# How Does Sea Level Rise Affect Members of the Marin Academy Community?

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## Background

Sea level rise poses many threats to the Bay Area's residents, businesses, eco-systems, and economy. Sea level rise will intensify existing coastal flooding, King Tides, and watershed flooding, which all already pose big threats for the Bay Area. A 1.0 meter sea level rise situation is predicted to cost $49 billion in coastal flooding damages and put 220,000 people at risk of a 100-year flood. And with 1.4 meters of sea level rise, estimations show that up to 270,000 people may be vulnerable to a 100 year flood and damages amount to $62 billion. (1) There is great reason to be concerned about these potential impacts, as 2009 report by the California Energy Commission's Public Interest Energy Research (PIER) Climate Change Research Program projects a potential rise in california sea levels from 1.0 meter to as high as 1.4 meter rise. (2) Before making any adaptions though to protect vulnerable populations, more most be done to actually undertand the communities that need to be protected. Adaptations must be made on a case by case basis, requiring more research into the demographics of effected people and their concerns. In order to further such research, I set out with this project to understand how people at Marin Academy are effected by sea level rise. I simplified my question for a 2-year research project, which was how does sea level rise effect residents of Marin County. Through this science symposium I intended to tests out my methods for my 2-year study, as well as provide meaningful results that the school can use, especially around transportation concerns.

## Methods

I created a survey, which targeted Marin Academy teachers/faculty, students, and parents members as the intended participants. No participants emails or names were collected, as I predicted anonymizing the results would increase confidence of participants to complete the survey. Wanting a short survey, I created a 20 question multiple choice survey, which took between one to two minutes to complete. The survey was broken down into two section, a demographics section (11 questions) and a concerns section (9 questions). The demographics section asked the participants for non-subjective information. Questions in this section were designed to collect information on participants housing, employment, economic, ethnicity, mode of transportation to school, and if they had been impacted by flooding while commuting to or from Marin Academy's campus. Many of the demographic questions were adapted from US Census Bureau questions (particularly questions on economic status, and ethnicity). The second section of the survey asked participants questions regarding their concern on certain impacts of sea level rise (impacts over certain time periods, economic status, use of open space, transportation, health, and daily life). I choose to ask questions about the impacts of sea level rise that have been most prevalent in the scientific and policy making communities. Using reports like the 2017 Marin County Sea Level Rise Vulnerability Assessment, I tried to replicate topics and language used in reports like these to measure the most relevant information to Marin County and the Bay Area in my survey.

## Abstract

Coastal cities and regions across the world have began to see the impacts of climate change and rising tides. According to a 2012 done by the Pacific Institute, global sea level averages have risen 7-8 inches as global temperatures have also raised 1.4F over the course of the last century (3). Before creating adaptations to protect vulnerable populations, research needs to be conducted to investigate who and where should be prioritized and how to specifically protect them from sea level rise. In order to contribute to this research, I decided to conduct a survey based experiment to investigate how sea level rise affects members of the Marin Academy Community for my science symposium. The goal of this experiment is to raise awareness to the fact that sea level rise is and will affect many members of the Marin Academy Community. My essential question is: how does sea level rise affect members of the Marin Academy Community? To answer this question, I conducted a survey broken down into two sections of questions: a demographic section and an "opinion" / personal experience section. I adapted several questions from the US Census for the demographics section. To create questions in the opinion section I used scientific reports such as the 2017 Marin County Sea Level Rise Vulnerability Assessment to generate questions that use the current language of scientific reports and address the most relevant information. Data from this experiment suggests that while reassessing transportation at Marin Academy, the school should distribute more attention to people who carpool and live in West Marin, San Francisco, and Sonoma (though concerns are not exclusive to these areas or carpooling). The data showed that these people face the most continual disruptions to there commutes from flooding, as well as expressed the most concern over sea level rise's potential impacts on their regular transportion.

## Results

These results compare the frequency of responses of two questions per graph. The graphs are all based of the percentage of particpants as the sample size was small for a survey (102 responses)

### Figure #1

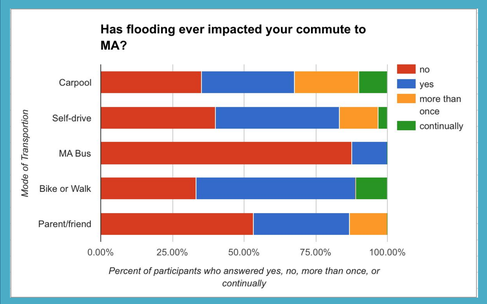


Figure #1: displays the percentage of participants frequency participants using different modes of transportation answered (no, yes, more than once, or continual) to the question stated it the title. Results show that MA bus riders are the least impacted group and that the majority (>50%) of bikers/walkers, carpoolers, and self-drivers were impacted by flooding.

### Figure #2

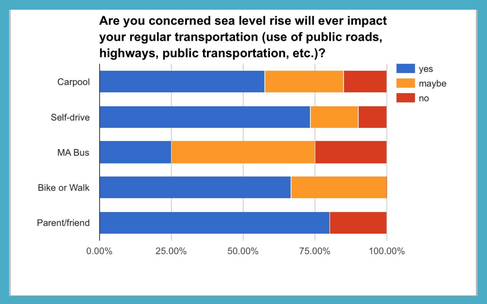


Figure #2 shows that the majority (>50%) of all participants, with the exception of the bus riders, said that they were concerned with the potential impacts of sea level rise of regular transportation.

### Figure #3:

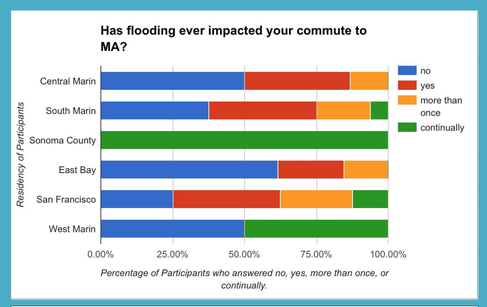


Figure #3 shows that the majority (>50%) of participants living everywhere except for the East Bay had their commute impacted by flooding. The more heavily affected locations were San Francisco and Sonoma County.

### Figure #4

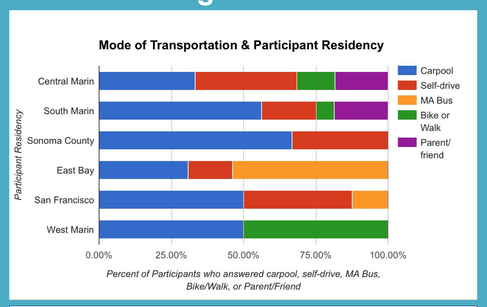


Figure #4: this graph shows the most common transportation for participants living in different areas. Carpooling tended to be on of the most common transportion in San Francisco, West Marin, Sonoma County, and South Marin.

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### Works Cited:

.) California Energy Commission's Public Interest Energy Research (PIER) Climate Change Research Program, Cayan et al. (2009)
2.) California Energy Commission. (2012). The Impacts of Sea Level Rise on the San Francisco Bay. California Energy Commission's California Climate Change Center.
3.) Ibid

## Discussion

Figure #1 compares participant's mode transportation to school with two dependent variables (impact of flooding on people's commutes and their concern that sea level will impact their regular transportation). Data in Figure #1 indicated that people walking/biking, carpooling, followed by people driving themselves to Marin Academy were most affected by flooding while commuting. 66.67% of bikers/walkers were affected at least once, and 11.11% said that flooding has been a continual disruption to their commutes. 65.00% of carpoolers were impacted at least once and 10% also said flooding was continually disruptive. Lastly, 59.99% people who drove themselves were affected at least once and 16.67% more than once / continually disrupted by flooding while commuting. This data from Figure #1 suggests that Marin Academy should distribute more attention to other modes of transportation, not just the bus, while reassessing transportation. An overwhelming 87.5% of bus riders indicated that they had never been impacted by flooding while commuting. Bus riders in Figure #2 expressed little concern in the survey for the concern that sea level rise will ever impacted regular transportation (only 25% said they were concerned), whereas an average of 69.38% of all bikers/walkers, self-drivers, carpoolers, and people who were driven by a parent/friend said they concerned. Figure #2 reinforces the significance of Figure #1, that MA needs to greatly broaden the its assessment of transportation beyond addressing the inefficient bus system to include community members whose commutes are impacted by flooding and will continue as sea level rise makes coastal flooding more frequent.

Figure #3 shows participants living in specific areas who answered (no, yes, more than once, and continual) to if they had ever been impacted by flooding while commuting. This figure suggests that Marin Academy members commuting from San Francisco, South Marin, Sonoma are most impacted by flooding while commuting to MA. Howeover there were only 3 people who said they lived in Sonoma County. Despite all 3 said flooding was a continual disruption to their commute, there is too little data to accurately repersent this data point and it will be exluded from the discussion. 75% of people who commuted from San Francisco were impacted by flooding at least once, 37.5% of them said that they had been impacted continually by flooding. Likewise, 62.5% of survey participants from South Marin were impacted by flooding at least once, 25% continually. The data in Figure #3 tells us that a greater focus on addressing delays and obstacles MA students, parents, or faculty & staff face commuting from San Francisco and South Marin (Sausalito, Mill Valley, Belvedere, or Tiburon). Figure #4 shows us which mode of transportation was most common for people living in different areas. If the school were to address concerns of MA members in Southern Marin and SF it may want to look into carpooling students, as carpooling was the main mode of transportation in both Southern Marin and San Francisco. Figure #4 shows that 50% of survey participants from San Francisco carpool to school and 56.25% from Southern Marin. Sonoma county's participants followed this trend of having a high amount of participants imapcted by flooding (100%) and a high amount carpooling to school (66.67%). Depsite a small sample size for Sonoma, the school may want to still consider the carpooling situation in Sonoma, addition to South Marin and San Francisco. Perhaps no tardies for carpools?