

Informed Evacuation Planning: Simultaneous TUFLOW Flood and Traffic Modelling

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Study Aim

The objective of this project was to determine the minimum time it would take for vehicles to escape to evacuation centres taking into consideration road congestion and a changing road network due to inundation.

Study Area

Natomas Sacramento California, USA
 Population = 100,000
 Dwellings = 39,000
 Flood Risk = **Extreme**. The city is bordered by the American and Sacramento Rivers. Flood protection is provided by a ring levee protection. Failure of the levee can result in inundation up to 7m deep!

Modelling Framework

The project involved the development of two separate models:

1. TUFLOW:

High resolution two-dimensional hydraulic model to accurately characterize the timing and propagation of flooding.

INPUTS:

- High resolution LIDAR topography
- High resolution aerial photography
- Levee breach boundary conditions

2. ArcCASPER:

An evacuation model capable of handling road network capacity and vehicle flow.

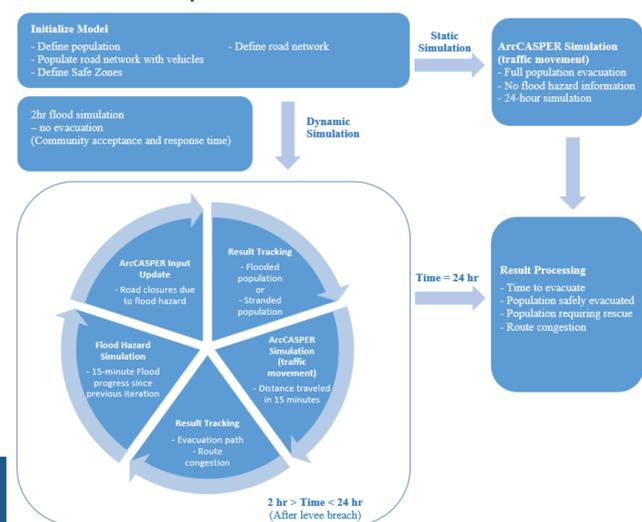
INPUTS:

- Census population data
- Road network data (network, number of lanes and road rules)
- Evacuation destinations

The hydraulic and evacuation models were dynamically coupled to enable assessment of the hazard, vulnerability, behavioural and transportation analysis elements of the Evacuation Components list shown below:

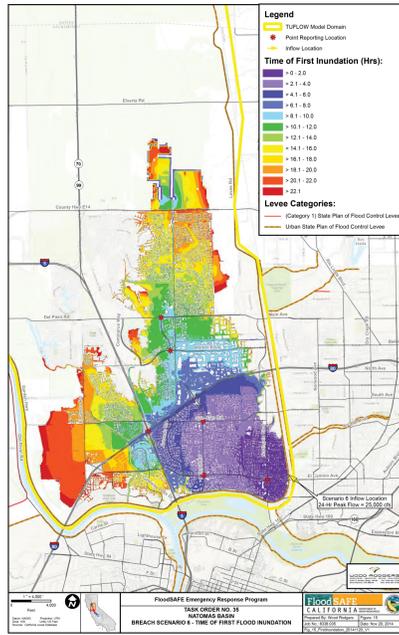


Evacuation Components List

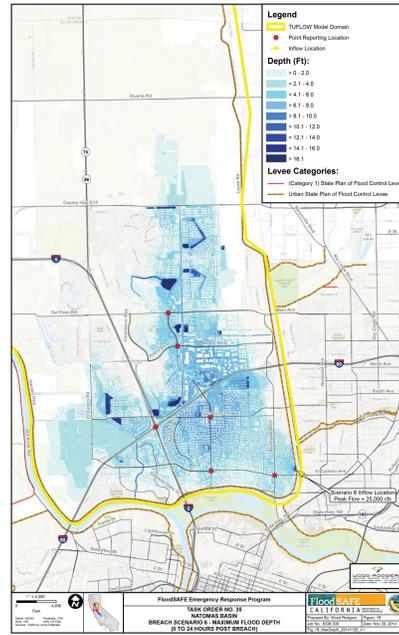


Dynamic Flood and Evacuation Model Flow Chart

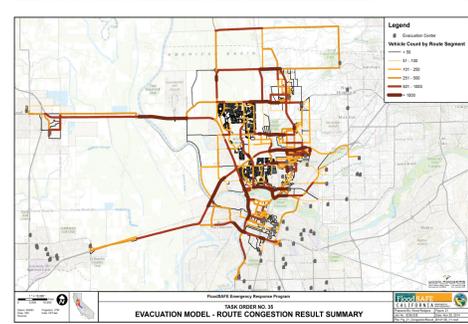
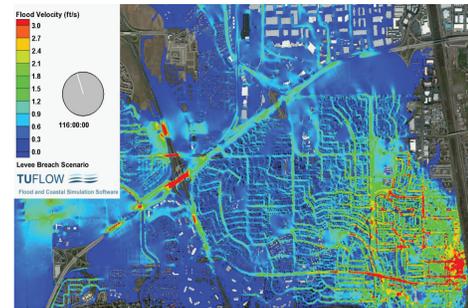
Assessment Results



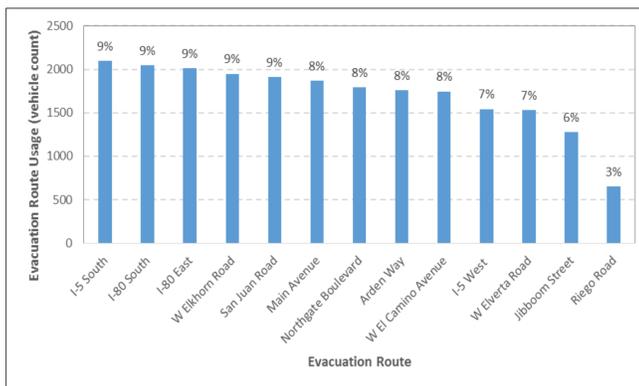
Time of Inundation



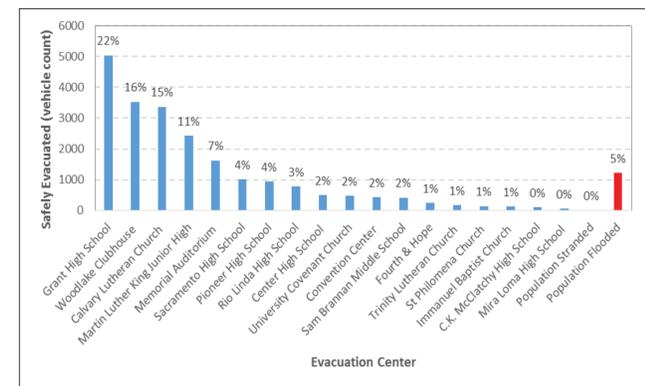
Peak Flood Depth



Route Congestion Results



Evacuation Route Result Summary



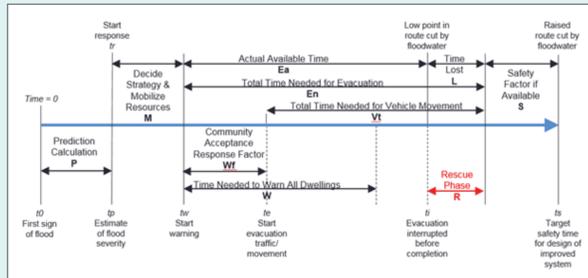
Evacuation Centre Result Summary

The evacuation model results have been validated using Department of Transport recorded mass evacuation vehicle peak flow rate data obtained during Hurricane Floyd, Ivan and Katrina.

Future Applications

This flood evacuation modeling approach can be used as a tool for optimising many of the elements which need to be considered during emergency management planning.

The potential applications of this flood evacuation modeling approach is best described by considering each of the individual elements which constitute the flood evacuation timeline.



Flood Evacuation Timeline (Opper, 2004)

(P) Prediction and (M) Mobilisation Time Results will be useful for determining whether or not the existing prediction instruments and mobilisation resources provide sufficient time to successfully evacuate the at-risk population.

(W) Warning Time and Required Time for Vehicle Movement (Vt)

This flood evacuation modelling approach is an appropriate tool for preplanning warning dissemination strategies and managing possible congestion issues.

- The tool can be used to design phased evacuation strategies. The goal of phased evacuation is to sequence evacuation warnings in such a way that it can optimize evacuation at a rate which matches the potential capacity of the evacuation route.
- Signage and changed road controls (such as contraflow) can be modelled to encourage the flow of traffic along preferential evacuation routes

(R) Rescue

The flood evacuation model is a tool which could be used to identify high risk areas which may require rescue. This is useful information for post-event rescue operations. Alternatively, the tool may identify locations where shelter in place is preferred to evacuation.