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Proposal

Abstract

As the world erupts, floods, and finds ways to change under our feet, hazardous events pose a threat to human life and properties, creating vulnerability in affected communities. Unfortunately, some communities do not have the proper hazard education resources that allows them to gain hazard awareness. When an event occurs, these communities are left unprepared and overwhelmed with feelings of panic, fear, and worry, hoping to find a sense of safety when a hazardous event occurs. Understanding the surrounding hazards allows individuals to be prepared for these events, making them feel safer as they can acknowledge what the event means, how to respond based on personal risk, and how to recover. By using GIS applications, preexisting hazard awareness resources, hazard assessment datasets, and historical hazardous event records provided by the Hawaii GIS Program and the United States Geological Survey, the project created will be a web application that community members of the Hawaiian Islands to insert a location onto a map and learn about their local hazards. The hazard assessments included will showcase their locations' history and projected susceptibility to flooding, tsunamis, fires, and lava flows in the future. As a result of using this platform, the community will increase their knowledge to create hazard awareness and be useful to future urban developments. Helping the communities further prepare for their local hazardous events moving forward, allowing for greater resilience through hazard impact recovery.

Introduction

Many regions throughout the world are not affected solely by one hazard, but by multiple hazards that can act simultaneously and/or consecutively (Skilodimou et al., 2019). Communities in multi-hazardous regions often live with the thought of a hazardous event occurrence as an afterthought, so when an event does occur, there is a lack of preparedness due to their lack of hazard awareness. Located within the Pacific Ocean above a hotspot plume, the Hawaiian Islands are at a great risk for a multi-hazardous event. For my capstone project, I will be creating a multi-hazard web application that analyzes historical and projected hazards throughout the Hawaiian Islands. Floods, tsunamis, fires, and lava flows are just a few of the hazards present throughout the Hawaiian Islands and are those that will be represented within my multi-hazard capstone project with data provided by the Hawaii GIS Program and the United States Geological Survey (USGS).

Multi-hazard maps allow for the advancement of hazard awareness and improve processes hazard management, mitigation, and resilience (Pourghasemi et al., 2020). By creating my multi-hazard capstone project through GIS applications, community members of the Hawaiian Islands will be able to insert a location onto a map and learn about the represented hazards. The hazard assessments will showcase the locations' history and projected susceptibility, increasing their personal hazard knowledge. This allows them to be better aware of their multi-hazardous environment, increasing their preparedness for the event of one or multiple hazards to occur. Furthermore, allowing for better community resilience throughout the impact recovery process.

Literature Review

To further development of my capstone project, assessing similar projects previously created allows for a greater understanding of what does and does not work in the geospatial community, how communities and hazard data are represented, current multi-hazard resources, and so much more. Through my literature review, these resources will be broken up into the following sections: participatory mapping, hazard communication in mapping, and hazard, with the subgroups hazard mitigation and contemporary hazards. These sections are created in motivation to answering my research questions, 'what approaches in teaching hazard preparedness have been found helpful in hazard recovery?' and 'what hazards are in Hawaii that are found in a mapping environment?'

Hazard mitigation highlights the ways hazard warnings and current hazard awareness resources are present throughout the Hawaiian Islands. As my capstone project will present a multi-hazardous map, it is necessary to understand what hazards, historical and projected, should be represented and how they have been previously represented. Previous representations will showcase ways data has been implemented in specific designs curated for community members, who may not have prior hazard knowledge, topics further addressed in the sections, hazard communications in mapping and contemporary hazards. To ensure true representation of the Hawaiian Islands in a spatial environment, the contribution of local knowledge and history becomes crucial. The working process, connections, and ethics required for community contributions is further discussed through participatory mapping.

Hazards

When discussing natural hazards of the Hawaiian Islands, they are divided by those that are land driven and coastal driven. Land driven hazards deal with volcanic and seismic influences, such as lava flows, earthquakes, and volcanic smog (vog) (Heliker, 1990). As the islands are created by an active hotspot plume among the Hawaiian-Emperor seamount chain (Tarduno, 2003), majority of the active occurring hazards are those that are volcanically influenced, which only is a large concern to those located on Hawai'i Island. The hotspot plume has continually been moving southward, currently located towards the southeastern flank of Hawai'i Island. Coastal driven hazards are a concern to all islands, these hazards are those pertaining to tsunamis, stream flooding, high waves, storms, tidal erosional, and sea level changes (Fletcher III et al., 2002). As the concern towards all hazards continues to fluctuate based on occurring events, below I'll be discussing efforts to mitigate hazard effects on communities and the state of contemporary hazards.

Community Mitigation

With or without any warning, the Hawaiian Islands are at risk to hazardous events. From earthquakes to tsunamis to volcanic eruptions and more, the Hawai'i Emergency Management Agency was formed to develop and implement early warning measures/systems to protect the people of Hawai'i (State of Hawai'i, n.d.). An implementation of their early warning efforts was found in Hilo, Hawai'i, following the potentially destructive tsunami on February 27th, 2010. Through research it was found that the effective methods of informing the people of Hilo, Hawai’i were new technology (social media), pre-existing community networks, and the most effective being news media outlets (radio stations), (Sutton et al., 2011).

Hawai’i Island is divided into hazard zones determined by an area’s risk severity to lava flows on a scale from 1 to 9 (Heliker, 1990). This lava flow hazard zone mapping system is still adapted today, but when looking at the two maps you can identify the current day map has made the hazard zones more specifically distinguished (USGS & Wright, 1992). By mapping the risk levels of hazards, the community can understand the chances that a hazardous event could affect their lives, but also shape their approach in urban development. When construction is set to occur, hazard analysis is critical to the development process to understand whether the land areas specific risks require the construction to include mitigation measures that fall within safety standards (Hwang, 2005).

Contemporary

The Island of Hawaii is composed of five shield volcanoes, including the most active volcanoes, Kilauea, and Mauna Loa (Bladt et al., 2019). With an ongoing eruption at the Kilauea volcano and the recent Mauna Loa eruption, the people of Hawai’i are amazed by the beauty but can also be affected by the volcanic risks. Lava and access to lava is currently contained, ensuring that exposed lava flow is not an accessible risk, but with lava flows in the past, closing off viewpoint access has not always been achievable. In 2018, access to Kilauea’s Lower East Rift Zone was at community reach due to its 107-day fissure eruption that destroyed Leilani Estates, a community in the Puna District on the Island of Hawai’i (Williams et al., 2020).

As magma reaches the surface, lava releases noxious sulfur dioxide gas and other air pollutants that can alter the atmosphere, water quality, and create vog (Elias & Sutton, 2017). Vog effects individuals differently, but they are known to cause sore throats, produce headaches, induce breathing difficulties, etc. (Elias & Sutton, 2017) As vog is not always recognizable in plain view, public resources allow for the people of Hawai'i to understand the flow of vog through the VMAP vog forecast website (Businger et al., 2015).

Being in the middle of the Pacific Ocean, hazards of flooding due to sea-level rise, storms, tsunamis and more continue to put communities at risk. This is addressed in the Federal Emergency Management Agency (FEMA) mapping system that states all hazard zones excluding the tidal erosional zone in Hawai'i are associated with the National Flood Insurance Program (Hwang, 2005). This means that any property within the tidal erosional zone is not eligible for coverage within the insurance program as the property owners understand the higher risk in losing their assets to any form of flooding event.

Hazard Communications in Mapping

Hazard communications through mapping should provide the same amount of informational depth as hazard communications outside of the mapping environment. The hazard information communicated are not shared as risk warnings that imply impending hazardous events, but are shared to be ways to create accurate emergency response methods and develop the communities understanding of the hazardous risks (Viscusi & Zeckhauser, 1996). To create effective hazard communication, many factors should be implemented such as being clear, providing various sources of support for more information, using different ways to communicate, providing multilingual content, and so much more (Mileti et al., 2004).

Although the hazards may be understood by those creating the hazard maps, they are often not understood by those in the community due to factors of aesthetics (Thompson et al., 2015). As an example, aesthetics of data plays a large role on the way that users engage with volcanic hazard maps because when determining a color scheme to a hazard map, designers often convey the message of hazard distribution through the red-yellow-blue color scheme, representing hazard risks that are highly present, to those that are low and not presently existent (Thompson et al., 2015). Used in the Hawaii lava flow hazard map (USGS & Wright, 1992) is a red-yellow-green color scheme which is similarly common as it follows the association that most individuals have with a stoplight, stop, slow, and go. It is likely you will not see hazard maps with a color scheme of purple-blue and/or pink-green-blue, simply because they are not common colors associated with one another on a safety scale. Colors influence the users understanding of the map, so choosing an appropriate color scheme is very important in the design process itself.

Interactivity and creativity in any map are also aesthetic factors to consider when determining user engagement. As tourism is present throughout Hawai’i, effective methods of hazard communication must be implemented to ensure that non-residents understand the measures to take when a hazardous event may occur. But often, knowing what tourist spots to go to is more important than understanding the hazardous risks presented in their lives by going there. The interactive platform, GeoPDF provides information on the relationship between tourist locations and hazard zones, while also providing additional information such as emergency measures on Hawai’i Island (the Big Island) (Cervantes, 2009). Providing levels of interactivity allows users to take only the information they want from your map, but also provides a way for them to understand it in their own means. Through GeoPDF users have the options to turn on and off layers of data so they can see only what they want, whether that is just tourist spot recommendations, hazard zones, or both, and mark points with their own applicable information (Cervantes, 2009).

Basemap design is also an important factor with aesthetic understanding and data representation. When choosing a basemap, you want to highlight the data you are using effectively in the location environment you are working in. Research results showcased that when looking at a volcanic hazard map, respondents were only able to locate and orient the map when looking at an aerial basemap, rather than a contour map (Haynes et at., 2007). As the islands have an interesting and constantly changing cartography, contour maps often do not represent the niche landforms and lava flows known to the community. While moving forward in the design process of my capstone project, I will provide an aerial basemap view to allow community members to orient themselves with the landform surroundings they are familiar with.

Participatory Mapping

Maps made for communities are best made when communities contribute to the creation. Participatory mapping is a method of identifying place values (Brown et al., 2020) by incorporating local knowledge and community participation to develop spatial information, an approach created to fill the gaps of current geographic information (Levine & Feinholz, 2015). Approaching communities can create controversy, communities can be misrepresented and mislead by the purpose of the project. Participatory map datasets act as a basis to make informed decisions (Brown et al., 2020), a way to further spatial data-based decision making (Levine &

Feinholz, 2015). Which initiates the ethics-based predevelopment process necessary for proper participatory mapping, which includes understanding the purpose and use of data, and ethics when it comes to approaching the specific communities for data collection. A major example of applying participatory mapping are maps representing indigenous communities, as their history and lifestyle may not be properly represented by those creating a geospatial environment (Chambers, 2006). This makes it possible for you to represent the communities correctly and include them in the spatial decisions made to affect their lives.

Data collection through participatory mapping methods can create very limited datasets. Looking back at the ethics of participatory mapping, developers must understand that to collect the data required, you are taking peoples time and raising expectations that their participation will make an impact (Chambers, 2006). Collecting data locally can also be used against people or benefit those who were not meant to be benefited, causing tensions in communities which can cause distrusting relationships with the dataset you are creating (Chambers, 2006). But alike to any limitation or controversy, you can learn more about what data throughout the community should and/or shouldn't be represented, what additionally data is necessary, what other ethics applications should be applied, etc.

On the island of Ambae, Vanuatu, participatory mapping research was conducted to create hazard maps to ensure that the indigenous populations trusted the datasets but were also capable of understanding the way they were digitized to ensure the map was used (Haynes et at., 2007). Another example of participatory mapping is through the Hawai'i Coastal Uses Mapping Project where they created a map that digitized locations of human recreation as it effects and relates to coral reef management (Levine & Feinholz, 2015). These projects of participatory mapping evaluate methods of community engagement and map understanding throughout island communities. Additionally ensuring that throughout the process of creating my multi-hazard capstone map, that it is trusted, understood, and used by the Hawaiian communities at the same depth as hazard maps throughout Vanuatu.

Through analyzing the hazards that effect the Hawaiian Islands as a whole, I've identified the historical and projected hazards will be represented throughout my capstone project and how each hazard type present pose concerns to how they're addressed throughout the communities. Recognizing approaches and designs in effective hazard communications in mapping environments allows me to move forward in designing my map in a way that is appliable to the communities and is designed in a way to further develop the understanding of hazards. By creating an understanding of participatory mapping, I'm offered insight on how dataset creation is approached to include communities that the multi-hazard map data will represent.

Methods

To complete my multi-hazard capstone project, I will be completing tasks in a three section split over the timespan of seven months. Design drafting is a planning and proposal development process that started in February 2023, and due to be completed within March 2023. The data period will conduct of data collection and editing, as well as data implementation into the created design interface, spanning from March 2023 to June 2023. Lastly is the evaluation stage where the conduction of user-interface testing, data analyzation and formal writeups from July 2023 to August 2023.

Design Drafting

The design drafting process has been completed throughout this proposal writing process but was a crucial part in my assessment of previously created resources and how my multi-hazard capstone project should be created moving forward. The resources assessed are those that similarly focus on hazard analyzations, connecting with the community to develop maps, and have taken place throughout the Hawaiian Islands. Through this process I've taken notes within a literature review on the found preexisting projects, allowing me to understand the implementation of participatory mapping when addressing community contributions, hazard communications in maps, and hazards throughout the Hawaiian Islands and how they are presently approached for hazard mitigation processes. I've additional created a methods section which is a timeline that discusses the process in which I will be creating my desires capstone project design features.

The code will be created through an HTML, JavaScript, and CSS environment, using GIS applications and leaflet to properly create a web application. With many islands and hazards being projected, the design must include cohesive functionality and knowledgeable design. Implementing design methods found in previously created hazard maps, the capstone map will be following a red-yellow-blue color scheme to properly identify regions of higher hazardous risk and lower hazardous risk. The ability to change basemaps will be implemented for the users personal preference but will initially be generated with an aerial map so lava flows and current urban features can be easily identified. As this resource will generate historical and projected data based on a specified location point, the ability to search for specific addresses throughout the islands will be provided for greater convenience.

Data

The focus of data within my capstone project will be to collect datasets and conduct any editing that is found necessary. To find datasets that represent the Hawaiian Islands floods, tsunamis, fires, and lava flows, I will be using the Hawaii GIS Program and the United States Geological Survey databases to collect datasets pertaining to historical hazards and future projected hazardous events. The Hawaii GIS Program will provide projected GIS data layers presenting flood zones, tsunami safe and evacuation zones, volcano lava flow hazard zones, and fire risk areas. The United States Geological Survey will provide GIS data layers containing past volcanic flows as early as 1790.

Datasets from the Hawaii GIS Program are broken up by islands due to specific jurisdictions, but for the multi-hazard capstone project, only four islands will be analyzed due to data availability. All GIS data layers will be collected in a shapefile format for the islands, Oahu, Kauai, Hawai’i Island, and Maui. After collecting their datasets, reprojection will have to occur to make sure datasets are in WGS84 to later work in the Leaflet mapping environment. Furthermore, a spatial data merge will be conducted to create one large data layer that includes features from all four islands. As there are a variable of datasets provided based upon specific state driven scenarios, I have to ensure that the GIS data collected for each island is within the same scenario parameters.

Currently the historical datasets for floods, fires, and tsunamis have been not found in a spatial mapping environment. In order to implement these datasets for the intended capstone project analysis, historical records may need to be found from other Hawaii GIS resources and/or created based upon state hazard event records. Additional live geojson data such as earthquakes and vog levels from the United States Geological Survey may be implemented as an additional user feature to provide users the ability to see current volcanic hazard data.

Evaluation

The final analysis includes testing the user-interface of the multi-hazard capstone project design, finalizing the data analysis and the projects written report. With the number of islands being represented in my capstone, I will break down my analysis through each individual island, allowing me to approach my final report in a chunked writing style based upon location. Through the completion of my capstone projects methods process, the creation of my multi-hazard capstone project will allow the Hawaiian communities a chance to expand their understanding of local hazards, historical and projected, establishing knowledge towards hazard preparedness.

Design Drafting

Feburary to March

- Proposal Writing
  - Literature Review
  - Methods
- Finding resources that can provide me desired datasets.
- Drafting a design on features wanted in my capstone project.

Data

March to June

- Collect datasets from the Hawaii GIS Program and the United States Geological Survey.
- Sort and edit datasets to fit particular specifications.
- Implmenting datasets into the drafted design plan.
  - Creating desired design plan through HTML, JavaScript and CSS.

Evaluation

July to August

- User-Interface and data testing.
- Data analyzation.
- Writing final capstone project paper.

Summary

Throughout the Hawaiian Islands, hazards are analyzed individually, although hazards can occur simultaneously and/or consecutive to one another (Skilodimou et al., 2019). By creating my multi-hazard capstone project that brings together the hazards; flooding, fires, tsunamis, and volcanic lava flows, the community will be provided a multi-hazard map that properly analyzes the regions susceptibility of all hazardous events. Represented through a red-yellow-blue color scheme and in an interactive Leaflet map user-interface that allows them to search, change basemaps, and more, the users will be able to scan through the data of Oahu, Kauai, Hawai'i Island and Maui. As a learning tool, users that are local to the islands or just visiting will build their hazard awareness, allowing them to understand the risks taken on island. These levels of interactivity will allow users to create a sense of place throughout the map, identifying regions they find familiar, intriguing them to learn more about them. Furthermore, learning where hazards could occur will allow for users to become more prepared, mitigating the negative impact that the hazard have on them, allowing for more resilient impact recovery.

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