DEVELOPMENT OF A RESILIENCE MANAGEMENT PLANNING, PREPAREDNESS, RESPONSE AND RECOVERY TOOL FOR CITIES

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ABSTRACT

This study highlights the capabilities of USGS’ ShakeMap software when coupled with a robust citywide building inventory and web visualization to perform scenario (what-if) analyses to aggregate and report key impact information, to aid city emergency planning and preparedness before, and recovery following, a major earthquake.

Emerging community resilience programs nationwide use an array of tools to assist in disaster planning, preparedness, response and recovery. The ability to aggregate and analyze in near real-time building and infrastructure hazard resilience at a city scale has been lacking. Whether analyzing anticipated needs for short-term recovery⁴ to deterministic or real-world events, or evaluating the impact of changes in public policy to city resilience, a ‘big data’ approach to aggregate and analyze data is essential. The analysis would deploy accepted scientific methodologies at a city scale to help determine impact such as:

- Estimating building damage to essential and post-hazard critical community facilities
- Estimating casualties
- Quantifying shelter and other community needs resulting from damage to housing stock
- Identifying transportation routes that are usable both for evacuation and delivery of emergency services and supplies
- Estimation of impact to energy supply and communication systems

Bentley Systems, the US Resiliency Council, and the City of Seattle are collaborating to develop a tool to provide natural disaster planning and preparation simulation capabilities to emergency

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managers and first responders. The tool will initially make use of the ShakeMap system developed by the USGS, a public earthquake information management system that is widely used by public and private emergency planners and responders. Integration of the ShakeMap platform with community-scale building inventory management systems has the potential produce valuable applications for cities, companies and institutions.

A city-scale simulation service allows cities and companies to input building inventory and critical infrastructure data, perform event simulations and what-if scenarios, and present key performance data and aggregated impact analysis in a city-scale web visualization format. Resilience of transportation networks will play a key role in raising overall community resilience. Bentley’s extensive capabilities in evaluating transportation infrastructure are thus able to extend the value of ShakeMap to include the performance of infrastructure and lifelines. Usefulness of the simulation can be extended to the private sector, banking and insurance, institutional stakeholders (e.g. universities), healthcare and other areas in order to create a broadly integrated community resilience program.

Figure 1. The Resilience Management Analytics Tool integrates science, building inventory, geographic information systems, seismic hazard and public policy with a user interface.

King County, Washington has a highly sophisticated property database, with information on every building that includes age, height, occupancy and structural material. These variables are enough to create a countywide HAZUS database that can be imported into the simulation tool.

Collection of building inventory data can be supplemented through the use of 3D digital mapping and “reality modeling” technology that is able to convert citywide renderings into vectorized building models.
Artificial intelligence systems can be employed to extract building data from these models such as height, plan configuration, the presence of tall stories and other metrics that affect building performance in natural disasters.
The simulation tool can be used after an actual earthquake event or with a hypothetical scenario, to estimate building performance individually, at a block or neighborhood scale, or aggregated by key functions. This information can be employed by emergency responders to gain essential situational awareness to allocate scarce resources to areas with the greatest impacts. It can be used by city planning departments and councils to establish long term strategies, such as seismic retrofit ordinances, that will address identified resilience deficiencies in key areas such as affordable housing or access to food.

Figure 5. Damage prediction methodology