Food Security in the Aftermath of a Seismic Event

Global Food Initiative
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Introduction

- Few tools exist to quantitatively measure food system functioning, which is a limitation in monitoring vulnerability and resilience.
- Considerable work has gone into the development of disaster scenario simulations as preparation tools, these tools often do not consider effects to the food system or food security following an event.
- We had previously proposed and developed a fault tree model as a conceptual framework.[1]
- Fault tree analysis is a risk assessment tool for the analysis of complex systems.

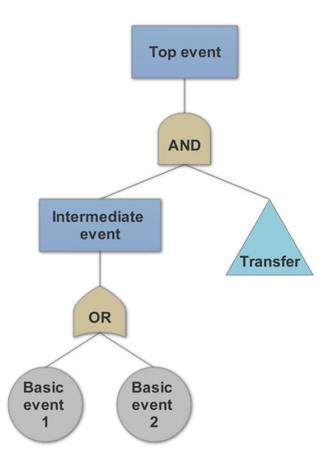

Figure 1. Fault tree Components

- Basic events of sufficient magnitude may cause failure at intermediate events, which then trigger failures farther up the fault tree that can potentially result in failure of the system.[2-3]
- Figure 1 illustrates basic fault tree architecture.[4]

- The fault tree was developed in the context of Baltimore, MD,[5] but we predict that its logic would hold for other contexts within the United States. The top level of the fault tree model is presented in Figure 2.

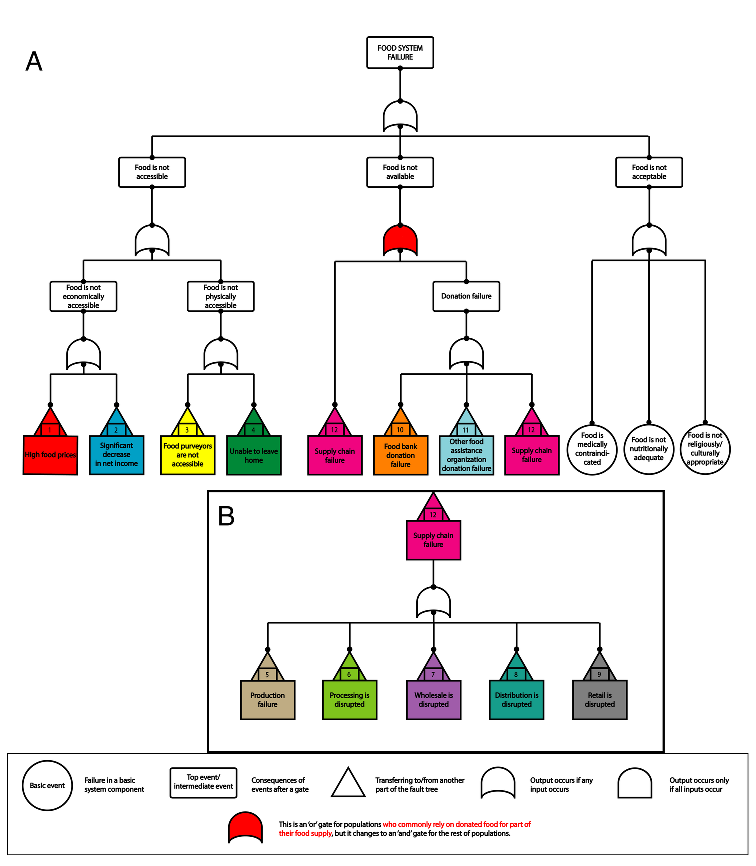

Figure 2. (A) Main food system fault tree with (B) supply chain subtree

Project Goals

- To validate the internal logic within a conceptual model of food system functioning
- To identify vulnerabilities within the food production system in Southern California
- To expand upon FEMA's 2008 ShakeOut Scenario (Figure 3) to capture the effects of an earthquake on the food system by analyzing the short and long term effects of an earthquake and an earthquake in the context of drought

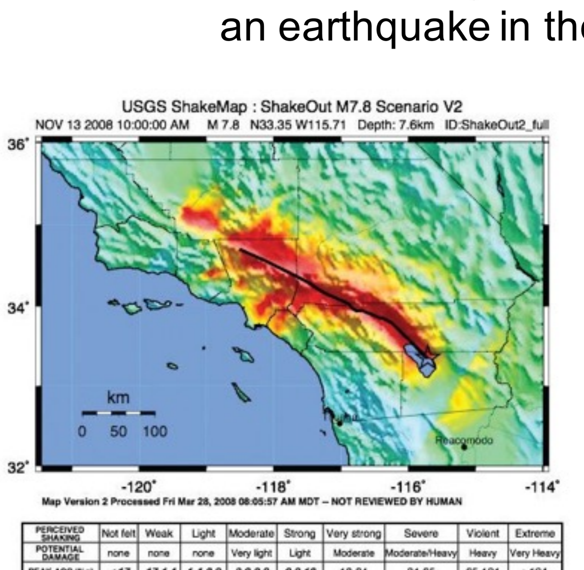

Figure 3. Areas within ShakeOut Scenario, which simulates effects of magnitude 7.8 earthquake on the southernmost 200 miles of the San Andreas Fault between the Salton Sea and Lake Hughes. This scenario would affect Kern, Ventura, Los Angeles, San Bernardino, Organge, Riverside, San Diego, and Imperial Counties.

Materials and Methods

- The production failure subtree was constructed using a top-down approach to identify necessary components of food production to populate events at different levels of the fault tree.
- Successful production requires multiple inputs, which form the basis of the branches of the production failure subtree. Production failure requires disruption of primary and backup production sources.
- We use FTA to analyze food production functionality and vulnerability after the occurrence of two representative scenarios in southern California:
  - magnitude 7.8 earthquake on the southernmost 200 miles of the San Andreas Fault
  - earthquake coupled with a prolonged severe drought
- We utilize scenario analysis to apply scenarios to the model, identify the vulnerabilities within the system, and propose feasible solutions to enhance resilience of food production in this area.

Results and Outcomes

Earthquake Scenario

- The consequences of the earthquake are severe 1) many buildings, especially un-reinforced masonry buildings, will sustain major damage or even collapse after the earthquake; 2) the earthquake will trigger over 1,600 fires in the region, and some fires will merge into conflagrations which may burn hundreds of city blocks; and 3) the water distribution system will be significantly damaged.
- The earthquake impacts will trigger two major basic events with particular relevance to food production: "decreased water," and "farmer displacement."
- The failures may be multiplicative rather than additive; in some cases, the combination of events makes for a worse impact and potentially more lasting failure.

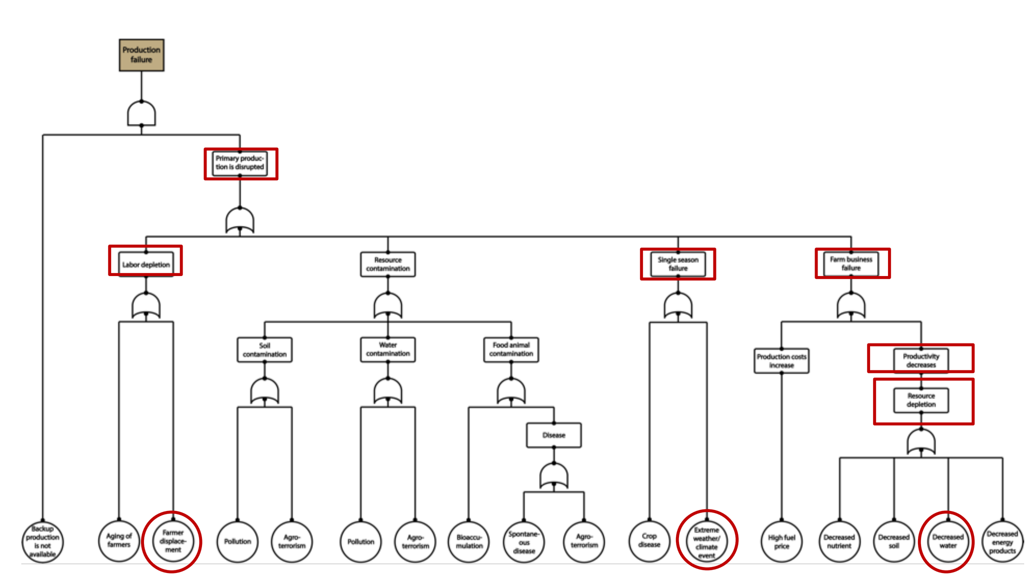

Figure 4. Production subtree demonstrating results of Earthquake scenario

Earthquake Plus Drought Scenario

- Earthquake in the context of drought would trigger the basic events "extreme weather/climate event", "decreased water," as well as "labor depletion" as described above.
- Drought will increase the risk for and scale of after-earthquake fires and the overall severity of damage

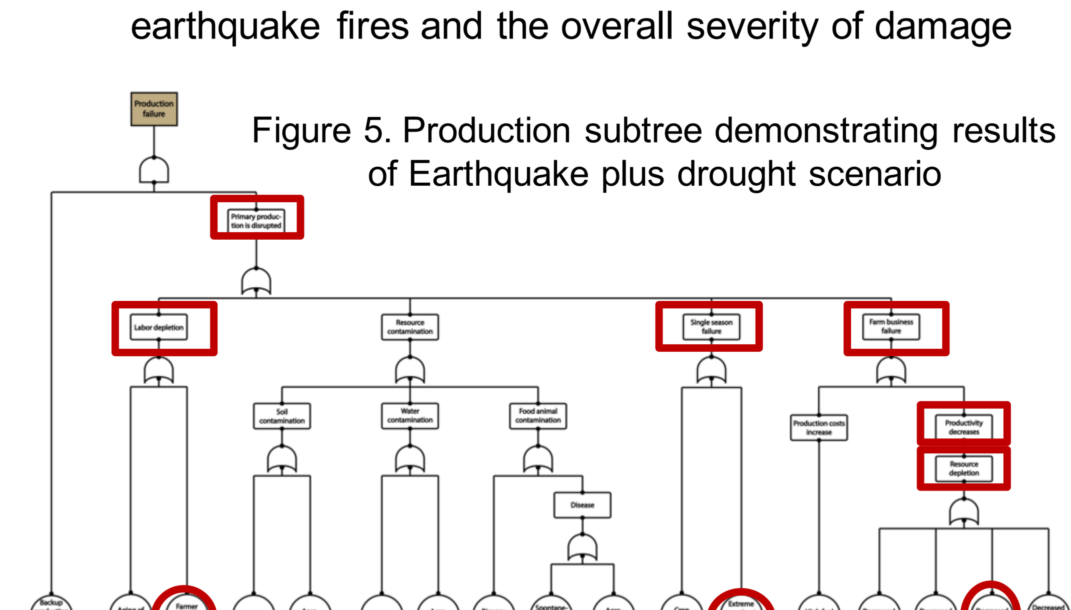

Figure 5. Production subtree demonstrating results of Earthquake plus drought scenario

Conclusions

- ShakeOut as currently written does not take into account the significant effects that will take place in the food system.
- The model does not predict top level failures in either of these scenarios; however, there will still be profound effects from the intermediate failures throughout the national food system.
- The interaction between an earthquake and a drought would stress an already inadequate water system more than either event would individually.
- Earthquake in the context of a continuing drought would also have significant implications for food production to recover effectively following an earthquake.
- To enhance the resilience of food production in this area, we need to measure and enhance the overall resilience of water distribution networks against earthquakes and other natural disasters.
- This work only focuses on the production aspect of such two events when effects will be expected in other aspects of the food system beyond production.

Future Goals

- To expand the work in this scenario to capture the failures that would result among other subtrees, including consideration of food prices and other aspects of food accessibility in order to capture the totality of effects of these two scenarios
- Develop quantitative indicators and thresholds to characterize intermediate effects
- Once quantitative indicators have been developed and validated, use the fault tree model in Monte Carlo simulation to determine food system failure
- Develop vulnerability indices and resilience curves for specific geographic locations or specific crops

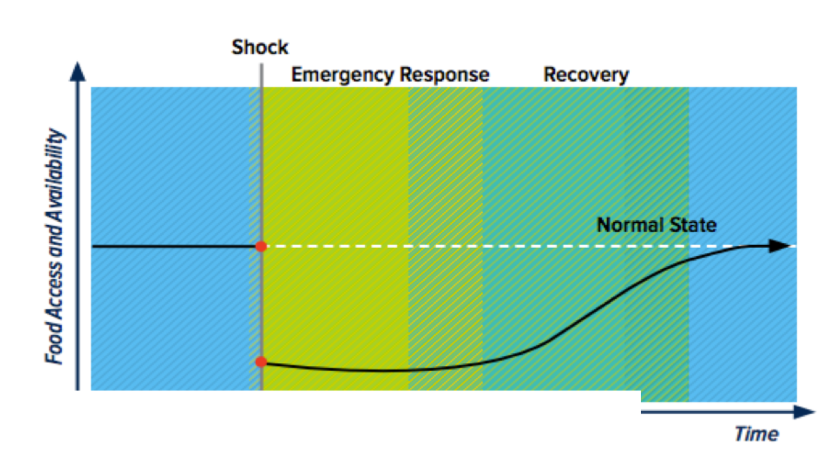

Figure 6. Example of resilience curve, showing the magnitude of a post-event shock and time to recovery

Literature Cited

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