Disaster debris management and recovery for housing stock in San Francisco, CA

Citation: Saiyed, Z. N., J. E. Fernandez, and J. L. Wescoat. "Disaster Debris Management and Recovery for Housing Stock in San Francisco, CA." 2012 IEEE International Symposium on Sustainable Systems and Technology (ISSST) (May 2012).

As Published: http://dx.doi.org/10.1109/ISSST.2012.6227994

Publisher: Institute of Electrical and Electronics Engineers (IEEE)

Persistent URL: http://hdl.handle.net/1721.1/89825

Version: Author's final manuscript: final author's manuscript post peer review, without publisher's formatting or copy editing

Disaster Debris Management and Recovery for Housing Stock in San Francisco, CA

Zahraa N Saiyed, Advisers: Professor John E. Fernandez, Professor James L. Wescoat, MIT

IN the wake of the next large-scale earthquake in the city of San Francisco, an expected 85,000 households are expected to become uninhabitable and beyond repair, leaving thousands of residents with immediate needs for shelter. Coupled with an overwhelming 6.8 million tons of debris generated, destroyed lifelines and affected livelihoods, recovery planning becomes critical for immediate response and long-term sustainable development of San Francisco[1][2].

Learning from recent disasters in Haiti, New Zealand and Japan, this research addresses pertinent recovery issues by investigating the effects of a 7.2 magnitude earthquake in San Francisco, particularly the implications on the city's residential housing stock and impacts on the construction and demolition waste stream.

HYPOTHESIS

Debris clearance is a great priority in the aftermath of an earthquake, second to life safety and search and rescue. How debris is managed lays the foundation for infrastructure and development patterns. *This research posits that construction and demolition debris recovery can create local supplies of building materials in the redevelopment of wood-frame residential housing stocks, while simultaneously diverting from landfills.* Variables and policies influencing housing stock refurbishment are detailed in providing timelines for housing recovery.

METHODOLOGY

System Dynamics is an approach to understanding behaviors of complex systems over time with the use of feedback loops, stocks and flows. This method is used to analyze the material flow within the boundary of San Francisco after a 7.2M earthquake. Two integral systems being studied include that of housing units and construction & demolition waste streams (see Figure 1).

RESULTS

Using variables that are not adjusted by policy changes, the following results are projected for a 7.2M earthquake. Recovery of construction and demolition materials at a mandated level of 65% as per San Francisco's Ordinance 27-06 [3] results in: 1.5 million tons of recovered material; 3 landfill-years saved, assuming 500,000 tons capacity per year [4]; 70,000 ton increase of transfer station capacity for material processing; and a *recovery time of 6.8 years,* assuming that recovery is only in terms of refurbishing lost wood-frame residential housing stock.

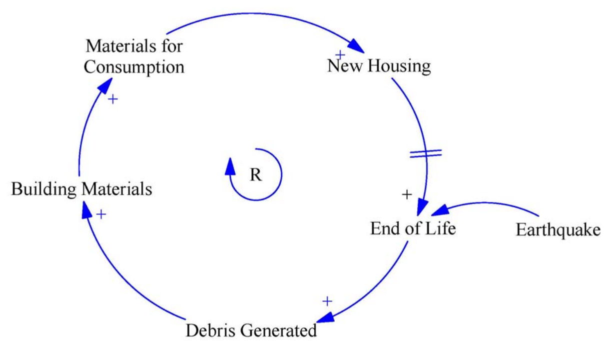

Figure 1. Driving causal loop diagram for research indicating reinforcing feedback loop of debris as feedstock for new materials in building construction.

CONCLUSIONS

Great potential exists for diverting disaster debris and converting it into viable building materials, given mandated recovery rates are stable or increased. Processing of recovered material for new building material delays overall recovery by 2 years in an extreme case, however, with the benefit of landfill diversions upwards of 1.6M tons. Finally, immense social benefits exist in localizing supply of building materials, which can have a significant economic and environmental impact as well.

ACKNOWLEDGMENTS

This research could not be possible without the support of Professor John E. Fernandez in the Building Technology Group, and the School of Architecture and Planning at MIT.

REFERENCES

[1] Applied Technology Council, *Potential Earthquake Impacts,* Community Action Plan for Seismic Safety, Redwood city, CA: 2010.

[2] California Emergency Management Agency, *Debris Management Training Manual.* Sacramento, CA: January 2010

[3] City and County of San Francisco, *Ordinance No. 27-06*. Sfenvironment.org: July 1, 2006.

[4] W. Kane, "*Yuba county May End Up With SF's Trash*" San Francisco Chronicle. San Francisco, CA: July 27, 2011.