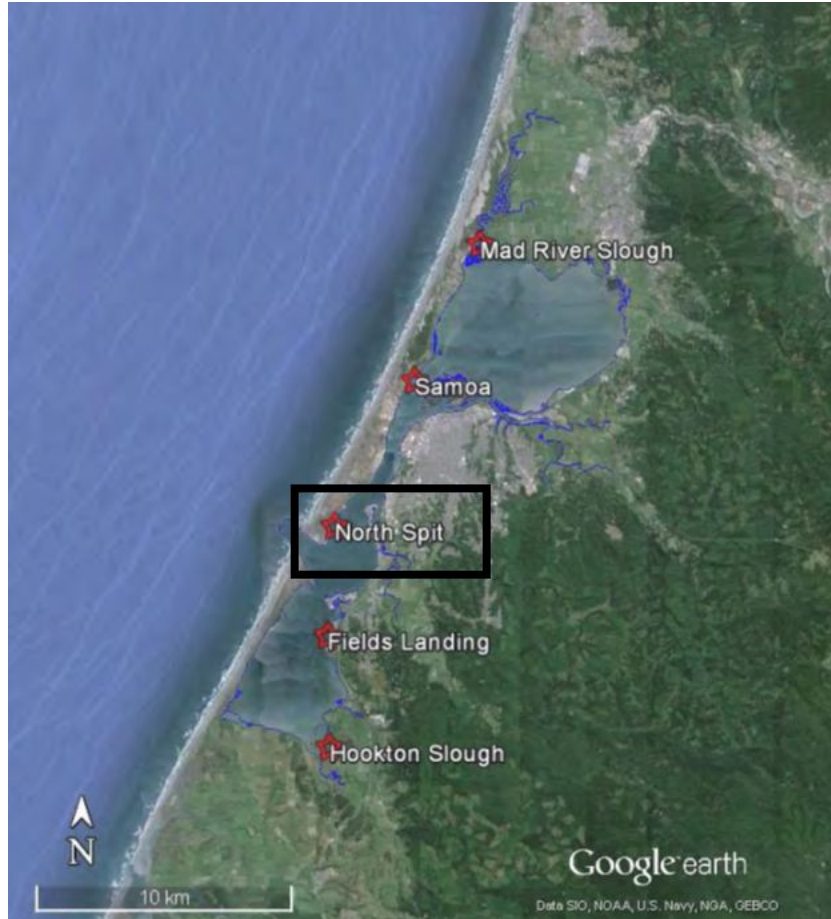


Figure 11. Five NOAA tide gauge locations in Humboldt Bay, with a locator of the North Spit tide gauge. Of all five tide gauges, the North Spit Tide Gauge has the highest rate of relative sea level rise on the West Coast. The North Spit tide gauge is located approximately a mile from Fairhaven (Graehl, Nicholas & Lori Dengler, 2008.).

Tidal Datum	Description	Elevation (ft.)
MLLW	Mean Lower Low Water	-0.34
MLW	Mean Low Water	0.91
MSL	Mean Sea Level	3.36
MHW	Mean High Water	5.8
MHHW	Mean Higher High Water	6.51
MMMW	Mean Monthly Maximum Water	7.74
MAMW	Mean Annual Maximum Water	8.78

Table 3. A table of the tidal datums and elevations for Humboldt Bay as measured at the NOAA North Spit tide gauge. Tidal datums are used to define local water levels (Laird, Aldaron. Trinity Associates, 2018).

Existing infrastructure and responsible agencies

Fairhaven and critical infrastructure that Fairhaven residents depend on are at risk from SLR due to tidal inundation, salt water intrusion, wave erosion, and groundwater elevation. First and foremost the community itself is at risk, namely the residential and commercial, properties and investments of individuals or private companies. Also at risk is access infrastructure such as New Navy Base Road and local public roads/streets. California's Department of Transportation is responsible for access to and maintenance of New Navy Base Road, while Humboldt County maintains local roads and streets. The third and largest subset of infrastructure at risk here are utilities such as the viability of a proposed sewer system, municipal water, and energy. The Humboldt Bay Municipal Water District is responsible for providing Fairhaven with potable water. It utilizes submerged water pipes that divert water from the gravels below Mad River out to the North Spit. The pipes then traverse underneath Humboldt Bay via the Truesdale pump

station to provide water to Eureka. Gas and electricity are provided by Pacific Gas and Electric Company (PG&E) by way of surface and subsurface cables and pipes originating from the Central Valley. Because Fairhaven currently has no sewer services, individual property owners have installed septic systems in compliance with Humboldt County's Onsite Wastewater Treatment System Regulations. Due to high groundwater levels, standard septic systems already do not function well in some parts of Fairhaven. Some homeowners have installed mound systems with engineered drain fields that may be used in areas where soils that have a high seasonal water table to address this challenge, but these are very expensive to install and their ability to withstand SLR is unknown (Figure 12). With SLR, groundwater contamination from existing septic systems and subsequent pollution of Humboldt Bay are likely.

A newly forming Peninsula Community Services District (PCSD) that will serve all townships throughout the Samoa Peninsula will be taking over water distribution responsibilities from the Humboldt Bay Municipal Water District beginning in 2019 and is seeking to extend sewer service to the North Spit including Fairhaven. Whether or not this proposed development will go forward will depend in large part on approval from the California Coastal Commission which regulates coastal developments, coastal health and coastal diversity under the Coastal Zone Management Act (1972).

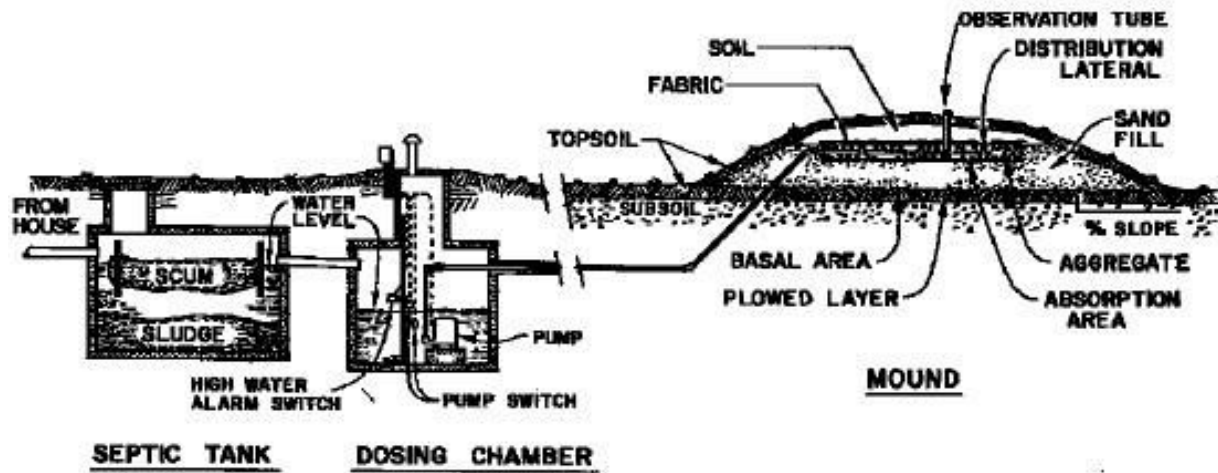


Figure 12: A typical Wisconsin Mound System that can be found in Fairhaven. Septic tanks in Fairhaven are failing and a new wastewater treatment system is needed in addressing sea level rise vulnerabilities (Martel, M. Humboldt County Department of Health and Human Services, 2017).

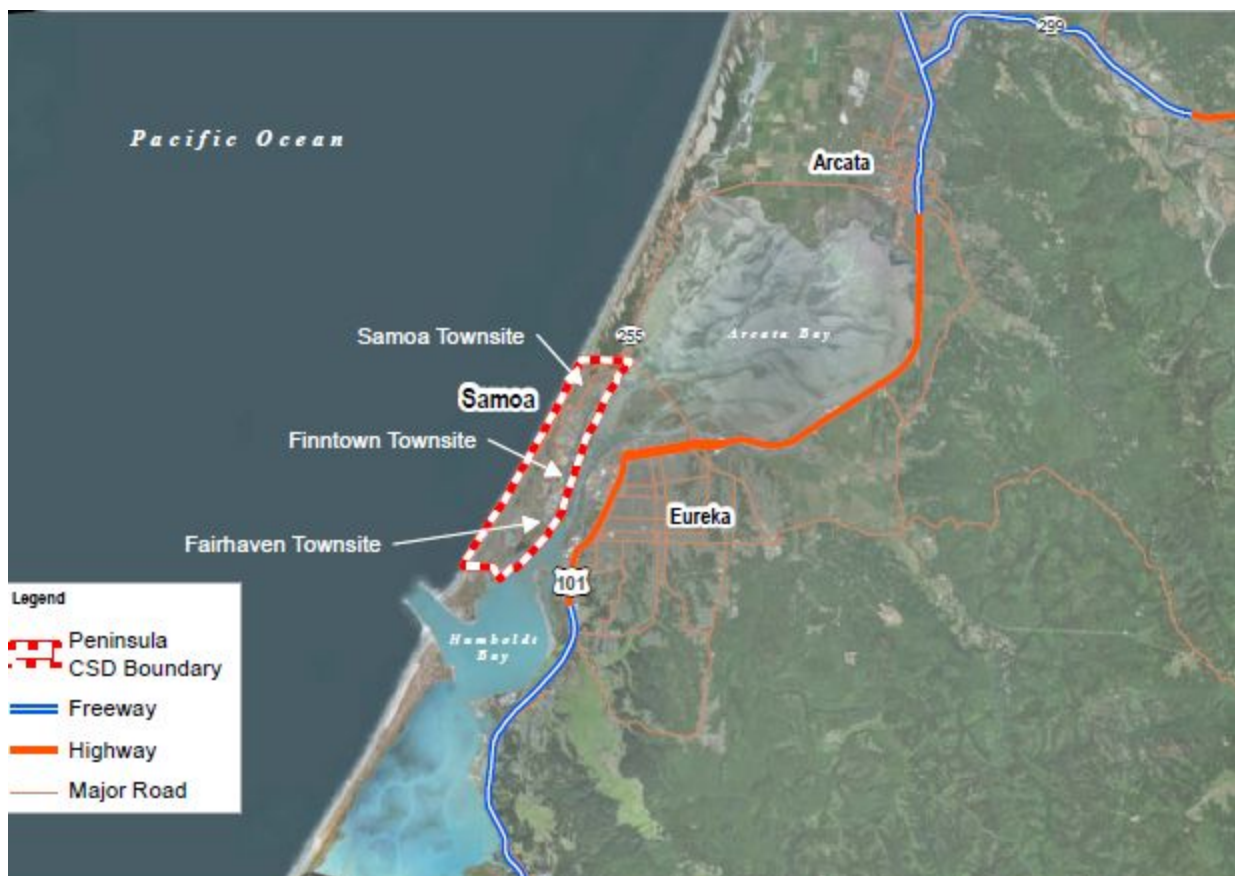


Figure 13: A map prepared by the Humboldt County Planning and Building Department for the Samoa Peninsula Wastewater Project, that illustrates the Peninsula CSD boundary the encompasses Fairhaven Town site. The project would result in the development and function of a wastewater collection, treatment, and disposal system for residential, and commercial/industrial. The project would provide wastewater service to the unincorporated communities of Fairhaven.

Research Methods¹

As noted above, little is known about what Humboldt Bay area residents living in communities vulnerable to SLR are thinking and how they may be responding to emerging information about SLR. In this project, we sought to learn how people living in Fairhaven were thinking about and responding to SLR. In order to begin our research, we contacted a long-term Fairhaven resident we knew, who shared his point of view and then helped us to identify several residents to be contacted via email or phone to ask whether they were willing to be interviewed. The community of Fairhaven is small and we used a snowball sampling approach to get recommendations from each resident we interviewed about which other residents we might contact for an interview. In this way we contacted 14 people and were able to interview six residents. The interviews were semi-structured, typically lasting approximately 40 minutes and focused on gaining residents' perspective and thoughts about SLR in their community. We asked residents some questions regarding what they like about living in Fairhaven and if SLR is a topic that is discussed amongst community members. We also wanted to know what impacts they have observed from SLR and what they believe are some opportunities to protect Fairhaven in moving forward with the given projections. For a list of questions asked, refer to Appendix 2.

We also contacted and interviewed a local historian, Jerry Rohde, who shared information about the history of Fairhaven with us (Appendix 1.)

Since one of our principle objectives was to provide the residents and landowners of Fairhaven with information pertinent to making their community functionally existent for as long

¹ This research was approved by the HSU Institutional Review Board for Research on Human Subjects (IRB 18-050).

as possible, we interviewed representatives of the California Coastal Commission, Pacific Gas & Electric, Humboldt County Public Works, and the Humboldt Bay Municipal Water District.

Once initial communications were made to establish and confirm interview dates, we provided our interview questions to the organizations in advance and then carried out interviews in person or via phone. Our interview questions focused on each organization's particular mandates, plans for the future, and how long they expected to provide services with rising sea levels. For a list of questions asked, refer to Appendix 3.

Results

Community

Our interviews with Fairhaven residents focused on what community members enjoy about residing in Fairhaven, their awareness of SLR and the projected impacts specific to their community, and their perspective on potential responses to SLR that could come from within the community and from local government.

Of the fourteen residents contacted, six residents responded. Five residents we interviewed have lived in Fairhaven under ten years, while one has resided there for almost 30 years. What residents said they liked most about living in Fairhaven were its seclusion, coastal access, and affordability, tight-knit community, and its intrinsic beauty. As one person noted,

“Access to the recreation of the bay and the ocean is why a lot of people live in Fairhaven...it is generally pretty quiet. I love my house and my personal space. It is a pretty affordable place to live to have substantial property and be within walking distance to the beach.”

One resident mentioned that Fairhaven was close to their business and that living in this area gave them many opportunities to live a sustainable lifestyle. All residents described the

serenity and calm atmosphere the area provides while also pointing out the safety and security they feel living among their neighbors in this community. All residents touched on features describing Fairhaven's beauty. One resident described the area as 'magical' and two others emphasized the views of the Bay from their home as one of their favorite parts of living in Fairhaven.

All of the residents agreed to talk about the subject of SLR with us. All but one said they had discussed SLR with others in the community. The degree to which these community members discussed SLR amongst themselves varied however. One person said they had not discussed SLR with neighbors but had discussed other similar hazards such as the potential for a tsunami².

Most interviewees said they had not noticed any immediate impacts of SLR directly on their own property at this time, except for one who was concerned about erosion along the edge of the bay. Others noticed SLR outside the community along the jetty. One resident expressed concern about impacts to New Navy Base Road which they said is already showing signs of SLR during the rainy months and sometimes floods.

We asked the people we spoke with whether they had attended the meeting the County hosted about SLR in August. Three residents that attended the meeting indicated that they felt vulnerable, were scared and thought they would have to relocate before SLR impinged on their residences. People that said they had discussed the meeting with others said they felt unsure about the situation and were rethinking their investments in Fairhaven. Residents who thought they would be able to stay long term, said they were now thinking about the future of their

² Fairhaven lies within the tsunami hazard zone in Humboldt Bay. We did not address this coincidental hazard for Fairhaven residents in this report.

investments and whether they should try to stay as long as possible or retreat sooner. They said they believed that their property value would decrease significantly, if they stayed as long as possible. However, three people we interviewed seemed to not be as concerned, because they had bought the property for an affordable price and were looking forward to enjoying it for the next 20-25 years.

Another resident acknowledged the SLR projections but said that they may not be around to observe these impacts. One resident indicated that his home would not be immediately harmed by SLR as it was built 13 ft above the ground, leaving only the garage susceptible to flooding.

When asked about the new Community Service District (CSD) and PCSD, three people were optimistic that the CSD would give the community a stronger voice to gain support from the County and could provide an opportunity to apply for grants. Three thought they could mitigate effects of SLR to prolong the inevitable through use of living shorelines, planting willows and other riparian vegetation to buffer the shore against flooding and slow erosion rates. Four residents felt that eventually they would stop fighting nature and surrender, leaving little to no room for protective opportunities in the future.

When asked whether respondents thought that Fairhaven residents might work together in response to SLR, answers were mixed. Two residents felt that it would be difficult to work together at this time because opposing views within the community would make it challenging. A resident indicated that as the threat of SLR increases, there could be a chance to build greater cohesiveness within the community with regard to a coordinated response.

When asked whether the rising water table was affecting the functioning of peoples' septic systems, most respondents said this was not an issue for them. Two people said they had

upgraded their septic systems to mound systems, because county ordinances required them to and they currently have no more problems with wastewater. One resident stated that if the ground water table got too much higher, wastewater systems might not percolate properly for sanitation and that would be problematic. One person noted that they have problems with their septic tank during the rainy season. Another commented that the high water table was 6 ft below and that they had not had any problems. Everyone we had spoke to were aware about the new CSD and proposed sewer system. All indicated that it would raise their property value and provide development opportunities. However, four did not understand how a functioning sewer line might reduce susceptibility to SLR in the short and medium term.

When asked to what degree they believed the county was responsible for protecting the community's assets, members' answers varied significantly. More people felt that the County was not responsible for protecting the homeowners' assets because living in Fairhaven is a risk that the individual homeowner took when purchasing land in a dynamic dune environment.

“No. you can't fight the ocean, it is a calculated risk like everything else. Living here is unstable and I don't think they bear any responsibility for the loss of my property, no. Maybe in combating climate change, yes.”

Other respondents said that however nice it would be for the County to protect them, they are not very optimistic, because the County has greater investments in other areas that are also being impacted by sea level rise. One person said they believe that the county doesn't want to spend money on Fairhaven and that the only protection government would provide to the peninsula would be raising the road to provide access to the jetties, and the Coast Guard and Bureau of Land Management properties.

When asked if the community of Fairhaven could work towards resilience to climate change, half of the responses were centered around the potential options once the CSD is formed. Interview respondents were hopeful that with the CSD and the already existing PCC there will be more opportunities for networking and collaborative efforts for responding to SLR. One member of the community emphasized the power and importance of education. They stressed that even though they can make an individual difference they don't believe that at any higher level there are enough individuals educated on the matter to make a collective difference. This person indicated that providing education about climate change and sea level rise broadly combined with eliminating false information in the media would be key to producing some form of collective response and greater resilience in general.

When being asked what Fairhaven may look like in 25 years, community members' answers varied. Some community members said that they couldn't say because they believe there's no way to truly tell what the future will look like even only 25 years ahead because the situation is unprecedented. Other respondents mentioned little to no viability for the area from how impactful SLR will be to properties and more specifically the road and if the county plans on maintaining it. Some speculated that unless the county began to be more proactive, Fairhaven's viability would rely entirely on the community's own internal initiatives. One member was hopeful that because Fairhaven is economically disadvantaged and small in scale, there might be potential for gaining grants. They indicated that they believed that their community would be an ideal test subject for innovative SLR adaptation strategies.

Utilities:

Residents of Fairhaven are dependent on essential services, such as municipal water, wastewater, energy (electricity and natural gas), and communications. Our questions for Pacific Gas and Electric (PG&E), the Humboldt Bay Municipal Water District (HBMWD), and Humboldt County Department of Public Works (Public Works) focused on the maintenance and operation of utilities as Fairhaven becomes tidally inundated. Questions to the California Coastal Commission focused on possible development of the proposed sewer system, marinas and moorings, and artificial beach nourishment as effective SLR adaptations. Fairhaven as a coastal community will need to address to what degree the continuation of utility services will be feasible with SLR, as well as adaptation strategies. Humboldt County is not responsible for the maintenance and operations of any utility systems in the Humboldt Bay Area Plan (HBAP), a component of the County's Local Coastal Program (Laird, A. Trinity Associates, 2018).

Pacific Gas & Electric

Representatives of Pacific Gas and Electric were asked about providing services with the expected increase in SLR induced flooding. We were told that PG&E, and all investor-owned utilities, have an obligation to provide adequate service on a non-discriminatory basis to all customers within their service territory who request electric or natural gas service from them (California Public Utilities Code Section 451). The residents of Fairhaven and the authorities of Humboldt County are becoming aware of the vulnerabilities of utilities. According to PG&E, residents are the ones who will make the decision on how to operate and manage with the expected increase of flooding. Representatives indicated that PG&E will continue to work

closely with the County, as well as other agencies when planning for SLR and that PG&E is committed to providing safe, clean, reliable energy as long as it is needed by the residents of Fairhaven. Investigating the existing infrastructure related to PG&E and how the infrastructure will be affected by SLR which include direct impacts such as physical damage, economic losses, and implications for the surrounding community is a key asset that will provide and support the basic services necessary for civil operation before and after, and during flooding in Fairhaven. PG&E will leave it up to the community itself to determine whether they would like services continued during flooding. PG&E is working to reduce hazard related risk and vulnerability for Fairhaven, while allowing the community to have an understanding of hazards and the risk they pose through public response, awareness, prep, and recovery alternatives. PG&E representatives noted that having the new CSD will make it easier to communicate with Fairhaven community members as a group. PG&E representatives noted that establishing a partnership among all members in the community is key for determining the affordability of the grid to residents, and the obligation of PG&E to serve as cost effectively as possible, while also fostering reliability, ensuring safety, and meeting California's clean energy requirements.

California Coastal Commission

Our questions for the representative from the California Coastal Commission focused on the livability of Fairhaven and the potential for different types of projects which might protect the exposed shoreline. Our interviewee stressed the severity of the predicted rise in the next century and that if these projections turn out to be accurate, the community would likely only be able to persist for the next few decades. When we asked about the potential for adding dredged

soils from the bay to the Fairhaven shoreline, we were told that the coarse sand grain size on shore varies too much from the very fine sand dredged from the bay and that dumping dredged bay soils in Fairhaven could damage shoreline habitats. As far as a proposed sewer extension to the community, the CCC representative said that it would likely be denied on the basis of limiting growth-inducing development in an area like Fairhaven located in a SLR and a tsunami hazard zone. However, the residents could potentially argue that sewer services are a constitutional right and, if victorious in court, force the County's hand.

Humboldt County Department of Public Works

We interviewed two representatives of Humboldt County Public Works and asked whether the County will be obligated to maintain the roads in Fairhaven when flooding becomes more consistent. They noted that they could not respond definitively about a hypothetical situation like this. With regard to the potential sewer system in Fairhaven they stressed the importance of the Samoa Peninsula, as the Humboldt Bay area's most important industrial zone. In their eyes, the residents there will be able to stay until it is no longer physically or financially possible for industries to operate there. When we asked about the challenge of flooding septic systems our interview respondents noted that the County is not responsible for replacing these systems or installing new ones. This responsibility falls on the land owners. Local Agency Management Plan regulations now prohibit the installation of new septic systems which do not have the proper space above groundwater required to properly filter wastewater, unless they are specifically retrofitted for these conditions (e.g. mound systems).

Humboldt Bay Municipal Water District

According to the representative of the Humboldt Bay Municipal Water District we interviewed, HBMWD has no concrete plan for addressing SLR on the Samoa Peninsula. When asked if water services will continue to Fairhaven if flooding becomes more consistent, we were told that the water can flow through the piped system until the Truesdale Pump Station (located across the bay in the Eureka bayfront district) is inundated. After this point, the only way water services to Fairhaven would continue is if the water valve were to be relocated. When asked about the potential sewer line extension to the community, the representative emphasized that it would be up to the newly-formed CSD to coordinate sewer, water, and parks and recreation services.

Discussion

Community

While we tried to interview a broad sample of Fairhaven residents, in our short time frame we were only able to connect with six people willing to be interviewed. Therefore, our results are very preliminary and not representative of the community as a whole. They do however, give a flavor of these residents' views and we hope, indicate the importance of carrying out more community-based research as responses to SLR are discussed and developed around Humboldt Bay.

While the six residents we spoke with had differing points of view, we found common themes throughout our interviews. Most significantly, these residents conveyed that their love for the area makes them wish to stay in Fairhaven as long as possible and that 20 years in the future seems like a worthwhile time frame. However, it was also clear that they understand that they

live in area that is at high risk of natural hazards including tsunami, seismic activity, flooding, and SLR. They were hopeful that SLR mitigation measures might delay the inevitable, but they understood that eventually retreat will be the only feasible option.

Fairhaven is an unincorporated community. The residents we spoke to indicated that they believed that Fairhaven is at a disadvantage politically and economically compared to incorporated communities, and a low priority for future investments from the County to mitigate impacts from SLR. Residents were hopeful that a functional CSD will provide them with a greater political voice and more funding opportunities for their community. Despite Fairhaven being unincorporated, interviews indicated that some residents feel a strong community bond that could serve as a building block for future cohesiveness.

The lack of information is challenging. While most residents understand that SLR will affect them in the future, they are uncertain about how this will happen and when they might need to retreat. One key issue for them, is understanding how the potential sewer system line would work and how it might extend the livability of Fairhaven for the short term.

Utilities

Our interviews with utility providers were useful in clarifying the efforts (and, in some cases, lack thereof) of public and private agencies in response to sea level rise in Fairhaven. Through these interviews, we were able to understand which organizations are beginning to plan responses to the threat of SLR and which are not. All of the utility providers we spoke with were at least aware of Aldaron Laird's work, and the Humboldt County Public Works Department directly referenced his findings during their interview with us. We discussed multiple key issues with the utility providers, including shoreline mitigation, the possible extension of sewer services

to Fairhaven and the varied progress of each agency in planning for SLR on the Samoa Peninsula.

The organization most closely focusing on sea level rise and its effects in Humboldt County is the California Coastal Commission (CCC). In our interview with a senior CCC representative, we discussed the viability of Fairhaven as a threatened coastal community, and were informed of the different costs and considerations which would need to be assessed if people wanted to live in the community for as long as possible. The California Coastal Commission, in their *Sea Level Rise Policy Guidance* report, outline their criteria for approving or denying new development in coastal areas. The criteria are straight-forward -- the CCC makes their decisions based on the best available information about an area's sea level dynamics and uses a cautious, "worst-case-scenario" approach to assessing the area's threat of sea level rise-induced flooding. The most important piece of information, however, is that the CCC requires coastal protection measures to, "...avoid construction of bluff retaining or shoreline protection devices which could significantly alter landforms" (SLRPG, Section 30253). Assuming the Coastal Commission provides little leeway in their development approval criteria, the idea of constructing a protective sea wall is essentially out of the question, due in large part to the loss of access to the shoreline that it would create. Additionally, our interviewee cast doubt on the idea of potentially using dredged soils from the bay to shore up the Fairhaven beach, indicating that the differences in sand grain size between the the bay floor and the beach would make the plan unapprovable by the CCC (SLRPG, Section 30706). However, the potential for dredging elsewhere is still worth investigating, as soils could potentially be sourced

from different, more geologically similar locations. This option, however, would likely require further funding and equipment to be realistic.

We then discussed the potential for a sewer line extension to the community of Fairhaven. A possible way for Fairhaven residents to encourage the County to provide sewer services to the community, in their opinion, would be to argue that sewage services are a constitutional right. If approved, the nearby town of Samoa would provide sewer services through an extension of their own line. However, this would be an important legal battle due to the potential precedent it would set for other coastal communities in California -- it could be argued that if Fairhaven were able to force the county's hand and allow for new development (sewer system), then others will as well. Furthermore, the community could also argue that the area is an economically-important industrial zone, which would require a new sewer system and different approval criteria. In general, the California Coastal Commission's main priority is to protect the environment of coastal areas, so acquiring development rights would be a challenge.

The representatives from the Humboldt County Department of Public Works were a bit more reserved in their answers, due to the legal ramifications which could come about by talking in hypotheticals. While the Department of Public Works and Humboldt Bay Municipal Water District do not (yet) have a plan for sea level rise in Fairhaven, the representatives interviewed there were adamant that the Samoa Peninsula is an important industrial zone which should be protected until doing so is no longer a viable option. This point was echoed by most of the representatives from utility providers that we interviewed -- the protection of the peninsula is important, and should be planned for. However, doing so requires a better understanding of a few different aspects, namely the septic systems on all livable properties in the community. The

costs of improving or replacing the systems would likely be entirely on the residents, which, in a community with a below average per capita income might not be feasible. The main point brought up by the agencies which had no Samoa Peninsula SLR plan was that legally speaking, there is no way for them to make any sort of commitment to maintaining infrastructure such as water lines and roads -- they would be required to continue allowing access to the roads, but not necessarily to continue maintenance on them. This poses an interesting question as to the approach that Fairhaven's new CSD should use. How should these residents plan for this impending threat if they do not know the stance that the county or utility providers will take? This leads us to believe that the responsible county parties would likely need to be the first to provide a concrete plan for the peninsula before more localized planning in Fairhaven can begin. For example, the county could hypothetically commit to maintain utilities/roads until 2030, and review for maintenance needs until 2040 beginning in 2025. If the county could assess conditions in set yearly intervals, the decisions about how to proceed would be much clearer and more informed.

Other examples of natural shorelines affected by sea level rise can be found all along the United States seaboard. Perhaps the most relevant to communities in California are experiences from the Gulf Coast. For example, the Galveston County, Texas, where "half of [the] homes face a yearly risk of flooding by [2000]" (Leatherman, 1984), is dealing with considerable challenges from sea level rise -- not because the mean sea level rise rates are higher than in Fairhaven, but because of the threat of hurricanes in the area (UCUSA 2017). The storm surges caused by hurricanes have led Galveston to take desperate measures to extend the viability of living on the Bolivar Peninsula, including raising the coastal highway by seven feet and

requesting a \$15 billion protective bluff from the federal government (UCUSA 2017). The approaches taken by Galveston County are likely similar to measures which will need to be weighed for implementation here in Humboldt County. A key difference between the two communities, however, lies in their approaches to new development. In Galveston County, the housing market is booming, with local realtors saying it is the strongest market they have seen in nearly 40 years. New homes are being constructed 20 feet off the ground on stilts, and millions of dollars have been put into replenishing the sands on the beach during the summer season to attract further tourism (UCUSA 2017).

Without integrated local government coastal planning, mitigating the effects of sea level rise in Fairhaven will be difficult. Before local residents can plan for themselves, they will need clarity from local regulatory agencies on whether they will approve or deny new development (or development-inducing infrastructure) for the area. While many of the agencies/utility providers interviewed did not (yet) have such a stance, they emphasized the economic importance of the peninsula, which would lead one to believe that planning for SLR is something that will certainly become a higher priority as the threat increases, or as its effects become more apparent. Our findings suggest the need for collaboration among agencies, local governments, and unincorporated areas in order to address sea level rise. The California Coastal Commission, and the California Ocean Protection Council are required to consider sea level rise impacts in their coordination of coastal zone management in California, using the OPC Sea Level Rise Guidance which was released in early 2018. The California Public Utilities Commission is a regulatory agency that regulates privately owned public utilities in the state of California, including electric power, telecommunications, natural gas and water companies. Gerston, L. N. (2012).

Legal context, pertinent regulations, limitations, and policies can provide guidance for the community of Fairhaven in developing an adaptive strategy. California Senate Bill 379 requires that the Safety Elements of General Plans be reviewed and updated to include climate adaptations and resiliency strategies (CA-SB 379 2015). Senate Bill 379, Assembly Bill 2800, requires the Natural Resources Agency, by July 1, 2017, and every 3 years thereafter, to update the state's climate adaptation strategy to identify vulnerabilities to climate change by sectors and priority actions needed to reduce the risks in those sectors. California Senate Bill No. 246 established the Integrated Climate Adaptation and Resiliency Program administered by the Office of Planning and Research to coordinate regional and local efforts with state climate adaptation strategies to adapt to the impacts of climate change. These finding highlight how incorporating sea level rise in policy making is possible, feasible and successful.

Recommendations

As Fairhaven seeks mitigation opportunities, the community will benefit from being able to apply for and administer grant funding through the new CSD. Fairhaven's beach front contributes significantly to quality of life for local residents but also exposes the community to SLR through direct flooding from king tides and storm surges. One opportunity to mitigate SLR in the short and medium term is to enhance the shoreline. There are two types of ecosystems here, coastal dunes and beach and coastal wetlands behind a narrow beach frontage. Three opportunities could be explored: use of sand fencing, beach nourishment, and creation and extension of a

living shoreline. Finally, as SLR progresses, Fairhaven has an opportunity for a managed retreat to higher ground on the peninsula.

Sand Fence

Sand dunes and fences can recharge beaches to increase the coast’s resistance to erosion and storms. (Arkell, Darch, & McEntee, 2007; Environment Canada, 2006). Implementing shoreline protection measures could possibly protect existing infrastructure and developments in Fairhaven. Developing a sand fence or dune build up could aid to buffer the effects of SLR, and extend the time frame during which people can live in low lying areas of Fairhaven.

Coastal Dune Build Up/Sand Fence		
Benefits	Challenges	Site Suitability
Low cost, easy to install	Potential to alter dune habitats	Coastal Winds
Fences could be constructed using wood or vegetation	Changing Pedestrian Traffic	Gently sloped, wider dune formations
Sand dune stabilization and controls erosion	Sand Transportation	Shoreline approximately 9-10 feet in elevation
Limits sand intrusion into coastal properties and roadways	Approval From Residents	Composed of erodible sand formations.
Does not reflect or redirect wave energy	Fence Life	Low Wave Energy
Traps sand to initiate foredune development perpendicular to wind	Life Maintenance	Fairhaven 0.8 miles
Reduce or prevent onshore sand drift that would bury cultural or ecological features	Marine debris	Area is rated highly vulnerable

Table 4. Benefits, challenges and site suitability criteria for using sand fencing to enhance beach build up. Source: Alghamdi, A. A., & Al-Kahtani, N. S. (2005).

Beach Nourishment

Beach nourishment is the process of sand being added by humans to a particular beach that has lost sand due to erosion and longshore currents. This type of sandy reinforcement to coastal areas serves as a protective buffer for inland infrastructure. As sea level rises in coastal communities, many municipalities are using this method to keep reinforcing their coastlines from erosion. Use of beach nourishment might be explored for the Fairhaven coastline as a way to help protect the low lying areas that line the bay and are at risk of flooding from sea level rise.

Beach Nourishment		
Benefits	Challenges	Site Suitability
Buffer against wave action	Cost of Sand Nourishment Expensive	Area is rated highly vulnerable
Buffer against flooding	Disturbances of the indigenous biota inhabiting the subaral habitats	Shoreline is approximately 9-10 feet in elevation
Longevity of three to ten years	Disruption to species that use subaerial beach habitats or adjacent areas for nesting, nursing and breeding	Accessible dredge spoils
Protection to coastal properties and infrastructure	Obtaining permits for beach nourishment projects that require monitoring of biological resources on the beach and dredging site	No waterfront development in Fairhaven
Improvement of the beach for recreational activities long term	Short term negative impacts of hardened structures on the recreational and biological habitat values	Fairhaven 0.8 miles

Table 5. Benefits, challenges and site suitability criteria for using beach nourishment. Source: National Research Council. 1995.

Like many flood protection measures, beach nourishment has advantages and disadvantages. Not only does this strategy buffer against waves and flooding, but it can also improve beaches for public access and recreation. In some cases dredged sediment can be used to protect eroding shorelines and infrastructure that are at risk of flooding (SHN et al, 2015). In Fairhaven's case, beach nourishment might be explored to reinforce the .8 miles of beach front. Challenges to implementing this strategy include finding a suitable source of sand, the cost of applying it, and gaining regulatory approval. Currently the Army Corps of Engineers dredges the harbor entrance of Humboldt Bay annually, and if this material were appropriate, this could be a source of sand for replenishing the beaches of Fairhaven. The financial cost of using the dredge spoils from the harbor entrance to reinforce beaches in Fairhaven is unknown. Not many studies have been done that look at the cost of beach replenishment. According to one study, sand dredged from Humboldt Bay is placed three nautical miles offshore and represents the single biggest loss of sand from the littoral zone due to harbor maintenance for the entire state...this may have a significant impact on the surrounding beaches (Connor et al, 2006). In our discussion with a representative from the California Coastal Commission, beach replenishment using recently dredged sand from the harbor entrance was seen as possibly a good idea, but additional studies would need to be done on its feasibility. The recommended study would look at the ecosystems that could be affected, monetary costs of beach replenishment, and other negative impacts.

Living Shoreline

Living shorelines help stabilize and build up shorelines through native plant species and hardened structures such as oysters, oyster reefs, and stone sill components that are expected to maintain elevation for predicted SLR through 2100 (NOAA Fisheries, 2017). This coastal technique also improves resilience from storm surges and erosion along coastlines. Other ecosystem service benefits include purifying water, storing carbon, buffer for floods, and ecosystem services for wildlife and habitat. As a form of “natural mitigation,” the structure of a living shoreline may prove to be effective for long term protection (NOAA Fisheries, 2017). Some reports indicate that living shorelines work better than hardened structures in the long term (NOAA Fisheries, 2017). According to one local, source installation is cost effective, ranging from \$1,000 to \$5,000 per linear foot, with annual maintenance costs averaging \$100 per linear foot (NOAA Fisheries, 2017).

Living Shoreline		
Benefits	Challenges	Site Suitability
Potential to protect habitats while stabilizing shoreline	Further studies for salt marsh habitat	Gently sloped shoreline
Traps Sediment, Raising the Shoreline Elevation	Deep Water, Navigation Channels	Low wave energy
Buffers shelter the shoreline processes and ecological services	Loss of Recreational Availability	Shallow water
Potential to Improving Shoreline Management Planning	Cost	Fairhaven 0.8 miles
Improved Resilience to Storm Surges	Public understanding	Area is rated highly vulnerable
Improves ecosystem	Permitting	Salt Marsh and Freshwater Marsh present

Table 6. Benefits, challenges and site suitability for living shorelines. Source: Davis, J. L., Takacs, R. L., & Schnabel, R. (2006).

A living shoreline works best with salt marsh and freshwater marsh habitat, making Fairhaven an ideal candidate for implementing a living shoreline along its small coastline of 0.8 miles long. The loss of recreational availability along the coastline of Fairhaven could prove to be a challenge for the community. Accessing availability for funding through grants and other investments may be challenging because the area is unincorporated. Any idea of using living shoreline as a mitigation for SLR in Fairhaven would need considerable exploratory research as to its ecological feasibility and appropriateness. If such an approach were found to be ecologically feasible and desirable for mitigation, it is likely that there would be considerable regulatory hurdles to negotiate before such an effort would be approved. Conflict between the regulatory status quo and the goal of adopting a newer, bioengineered process may not be unattainable and extensive research needs to be conducted on the stability of a living shoreline along this coastline.

Managed Retreat

As SLR makes living in Fairhaven infeasible, the community may have a retreat option. The Fire District (soon CSD) owns 11 acres of land in the dunes at higher elevation. All 63 houses currently inhabited in Fairhaven could be moved upslope and would fit inside the proposed 11 acres. This effort would be costly and would require careful collaborative planning with community residents, service providers and local government along with complex permitting for “development” in the coastal zone. We heard Fairhaven residents make a number of arguments to support such development. The dunes are currently largely disturbed and

covered with exotic invasive plants. Retreat would allow for saltwater marsh habitat to be restored in the currently inhabited areas of Fairhaven. The community would be a good test case for managed retreat in Humboldt County and in California, a point that the new CSD could make in grant proposals by the new CSD to explore this opportunity.

Managed Retreat		
Benefits	Challenges	Site Suitability
Above flooding inundation	Setting legal precedents	11 acres of land
Higher elevation	Setting planning precedents	63 houses
Long term retreat from SLR	Sustaining the collective sense of coastal community; ensuring equitable outcomes	All of the houses will fit within the 11 acres
Wetland rehabilitation - Restore salt water marsh for ecosystem services including wildlife habitat	Financial costs for a low income community; raising grant funding	High dune habitat

Table 7. Benefits, challenges and site suitability for Manage Retreat. Modified from: Alexander, K. S., Ryan, A., & Measham, T. G. (2012).

Conclusion

Addressing the complexities of SLR adaptation along the California Coast will require collaborative efforts among community members, businesses, service providers and local and state governments. Rising seas will directly affect the community of Fairhaven sooner than most coastal communities. Fairhaven therefore presents an opportunity to local entities to begin to take SLR adaptation seriously. With the new CSD providing increased community capacity, Fairhaven may have the opportunity to generate political and financial support to explore short term mitigation opportunities such as those recommended here, and in the longer term to provide a test case for managed retreat.

APPENDICES

APPENDIX 1:

Interview Questions for Jerry Rhode, Don Tuttle and other historians about Fairhaven

1. Who were the indigenous peoples that were established in what is now Fairhaven prior to European settlement?
2. Could you brief us on the Rolph Era?
3. Could you tell us about the shipping yard that existed in Fairhaven?
4. How did the development of lumber mills affect the communities of Manila, Samoa, Fintown and Fairhaven?
5. Are there brownfields in Fairhaven and has any restoration work been conducted on them?
6. What do you believe will become of the community of Fairhaven?

APPENDIX 2: **Interview Questions for Residents of Fairhaven**

1. How long have you lived in Fairhaven?
2. What do you like about living in Fairhaven?
3. What do you like about your community?
4. Is it ok if we ask you a few questions about sea level rise?
5. Do you ever talk about SLR with your neighbors or other community members?
6. Have you noticed any impacts of sea level rise in the community? Over the last few decades?
7. Did you or anyone from your household go to the community meeting about Sea Level Rise in Fairhaven in August?
 - a. What did you learn?
 - b. Is the prospect of Sea Level Rise changing your plans for the future?
8. What opportunities do you see for protecting Fairhaven from Sea Level Rise?
9. Could Fairhaven residents work together on a response to Sea Level Rise?
10. Do you notice any impact of a high-water table on the functioning of your septic system (so, for example: Is your toilet slow to flush during the rainy season?)
11. If your answer to question above was "yes", have you noticed any change in how your septic system functions over time? If so, how has it changed and over how many years?
12. What do you think about the possible sewer system that is being evaluated for Fairhaven?
13. At what level is the county responsible for protecting Fairhaven and its assets?
14. What gives you hope that your community will be resilient to climate change?

15. What do you believe Fairhaven will be like in 25 years?

APPENDIX 3:

Interview questions for Representatives from the Utilities and Humboldt County

Questions for California Coastal Commission

1. With impending sea level rise, how long do you believe Fairhaven and other communities on the North Spit will be livable?
2. Fairhaven is forming a Community Services District and hopes to extend sewer services to its community. What are the benefits and costs of this proposal?
3. What is the likelihood that Fairhaven will be allowed to implement its sewer proposal?
4. It appears that dunes are forming on the beach at Fairhaven and are buffering the shoreline against high tides and storm surges. Would artificial beach nourishment (adding sand) to build up the dunes be feasible to protect Fairhaven ?
5. As sea levels rise, would it be possible to consider construction of a marina and moorings for houseboard at Fairhaven?

Questions for Pacific Gas & Electric

1. With impending sea level rise, how long do you believe Fairhaven and other communities on the North Spit will be livable?
2. What environmental risks come with flooding in areas with power and gas lines? (Potential incentive to continue services in the area)
3. In the PG&E Climate Change Vulnerability Assessment, PG&E is planning for 2 feet of SLR by 2050 -- How do you plan to respond to rising seas in places like Fairhaven that are going to be the first impacted by this?
4. Would PG&E consider abandoning services to a community that could be potentially flooded every month?
5. Does the agency have any public obligations or mandates to provide services if a majority of the population of Fairhaven retreat and a few decide to stay?

Questions for Humboldt County Public Works

1. With impending sea level rise, how long do you believe Fairhaven and other communities on the North Spit will be livable?
2. What's the county's current policy on septic tanks and SLR?
3. What do you think about the possible sewer system that is being evaluated for Fairhaven?
4. If the sewer system was not built, would residents have to upgrade their septic systems?
5. Are there septic systems that can be installed in Fairhaven given the rising groundwater? (mounds?)
6. Is the county obligated to keep roads open to places where people currently live?
7. How will Humboldt County respond if there is monthly flooding of New Navy Base road?
8. How far ahead is Humboldt County thinking in terms of maintaining roads in the Fairhaven area in the face of SLR?
9. Is there any possibility of not maintaining New Navy Base Road in the face of SLR?

10. Is there anybody else who you recommend that could provide information on this subject?

Questions for Humboldt Bay Municipal Water District

1. With impending sea level rise, how long do you believe Fairhaven and other communities on the North Spit will be livable?
2. How will water services from the Truesdale Pump Station to Fairhaven continue after flooding becomes more consistent?
3. Is maintaining the pump station during flooding incorporated in HBMWD water management plans?
4. Do you support a non-growth-inducing extension of sewer to Fairhaven as a way to address potential pollution from septic systems with rising groundwater?

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