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Reflective Essay

With great appreciation for the UCSB Library, I am submitting my Senior Thesis in Environmental Studies for the Library Award For Undergraduate Research. From start to finish, the library played a key role in everything I learned for this project. My project examined the issue of sea level rise (SLR) through the lens of stakeholder risk perceptions. The SLR hazards of cliff erosion, flooding, and wave damage will present considerable localized risks to the student community at the University of California, Santa Barbara (UCSB) making them stakeholders in this issue.

Based on this rationale, my research question asked how UCSB students' perception of SLR risk for Lagoon Road (LR) and Del Playa Drive (DP) related to their demands for adaptation actions in each of these locations. The process of getting to this very specific question took months of work. At first, I only knew I was interested in writing about sea level rise and nothing beyond that. I went to the online library and searched for peer reviewed articles which matched “sea level rise.” I was met with thousands of relevant articles, but I was unsure how to parse through them and get to more specific information.

As part of my Senior Thesis class, Professor Jennifer Martin and Librarian Kristen LaBonte created a “libguides” page which I used to obtain valuable sources. This also led me to set up a consultation with Kristen LaBonte where I learned about conducting advanced searches and using formatting in search engines to obtain relevant results. I was even able to request papers from other institutions using the InterLibrary Loan system.

After familiarizing myself with the cornucopia of existing sea level rise literature, it slowly became clear that there was a conversation I wished to join and further expand upon. While many previous studies had looked at stakeholders and risk perceptions in the issue of sea level rise, none had specifically examined students' risk perceptions. UCSB is a coastal campus which means that as the sea level continues to rise, our campus will face increasing risks from cliff erosion, wave damage, and flooding putting students at risk. I began to use specific search terms such as: "sea level rise" OR "rising sea level" & "adaptation" AND "stakeholder." to get closer to my research question. I took note of searches like this one on a living Google Document. Then, once I found a usable source, I would store it in Zotero and later export the APA citation to my references section. This process demonstrated the importance of organization and attention to detail when dealing with sources.

In addition, the criteria I used in choosing my sources was multifaceted; I conducted an extensive literature review with seven sections and each section contained varied sources. That said, I made sure that regardless of their topic, all of the sources I found from the library were credible, peer reviewed, and had been heavily cited in the past. For my "Sea Level Rise Stakeholders" section, I chose sources which utilized survey methodologies similar to my own project. Another useful trick was to identify an excellent paper and read through their reference list to find more information about a given topic. I quickly learned that using this strategy allowed me to dive deeper into the conversations about sea level rise risk perceptions which I hoped to join. First I read the sources' abstracts, then I evaluated their relevance, methods, and results to see whether I felt a source would be useful. If the abstract was of interest to me, I explored their methodology and results. Looking at studies which provided counter arguments to

my own were also important, as was exploring different methodologies to confirm the viability of my own choices.

Without a doubt, this research was the most lengthy and strenuous project I have ever completed. Having access to the UCSB library was a privilege that I do not take lightly; it truly made this work possible and I would like to express my deepest gratitude for that opportunity. The UCSB library has allowed me to be curious, get deeply involved with all aspects of research, and find answers to questions I was previously unable to answer.

UNIVERSITY OF CALIFORNIA

Santa Barbara

Sea Level Rise Risk Perceptions:

Assessing Students at the University of California, Santa Barbara

by

Taylor Grace Roe

A senior thesis submitted for the degree of

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in

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ABSTRACT

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This Senior Thesis examines sea level rise (SLR) through the lens of stakeholder risk perceptions. The SLR hazards of cliff erosion, flooding, and wave damage will present considerable localized risks to the student community at the University of California, Santa Barbara (UCSB) making them stakeholders in this issue. I surveyed 267 UCSB students to assess how their perceptions of SLR risk for Lagoon Road (LR) and Del Playa Drive (DP) related to their demands for adaptation actions in each of these locations. LR and DP are both roads with near identical *actual* risks to SLR hazards, but LR is on university property while DP is in Isla Vista, an unincorporated community of Santa Barbara county. Existing literature suggests that risk perceptions can be influenced by the policy environment (the existing policy conditions in a place), culture, knowledge, and individual values in a given area. My findings show that (1) higher student SLR risk perceptions are related to greater demands for SLR adaptation actions, and that (2) students perceive the risks of SLR to be higher for DP than LR. The student community in IV and at UCSB expressed the highest demands for "accommodation" adaptation strategies, demonstrating the value placed on preserving coastal infrastructure as it exists currently. Ultimately, this project will serve as a useful tool to both students and decision makers alike.

Key words: Sea level rise, risk perceptions, adaptation, stakeholders

Gratitude and Acknowledgements

First and foremost, I would like to express my deepest gratitude to my advisor, Elliot Finn, for the countless hours he spent advocating for this project and helping it bloom. Additionally, my work would not have been possible without the marvelous Jen Martin, who worked tirelessly to spearhead the Environmental Studies Thesis course this academic year.

I would next like to thank the UCSB professors who shared my survey instrument with their students to obtain data for my project. Both the UCSB Library team and experts I interviewed were also key resources that this research relied upon heavily from start to finish.

Then, of course, my kindest regards go to my awesome friends and family who were always there to encourage me. A few of them told me that the first child is always the most challenging.

Finally, I would like to acknowledge the Ocean. I see the Ocean as a powerful mentor, wise friend, and place of abundant life. We can all learn from the churning blue water that supports us each day. Without the Ocean, all life on Earth, and less importantly, this project, would cease to exist.

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Chapter 1: Introduction and Overview

1.1 Introduction Overview

As the certainty of sea level rise (SLR) due to human activities becomes undeniable, society will be forced to make adaptation plans to survive on planet Earth. The growing coastal populations in the United States, and specifically California, mean that more people are exposed to risk of loss from SLR (NOAA, 2017). People, critical infrastructure, and coastal ecosystems are in vulnerable positions which will require extensive adaptation planning to prepare for the future. A SLR adaptation pathway is a set of measures a community can implement which helps to lower their risk to SLR-related hazards (ie: cliff/beach erosion, flooding, and wave damage). Adaptation strategies incorporate measures which fall into three categories: protection, accommodation, and managed retreat. To implement these strategies, people must accurately perceive the risks presented by SLR. To further complicate the process of getting from adaptation plans to adaptation actions, these strategies present ecological, economic, and social tradeoffs which stakeholders weigh differently depending upon their personal values.

Challenges to adopting SLR plans abound. Climate skepticism, individual risk perceptions of SLR, and high initial costs of some measures all inhibit planning for SLR (Griggs et al., 2012). Additionally, adaptation is viewed as secondary to mitigation (Griggs et al., 2012). However, even using SLR predictions under very low emission scenarios means that we will have to adapt to SLR in the near future (IPCC, 2021). These physical realities mean communities need to make policy choices to adapt and will need

to engage with stakeholders affected by SLR. Stakeholders' demands for adaptation measures may depend upon their self-perceived level of risk and personal values.

The University of California, Santa Barbara (UCSB) and the neighboring community of Isla Vista (IV); an oceanfront campus and community bordered by the Pacific Ocean, are ideal cases to assess stakeholder perceptions. At UCSB, the university manages SLR planning while the county of Santa Barbara manages it in IV. UCSB's choices will affect the planning process for IV since the two locations have comparable hazards and risk levels. In both places, the central hazards from SLR are cliff erosion, wave action, and inundation from flooding (Griggs et al., 2012). As the ocean draws closer to the retreating cliff edge and communities atop them, there is an opportunity to study what stakeholders' risk perceptions reveal about their demands for SLR adaptations. In this study, stakeholders are defined as community members affected by the issue of SLR at UCSB or in IV. This includes people who have influence over or are affected by the decisions made at UCSB or in IV. Although students are among many community members and stakeholders, this study focuses only on the student population at UCSB since they make up the majority of the campus community and residents of IV, making them an important population to understand. This study starts a conversation with an important group of stakeholders, UCSB's student body. I assess whether UCSB students' perceptions of SLR risk for Lagoon Road (LR) and Del Playa (DP) relate to their demands for adaptation actions in each of these locations.

1.2 Research Positionality and Reflexivity

The ocean is a very important part of my life and drove me to pursue a larger project that I could walk away from UCSB with. After four years living here, I felt compelled to study the coastal processes which shape life near the ocean. My curiosity about the ways in which humans are changing their natural environment, perpetuated by the economic systems we have in place, fueled my passion for this Senior Thesis. However, I am still a visitor in the Santa Barbara area. It is important to acknowledge that UCSB was:

> founded upon exclusions and erasures of many Indigenous peoples, including those on whose lands it is located, the villages and unceded territories of the Chumash people… The Chumash people are comprised of the descendants of Indigenous peoples removed from their Island of origin: Limuw (Santa Cruz), Anyapac (Anacapa), Wima (Santa Rosa) and Tuqan (San Miguel), and subjugated by five missions during Spanish colonization of the Central Coast, from Malibu to Morro Bay and inland to Bakersfield (Lopez & Salomón).

Enjoying the natural beauty of this land is a privilege which must be acknowledged mindfully and with respect to the people who were the original stewards of this region.

1.3 Research Question

This study investigates student risk perceptions to SLR and demands for adaptation measures in UCSB and Isla Vista. The research question guiding this paper is: *How do UCSB students' perception of SLR risk for Lagoon Road (LR) and Del Playa Drive (DP) relate to their demands for adaptation actions in each of these locations?* First, I interviewed SLR adaptation experts and USCB officials charged with planning institutional responses on campus. Using this data, I developed a survey to assess student risk perceptions and demands for adaptation actions. From the responses gathered via

survey data, student stakeholder values can be elicited to inform better SLR planning and resilience. This study assesses whether students have different risk perceptions of SLR on campus versus in IV and how these differences might relate to demands for adaptation actions from institutions. I also explore the often overlooked uncertainties and unintended consequences in existing SLR literature. The results demonstrate how individual and community values can inform plans to increase resilience to SLR locally and globally.

1.4 Rationale

This research is important because SLR will impact UCSB and IV. The campus' property forms a U-shape around the unincorporated community of IV, which houses roughly 27,707 residents (2019 data) 8,441 of whom are UCSB students (Marsano, 2021). Included in the population are also long-term residents, Santa Barbara City College students, and "low-income Latino families, many of them undocumented" (Marsano, 2021, p. 2). Given that many students are exposed to SLR both on campus and in their community, they are central SLR adaptation stakeholders.

Campus touches the Pacific Ocean on three sides and includes university owned beaches, cliffs, and oceanfront structures. The most recent State of California SLR Guidance Report from 2018 and widely used data suggest that the probabilistic SLR scenarios for Santa Barbara are 0.8 feet by 2030, 2.5 feet by 2060, and 6.6 feet by 2100 (Kopp et al. 2014; California Ocean Protection, 2018). With water levels rising significantly in the near future, UCSB and IV have a heightened and increasing risk of exposure to cliff retreat, flooding of low-lying areas, and damage from increased wave action (Griggs et al., 2012). Campus must start employing SLR adaptation measures.

These measures fall into the categories of protecting existing infrastructure with green/gray solutions, accommodating existing life to SLR, and retreating away from high risk coastal areas (California Coastal Commission, 2018). Campus/community has three types of solutions at their disposal. These include *protection* which entails building "hard" or "soft" infrastructure such as seawalls or dune/wetland restoration, *accommodation* which entails measures such as elevating and strengthening buildings with flood proofing materials, and *retreat* which entails vacating or relocating at coastal risk infrastructure. For public officials and planners to decide which to pursue, they need to understand the preferences and desires of key stakeholders such as students.

1.4.1 Scholarly Contribution

This research contributes to the scholarly conversation surrounding SLR by clarifying the preferences of a subset of often disregarded SLR stakeholders, UCSB students, and helps explain how and why they perceive local climate issues in particular ways. This case study provides a better understanding how risk perceptions within a community relate to demands for SLR adaptation measures. While much research assesses SLR and stakeholder risk perceptions, student perceptions are underexplored. Talking with students can clarify the role of students as stakeholders which has been overlooked by the existing SLR literature and provide important scholarly knowledge to the field. Uncertainty in SLR scenarios decreases individual urgency to demand adaptation planning, however, foresight can prepare humanity for a future filled with climate challenges. This project assesses whether SLR concerns UCSB students.

Past UCSB and Santa Barbara County vulnerability assessments, city planning, qualitative and quantitative research projects have explored Santa Barbara's SLR problem. While many stakeholders have been accounted for, UCSB students have not been a significant part of these efforts. Further, the California Coastal Commission's protect, accommodate, and retreat framework does not consider or integrate the opinions and preferences of UCSB students (California Coastal Commission, 2018). Surveying students, planners, and leaders is important in establishing a prosperous coastal community for future generations.

1.4.2 Policy Contribution

Researching SLR adaptation pathways is a necessary process in community planning, building networks of resilience, and informing policy. In the case of UCSB, surveying students about their risk perceptions and demands will elicit useful information for UCSB decision makers to utilize when deciding on adaptation actions. Understanding local community values and culture helps decision makers plan an equitable future. Furthermore, engaging with students early in the planning process "can create important educational opportunities and develop trust and consensus that is necessary for moving from concept to implementation" (Douglas et al., 2012, p. 538). University officials should consider the values of the people the institution is serving when planning for an uncertain future and can build community resilience by engaging students early on.

The cost of *not* addressing problems associated with SLR is significant. SLR will damage vital infrastructure like airports, hospitals, and homes as well as displace communities and disproportionately burden marginalized groups. UCSB and IV both

have many vulnerable structures and property at risk of loss or damage from SLR. We must find out what stakeholders value preserving. Whether stabilizing the cliffside homes in IV, preserving the campus dorms, or maintaining local beach access, providing tangible evidence of student preferences to those who ultimately make the decisions about the measures implemented for UCSB students.

Students must be part of climate change and local resilience building conversations. While campus and community decision makers often view students as temporary residents to discount their preferences, I argue that the values of the collective student body will survive multiple generations of UCSB students, thus we must listen to their demands. UCSB fostered the environmental movement and continues to produce educated environmentalists. The climate crisis is the most pressing issue of our time (IPCC, 2021) and future UCSB students will likely be even more aware of environmental issues and feel strongly about solving them. Larger networks can help a community prepare for disasters (Nordenson et al., 2018), so incorporating students as important stakeholders is essential in the process of adapting UCSB's campus and IV to SLR. UCSB students contribute to the local economies of Santa Barbara and Goleta; if their homes, no matter how temporary, are damaged by SLR or they have to relocate, surrounding communities will suffer. Finally, this research will be helpful when applied to other coastal campuses and any communities affected by SLR.

Eliciting risk perceptions and demands from stakeholders provides valuable insights about what we value protecting. These efforts could help to diminish the risk of students losing access to what they value. If students value access to sandy beaches, waves to surf, or walking trails on the cliffs, administrators should know. This knowledge

reduces the risk of the university making unfavorable decisions for the students it was built to serve. UCSB encourages students to be "community-driven and globally-focused" (UCSB Mission Statement), so they should consider tackling a global issue which is simultaneously affecting the local community, economy, and ecology.

1.5 Hypotheses

Extensive research and expert interviews inform these hypotheses. Policy environment (the existing policy conditions in place), culture, knowledge, and individual values all affect risk perceptions. Risk perceptions require people to internalize a risk accurately. SLR presents a high risk to IV and UCSB. If students accurately perceive this, it is likely that they will demand adaptation actions to counteract the risks. Students who do not perceive SLR as a threat to UCSB/IV will likely not feel inclined to demand action. If, for example, a student has seen the local cliff erosion destroy infrastructure first hand, they might feel that this is a high risk to the area and thus demand adaptation actions to prevent further damages. This suggests that:

1. *Students with higher SLR risk perceptions will express greater demand for SLR adaptation action.*

Adaptation action on campus is managed by the university. The general mission of the university includes being a responsible entity which tries to account for the best interest of students. The university has already arranged multiple teams of people tasked with developing climate resiliency plans. The set policy environment at the university is very different from that of IV. IV is an unincorporated community where the immediate effects of cliff erosion are highly visible; houses are dangling over the retreating cliff

edge. Residents of IV embrace freedom from the university. IV has fewer formal institutions and does not provide services that many other communities enjoy. The main enforcement concerns in IV are centered around managing issues such as underage consumption of alcohol and preventing people from setting couches on fire, rather than looking at ways to adapt to climate change. This suggests that:

2. *Students will perceive higher SLR risk on Del Playa Drive than on Lagoon Road.*

1.6 Research Design: Methods and Data

I investigate the relationship between UCSB student risk perceptions and demands for SLR adaptation strategies. The results of this study help demonstrate how assessing stakeholders' risk perceptions can indicate what a community values protecting in the face of SLR. Knowledge of values can be used to build resilience to SLR both locally and in a broader context. I use a quantitative survey instrument with multiple choice questions. The survey aims to gather responses from a representative sample of students in the UCSB student community.

First, I analyze the existing SLR literature as well as local governmental SLR plans from Goleta, Santa Barbara, and the state of California (California Coastal Commission, CCC). This helped clarify a set of viable SLR adaptation options for UCSB as well as reliable information to include in the surveys.

Second, I interview five SLR planning experts to better understand the threats SLR poses to campus and Campus planning efforts. Charles Lester, Summer Gray, Shari Hammond, Chris Noddings, and Lisa Stratton are respected experts who provided a variety of valuable perspectives presented in this paper and helped inform an accurate

and reasonable survey. Their professional opinions helped select appropriate questions for the survey and increase the reliability of my data.

Third, after the preliminary document analysis and informational interviews with experts, I created an online Qualtrics multiple choice survey and recruited UCSB student respondents. I discuss the connection between stakeholders' demands and values in the analysis chapter. In order for respondents to access the survey, I created a link and QR code which took respondents to a Qualtrics survey. I recruited a convenience sample of 267 UCSB students by sending out surveys through professors and listservs. I left the survey active for four weeks hoping to gather a diverse group of representative student demographics. The survey gathered demographic information such as year in school, area of study, place of residence, and age for further discussion. The raw data was then cleaned and analyzed using the R programming language.

The literature and expert interviews suggested focusing on three main types of adaptation measures: protection, accommodation, and retreat. The survey did not explicitly indicate to the respondents which of the measures fall into which of these categories. In addition, based on advice from expert Charles Lester, this study focuses on two of the key sections of coastline which will be affected by SLR and are highly visible to UCSB students: Lagoon Road and Del Playa Drive (C. Lester, personal communication, December 2nd, 2021).

There were limitations to this research design. First, time constraints with my own graduation timeline meant that I could only field the survey for four weeks, from March 7th to April 3rd, 2022. These four weeks fell on weeks 10-11 of Winter quarter and spring break when students were busy with other obligations. The sample was majority

female, White, Environmental Studies students, and thus was not as representative of the UCSB student body as I intended. In addition to the regular challenges that arise from surveying, the COVID-19 global pandemic may affect how people feel about choosing to participate in this study.

Ultimately, the student survey data tried to answer my research question: How do UCSB students' perception of SLR risk for LR and DP relate to their demands for adaptation actions in each of these locations? I hypothesized that students with higher SLR risk perceptions would have greater demands for SLR adaptation action. Further, I hypothesized that students would have a higher perception of SLR risk on DP than on LR. OLS regression analysis supports H1, that there is a positive relationship between student risk perceptions and demand for adaptation actions. T-tests and descriptive statistics illustrate that risk perceptions were higher for DP than LR, providing support for (H2).

1.7 Thesis Chapter Roadmap

To explore UCSB students' perception of SLR risk and demands for adaptation actions for Lagoon Road and Del Playa Drive, the remainder of this Senior Thesis is organized into relevant chapters. In Chapter 2, I conduct an extensive literature review. I join the scholarly conversation surrounding SLR adaptation and stakeholder risk perceptions by connecting key themes and interjecting how these relate to the conversation I wish to start with UCSB students. The literature review is divided into multiple sections. First, I review SLR risk perceptions. The next section explains adaptation planning and actions followed by the importance of stakeholders and

community resilience. Chapter 3 provides context on climate change, SLR, governing bodies, the history of IV/UCSB, local risks, and potential adaptation methods. Understanding perceptions of SLR in IV and UCSB requires understanding each community's history. Chapter 4 reports the survey data which I collected from UCSB students. In Chapter 5, I analyze the data and provide policy recommendations for UCSB/IV. Finally, Chapter 6 concludes this Senior Thesis by commenting on questions arising from this study, synthesizing the findings and how they fit into the larger conversation, and giving concrete recommendations for the future of SLR adaptation actions in IV/at UCSB.

Chapter 2: Literature Review

2.1 Introduction

In this chapter I discuss the existing literature on SLR risk perception, adaptation planning and action, stakeholders, and building resilience. I place my research in the context of others in order to explain why my question is relevant. First, it is important to return to the research question: How do UCSB students' perception of SLR risk for Lagoon Road and Del Playa Drive relate to their demands for adaptation actions in each of these locations? In order to investigate this question, this literature review is organized beginning with a section on the existing work surrounding SLR risk perception. The criteria for analyzing the literature on risk perceptions is that it pertains to SLR. I exclude general literature on perceptions of other types of risks because it is not as relevant to answering my research question. This will be followed by background on various adaptation measures, planning, and actions. The adaptation section consists of case studies and an analysis of SLR adaptation plans made by local governments. Then, I will discuss stakeholders in SLR and how UCSB students fit into this role locally. There are a plethora of existing works which focus on SLR stakeholders and I have chosen to review those which utilize the survey methodology. Finally, there will be a discussion of how taking action to adapt to SLR builds community resilience. The community resilience section's criteria for analyzing and comparing is based on literature which specifically discusses building resilience as it pertains to climate issues.

2.2 Sea Level Rise Risk Perceptions

Adaptation to SLR requires accepting one's perceived risk. For example, if there is a high *actual* risk of wave damage, but stakeholders have low risk *perceptions* (ie: they do not accept that there is a high risk of living in a coastal community), it is unlikely that proper adaptation, such as a protective seawall, will be advocated for. To add, stakeholders' perceptions of risk can influence coastal management decisions such as which adaptation actions a community chooses, land-use decisions (Constable, 1998), and how the future of a given community will look. An individual's risk perception to SLR is defined in this paper as their personal expression of risk to SLR. This encompasses how strongly someone might feel about the local hazard of SLR. Objective risk assessments have been made by online mapping tools such as Our Coast Our Future (OCOF)/CoSMoS and therefore this map will be used to inform this project. The data from OCOF indicates the best estimates of the *actual* risk of SLR related hazards to this area including cliff erosion, wave action, and flooding for much of California's coastline. While this data is available and accessible, peoples' risk perceptions may not accurately reflect this information because there are also many subjective factors which can influence one's risk perception (McGuire, 2015).

The policy environment (the existing policy conditions in place), culture, knowledge, and individual values in a given area influence how people perceive the risk of SLR (McGuire, 2015). If the status quo policy environment has not been historically planned for SLR, the public perception of the risk may not reflect the actual risk. At UCSB, the Planning commission's Long Range Development Plan (LRDP) is currently working on a SLR Resilience amendment which will dictate how UCSB, and specifically

LR, take action to adapt to SLR. With that being said, there has been knowledge of the risks presented by SLR on campus for many years. Therefore, only beginning to take action now is not necessarily conducive to high risk perceptions on campus. In IV, the incremental setback of oceanside homes on DP has been underway for years, but there is not an established, actionable SLR plan for the future of this community. IV is governed by the County of SB and therefore follows the SB Coastal Land Use Plan (CLUP). This addresses the risks of SLR and requires homes to be setback 30 feet from the cliff edge, but most residents of IV have no existing knowledge of these policies.

It is important to take a closer look at UCSB students' culture in order to better understand student risk perceptions. According to Akerlof et al., "cultural theories of risk perception hold that individuals identify threats according to views of the group culture with which they identify" (Akerlof et al., 2016, p. 315). It follows that if UCSB students identify as being UCSB students, they will hold risk perceptions which accurately reflect this culture. There is a culture of caring for the natural environment amongst UCSB students, demonstrated by large participation in the environmental studies major, environmental organizations, related protests/demonstrations, and preservation of outdoor spaces on/near campus. There is also a unique culture in IV. As a small community, there are environmental efforts based in composting, recreation, and climate action. However, there is also a party culture which leaves littered streets and a general feeling of neglect to some areas. This may be explained by the lack of governance of the community and limited rule enforcement. These factors could sway student risk perceptions of SLR because they are affiliated with these cultures. Of course, there are a diverse range of

opinions and worldviews amongst UCSB students; not everyone participates or feels connected to the cultural norms explained above.

The knowledge individuals and groups hold about the issue of SLR can help explain risk perceptions. As explained by McGuire, there is "an inverse relationship between risk and knowledge: the greater the knowledge, the less risk" (McGuire, 2015, p. 461). Due to the fact that students are not always considered in SLR planning and subsequent action, this may not hold completely true in this project. Informing the UCSB student community about the actual risk of SLR will lead to far more accurate risk perceptions of it. Knowledge may include general awareness of local hazards such as cliff erosion, wave action, and flooding. Knowing what SLR is and accepting that it is occurring would also indicate that students possessed knowledge of the issue. These are questions that will be explored in the survey and subsequent chapters of this paper.

Personal values can also impact risk perceptions. Hazards, like SLR or cliff erosion, are threats to assets which people value. Risks measure the intensity of hazards (Constable, 1998). Thus, determining whether the assets (beaches, houses, etc.) people value at a high risk of loss due to SLR can bring us closer to understanding how risk perceptions are formed. In IV and at UCSB, students value the structures near the cliff edge. These structures include student housing, classrooms, parking lots, and beach access points to name a few. What people are willing to give up might depend on their personal values and what the personal consequences will be (Constable, 1998). For example, giving up housing in an oceanfront home on DP might be worth averting the risk of one's home falling into the ocean for some students, but perhaps not for others. Ultimately, risk perceptions as explained by policy environment, culture, knowledge, and

individual values illustrate challenges in adaptation planning, and furthermore they explain why it is difficult to get from adaptation *plans* to adaptation *actions*.

2.3 Adaptation Plans and Actions

Adaptation planning is an essential feature of preparing developed coastal areas for SLR. It can be thought of as an approach to planning which accounts for how the shoreline might change with regard to SLR and identifies key thresholds at which point adaptation actions must be taken. One of the barriers identified by Palutikof et al.'s 2019 paper is the lack of SLR adaptation plans which have been carried through to implementation. Visible actions help provide the public with knowledge on what the future of their community may look like with rising seas. This point is especially important when considering UCSB students and how they perceive the risk of SLR. The way that an Australian SLR adaptation project, CoastAdapt, aimed to overcome this issue was through the delivery of knowledge and risk recognition via their online toolkit. By distributing accessible decision making information to SLR stakeholders, they have begun the process of informing people about the reality of SLR in their communities (Palutikof et al., 2019).

A SLR adaptation pathway is a set of measures a community can implement which helps to lower their risk to SLR-related hazards (ie: flooding, erosion, and wave damage). The future of living near the coast, and attending a university which is bordered by the ocean, will be shaped by the coastal management strategies and adaptation pathways chosen by decision makers; some of which could ensure thriving, sustainable communities (Nordenson, 2018). The California Coastal Act (1976) granted power to the CCC for oversight and regulation of coastal development with a goal to "protect,

maintain, and where feasible, enhance and restore the overall quality of the Coastal Zone environment and its natural and artificial resources" (CCA, 1976, §30001.5). This document determines much of the adaptation planning in California, and thus many of the pathways researchers have recommended are based on this legislation.

2.4 Protection, Accommodation, and Retreat

Adaptation measures can be organized into three main categories: protection, accommodation, and retreat. Within these categories, there are adaptation tools that work alongside the physical solutions such as creating social networks, funding community education on SLR, and understanding the existing cultural values of a place (Douglas et al., 2012). Additionally, there are many cases in which using a mixture of protection, accommodation, and retreat are implemented (a hybrid approach); highlighting the fact that there is no single *best* way to adapt to SLR. The context of a specific place including risk perceptions, policy environment, culture, knowledge, and individual values are some of the considerations which further complicate this issue. In general, SLR adaptation plans/actions aim to lower the risk of a local hazard which poses a threat to something people value (Constable, 1998). At UCSB, cliff erosion, flooding, and damage from wave action are hazards of chief concern which will be considered when choosing adaptation strategies (Griggs et al. 2012). Looking at students' perception of SLR risk, and demands for adaptation actions will help decide the ways we can adapt UCSB to these hazards.

Protection measures for SLR include "hard" approaches such as shoreline armoring via seawalls as well as "soft" approaches which rely on actions such as dune/wetland restoration. For gray measures, a "protective structure such as a seawall

would minimize threats to the residence due to erosion, though if the development is protected by shoreline structures, the fronting beach will eventually be lost" (California Coastal Commission, 2018). The reality is that California's coastline already has over 100 miles of hard armoring (Slagel & Griggs, 2008). Exploring whether students value the avoidance of measures which include hard shoreline protection will elicit useful information about what UCSB students value, and how UCSB/IV might want to proceed with regard to the demands of stakeholders.

An example of a softer approach would be letting natural processes do the brunt of adaptation work (Boudreau et al., 2018). As mentioned by expert David Hubbard, there are powerful case studies which demonstrate that letting natural processes restore themselves is an effective SLR adaptation method (Boudreau et al., 2018). The case of San Buenaventura State Beach in Ventura, California showed that by stopping beach grooming, the native dune vegetation was able to repopulate the sand within two years (Boudreau et al., 2018). With the restored vegetation, 2-3ft tall dunes formed in the following thirteen years "demonstrating an ability to store sand, build topography, and self-repair following extreme wave erosion" (Boudreau et al., 2018). At Surfer's Point in Ventura, CA beach nourishment provides public goods like recreational value and storm protection (Gopalakrishnan et al. 2016; Boudreau et al., 2018). In Ventura there was an initial demand from stakeholders to preserve a beach they valued; these demands, based on an accurate perception of SLR risk, led to adaptation actions which prioritized the values and concerns of community members. If this information is applied to UCSB/IV, further research on how students wish to proceed in the future will lead to favorable outcomes which protect critical infrastructure and preserve spaces that people value.

Accommodation approaches to SLR refer to the measures and policies that work to modify *existing* structures in ways which make them stronger and more resilient to SLR (California Coastal Commission 2018 & Jeroen 2018). Some examples of accommodation measures include elevating and strengthening buildings with flood proofing materials, building structures that can easily be moved and relocated, clustering development in less vulnerable areas, tightening zoning regulations, and having specific land use designations (California Coastal Commission, 2018). In the case of IV, home to 8,441 UCSB students (Marsano, 2021), zoning regulations must continue to be flexible as the cliffs erode rapidly, leaving many student residences exposed to high risk of property loss or personal harm. Ensuring that student residences in hazardous areas are ready for the risks they are being exposed to is important to the wellbeing of students as well as ensuring housing for future students. These accommodations can be economically expensive, and require time to implement, further burdening students who simply need a place to live. For these reasons, surveying the student population at UCSB with regard to perception of risk is a key step in turning adaptation plans into adaptation actions.

Finally, managed retreat, whereby a given development is relocated or completely vacated due to the imminent risks of SLR, is considered a necessary component of future adaptation pathways (Jeroen et al., 2018 & Rush, 2018 & California Coastal Commission, 2018). Managed retreat policies include limiting new development of structures in vulnerable coastal zones, government buy-outs, and transfer of development rights programs (Jeroen et al., 2018 & California Coastal Commission, 1976). As aforementioned, IV houses thousands of students. The street closest to the ocean, DP, has houses situated on cliffs overlooking the ocean. These homes face serious issues with

cliff erosion and property loss; parts of these properties are currently crumbling into the Pacific Ocean at a rate of over one-half foot per year (Alessio & Keller, 2019). Stakeholders must acknowledge that these homes will not survive the century. It is important to ask UCSB students who live in these homes if they would value having adaptation pathways planned for IV which account for the needs of students, especially those made more vulnerable by the ongoing housing crisis. When looking at the future of UCSB's campus, LR will eventually need to be relocated. There are also student dorms behind this road which need to be considered in longer term scenarios. An important component of making plans such as managed retreat is to involve the stakeholders from the early stages.

2.5 Sea Level Rise Stakeholders

SLR Stakeholders are those that have a claim to something which could be affected by a rise in the sea-level. Stakeholders benefit from SLR planning (McNamee, 2021; Constable, 1998; Stephens, 2020; Petzold 2018). Further, stakeholder perceptions of risk to SLR and SLR can inform appropriate adaptation actions for a place. McNamee et al.'s case study focusing on the extreme SLR near Jacobs Avenue community in Eureka, California provides a great example of risk perceptions informing adaptation actions. Researchers asked how the social, environmental, and political context of the local area could help stakeholders better understand SLR planning (McNamee, 2021).

McNamee et al.'s methodology included conducting interviews/surveys with stakeholders, using geospatial analyses, and surveying political documents (McNamee, 2021). They interviewed seven people who were experts on SLR in the study area,

similar to what I hope to accomplish with the five expert interviews for my research (McNamee, 2021). The researchers created a “scenario planning framework with three distinct and plausible scenarios for the Jacobs Avenue parcel” by integrating the three methods (McNamee, 2021). The three finalized actions for residents were to (1) take no action, (2) upgrade flood infrastructure like levees, or (3) utilize managed retreat (McNamee, 2021). These three actions, based on the data they gathered from stakeholder surveys, utilize the protection and retreat strategies, as well as highlighting residents' propensity to vote in favor of the “do-nothing” approach. Long term residents and homeowners are different from UCSB students, but nonetheless, this study points out that adaptation measures will not satisfy demands for a quick fix. Interpreting results when people have different adaptation pathway preferences, values, and risk preferences can be a challenge. Surveying students at UCSB has elicited useful information which decision makers can use in the implementation of localized adaptation actions.

In another case study by Stephens et al., researchers were seeking to better understand perceptions of adaptation in the northern Gulf of Mexico region by holding focus groups with coastal stakeholders (Stephens et al., 2020). The focus groups found that these stakeholders recommended four main SLR adaptation techniques: (1) ensuring leadership in affected communities alongside resources and acceptance of SLR planning impacts, (2) “conducting more rigorous scientific research on SLR impacts, (3) improving land-use planning, and (4) implementing effective outreach to the general public” (Stephens et al., 2020, p. 413). This suggests that engagement with the community can elicit personal values which reveal preferences for adaptation actions. In this study, the public generally wanted to be involved in the adaptation planning process.

Improving public knowledge of SLR and local hazards leads to more accurate risk perceptions and thus demands for adaptation actions which best suit the needs of a community.

At UCSB, if students are not made aware of the real impacts SLR will have on our campus, stakeholders are not as likely to have a say in adaptation pathways chosen. Without student representatives in the planning process, it will be difficult to prioritize protection of assets that students value. In Stephens et al's paper, some people valued protecting salt marshes while others preferred to develop the marsh land; we must ask students how they view comparable dilemmas with regard to UCSB and IV. The barriers faced by Stephens et al in the Gulf of Mexico study included climate change skepticism, ignorance and apathy, short-term thinking, engagement of diverse stakeholders, and communicating risk and uncertainty (Stephens et al., 2020). If students are continuously ignored under the assumption that the consequences of SLR will only be an issue in the distant future, this important group will continue to be underrepresented. Through involvement, we can build community resilience to climate issues, including SLR.

2.6 Building Resilience to Sea Level Rise

Adaptation planning and action can build resilience to SLR. Resilience is the capability to face climate stress (Nordenson et al., 2018); UCSB and IV's resilience to SLR could be increased by planning specific adaptation pathways which take into account the preferences of stakeholders such as students. Further, community resilience, as defined by the California Coastal Commission, is the "ability of communities to withstand, recover, and learn from past disasters to strengthen future response and

recovery efforts" (California Coastal Commission, 2018, p. 39). Factors which can increase resilience include "effective risk communication" and the "integration of organizations (governmental and nongovernmental) in planning" (California Coastal Commission, 2018, p. 39). By eliciting students' SLR risk perceptions, we can better understand how the existing policy environment at UCSB/IV has contributed to the knowledge stakeholders hold about SLR.

After adaptation plans are made, we can prepare for a future in which specific actions are taken to better inform the community of the actual risks of SLR. In a powerful message from Nordenson et al.'s book on building coastal resilience they say that "coastal resilience does not mean restoring coastal communities to… [pre SLR] conditions or creating a steady state; rather, it means building dynamic systems that can transform, change, and evolve during and after" a SLR hazard affects a community (Nordenson et al., 2018). In the case of IV/UCSB, we must create plans which not only account for the dynamic nature of SLR, but also consider the perceptions and values of the diverse student population which these places support.

2.7 Literature Review Conclusion

This literature review identifies the key intersections between SLR adaptation planning and student risk perceptions. Students' perceptions of risk to SLR and demands for adaptation actions should shape SLR adaptation plans.

The literature suggests that the policy environment, culture, knowledge, and individual values in a community contribute to risk perceptions held in a given place. For this reason, it is important to explore the advantages and disadvantages of possible

adaptation actions and determine whether these fit the demands of stakeholders. Considering stakeholders is an essential part of the planning process, and produces win-win solutions for communities and the environment. Further, planning for the future of IV and UCSB can build resilience to SLR and uplift the often-excluded student voices. This study will play a key role in assessing the UCSB student population and relating their risk perceptions to demands for SLR adaptation actions, specifically observing the two high risk areas of LR and DP. This study will also paint a better picture of how the differing policy environments at UCSB and in IV can contribute to risk perceptions of serious climate hazards.

Chapter 3: Contextualizing SLR in Isla Vista and at UCSB

3.1 Introduction

This chapter provides background necessary to understanding UCSB students' risk perceptions to SLR for Del Playa Drive and Lagoon Road. First, an explanation of climate change and SLR on a global scale will be presented; moving into how these massive problems also shape local level issues. Next, this chapter dives into how the government reacts to SLR, the public's responses to the government's decisions, and the decision makers' ability to shape public perceptions of SLR risk. From here, the chapter focuses on two important case studies of IV and the University of California, Santa Barbara where there is a living history of dealing with the local risks SLR presents. Finally, based on SLR adaptation options, there will be a discussion of local responses to SLR.

3.2 Climate Change and Sea Level Rise

Climate change and SLR are global issues which affect local communities on different scales; thus providing a demand for specialized case studies. Beginning with an understanding of how climate change drives SLR is necessary to understanding this project. As predicted by the IPCC, "it is virtually certain that mean sea level will continue to rise over the 21st century" (IPCC, 2021). SLR, the process by which the mean sea level is becoming higher, has two main causes: the thermal expansion of warming ocean waters, and the melting of glacial ice around the world (IPCC, 2021). Since the sea level stabilized one-thousand years ago, there has been a mass migration to and settlement in coastal regions (Griggs, 2017). A population increase brought the rise of fossil fuels and

climate change, contributing to the current average annual sea level rise of 3.3mm/year (Griggs, 2017). The predictions for the amount of actual SLR vary depending upon the level of warming greenhouse gasses humans emit into the atmosphere by 2100 (IPCC, 2021). The IPCC has classified scenarios of socioeconomic changes which could drive human-caused (anthropogenic) climate change up to the year 2100 known as Shared Socioeconomic Pathways (SSPs) (IPCC, 2021). The amount of fossil fuel economic activity and subsequent global warming could affect the amount the sea-level rises. If excessive emissions come in the rest of the 21st century, ocean temperatures will rise leading to further thermal expansion and ice sheet melt. If emissions are cut to very low levels under the sustainable SSP, global SLR by 2100 could be 0.92-1.8 ft (0.28-0.55m), but under the intermediate and high emission scenarios with fossil-fuel driven economies SLR could be 1.4-2.5ft (0.44-0.76m) and 2.0-3.3ft (0.63-1.01m) respectively (IPCC, 2021).

Three billion people now live within 125 miles of the coast (Griggs, 2017), and are facing the consequences: increased flooding, storms, wave action, cliff erosion, and subsequent environmental justice concerns. As SLR decreases the availability of land humans can use to live (Constable, 1998), we will be forced to find ways to adapt to the increasing risks associated with coastal life, including necessary migration further from the coasts. Shifting the way people view their relationship with coastal life means that the massive number of people who live by, use, or enjoy the coast must accept their roles as stakeholders in the issue of SLR. Stakeholders can help to make important decisions in their communities. In order to streamline the process of including the *billions* of

stakeholders who now live near the coast, there have been important decision making bodies designated with the oversight of SLR planning.

3.3 Governing bodies and how they affect public perceptions

This section will discuss the federal, state, and local governing bodies who manage SLR in the United States, California, and Santa Barbara. To understand the context of decision making with regard to SLR in the US, the Federal Emergency Management Agency (FEMA) must be discussed. FEMA was created in 1979 to help Americans rebuild their communities post-disaster and to set zoning standards in designated flood areas (National Geographic Society, 2020). In addition, FEMA manages the National Flood Insurance Program (NFIP) to financially compensate policyholders post-flood (FEMA, 2021). The NFIP now covers more than 5 million policies in over 22,000 American communities, making it the largest provider of residential flood insurance in the country (Horn, 2021). Historically, the NFIP used Flood Insurance Rate Maps (FIRMs) produced by the Risk Mapping, Assessment and Planning (Risk MAP) process to calculate NFIP rates (Horn, 2021).

In a recent change, FEMA is altering the way flood insurance premiums are calculated with "Risk Rating 2.0" (Horn, 2021). For new policyholders, the rates began on October 1, 2021, and rates are projected to change for existing policyholders on April 1, 2022 (Horn, 2021). This massive shift is a result of heavy criticism from stakeholders that the NFIP encouraged development in high risk, flood-prone areas (Jurjonas et al., 2020 & McGuire, 2015). As was pointed out by Jurjonas in 2020, the NFIP spent more funds on settlements than it had budgeted "resulting in multiple bailouts at the expense of

the taxpayer, which ultimately leads to the financing of expensive beachfront property in highly vulnerable coastal zones… the NFIP encourages high-risk development" (Jurjonas et al., 2020, p. 3). It can be argued that these policies were influencing individuals' risk perception to SLR by financing potentially dangerous developments. In this way, the federal government was influencing the public's risk perception of SLR (Jurjonas, 2020; Leatherman, 2018; Neal et al., 2017; Craig, 2018; Wilkins, 2011). This supports the argument that the government plays a powerful role in dissemination of information. This information is what produces public risk perceptions (McGuire, 2015).

Coastal managers have long been advocating for FEMA to adopt a policy which internalizes the risk of a flood; meaning that insurance premiums would be higher and reflect the actual risk of living in a flood zone (McGuire, 2015). Thus, "Risk Rating 2.0" aims to consider the demands of coastal managers and provide rates which accurately reflect the risk of living in flood prone areas, however, some residents now face the issue of increased premiums which disproportionately burden low-income, flood prone communities (Herreros-Cantis, 2020). To add to this messy situation, FEMA has a history of favoring high value properties with their insurance settlements (Jurjonas et al., 2020; Leatherman, 2018; Neal et al., 2017; Morse, 2008), further marginalizing the communities who need the most help.

FEMA's management goals are often overshadowed by their failure to provide adequate emergency relief for Americans (McGuire, 2015). For example, in 2014 the NFIP insured $1.28 trillion of property value and charged $3.8 billion in premiums, but due to spending on superstorms like Hurricane Sandy in 2012, the NFIP has "outstanding obligations in the excess of $15 billion" which exceeds their $4 billion provisions from

Congress (McGuire, 2015). This implies that the NFIP is underfunded and in debt (McGuire, 2015). In fact, as of November 2021, the NFIP is in debt $20.52 billion to the US Treasury (Horn, 2021). To add insult to injury, FEMA flood maps were created using shoreline features, wave characteristics, and storm climatology based on historic data which does not take SLR and erosion into account (California Coastal Commission, 2018; Jurjonas 2020). This means that the flood maps most of the public uses do not necessarily anticipate increased storm intensity or future SLR (California Coastal Commission, 2018; Jurjonas 2020). Due to this complexity, there has been an obvious need for further SLR guidance apart from the federal government.

The California Coastal Commission (CCC) governs SLR planning in California by enforcement of the California Coastal Act (CCA, 1976). In 1976 the California Coastal Act (CCA) granted power to the CCC for oversight and regulation of coastal development with a goal to "protect, maintain, and where feasible, enhance and restore the overall quality of the Coastal Zone environment and its natural and artificial resources" (CCA, 1976, §30001.5). In accordance with the CCA, California's 76 local coastal governments have been required to complete a Local Coastal Program (LCP) certification to implement the act (Resilience, 2019).

Local Coastal Programs (LCPs) are effective planning tools for local governments which work to protect natural resources and govern future coastal development (California, 2019). If there is a proposed change to land/water resources, communities can look to their personalized LCP for specificities on the location, type, and scale of permissible actions (California, 2019). Rules such as land ordinances can help plan for short and long term outcomes while considering SLR and associated coastal hazards

(California, 2019). LCPs are specific to communities and also adhere to state level interests in alignment with the CCA (California, 2019). The 76 coastal segments with LCPs have been further divided into 126 jurisdictions based on geographic segmentation (California, 2019). In 2019 Santa Barbara's LCP was certified through their Land Use Plan (LUP) and updated in 2020 with aid from a CCC grant (City, 2019). This grant required the City of Santa Barbara to bake the hazards of SLR into their LCP, an action which has better prepared the city for the future. One of the main goals of the CCC is to collaborate with local governments in order to complete/update these LCPs. As opposed to FEMA, the state government works to set guidelines which can then be incorporated into local level planning.

In the short, medium, and long term, plans from governing bodies will help communities adapt to the risks of facing SLR. A community's individualized SLR risk levels can be better understood through the lens of the local government's response rather than FEMA's flood insurance program. Local level planning tends to be the most effective way to manage coastal communities because every case is different. With community level efforts, the specific demands of people who live in a community can be better considered. In the context of this project, the majority of the populations in IV and at UCSB are students at the university. To contextualize the places which UCSB students live in, we must learn about the histories of IV and UCSB.

3.4 The History of Isla Vista and UCSB

Understanding perceptions of SLR in IV and UCSB requires understanding each community's history. During World War II, present-day UCSB and IV were a US Marine

Corps base (Early, 2019), but interestingly once the war ended, the UC Regents bought this land for a small sum of ten dollars (Early, 2019). In 1954 UC Santa Barbara moved from its original location, where present-day Santa Barbara City College campus resides, to its current location nestled inside the City of Goleta (although not part of the City of Goleta). The original 1950 development plans for UCSB's new campus were intended to hold 3,500 students, far from the 25,000 which attend today (World, n.d.). Similar to the present situation, there was a housing crisis in the 1950s in which residents were forced to find alternative living solutions. The eventual opening of on-campus dormitories like Santa Rosa (near LR) and residential development of IV allowed more students to live on or near campus (World, n.d.).

In 1958 UCSB's target number of students jumped to 10,000 and a subsequent mass construction of apartment buildings in IV resulted (Early, 2019). IV's residential population was 350 in 1954; this grew to 11,600 by 1970, and today is near 27,707 residents (Early, 2019). Condensing large numbers of like-minded students into one small area created a unique community which helped build a base for the grassroots environmental movement. In 1969, there was a tragic oil spill off the coast of Santa Barbara. This horrific event brought the modern environmental movement together and initiated the first Earth Day (World). Movements such as GOO! (Get Oil Out) amplified the voices of the young environmental movement and created the foundation for the thriving UCSB Environmental Studies program we know today. This makes UCSB/IV important places in the history of community led environmental movements. Considering the rich history of the campus, IV, and the oil spill, it is clear that the UCSB student

community is a special case worthy of being listened to and studied in the context of SLR.

Further adding to the history of IV, it has very limited direct governance due to its status as an unincorporated community and census designated place, and the County of Santa Barbara is responsible for granting IV most of its limited resources (Pardall Center). The primary governor of IV was the office of the Third District Supervisor of Santa Barbara (Pardall Center), but in a recent census change, IV was moved into Santa Barbara County's second district, which means IV's representative on the Santa Barbara County Board of supervisors is Gregg Hart (Iyer, 2022). With IV's unincorporated status, representation on the county's board of supervisors is very important (Iyer, 2022). As for community parks and open spaces, the IV Recreation and Parks District (IVPRD) takes care of the land and provides local services (Pardall Center). Another primary difference between other university communities and IV is that others were built around urban centers which provide students with necessary services (County of Santa Barbara, 2016). IV, on the other hand, is more densely populated than most student areas yet lacks basic services and has poorly designed/maintained housing from the 1960s and 1970s (County of Santa Barbara, 2016).

Uniquely, IV faces the Pacific Ocean and is surrounded on its other three sides by UCSB property. The entire community sits atop a coastal bluff which, as aforementioned, is rapidly eroding away leaving the homes and parks on DP extremely vulnerable to SLR. Thus, SLR in IV falls under the jurisdiction of Santa Barbara County and the CCC. With approximately 8,441 UCSB students living in this 1.8 square mile community (Marsano, 2021), it is important for decision makers to consider the adaptation demands of students

when planning for the future of IV. This could be difficult considering the limited government and semi-permanent status of most student residents. Nonetheless, the values of past, present, and future student residents may collectively represent the values of this community.

This unique community receives specific planning guidance from the The Coastal Land Use Plan (CLUP) and Goleta Valley Community Plan (GV). As mentioned in Santa Barbara County's CLUP, cliff retreat in IV is a serious issue, and protective measures have been required in the past. Because of the high risk of living near the cliff edge, there is a 30-foot setback requirement, or minimum distance something can be built with proximity to the cliff edge, specifically in IV (County, 2019). The county bases this recommendation on an engineering study from 1963 which identified a natural cliff retreat rate of a half foot per year (City, 2019). Thus, the county recommends that a retreat rate of 1 foot per year be used for planning purposes in IV (City, 2019). There is an assumed economic life of 30 years per structure built in IV, which led to the 30-foot setback requirement (City, 2019). However, the "inadequacy of the present requirements with respect to the Coastal Act" is clear in IV (City, 2019). The community will require protection measures to maintain houses until a retreat away from the eroding cliff edge is inevitable (City, 2019).

Governance of UCSB is different from that of IV despite their close proximity to one another. UCSB is not governed by the city of Goleta nor Santa Barbara, they are their own jurisdiction and follow state guidelines (S. Hammond & C. Noddings, personal communication, January 18th, 2022). In Accordance with the CCC, the UCSB Office of Campus Planning and Design is currently amending UCSB's Long Range Development

Plan (LRDP) to create a Comprehensive Sea Level Rise Hazards Assessment which addresses the future impacts of SLR on the Goleta Slough side of campus and along the Pacific Ocean shoreline (Campus, 2017). This assessment should be available later in 2022 and will be subject to state environmental laws such as the California Environmental Quality Act (CEQA) and California water quality regulations (S. Hammond & C. Noddings, personal communication, January 18th, 2022). UCSB has long been aware of the threats presented by developing near the coast, however, recently the urgency in adaptation planning has increased based on pressure from the CCC. This is the perfect time to survey students and involve them in the planning process. While UCSB has no jurisdiction over IV, their work on the Sea Level Rise Hazards Assessment will inextricably help the planning process for IV since the two locations have comparable hazards and risk levels.

3.5 Local Risks Associated with Sea Level Rise

The local SLR risks which adaptation actions aim to minimize will be discussed in this section. As established in the literature review, this paper will focus on the SLR hazards and associated risks of cliff erosion, inundation from flooding, and increased wave action from SLR in IV (DP) and on UCSB's campus (LR). With the probabilistic SLR scenarios for Santa Barbara projected to be 0.8 feet by 2030, 2.5 feet by 2060, and 6.6 feet by 2100 (Kopp et al. 2014; California Ocean Protection, 2018), we must consider a future in which cliff erosion, flooding, and increased wave action are intensifying threats to UCSB's campus and IV. For more visuals, refer to Appendix C, which provides map images of cliff retreat and flood scenarios under SLR projections. Figure 1 below

illustrates with the red line, where the edge of the cliff will sit with 6.6ft of SLR for Del Playa Drive. Notice that much of Del Playa Drive where houses currently exist will erode away.

Figure 1 (above): Cliff retreat with 6.6 ft SLR for DP

Cliff erosion can be defined as the "physical removal of sediment/rock" from the cliffs which is "transported offshore, alongshore, into bays and lagoons, resulting in landward retreat of the" cliffs (Marin, 2020, p. 33). Cliff erosion is irreversible (Griggs, 2017) and endangers any infrastructure built on the retreating cliff edges of both UCSB's LR and IV's DP (Griggs, 2017). Cliff retreat is accelerated by driving forces and deterred by resisting forces (Griggs, 2017). Some driving forces include "hydraulic wave action, abrasion," and "positive pore-fluid pressures from rainfall" (Alessio & Keller, 2019). Specifically at UCSB and in IV, the primary mechanisms for cliff retreat can be attributed to rainfall increasing the rate of erosion at the top of the cliff and wave action undercutting the cliff from its base (Alessio & Keller, 2019). The resisting forces which act against retreat include "material strength of the cliffs" (Alessio & Keller, 2019) which is low in the Santa Barbara area. Cliffs here are predominantly made of Monterey or

Sisquoc shale which have the tendency to disintegrate when exposed to water; thus the rising sea levels and increasing wave action only accelerate the rates of cliff retreat (Alessio & Keller, 2019). The average cliff retreat rate from IV to UCSB, elicited using permanent markers, is 0.26-0.75 ft/year (0.08-0.23m/year) (Sylvester, 2016). Based on permanent markers in IV, the county of Santa Barbara measured a cliff retreat rate of 0.26-1.21 ft/year (0.08-0.37m/year) (Alessio & Keller, 2019). This means that in both IV and on UCSB's campus, adaptation actions need to be taken if we wish to preserve existing structures near the cliff edges.

Santa Barbara County is home to more than 110 miles of coastline which supports varying levels of recreational and residential land use. SLR will lead to an increase in the duration of high tide and storms which leads to severe coastal weather events (Nordenson et al., 2018). Because of the increased likelihood of these hazardous events, the coast will be exposed to severe flooding, erosion, and wave damage to coastal infrastructure. A powerful SLR mapping tool from the United States Geological Survey, Coastal Storm Modeling System (CoSMoS), indicates that there are flood risks for UCSB/IV, especially towards 2100 and under very high emission scenarios (Our Coast, 2021). As is made clear by the maps in Appendix C, one of the mapping tools used for UCSB's SLR planning, CoSMoS/Our Coast Our Future (OCOF), predicts that with the probabilistic SLR scenarios for 2030, 2060, and 2100 there will be damage to both DP and LR (Our Coast, 2021). For the long-term scenarios, the probabilistic cliff retreat by 2100 brings the cliff edge well past the oceanside houses on DP, completely engulfs LR, and encroaches on campus structures such as Anacapa and Santa Cruz residence halls (Our

Coast, 2021). Taken from Griggs et al., 2012, Figure 2 (below) shows the actual risks in the short-term future (until 2050) next to the adaptive capacity of Santa Barbara.

Hazard	Risk	Adaptive Capacity of City of Santa Barbara
Wave damage to shoreline development and infrastructure	High	Moderate
Flooding and inundation of low-lying coastal areas	Moderate	Moderate
Increased rates of cliff erosion	Moderate	Low
Passive erosion and inundation of beaches	Low	Moderate

Figure 3 (below) shows the actual risks in the long and medium-term future (2050-2100) next to the adaptive capacity of Santa Barbara.

Hazard	Risk	Adaptive Capacity of City of Santa Barbara
Wave damage to shoreline development and infrastructure	High to Very High	Low
Flooding and inundation of low-lying coastal areas	High to Very High	Low
Increased rates of cliff erosion	Very High	Low
Passive erosion and inundation of beaches	High	Low

The combination of increased wave action, flooding, and cliff erosion are of concern to the future of UCSB and IV, specifically LR and DP. The next steps in addressing these issues are adaptation planning and adaptation action. Further exploring students' risk perception and how high the demand for adaptation actions are in each of these locations will elicit important data about stakeholder preferences. Involving students early on will help ensure the success of these plans and avoid protest from the student body. Thus, next this paper will discuss and define basic adaptation options.

3.6 Adaptation Options and Local Responses to Sea Level Rise

There are a variety of SLR adaptation options for IV and UCSB. It is important to understand what these adaptation options consist of to better understand what motivates demands for adaptation actions. To start, a given place's adaptive capacity is the ability of the community to respond to SLR and related hazards (Griggs & Russell, 2012, p. 13). It is essential to assess a specific place's level of risk to certain hazards (ie: cliff erosion, wave damage, and flooding), and then determine if the place's adaptive capacity is at an adequate level to respond to these threats. One study in the City of Santa Barbara, comparable to UCSB and IV, found that despite high-very high levels of risk, the city had a low adaptive capacity (Griggs & Russell, 2012). In short, we may not be ready for the future. The tradeoffs between various adaptation strategies pose difficult questions for stakeholders about what they value; however these decisions must be made before the onset of damage to their treasured places.

According to the CCC, protection, accommodation, and retreat are the three main techniques for communities to adapt to SLR (California Coastal Commission, 2018). Within these three categories, there are a plethora of adaptation strategies that are mainly used in combination with one another. The challenge in planning for the future stems from choosing which of these measures is *best* for a local community. As expected, what is "best" means different things to different people. Based on one's personal preferences, values, risk perception, and knowledge of the issue there may be different considerations which someone considers. Oftentimes what is best for a specific group of decision makers is prioritized above the needs of a larger community. From listening to the survey responses from students, we will learn more about what these stakeholders value taking

care of in the future. Locally, the CCC has the final say on protection, accommodation, and retreat plans. Currently, students have no input in these decisions, but the CCC has historically advocated for the best interest of stakeholders, so surveying students may help change this lack of involvement. Nonetheless, some of the objective tradeoffs between various strategies must be considered.

Protection, accommodation, and retreat measures are necessary for the future of both IV and UCSB. Protecting the coastline from SLR can be thought about as the ways in which humans can utilize engineered structures to defend resources where they currently exist (California Coastal Commission, 2018). These methods do not alter the existing development, nor do they require the relocation of structures (California Coastal Commission, 2018). Further, protection can be sectioned into two parts: "soft" green infrastructure/living shorelines, and "hard" gray infrastructure/coastal engineering. As stated in the County of Santa Barbara's LUP and in accordance with the CCC, "seawalls shall not be permitted unless the County has determined that there are no other less environmentally damaging alternatives reasonably available for protection of existing principal structures" (County, 2019, p. 35). This demonstrates the local preferences for green infrastructure/living shorelines when possible, however, at this point in IV, it has been notably challenging to meet the demands of maintaining homes on oceanside DP using only green infrastructure.

Accommodation refers to the measures that work to modify existing structures in ways which make them more resilient to SLR (California Coastal Commission, 2018). By decreasing hazard risks, the impacts of SLR may be less severe on a given area. Accommodation has been used in IV with the county's 30-foot set-back mandates and

other zoning regulations which try to minimize the inherent risk of building on the cliffside. Next, the method of managed retreat whereby a given development is relocated or completely vacated due to the imminent risks SLR is a necessary component of future adaptation pathways in IV and at UCSB. Managed retreat policies may include limiting new construction of structures in vulnerable coastal zones, government buy-out programs, and transfer of development rights programs (Jeroen et al., 2018 & California Coastal Commission, 1976).

In IV, the coastline has been hardened to support the homes, many of which are hanging over the unstable cliff edge. Alongside hardening of the cliffs with concrete, a form of managed retreat has been underway incrementally for years; when part of a home becomes unsafe to live in or falls into the ocean, it is removed and the house is effectively set-back from the cliff edge when it is made smaller. Another option for the homes on oceanside DP is to fully retreat. Some experts such as campus point lagoon manager Lisa Stratton have pondered the idea of a government buyout of the oceanside Del Playa homes (L. Stratton, personal communication, January 11th, 2022). Once these homes are bought out and owners are compensated, more housing would be built further inland in IV to accommodate the needs of students. Then, the remainder of DP could be naturalized with native vegetation, turned into a park, and/or complete the coastal trail which is present on either side of IV.

On UCSB's campus, LR has long been an area of concern. Located on the east side of campus, this road is an important entryway for both emergency vehicles and visitors. The road sits atop a rapidly eroding bluff and faces the Pacific Ocean to the east (Our Coast, 2021). With SLR projections of 0.8 feet by 2030, 2.5 feet by 2060, and 6.6

feet by 2100, the fate of the existing road is grim. In the short term (2030), LR is projected to erode away near the Anacapa residence hall, and become much closer to the cliff edge in all other portions (Our Coast, 2021). The proposed adaptation is to gradually retreat the road, beginning with moving high risk sections, such as the one by Anacapa, landward. Eventually, for medium and long term scenarios, the road might need to become one-way, and then reduced to a bike path, and eventually relocated (S. Hammond & C. Noddings, personal communication, January 18th, 2022). It is important at this point to ask what students value. Perhaps the heavily irrigated grass lawns just landward of the east bluff contribute to the demise of the cliff beneath it. Would students be willing to give up this grassy space in the short term? Natural chaparral vegetation is often dry and scraggly; it is not as aesthetically pleasing as a green lawn, however it would be better for the stability of the cliffs.

3.7 Background Conclusion

This section established the context of climate change, SLR, governing bodies, the history of IV/UCSB, local risks, and potential adaptation methods to lay the foundation for the research question. The unique geography and community of UCSB and IV present an opportunity to study a specialized case of SLR and how risk perception affects demands for adaptation actions. The actual adaptation actions taken in the future for IV/UCSB ought to consider the stakeholders which represent their populations. The short, medium, and long term scenarios for SLR are worth planning for now; this includes involving stakeholders early in the process. In the coming chapter, I present the

methods and data obtained from the survey sent out to UCSB students to help answer my research question.

Chapter 4: Data and Analysis

4.1 Introduction

This chapter discusses the process through which data was collected using the survey instrument, the results obtained from the survey instrument, and an analysis of those results. Chapter 5 expands on the survey results and presents further interpretations and implications. To begin, it is helpful to return to the guiding research question: how do UCSB students' perception of SLR risk for Lagoon Road and Del Playa Drive relate to their demands for adaptation actions in each of these locations? I hypothesized that students with higher risk perceptions to SLR would have greater demands for SLR adaptation action (H1). That is to say, students who are more concerned about SLR might express greater demand for adaptation measures to protect their community. Further, I hypothesized that Students would have a higher perception of SLR risk on Del Playa Drive than on Lagoon Road (H2). The extent of support for H1 and H2 can be determined by the data obtained from the survey instrument.

4.2 Survey Methodology

I used a survey instrument to collect data aimed at testing my hypotheses and shedding light on the research question. The survey questionnaire was based on advice from five expert interviews, my advisor, and an extensive SLR literature review. I created and administered the survey instrument with Qualtrics software. I used a shareable URL link and scannable QR code to distribute the survey to professors and subsequently, their students. The QR code served as a focal point on the recruitment flier which was distributed via email. A convenience sample was used in an attempt to gather a generally

representative sample of students. Specifically, more environmentally minded students (from the Environmental Studies department) and typically less environmentally focused majors (from the Economics/ Communications/ Sociology departments) were recruited to create variation of risk perceptions within the sample. The recruitment emails provided professors, excluded from the sample, with additional information about this project. The recruitment emails also contained the URL link directly to the Qualtrics survey so that respondents had easy access to the questionnaire. Cajé gift cards were raffled off to incentivize participants to respond to the survey. This local cafe has been certified as ocean friendly by the prominent Isla Vista Surfrider team.

The survey was active for four weeks, from March 7th to April 3rd, 2022 and yielded 267 responses. Using R Studio, I was able to clean the data collected, eliminating those who were not UCSB students, had not completed the survey, or missed an attention check question (Question 15 had one choice which asked respondents to intentionally select “no opinion”). After that, I was left with 185 usable responses. From these, I elicited descriptive statistics, created visuals, and ran regressions in R Studio to see the extent to which the survey results supported my hypotheses. The survey questions tied directly back to my hypotheses, and the extent to which the data collected supports my hypotheses was determined by data analysis.

To predict demands for adaptation actions, the survey contained answer choices on a priority likert scale with the following options: not a priority (coded as 1), low priority (2), medium priority (3), high priority (4), and essential priority (5) as well as a no-opinion (0) choice. The predictor variable, student risk perceptions, was measured using a concern likert scale with the choices: very concerned (coded as 4), somewhat

concerned (3), not too concerned (2), and not concerned at all (1) as well as a no-opinion (0) choice. To see if there were differences between responses for Del Playa Drive and Lagoon Road, I used separate questions for each location asking for the same information with regard to adaptation demands and risk perceptions.

4.3 Survey Results

The results of the survey shed light on the research question and hypotheses. First, I will provide some descriptive statistics obtained from the survey instrument. 185 out of 267 responses provided usable information. From the demographic information gathered, I found that 167 people were in the age range of 18-24, with the remaining 16 respondents aged 25-34 years old. This was consistent with expectations since the sample population contained only UCSB students. There are 26,179 total students at UCSB. Of the respondents, 69.84% identified as women, 23.28% as men, 2.65% as nonbinary, 1.59% as genderfluid or genderqueer, 1.06% as prefer not to disclose, 0.53% as agender, and 0.53% as questioning.

Table 1: Racial or Ethnic Group Statistics (below)

Racial or ethnic group that best describes you:	**Total at UCSB**	**Percentage of sample surveyed**
White	31.3%	69.57%
Black	2.05%	1.09%
Native American or Alaskan Native	0.19%	0.54%
Hispanic or Latinx	23.3%	11.41%
Native Hawaiian or Pacific Islander	0.14%	0.54%

Racial or ethnic group that best describes you:	Total at UCSB	Percentage of sample surveyed
Middle Eastern	No data	0.54%
Mixed Race	7.56%	7.07%
Asian or Asian-American	16.5%	8.70%
Other race	No data	0.00%

Table 2: Age Demographic Statistics (below)

Age	Total at UCSB	Percentage of sample surveyed
18-24 years old	86.98%	91.26%
25-34 years old	9.59%	8.74%

Table 3: Gender Identity Statistics (below)

Gender identity	Total at UCSB	Percentage of sample surveyed
Women	54%	69.84%
Men	46%	23.28%
Other	No data	6.89%

Areas of study ranged from Statistical Science to Zoology, but the largest subgroup, 46%, of respondents were Environmental Studies students. Of UCSB's total student population, there are approximately 1,000 Environmental Studies students (UC Santa Barbara, n.d.). One note on majors is that 26.29% of respondents answered "other"; 27% of these folks wrote in Economics, and since this survey was shared with a large proportion of Economics students, it can be assumed that even more of the "other" category were Economics majors. In the "other" major category, 7% wrote in Communications and 7% wrote in Sociology. Therefore, the "other" category largely represents those majors not directly associated with environmental consciousness .

Of students who answered the survey, 59.04% lived in Isla Vista, 31.38% in UCSB facilities, 4.79% in the city of Santa Barbara, 4.26% in Goleta, and 0.53% elsewhere in California. 63.78% of these respondents consider their current place of residence their home, despite the fact that 70% of the sample has lived in their place of residence for only 4-11 months. Most of the respondents, 90.12%, self-identified as environmentalists, which is in-line with the number of environmental studies majors who participated. As far as political views, 75.41% identified as Democrats, 2.73% as Republicans, 12.02% as Independents, and 9.84% as something other than the three options listed.

Interestingly, 98.92% of respondents were familiar with the term "sea level rise," highlighting the attention this topic has received in recent years, especially in coastal communities. Additionally, 96.76% think that sea level rise is happening while 3.24% were unsure. That said, the majority of the sample, 52.05%, were *unfamiliar* with the term "sea level rise adaptation." For those that were familiar with adaptation, a list of terms (ie: seawall, revetment, wetland restoration) was populated to see which adaptation measures respondents had heard before. A list of definitions can be found in Appendix A. These respondents had been acquainted with some specific terms in SLR adaptation; the most recognized SLR adaptation was a seawall, which 92% of the sub-sample had heard of. 86% of respondents were familiar with wetland restoration and 56% with tightening zoning regulations as adaptation strategies. On the lower end, 9% of the sub-sample had heard the term "revetment" before.

The risk perception questions indicated that 92.43% of the sample was concerned about general sea level rise, and 88.65% of students expressed concern about the risk of

sea level rise in Isla Vista or at UCSB (Figure 4). However, only 41.08% were concerned about the *personal* risk SLR posed to them at UCSB/in IV (Figure 5).

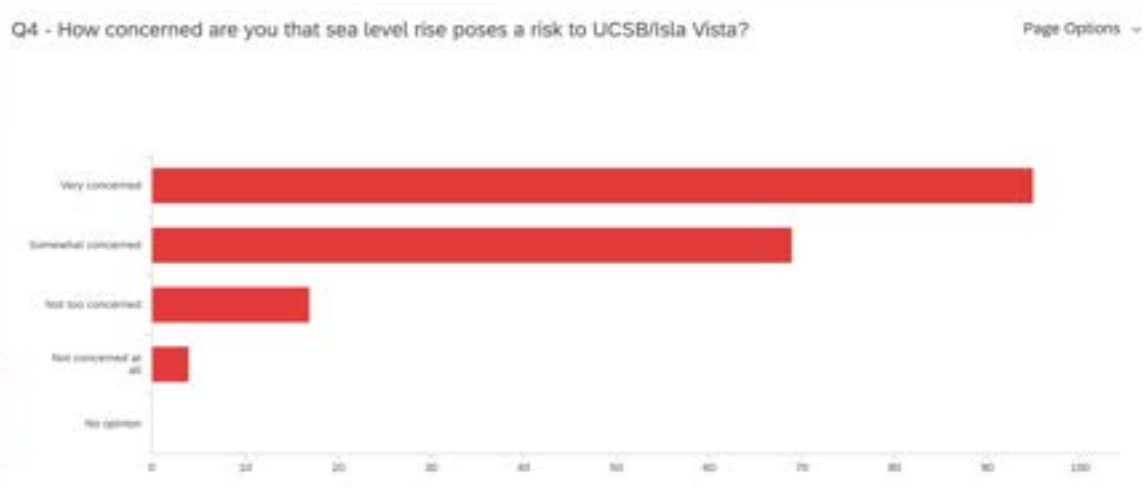


Figure 4 (above): Student's general risk perceptions to SLR for IV/USCB

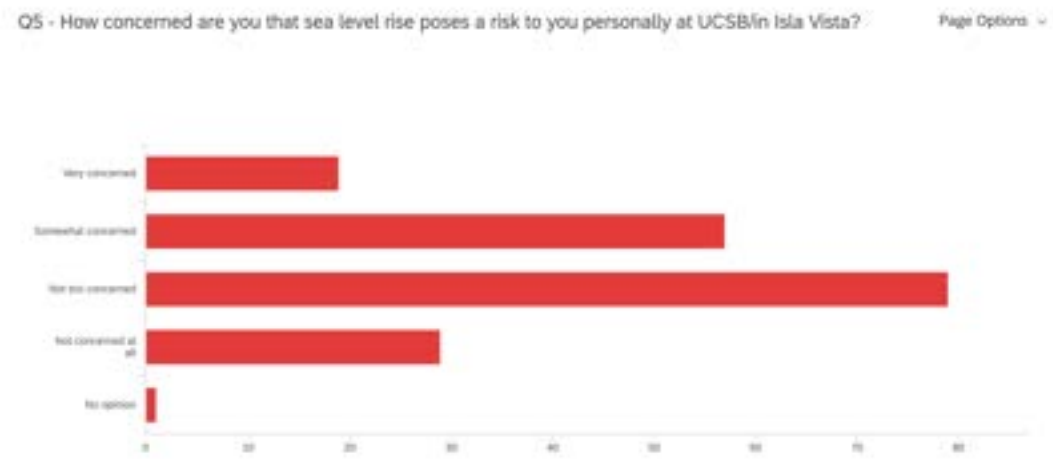


Figure 5 (above): Student's personal risk perceptions to SLR for IV/UCSB

Furthermore, for DP specifically, 49.19% of respondents were very concerned about SLR, 19.46% were very concerned about flooding, 55.68% were very concerned about wave damage, and 88.11% were very concerned about cliff erosion. Then for LR, 29.19% of respondents were very concerned about SLR, 24.32% were very concerned

about flooding, 30.27% were very concerned about wave damage, and 45.57% were very concerned about cliff erosion. See Appendix B (Figures 6-8) for visualizations of these comparisons.

The priority questions which elicited student demands for adaptation actions were next. This type of question asked students how much of a priority certain SLR adaptation measures should be in relevant governing bodies' plans for either DP or LR. For building a seawall, 10.27% of respondents said that this should be an essential priority on DP, while for LR, only 5.95% of respondents said a seawall was essential. 45.95% of respondents said that planting native vegetation on the cliffs was of essential priority for DP and 41.08% said the same for LR. Tightening zoning regulations to ensure that no new development is built in hazardous areas gained the most support with 56.76% and 51.35% voting it an essential priority for DP and LR respectively.

Questions which elicited students' preferences between the use of protection versus accommodation versus retreat measures revealed that for both LR and DP respondents most favored accommodation, then protection, and finally retreat. For DP, 28.80% consider accommodation essential, 23.91% consider protection essential, and 18.92% consider retreat essential. Similarly for Lagoon Road, 30.05% consider accommodation essential, 21.31% consider protection essential, 15.85% consider retreat essential.

Students were asked their reasoning behind decisions to attend UCSB in order to determine whether reasons for attendance may be threatened by increasing risks presented by SLR hazards. 30.05% of students said that academics (research opportunities, certain program/major/professor/lab) was the most important reason they

chose to attend UCSB. In second place, 21.86% of students cited UCSB's location (proximity to natural amenities such as the ocean/beach) as the number one reason they chose to attend UCSB. These statistics make it clear that UCSB's proximity to the coast drives many students to choose this university; thus, eliciting students' preferences with regard to SLR adaptation will be an important part of planning for the university. The vibrant UCSB student community tends to be involved both on and off campus, therefore, it is plausible to think about the future of adaptation with regard to student demands. To demonstrate student involvement, the survey asked if respondents were involved in extracurricular activities at UCSB or in IV. 64.32% are involved in an on-campus club, 20% are involved in a club in IV, 38.38% have on campus jobs, and 30.81% participate in research for UCSB. Meanwhile, for respondents who have lived in Isla Vista, 40.31% said that its proximity to the university was their main reason for living there. 21.71% said that Isla Vista's culture (community, reputation for high happiness levels of residents, parties) was the most important reason for living there.

4.4 Data Analysis

Analyzing the results of the student risk perception and demand for adaptation questions yielded evidence to support my hypothesis that risk perceptions do relate to higher demands for adaptations (H1). Further, the risk perceptions were higher for Del Playa Drive than Lagoon Road, which supports H2. Using ordinary least squares (OLS) regression analysis in R Studio, I analyzed the relationship between students' SLR risk perceptions on their demand for SLR adaptation measures, controlling for various demographic information.

To measure student demands for adaptation actions, I averaged the respondents' eight answers from questions fourteen (DP) and fifteen (LR) which elicited priority rankings for different measures on both Del Playa Drive and Lagoon Road. This average represents student demand for adaptation measures at each location. To test H1, I estimated a model of student demand for SLR adaptation on student risk perceptions to SLR controlling for gender, voter status, whether the student had ever lived in IV, race, and political party, and whether the student was an Environmental Studies major. I found that every one unit increase in student risk perceptions to SLR on Del Playa drive (for example, moving from "not at all concerned" to "not too concerned") was associated with a 0.291725 increase on the 5 point likert scale for average adaptation demands (for example, a 1 unit increase could be from "medium priority" to "high priority") with a statistically significant relationship ($P<0.001$). For the same analysis of Lagoon road, I found that for every one unit increase in student risk perceptions to SLR, the demand for adaptations was associated with a 0.24985 increase (statistically significant $P<0.001$). These OLS regressions were conducted at the 95% confidence level.

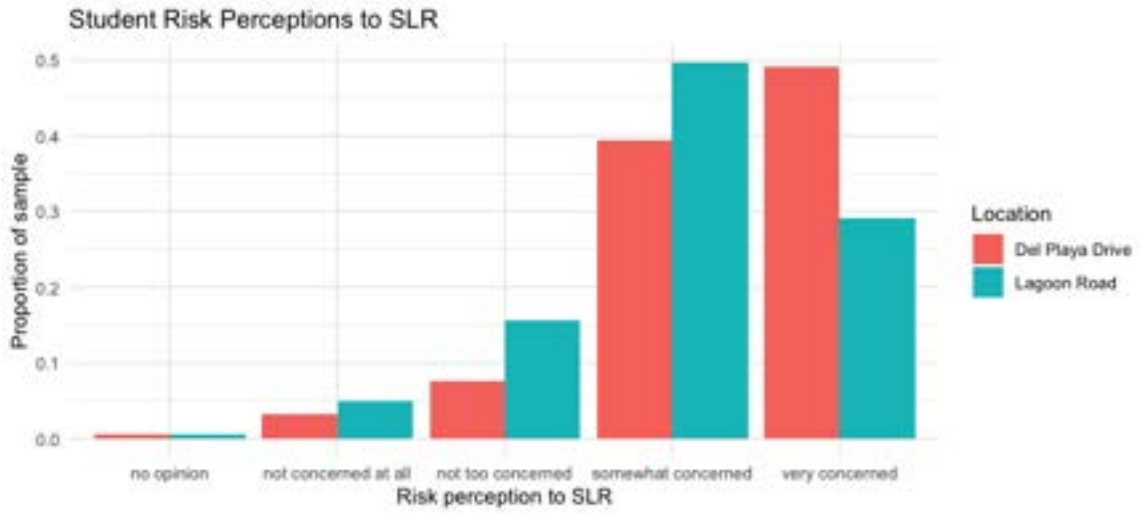


Figure 6 (above): Student Risk perceptions to SLR.

To analyze H2, I used basic calculations and data wrangling through RStudio. I predicted that students would have a higher perception of SLR risk on Del Playa Drive than on Lagoon Road. The data supports this hypothesis. I aggregated the top two responses on the concern Likert scale ("very concerned" and "somewhat concerned") and found that 88.65% of respondents expressed concern for SLR on DP and only 78.92% of respondents expressed concern for SLR on LR (see Figure 6 above).

I also ran multivariate regression analysis with RStudio on risk perceptions to flooding, wave damage, and cliff erosion for both Del Playa Drive and Lagoon Road. Using the same model from H1, I estimated a model of student demand for SLR adaptation on student risk perceptions to flooding, wave damage, and cliff erosion controlling for gender, voter status, whether the student ever lived in IV, race, political party, and whether the student was an Environmental Studies major. For every one point increase in concern (student risk perceptions) to flooding, demands for adaptation significantly increased by 0.14819 on DP, and 0.18921 on LR. For every one point increase in concern (student risk perceptions) to wave damage, demands for adaptation significantly increased by 0.24487 on DP, and 0.21187 on LR. For every one point increase in concern (student risk perceptions) to cliff erosion, demands for adaptation significantly increased by 0.45186 on DP, and 0.218591 on LR. The above values were found to be significant at $P<0.001$. This implies that the relationship between student risk perceptions and demands for adaptation is significant enough for decision makers, such as the University and County of Santa Barbara, to consider when implementing adaptation actions.

4.5 Data Conclusion

Ultimately, the survey data illustrates the importance of listening to UCSB students' voices with respect to SLR adaptations in Isla Vista and on campus. Students' SLR risk perceptions are substantively associated with their demands for adaptation actions. With increasing concern from students, we see that demands for SLR adaptation, such as tightening zoning regulations, increases. In the next chapter, a further discussion of the implications this relationship has will be discussed at length. For most UCSB students, SLR hazards are of much personal concern. Their demands for adaptations reflect this, and now it is important to consider the next steps that the County of Santa Barabara and University can take to reflect students' priorities as well as the actual risk presented by local hazards. It is essential to recall the fact that 88.65% of the sampled student population expressed concern about SLR in IV/at UCSB. With the effects of SLR already prominent in the two areas of study, mainly cliff erosion, and expected to cause real damage to both Lagoon road and Del Playa Drive by 2030, we must begin to turn adaptation *plans* into adaptation *actions*. Students experience firsthand the risks of SLR, and have valuable opinions on where legislation can be most impactful.

Chapter 5: Discussion

5.1 Introduction

In this chapter the key findings, interpretations, and implications of the data will be discussed. I evaluate the evidence for and against the hypotheses, and dive into a comparison of the hypotheses with the actual results of the survey instrument. In addition, this chapter will help place the results of my research into the larger context of SLR research which was discussed at length in Chapter 2, the Literature Review, allowing for thoughtful conversation about the future implications of this study, and explaining why students are in fact valuable stakeholders in the issue of SLR.

5.2 Key Findings

The aim of this research was to explore how UCSB students' perceptions of SLR risk for Lagoon Road and Del Playa Drive related to their demands for adaptation actions in each of these locations. There is a statistically significant relationship between students' SLR risk perceptions and demands for adaptation actions on both Del Playa Drive and Lagoon Road. Students perceived the risks of SLR, cliff erosion, and wave damage to be higher for DP than LR. However, they perceived the risk of flooding to be higher for LR than DP. Moreover, general risk perceptions to the issue of SLR at UCSB/in IV gained concern from 88.65% of students sampled. While the results were statistically significant, the R squared values obtained were low. This implies that further analysis of the results is necessary to interpret the results on a deeper level. Students perceived the risk of SLR to be higher on DP than on LR despite the near identical *actual*

risks, posing a need to question what factors, apart from risk perceptions, lead to demands for adaptation action.

5.3 Interpretations

The results of this experiment can be better understood in the context of previous studies conducted about risk perceptions, SLR stakeholders, and resiliency. As discussed in the literature review, the culture, policy environment, knowledge, and individual values in a given area also influence how people perceive the risk of SLR (McGuire, 2015). These factors played a role in asking students about the ways in which they participate in their community and determining what students value. I hoped to partially explain the culture and values of students in IV/at UCSB with some of the survey questions. 48.83% of students cited the location of IV with respect to natural amenities (ie: the ocean/beach) and 46.52% said the local culture (defined by the community, reputation for high happiness levels of residents, and parties) as one of their top two reasons for living in IV. UCSB's proximity to natural amenities and UCSB's campus culture were the highest-cited reasons for students to attend the university, at 41.53% and 28.96%, respectively. UCSB students largely consider themselves part of a happy community, both on campus and in IV.

These statistics imply that culture and personal values do influence risk perceptions because the things people value most about life here are at stake with rising sea levels, cliff erosion, wave action, and flood risk. With an increase in risk perceptions, we observe that the demands for SLR adaptations also grow. The community enocmpasses a diverse group of folks who value living near the ocean and beach; a

vicinity that necessitates adaptation actions It is yet unclear whether the community is fully accepting of this fact. The overall SLR risk perceptions submitted by students were high for IV and UCSB at large, but lower when it came to SLR risk perceptions for them *personally* in IV/at UCSB. This is likely because many students are leaving within the next four years and do not feel that SLR poses any risks to them in that time period. Perhaps it is easier to maximize one's self interest in the short run rather than consider the long term future of a larger group of people. That said, despite the fact that the student population is nonpermanent, there is love for the tight-knit community here. Love for a place can extend beyond time lived in it, and students have expressed that they wish to see adaptation actions implemented which preserve the features that initially drew them to this place. The community is centered around the ocean; whether it be a love for surfing, beach walks, or impeccable sunsets, students want to keep the community intact by preparing natural spaces for impending SLR hazards.

Another element of understanding risk perceptions is understanding the local policy environment. At UCSB, the campus's Long Range Development Plan (LRDP) and the SLR Resilience amendment will determine what adaptation looks like for the university (Lagoon Road). Meanwhile, IV (Del Playa Drive) is governed by the County of SB and therefore follows the SB Coastal Land Use Plan (CLUP). The information which coastal managers disseminate to the public shape the perceptions the public has about risk to SLR. Currently, as a UCSB student and IV resident myself, I do not feel that the county nor university have put out much information with regard to the local risks of SLR. There are signs around the cliffs which say things like "danger" and "unstable," but there does not seem to be much advocacy for student involvement in the planning

process, especially in IV. The status quo is something along the lines of waiting for an oceanside DP home to partially collapse when the cliff crumbles beneath it, and then deal with the damage at that point. This strategy would simply not be accepted in other coastal communities which serve larger proportions of homeowners and permanent residents. It seems that a large reason there have not been more adaptation actions implemented is the semi-permanent status of students at the university and in Isla Vista. This reasoning is dismissive of the knowledge that students hold, as well as the role students play as stewards of both UCSB's campus and the community of IV. This stewardship and connection to place may change hands every few years to a different group of students, but the group is still composed of students, likely with comparable values and reasoning behind choosing to attend this university.

Again, students value access to the beach and the community which is centered around the ocean here, meaning that even when the current cohorts of students disperse, the next generations will be equally as concerned with the well being of this place. To add to this argument, a vast majority of the students surveyed consider their current residence their home; despite only having lived there for an average of less than one year. Feeling like this place is home might be one interpretation of why students feel like they're connected to the community here. Being a member of this community should mean being involved in the decision making processes which affect residents. SLR is and will continue to be a very pressing issue for this community. It is time to elevate the voices of students in the decision making process.

Furthermore, students demanded certain adaptation actions at much higher rates than others. For example, tightening zoning regulations to ensure that no new

development is built in hazardous areas gained the most support from students on both LR and DP out of all the adaptation actions mentioned. For both the county and the university, this is important information to consider. According to university officials I spoke to, some level of this type of adaptation is in the works. Students, whether aware of the University's plans or not, perceived the risk of SLR as less risky to Lagoon Road. In Isla Vista, however, despite the inherent danger of cliffside development, a new house was constructed on oceanside Del Playa Drive in 2020. This recent infrastructure is just one example of the fact that students have not historically been considered SLR stakeholders. IV has a reputation for irresponsible decision making by students as is highlighted in the media; especially surrounding events like the annual block party Deltopia. It seems like when a student falls off a deck and suffers casualties, alcohol and parties are blamed. Even if some students are unaware of the danger partying on a deck hanging over a cliff presents, the county and those responsible for enforcing zoning regulations should be held accountable when these injuries occur. The construction of this new home seems to also contradict written laws. It is not setback 30 feet from the cliff edge, and is symbolic of the power landlords and property management companies have in Isla Vista.

To expand on the idea that students expressed preferences for certain adaptation actions over others, we can look to the protection, accommodation and retreat framework which has been established by the California Coastal Commission (CCC). In general, SLR adaptation planning can be thought of as an approach which accounts for how the shoreline might change with regard to SLR and identifies key thresholds at which point adaptation actions must be taken. Survey data indicated that students most favored

accommodation, then protection, and finally retreat. This brings up important questions for decision makers as to what exactly the key thresholds are for UCSB and IV. Waiting until infrastructure falls into the ocean does not look out for the safety of students, key stakeholders who are advocating for tighter zoning regulations and the halting of construction in risky areas. Also in accordance with previous SLR literature, students expressed demand for a multitude of adaptation approaches which encompass protection, accommodation, and retreat. This demonstrates that there is no single *best* way to adapt to SLR. The conversation surrounding moving towards living shoreline approaches rather than traditional hard armoring solutions can also be framed from the survey results. The debate between hard shoreline armoring and the use of green infrastructure is tough; many approaches will ultimately require a hybrid approach which combines both types of protection measures. Students surveyed gravitated towards approaches which have been highlighted in more recent SLR literature as less ecologically harmful ways to adapt to SLR: wetland restoration, re-vegetation, and tightening zoning laws. The implications of which actions students were drawn to should be considered by decision makers, which will be discussed in the following section.

5.4 Implications

The importance of these survey results is multifaceted. First, they expand upon previous research done in the field, and in the context of stakeholders they extend an invitation to students. Given that students make up majority populations in IV and on UCSB's campus, it is important to consider them as stakeholders in the issue of SLR.

Thinking about students as stakeholders means that decision makers ought to include more folks in the conversations leading up to the implementation of decisions; in this case those decisions are SLR adaptation plans and actions. Another easy way to include students in the process is to increase education surrounding SLR, cliff erosion, wave damage, and flooding. At UCSB, there is much emphasis on being "community-driven and globally-focused" (UCSB Mission Statement), so it is imperative to consider tackling a global issue which is affecting the local community from the ground up.

Familiarization with the natural coastal processes that shape this environment and their acceleration due to climate change is both interesting and important. This education could take many forms. Access to an online toolkit would allow students to view relevant information alongside useful services such as CoSMoS/OCOF, the SLR mapping tool which is among the instruments UCSB is taking into consideration for their SLR adaptation plans. Perhaps education and student involvement could take the form of a student committee on SLR on campus and in IV. Further, easy tools like making short videos for social media which link students to useful resources about SLR would spread awareness. Other studies which surveyed SLR stakeholders found that top demands from communities were often centered around improving public outreach (Stephens et al., 2020, p. 413). This supports my argument that engagement with the community can elicit personal values which reveal preferences for adaptation actions. The majority of the students surveyed were *not* familiar with the term SLR adaptation, despite feeling concern for SLR. This indicates that there is space for further education and community outreach which makes knowledge accessible to students. The ocean is physically close to

the campus and Isla Vista, but there seems to be a disconnect between the risk of SLR, and how we can prepare for it.

While student risk perceptions can help predict demands for adaptation, there is a disconnect between knowledge of SLR and knowledge of how to prepare our communities for SLR. This gap can be improved by building community resilience to climate change, and more specifically SLR. Community resilience, as defined by the California Coastal Commission, is the "ability of communities to withstand, recover, and learn from past disasters to strengthen future response and recovery efforts" (California Coastal Commission, 2018, p. 39). Larger networks can help a community prepare for disasters (Nordenson et al., 2018), which implies that recognizing students as important stakeholders is essential in the process of adapting UCSB's campus and IV to SLR. UCSB students are large contributors to the local economies of Santa Barbara and Goleta; if their homes, no matter how temporary, are damaged by SLR or they are forced to be relocated, there would also be adverse effects on the surrounding communities. According to the survey results, UCSB students have favored accommodation strategies over protection and retreat. All forms of adaptations to SLR present tradeoffs for stakeholders. The clear tradeoff with managed retreat is that it moves infrastructure further away from the coast; a central point of this community. Protection strategies can take many forms, but among trade offs are economic costs and possible changes to natural systems. Perhaps the logic behind most favoring accommodation strategies is that they deal with making *existing* infrastructure more resilient to SLR; an idea that most lovers of the coast can rally behind. Increasing resilience is something that student

stakeholders are eager to support. This will be helpful in ensuring that these places are protected for future generations to enjoy.

One of the major implications of this project is that it can help inform policy and upcoming decisions that will be made by coastal managers. At UCSB, the topic of coastal resiliency is currently being discussed with regard to the University's Long Range Development Plan. UCSB's choices will inextricably help the planning process for IV since the two locations have comparable hazards and risk levels. That said, after observing and participating in Isla Vista's student life first hand, I feel that Isla Vista is more dangerous for students than UCSB's campus. The homes on DP dangling precariously over the cliff edges are not being strictly managed, and if this continues, the risks of SLR may be felt more harshly in Isla Vista than on UCSB's campus. The differing policy environments affect people's risk perceptions, and in longer term scenarios, if management is not parallel in these two locations, the futures of LR and DP could look very different. Perhaps the student input received from the survey will have some impact on these decisions, or at least discussions. In the context of the County of Santa Barbara, my hope is that IV's SLR related issues begin to receive more attention from the county, especially cliff erosion. When looking at adaptation plans, moving from concept to implementation is a challenging process. Examples of adaptation actions, as aforementioned, do not always have reliable case studies to share with stakeholders. However, if stakeholders, such as students, can at least be made aware of adaptation possibilities, it will help decision makers when it comes time to implement actions.

Chapter 6: Conclusion and Recommendations

This Senior Thesis in Environmental Studies asked how UCSB students' perception of SLR risk for Lagoon Road and Del Playa Drive related to their demands for adaptation actions in each of these locations. Ultimately, I found that the results of the survey supported my initial hypotheses, but there were also unexplained factors apart from risk perceptions which influenced students' demands for adaptation actions. The data supports H1 since higher risk perceptions do have a statistically significant relationship to greater demands for adaptation actions. Students demonstrated the highest demand for adaptations in the accommodation category, which indicated that they valued staying physically close to the coast and maintaining existing infrastructure. For the second hypothesis, the data illustrated that students had a higher perception of SLR risk for Del Playa Drive than for Lagoon Road. While the actual risks are nearly identical, there are differences in the policy environments in IV and on campus. The university has a more specific plan for addressing SLR related hazards and increasing resilience than Isla Vista.

The broader implications of this study will pertain to both the stakeholders and the final decision makers/experts in this issue. SLR risks for IV/UCSB are part of the global climate crisis and further shed light on the fact that localized, bottom-up efforts are important in preparing for a future in which climate change is inevitable. For the students at UCSB, hopefully this research will involve them in the planning process. Students are viable stakeholders and should be taken seriously with regard to issues that affect them, no matter how long they are living in a place. For the county of Santa Barbara and University, this study is important in painting a more holistic picture of the patrons they intend to serve. In the broader context of society, implementing a framework which looks

at what types of demands human beings have and how these can be linked to external factors, such as risk perceptions, allows for a greater understanding of how society faces challenges. With a greater understanding of how society faces challenges, especially with regard to the environment, we can continue to grow with the Earth and protect the systems we value.

There is much to be learned from any research or project of this scale, and while the results of this study do support significant claims, there were limitations throughout the process. First, the generalizability of the results is limited because the sample was not representative of the entire UCSB student population. This was in part due to the fact that only 267 students took the survey, and of those, 185 responses were usable for the data analysis. Therefore, this study does not claim to represent the views of all UCSB students, but it does provide a legitimate record of some UCSB students' demands for adaptation actions. Further, a large proportion of the respondents were environmental studies majors. As a member of the Environmental Studies Department, my peers were the most accessible due to connections with professors and advisors. That said, this is also a limit to generalizability because a majority of the Environmental Studies students surveyed were both familiar and concerned with the issue of SLR, which may not be the case for students across all departments. The methodology also impacted the reliability of this data. While a survey was the most effective tool to gather data, there are some limitations to it. First, some opinions cannot be fully expressed in a quantitative survey. That said, the methodological choices were constrained by time and Covid-19 safety. I felt that an online survey would be more appropriate and accessible for folks.

To expand on the survey, an attention check question was included in the questionnaire to weed out respondents who clicked answer choices at random. That said, 185 responses is still a significant sample and, through filtering, provides reliable data about that sample. Due to the limited data on student risk perceptions, the results cannot

confirm that higher student risk perceptions are causally related to greater demands for adaptation actions amongst UCSB students. It is beyond the scope of this study to prove causation or imply definitive answers as to the student opinions surrounding SLR on campus and in Isla Vista.

To continue, the design of the survey instrument itself had flaws. On the Likert scale used for the level of concern questions which aimed to elicit student risk perceptions, there were four concern choices: very concerned, somewhat concerned, not too concerned, and not concerned at all, as well as a no opinion option. Ideally, there should have been a middle option apart from the "no opinion" choice. The scale options should be changed in the future to: extremely concerned, moderately concerned, somewhat concerned, slightly concerned, and not at all concerned. This allows for a greater expression of opinions from respondents and less bias in the results.

In the future, I recommend that this study is replicated with appropriate modifications at UCSB, as well as at universities all over the world which are facing similar challenges with regard to SLR. Additionally, results should be shared with governing bodies such as the UC Regents, the County of Santa Barbara, and the California Coastal Commission. If the study is replicated by another university or entity, the researchers should identify, research and, if possible, contact their local governing bodies.

If this study is repeated at UCSB, I advise allocating for a longer window to leave the survey open, perhaps three months. In addition, interviews with students could provide rich qualitative data which could supplement the results of the quantitative survey. A goal to reach students in every department would also increase the generalizability of the results. This survey, while important to replicate, will eventually need to change to evaluate student satisfaction with adaptation actions which will inevitably be implemented. Right now, SLR adaptations have largely been plans rather

than actions. As the situation becomes more urgent in the near future, the survey itself would need to adapt to the present climate and reflect the actions taken by the University and County. It would also be helpful to ask how students perceive the governing bodies' level of preparedness. In the case of UCSB, the redone survey might ask students to assess how prepared they feel the university or county is in terms of SLR.

As far as replication of this study in other locations, it is important for student voices all over the world to be considered when building resilience to local climate change issues. For universities facing local SLR hazards, a similar survey which elicits risk perceptions and predicts demands for adaptations would be useful for local governing bodies. Students everywhere deserve to be represented in the planning process, even at universities where SLR does not present an imminent threat. This framework would also be useful in asking about other types of climate hazards such as wildfires or hurricanes.

Another consideration which must be taken into account is the fact that this study mainly focuses on the opinions held by students, and not the opinions of the governing bodies involved (Planners from the County of Santa Barbara and University of California). The reason this should be considered is that despite my argument that students' voices deserve to be considered in this issue, the entities previously mentioned are making the final decisions with regard to SLR adaptations. For this reason, it could be useful to survey and interview decision makers and stakeholders from the governing bodies involved for future studies. It would also be useful to ask students about their trust and perceptions of governing bodies. Questions such as "To what extent do you agree with this statement: I trust the County of Santa Barbara with regard to building SLR planning tools" could elicit interesting responses as to how stakeholders view governing bodies and the perceptions of the local policy environment.

Another area that could be of great interest for a future survey is the idea of a moral hazard. In economics, this concept refers to the idea that insured bodies might be willing to take more risks knowing that they are covered by insurance. It could be interesting to study how this concept relates to the ways in which adaptations are implemented by governing bodies. For example, if a town is covered by a flood insurance policy which does not reflect the *actual* risk of living in a flood zone (ie: inexpensive premium), there is an incentive to build houses in areas which are prone to routine flooding. Furthermore, if there are no zoning restrictions to prevent construction in hazardous/flood-prone areas, buyers' risk perceptions are unlikely to match the actual risks presented by SLR in a given area. Then, in this hypothetical situation, there will be infrastructure which has a high risk of loss from SLR but people who are unwilling or *financially unable* to move elsewhere. Even if these property owners would like to move, they may not be able to sell their property for enough money to make it worthwhile. Tying this back to adaptation, this leads to a situation where people are in dire need of protection or retreat measures to SLR as the viability of accommodation measures becomes less viable. It would be interesting to explore this concept with regard to homeowners' insurance in Isla Vista or the insurance used by the University. That said, it was not within the scope of this study to analyze insurance policies used by the University nor homeowners in the County of Santa Barbara.

On that note, the homeowners, property managers, and landlords in Isla Vista are also very important stakeholders to consider in this issue, but again, were not within the scope of this study. Provided with more time, I would have loved to conduct interviews with those who own/manage the at risk properties in IV. This could shed light on why there is continued development of areas with rapidly eroding cliffs. Following neoclassical economic theory, I assumed that IV's landlords and property owners aim to

maximize short run profits rather than concern themselves with the longer term consequences of environmental issues.

Sharing the results with the relevant governing bodies is an important part of the implications of this research. In the case of UCSB and Isla Vista, I will share my work with the two main jurisdictions involved locally, as well as the reputable UCSB Environmental Studies Department. For UCSB's campus, there is the Office of Campus Planning and Design who oversees the long range development plans on campus, and is currently working on a Comprehensive Sea Level Rise Hazards Assessment. Then, there is the office of the Second District Supervisor of Santa Barbara county who governs Isla Vista. Parallel institutions at other universities should be contacted and researched if this study is replicated elsewhere.

The intended audience for this research includes, but is not limited to, students, administrators, coastal managers, and local governmental organizations. This project was created to begin a conversation with college students and invite them to participate in discussions surrounding climate change issues which affect their campus communities. My hope is that all the content I compiled is accessible, empowering, and informative. The opportunity to take a deep dive into this specific climate issue allowed me to develop an understanding of sea level rise and how it affects the community I consider myself to be a part of. While challenging, this process has been the most rewarding adventure I have embarked on during my four years studying at the University of California, Santa Barbara. Despite the direness of the climate crisis, I am walking away from this journey with a feeling of hope for the future generations of UCSB students who will become stewards of our beloved campus and community of Isla Vista.

References

Akerlof, K. L., Rowan, K. E., La Porte, T., Batten, B. K., Ernst, H., & Sklarew, D. M. (2016). Risky business: Engaging the public on sea level rise and inundation. *Environmental Science & Policy*, *66*, 314–323. https://doi.org/10.1016/j.envsci.2016.07.002

Alessio, P., & Keller, E. A. (2020). Short-term patterns and processes of coastal cliff erosion in Santa Barbara, California. *Geomorphology*, *353*, 106994. https://doi.org/10.1016/j.geomorph.2019.106994

Boudreau, D., Engeman, L. and Ross, E. (2018). Living Shorelines & Resilience in Southern California. Resilient Coastlines Project of Greater San Diego.

CALIFORNIA COASTAL ACT. (1976). *PUBLIC RESOURCES CODE DIVISION 20.* (§ 30001.5a)

California Coastal Commission (2018). Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLRGuidanceUpdate.pdf

California Coastal Commission. (2019). *Local Coastal Programs*. California Coastal Commission . Retrieved January 21, 2022, from https://www.coastal.ca.gov/lcps.html

California Ocean Protection Council (OPC) & California Natural Resources Agency (2018). *State of California Sea-Level Rise Guidance.* https://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

Campus Planning & Design. (2017). *2010 UCSB Long Range Development Plan*. Google

Drive. Retrieved January 24, 2022, from https://drive.google.com/file/d/1sv6C1r957kwLHIIXls57_3y4WP6aXRh_/view

City of Santa Barbara, Public Works Department. (2019). *CITY OF SANTA BARBARA LOCAL COASTAL PROGRAM COASTAL LAND USE PLAN*. City of Santa Barbara. Retrieved January 21, 2022, from https://www.santabarbaraca.gov/civicax/filebank/blobdload.aspx?blobid=240319

Constable, A. (1998). *Stakeholder Perceptions of Risk from Sea Level Rise*. [Unpublished doctoral dissertation]. University of Southern California.

County of Santa Barbara. (2016). *Isla Vista Master Plan Draft*. County Executive Office. Retrieved January 24, 2022, from https://www.countyofsb.org/ceo/successor-agency/isla-vista-master-plan-eir.sbc

County of Santa Barbara Planning and Development. (2019). *SB County Comprehensive Plan: Coastal Land Use Plan*. Santa Barbara County. Retrieved January 24, 2022, from https://cosantabarbara.app.box.com/s/cx95k0r4hnfo58hg291fi5gzf5rrdurd

Craig, R.K. Coastal adaptation, government-subsidized insurance, and perverse incentives to stay. Climatic Change 152, 215–226 (2019). https://doi.org/10.1007/s10584-018-2203-5

Douglas, E. M., Kirshen, P. H., Paolisso, M., Watson, C., Wiggin, J., Enrici, A., & Ruth, M. (2012). Coastal flooding, climate change and environmental justice: Identifying obstacles and incentives for adaptation in two metropolitan Boston Massachusetts communities. *Mitigation and Adaptation Strategies for Global Change*, *17*(5), 537–562. https://doi.org/10.1007/s11027-011-9340-8

Early history of Isla Vista and UCSB. Isla Vista - UC Santa Barbara Library. (2019, July

12). Retrieved January 21, 2022, from https://spotlight.library.ucsb.edu/starlight/isla-vista-building-a-community/feature/early-history-of-isla-vista-and-ucsb

FEMA Mapping and Insurance eXchange. (2021, March 22). *Coastal Flood Risk*. FEMA.gov. Retrieved January 20, 2022, from https://www.fema.gov/flood-maps/coastal

Gittman, R. K., Fodrie, F. J., Popowich, A. M., Keller, D. A., Bruno, J. F., Currin, C. A., Piehler, M. F. (2015). Engineer- ing away our natural defenses: An analysis of shoreline harden- ing in the US. *Frontiers in Ecology and the Environment*, *13*, 301– 307.

Grifman, P., Hart, J., Ladwig, J., Mann, A. N., Schulhof, M., Flick, R., ... Ewing, L. (2013). *Sea Level Rise Vulnerability Study for the City of Los Angeles* (Tech. Rep. No. USCSG-TR-05-2013). Los Angeles, CA: University of Southern California Sea Grant Program.

Gopalakrishnan, S., Landry, C. E., Smith, M. D., & Whitehead, J. C. (2016). Economics of Coastal Erosion and Adaptation to Sea Level Rise. *Annual Review of Resource Economics*, *8*(1), 119–139. https://doi.org/10.1146/annurev-resource-100815-095416

Gray, S. (January 10th, 2022). personal communication.

Griggs. (2017). Coasts in Crisis: A Global Challenge (1st ed.). University of California Press. https://doi.org/10.1525/j.ctv1xxx5h

Griggs, G. B., & Russell, N. L. (2012, July). *City of Santa Barbara Sea-Level Rise*

Vulnerability Study (Tech. Rep. No. CEC-500-2012-039). Santa Cruz, CA: University of California, Santa Cruz.

Herreros-Cantis, P., Olivotto, V., Grabowski, Z. J., & McPhearson, T. (2020). Shifting landscapes of coastal flood risk: Environmental (in)justice of urban change, sea level rise, and differential vulnerability in New York City. *Urban Transformations*, *2*(1), 9. https://doi.org/10.1186/s42854-020-00014-w

Horn, D. P. (2021). *National Flood Insurance Program*. The Current Rating Structure and Risk Rating 2.0. Retrieved January 20, 2022, from https://sgp.fas.org/crs/homesec/R45999.pdf

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

Iyer, A. (2022, January 15). *I.V.'s new district supervisor announces bid for State Assembly: The daily nexus*. The Daily Nexus | The University of California, Santa Barbara's independent, student-run newspaper. Retrieved April 4, 2022, from https://dailynexus.com/2022-01-15/i-v-s-new-district-supervisor-announces-bid-for-state-assembly/

Jeroen C.J.H. Aerts, Patrick L. Barnard, Wouter Botzen, Phyllis Grifman, Juliette Finzi Hart, Hans De Moel, Alyssa Newton Mann, Lars T. de Ruig, and Nick Sadrpour. (2018). *Pathways to resilience: Adapting to sea level rise in Los Angeles* (p. 90)

[Technical]. Institute for Environmental Studies (IVM), VU University Amsterdam, the Netherlands. United States Geological Survey, Santa Cruz, California. Utrecht University School of Economics, Utrecht University, the Netherlands. 4=University of Southern California Sea Grant, Los Angeles, California.

Jurjonas, M., Seekamp, E., Rivers, L., & Cutts, B. (2020). Uncovering climate (in)justice with an adaptive capacity assessment: A multiple case study in rural coastal North Carolina. *Land Use Policy*, *94*, 104547. https://doi.org/10.1016/j.landusepol.2020.104547

Kopp, R. E., R.M. Horton, C.M. Little, J.X. Mitrovica, M. Oppenheimer, D.J. Rasmussen, B. Strauss, C. Tebaldi. (2014). Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. Earth's Future, 2(8), 383-406.

Leatherman, Stephen P., 2018. Coastal Erosion and the United States National Flood Insurance Program. Ocean Coast. Manag. 1–8. https://doi.org/10.1016/j.ocecoaman. 2017.04.004. Elsevier Ltd.

Leonard, K. (2021). WAMPUM Adaptation framework: Eastern coastal Tribal Nations and sea level rise impacts on water security. *Climate and Development*, *13*(9), 842–851. https://doi.org/10.1080/17565529.2020.1862739

Lester, C. (December 2nd, 2021). personal communication.

Lopez, M., & Salomón, A (n.d.). *Chumash Land Acknowledgement*. UCSB English

Department. https://english.ucsb.edu/sites/default/files/docs/land_acknowledgement.pdf

Marsano, V (2021). *UCSB and Isla Vista 2020 Census Presentation to Redistricting Commission*. https://drawsantabarbaracounty.org/wp-content/uploads/2021/05/20210201_Dr__Viviana_Marsano_UCSB_Census_Complete_Count_Update.pdf

Marin County Community Development Agency. (2020). *Stinson Beach Nature-Based Adaptation Feasibility Study*. Marin County. Retrieved January 24, 2022, from https://www.marincounty.org/-/media/files/departments/cd/planning/slr/public-presentations/stinson_kickoffmtg.pdf?la=en

McGuire, C. J. (2015). U.S. Coastal Flood Insurance, Risk Perception, and Sea-Level Rise: A Perspective. *Coastal Management*, *43*(5), 459–464. https://doi.org/10.1080/08920753.2015.1051418

McNamee, K., Wisheropp, E., Weinstein, C., Nugent, A., & Richmond, L. (2021). Scenario Planning for Building Coastal Resilience in the Face of Sea Level Rise: The Case of Jacobs Avenue, Eureka, CA. *HUMBOLDT JOURNAL OF SOCIAL RELATIONS*, *36*, 30.

Morse, R., 2008. Environmental Justice Through the Eye of Hurricane Katrina. Joint Center for Political and Economic Studies, Health Policy Institute, Washington, DC, pp. 7–9. http://198.65.105.204/hpi/sites/all/files/EnvironmentalJustice.pdf.

National Geographic Society. (2020, July 30). *FEMA*. National Geographic Society. Retrieved January 20, 2022, from https://www.nationalgeographic.org/encyclopedia/fema/

Neal, William J., Pilkey, Orrin H., Cooper, J.Andrew G., Longo, Norma J., 2017. Why Coastal Regulations Fail. Ocean Coast. Manag. 1–14. https://doi.org/10.1016/j.ocecoaman.2017.05.003. Elsevier Ltd.

Noddings, C & Hammond, S. (January 18th, 2022). personal communication.

Nordenson, C. S., Nordenson, G., & Chapman, J. (2018). *Structures of Coastal Resilience*. Island Press/Center for Resource Economics. https://doi.org/10.5822/978-1-61091-859-6

Our Coast Our Future. (2021). *California Coastal Flooding/Erosion Hazard map*. Our Coast, Our Future (CoSMoS). Retrieved January 24, 2022, from https://ourcoastourfuture.org/hazard-map/

Pardall Center. (n.d.). *Isla Vista Governmental Entities*. A.S. Pardall Center. Retrieved January 24, 2022, from https://pardallcenter.as.ucsb.edu/isla-vista-community-resource-guide/isla-vista-governing-entities/

Petzold, J., Ratter, B. M. W., & Holdschlag, A. (2018a). Competing knowledge systems and adaptability to sea-level rise in The Bahamas. *Area*, *50*(1), 91–100. https://doi.org/10.1111/area.12355

Petzold, J. (2018b). Social adaptability in ecotones: Sea-level rise and climate change adaptation in Flushing and the Isles of Scilly, UK. *Island Studies Journal*, *13*(1), 101–118. https://doi.org/10.24043/isj.17

Reiblich, J., Hartge, E., & Sito, C. (2018). *Coastal Adaptation Policy Brief*. Buyout Programs. Retrieved November 18, 2021, from http://marineapps.naturalcapitalproject.org/california/docs/BuyoutProgram.pdf.

Resilience along the West Coast. (2019). *YouTube*. Retrieved January 21, 2022, from https://youtu.be/XPJIKSQAkN8.

Rush, Elizabeth. (2018). RISING: Dispatches from the New American Shore. Milkweed Editions.

Santa Barbara California vulnerability assessment, BREN PROJECT: Denka, S., Hall, A., Nicholson, L., & Frew, J. (n.d.). *City of Santa Barbara Sea Level Rise Vulnerability Assessment*. 104.

Scyphers, S. B., Beck, M. W., Furman, K. L., Haner, J., Keeler, A. G., Landry, C. E., O'Donnell, K. L., Webb, B. M., & Grabowski, J. H. (2020). Designing effective incentives for living shorelines as a habitat conservation strategy along residential coasts. *Conservation Letters*, *13*(5). https://doi.org/10.1111/conl.12744

Slagel, M.J. and Griggs, G.B. (2008). Cumulative losses of sand to the California coast by dam impoundment. *Journal of Coastal Research* **24** (3): 571–584.

Smith, J. W., Anderson, D. H., & Moore, R. L. (2012). Social capital, place meanings, and perceived resilience to climate change. *Rural Sociology*, *77*, 380–407.

Smith, J. W., Davenport, M. A., Anderson, D. H., & Leahy, J. E. (2011). Place meanings and desired management outcomes. *Landscape and Urban Planning*, *101*(4), 359–370.

Stephens, S. H., DeLorme, D. E., & Hagen, S. C. (2020). Coastal Stakeholders' Perceptions of Sea Level Rise Adaptation Planning in the Northern Gulf of Mexico. *Environmental Management*, *66*(3), 407–418. https://doi.org/10.1007/s00267-020-01315-3

Stratton, L. (January 11th, 2022). personal communication.

Sylvester, A.G., 2016. Sea Cliff Retreat, Campus and Isla Vista beaches, Santa Barbara, California. Geol. Soc. Am. Abstr. Programs 48 (4). https://doi.org/10.1130/abs/2016CD-27435.

UCSB Mission Statement. https://www.ucsb.edu/about

UC Santa Barbara general catalog. UC Santa Barbara General Catalog - Environmental Studies. (n.d.). Retrieved April 11, 2022, from https://my.sa.ucsb.edu/catalog/current/CollegesDepartments/ls-intro/envst.aspx

Wilkins, James., 2011. Is sea level rise foreseeable? Does it matter? J. Land Use Environ. Law 26 (2), 437–502. http://www.jstor.org/stable/42842971%5Cnhttp://www.law.fsu.edu/journals/landuse/vol26_2/wilkins.pdf.

World War II and the Goleta Mesa Campus. UCSB ADC Omeka. (n.d.). Retrieved January 21, 2022, from http://www.adc-exhibits.museum.ucsb.edu/exhibits/show/ucsbcampusarchitecture/world-war-ii-and-the-goleta-me

Appendix A: Adaptation Definitions From Survey Instrument

1. **Seawall**: vertical or near vertical shore-parallel structures designed to prevent upland erosion and storm surge flooding.
2. **Groin**: a structure oriented perpendicular to the shore that reduces the flow of sediment along that shore. Can help to capture sand and sustain the lifetime of sand on beaches. Sand collects on the updrift side of the groin until it is filled and the amount of sand on the beach stays the same.
3. **Jetty**: a structure extended into a sea, lake, or river to influence the current or tide or to protect a harbor.
4. **Beach Nourishment**: periodic investments in rebuilding a beach with sand dredged from another location, typically offshore or inlets (Dean 2002).
5. **Living Shorelines**: aim to provide the wave buffering and erosion control functions desired of armored structures, while also maintaining, enhancing, or restoring the ecological benefits of natural coastal habitats (Davis, Currin, O'Brien, Raffenburg, & Davis, 2015; Gittman et al., 2016a; Piazza, Banks, & La Peyre, 2005; Scyphers, Pow- ers, Heck, & Byron, 2011; Scyphers et al., 2015a). They implement restoration and green techniques as opposed to using purely engineered solutions.
6. **Wetland restoration**: restoration of natural wetland systems to act as giant sponges which help buffer inland areas from flooding and storm surge.
7. **Dunes**: mound or ridge of sand sometimes vegetated which can buffer beach from wave action and erosion

8. **Cobble berm**: mat of cobble on sand to dissipate wave energy and act as a backstop for limiting landward extent of shoreline erosion
9. **Bulkhead**: vertical wall parallel to the shoreline (stabilizing cliffs) intended to hold soil in place and prevent erosion
10. **Revetment**: lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shorelines.
11. **Breakwater**: Parallel to vegetated shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.
12. **Sills**: Parallel to vegetated shoreline, reduces wave energy and prevents erosion.
13. **Edging**: added structure which holds the toe of existing vegetated slopes in place and prevents erosion.
14. **Vegetation**: vegetation planted along shoreline provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments
15. **Tightening zoning regulations**: a form of adaptation which requires changing zoning laws so that development can no longer be constructed in hazardous areas.
16. **Requiring development to be setback from the ocean/cliffs**: writing laws which require developers to build infrastructure a certain distance from the shoreline or cliff edge. In Isla Vista, there is a 30 feet set back rule.

Appendix B: Figures Not Included in the Text

Figure 6 (below): Student Risk Perceptions to Cliff Erosion

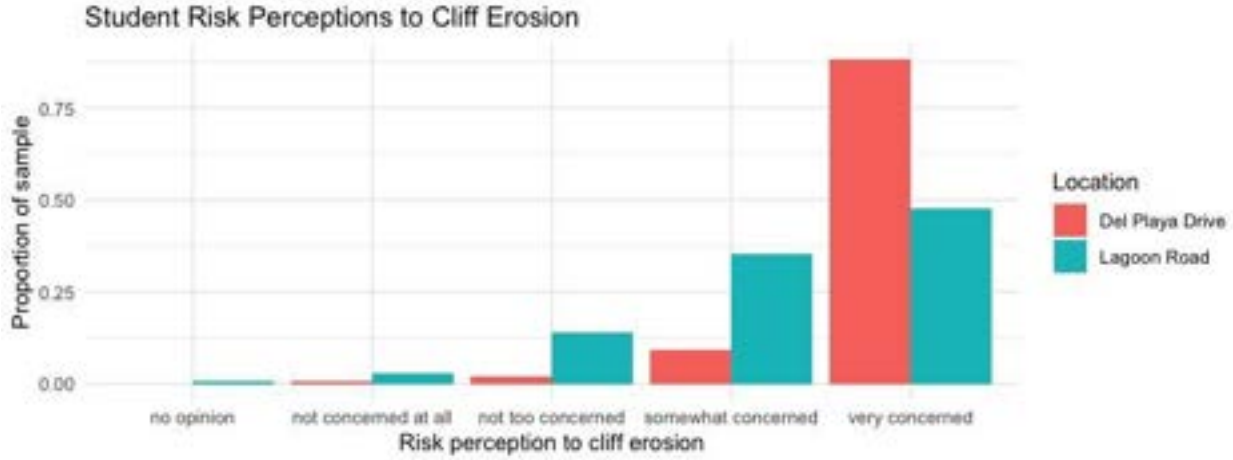


Figure 7 (below): Student Risk Perceptions to Wave Damage

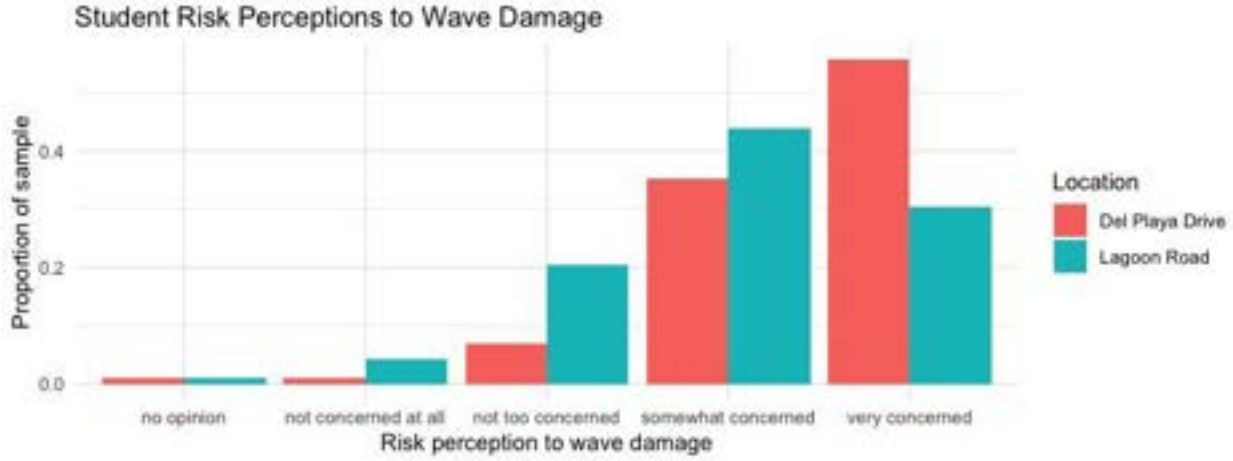
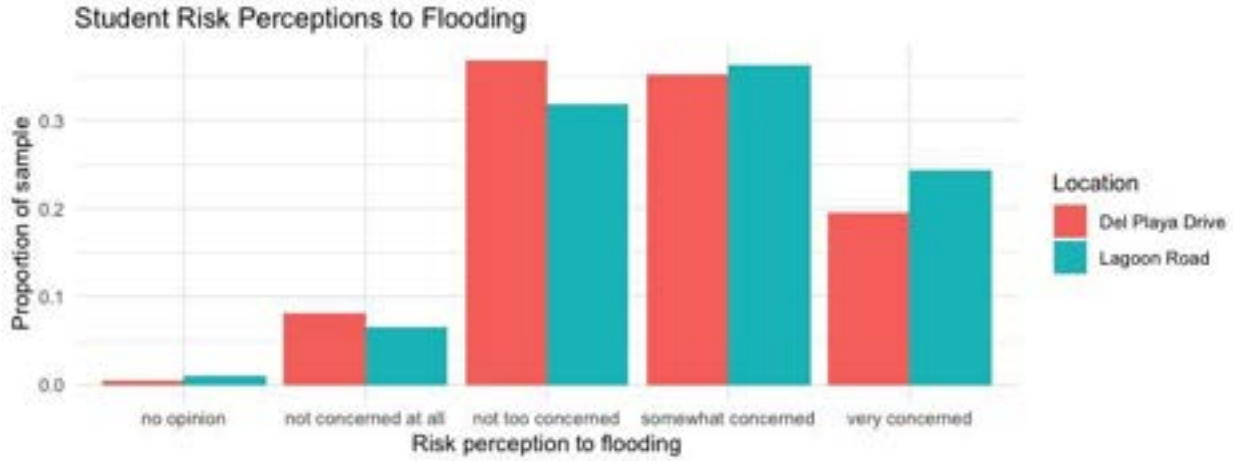
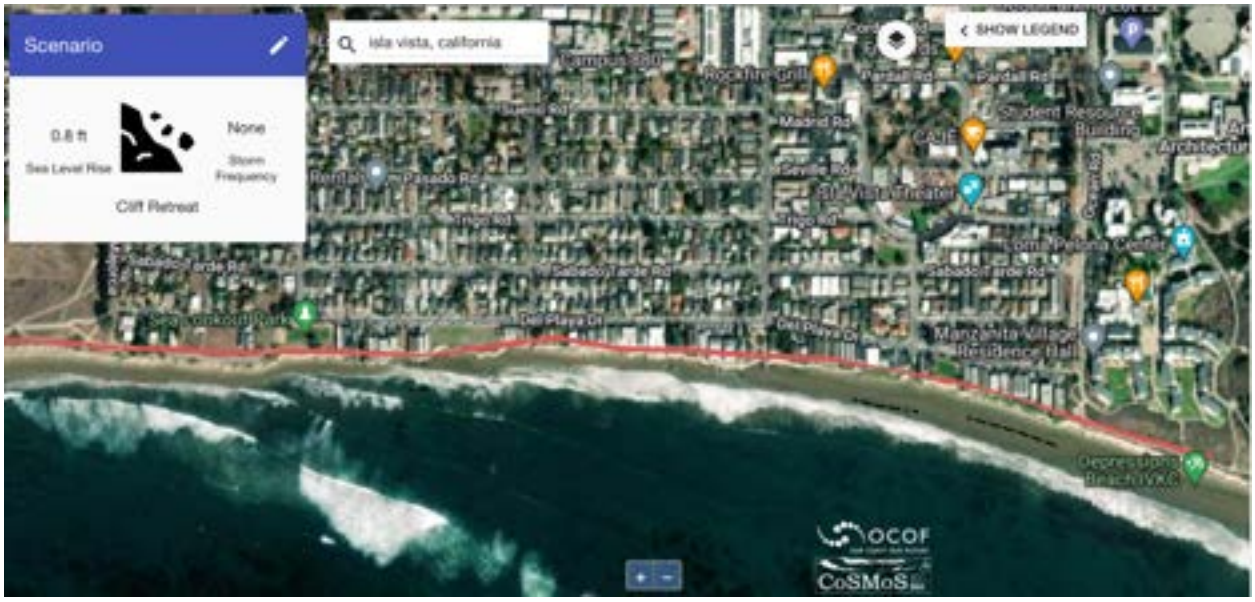


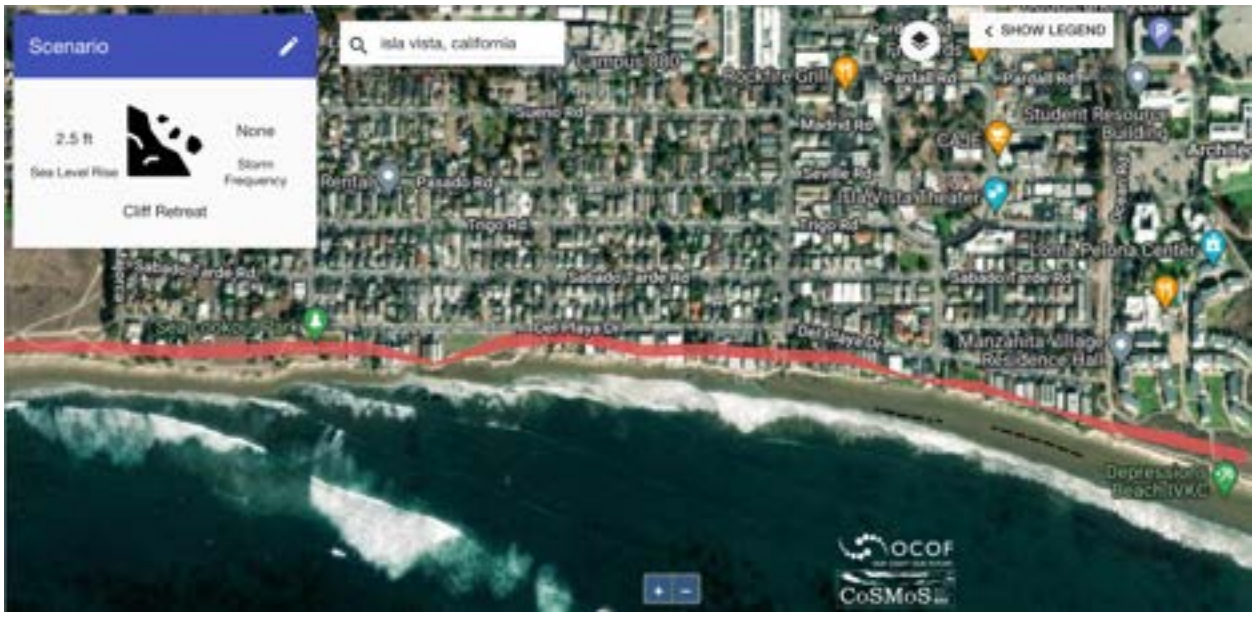
Figure 8 (below): Student Risk Perceptions to Flooding



Appendix C: Maps (From CoSMoS and OCOF)

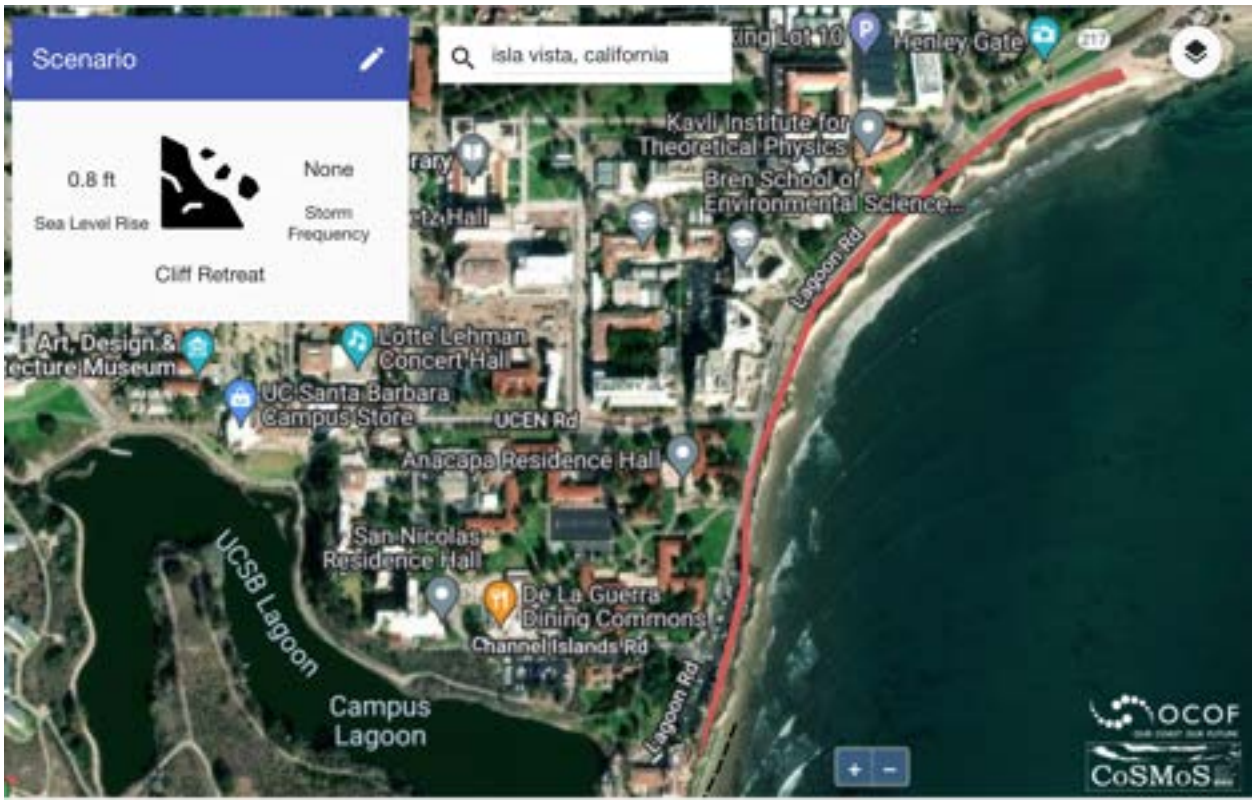


Map 1.1 (above): Cliff retreat with 0.8 ft SLR for DP

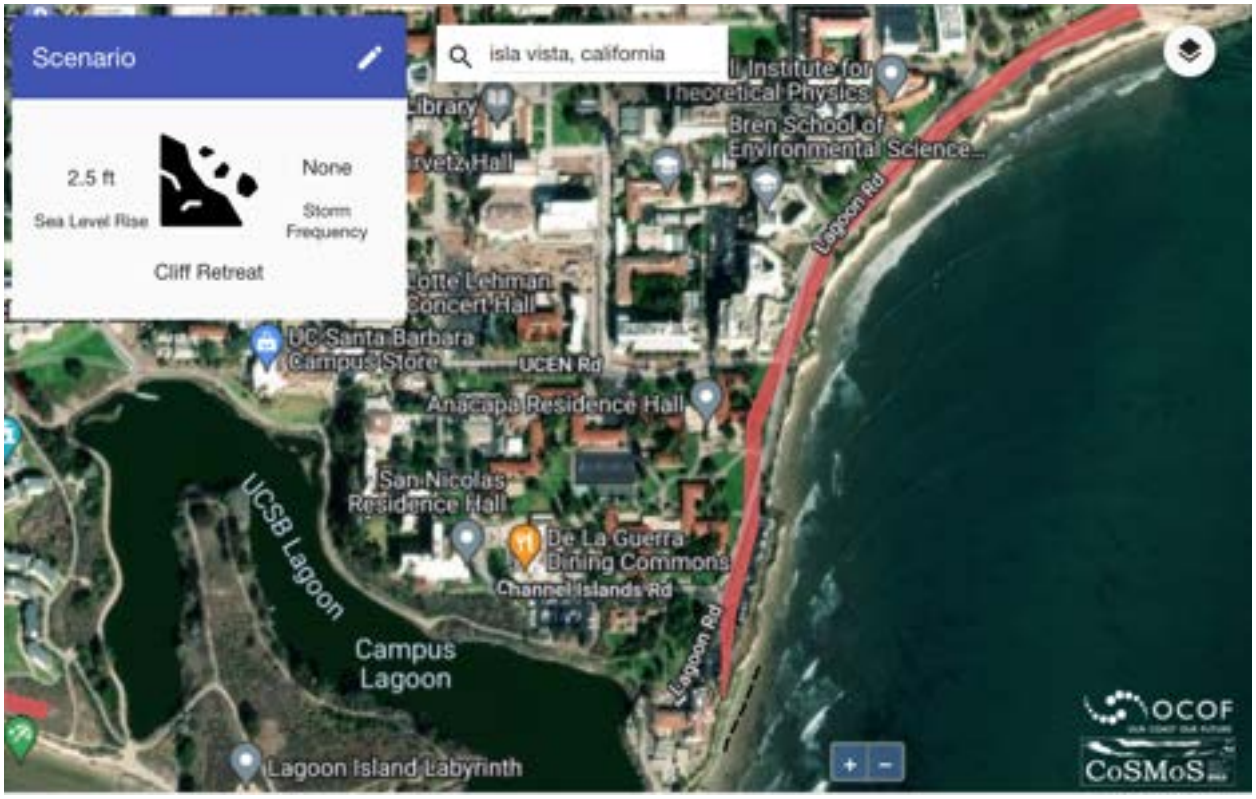


Map 1.2 (above): Cliff retreat with 2.5 ft SLR for DP

Map 1.3 (above): Cliff retreat with 6.6 ft SLR for DP

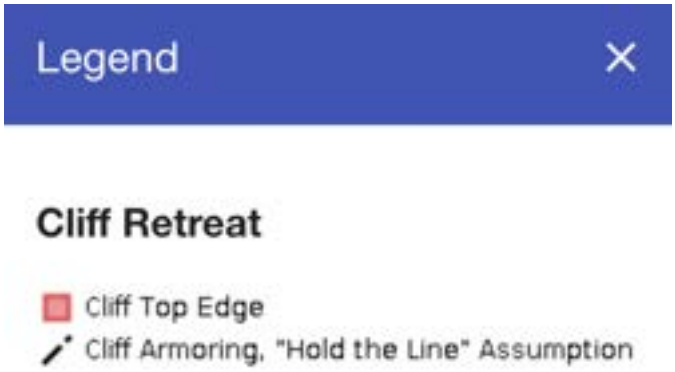


Map 1.4 (above): cliff retreat with 0.8ft of cliff erosion LR



Map 1.5 (above): cliff retreat with 2.5ft of cliff erosion LR

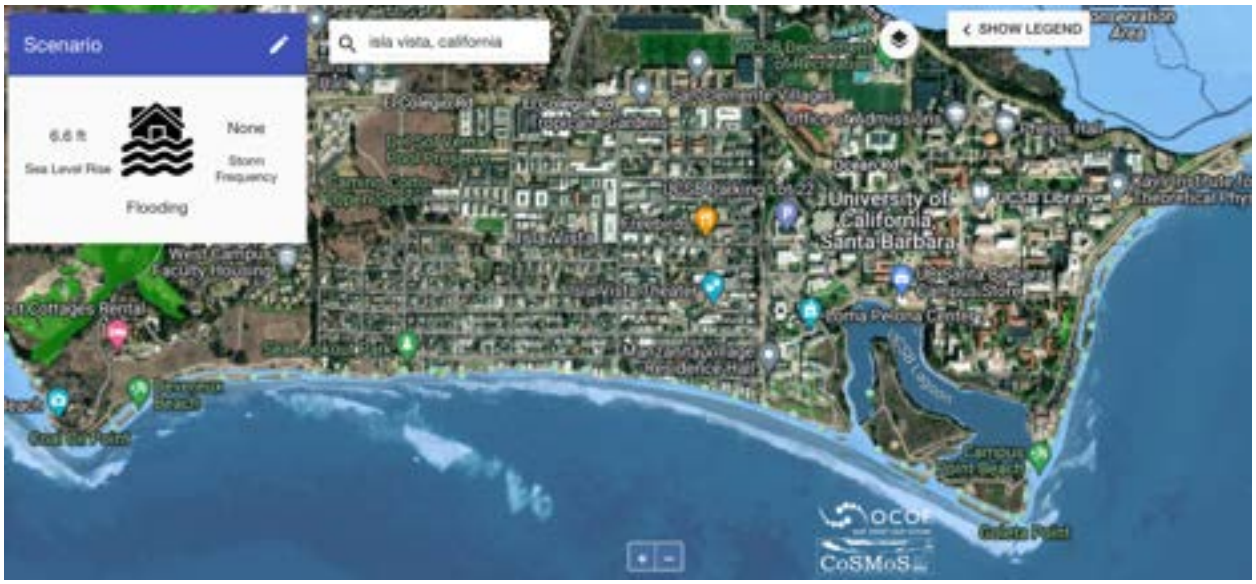
Map 1.6 (above): cliff retreat with 6.6ft of cliff erosion LR



Legend 1 (above): for cliff retreat maps 1.1-1.6

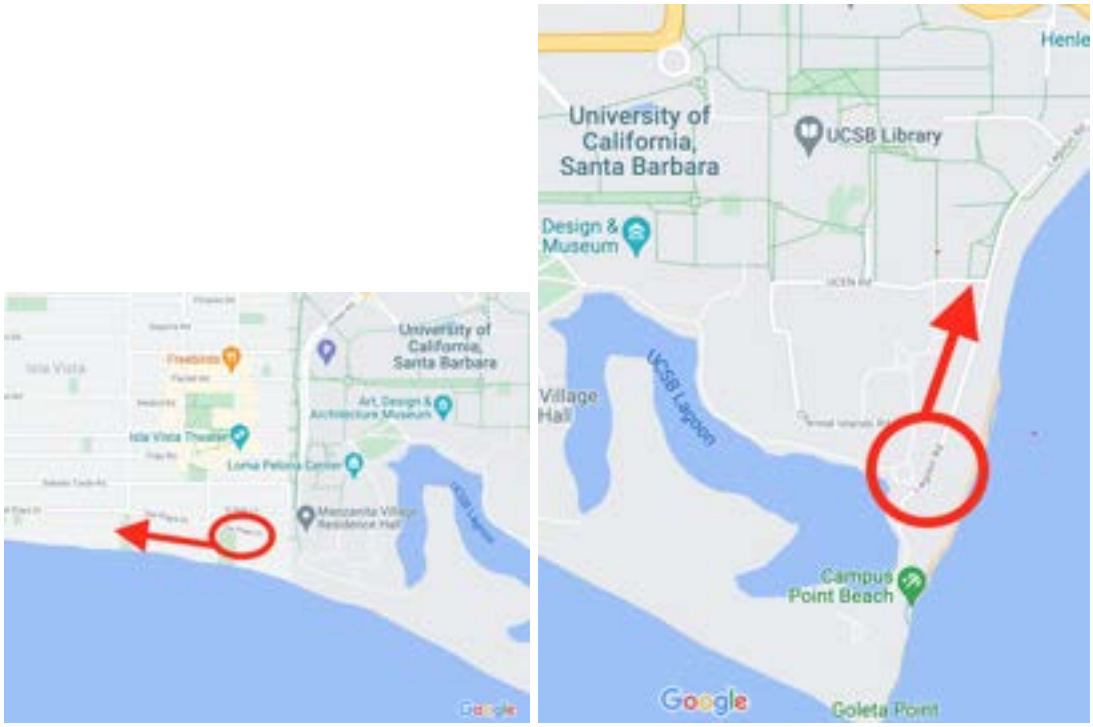
Map 2.1 (above): flood risk under 0.8ft SLR scenario

Map 2.2 (above): flood risk under 2.5ft SLR scenario



Map 2.3 (above): flood risk under 6.6ft SLR scenario

Legend 2 (above): for maps 2.1-2.3 flooding



Map 3.1 (above, left) was used in the survey instrument to show the location of Del Playa Drive and Map 3.2 (above, right) was used to show Lagoon Road.

Appendix D: Survey Questionnaire

1. Are you familiar with the term sea level rise? (yes/no/don't know)
2. Do you think that sea level rise is happening? (yes/no/don't know)

Answer choices for #3-7: very concerned, somewhat concerned, not too concerned, not at all concerned, no-opinion

3. How concerned are you about sea level rise generally?
4. How concerned are you that sea level rise poses a risk to UCSB/Isla Vista?
5. How concerned are you that sea level rise poses a risk to you personally at UCSB/in Isla Vista?
6. How concerned are you that each of the following sea level rise effects pose a risk to Del Playa Drive in Isla Vista, CA?
7. How concerned are you that each of the following sea level rise effects pose a risk to Lagoon Road (UCSB's campus)?
8. Are you familiar with the term sea level rise adaptation? (yes/no)
9. (If yes to 8) Planning agencies, cities, and local organizations have started proposing a variety of sea level rise adaptation measures. Have you ever heard about any of the following adaptation measures in relation to sea level rise? Check all the terms from the list below which you are familiar with:

Seawall
Groin
Jetty
Beach nourishment
Living shorelines
Wetland restoration
Dunes
Cobble berm
Bulkhead
Revetment
Breakwater
Sills
Edging
Vegetation
Tightening zoning regulations
Requiring development to be setback from the ocean/cliffs

10. How much of a priority should each of the following sea level rise adaptation measures be for the County of Santa Barbara's plans for DEL PLAYA DRIVE, ISLA VISTA?

(not a priority, low priority, medium priority, high priority, and essential priority, no-opinion)

Building a sea wall to prevent the loss of the beach and cliffs behind it
Building concrete groins to restrict the loss of sand from the beach
Planting native vegetation on the cliffs to prevent erosion
Using concrete on the cliffs to prevent erosion
Removing ocean-side Del Playa Drive houses to a location further away from the cliffs to prevent homes from crumbling into the ocean.
“Nourishing” the beach with more sand periodically to prevent the loss of beach access.
Requiring developments to be setback from the ocean/cliffs 30+ feet to prevent putting people/property at risk of being damaged.
Tightening zoning regulations to ensure that no new development is built in hazardous areas.

11. How much of a priority should each of the following sea level rise adaptation measures be for the University's plans for UCSB’s LAGOON ROAD?

(not a priority, low priority, medium priority, high priority, and essential priority, no-opinion)

Building a sea wall to prevent the loss of the beach and cliffs behind it
Building concrete groins to restrict the loss of sand from the beach
Planting native vegetation on the cliffs to prevent erosion
Using concrete on the cliffs to prevent erosion
(Attention check) Select “No opinion” on this item
Removing campus point infrastructure (such as the restrooms) to a location further away from the ocean to prevent them from crumbling into the ocean / flooding
“Nourishing” the beach with more sand periodically to prevent the loss of beach access.
Requiring developments to be setback from the ocean/cliffs 30+ feet to prevent putting people/property at risk of being damaged.

Tightening zoning regulations to ensure that no new development is built in hazardous areas.

Answer choices for #12-13: not a priority, low priority, medium priority, high priority, and essential priority, no-opinion

12. How much of a priority should each of the following sea level rise adaptation strategies be for the County of Santa Barbara's plans for DEL PLAYA DRIVE, ISLA VISTA?
13. How much of a priority should each of the following sea level rise adaptation strategies be for the University's plans for UCSB's LAGOON ROAD?

Measures which prioritize relocation of vulnerable structures
Measures which prioritize the protection of existing structures through engineering such as seawalls, or dune restoration.
Measures which prioritize making changes to existing structures to increase resiliency to sea level rise, such as raising a building or abiding by stricter zoning regulations.

14. Rank the following items in terms of their importance to your decision to attend UCSB (#1 being your most important):

Academics (prestige, postgraduate job opportunities)
Academics (research opportunities, certain program/major/professor/lab)
Recreational opportunities (sports/clubs, outdoor recreation)
Location (proximity to natural amenities such as the ocean/beach)
Location (proximity to city amenities such as the City of Santa Barbara)
Campus culture (community, reputation for high happiness levels of students)
Cost (financial aid/scholarships)
Weather (300 days of sun per year)
Other:

15. Rank the following in terms of importance to your decision to live in Isla Vista (#1 being your most important)

Cost of living
Recreational opportunities (sports/clubs, outdoor recreation)

Location (proximity to natural amenities such as the ocean/beach)
Location (proximity to University)
Culture (community, reputation for high happiness levels of residents, parties)
Other:

16. Current place of residence (check one):

Isla Vista
University of California, Santa Barbara (UCSB) owned facilities
Goleta (not Isla Vista)
City of Santa Barbara (not Isla Vista)
Other Santa Barbara county
Elsewhere in California
Elsewhere in the United States
International
Car/Van/Recreational Vehicle
Hotel
Unhoused
Other:

17. How long have you lived in your current residence? (months)
18. Do you currently or have you ever lived in Isla Vista? (yes/no)
19. How long did you or have you lived in Isla Vista? (months)
20. Do you consider your current place of residence your home? (yes/no)
21. Are you involved in any clubs on UCSB's campus? (yes/no)
22. Are you involved in a club in Isla Vista? (yes/no)
23. Are you involved in an environmental club on UCSB's campus? (yes/no)
24. Do you identify as an environmentalist? (yes/no)
25. Do you have an on campus job at UCSB? (yes/no)
26. Do you participate in research for UCSB? (yes/no)
27. Are you a UCSB student? (yes/no)
28. What is your major(s)? (list of all UCSB majors and "other")
29. What year are you in school?
30. How old are you?
31. What best describes your employment status over the last three months?
32. What is your current marital status?
33. What is the highest level of education you have completed?
34. Which racial or ethnic group best describes you?

35. Are you of Spanish, Latino, or Hispanic origin or descent?
36. Are you registered to vote? (yes/no/don't know)
37. What is your personal income level?
38. What is your present religion, if any?
39. In general how would you describe your own political viewpoint?
40. Generally speaking do you think of yourself as a...

Democrat
Independent
Republican
Other

41. If you think of yourself as a Democrat, would you consider yourself a strong Republican or a not strong Democrat?
42. If you think of yourself as a Republican, would you consider yourself a strong Republican or a not strong Republican?
43. [If "other" was selected on number 40] Do you think of yourself as closer to the Democrat party or the Republican party?