

## **Using a Smartphone App to Track Individuals in Experiential Drills to Compare with Actual Evacuation Events: A Simulation Fidelity Theory Approach**

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(In discussion with Dr. Michael Lindell@UW Seattle with his contributions)

Experiential drills are simulation exercises to replace and amplify real experiences with guided ones, often "immersive" in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. The goal of this research is to use a smartphone app to track individual's movement in experiential drills to create an integrated trajectory dataset to systematically compare drills to actual evacuation events to uncover the ways they differ. I have been collaborating with Mr. Mark Farley, app/exhibit designer at Hatfield Marine Science Center's Visitor Center and colleagues Prof. Daniel Cox, civil engineering, and Prof. Lori Cramer, social science, in the development of a tsunami evacuation app for augmented experiential drills. There are several unique perspectives to these drills. First, this App allows participants to record their evacuation trajectories. These anonymous trajectories are processed and visualized during the debrief session. The visualizations are coupled with pre-computed tsunami inundation dynamics to provide participants a practical understanding of how their evacuation behavior - such as milling time, walking speed, and choice of routes - affects their ability to 'beat the wave.' Second, web-based pre and post surveys are conducted to measure the participants' perceptions about tsunami hazards and to understand the extent to which these organized drills motivate people to prepare for coastal hazards. Third, subsequent drills are organized with increasing complexity. For instance, we performed experiential role-playing drills (i.e., defined roles in a sealed envelopes) and night drills. We also have tested cases with delayed evacuation start, family member reunification, and coalescing behavior, to advance our understanding of how these factors can influence an individual's adoption of protective actions. We have conducted five experiential drills at South Beach State Park (SBSP), Newport, OR on 02/18, 05/11, 06/16, 06/29 (role-playing), and 07/13 (night drill) of 2017 working with Oregon Parks including the Teen CERT from Toledo Junior High School in the second drill.

Tsunami evacuation drills have two functions: training and assessment. The goal of the training function is to ensure that people in the risk area can implement any evacuation instructions they have received through brochures, lectures, videos or other media. The goal of the assessment function is to measure the degree to which the evacuation plans and training materials can evacuate the largest number of people possible before the expected time of tsunami wave arrival. With respect to the assessment function, experiential drills can be viewed as scheduled simulations of actual evacuations. They are based on planned scenarios designed to enhance evacuation preparedness by identifying gaps in response performance. A major limitation of drills as assessment tools is that the conditions in which drills occur are not identical to those in which a real tsunami occurs. Thus, my goal is to conduct a systematic comparison of evacuation drills to actual evacuations. The major issue here would be to identify the specific ways in which scheduled evacuation drills differ from actual events. My approach is to adapt the simulation fidelity framework} to tsunami evacuation drills. Fidelity is the degree of similarity between the simulation and reality. The level of fidelity depends on the complexity of the simulated tasks, as well as the feasibility of simulating real event conditions. Tsunami evacuation drills differ from actual tsunami evacuations in five important aspects. Drill participants (1) are all forewarned by clear warning messages from credible sources; (2) do not need to delay their departure time because of worry about the safety of separated family members; (3) depart from a limited number of predefined origins at a predetermined time; (4) use predefined modes and routes of travel, and (5) are able-bodied people who can move at a "normal" speed to reach predefined destinations. In real events, none of these conditions is met completely, so I propose the following key research questions to accomplish the goals of this study by assessing the degree of deviation from these conditions. Specifically, (1) what will the actual distribution of origins throughout the community be during a real tsunami evacuation, (2) how credible will the warning sources be and how clear will their messages be (and what percentage of the population will recognize severe earthquake shaking as an environmental cue for evacuation)? (3) what will be the distribution of physical, social, and household contexts that will produce departure delays, (4) what will be the distribution of evacuation modes and routes? and (5) what will be the distribution of demographic characteristics (especially tsunami evacuation planning and physical ability) that will

determine evacuees' movement speeds and destinations? By systematically comparing the characteristics of a tsunami evacuation drill to those of an actual evacuation, we will be able to achieve two objectives. First, we will be able to identify population segments that are under-represented in the evacuation drills. This will provide a basis for working with local emergency managers to design outreach materials that increase the participation of those under-represented population segments in tsunami evacuation training. Second, I will be able to refine current tsunami evacuation models by replacing point estimates of variables with distributions of those values (e.g., replacing point estimates of departure delay time with a distribution of departure delay times). Evaluation tools are critical to measuring simulation fidelity. Thus, people's behavior during evacuation drills will be videotaped, which will not only serve as a research device but also provide a realistic debriefing tool for local emergency managers to explore what went well and what needs improvement after an exercise has been completed. These videos will also be supplemented by checklists that participants can use to report their individual and household performance.