Physical Exposure and Social Sensitivity Estimating Sea Level Rise Impacts to Transportation through Vulnerability Assessment and Social Media Analysis

PI: Suwan Shen[1]
Co-PI: Yi Qiang[2]
[1]Department of Urban and Regional Planning
[2]Department of Geography
University of Hawaii at Manoa, Honolulu, HI 96822
Email: suwans@hawaii.edu; yiqiang@hawaii.edu

Project Objective

Sea level rise, as one of the most wide-spread and important climate change factors, has become a pressing threat to transportation infrastructures, especially in coastal region such as Hawaii. While many research have been conducted to assess the potential impacts and physical vulnerability of transportation network to sea level rise, it is often difficult to validate the results due to the lack of empirical data. This project combines transportation vulnerability assessments with social media analysis and community mapping to understand the potential impacts of sea level rise on transportation and potential adaptive responses. Through the examination of past extreme coastal flooding events in Honolulu, it aims to search for empirical evidence for sea level rise's potential impacts on transportation, to identify the most physically vulnerable infrastructure and exposed communities, and to understand the major concern, attitude, and aspects of transportation being affected by coastal flooding from the traveler's perspective.

Problem Statement

Sea level rise, as one of the most wide-spread and important climate change factors, has become a pressing threat to transportation infrastructure, especially in coastal region (1). The increase in frequency and intensity of coastal flooding has increased the risk of delays, disruptions, and damage across the U.S transportation systems (*2*). Road infrastructure in coastal areas is particularly sensitive to more frequent and permanent flooding from sea level rise because of 1) erosion and subsidence of road bases, 2) flooding of underground tunnels and low-lying infrastructure, 3) inundation of roads and rail lines, 4) traffic congestion, and 5) damage due to increased storm intensity (*3*). Studies have discussed various impacts of climate change and sea level rise on transportation infrastructure. Recurrent flooding and inundation have significantly burdened major roads in low-lying areas in Washington D.C, Maryland, Virginia and New Jersey (*4-7*). Sea level rise impacts on the West Coast are just as exacerbating as in the East Coast with approximately 200 miles of roads are presently at risk to sea levels. Sea level rise is particularly a challenge for Hawaii given the geographic and topographic situation of the islands (*8*). While much research have been conducted to assess the potential impacts and physical vulnerability of transportation network to sea level rise (*9-11*), it is often difficult to validate the results due to the lack of empirical data. Furthermore, there were few studies focusing on travelers' experience, views, and concerns, and hence the social sensitivity to such impacts and the public's major concerns during such events are little understood.

Research Methodology

This project combines transportation vulnerability assessments with social media analysis and community mapping to understand the potential impacts of sea level rise on transportation and potential adaptive responses. Social media provides a good overview of people's concern and attitude towards flooding's impacts on transportation in general at the global, regional, and state level. Localized transportation vulnerability analysis helps to better understand where and how local communities' transportation accessibilities to different types of opportunities are being affected by sea level rise related flooding. Finally, community mapping and outreach helps to validate and interpret the results of vulnerability analysis and social media analysis, helps transportation researchers and planners to better understand the local problem and engage the local communities in response to sea level rise.

Results

The three approaches complement each other and generate the following key findings:

- At the global level, flight cancels and travel delay are the major impact of flood and king tides on the transportation system. At the national scale, coastal states have endured more severe impact of flooding hazards on transportation compared to inland states. In another word, coastal flooding has more severe impacts on people's travel than other types of flooding. At the local level, for City and County of Honolulu, the vulnerability in terms of accessibility reduction is unevenly distributed spatially. The North part of the island near Kahuku, the east part near Hawaii Kai, and the central part near Honolulu Harbor may experience more impacts from tidal flooding than others. These communities also have a low level of accessibility even without coastal flooding.
- In the case study area, City and County of Honolulu, work related trips and grocery shopping trips have been more affected than others. Accessibility reduction correlates positively with the percentage of affected road in the TAZ, the total length of affected roads, percentage of residents in educational, health and social services industries, and percentage of white alone population, and negatively related with the percentage of residents in public administration, information, and retail industries. Poverty levels, car ownership, age, minority status, and urban rural settings are not significant.
- Finally, despite the dominant concern for sea level rise impacts on future travel, the local community in general considers the impacts of the sea level rise as manageable if appropriate actions are taken.

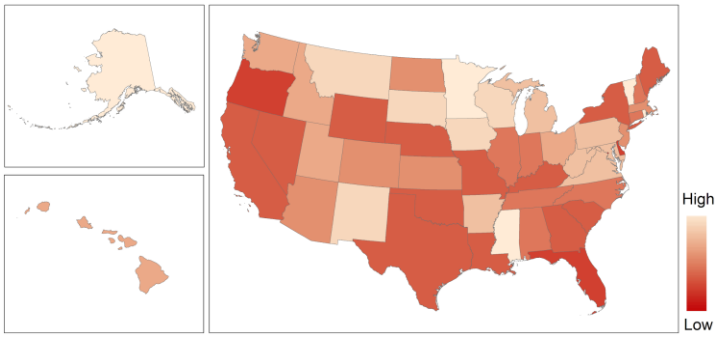

Figure 1 Ratio of tweets containing the hazard and transportation keywords to population in United States

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