Toward a Robust Flood **Emergency Evacuation** Integration of 2-D **Hydraulic Modeling** and Dynamic **Evacuation Routing** POR

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Presentation Overview

- Study purpose
- Case study location
- Methodology
- Evacuation modeling elements
- Assessment results
- Future applications



Study Purpose / Background

- Undertake a pilot flood evacuation study
- The goal of the study is to develop a decision support tool for emergency managers
- The tool considers the time-varying hazard resulting from the propagation of a flood during an evacuation
- This dynamic consideration of the hazard definition is a new addition to the science of Emergency Management planning for flooding



Pilot Study Location – Natomas Basin



- Development in deep floodplain
- Well-defined physical boundaries
- 100,000 residents
- Critical infrastructure
- Increased risk from future development



Methodology

- High-resolution 2D hydraulic flood modeling
- Vehicular evacuation modeling
- Both models currently exist independent of one another
- Wood Rodgers has developed a methodology to link both types of models
- Linked modeling enables the dynamic assessment of an evacuating population, accounting for the progression of a flood hazard during an event



Evacuation Process During Flood Propagation



CVFED Principal Objectives

(Central Valley Floodplain Evaluation and Delineation Program)

The principal objectives of the CVFED Program are to:

- Develop foundational datasets, models, and tools associated with SPFC to support State's flood management programs and projects
- Improve quality and accuracy of flood hazard data to help local communities comply with (recent) legislative mandates (SB 5, AB 156, SB 1278/AB 1965, etc.)
- Develop new hydraulic models acceptable to the USACE and FEMA and available for use for future studies.
- Provide information to support future planning and project design



2D Hydraulic Modeling Purpose in CVFED Program

- Determine maximum depth and extent of flooding
- Develop a level of detail in the 2D models suitable for planning and for legislative requirements
- Develop models that are acceptable to FEMA and USACE



Hydraulic Model Requirements for Emergency Response

- High resolution is necessary to adequately characterize flood propagation in the floodplain
- Temporal variations in inundation extent, depth and velocity





Hydraulic Modeling

- TUFLOW is recommended for high-resolution twodimensional flood hazard modeling
 - Inputs can be easily migrated from existing FLO-2D model datasets
 - Simulations are up to ten (10) times faster than FLO-2D
- TUFLOW estimates the time of flood arrival earlier than FLO-2D does.
 - More conservative assessment
 - TUFLOW results are consistent with other industry standard 2D hydraulic models (MIKE 21, XP-2D)





Hydraulic Modeling

TUFLOW Result Summary:

- Flood propagation ≈ 0.4mile/hour
- Peak flow velocities at flood wave front ≈ 3 to 6ft/s
- Rate of rise ≈ 1ft in 10 minutes





Evacuation Modeling

- An effective evacuation model will need the following criteria:
 - The capacity of the road network is considered
 - The traffic model is integrated to simulate traffic congestion
- ArcCASPER (Capacity-Aware Shortest Path Evacuation Route) meets both criteria
- ArcCASPER solves for routes with the shortest evacuation time



Pilot Study Assessment Results



Pilot Study Assessment Results



- Pilot study population = 22,612 vehicles (portion of Natomas)
- Time required to evacuate population = 54 minutes
- 1,216 vehicles flooded (before and during evacuation)
- 8 vehicles stranded (though not flooded)
- 21,388 vehicles safely evacuate



Pilot Study Assessment Results

Evacuation center (safe zone) results



Evacuation Center



Future Applications (General)

- Useful tool for planning studies
- Assessment significantly increases certainty in evacuation time predictions
- This information be used to improve planning associated with all elements of the evacuation planning process to achieve a successful evacuation
 - Hazard prediction time (P)
 - Resource mobilization time (M)
 - Evacuation warning time (W)
 - Community acceptance / risk education (Wf)
 - Vehicle movement during an event (Vt)



Timeline – Failed Evacuation





Timeline – Successful Evacuation





Future Application (Jurisdiction Examples)

- Useful for emergency response personnel to plan and guide large-scale evacuations
- Helpful for local authorities to decide when to call for a mandatory evacuation to save life and property
- Can be used by DWR Flood Operations Center staff to advise local authorities of probable risks
- Evacuation results can be used as a community education tool, enhancing the DWR Flood Risk Notification Program



Questions?

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