Response System Application

THE RIGHT DISASTER RESPONSE SYSTEM

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RESEARCH TOPIC

What role does architecture play in post disaster response? How can architects become more involved with responding to disasters? How do we keep in mind that "Emergency management is not just the responsibility of emergency managers."? (Syllabus, pg.5) These were my driving questions throughout this semesters research to develop my thesis. The research that was conducted is to provide a background to fully develop a disaster response system that has three important elements; a response system smartphone application, casualty collection units, and temporary couchette units.

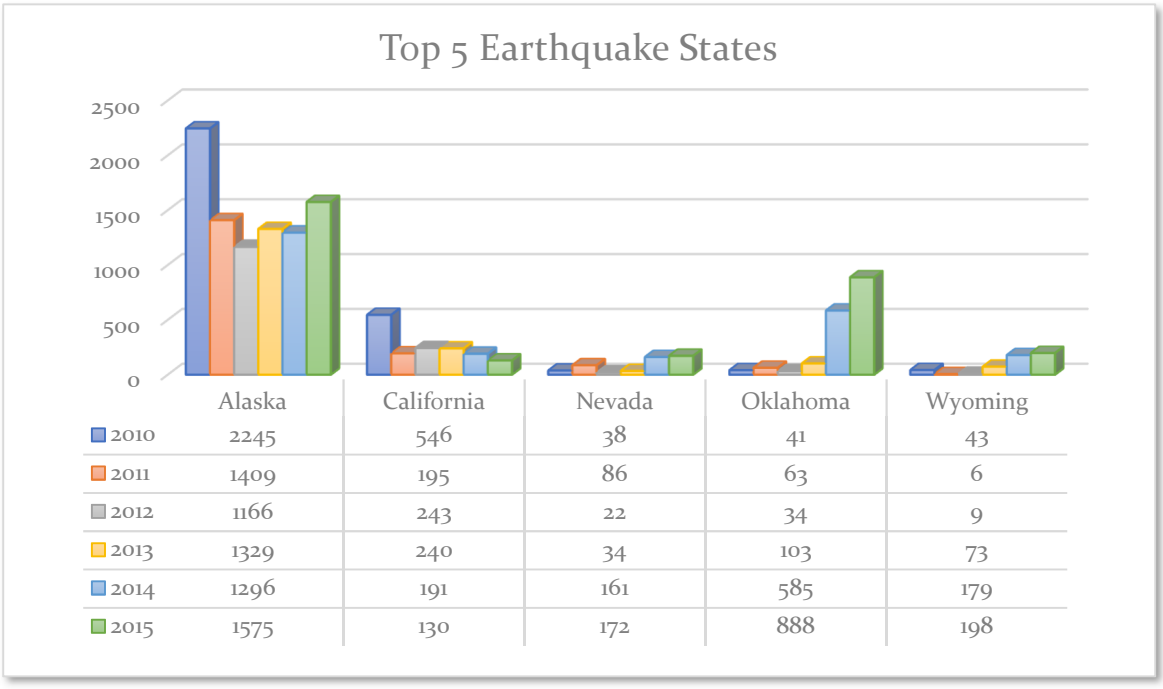
This semesters focus was to start developing the response system smartphone application that can be used by emergency managers, first responders, hospitals, and government officials. Currently the smartphone application has been developed to the point of producing general data based on the ideal system output numbers for the casualty collection units and the temporary couchette units. It is expected that next semester the output of the response system smartphone application will have more solid numbers based on the final design of all unit types sent.

The entire response system with every element could be a valuable resource for first responders that they currently don't have during disasters. It will also provide a uniform response system throughout the United States.

BACKGROUND

A disaster can be defined as an interaction of nature and people that results in the destruction of property and loss of life. Following is a list of disasters and their definitions which are all events that have and can occur again in the United States:

Earthquakes are “a shaking or trembling of the earth that is volcanic or tectonic in origin”. (Merriam-Webster) These happen in almost every part of the United State, most are not felt by people unless they are greater than a 4 magnitude, but they are picked up on seismic readings, which is shown in the data that has been compiled below. I graphed the top five earthquake states to show the ones that are doing the most moving throughout the year.



	Alaska	California	Nevada	Oklahoma	Wyoming
2010	2245	546	38	41	43
2011	1409	195	86	63	6
2012	1166	243	22	34	9
2013	1329	240	34	103	73
2014	1296	191	161	585	179
2015	1575	130	172	888	198

Table 1: Rae, USGS Data

The surprising thing about the collected data is that where earthquakes are occurring isn't just limited along the points of the continental plate and the oceanic plates. As the map below shows earthquakes happen throughout the United States with an average of 2,300 earthquakes a year.

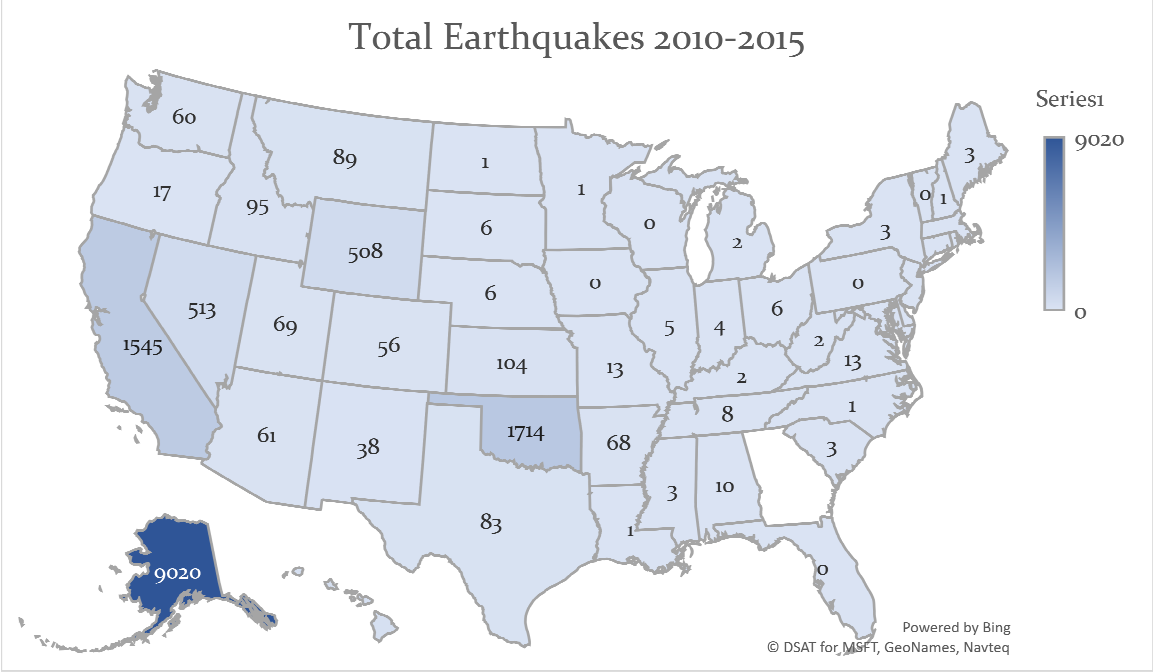


Figure 1: Rae, USGS Data

Floods are "a rising and overflowing of a body of water especially onto normally dry land". (Merriam-Webster) Flash floods are "a local flood of short duration generally resulting from heavy rainfall in the immediate vicinity". (Merriam-Webster) The interesting thing about floods of any kind is that there is a chance for it to happen almost anywhere with the right amount of water. There are places in the United States that flood every year, and there are places that need different storms to compound on each other to

create the disaster. Blow is the data that has been collected to represent the major floods that have occurred over the years.

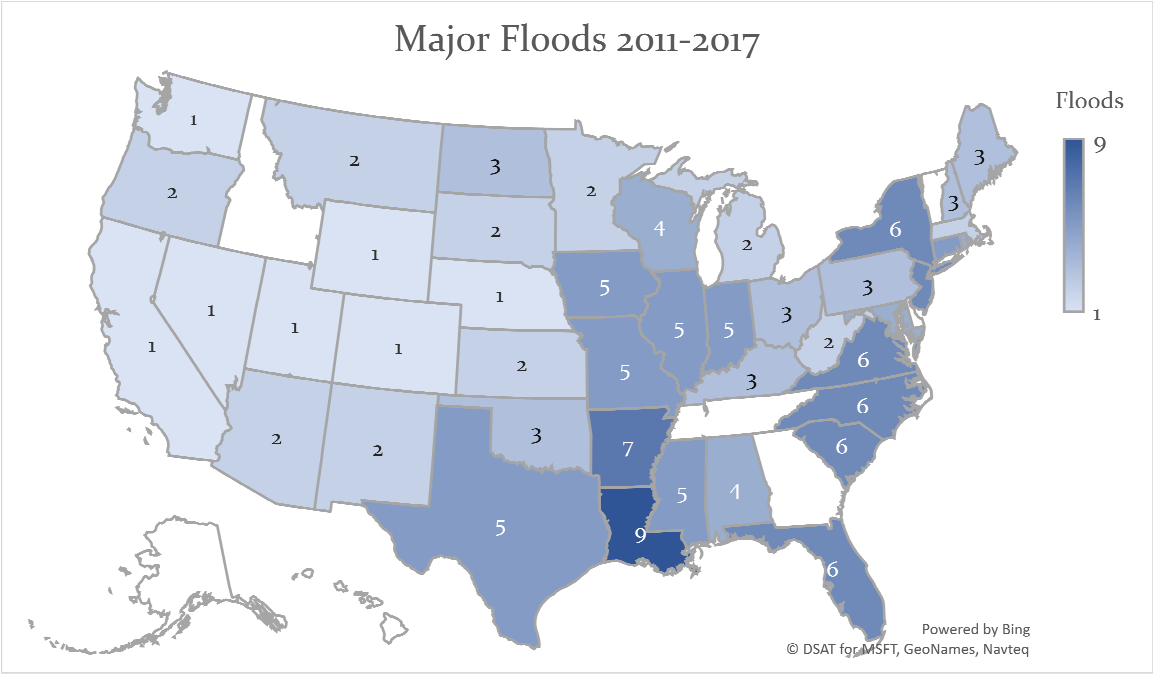


Figure 2: Rae, USGS Data

Hurricanes are "a tropical cyclone with winds of 74 miles per hour or greater that occurs especially in western Atlantic, that is usually accompanied by rain, thunder, and lightning, and that sometimes moves into temperate latitudes". (Merriam-Webster) Cyclones are "a storm or system of winds that rotates about a center of low atmospheric pressure, advancing at a speed of 20 to 30 miles an hour, and often brings heavy rain". (Merriam-Webster) These types of disasters are picking up strength as the overall temperature of the Atlantic Ocean increases, which provides the storm with a longer life span. From 2011 to 2017 about $574 billion worth of damages has occurred due to hurricanes in the United States, below is the price of damage caused by each.

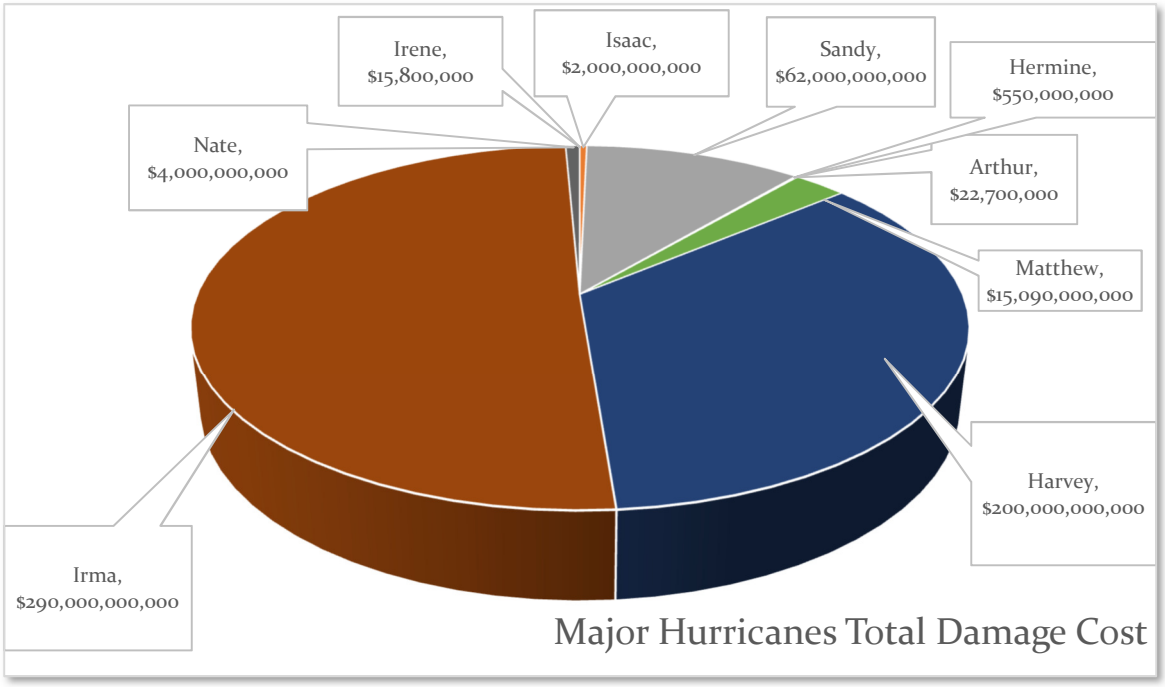


Table 2: Rae, NOAA Data

Landslides are "the usually rapid downward movement of a mass of rock, earth, or artificial fill on a slope". (Merriam-Webster) These seem like the turtles of disasters but can cause mass devastation depending on their location as it brings tons of debris that includes mud, rocks, trees, and anything else in its path. Any combination of earthquakes, volcanic eruption, erosion, excess weight, increased rain fall, deforestation, and large snow melts along with rain can set this disaster into motion. The speed and direction are dependent on the degree of the slope on where the disaster originates. Regions located near the Appalachian Mountains, the Rocky Mountains, and the Pacific Coastal Ranges are at a higher risk of this disaster, however, they can occur anywhere.

Tornadoes are "a violent destructive whirling wind accompanied by a funnel shaped cloud that progresses in a narrow path over the land". (Merriam-Webster) People

are in awe of these types of disasters, that can strike when the conditions are right, however, you don't know exactly where until they start forming funnel clouds. Shown is a graph representing the states with the highest amount of tornado activity during the given time.

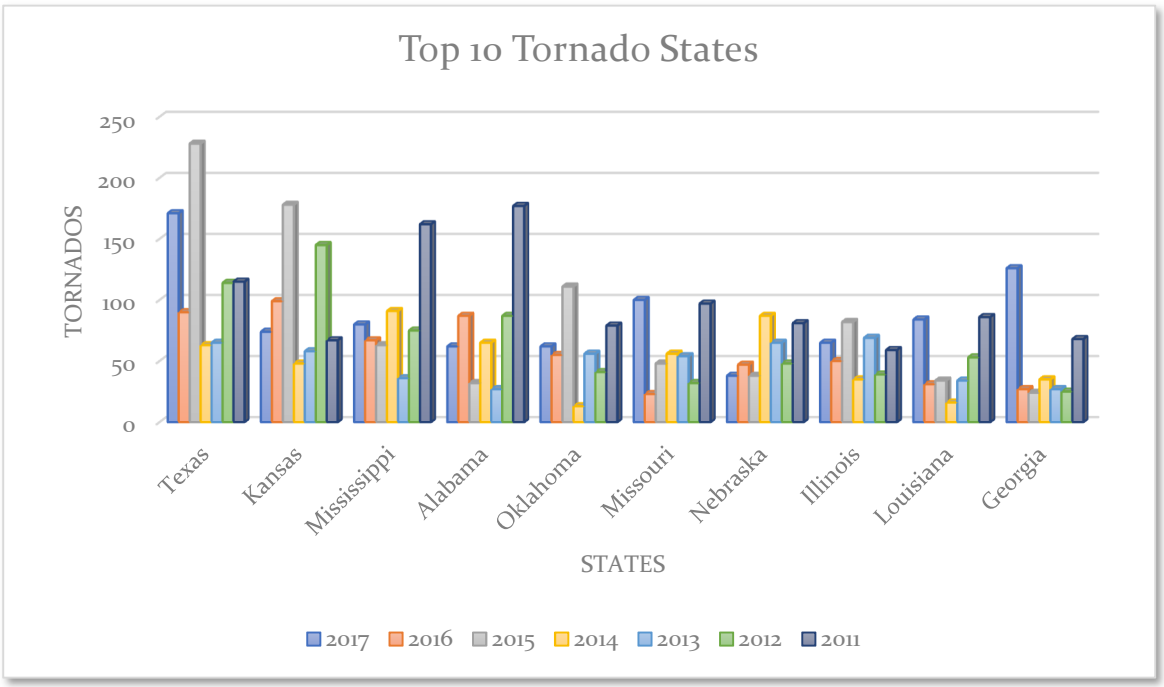


Table 3: Rae, USGS Data

Since tornados can occur in any state given the right conditions the data that was collected during this time frame was surprising that some states like Alaska, Hawaii, and New Hampshire have not experienced any during this time, which is represented in the map below.

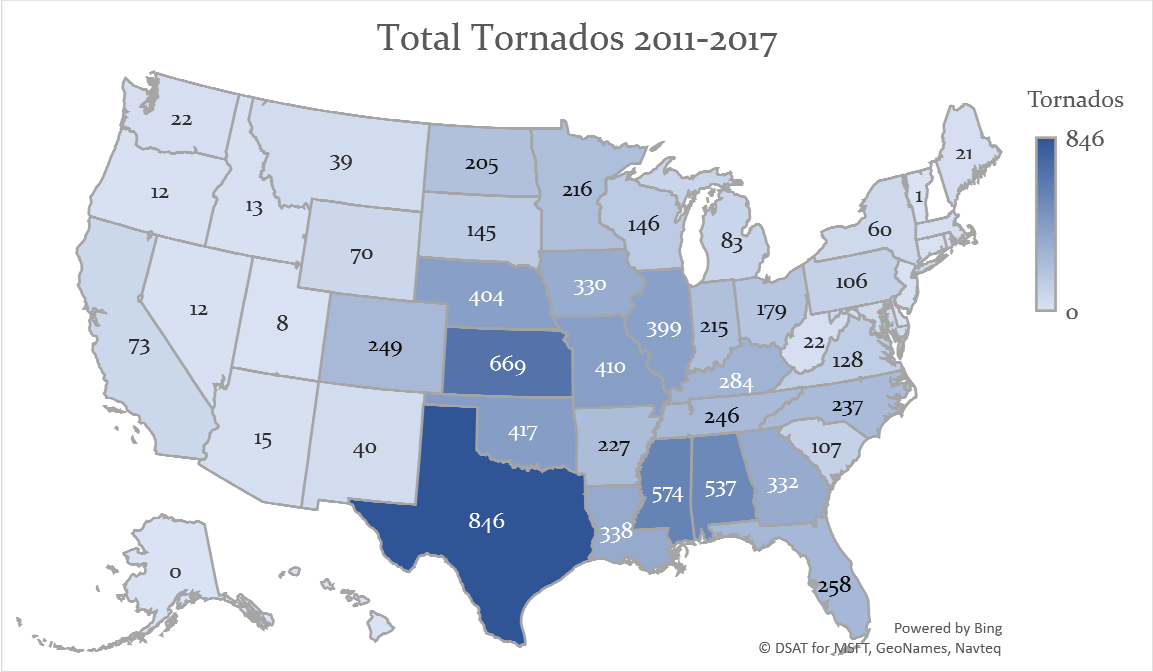
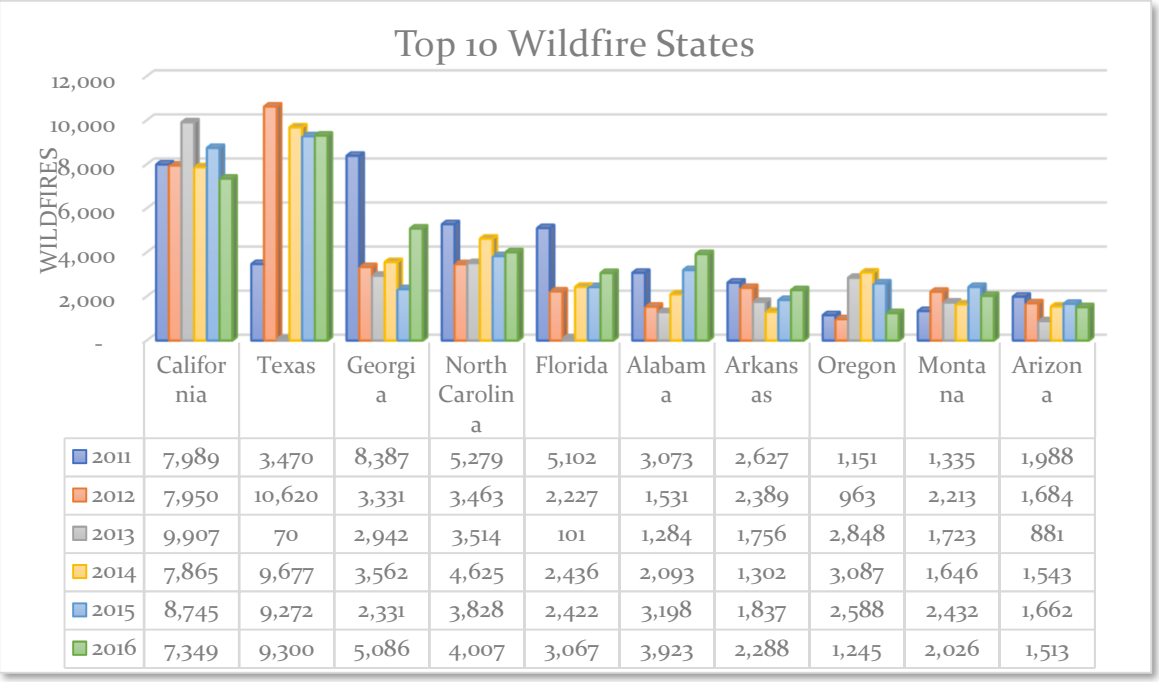


Figure 3: Rae, USGS Data

Tsunamis are "a great sea wave produced especially by submarine earth movement or volcanic eruption". (Merriam-Webster) These are difficult to predict sometimes and be able to give enough forewarning based on their epic center. For example, if the Cascadia subduction zone produced an earthquake it would create a tsunami just off the west shore of the United States. With the location of the epic center so close and it being right after a major earthquake it wouldn't allow enough time for people to safely evacuate. To help provide an early warning for populations of this disaster type there are different types of wave equipment being developed and refined to get readings of an approaching wave since they are difficult to identify in the open ocean. These alarm systems are only helpful if the epic center is far enough away to provide enough time for people to start evacuating after the warning is sent.

Wildfires are “a sweeping and destructive conflagration especially in a wilderness or a rural area”. (Merriam-Webster) These are affected by many factors such as area dryness, vegetation, fuel, and wind which makes their movements sometimes difficult to forecast. They can be created from natural means like lightning strikes or caused by human carelessness. These are unique disasters because form the first signs responders are trying to get it contained enough to extinguish it.



	California	Texas	Georgia	North Carolina	Florida	Alabama	Arkansas	Oregon	Montana	Arizona
2011	7,989	3,470	8,387	5,279	5,102	3,073	2,627	1,151	1,335	1,988
2012	7,950	10,620	3,331	3,463	2,227	1,531	2,389	963	2,213	1,684
2013	9,907	70	2,942	3,514	101	1,284	1,756	2,848	1,723	881
2014	7,865	9,677	3,562	4,625	2,436	2,093	1,302	3,087	1,646	1,543
2015	8,745	9,272	2,331	3,828	2,422	3,198	1,837	2,588	2,432	1,662
2016	7,349	9,300	5,086	4,007	3,067	3,923	2,288	1,245	2,026	1,513

Table 4: Rae, National Interagency Fire Center Data

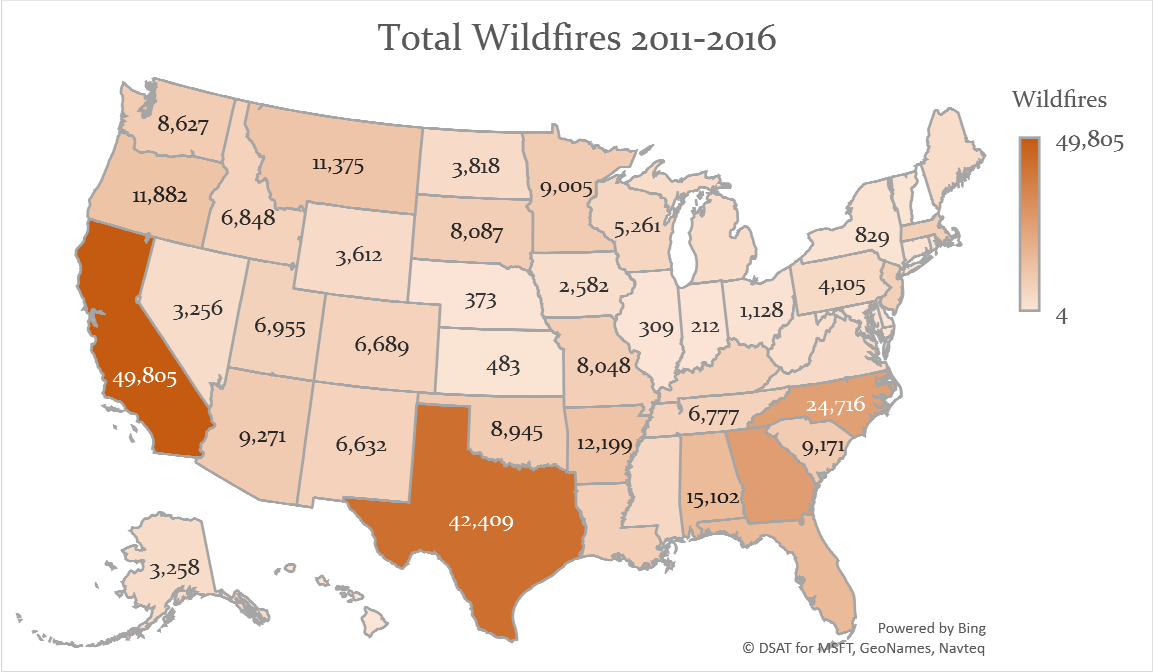


Figure 4: Rae, National Interagency Fire Center Data

Volcanic is "related to, or produced by a volcano", (Merriam-Webster) eruption is "an act, process, or instance of eruption". (Merriam-Webster) People may think that since they don't live on a tiny island that this event will never occur, they are wrong. There is a total of 169 active and 110 dormant volcanos in the United States and they aren't all located on islands.

Figure 5: Rae, NOAA Data

There is a disaster management cycle that is discussed by emergency managers that doesn't always follow the same path for every disaster. This cycle is pictured to the right and showing the different parts of dealing with disasters before, during, and after. These phases are defined in this paper to provide a base definition for how they are used within this document since there are many different definitions of each.

Figure 6: Disaster Management Cycle

"Mitigation consists of pre-disaster activities that involve the assessment of risk and lessen the potential effects of disasters; increasingly, it also involves post-disaster activities to reduce potential damage from future disasters." (Rubin, pg. 140) There are

only so many ways to work to mitigate disasters and most times states don't spend the money to accomplish them. It is also important to keep in mind that you can't mitigate for every disaster out there it is impossible.

"Emergency preparedness refers to the readiness of a political jurisdiction to react constructively to threats from the environment in a way that minimizes the negative consequences of impact for the health and safety of individuals and the integrity and functioning of physical structures and systems." (Perry, Lindell, pg. 3) This is where the preassembly of the casualty collection units and the temporary couchette units is important. The response system smartphone application that will provide those jurisdiction with a direct link to those units.

Response is "the immediate actions taken before, during, or after a hazard event to save lives, property, and/or the environment." (Jensen, pg. 2) This is exactly where the entire response system comes into play. Local communities can easily become over whelmed by the disaster if they have no previous training or the enough resources.

"Recovery is the differential process of restoring, rebuilding, and reshaping the physical, social, economic, and natural environment through pre-event planning and post-hazard event action … with the goal of returning all stakeholder groups to self-sufficiency within generally accepted standards…" (Jensen, pg. 2) This is where the casualty collection units and the temporary couchette units can be used longer if the need for them is still there. These include but not limited to hospitals needing to be rebuilt or rebuilding homes.

FORMULATION OF PROBLEM

Nature is an ever-changing element in our world that we are unable to control or predict so all we can do is react. Throughout history we have been reacting to different natural events that have caused disasters. The ground shakes and we develop building codes that prevent certain materials from being used for building structure. Winds increase and start picking up people, animals, large objects, and destroys buildings so we produce alarm systems and shelters for people to have a safe place to wait out the storms. Waters become choppy with high winds, so we board up our buildings and hope that the major part of the storm doesn't swing our way. Increased rain causes the mountains to slide and the valleys to fill with an excess of water and mud, so we build land gates to hold back the excess rock and over flows to release the water from the damns.

These are only some of the reactions we have to disasters, and all of them fall under the categories of mitigation and preparedness. Where is the response? How as architects can we provide a system that can help the way we as a nation respond? Is there a way to have that system of response available to first responders? These are just some of the questions I have been working to provide an answer for. The best part about this answer is that it isn't the only one, people will keep developing new ways to respond. I believe architects can play a large role and here is one of the ways they can.

METHODS AND TATICS

The first step in the journey to develop an effective response system is to look back, and learn from the past. Which involved diving head first into the history of disasters which have occurred throughout the United States. This shows how response has developed throughout history, the frequency of occurrences, the impact on the different areas, and the injuries involved. Knowing how people have and will respond to a disaster is highly important since people will always be a major factor in every response, and will always be the wild card in each event. History confirms that every disaster is unique, and each event causes a different response, however, there are underlining items that seem to always remain constant. This historical research aided in developing the questions that are futured on the response system smartphone application to calculate the required aid for the survivors, which is supported by the design of casualty collection units and the temporary couchette units.

Developing the response system smartphone application is important to designing the entire response system. The smartphone application will provide the calculated totals of the units that are required to provide aid for disaster survivors, supply information about the units, transportation methods, and the maps of the local area. It is the goal of this entire project to provide this application to first responders, emergency managers, hospitals, and government officials to provide easy access to the entire response system. The response system smartphone application will provide a resource that isn't currently available to communities during a disaster. This application will help develop a uniform

response system for the entire United States that is highly effective on providing the required aid. Since nothing can produce aid data without asking questions the following questions were developed in the response system smartphone application to gather the required information to design the best response possible. These questions are listed and explained farther to show the reasoning behind each question.

What kind of disaster? This question refers to the main disaster that is the epic center of the event and the start of the following disasters that may be involved in a chain reaction. The selection of answers to the question are earthquake, flood, hurricanes, landslides, tornado, tsunami, wildfire, and volcanic eruption. Only one can be selected since there is only one event to start the chain.

What other disasters are created? This question refers to the disasters that are created from the epic center disaster, the chain reaction. The selection of answers are floods, fires, landslides, tsunamis, and volcanic eruptions. Multiple secondary disasters can be selected since one event can cause many different disasters. Answers to this and the previous question determines the types of casualty collection units that are sent.

What is the location? This question is linked to google maps that are available at the bottom of the response system smartphone application. Each map is designed to search the given area for locations and phone numbers of hospitals and Air Force Bases in the immediate are. Users just need to input the City and State where they are providing aid to.

What is the amount of the population affected? This question is the most difficult to answer since it is impossible to take a head count of the affected area. The number is based on city population since the amount of people in an area is always in flux. There is a total of about 326 million people in the United States, but as little as 100 could be affected by a single disaster. Population per state is visualized in the following map along with graphs representing the largest city per state.

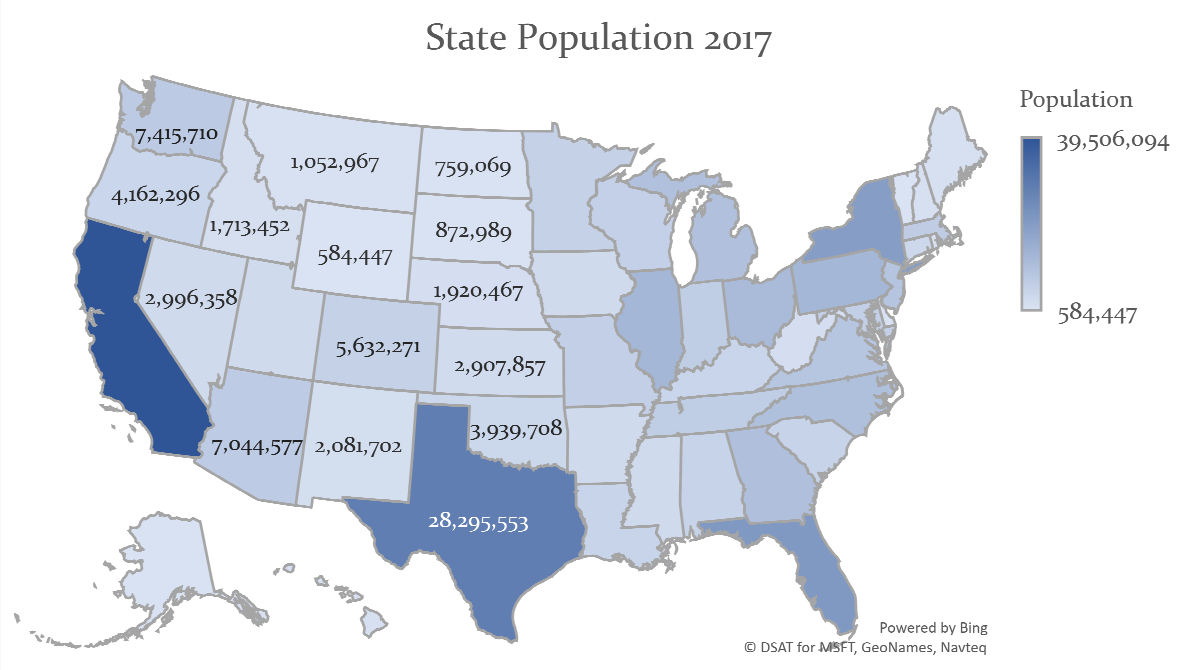


Figure 7: Rae, Census Bureau Data

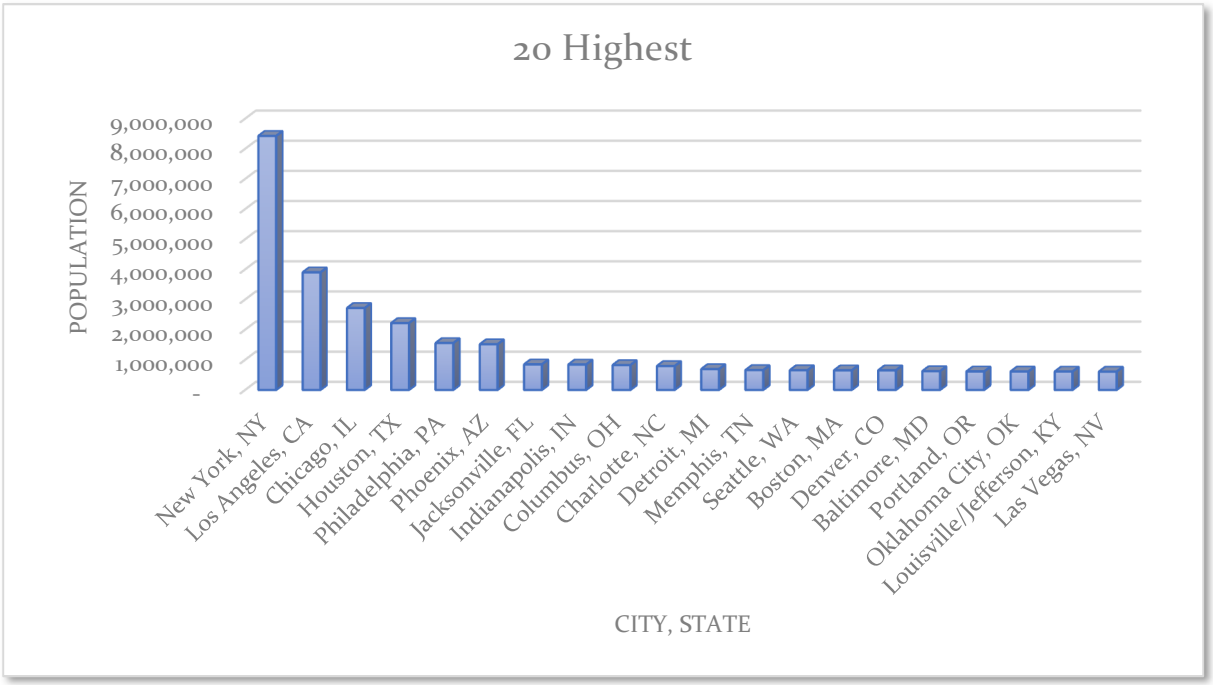


Table 5: Rae, Census Bureau Data

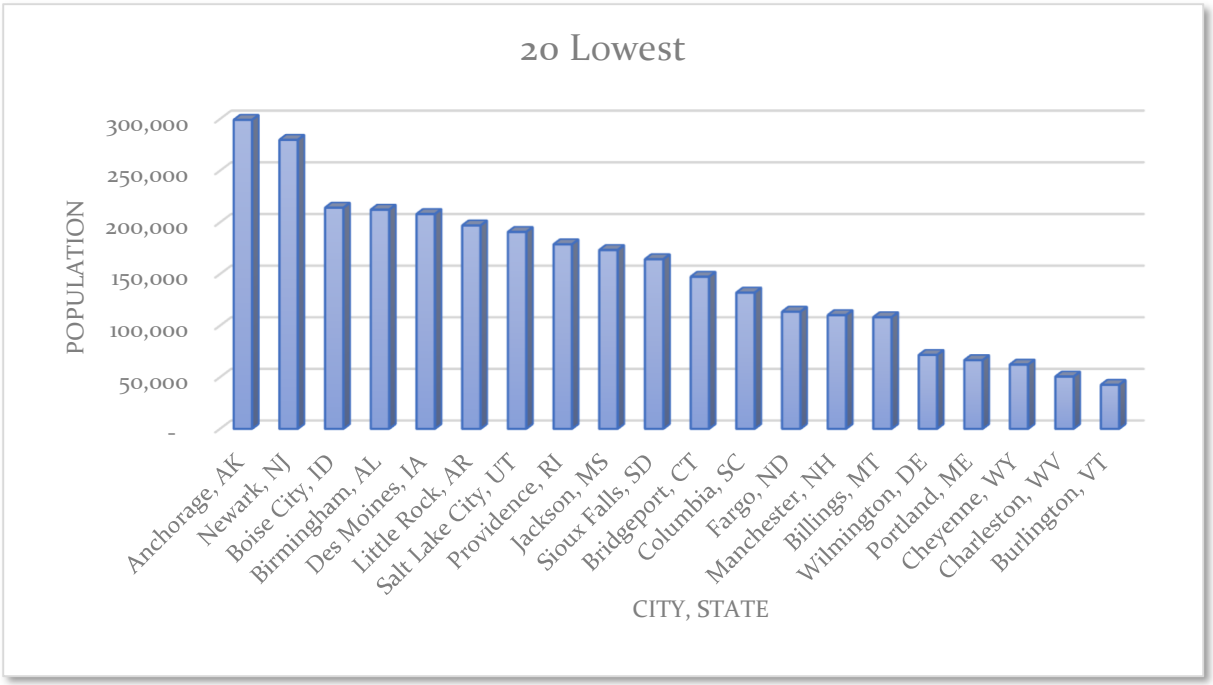


Table 6: Rae, Census Bureau Data

Are the local hospitals still functional? This question is highly important since it will affect the amount of aid required. Hospitals are prone to being destroyed during a disaster or rendered unavailable due to power shortage, these are just a few factors that can affect how over whelmed a hospital becomes during the event. Emergency medical services can also become over whelmed, unreachable due to cell service or amount of calls coming in, or unable to get to locations. History has shown us that survivors will not patently wait for aid to come to them, there are documented accounts from hospitals during disasters which has shown that people show up in three waves. People will do their best to get themselves to help be that limping to their normal hospital, being transported by civilian vehicles, or any other methods of self-transport. The problems that occur during these situations are the waves, since people that are less injured can get to the hospital sooner causing the waiting line to grow, while life threating injuries arrive later when the wait que is full. Another issue is that well-meaning private practices close their doors to go aid hospitals that are already fully staffed. Placing the casualty collection units along major paths of travel to hospitals will help lessen the waves and give a place for well-meaning private practices to congregate to provide aid.

What are the travel conditions? This question is to decide the best way to transport the casualty collection units into the area. Sending them in by air or all-terrain military vehicles will allow for the units to show up quickly without having major obstacles to overcome. The selection of choices is set to debris blocking some routes, some routes destroyed, impassible roads, high winds, and restricted air space, only one of

these options can be selected. These selections will let the users know what kind of transport they should expect to deliver the units. The following vehicles all can carry the units and deposit them to where they are needed.

Figure 8: LVSR MKR 18

All-terrain vehicles that are in consideration can self-load are the LVSR MKR 18 Cargo, which can carry 45,000 pounds on paved roads and 33,000 pounds off roads with a driving range of 300 miles, and PLS A1 M1075A1, which can carry 36,250 pounds and a driving range of 300 miles.

Figure 9: PLS A1 M1075A1

While air crafts that can deposit payloads with little to no landing space are: The C-130J Hercules, which has the possibility of carrying two units at once if their total weight is less than 44,000 pounds and has a range of 2,000 miles, this air craft can land on make shaft run ways as pictured it is possible to land on a beach. The CV-22 Osprey, which has the lowest carrying capacity of 10,000 pounds and a range of 575 miles, can fly like an

Figure 11: C-130J Hercules

Figure 10: CV-22 Osprey

airplane but land like a helicopter. Those factors could knock the Osprey out if the units end up weighing more than 10,000 pounds. The CH-47 Chinook, which has the carrying capacity of 24,000 pounds and a range of 230 miles. And the Mil Mi-26, the world's largest helicopter which has the carrying capacity of 40,000 pounds and a range of 1,212 miles.

Figure 12: CH-47 Chinook

Figure 13: MilMi-26 Halo

As stated before these questions are required to determine the needed casualty collection units to provide aid to the survivors. When the results button is pressed the field is populated by unit types that will be sent along with the total number of units required to provide the required aid. The units will be show cased in the application to show the user what will be arriving. Along with the response results will be the mode of transportation and maps will be available with cellular connection that provides the location and phone numbers for nearby hospitals and Air Force Bases.

The next consideration was the limitations of each of the transportation methods. Since the casualty collection units will be transported with different vehicle types, that were described above, it is important to consider the size and weight restrictions for all types. Through researching each available vehicle helped determine the size and shape of

the units. The transportation size is set to 8 feet by 8 feet by 20 feet with a weight limit of 10,000-pounds to 40,000-pounds, keep in mind that the weight limit is in flux, once the weight is calculated for the casualty collection units some transportation methods maybe eliminated since not all the aircrafts can carry much over the 10,000-pound payloads.

The items that contribute to the transportation weight will include the dead load of the structure and the live load of the different equipment to treat the variety of types of injuries. Utilizing light wait steel and aluminum that can hold up to the pressure of being transported will make up the skeletal structure. This calculation will be included into all the units no matter the type since all will have the same frame structure. Types may vary in weight depending on the equipment needed to treat injuries unique to different disasters. The goal of the design of the inside space of the casualty collection units is to utilize the small area. Items will be built into the walls to provide quick and easy set up. Monitors, beds, storage, utilities, and air movement are just some of the items so far considered in incorporating into the wall panel system.

Another aspect to keep in mind about all the equipment is their power draw. The amount of power that needs to be generated has to be carefully considered so the casualty collection units will be self-supported in all its energy needs.

FINDINGS

Throughout all this research I have conducted this semester pertaining toward the topic of disasters was to set up a base of information to develop the requirements to design an effective disaster response system. Looking throughout all the historical research, it is important to note that no place in the United States that is completely safe from disasters. They can strike at anytime and anywhere depending on a mix of elements of mother nature and our built world to cause a chain reaction of destruction.

As I look at all the data on disasters throughout the years through case studies of the worst disasters and occurrence data through recent years collected through USGS, NOAA, and the National Interagency Fire Center I notice that we don't have an organized response system. It seems that every state has a different approach for dealing with the response, and when other states send aid it isn't always useful. Another thing I have learned from Emergency Management class and readings I have done throughout the semester is that there is a lack of communication throughout the response process. First responders don't always have training or the resources available to deal with a disaster. Hospitals aren't always informed of what is happening, how bad the damage and injuries are, and don't always have the training of dealing with the disaster. Hospitals and governmental officials may have emergency plans laid out in writing but most time these plans are only known to the supervising positions and many times out of date and unpracticed.

The difficult part about emergency management is that it is on the bottom of the budget totem pole. This makes planning for emergencies of disaster magnitude difficult and unimportant to organizations involved in the response. These organizations would include first responders, hospitals, and government officials since they will be directly involved in what is unfolding as the disaster strikes and the results are reviled.

This is where the response system smartphone application will come in and provide a resource for those organizations to use when disaster strikes. Entering the required data of the disaster type, location, affected population, transportation restrictions, and hospital function will produce the amount of casualty collection units required to help. This system is a well laid plan that adapts over time and is based on set units that can be sent out quickly. Organized information is available that wasn't there before to help those trying to help survivors get to safety. First responders are our super heroes during our greatest time of need when our world has been turned upside down. The smartphone application will be an item that they currently don't have on their utility belts.

CONCLUSION

The goal of developing the response system smartphone application is to make the casualty collection units available as a resource for first responders during disasters. Since first responders are normally over whelmed because of lack of training, and available resources the smartphone application will help fill the lack of resources. Information entered in the response system smartphone application will create an out put of information on how many units, what types of units, and how to transport them. From that point first responders can figure out where to station the casualty collection points and focus on getting people to those locations as they come in. This response system smartphone application will be available to first responders, emergency managers, hospitals, and government officials which will provide them with the aid that they need to help the survivors of the disaster effectively.

History and occurrence data were viewed to provide a base for disaster response. Every disaster is different with the location, amount of people, intensity, and chain reactions, this is all highly important to keep in mind. We can only plan to a point, but we can prepare ourselves with an active response system, that is made available by the response system smartphone application.

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LIST OF FIGURES AND TABLES