Natural Disasters Around You

Final Project Report for 05619

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INTRODUCTION

Natural disasters are catastrophic events that lead to serious health, mental, social, and economic consequences. Earthquakes, volcanic eruptions, floods, wire fires, droughts, etc, with atmospheric, geologic, and hydrologic origins, are all regarded as natural disasters. During the past decades, natural disasters have killed millions of people, threatened billions of residents worldwide, and led to massive economic loss worldwide. To address this global issue, natural disaster records in the past 50 years are analyzed and visualized to help readers understand the physical, psychological, and economic impacts brought by them. The interactive website can be explored by readers for more detailed information, such as geographical features, broad impact by country and category, etc. Natural disaster prevention suggestions for both individuals and governments are also provided to help the readers prepare better for potential dangers. The ultimate goal is to help readers understand and react properly in the future.

RELATED WORK

Natural disasters are a complicated global problem and an inevitable part of our lives. The various problems caused by disasters may arise from both direct and secondary effects [1]. Usually, the direct impact is defined as the physical effect caused by the disaster (e.g., Damage to homes, contents, and infrastructure, as well as Environmental degradation), while the secondary impact, or higher-order impact, is defined as any following consequences (e.g., Business interruption, costly adaptation or utility reduction from loss of use) [2][3]. Theoretically, summing up all the direct and indirect impacts and measuring them in terms of economics is possible. But this would bring two challenges. Firstly, a special and temporal range of the specific disaster is necessary for such measurement. Secondly, the losses are easy to be double-counted, as the sourcing raw data usually comes from different organizations [4]. However, most economics studies focus on the evaluation on the macroscope using GDP, rather than naively calculating the sum of all the losses. GDP could also be affected by any post-disaster constructions, which, even though are essentially indirect impacts, should be counted as total economic loss [5] .

Additionally, mental health damage done by natural disasters is another important factor. It is common sense that life-threatening events, which undoubtedly include natural disasters, could cause mental consequences [6]. Disaster mental health research began in the 1940s. And in 1950, the term “disaster syndrome” is redefined and the conclusion of 20%-25% of those exposed are affected is reached [7]. Later, the direction is shifted to the large-scale effect and different consequences of different types of disasters and the unique needs of their victims [8]. In 1980, posttraumatic stress disorder (PTSD) was added to the researchers’ scope [9]. In addition, there is also the development of structured diagnostic instruments and interventions to prevent or reduce post-disaster psychopathology. As more organizations like WHO are founded, studies from the past decade have shifted to the development of evidence-based treatment handbooks and interventions against massive violence [8].

Globally, earthquakes, floods, and storms are the main disaster types accountable for the biggest losses [10]. Until the end of the 20th century, there are about 40 disastrous earthquakes, which cause nearly 1.7 million deaths in total, accounting for almost 50% of all victims of natural disasters [11]. There are around 90 annual average tropical cyclones, which is usually the cause of storm surges. According to World Meteorological Organization (WMO), both are the most influential disasters in terms of physical losses. Floods, while less fatal, has a rather wide range of affected area. Based on the statics from the Asian Disaster Reduction Center, half of the total population affected by natural disasters are affected by floods. Due to the severity of all three kinds of disasters, this project mainly focuses on them.

EDA

The main database used in this project is the Emergency Events Database (EM-DAT) from the Centre for Research on the Epidemiology of Disasters [12]. The entire dataset contains the records since 1970 with 14643 samples and 17 variables from globally 228 countries. A sample of the data looks like the following:

	Disaster Type	Country	ISO	Region	Continent	Location	Dis Mag Value	Dis Mag Scale	Latitude	Longitude	Start Year	Start Month	Start Day	Total Deaths	Total Affected	Total Damages ('000 US$)	CPI
0	Flood	Argentina	ARG	South America	Americas	Mendoza	NaN	Km2	NaN	NaN	1970	1.0	4.0	36.0	NaN	25000.0	15.001282
1	Storm	Australia	AUS	Australia and New Zealand	Oceania	Queensland	NaN	Kph	NaN	NaN	1970	1.0	NaN	13.0	NaN	72475.0	15.001282
2	Flood	Benin	BEN	Western Africa	Africa	Atacora region	NaN	Km2	NaN	NaN	1970	9.0	NaN	NaN	NaN	200.0	15.001282
3	Storm	Bangladesh	BGD	Southern Asia	Asia	Khulna, Chittagong	NaN	Kph	NaN	NaN	1970	11.0	12.0	300000.0	3648000.0	86400.0	15.001282
4	Storm	Bangladesh	BGD	Southern Asia	Asia	NaN	NaN	Kph	NaN	NaN	1970	4.0	13.0	17.0	110.0	NaN	15.001282

Figure 1: What does the dataset look like.

The response variable is defined as one of "Total Deaths", "Total Affected", and "Total Damages ('000 US$)". There is one row containing the date 1992/9/31, which obviously does not exist. We take that as a typo and replace it with 1992/9/30. In the dataset, the time variable is separated as Year, Month, and Day, which is inconvenient for the following analysis and visualization, we combine the three variables into one Date variable. And the samples missing the month are deleted, while the ones missing the day are filled as 15th. In addition, we exclude data with all response variables absent or 0. These disasters do not affect the public and are not included in the scope of this study.

The dataset contains 14 types of disasters: Flood, Storm, Epidemic, Earthquake, Landslide, Extreme temperature, Drought, Wildfire, Volcanic activity, Insect infestations, "Mass movement (dry), Glacial Lake outburst, and Impact, Animal accident.

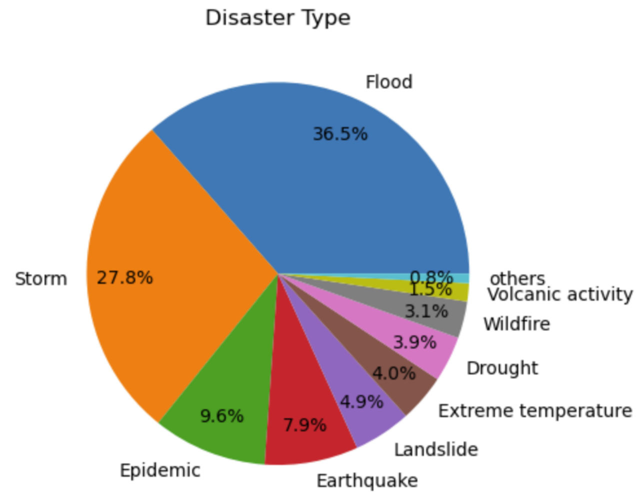

Figure 2: Proportion of various types of disasters.

The data was collected from 228 different countries from 23 different regions, with most records from the US, China, and India.

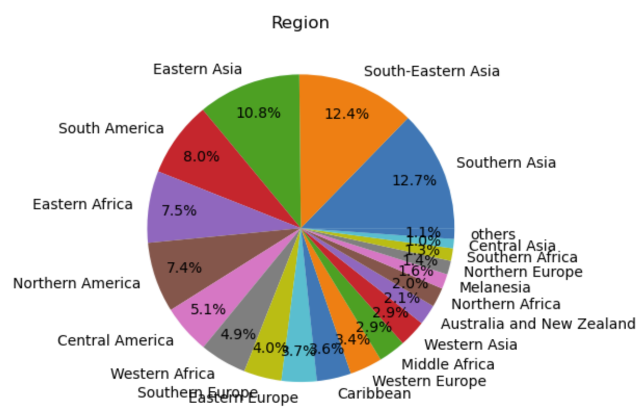

Figure 3: Proportion of different regions.

METHODS

For better visual effects, Shorthand was applied to the overall construction of the web page. Flourish and Tableau were used for the first three data visualizations to show the huge impact and economic loss caused by natural disasters. Compared to other methods, the final results of these two applications were more vivid.

In the Wide Impact section, an interactive timeline of the most influential ten earthquakes, floods, and storms is plotted by R with details such as country, magnitude, etc. Different categories are colored differently for better visualization. Also, an interactive disaster globe is built with R Plotly Library to demonstrate the geographical features of earthquakes, floods, and storms. Another technical software tool used in this section is python (i.e., Pandas, Plotly & Dash). Pandas is mainly used to import and filter the data as well as the necessary processing. The main purpose of the graph is to display the geo-distribution of various disasters and the most impactful disaster in terms of the number of total affected people for each country. To better show the change of distribution along the timeline since 1970, the graph includes a time slide bar. The interactive graph can also show the year, the number of people affected, the country, and the disaster type upon hover.

In the mental health section, data collection and data processing were performed before drawing the plot. Then, Pandas and Matplotlib of python are used. Pandas is mainly used to import the processed data, and since the team is trying to show the different types of people (independent groups) who are affected by the GEJE, the best visualization is the area plot. Therefore, the team used the fill-in function of the Matplotlib package, and by adding on the legend, the label, and the title, the area chart is more understandable than the line chart.

In the final call to action section, python (i.e., Pandas, Matplotlib, and Gradio) is used. Pandas are mainly used to import and filter the data as well as the necessary processing for selecting the top 3 disasters according to the ISO of choice. Gradio is employed to design the graphic user interface. Matplotlib is used for displaying the disasters' icon. The main purpose of the GUI is to display the icon of the top 3 disasters of the country of choice in terms of the total affected population. From our point of view, such searching could help the audience to be better prepared accordingly.

RESULTS

The research first explores the economic loss and people-affected situation. And the visualization of people affected by natural disasters compares the large difference between the number of people affected by natural disasters in 2021(101.8 million) and the population of California. According to Swiss Re's sigma report, the visualization of economic loss directly compares the large difference between the total global economic loss due to natural disasters in 2021 ($270 billion) and the annual GDP of Libya [13].

And the team also create a dashboard visualization which includes a country map showing the count of disasters of each country, a scale chart to show the different disaster types distribution and a list chart shows the detail information about each disaster including the total death, total affected people, and the economic damage, and all three charts are connected, which can give the readers a better experience.

Also, based on the EM-DAT database, the team creates a timeline map, which can be adjusted to see the disasters that occurred in each country from 1970 to 2021. And after comparing the total economic damage caused by each disaster worldwide from 1970 to 2021, it was found that earthquakes, floods, and storms took the lead. And to better clearly understand what these powerful disasters are, the team found some famous disasters in history and also those that led to great losses around the world based on filtering the EM-DAT database. Meanwhile, the team also made a global disaster visualization to find insights on the three powerful disaster's geo-distribution.

In the second section of this project, the team focuses on the mental issues caused by traumatic disasters, and the team-specific research on the massive 9.0 magnitude earthquake that occurred in the Pacific Ocean, 72 km (45 mi) east of the Oshika Peninsula of the Tōhoku region in 2011, and the data are from some articles. In this section, based on the Fukushima Medical University Health Management Group conducted mental health surveys with roughly 185 000 evacuees. Among those surveyed[14], 14·6% in 2011, 11·7% in 2012, and 10·3% in 2013 screened positive for high distress, and 21·6% in 2011, 17·4% in 2012, and 17·2% in 2013 had probable post-traumatic stress disorder (PTSD). After the earthquake, in March 2011 the suicide rate was 18% lower than the average mortality rate for the previous three years. However, it increased by 18% in May and 8% in June. Also, based on another study [15] that focuses on people of different groups who have mental health problems after GEJE, the team plotted an area plot, which shows the number of mental health problems arising from earthquakes has increased to different degrees for all types of people.

Finally, after showing a clear overview of how natural disasters can affect not only physical life but mental health, the team also did some research about what actions have been recommended for each disaster by CDC websites [16]. And In order to better facilitate the viewers, the team developed a search box, audiences can search for the country they want to know according to their specific situation, the search box results can display the three most common natural disasters in the search country, which can also be more convenient for audiences to find the appropriate preventive measures.

DISCUSSION

Since natural disasters are large-scale geological or meteorological events, the economic losses caused by natural disasters on a global scale are also very shocking. By using directly comparable data visualization to show how powerful natural disasters influence the economy and people, the audience can have a simple overview of natural disasters. And from the dashboard system, it is easy for the audience to know about their home country or some countries' situation.

Since natural disasters are diverse, different countries have experienced some level of disaster at different times. To better explore the distribution and impact of natural disasters at a practical level, the audience can try to play with the timeline map. In general, the number of disasters worldwide is increasing over time. This visualization allows the reader to see the trend of natural disasters worldwide over time in a short period of time, allowing the reader to quickly develop an understanding of the current situation.

And from the dashboard, it is clear to see what damage all disasters caused to all countries and to dig further into the most influential disasters, and economic damage has been considered as a metric because a huge economic loss could be a devastating hit for every country. Therefore, to dig into much detail, as can be seen from the timeline's famous disaster plot, earthquakes occurred frequently and had a large impact between 2003 and 2010, while blizzards and floods were relatively spread out in the timeline in terms of when they occurred and did not occur frequently over a period. In addition to understanding the temporal patterns of these three powerful disasters, the team counted the locations where they occurred to find out if they were geographically aggregated. Audiences can look at the global disaster map below, floods are frequently located along riverine zones in Asia and Europe, with clusters in China, India, and Indonesia. Earthquakes are also frequent in parts of Asia and Europe and North America, with concentrations in China, Japan, and the Philippines, while storms are more dispersed than earthquakes and floods, occurring mostly along the coast and near the equator.

Because the damage caused by natural disasters not only involves economic and physical health but also brings great Mental Injury. When people experience or just witness a disaster, they may experience a variety of reactions, it is common for people to show signs of stress after exposure to a disaster. Although everyone reacts differently to disasters, some of those affected may suffer from serious mental or emotional distress. From the data and the area plot showing the insights of the mental consequences [15], audiences can see that as time increases, the increasing number of residents with mental problems is the highest, with over 170000 residents suffering from mental issues within a year. Followed by a relatively large proportion of students with mental problems, totaling about 60,000 students with mental problems such as depression, and this disaster also leads to over 50000 existing patients having mental disease problems, and there are also about 60000 employees who become more mentally distressed in their lives. And all above show that the serious results may be due to natural disasters.

Therefore, from all the research, the team gave three recommendations about how to react when people face a disaster, and also provide a search bar, which is much more convenient for people to know about their own country's disasters and also provide some react action articles for the audience.

FUTURE WORK

Much more work can be done based on the current analysis. Future research can be continued in three directions: disaster prediction, modeling disaster solutions, and post-disaster management and reconstruction. The prediction of meteorological disasters, earthquakes, mountain fires, etc. is currently receiving more attention. In the future, increasingly advanced AI and DL technologies can be applied to build prediction models for natural disasters that are challenging to predict. Based on historical data, disaster solution models can be designed to minimize the impact of disasters. Post-disaster management and reconstruction work need to be further optimized, taking into thorough consideration the physical and mental health of the affected people, as well as efforts to speed up the economic recovery of the affected areas.

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