RESEARCH BRIEF

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Stanford WOODS INSTITUTE for the ENVIRONMENT

Coastal Flooding Increases Traffic Delays and Accidents

Disruptions from sea level rise and coastal flooding events have significant indirect impacts on urban traffic networks and road safety.

Background

Almost half of the world's population currently lives in cities and that number is projected to rise significantly in the near future. This rapid urbanization is contributing to increased flood risk due to the growing concentration of people and resources in cities and the clustering of cities along coastlines. These urban shifts also result in more complex and interconnected systems on which people depend, such as transportation networks. Disruptions to urban traffic networks from flooding or other natural disasters can have serious socioeconomic consequences. In fact, what are defined as indirect impacts from these types of events, such as commute-related employee absences, travel time delays and increase in vehicular accident rates, could ultimately outweigh the more direct physical damage to roads and infrastructure caused by severe flooding.

Stanford researchers examined traffic networks in the San Francisco Bay Area (SF Bay Area) as a case study to quantify the indirect impacts of sea level rise and intensifying coastal flood events on urban systems. Specifically, the researchers sought to identify the effects flooding would have on traffic delays and safety, particularly as road closures rerouted vehicles into adjacent streets and residential neighborhoods not designed to handle heavy vehicle flows.

POINTS FOR POLICY MAKERS

▶ **Increasing resilience — or the ability of the traffic system to mitigate disruption resulting from road closures — will be necessary to avoid cascading socioeconomic consequences likely to be worsened by sea level rise.** The extensive nature of flood-related traffic disruption also highlights the need for a coordinated regional response to coastal flooding and sea level rise. Integrating a traffic model with flood maps can help planners to quantify how flood exposure, regional commute patterns, and characteristics of the road network affect traffic resilience.

▶ **The characteristics of a traffic system — the availability of alternate routes — can play a larger role in the magnitude of indirect impacts from flooding and hazards than the exposure to the hazard itself.** As sea level rises, travel time delays increase in communities where the road network lacks sufficient alternate road capacity to offset flood-related traffic disruption. Without sufficient alternate routes to offset road closures, even communities with overall low coastal flood risk, are potentially more vulnerable to delays than those with higher risk factors but more efficient local road networks.

▶ **Traffic re-routing due to coastal flooding may result in increased car and pedestrian accidents.** When highway flooding forces commuters onto local roads which pass through residential communities a spike in accident rates occurs. This may especially impact lower income or historically disadvantaged communities that are more likely to be adjacent to highways and may have fewer road-safety provisions.

▶ **Accident rates versus travel time delays present differing pictures of traffic resilience for communities in the San Francisco Bay Area.** Delays increase sharply at higher water levels, while region-wide accident rates increase the most at low water levels, suggesting that accidents may be a greater concern than delays at low-to-moderate water levels. Using only the metric of travel time delay for estimating traffic resilience could impart a bias toward travel efficiency rather than road safety into planning efforts.

Similar to many other regions across the country, the SF Bay Area has dense urban development concentrated along its coastline and heavily congested traffic grids. Currently, even relatively minor instances of coastal flooding have the potential to inundate major traffic corridors and increase already lengthy commute times and traffic accidents. For coastal flooding events, three types of flood impacts were identified: *impassable commutes* where the origin, destination or critical road connections are flooded and impede driving; *travel time delays* caused by commuters rerouting to avoid flooded roadways; and *increases in car and pedestrian accident rates* in communities that experience high inflows of traffic as commuters reroute onto local roads.

The study highlights the challenges of preparing the traffic network in the Bay Area for climate change. Increasing coastal flooding could lead to significant travel time delays across the entire Bay Area, including communities that do not encounter any flooding themselves. However, focusing exclusively on reducing travel time delays may be problematic as some communities will be impacted by coastal flooding primarily through an increase in accident rates.

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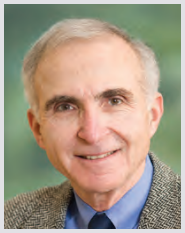

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This brief is based on the papers **"When Floods Hit the Road: Resilience to Flood-related Traffic Disruption in the San Francisco Bay Area and Beyond,"** published in *Science Advances* and **"Traffic accidents and delays present contrasting pictures of traffic resilience to coastal flooding in the San Francisco Bay Area, USA,"** published in *Urban Climate*.

FOR MORE INFORMATION

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