

Geog 333 Final Project
Group 1 Earthquakes

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Case Study - Salt Lake County, Utah

Background

Utah's most populous county, Salt Lake County, has never experienced a direct earthquake since settlement in 1847. The metropolitan area of Salt Lake City sits on top of a sediment filled valley right along historically active fault line. Geologists have discovered that the Wasatch Fault zone has been active for millions of years with an earthquake about every 1,200-1,400 years to relieve the pressure built from extension of the North American plate. The last earthquake was discovered to have occurred 1,283 years ago, leaving this place sitting in the expected time range for the next slip.

Past earthquakes suggest a massive earthquake is possible here in the near future and could have a magnitude of 7.5 causing widespread destruction in the area. The region was built up before earthquake codes were even in place before some of the more prone areas leaving Salt Lake County extremely vulnerable to a large earthquake. The county has no previous experience with earthquakes since settlement and therefore means this earthquake will come as a surprise to many.

With the latest discovery of this potential hazard, and with its unpredictability other than its expected range of 200 years, it is vital to implement a mitigation plan as this could happen any day now. The mitigation plan should fit and cover the majority of the stakeholders, and the best way to do that is to simulate it by having the class participate in a mock mitigation planning activity.

Class Activity - Day 1

Before beginning the activity, our group of earthquake hazard experts gave a brief 10 minute case study presentation of the potential risks due to an earthquake in the Salt Lake

County area. Each student was then assigned a specific individual role belonging to one of four different stakeholder groups. These roles ranged from being a middle class working parent, living in a brick apartment building, to the Mayor of the city, who spends most of his time in a local government building. Other roles included Business owners such a sandwich shop owner and oil and gas refinery, and special interest groups that would be affected by an earthquake in the area, even though they may not live there physically. Students were then split into groups based on the type of stakeholder position they were a part of. The four groups were citizens, business representatives, special interest groups, and government officials.

As a group, students determined their individual social vulnerabilities due to an earthquake and brainstormed mitigation efforts that would best suit them as a whole. The groups identified the physical and social vulnerabilities and documented them onto a vulnerability diagram facilitated by various overlay maps of the region's geography. These maps included city infrastructure like roads, railways and airports, as well as vital emergency response facility locations. Additionally, there were maps of some social aspects, such as the percentage of hispanic population and percent of rental homes in the area. The overlay included fault lines, possible liquefaction zones and estimated damage extent boundaries. Students aimed to fill out the adaptive capacity portion of the chart to come up with a list of possible mitigation efforts to consider for the second part of the activity.

Class Activity - Day 2

On the second day of the activity the groups were reassembled and asked to review all of their possible mitigation efforts and to pick their top, up to ten, choices they would like to have implemented into the county's mitigation plan. After a brief meeting the groups then presented their roles to everyone else followed by a list of their top mitigation procedure choices.

Group Consensus

The following earthquake mitigation plans were presented as each stakeholder's priorities to be considered for the county's final mitigation plan. Their specific requests are colored (more on the specific color is covered afterwards).

Citizens were looking for **earthquake proofing emergency shelters**. This was brought up in the case that people cannot evacuate there would still hopefully be a standing building that would provide essentials. They were also interested in **earthquake proofing emergency service centers** such as fire departments and ambulance garages, that way in the event of an earthquake they could still provide assistance. A man with a father in law that spoke little english pushed hard for **bilingual responders**, ones that were able to speak and convey the situation to people who otherwise would not understand. The **time it took for responders to make it to the scene** of an emergency was also a hot topic. In the event of an emergency, those who are unable to drive themselves will be **reliant on public transportation**, this needs to be dependable. Concerns were raised due to the lack of response after Hurricane Katrina. The majority of these people were **elderly** individuals or students at the nearby universities. The students expressed concerns and were desiring a **campus emergency shelter** since most students lack vehicles. Students also desired a **campus wide emergency plan**. Several citizens expressed a concern about **avalanches**, they were worried about the houses on the hill sides being in danger. Roadways were a topic that started conversations, since some major roads were located near or on faultlines this presented a serious risk of destruction. It was suggested that other roads potentially be created. The buildings in Salt Lake County are not built to withstand an earthquake townspeople wanted them **reinforced**. Current developments that are located along fault lines and vulnerable areas are going to be **reconsidered for future development**, the argument was "why keep building on vulnerable ground".

Business representatives were interested in seeing changes that would not affect profits and financial stability. It was suggested that **evacuation sites** be moved westward. This would put major roads and highways away from the city, being located on higher grounds. Much of the

current roadways are located in low elevation areas having the greatest probability of flooding. Therefore anyone located within the city would most likely be trapped. [Protected clean water supplies](#) was also a point of emphasis. The effect of liquefaction and potential flooding could contaminate water sources affecting multiple businesses. Potential contamination of water resources would be the result of a non-point source of pollution. Local businesses owners particularly were concerned with this such as a local sandwich shop owner. without clean water businesses may be forced to close until the problem is fixed. This is also why [liquefaction mitigation/prevention](#) was also talked about. While the best alternative would be to relocate businesses it was discussed in the group that this would not be feasible or reasonable. There are ways to mitigate the effects of liquefaction however by improving the durability the soil by means of vibroflotation and dynamic compaction. [Earthquake proof dams](#) were suggested so that the transport of water wouldn't be an issue. [Enhanced building codes](#) should be implemented so that businesses don't have to deal with the stresses of liquefaction. For the future all businesses should equip their buildings with strong foundation mats so that loads from liquefied zones can be transferred to stronger adjacent ground. Also, shallow foundation elements should be tied together to decrease the amount of shear. Underground utility [pipelines](#) are especially vulnerable to seismic events and require careful organization and structuring. Critical utilities such as natural gas, clean water and sewage can be knocked out for extended periods after an earthquake; the extent of the damage is often difficult to determine and locate due to the wide area being affected. Furthermore, broken gas mains pose a severe fire/explosion hazard, while damaged sewage and water pipes can create a severe environmental hazard. To reduce the impacts created by damaged utilities, improvements in design and placement of underground utilities can be implemented in the long term. Grouping utilities within hardened casings will do much to minimize damage and expedite repair efforts.

The special interest groups wanted to make sure there were more [public information campaigns](#), for the earthquake hazard, implemented through social media and the local

churches, which are still considered as the center of the community. They would also like the county to **implement earthquake insurance availability** into the area without making them look like the enemy. This may require some help with the media presenting the companies as a friend. Aside from the mentioned social concerns, physical vulnerabilities were also addressed. **Strengthening building codes** of community buildings, airports and highways were thought to be of importance. Conservation groups were concerned with preserving the landscape and preferred **reinforcing existing facilities** as opposed to new construction.

Government Officials were seeking improvements to **emergency response** procedures and **Incident commands** to help mitigate secondary hazards such as fires and spills. They also wanted to be able to **request outside aid**, making sure surrounding areas were aware and able to help when needed. It was suggested that **emergency response drills** be performed so that specific facilities (such as schools and hospitals) will be prepared for the real event. Increasing **public awareness or hazard education** were also of interest. Special attention was requested towards **evacuation procedures** making sure there are **established safe transportation routes** in the event of a disaster. The group wanted to perform **assessments of current road stability** to determine if they should be reinforced or replaced. Due to the **vulnerability and limited capabilities of public safety departments** in the immediate aftermath of a disaster, efforts to restore these services is of importance.

After presenting, the groups were then asked if they had an opposition to any of the suggested plans. A few members had expressed some concerns with the avalanche protection plan, some stated that current methods were sufficient and efforts should be focused elsewhere.

Conclusions (Mitigation Plan):

There were three main concerns: infrastructure and building safety, public safety and evacuation, and emergency response. These were classified by color as seen above. **Blue** was for infrastructure and building safety, **red** for public safety and evacuation, and **yellow** for emergency response.

The civilians were most concerned about their own safety and evacuation. Businesses were mostly concerned with protecting their assets and evacuation routes, while the special interest groups have public safety and infrastructure & building safety as the prerogative. The government tended to want to preserve the current way of life.

The infrastructure and building safety plans were prominent in each group's proposal. The most popular proposal was to reinforce current buildings to codes so that they could be earthquake resistant. This would involve cross bracing existing buildings to help absorb the stresses experienced during a quake. Since the county has faults all around it, it was suggested that the county rethink building locations to avoid faultlines. The county is located on what used to be an old lake bed, so liquefaction poses a serious danger. It was proposed that efforts are put forth to mitigate and/or prevent such a risk. Potential solutions include studying the area to find which soils are the most compact and conducive for building, and to potentially reinforce current buildings. There are several dams in the area that should be studied and tested to see if they would withstand the stresses put forth on them by a quake. If these dams cannot withstand the potential shaking, then they will need to be fortified to ensure the safety of the people. The underground pipelines also need to be examined and fortified to reduce the risk of a fracture. Underground lines have been shown, in the past, to contribute heavily to the total damage after an earthquake hits. The road network around Salt Lake County appears to be particularly vulnerable, where several of the roads pass over faultlines. These roads would potentially be destroyed and thus be impassable for escape in the event of a quake. Although costly, the road network needs to be revamped to withstand an earthquake, or even potentially relocated. Ski slopes and the natural beauty of the area attract tourists in Salt Lake County; Thus the airport needs to be reinforced and protected in the event of an earthquake, to ensure unhindered transfer of relief materials and resources.