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HOW LAND USE CHANGES DUE TO SEA LEVEL MAY AFFECT TRAFFIC CONGESTION

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ABSTRACT

In this paper we explore the possible effects of land use changes that may occur due to sea level rise (SLR) on the traffic network delay. This numerical simulation study is conducted for the San Francisco Bay Area. If no preventive protection action is taken, inundation will occur in coastal areas, and the population residing or working in inundated areas will then adapt to this new situation by relocating to dry areas. The San Francisco Bay network is already congested, so removing links that lie in inundated parts of the network and simultaneously increasing the population density in other areas will have consequences on traffic network delays. We are interested in evaluating these delays and use as a metric the additional Vehicle Hours Traveled (VHTs). We identify areas that are likely to be inundated in 2100, and consider a one-meter SLR, expected by 2100 [1]. We consider what will happen if there is no preventive protection at all, and we use as reference the case of complete shoreline protection with levees. Once the flooded areas are identified, inundated, and isolated links of the traffic network are cut, as the inundation is not temporary but happens in a gradual and permanent manner. Thus, we obtain a reduced transportation network. Additionally, we can identify the affected population: individuals whose work locations, residencies and activities lay within the inundated areas. The affected population is assumed to shift to dry areas. We use an approach similar to Monte Carlo simulation, where we run several traffic assignment simulations using scenarios with random relocation of the affected population, to observe the mean and variance of the additional delay, and of the number of affected commuters. We perform traffic network simulations using the Multi-Agent Transport Simulation (MATSim), an activity-based transportation simulator [2].

After running 30 simulations for the traffic assignment in MATSim, where the agents residing in inundated areas are randomly relocated, we analyze the results for the morning peak hour, 6-10am, we thus capture the traffic assignment during the morning peak for different relocation scenarios. For the VHTs in the whole San Francisco Bay area we notice that the random relocation scenarios are consistent with each other, and there is a substantial difference between the VHT under the random relocation case and the full protection base case. Comparing the base case to the mean of the random relocation case, we notice a 12.5% increase in VHT when the Bay shoreline is not protected. We also find that the number of commuters who stay at home instead of completing their trip increases, because the congestion levels are high, and the utility associated with realizing their trip with such high delay is lower than that of staying at home. However, the result of this chain of events is still a network with a smaller number of realized trips and higher levels of

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delay. Therefore, not only do we have more realized trips under a full levee protection, but also lower total VHT.

Overall, we can clearly see that not protecting the shoreline with levees leads to significant delays in the Bay Area and increases substantially the number of commuters who cannot realize their trip. The result of this shift of traffic demand is a statistically significant increase in delay, measured in VHTs, as well as in the number of trips that cannot be undertaken. The overall cost of these effects, as well as other costs associated with the interaction of SLR with coastal infrastructure, should be accounted for in the decision-making process to adopt proactive strategies against SLR.

* The asterisk denotes the presenting author.

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