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<th><strong>UTC Project Information</strong></th>
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<td><strong>Project Title</strong></td>
<td>Agent-based modeling framework for wildfire evacuation in damaged transportation settings</td>
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<td><strong>University</strong></td>
<td>Washington State University</td>
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| **Funding Source(s) and Amounts Provided (by each agency or organization)** | University of Washington PacTrans $40,000  
Washington State University $ 40,000 |
| **Total Project Cost**      | $ 80,000                          |
| **Agency ID or Contract Number** | 69A3551747110                     |
| **Start and End Dates**     | May 16, 2020-May 15, 2022         |
| **Brief Description of Research Project** | Wildfires pose an increasing threat to residents in the Pacific Northwest (PNW) region as more people are moving to the wildland-urban interface. In addition, the increasing frequency and magnitude of wildfires induced by climate change will greatly intensify wildfire threats to human and economic losses in the PNW region. While many state- and local-level initiatives are underway to mitigate wildfire risks, it is not possible to completely remove such risks due to substantial inherent uncertainties. In this case, evacuation is the most important and effective method to reduce human losses during a wildfire event.  
The main goal of this study is to support effective evacuation planning by developing an agent-based modeling framework for wildfire evacuation in damaged transportation settings. The framework predicts traffic conditions during an evacuation and identifies the critical parts of the transportation network for pre-fire risk mitigation actions aimed at improving mobility during a wildfire evacuation. |
Describe Implementation of Research Outcomes (or why not implemented)

Place Any Photos Here

Effective community-based transportation evacuation planning is an important issue for state and local policymakers at great risk of wildfires in the United States. During the project period, the research outcomes were shared in a poster session (see the poster below) at the 2022 Region 10 Transportation Conference. We will continue our efforts in distributing these outcomes and communicating with state and local agencies to help them use the results in developing their evacuation planning.

Agent-Based Modeling Framework for Wildfire Evacuation in Damaged Transportation Settings

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Background

- Wildfires pose an increasing threat to residents in the PNW region
- Evacuation is one of the most important and effective methods to reduce human losses during a wildfire
- Mass evacuation can lead to severe traffic congestion and reduce mobility, thus endangering human lives
- Bridge damage may further exacerbate the problem

Research Goal

- Support effective evacuation planning by developing an agent-based modeling framework for wildfire evacuation in damaged transportation settings

Framework

- Integrate wildfire simulation, vulnerability assessment, evacuee response model, and traffic simulation

Data Collection: Online Survey

- Online survey of residents in wildfire-prone areas in CA, OR, and CO
- Participants recruited through Amazon MTurk
- 883 valid responses
- Questionnaires about demographic information, property location, car ownership, mobility issue, risk perception, previous experience with wildfire, and evacuation responses and behaviors

Data Analyses and Survey Results

- Logistic regression analyses to identify key independent variables that influence (a) evacuation timing and (b) the use of real-time navigation during a wildfire evacuation
- Binary evacuation decision: early evacuation vs. delayed evacuation

Case Study

- The 2017 Rye Fire in the City of Santa Clarita, CA
- Fire damages destroyed 41 of 11 bridges
- Synthetic population: 83,668 households; 246,830 residents

Conclusions

- Improve the accuracy of wildfire evacuation in damaged transportation settings by incorporating advanced wildfire hazard modeling and vulnerability assessment
- Better understand individual evacuee behaviors

Fig 1: Flowchart of the proposed framework

Fig 2: Evacuated vs. the Rye Fire

Fig 3: Bridge locations and damages

Fig 4: This number of vehicles that have departed or evacuated, and this number of vehicles in the network

Fig 5: Traffic map at 10:36 am
The developed evacuation simulation model can assist a well-developed evacuation plan and ultimately could save human lives. More specifically, the outcomes of this project include (a) the comprehensive evacuee response model based on the web-based stated preference survey and (b) the agent-based modeling (ABM) framework for wildfire evacuation in damaged transportation settings. The evacuee response model can be used to predict individual evacuees’ behavior as a firefront approaches, which may help state or local agencies prepare an effective evacuation planning guide or identify the appropriate timings of various evacuation orders. The proposed ABM framework introduced damaged traffic settings to the evacuation process and showcased how the reduced network capacity impacted evacuation efficiency, especially when combined with the elevated travel demand. The simulation results can be used to identify bottlenecks and critical network segments that may experience heavy congestion during an evacuation. Thus, as pre-fire mitigation actions, the identified network components and segments can be retrofitted or expanded, while alternative routes are constructed, aimed at facilitating evacuation during a wildfire event.

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