Local Hazard Mitigation Planning Tool Proposal for the City of San Marcos, TX

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1. Introduction

Natural hazards affect communities across the world. One question that arises when thinking about natural hazards and the communities that they affect is: how can we, as GIS analysts and city planners, expect to prepare and respond to these natural hazards, as well as provide information to the public to keep them informed? Although there are a couple of options when it comes to planning for natural disasters and keeping the public informed, the most pertinent way to go about this is to create an online hub containing different kinds of relevant information. Creating a centralized hub of information will not only keep the data collected localized in one place for ease of access on the back end, but it will also give the public a better way to quickly get information about past, present, and future hazards that have affected or will affect the area. Being able to give the general public information about natural hazards in this way will not only increase awareness about natural hazards but will also give them a chance to interact with something tangible to view and read, rather than relying on phone calls or notices sent out via mail.

The objective of this project is to outline a hub website that will contain information about past hazards, potential future hazards, and past and future mitigation efforts in the City of San Marcos. The project will also outline interactive maps, descriptive text, and data content necessary to convey this information on the hub website. Our study area, the City of San Marcos, is home to nearly 70,000 residents, many of whom live in areas that have been or will be affected by natural hazards such as flooding. Being located in the meeting place of the Texas Hill Country/Edwards Plateau and Coastal Plains, as well as situated almost right on top of the Balcones Fault Zone, this area is subject to many different types of hazards, with the most notable being flooding, which affects the city and community as a whole. Flooding is not the only hazard this area may face, as this area has also seen wildfires, severe winter storms, extreme heat, hail, lightning, and drought, just to name a few. Below is a map of the area with the city boundary in light blue and the extra-judicial zone outlined in bold (figure 1).

To reiterate, the goal of this project is to provide the City of San Marcos with a site plan that will show the suggested structure of a hub website containing information about different types of natural hazards, where those hazards occur, how frequently they occur, and efforts being made by the city to plan for and mitigate damage caused by these natural hazards. It is our goal to create a detailed site plan, wireframes for specific pages, detailed suggestions about data to be gathered and included, and ways for the community to get involved, whether that be by sending information about potential hazards or just simply being able to view interactive maps with hazard information visualized.



Figure 1: San Marcos City Limits and ETJ

2. Literature Review

Hazard Mitigation has been regulated and guided by the Federal Emergency Management Agency (FEMA) since 1979. Therefore, over time, there has been a necessity for individually created and assessed hazard mitigation plans for the whole country, states, tribes, territories, and local cities. These regions have a distinct environment that benefit greatly from Hazard Mitigation Plans. Mitigation plans reduce risks of natural hazards on infrastructure, inform the public of these risks, and what exactly the agency is planning on implementing to decrease threats. Consequently, there is a growing demand for web-based tools, WebGIS, to display short and long-term planning for individual and community use. Web-based tools have many advantages, such as allowing for the public to submit data; however, there are disadvantages, such as the inability to reach part of the community without internet access. Along with a suggestion of increasing web-based platforms, there should be consideration for a natural hazard education program or outreach due to the disadvantages. The City of San Marcos will benefit greatly from a WebGIS application due to its 188% population growth increase from 1890-2020 and the public and stakeholder involvement from organizations, such as Texas State University, that create an important understanding of concerns and increase the success of proposed hazard mitigation actions (COSM 2024).

Due to federal involvement with the environment, there have been many acts and programs passed by Congress over the last 40+ years. To name a few, the Hazard Mitigation Assistance Program, the Flood Mitigation Assistance Program, and the Disaster Mitigation Act of 2000 are all crucial to maintaining health and prosperity (FEMA 2018). While FEMA regulates and guides Hazard Mitigation programs, the City of San Marcos additionally used studies and information from the National Centers for Environmental Information (NCEI), the United States Army Corps of Engineers (USACE), the Texas Commission on Environmental Quality (TDEM), and the National Oceanic and Atmospheric Administration (NOAA) to incorporate in the COSM Mitigation plan (COSM 2024 Mitigation Plan). A WebGIS site would allow users to view and assess information from all related sources on one platform. Each hazard mitigation plan has to be FEMA-approved to receive Hazard Mitigation Assistance (HMA) (FEMA 2023). These plans have to be updated every 5 years to maintain eligibility, so the City of San Marcos is required to update their 2018 Hazard Mitigation Action Plan (HMAP) and did so with the 2024 update. According to FEMA, mitigation lowers the vulnerability of public health and social organizations while encouraging justice (FEMA, p. 3).

Furthermore, WebGIS and web-based tools for hazard mitigation have been used at global, federal, and local scales to store and manage natural hazard historical data and provide the community with an interactive way to be involved. Web-based tools have many advantages, such as informing the public about what hazards historically pose a risk and where they pose a risk, increasing community participation, and allowing the public to understand what the agency

is doing to protect their region and mitigate hazards. A study conducted in China allowed analysts to create a WebGIS platform that allowed for a geodatabase of historical natural hazards instead of relying on ancient literature which was not systematic (Dong et al., 2012). Geodatabases are systematically helpful for a country, state, and city, but also for the general public by storing and displaying comprehensible information. On the contrary, there are disadvantages to implementing web-based tools, such as the inability to reach the part of the community without internet, internet or social media illiteracy, a false sense of immunity from hazards, and online outreach during or after natural hazards may be limited or completely cut off. Many people live in subsidized housing and or have vulnerabilities including but not limited to old age, low income, low education, and low proficiency in the internet or social media (Kang et al., 2023). As a result of this, population preparedness and awareness, especially for disadvantaged communities, for any given hazard should be outlined by face-to-face education programs or outreach programs. Additionally, Hurricane Katrina taught the United States multiple lessons, but most crucially how unpredictable a predictable weather event can get. WebGIS and web-based tools can and should serve as a way to communicate with the public before, during, and after a natural hazard event. Unfortunately, there are atmospheric, hydrologic, and technological hazards that can destroy cellular towers and lead to power outages making online public outreach through web-based platforms extremely challenging or entirely absent (Samuel 2017). Although precise predictably is incredibly difficult with natural hazards, a WebGIS platform communicates critical knowledge to avoid low awareness and preparedness.

Overall, climate change is playing a gigantic factor in increasing regularity and severity of natural hazards. The intensifying risks from rising sea levels, warmer ocean temperatures, and stronger storms increase the need for public education and involvement. San Marcos is a city with a public university, Texas State University, with over 38,000 students enrolled in a given school year (TXST 2016). Over 74% of people are housed in a rental, based on a 2021 survey (COSM 2024). This stems from many students constantly flowing in and out of San Marcos. Many of those same students believe that on-demand information will always be readily available from the news, parental guardians, media, or the university (Samuel 2017). The indicated population causes a very low level of awareness and preparedness behavior in the rapidly developing city (Ponstingel et al., 2019). For this reason, web-based and WebGIS platforms make natural hazard mitigation easier to comprehend with interactive maps and key

text. Coinciding with face-to-face education programs over natural hazards, including mitigation techniques, that could be taught by Texas State University or the City of San Marcos the readiness and consciousness of the city will drastically increase. All of the above-mentioned will greatly help the City of San Marcos with educating the public on natural hazards and how to assess the city and their individual risks. A WebGIS platform including an overview of the city, individual hazard risks, an interactive map of historical hazards, and a community involvement page to allow the public to submit information will allow for the City of San Marcos to be interconnected with the citizens and enhance public safety.

3. Data

The data collection for this project will be in the form of suggested data to collect. As we are simply creating a site plan, data collection is not necessary for this step of the process; however, we will outline what data needs to be collected and why. Although there will be no data actively collected, this step of the process is important nonetheless because it will make future data collection more streamlined. Having an outline of potential data that needs to be collected will remove the process of having to generate a list when it comes time to collect the data. This list of suggested data will include different types of natural hazards, such as flooding, wildfires, winter storms, extreme heat, hail, lightning, and drought. Along with this suggested data list, we will also include a section dedicated to outlining specific descriptive text for each hazard. Seeing as this project will outline not only a tool for the city but an informative, interactive experience for the public, each hazard type will have a section describing different elements of that hazard. For example, what that hazard is, how dangerous it is, how many times it has happened in San Marcos, etc. Combining interactive maps with effective descriptive text elements will ensure that the public has not only informative visual aids but also adequate information to stay as up to date as possible.

Another aspect of the data involved with this project is the draft of the City of San Marcos Hazard Mitigation Action Plan provided by the city. This draft outlines many aspects of the city's plans to mitigate potential natural hazards and has valuable information about each hazard and its frequency and danger levels. The HMAP will be referred to extensively in creating suggested data to collect and descriptive text to be generated, as this is already a very comprehensive document. We will certainly be combining this document with outside research to ensure that we get the full scope of data available so as not to constrain ourselves.

4. Methodology

The goal of this project is to create a website plan to disseminate information from the City of San Marcos Hazard Mitigation Action Plan to the existing community and future residents of San Marcos in a way that is interactive and easy to understand. The 2024 updated draft of the HMAP details the city profile and risk overview, 13 different hazards that impact the city, their historical occurrences, critical facilities, and past and planned mitigation actions. The expected workflow for the project is shown below in Figure 2. As shown in the figure, the team will first analyze the components of the HMAP to determine which portions of the report are most relevant to the community to include in the website plan. The team will also determine whether incorporating a map element would better convey the information to the community. From here, the team will outline what an interactive map for the necessary pages would look like, the data needed to create the map, and create descriptive text for the page. The team will then determine whether HMAP components should have their own page and, if not, allocate them appropriately to another page. After outlining the necessary page components, the team will create a site plan flowchart that will help visualize the expected structure of the website. This site plan will guide the wireframe creation, utilizing the free software Lucidchart. The wireframes will assist the team in ultimately creating a prototype of the website utilizing ArcGIS Online's Hub templates. The prototype will first focus on the main page and one hazard type and then continue to the rest of the site if time permits.

The City of San Marcos can utilize the site plan and prototype created in the project to effectively convey its updated Hazard Mitigation Action Plan to the community. Disseminating the information of the HMAP to the public is vital as it allows individuals to gain a better understanding of the natural hazards that could affect them and the mitigation efforts the city is undertaking to prevent damages from these hazards. A webpage that could share this information effectively would ultimately help increase the community's awareness of the hazards that can impact them.



Figure 2: Methodology flow chart

5. Timetable

This project spans a total of 14 weeks. A breakdown of the time expected for each phase of the project can be seen below in Figure 3. This figure highlights the expected time utilization for each project phase and important dates. The following is the expected work for each phase:

- Mitigation Plan Review: The first phase will take approximately four weeks. The team will take this time to review the Hazard Mitigation Action Plan and identify what information from the plan is vital to share with the community and which components would need interactive maps to best relay information.
- Site Plan/Wireframe Creation: The second phase of this project will take approximately 3.5 weeks and focus on creating a site plan to outline the structure and flow of the proposed website. Utilizing the site plan as a guide, the team will then create wireframes for each planned page.
- Descriptive Text/Data Suggestions: The team plans to use 3.5 weeks to create descriptive text for each page, outline data suggestions, and outline necessary map elements.
- Prototype: The final phase of this project will utilize the remaining three weeks of the timeline to build a prototype of the planned website utilizing an ArcGIS Online Hub template. The team will first focus on creating a site home page, historical events viewer, and flood visualization page, and if time allows, build out the website further to include additional pages.

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Figure 3: Expected Project Timetable

6. Budget Strategy

Table 1 shows the expected project budget. The budget strategy breaks down costs into three categories: HMAP review, website planning and prototype creation, and equipment costs. The budget bases the total hours worked on expected ten-hour work weeks and hourly rates on average pay for these positions in Texas.

San Marcos Hazard Mitigation Action Plan Review							
	Hourly Rate	Total Hours	Cost				
Project Manager	\$50	40	\$2000				
Senior Web Designer	\$35	40	\$1400				
Senior Data Analyst	\$45	40	\$1800				
		s	Subtotal: \$5200				
Website Planning and Prototype Creation							
	Hourly Rate	Total Hours	Cost				
Project Manger	\$50	100	\$5000				
Senior Web Designer	\$35	100	\$3500				
Senior Data Analyst	\$45	100	\$4500				
		ubtotal: \$13000					
Equipment Costs							
			Cost				
Supplies	\$130/workstat	\$390					
Maintenance	\$200/workstat	\$600					
Depreciation	\$75000/ 48	\$6250					
ArcGIS	\$3025/ year (Professional Standard) \$504.17 \$3025/12 months * 2 months						
	Subtotal: \$7744.17						

Table 1:	Project	Budget	Strategy
		<u> </u>	<u> </u>

Subtotal: \$7744.17 Total Costs: \$25944.17

7. Final Deliverables

The main deliverable for this project will be the website plan/outline. This will be comprised of multiple items including an outline of the content presented in the existing hazard mitigation plan, a sitemap including a table of contents for pages within the hub site, wireframes for each page, and any descriptive text and interactive maps/data that will need to be gathered and developed. A working site home page, historical events viewer, and focused page for flooding visualization will be completed if time and resources allow. Figure 4 is a very generic example of what the wireframes will look like stylistically for each hazard type. For the final deliverables of these wireframes, there will be more attention to detail and clear outlines for what each section of the wireframe will be composed of.

As mentioned above, if time allows, we will create a site home page, a historical events viewer, and a flood visualization page. The home page will have links to the map viewer with additional links at the top of the viewer for each hazard type, similar to the wireframe layout of Figure 4. The historical events viewer will contain information about past hazards such as where they were, how destructive they were, the likelihood of them happening again, etc. The flood visualization page will contain similar information, but instead of all past hazards, it will only contain information about flooding, including where the flood occurred, damages inflicted, monetary loss, etc.



Figure 4: Example wireframe

8. Conclusion

This project's goal is to provide the City of San Marcos with a site plan outlining a refined Hazard Mitigation Tool. This is an important tool to have for a couple of reasons. In terms of city planning, this tool will assist in allocating resources throughout the city to areas that suffer from certain types of hazards more than others. For example, if one part of the city is more prone to flooding, this tool will not only show that on a map but will also provide the city with a better idea of where their funds should go for that part of the city. In terms of community involvement, this tool will be invaluable in providing the public with a way to get involved with planning or suggesting ideas for planning, as well as keeping them informed about what kinds of hazards they may be facing. By giving the community an easier and more streamlined way to get information as well as get involved, one potential benefit of this, among others, is the currentness of data. It may be hard for the city to get around to every part to conduct data collection or anything related, so giving the community a way to report hazards or suggest ideas for hazard management may provide the city with more time to plan and gather data for the highest problem areas, rather than expending time and resources on areas that may need less attention.

9. References

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- "Hazard Mitigation Assistance Program and Policy Guide." *FEMA.Gov*, www.fema.gov/grants/mitigation/guide.
- "Multi Hazard Mitigation Plan." *Multi Hazard Mitigation Plan*, www.roseville.ca.us/government/departments/fire_department/emergency_preparedness/ multi hazard mitigation plan.

10. Appendix

Participation:

Austin Nicholson (Project Manager)

- Logo design, constructed the blueprint for the document, cover page, table of contents, introduction, data, final deliverables, conclusion, formatting and editing proposal

Madelyn Flores (Senior Web Designer)

- Acquired supplemental journal articles for literature review, methodology, timetable, budget strategy, formatting and editing proposal

Corina Whitman (Senior Data Analyst)

- Analyzed and summarized the City of San Marcos Hazard Mitigation Action Plan, literature review, references, appendix, formatting and editing proposal