Disaster Management Analysis - St. Himark

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***Abstract*— This report addresses the mini-challenge 1 of VAST Challenge 2019 providing analytical and inferential insights about the damage caused due to an earthquake in St. Himark for a period of 5 days. This report shows a visual analytics approach to collaborative management of large scale disaster management.**

***Keywords*— Visual analysis, Dashboard, VAST 2019**

I. INTRODUCTION

A fictitious city named St. Himark is struck by an earthquake and the city officials find it hard to deal with the situation due to a shortage of various supplies like medical support or fire emergencies. A mobile application launched earlier comes to the rescue and helps officials make quick decisions with reports from the citizens that show a damage score ranging from 0 to 10. The shake intensity data was collected for a period of 6 days from the 4th of April to the 11th of April with a total of about 81 thousand reports from the users.

II. DATA PREPROCESSING AND MANIPULATION

A. Dataset

The dataset contains a shape file for background knowledge of the city and neighborhood reports showing damage on a scale of 10.

TABLE I
SEISMIC READINGS DATATYPES

Fields - Data Types	
Fields	**Type**
Time	datetime stamp
Sewer_and_Water	numeric
Power	numeric
Roads_and_Bridges	numeric
Medical	numeric
Buildings	numeric
Shake_Intensity	numeric
Location	numeric

B. Data Transformation

A SQL join was used to obtain the location names since the dataset had location IDs. Moving further, a connection was established between the user reports data and the shape file for spatial analysis in Tableau.

C. Data Wrangling

The first step to clean the data was to deal with null values. These null values were replaced by the row average since it closely relates to the real-life scenario at a certain time. In addition, pivot tables helped create radar plots for time-series analysis.

III. VISUALIZATIONS AND ANALYSIS

The first approach to handle the situation was by using radar-plots. This helps understand a scenario with a time-scale with location-filtering in an interactive way.

A. Radar Time-Series Plots

Radar plots help understand a scenario with a radial time-scale in addition to location filtering in an interactive way. With the time-scale in a circumferential direction and magnitude in the radial, it could simply look like a clock with the ease of interpretability and ability to make judgements and inferences with minimal supervision as shown in Fig 1 below.

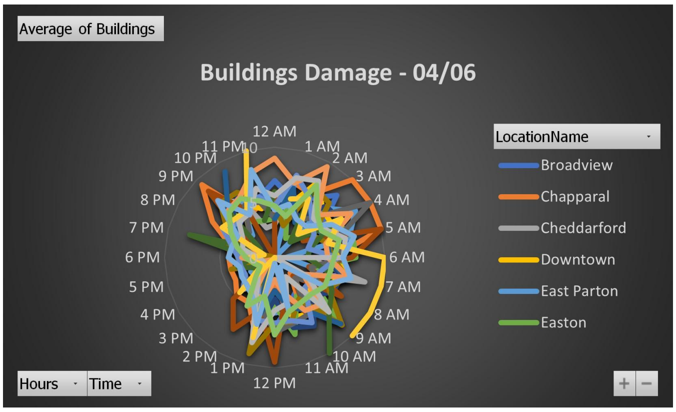

Fig. 1 Buildings damage reported by users on April 6th

From a quick glance, a plot like Fig. 2 can help someone understand that attention needs to be diverted towards Terrapin Springs from 5 AM and if there is a shortage, resources from Southton could be used since there isn't much demand in Southton from 5 AM to 9 AM. Also, it helps to make a decision based on previous and present data for someone who has the right background knowledge of this city.

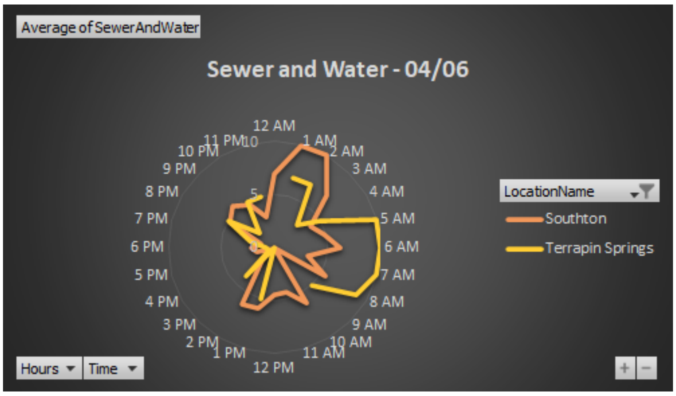

Fig. 2 Sewer and water damage intensity reported by users in Southton and Terrapin Springs on April 6th

B. *Spatio-temporal Tableau Interactive Dashboards*

A choropleth shake intensity heatmap of the city at different hours of a day with each location plotted along with the shake intensity variance over locations also gives a broader picture about the city's condition at each point in time as depicted in Fig 3.

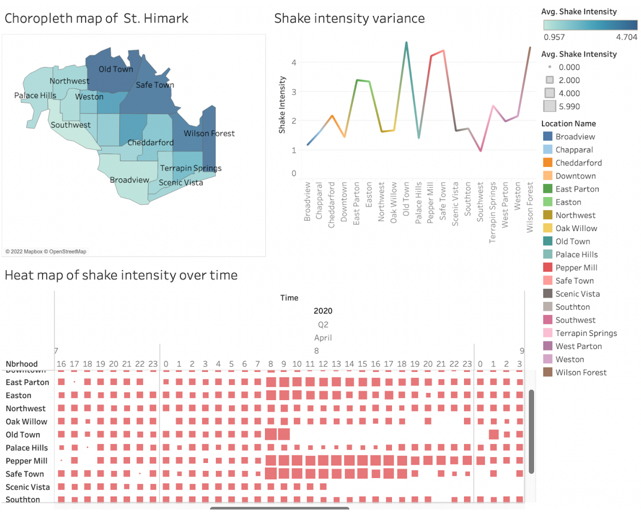

Fig. 3 An interactive dashboard with a choropleth chart and time-scale with location filtering to visualize the average shake intensity

Another interesting plot involves an area-graph of the intensities reported over time based on location filtering as shown in Fig 4. A simple line plot shows the variation in average shake intensity values at different instances, but the simple use of brushing can help understand which utility was the most affected and in which region.

While these are some of the main dashboards that bring a lot of insights, there were other dashboards that showed the time series variation of average shake intensity reported by the users compared with the number of tweets during that period, trying to establish a relation between shake intensity and message count and also to evaluate the credibility of user reports.

Fig. 4 A dashboard that shows the average shake intensity and its consequences on utilities for each location at different time periods

IV. CONCLUSION

With prior knowledge of the city, one can easily understand where, how and when help or resources need to be diverted at specific times using radar plots. The aftermath of a disaster can be easily analyzed to comprehend and discuss the regions that had significant impact and are worth directing attention to.

Tableau's choropleth heatmap plot integrated with a time scale and location filter in addition to radar plots prove to be helpful in making disaster management reports.

V. FUTURE WORK

The scope of first advancement that could be made before we start with a disaster would be to install early earthquake detection systems that can sense disturbances under the Earth's crust.

The user credibility can also be evaluated by using tweets to generate periodic word clouds to get a feel for the most discussed topics. This tweet data can also help the officials understand user pain-points, for example, tweets about a major water pipeline breaking. Heatmap mosaics like the one shown in [2], or a NEAT tool in [3], or Bayesian Structural Time series analysis [4] can be used for a bigger perspective of the scenario

Looking at this problem from another frame of reference, a graph analytics approach to provide timely solutions with the locations as nodes, services and utilities as node properties and distances between cities as weights, one can refine and report the best minimal ways to solve problems like scarcity of resources.

VI. REFERENCES

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Link to the dataset:
https://cartext.datahub.pnnl.gov/0518d63ac66184661ca992034a927b5b32277488742264f21f192fab547354e2

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VII. APPENDIX

Link to GitHub repository (all modified files):
https://github.com/ritvik-chebolu/VAST-2019-MC1
Link to the website:
https://ritvik-chebolu.github.io/VAST-2019-MC1