VISUAL ANALYSIS OF LOCAL EARTHQUAKE IN NORTH TAPANULI BASED ON DATA SCIENCE

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ABSTRACT

Earthquakes are natural phenomena that occur when the Earth's tectonic plates move and release energy. Big Data's emergent epistemological and research paradigms, as well as data science, an increasingly integrated field of data research, are opening up new opportunities. Visualizing earthquake data is all about understanding earthquake characteristics such as size, location and depth. The result show that September was the quietest month in terms of earthquakes, and in this graph we can see the number of earthquakes for each month in 2022. The month of October is the one that has the highest number of earthquakes. We can see the average depth and magnitude of each year on the bubble chart. In addition, the size and color of the bubbles indicate the number of earthquakes that month. In general, most of the earthquakes occurred in the shallow earthquake range and the 1.8-3.85 magnitude range.

Keyword: Earthquakes, Data Science, Big Data, North Tapanuli, Visualizing.

INTRODUCTION

Earthquakes are natural phenomena that occur when the Earth's tectonic plates move and release energy. The emergence of the big data era has opened up new opportunities for a range of fields, namely the transformation of epistemology and research paradigm, and the emergence of data science, a field of data research that is becoming increasingly integrated (Sinambela, 2020).

The total number of people who die as a result of natural disasters is lower today than it was in the past, and the world has become more resilient to disasters. However, earthquakes can still claim many lives (Disasters, 2023; Meghraoui et al., 2003). Whereas in the past floods, droughts and epidemics were the main causes of disaster deaths, today large earthquakes, and possibly the tsunamis they produce, are often the cause of large numbers of deaths. However, the laws of earthquake occurrence are difficult to predict, and the scientific community has yet to clarify the mechanisms and principles of their occurrence. It is also difficult to determine which places have a high probability and which have a low probability. Therefore, we need to use seismic data sets, to use Python for visual analysis, to find rules from the data, and to conduct scientific research with methods in order to reduce the damage caused by earthquakes to human beings and to all material culture and other life on Earth (Xiangrong, 2020a).

In this study, visual data analysis of earthquake events that occurred in Tarutung, North Sumatra in 2022 was conducted. The main goal of visualization of local seismic data is to provide a clear and comprehensive understanding of the seismic features like magnitude, location and depth. Visualisation of local earthquake data helps the disaster response community and the general public to obtain timely and accurate information about the earthquake's impact and potential risk. Visualisation of earthquake data allows real-time monitoring of seismic activity, which is crucial for early warning systems, research and emergency preparedness.

DATA AND METHODS

North Sumatra has been very active in tectonics in recent years. This can be seen from the results of the seismic activity in the year 2019. The dominance of earthquake activity in North Sumatra generally occurs on land, as shown in Figure 1. In this case, it needs to be identified how to distribute the earthquakes occurring in North Sumatra. The identification of land earthquakes based on Figure 1 shows that variations in magnitude can be classified into 2 colours, namely small and medium magnitude. Land earthquake events in 2019 show that land earthquake event distribution is strongly dominated by Sumatra fault zone activity and local segment (Sinambela et al., 2020).

On Saturday, 01 October 2022 at 02:28:41 WIB an earthquake with a magnitude of 5.8 occurred. The epicentre is located at coordinates 2.108242o LU 98.913916o BT on land in North Tapanuli, North Sumatra at a depth of 10km. The earthquake can be classified as a shallow earthquake due to the activity of the Great Sumatra Fault Renun Segment with strike-slip movement (Julius et al., 2023).

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The earthquake that occurred on Saturday, October 01, 2022 at 02:28:41 WIB caused significant shaking in the area around the epicentre (Juraidi, 2022). Figure 1 shows that the magnitude 5.8 earthquake was recorded by BMKG's network of accelerographs distributed throughout Indonesia. A total of 37 accelerograph stations recorded the earthquake, which had a magnitude of up to V on the Richter scale. Onan Ganjang Station, Humbang Hasundutan, North Sumatra (ONSM) is the station closest to the epicentre at a distance of about 23.21 km. Sampoiniet Station, Aceh Jaya, Aceh (SASM) is the station farthest from the epicentre at a distance of about 488.16 km.

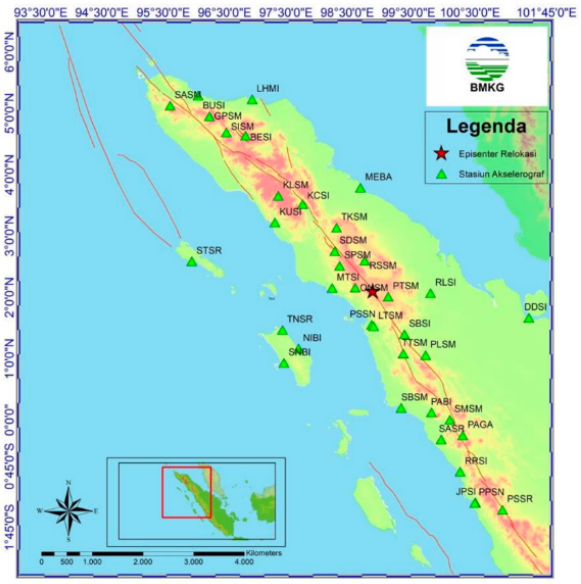

Figure 1. Earthquake epicentre map The earthquake epicentre was on land in the North Tapanuli region, Saturday 01 October 2022 at 02:28:41 WIB, along with the accelerograph station that recorded the earthquake.

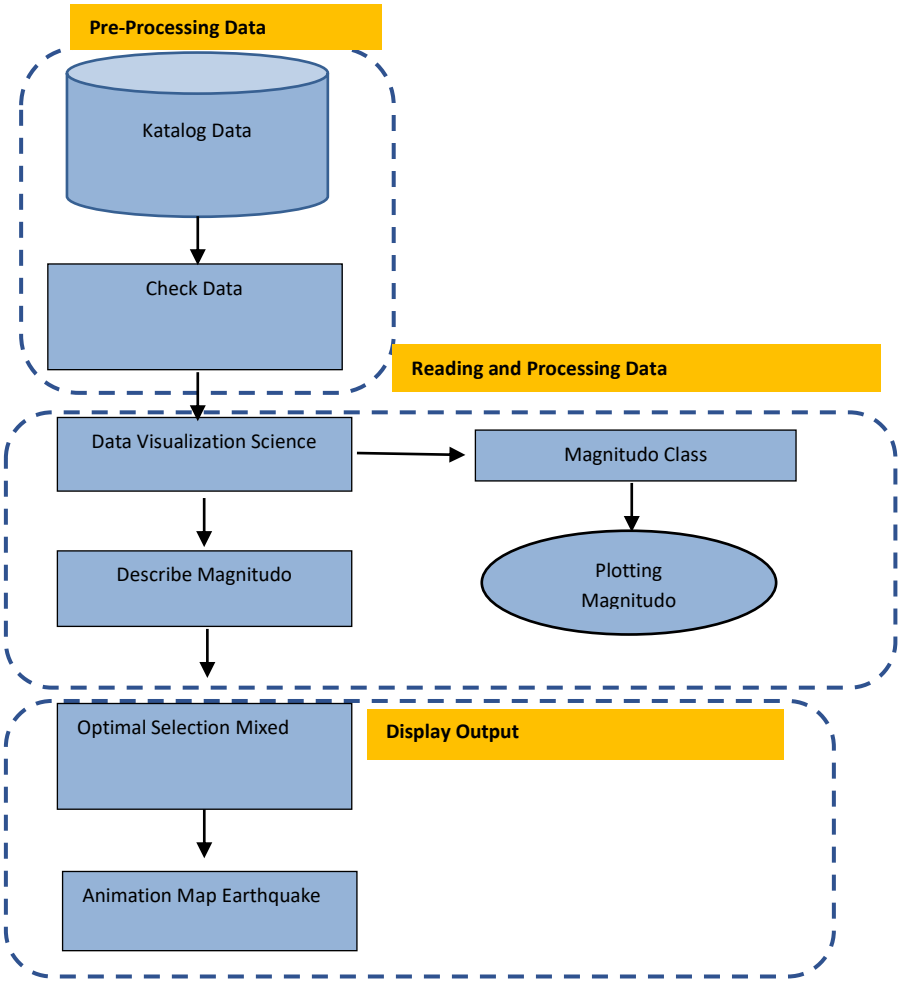

Figure 2. The flowchart of Local Visual Earthquake

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In Figure 2, the data used in this study is from the BMKG data catalogue, which records the Tarutung earthquake event in October 2022. In the pre-processing of earthquake data, it is first done, then data processing is done with visual earthquake data and earthquake magnitude classification (Xiangrong, 2020b).

RESULTS AND DISCUSSION

According to the BMKG release, this earthquake is the main shock of the earthquake that occurred on 01 October 2022. As the earthquake progresses, aftershocks of lesser intensity and decreasing frequency will continue to occur. Up to 21 October 2022 at 00:00 WIB, there have been 169 quakes.

This study attempts to explore and visualize "Significant local seismic events in Tapanuli Utara, Northern Sumatra, using a dataset". In addition, there are basic analysis on parameters. The graphs are bar graph (frequency of earthquakes), bubble graph, mixed line graph (maximum and average magnitude of the event), 3D scatter plot and animation map.

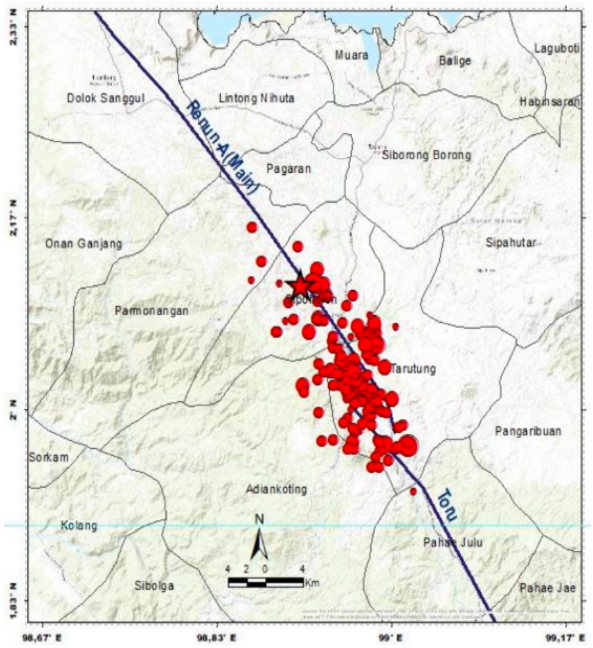

Figure 3. Earthquake inland clusters in Local Visual, Tapanuli Utara, Northern Sumatra

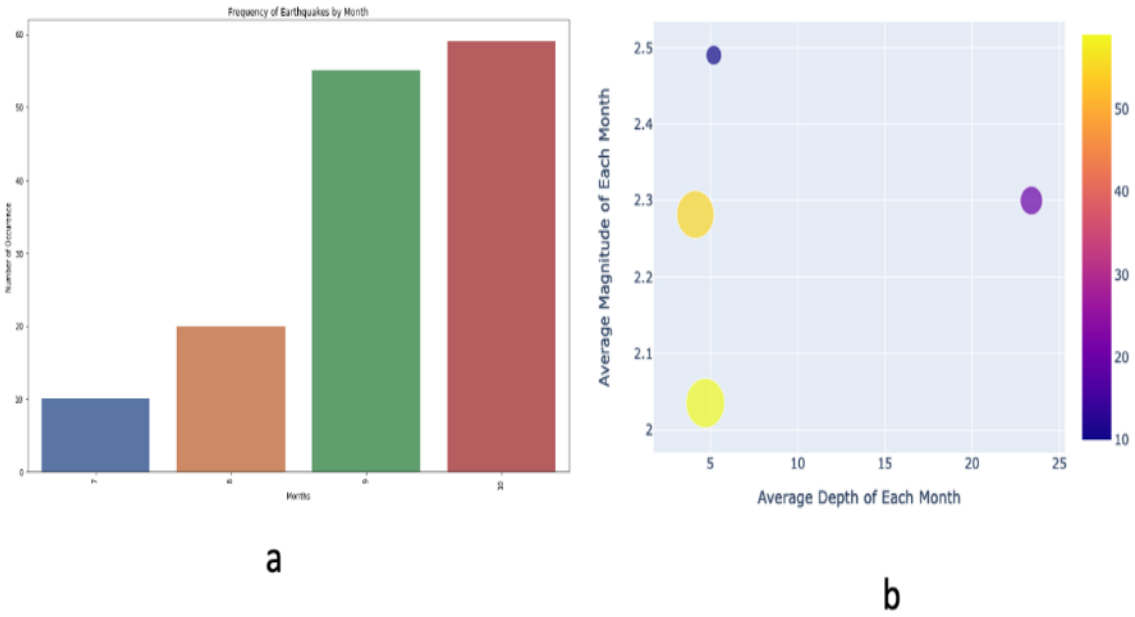

Figure. 4. a. Frequency of earthquakes by Month, b. Average.Magnitude vs Depth of Each Month

In this plot, we can see the number of earthquakes at the time of occurrence (Figure 4.a). The year 2022 in October is the year with the highest number of significant earthquakes in North Tapanuli. The characteristics of North Tapanuli induced earthquakes were statistically evaluated. A probabilistic model was developed to simulate stochastic seismic events. Four well-known local earthquake zones were selected from the northern part of Sumatra. Based on the In Figure 4.b, the earthquake magnitude for each month shows that the average earthquake magnitude is between 2 and 2.5 with depths varying between 20 and 50 km.

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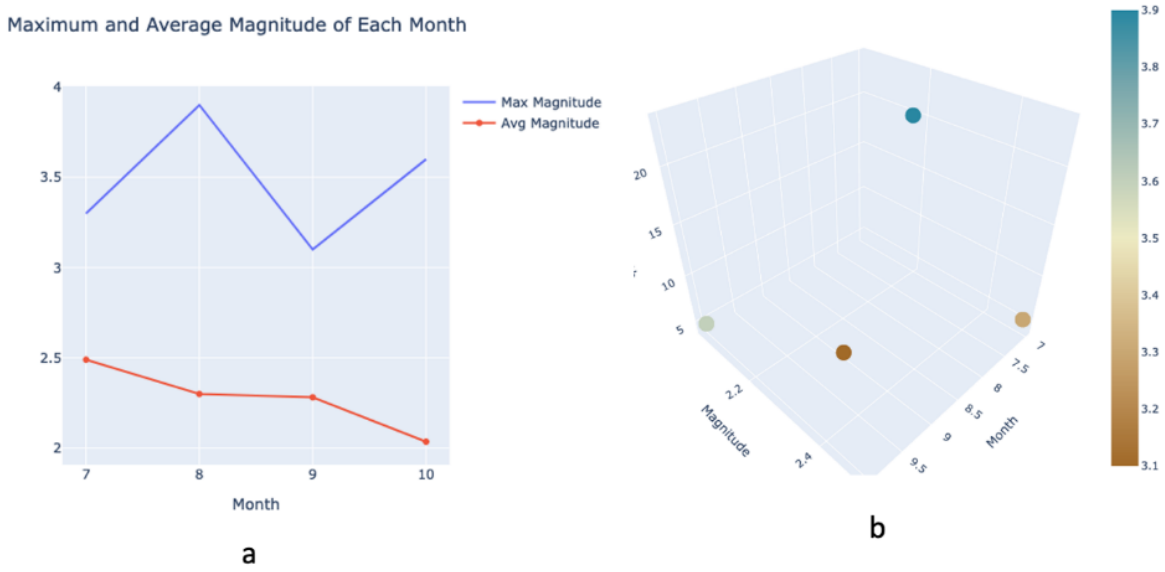

Figure 5. a. Maximum and Average Magnitude of Each Month b. 3D Scatter Earthquake Plotting

In Figure 5 a, the maximum magnitude in the blue line is 3-4 in each month and the average magnitude in the red line is 2-2.5. and figure 5.b show the 3D Scatter Earthquake Plotting.

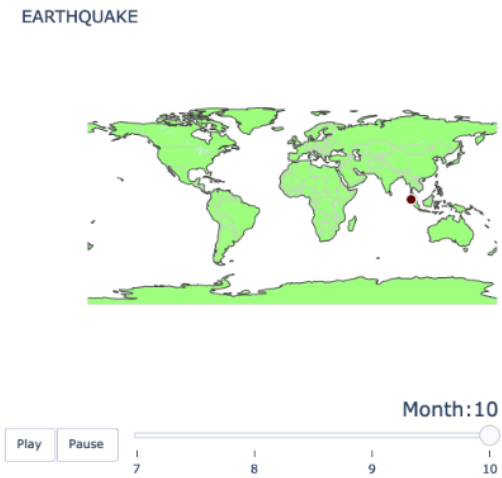

Figure 6. Animation Map Earthquake Plotting

The circle in figure 6 represents a quake - the red in the circle is the local event in size. The depth of the quake is shown by the line across the circle. The graph is particularly useful to give an idea of the distribution of earthquakes, both around the globe and over time.

CONCLUSIONS

From the results of the visual analysis of the local earthquakes in North Tapanuli based on the data science approach, it can be concluded that the dominance of the land earthquakes in North Tapanuli, North Sumatra is highly variable based on the magnitude. The frequency distribution of the magnitude in the 2022 period is dominated by earthquakes with a magnitude of less than 4. The data science approach in this study illustrates the classification of the magnitude of onshore earthquakes in North Sumatra into the categories of minor, mild and moderate. In the period October 2022, the dominance of the largest earthquake source was caused by the Sumatra Rhenum segment shear fault. The results of sensor performance studies in previous studies have significantly affected earthquake recording especially in North Tapanuli, North Sumatra.

Data Availability

The data in this article is an exclusive property and new mini region stations of BMKG Network and cannot be totally public. Some of this data was put to the public service so that reviewers could verify the reliability of the results. So, if reviewers need the raw data in this study, send me your request.

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