Measuring Disaster Risk Around Portland College Campuses

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Introduction:

In the field of disaster research, earthquakes are complex, interdisciplinary, and in dire need of being understood for their impacts. With the intention of framing an approach to get into this complex field and develop a confident grasp on earthquake resilience, I ask: how can we plan for, and respond to, the impacts earthquakes have on structures in urban areas? Below, using the urban area of Portland, Oregon; I provide a focused, understandable and repeatable methodology for exploring vulnerabilities and hazards to earthquakes, from which an understanding of earthquake resilience can be gained, generalized, and applied to broader contexts. As a thesis statement, I argue that the need for improvised shelter structures in earthquake-prone urban areas is a gauge of the earthquake resilience present within that area, in which the need for improvised shelter structures is based on the disaster risk present in the urban area. The distribution of disaster risk around Portland college campuses reflects the social, economic, and physical vulnerabilities of populations in hazardous locations.

Background:

Disasters studies define the aspects of a disaster as events or processes that possess a temporal destructive characteristic at the core of the event, in which normality is disrupted to a point where assistance from outside resources is necessary to cope with the situation (Vacano et al, 2014). One can argue the natural event itself, is only a disaster in light of the human element of loss associated with the natural event. The scholarship of Blaikie et al (1994) shed light past the boundaries of geography for such definitions of disasters and vulnerability. It is indeed the human characteristic of natural disasters that opens up a vast field of research in the complex areas of risk, resilience, and mitigation. For example, the disaster placed on Japan in 2011 may have been of "natural" seismic origin, however, the disaster that unfolded was a combination of the natural events and technological failures or as Keith Smith (2009) denotes as a "nature-technical" disaster. However, "natural disasters" are what Wisner et al (2012), categorizes as; famine, biological hazards, floods, coastal storms, earthquakes, and volcanoes. These natural events vary from region to region but are nonetheless major risks for urban areas. Earthquakes occurring in urban areas can leave structures damaged and unlivable. The hazards posed by the building themselves and the exposure of their absence is a major vulnerability of populations who lack adequate housing locations and/or structural soundness; due to social, political and/or economic pressures (Wisner et al, 2012).

In Miller et al (2010), they examine the concepts of resilience and vulnerability, seeing how both approaches are primarily concerned with how systems respond to change. In light of resilience, Smith (2009) defines resilience as the rate of recovery from a stressful experience like a natural disaster, thus reflecting the capacity a society can cope and recover from such an event

(25). Resilience as an aspect of social processes and how recovery is impacted by such processes is a great insight for improvised shelter structures and the resilient aspect of them.

Observed in the aftermath of Hurricane Katrina; though not an earthquake, the event sparked a similar major displacement of residents and caused major damage to buildings, improvised structures rose out of the disaster-stricken environment reducing the exposure and improving the livelihood of many people (Rodríguez et al, 2006). Sheltering came as an improvisation and pro-active response to the hazardous event, displaying the capacity of the society to absorb such a change to their normal lifestyles. Social behavior preceded the shelters and henceforth resilience to the situation was created through social action. Understanding the social systems and affected people is a key element in examining resilience and earthquake risk. The generation of a shelter is a byproduct of being aware of people who need sheltering and pro-actively responding to the hazards posing threat to their wellbeing. This is true in the event of needing to improvise a structure to be a shelter or fixing predetermined shelters through planning and forethought.

Situated Context:

The question is not "*if* the earthquake will happen", the question is "*when* will the earthquake happen". Portland, Oregon, is located in a region subject to experience substantial shaking if a magnitude 9.0 earthquake is released from the Cascadia Subduction Zone (Oregon Resilience Plan, 2013). Urban areas existing in regions with similar risks present is a phenomenon that is occurring across the globe, such as cities found in Japan and New Zealand. However, the unique hazard that Portland faces is Portland itself; a major urban area at risk to earthquake hazards with little to no earthquake experience or resilient infrastructure. It was only after much of Portland's major water/wastewater, energy, communication, and transportation infrastructure had been built, did new knowledge reveal that this infrastructure might need to withstand some serious shaking from a large earthquake (Oregon Resilience Plan, 2013). Likewise, in the 1980's geologists finally came to the consensus that earthquakes were a far bigger hazard to Portland than previously thought (Flynn et al, 1999).

Portland college campuses have a key and perceivable role in the communities surrounding the college. Colleges have the ability to take part in an earthquake response scenario through seeking public assistance by the development of Initial Damage Assessment (IDA) and Preliminary Damage Assessment (PDA) that can then be submitted to the most local authority, in this case being the City of Portland (Oregon Gov). If a large number of residents in the surrounding area are without food, shelter, or water, they will begin seeking these basic survival needs (Blaikie et al, 1994).

Methods:

Using the situated context of Portland, I ask how is the earthquake risk distribution around Portland college campuses impacting the need for improvised shelter structures? My methods will answer this question with the assumptions of disaster risk outlined by the *Progression of Vulnerability* framework from Wisner et al (2012). This framework will be justified in finding the need for improvised shelter structures by its feature of interpreting physical, social, and economic vulnerabilities. The disaster risk present will shed light on the need for improvised shelter structures, which I argue highlights the earthquake resilience present in the area. My methods are as follows:

1. Designate possible improvised shelters for vulnerable populations
    a. College campuses: required to have hazard mitigation planning by authorities. This includes possessing resource provisions and they have a key and perceivable role in the communities surrounding the college.
2. Find out who is vulnerable in the area that may be in need of a improvised shelter structure
    a. Populations considered vulnerable through their fragile livelihoods; elderly, minors, unemployed, and limited English proficiency.
    b. A radius of 0.5-miles: transportation infrastructure will be heavily damaged in an event where improvised shelter structures will be needed. Walking will be the main mode of transportation and people further than 0.5-miles might not walk or not know the college's location.
3. Find what hazards are present around the college campuses
    a. Magnitude 9.0 earthquake peak ground acceleration (PGA) shakemap: PGA is a value of shaking used in engineering and design, this shaking can damage residential housing leading to the need of an improvised shelter structure
    b. Unreinforced masonry buildings: have a high risk of failure during a magnitude 9.0 earthquake event.
4. Find how the possible improvised shelters are exacerbating or reducing the risks present
    a. Information from the college's emergency/crisis management online resources: accessible to the public and is largely based on the college's emergency response plan that every college is required to have.
5. Interpret the disaster risk surrounding the possible improvised shelter structures

Analysis:

In implementing my methodology, I used ESRI’s mapping and analytics platform; ArcGIS. The platform provided essential tools for mapping vulnerabilities, hazards and I could see where things were, how much there was, and how the information was connected.

My procedure first began with creating polygon shapefiles of the perimeter of the college campuses I designated as being possible improvised shelter structures; Lewis & Clark College, University of Portland, Reed College, Concordia University, Portland State University (PSU), and Oregon Health and Science University (OHSU). This was done by drawing the perimeter of the college campuses stenciled off of ArcGIS’s satellite basemap, using the construction editing tools on an empty layer, and then finally saving the edits. I then added census data onto the map that was in block groups.

Next, I created the 0.5-mile buffer radius around the college campus polygons. This was done by first creating a centroid of the polygons, then identifying the centroid as a facility that could then have a service area generated around it. The service area was created using data of Portland’s street network, and the buffer zone reflected the network distance surrounding the college campuses. I found that the buffer zones of PSU and OHSU closely interacted so I decided to join the two buffer zones.

With the buffer zone shape created, I then clipped the demographic data with the buffer zone to isolate the people with this 0.5-mile radius. Some of the block groups were cut by the clip, so I used the ratio of the new area that was in the buffer area with the demographic population and assumed the ratio of the area would give me an accurate representation of the population present in the buffer zone. Finally using the same clip tool method, I found the number of unreinforced masonry buildings and PGA values within the buffer zone.

Finally, I went to each of the college's websites to sift through their emergency procedure information that is available to the public and interpreted if it exacerbated or reduced the disaster risk.

Results:

Utilizing the Progression of Vulnerability framework of analyzing disaster risk from Wisner et al (2012), I examined the vulnerability of the residents and hazards posing threats to the residents around various Portland college campuses. The results were generated using GIS spatial maps and interpreted with the framework.

Lewis & Clark College:

The vulnerable residents surrounding Lewis & Clark College have the least degree of disaster risk than the other college campuses. The vulnerable residents are located on top of a moderate zone of hazard, but there are only 2 URM buildings that would be affected by a large earthquake. If shaking does occur, hazardous buildings are not prominent in their surrounding area. The school plans to use its website and radio channel to post updates after an emergency situation. This could be helpful for the vulnerable residents who have access.

University of Portland:

University of Portland does not have the least amount of disaster risk, mainly due to the areas that have URM buildings and the shaking expected to occur, but it is still less than other colleges based on the hazards and vulnerabilities present. The College does a good job in offering emergency preparedness resources for the public.

Reed College:

The disaster risk surrounding Reed College is showing a need for the college to provide improvised shelter structures. The area has 7 URM buildings that could cause major harm but is not a hazard to a majority of the vulnerable populations. The college provides decent public information regarding its plans for after an earthquake event but is not useful in reducing the disaster risk since it does not address the vulnerabilities present.

Concordia University:

Concordia University is surrounded by a fair amount of disaster risk and the need for it to be an improvised shelter structure is prominent. The information from their website for the public is not plentiful in preparation or helpful to the vulnerable populations surrounding the campus. There are 22 URM buildings in the surrounding area and also a large majority of minors.

PSU/OHSU:

The OHSU and PSU campuses have the most vulnerable surrounding areas and the most need to provide improvised shelter structures. There are 381 URM buildings in the area and a large number of vulnerable populations. OHSU provides good information on planning, responding, and recovering from an earthquake event. PSU, provides pretty good information for the public, none addressing the URM building problem however.

Comparisons/Generalizations:

What I see from the results, is that unsafe buildings are a very big factor in whether or not there will be a need for improvised shelters in the aftermath of a large earthquake. The disaster risk and henceforth the need for improvised shelters increased when large numbers of URM buildings were present. Similarly, in San Francisco, a major obstacle in San Francisco's earthquake resilience to the Hayward and San Andreas Fault lines are soft-story buildings; a multi-story building with open spaces that are not braced and lack stability in terms of earthquake engineering design (Baldridge, 2012). Resilient housing is a large factor in an urban area's resilience to earthquakes, in which the demand on emergency response is decreased when residents can stay in their homes and the demand for a post-earthquake shelter is greatly decreased (Baldridge, 2012). Furthermore, looking at URM school buildings in Turkey, Yilmaz et al (2013) concluded that these types of buildings will perform poorly in the event of an earthquake regardless of their size or shape. There was no specific way to build URM buildings that would make them seismically stronger or resistant, it was the material used to build that made the most influence on performing well in an earthquake (Yılmaz et al, 2013). Building performance and resistance to earthquakes are major elements of an urban area's earthquake resilience.

Next Steps/Further Research:

In planning for, and responding to, the impacts earthquakes have on structures in urban areas one needs to address aspects of the structures building material and location. Improvised shelter structures are only needed if the present structures are unsafe to an earthquake event. Therefore, if structures in an urban area are seismically resistant, an earthquake would have much less of an impact on the structures making the area more earthquake resilient.

Portland is in an area of major earthquake disaster risk and the need for shelter structures reveals its vulnerability to large earthquakes. The URM Seismic Retrofit Project is a project proposed by the Portland Bureau of Emergency Management's Policy Committee. The project seeks to require retrofits done on URM buildings in Portland, however public comment has shown that small business owners are worried about rent increases from such retrofits and building owners with smaller budgets would have a harder time completing the retrofits of their buildings (City of Portland). However, I recommend that this policy change in the aspect that it should focus on the downtown area in Portland. Retrofits would be mandatory, tax reductions would be used to help building owners and school buildings would receive federal aid for the costs of the retrofits. Furthermore, I recommend that a policy be made to require implementation of earthquake preparedness information and activities into education curriculums. Earthquake resilience stems from living in a resilient manner day-to-day.

Above I established a method of exploring vulnerabilities and hazards to earthquakes, and ultimately an understanding of earthquake resilience can be gained, generalized, and applied to broader contexts. The demand for improvised shelter structures, in urban area exposed to disaster risks, can be a measure of the earthquake resilience present in that urban area.

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