

Statistical And Data Inferential Analysis of Turkey's Earthquakes

Aaron Francis Mendonca | Pearlyn Theresa Rodrigues

Abstract

Earthquakes are one of the most powerful and destructive natural disasters on Earth. Moderate earthquakes, between 5 and 6, can cause shaking and some damage however large earthquakes, with magnitudes greater than 7, can be catastrophic, causing widespread destruction and loss of life. A devastating earthquake of 7.8 on the Richter scale hit Southern Turkey in the early hours of 6 February (4.17 a.m.), with epicentre in the Pazarcık district of Kahramanmaraş province. In this report we will be conducting an analytical and statistical study of historical data from 1915 to 2023, to gain valuable insights.

Our data consists of a dataset with over 17370 entries and of the columns {Date, Latitude, Longitude, Magnitude, Depth, Location, Deaths, Injuries, Houses destroyed}. Data used for the Hypothesis Testing are web-scraped

Hypothesis Testing

H₀: *USD/Turkish Lira Rate Before 2023'Quake* \geq *USD/Turkish Lira Rate After 2023'Quake*

H_a: *USD/Turkish Lira Rate Before 2023'Quake* $<$ *USD/Turkish Lira Rate After 2023'Quake*

A hypothesis t-test was conducted on firstly the USD/Turkey Lira Exchange rate to determine the significance of difference between the mean rates from 5/1/2023 to 5/2/2023 and 6/2/2023 to 6/3/2023 (6/2/2023 being the first day of the 2023 earthquakes) keeping in mind the normality and variance of both the groups. The data for the groups was scraped from 'finance.yahoo.com' historical chart data. A p-value of **1.74895797e-12** was obtained which hence proves that the exchange rate increased after the earthquake, it means that the Turkish Lira depreciated relative to the US dollar.

H₀: *Population growth (annual %) Before 2011'Quake* \geq *Population growth (annual %) After 2011'Quake*

H_a: *Population growth (annual %) Before 2011'Quake* $<$ *Population growth (annual %) After 2011'Quake*

Another Hypothesis t-test was conducted on the Population Growth rate (annual); before and after the devastating 2011 Van earthquakes occurred in eastern Turkey near the city of Van. The first earthquake happened on 23 October at 13:41 local time. The shock had a M_{ww} magnitude of 7.1 and a maximum Mercalli intensity of VIII (Severe). The data for the groups was collected from the World Bank (World Development Indicator) Meta Dataset. A p-value of **0.314516696** was obtained which hence proves that the population growth rate dropped after the disaster.

Spatial-Temporal Analysis on Historical Data

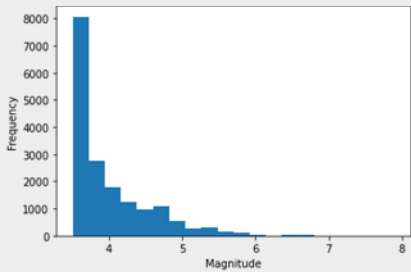


Figure 1

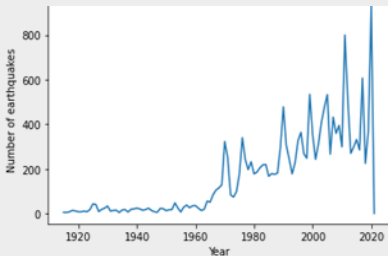


Figure 2

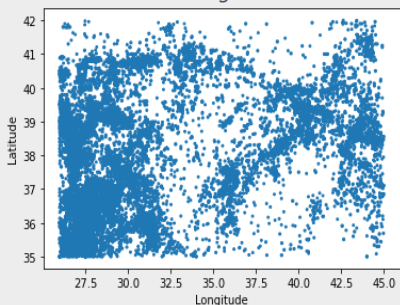


Figure 3

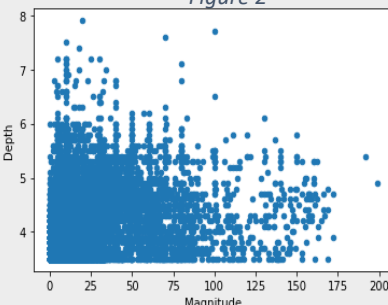
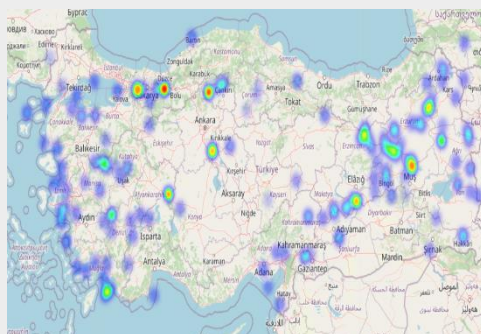


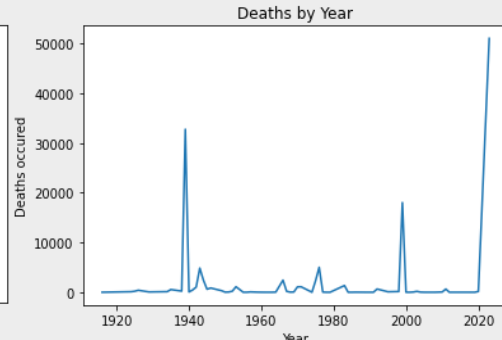
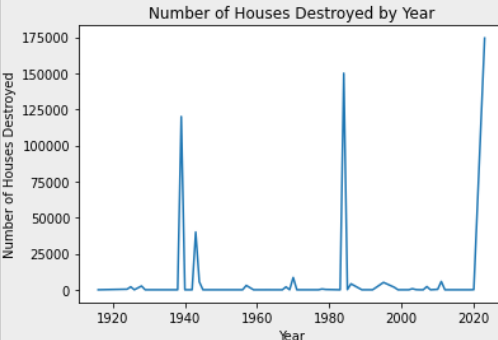
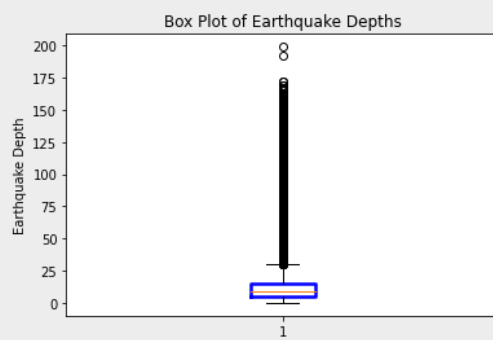
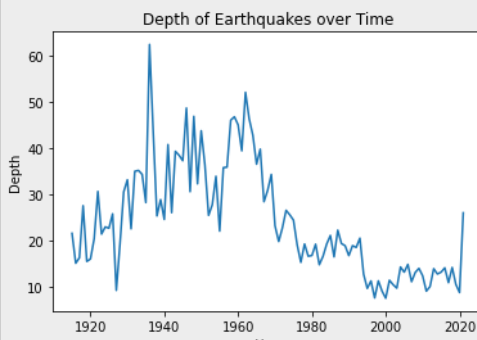
Figure 4

Fig 1: Magnitude Distribution Analysis. Fig 2: Temporal Analysis of Freq of quakes wrt years. Fig 3: Spatial Analysis wrt to Latitude and Longitudes (Which resembles the Anatolian Range). Fig 4: Correlation Analysis



All the earthquakes over 7 in magnitude are situated exactly over the **North Anatolian Fault** and the **East Anatolian Fault**. This is probably the most active fault system in the entire world.

Data Inferential Visualizations



Conclusions:

- Most of the major earthquakes occur along the North Anatolian Fault, The East Anatolian Fault and South-East of the Aegean Sea.
- The median Magnitude of the earthquakes decrease from the year 1960s to the 2000s; and the frequency of small earthquakes increased exponentially.
- Akdeniz (Mersin) experiences weaker, but more frequent earthquakes which we could hypothesize that tectonic activity is shifting to another region however more geological data would be required.
- Kurutilek (Erzincan) experiences stronger, but less frequent earthquakes; with a median of 7.9.
- It is possible that the decreasing median of earthquakes could be an artifact of changes in the methods of earthquake detection and measurement overtime; given that the data exists from 1915 old models of detection were used and newer technological norms have been adopted ever since.
- Around 4,00,860 cases of internally displaced persons were reported from 2008 to 2021 due to the disasters.
- Approximately 60 million dollars spent in damage control.
- In conclusion, the study shows that Anatolian Range is a high-risk area for earthquakes, highlighting the need for effective public policy and disaster management measures to minimize the potential damage and loss of life. It is crucial to prioritize the development of earthquake-resistant infrastructure, emergency response plans, and public education programs to raise awareness about earthquake safety measures in this region.

References

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- <https://finance.yahoo.com/quote/USDTRY%3DX/>
- <https://data.worldbank.org/country/turkiye>
- <https://ngdc.noaa.gov/hazard/earthqk.shtml>