

# Climate change and environmental disasters in Indonesia

Team Name - ClimateTech

## Environmental Science and Technology - Project Presentation

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# Objective of Our Study

- **Identify Disaster-Prone Regions:** Analyze data to pinpoint areas in Indonesia that are most vulnerable to natural disasters.
- **Climate Change Impact Analysis:** Conduct a meta-analysis to understand the effects of climate change on disaster frequency and intensity.
- **Interactive Visualization:** Develop a user-friendly website that provides visual insights into climate-related data, showcasing trends, and critical information on disaster occurrences.
- **Policy Recommendations:** Generate data-driven recommendations for policies aimed at mitigating the adverse impacts of climate change and enhancing resilience in vulnerable regions.

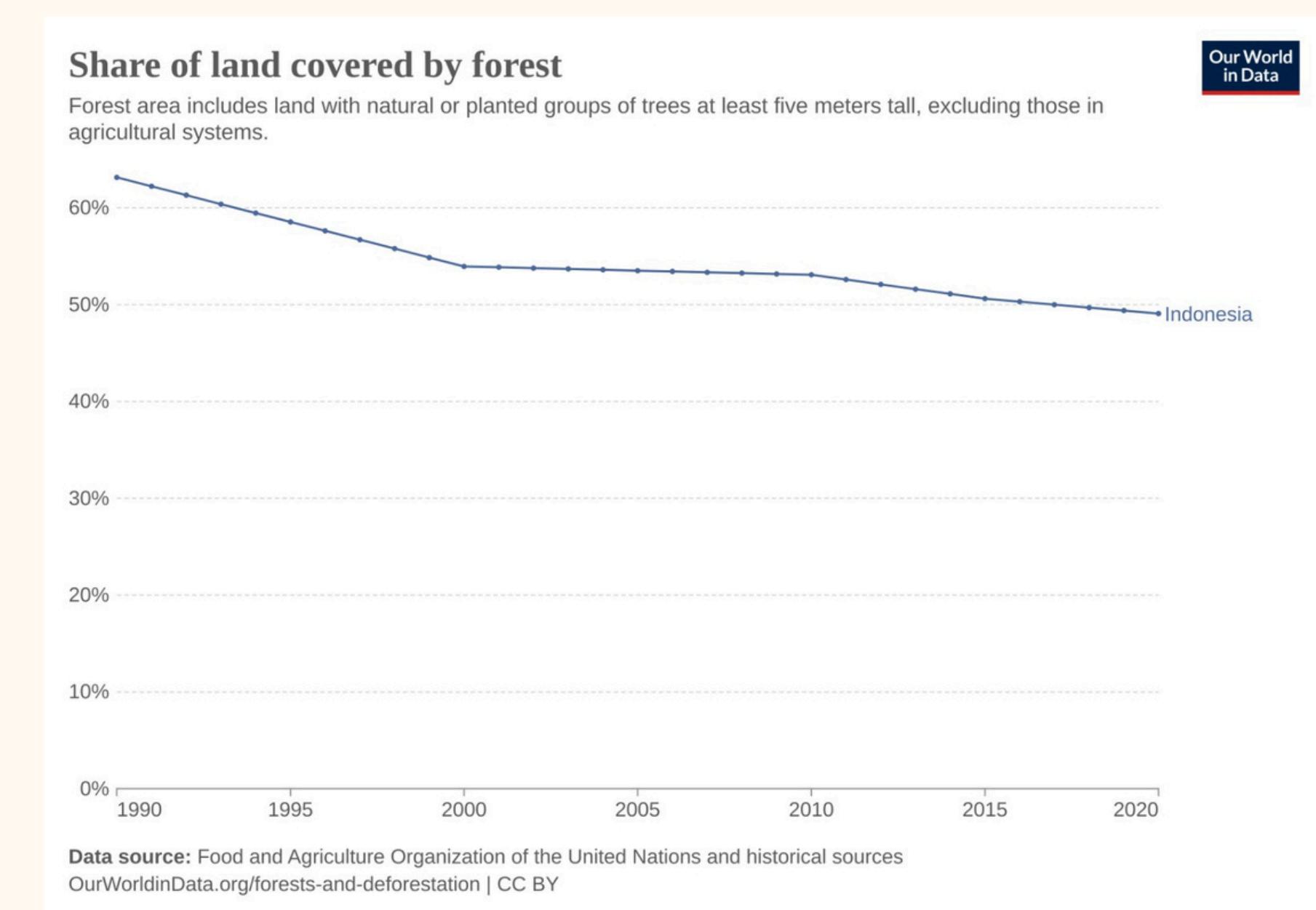
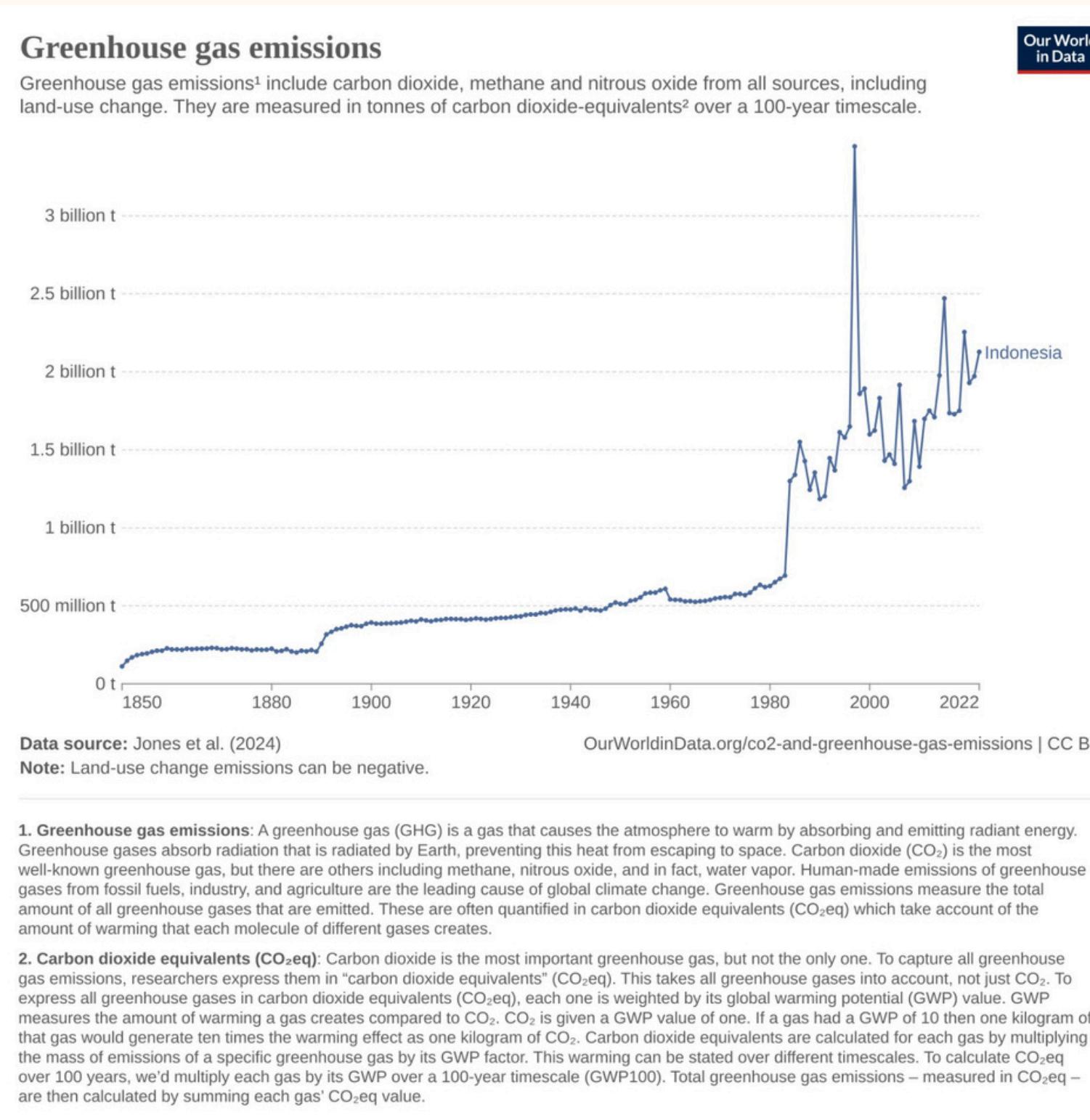
# Brief Introduction about Indonesia Climate

- Indonesia's tropical climate is characterized by a wet and dry season and is increasingly affected by climate change due to rising temperatures, unpredictable rainfall, and sea level rise.
- These changes result in more frequent and severe environmental disasters including floods, landslides, droughts, earthquakes, sea level rise and heatwaves.

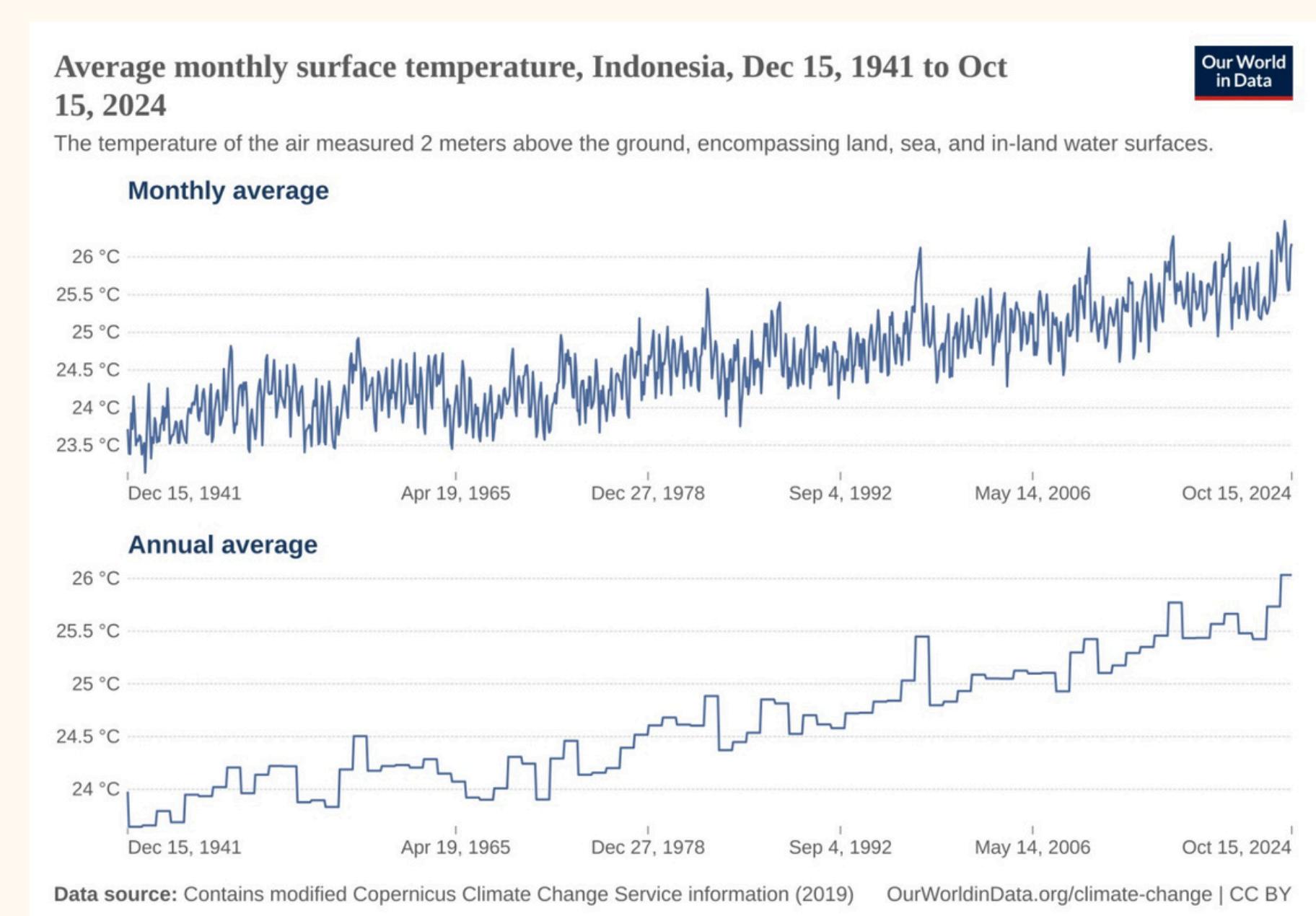
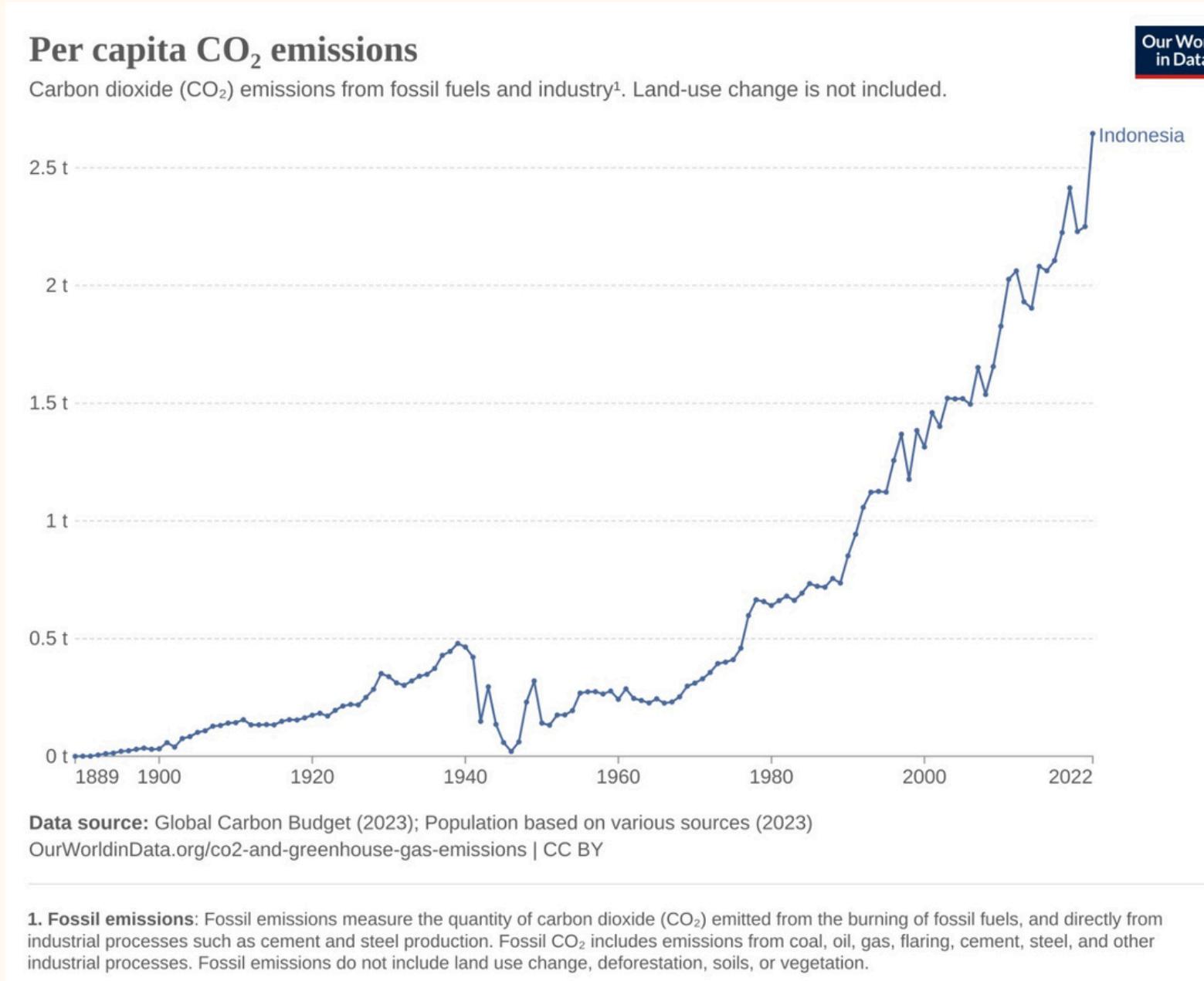
# Relationship b/w Climate Change & Disaster

- Rising temperatures → Drought
- Intense rainfall patterns → Floods
- Melting glaciers and ice caps → Sea-level rise and coastal flooding
- Glacier Melting → Earthquakes
- Land erosion and deforestation → Landslides and volcanic activity

# Relationship b/w Climate Change & Disaster



# Relationship b/w Climate Change & Disaster



# Environmental Disaster's in Indonesia Region

- Earthquake - Tsunami, Landslides
- Volcano - Lava Flows, Ash Fall, Volcanic Mud Flows
- Extreme Weather Events - Floods, Droughts, Cyclones
- Rising Sea Level - Coastal Flooding, Tidal Inundation , Erosion & Loss of Coastal Land
- Forest Fires - Haze Pollution , Air Quality Crisis
- Ocean Acidification - Coral Bleaching, Decline in Fish Population



## Earthquake

- Indonesia is one of the most seismically active regions in the world, frequently experiencing earthquakes due to its position along the Pacific Ring of Fire, a horseshoe-shaped zone known for frequent seismic activity and volcanic eruptions.

# Causes

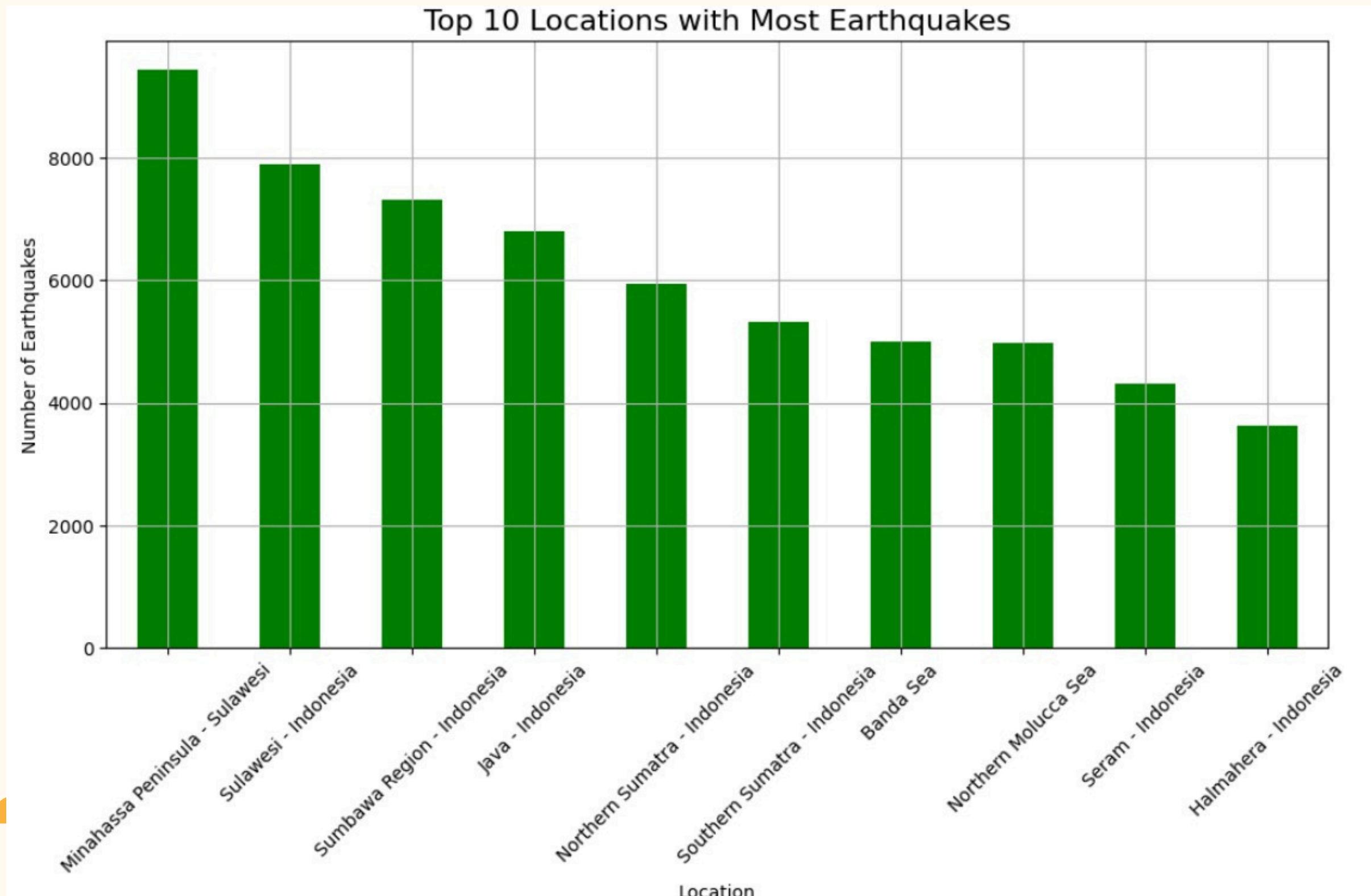
- Tectonic Plate Movement
- Subduction zone
- Fault Lines
- Volcanic Activity

# Outcome

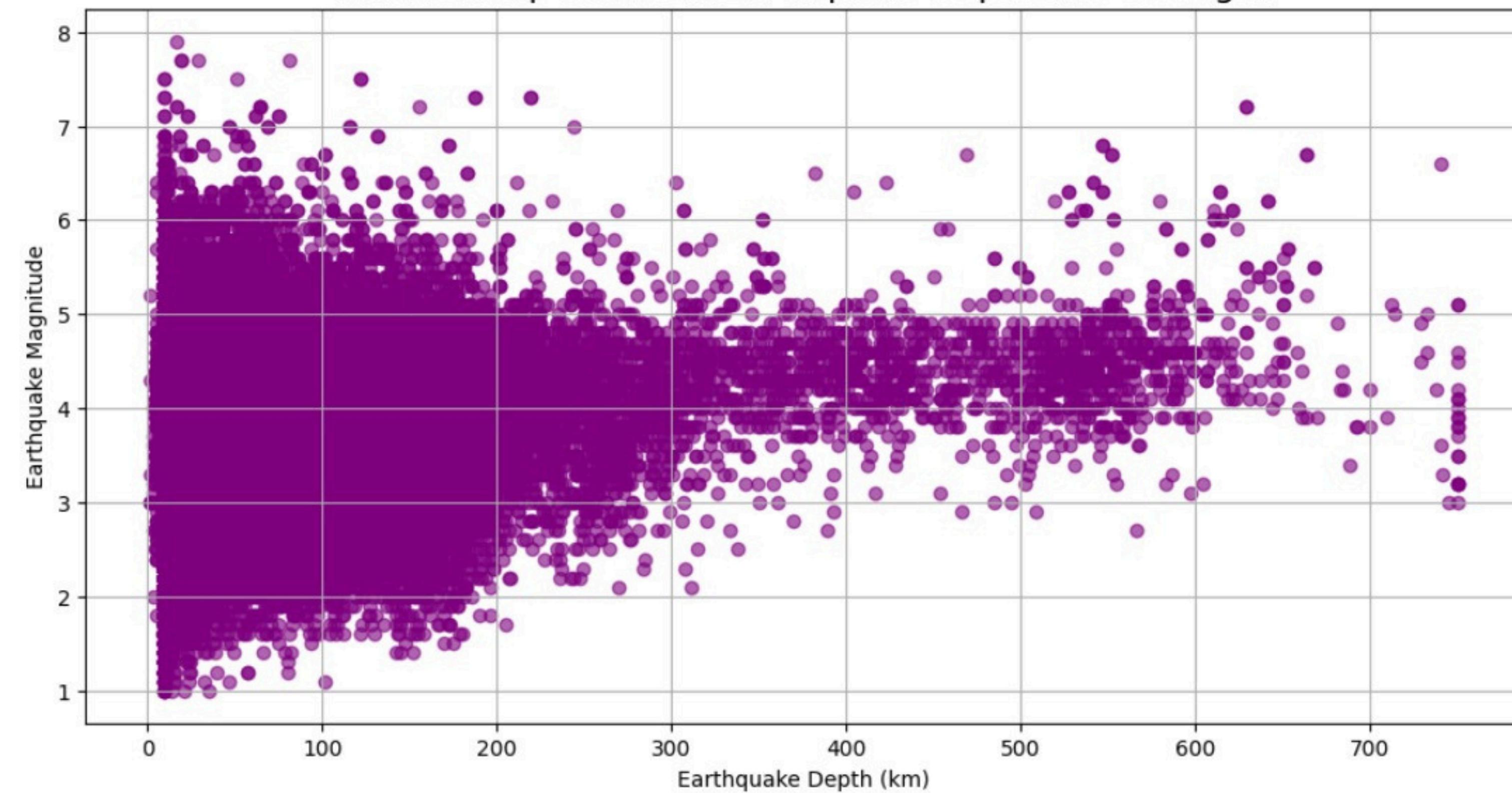
- Tsunami
- Landslides
- Liquefaction

# Our Analysis

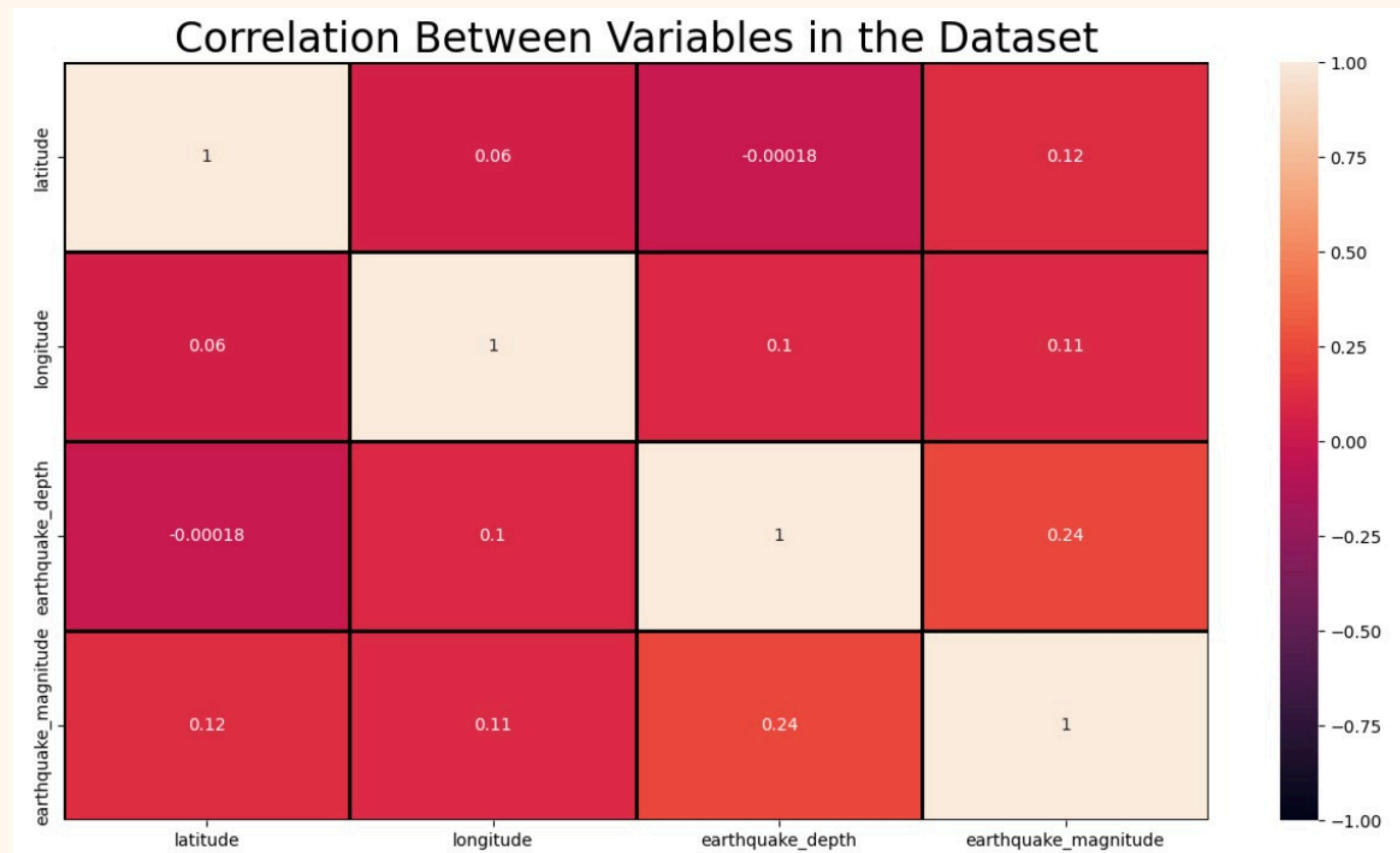
- Dataset Used - Earthquakes in Indonesia
- Link - (<https://www.kaggle.com/datasets/kekavigi/earthquakes-in-indonesia>)



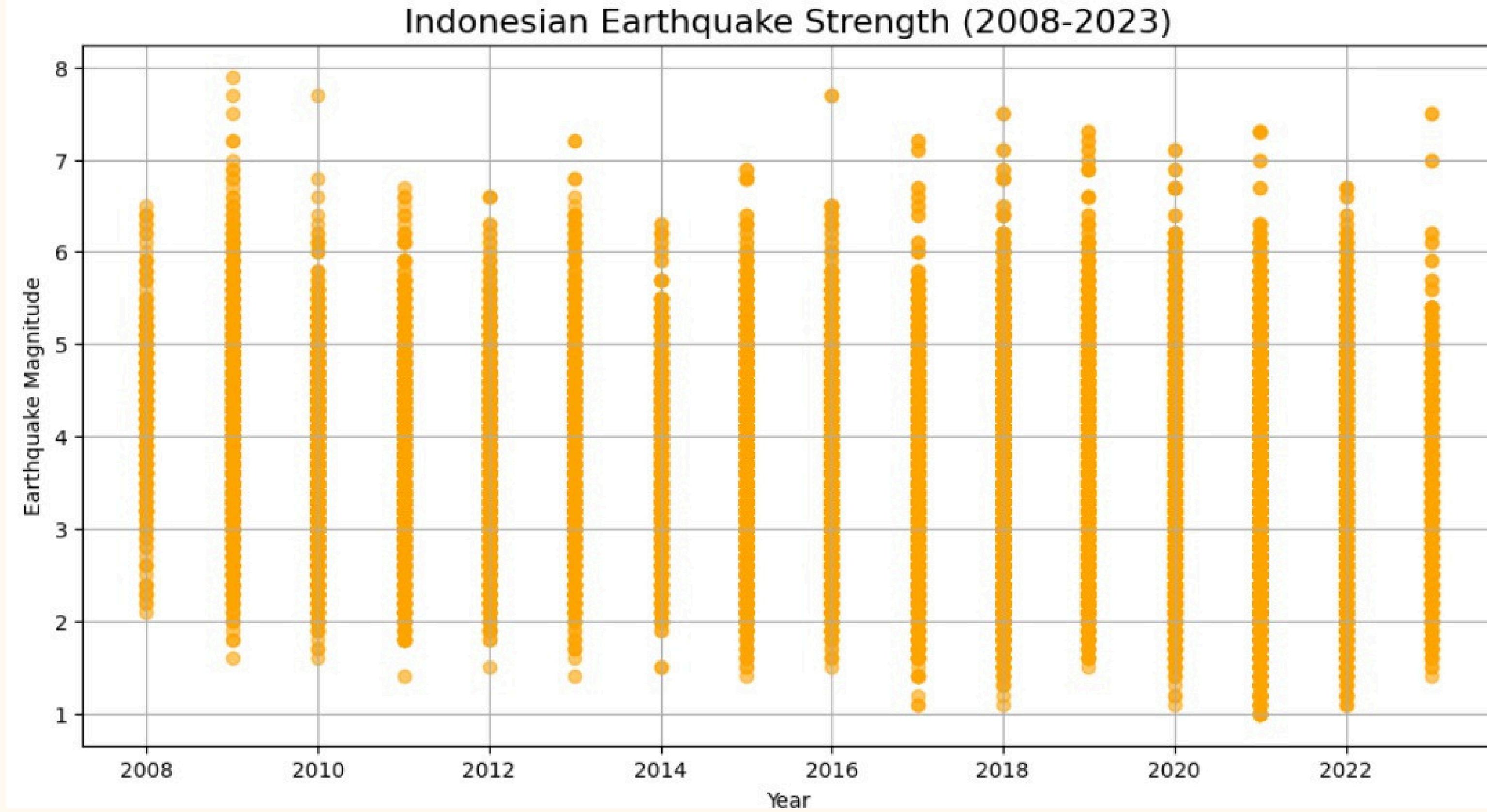
## Relationship Between Earthquake Depth and Strength



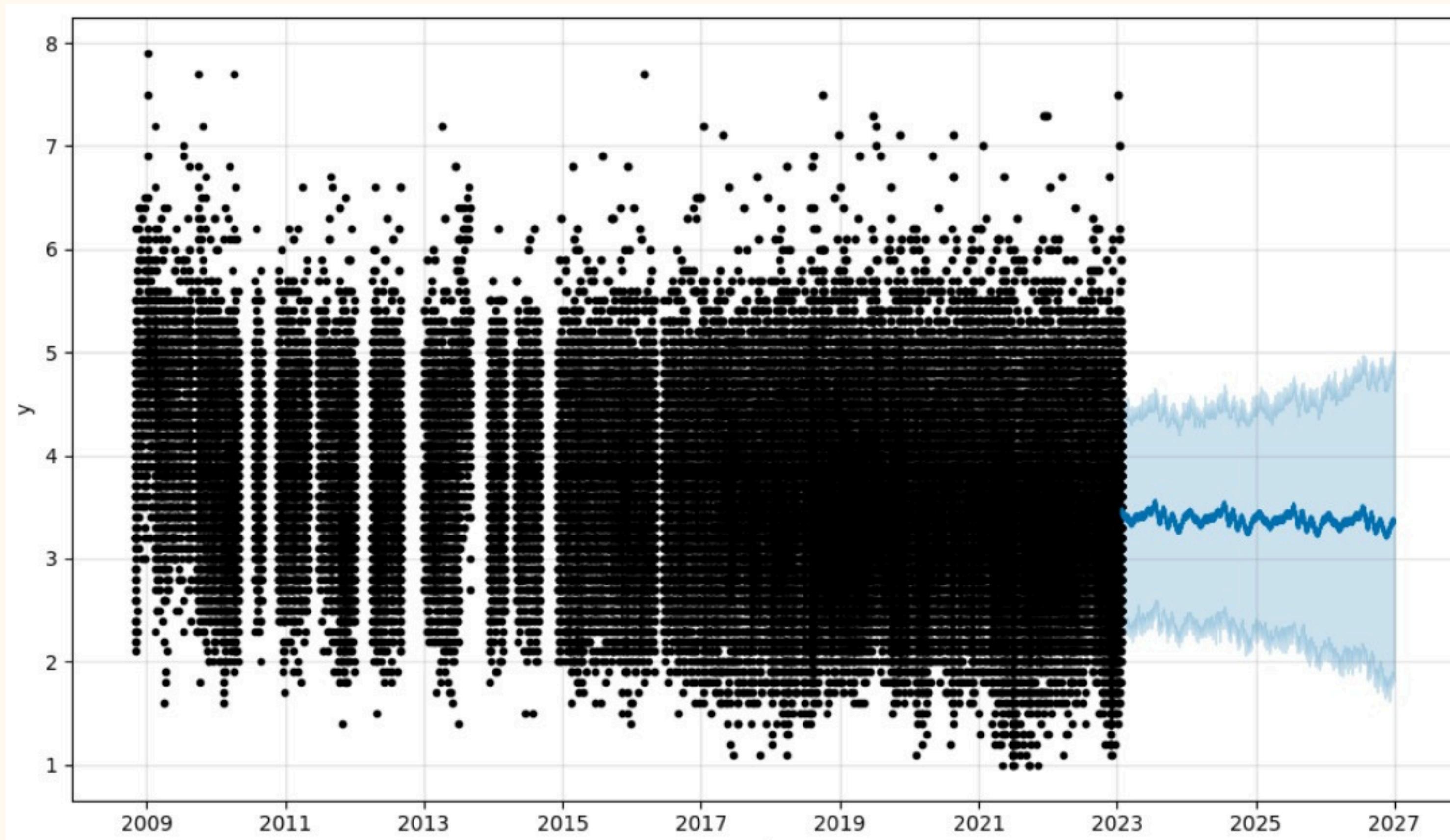
# Co-relation Matrix



# Earthquake Strength Year-Wise in Indonesia



# Predictions



# Observations and Conclusions

- The number of earthquakes increased quite drastically from 2008 to 2020, but the number of earthquakes that occurred from 2021 to 2023 was fairly constant.
- On average, earthquakes that occurred from 2008 to 2023 had a magnitude of 2 to 5. Only a few earthquakes occurred with SR 6 to 7.
- Most earthquakes in Indonesia are less than 100 km deep.
- The number of locations where earthquakes frequently occur are Minahasa Peninsula, Sulawesi, Sumbawa, Java, North of Sumatra Island, South of Sumatra Island, Banda Sea, Halmahera, Irian Jaya and South of Java Island.

# Observations and Conclusions

- The largest earthquake occurred in 2009 in Irian Jaya with a magnitude of 7.9 SR and an earthquake with a magnitude of 7.7 SR occurred in 2009 in the South of Sumatra Island, in 2020 in the North of Sumatra Island and in 2016 in the Southwest of Sulawesi Island
- The predicted strength of earthquakes in Indonesia until 2026 is no more than 5 on the Richter scale
- The predicted strength of the earthquake in Indonesia will be the highest for the next 1 year in 2024, namely 3.6 on the Richter scale



## Volcano

- Indonesia has more than 130 active volcanoes, making it one of the most volcanically active regions in the world. These volcanoes are primarily located along the Sunda Arc, a region where the Indo-Australian and Eurasian tectonic plates meet. Volcanic eruptions in Indonesia can be highly explosive, affecting large areas and leading to multiple types of disasters

# Causes

- Tectonic Activity
- Magma Chamber Pressure
- Volcanic Gas Accumulation

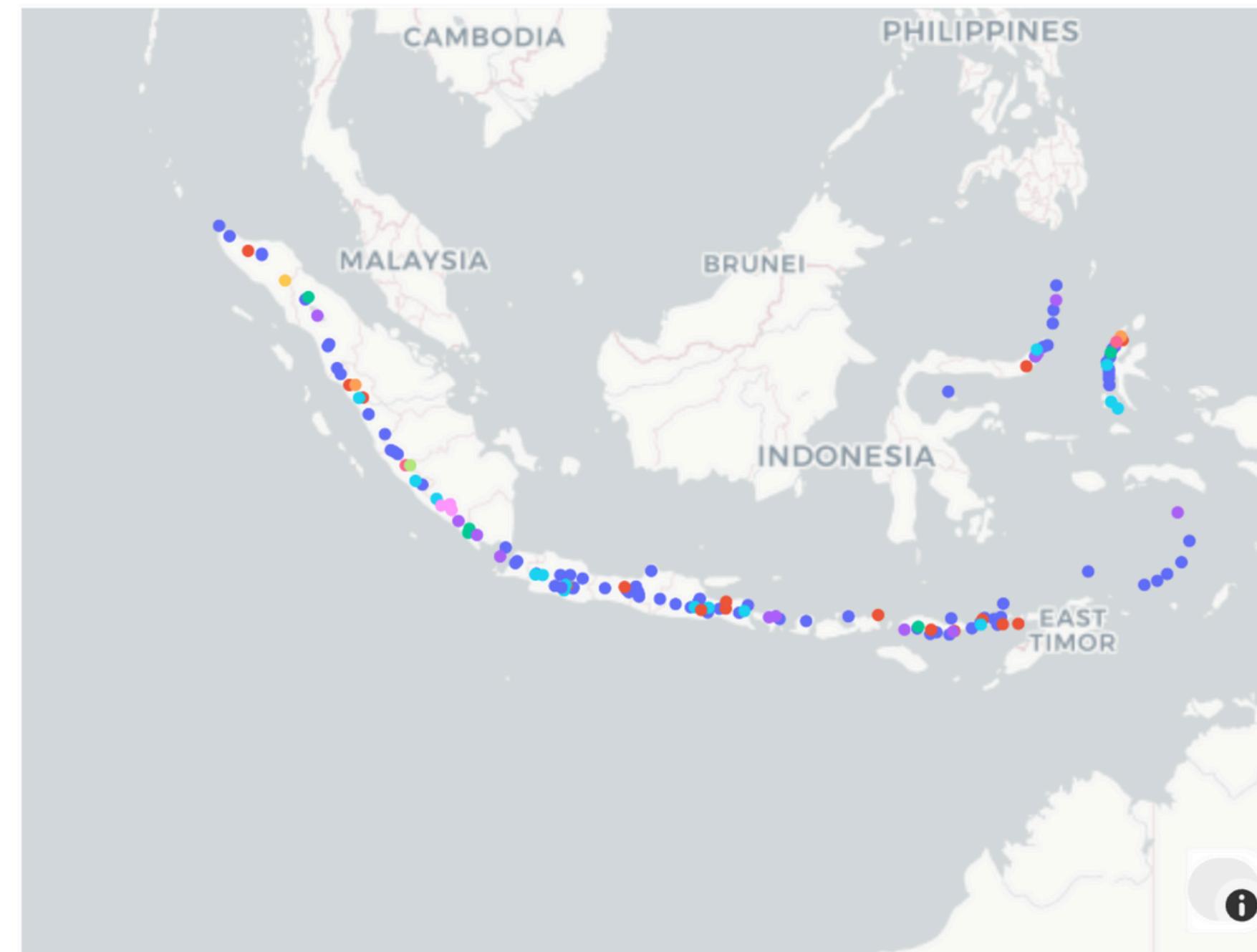
# Outcome

- Lava Flows
- Pyroclastic Flows
- Ash Fall
- Volcanic Mud Flows

# Our Analysis

- Dataset Used - Volcanoes in Indonesia
- Link - (<https://www.kaggle.com/datasets/jayankmahaur/volcano-dataset>)

Volcano Locations in Indonesia



## Type

- Stratovolcano
- Complex
- Caldera(s)
- Caldera
- Pyroclastic cone(s)
- Stratovolcano(es)
- Unknown
- Compound
- Stratovolcano?
- Shield
- Lava dome
- Maar(s)
- Lava dome(s)
- Submarine

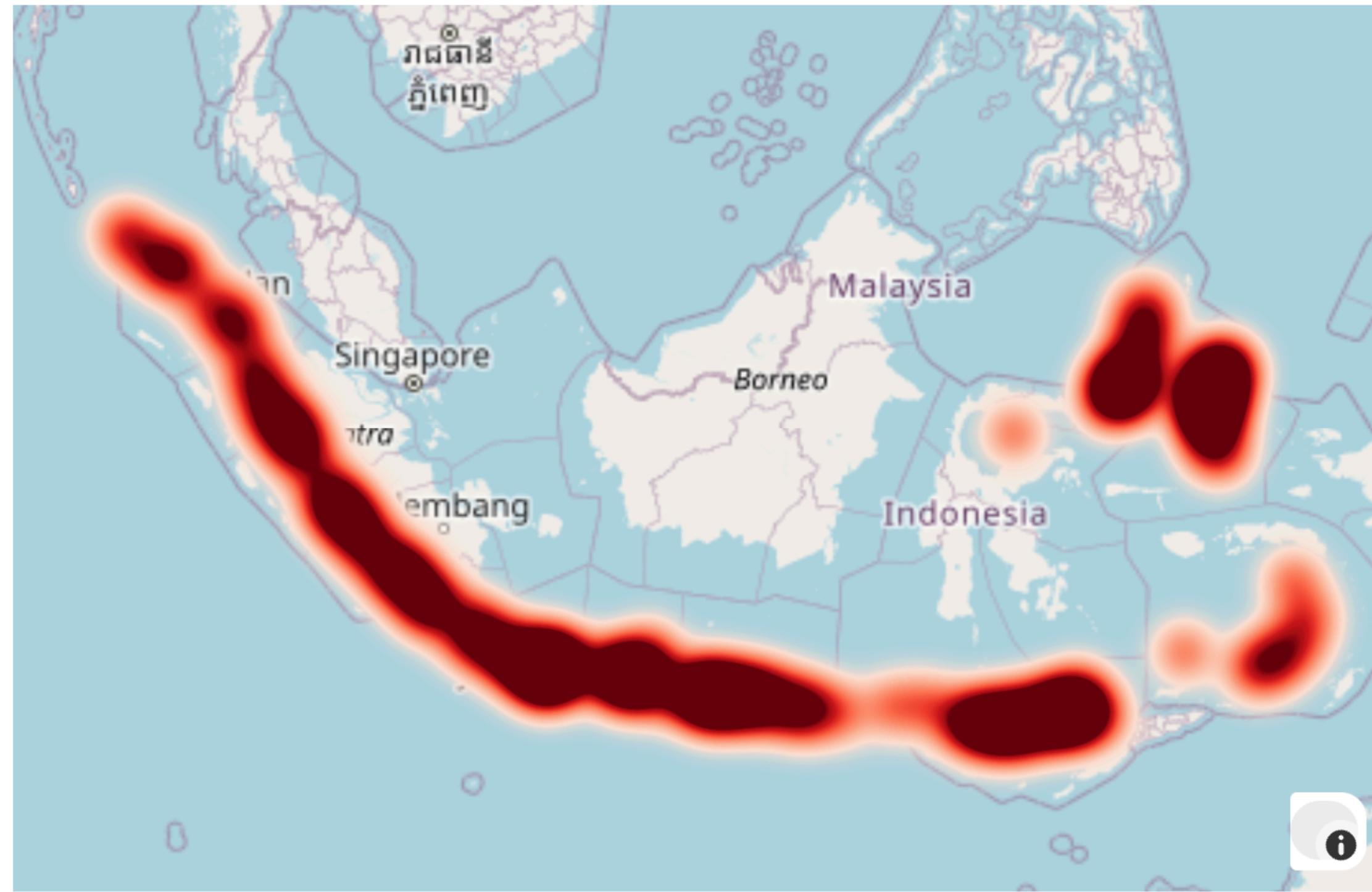
# Observations

## Graph 1 - Volcano Locations by Type

- This graph provides a geographic overview of volcano types across Indonesia.
- It highlights the diverse types of volcanoes in the region, such as stratovolcanoes, calderas, and shield volcanoes etc.
- The spread indicates that Indonesia's volcanic activity is widespread across different islands, which aligns with the region's tectonic movement.
- The clustering of certain volcano types may suggest specific geological conditions favoring their formation in those areas.

# Density Heatmap of Volcanoes

Density Heatmap of Volcanoes in Indonesia (Elevation Range: -5m to 3800m)



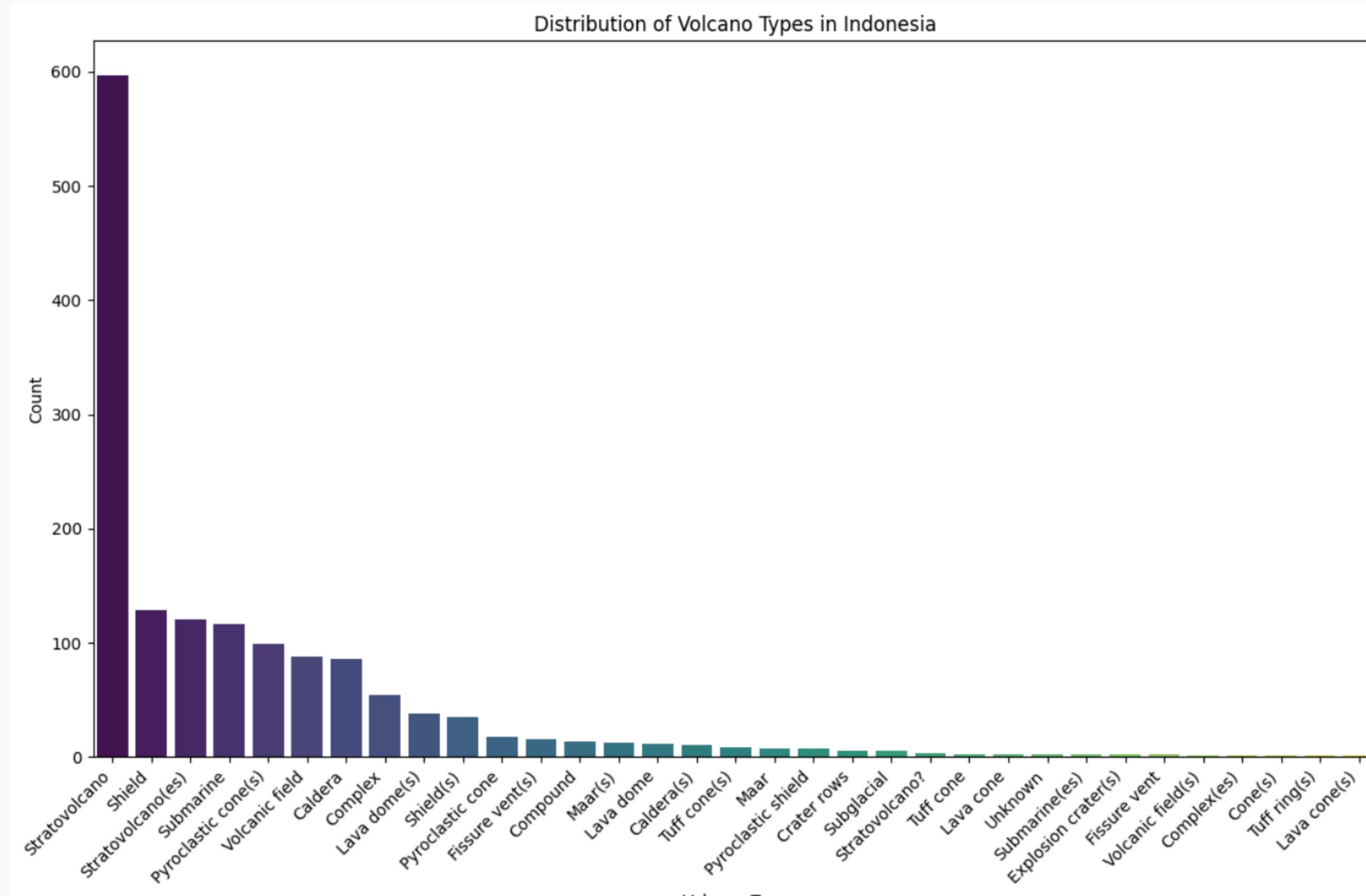
# Observations

## Graph 2 - Density HeatMap of Volcanoes

- The heatmap reveals the concentration of volcanic activity in Indonesia.
- High density areas, shown by warmer colors, indicate regions with a high number of volcanoes, such as Java and Sumatra.
- This concentration aligns with Indonesia's position along the Pacific Ring of Fire, where tectonic activity is especially intense.
- These densely populated volcanic areas are potential hotspots for volcanic hazards, suggesting a need for focused monitoring and risk mitigation in these regions.

# Our Analysis

- Dataset Used - Volcanoes in Indonesia
- Link - (<https://www.kaggle.com/datasets/jayankmahaur/volcano-dataset>)

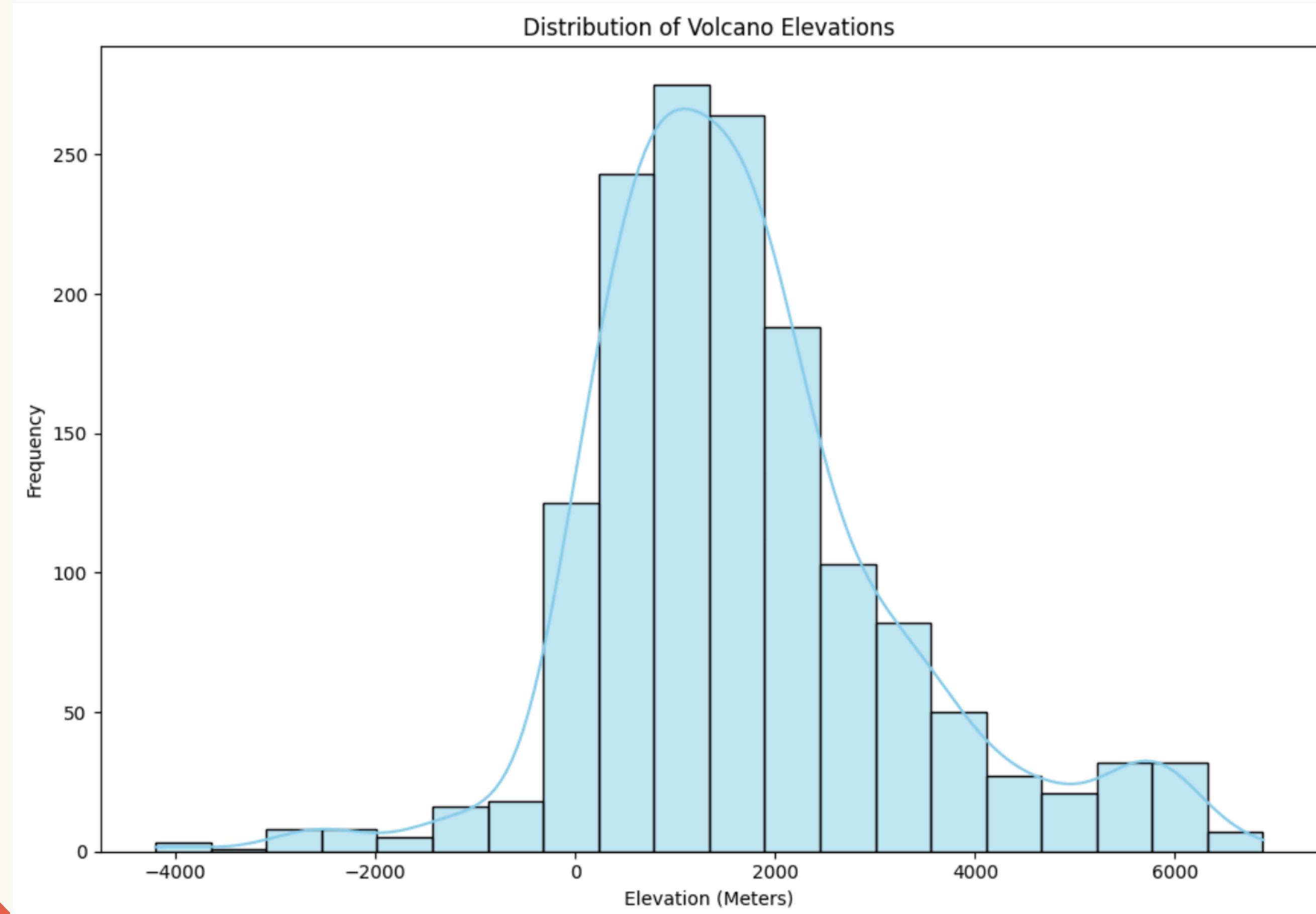


# Observations

## Graph 3 - Distribution of Volcano Types by Count

- This graph illustrates the variety and prevalence of different volcano types in Indonesia, with stratovolcanoes likely forming the majority, followed by other types like calderas and shield volcanoes.
- The dominance of stratovolcanoes reflects Indonesia's active tectonic environment, as they are commonly formed in subduction zones.
- This distribution offers insights into the types of eruptions that might occur, as stratovolcanoes are typically associated with more explosive eruptions, posing greater risks to nearby populations.
- Understanding the type distribution can help prioritize safety and preparedness measures based on the eruption styles commonly associated with each volcano type.

# Relationship b/w Elevation and count of Volcanoes



# Observations

## Graph 4 - Volcano Elevation Ranges and Count

- - The majority of volcanoes in Indonesia fall within the elevation range of 500m to 2500m, indicating that most Indonesian volcanoes are of moderate height.
- Volcanoes below 500m and those above 3000m are comparatively fewer.
- This distribution suggests that while there are some low-elevation volcanoes and a few towering ones, the region's volcanic landscape is largely dominated by mid-sized volcanoes.
- This information is essential for assessing potential eruption impacts, as elevation can influence eruption behavior, lava flow distance, and ash dispersion.

# Conclusion

- From 2000 to 2024, volcanic eruptions in Indonesia have generally increased, peaking from 2010 to 2020, then stabilizing from 2021 onward.
- Most eruptions during this period had a Volcanic Explosivity Index (VEI) of 2-3, with only a few larger eruptions reaching VEI 4 or higher, such as Mount Merapi in 2010 and Anak Krakatau in 2018.
- The majority of eruptions in Indonesia occurred at shallow depths (less than 10 km), leading to lava flows, pyroclastic flows, and moderate ash plumes
- High volcanic risk zones in Indonesia are concentrated along the Sunda Arc, especially in Java, Sumatra, Bali, and the Sunda Strait, where active volcanoes pose ongoing hazards to nearby populations.



## Rising Sea Levels

- Indonesia, with its extensive coastlines and numerous islands, is highly vulnerable to rising sea levels caused by climate change. Global warming, due to human activity, is melting polar ice caps and glaciers while thermal expansion of the oceans increases the volume of water, leading to higher sea levels. In addition, land subsidence in major urban areas like Jakarta exacerbates the effects.

# Causes

- Land Subsidence
- Melting Ice Caps
- Thermal Expansion

# Outcome

- Coastal Flooding
- Tidal Inundation
- Erosion and Loss of Coastal Land

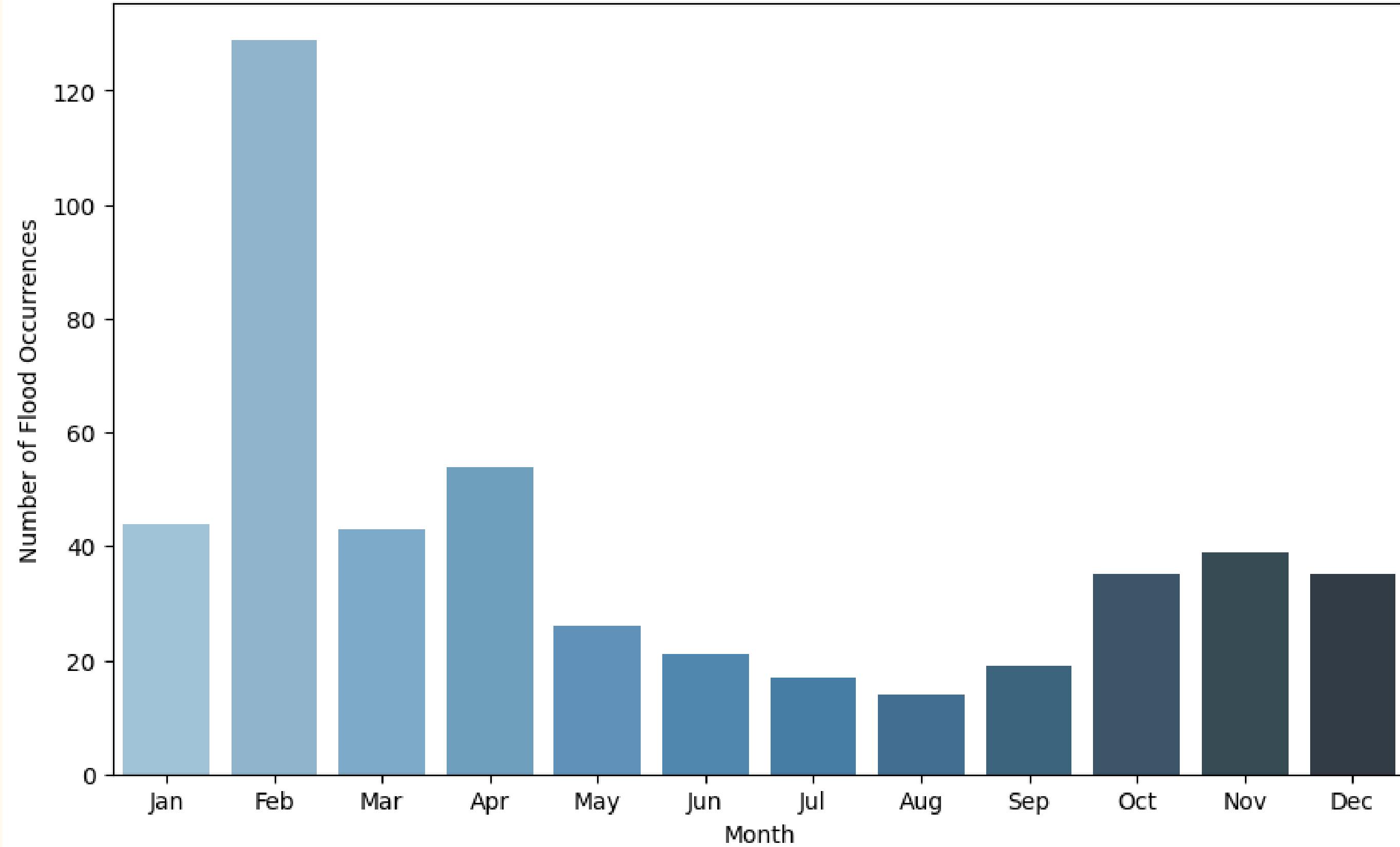


## Floods

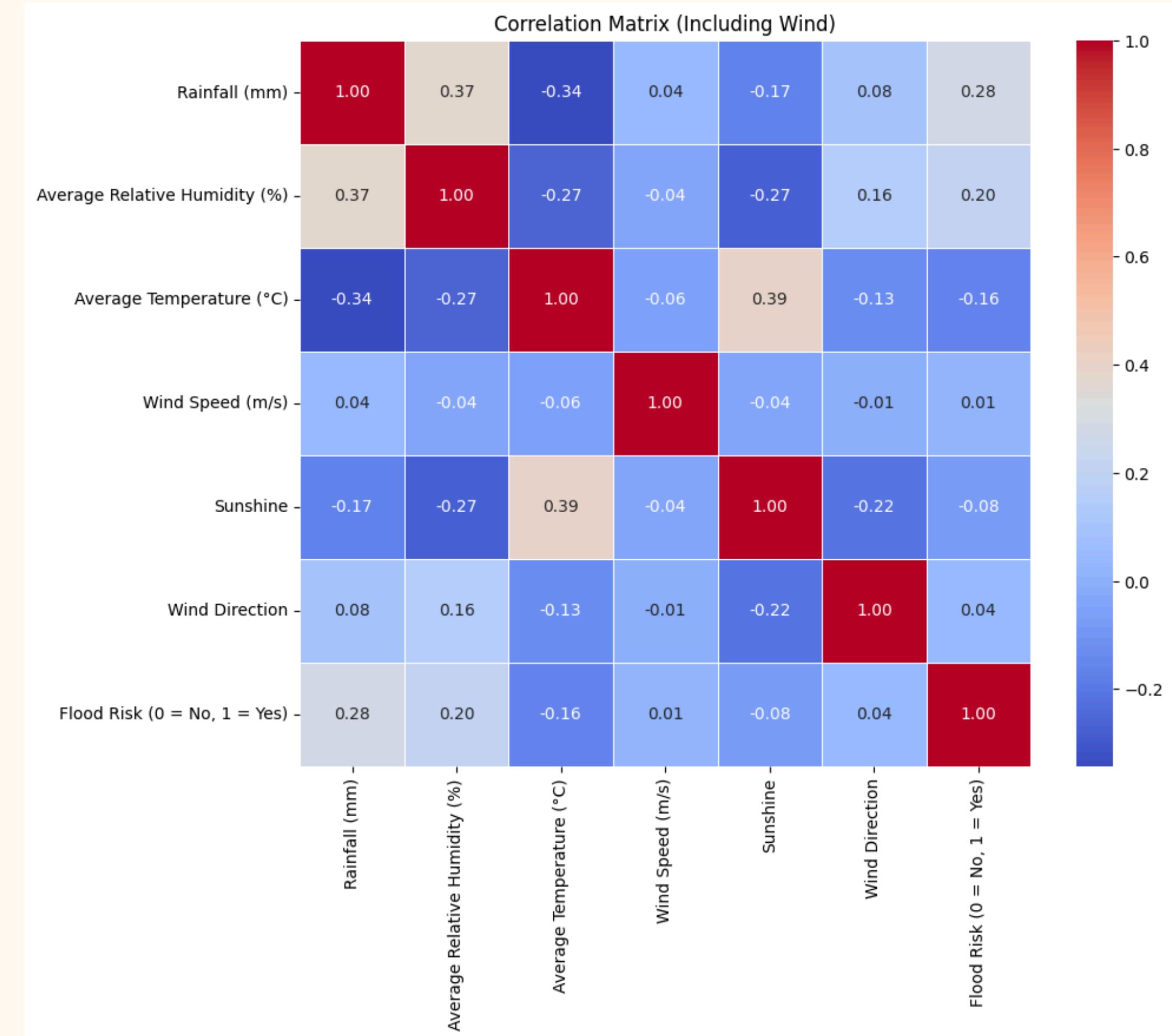
- Floods are common in Indonesia, driven by heavy monsoon rains, river networks, and rising sea levels. Climate change intensifies these floods, especially in low-lying cities like Jakarta. Rapid urbanization, Melting ice caps, and Ground Water extraction further worsen flood impacts, causing significant community and infrastructure damage.

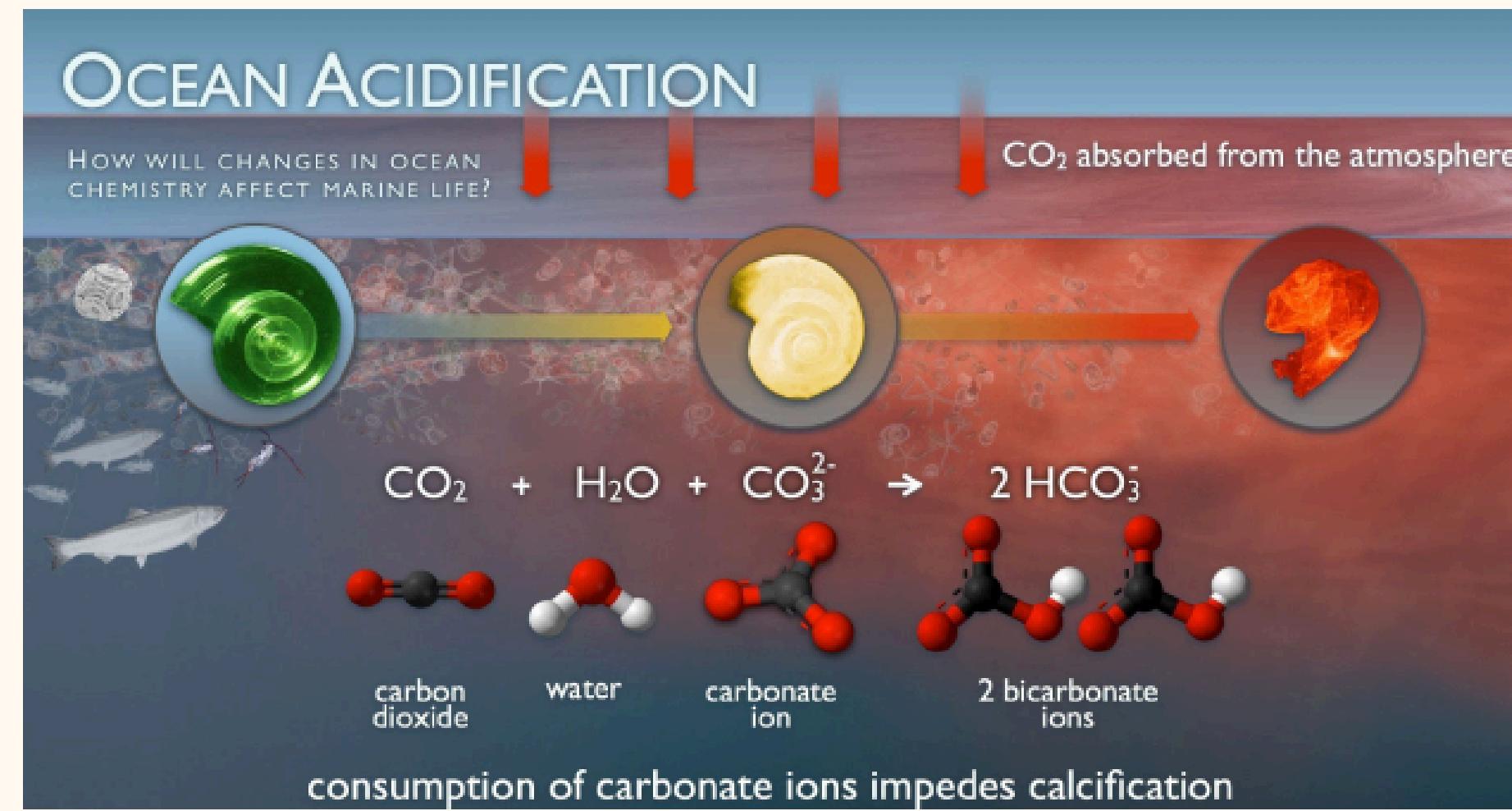
# Analysis

Frequency of Flood Occurrences by Month



# Co-relation Matrix





## Ocean Acidification

- Ocean acidification is the ongoing decrease in ocean pH levels due to the absorption of excess atmospheric CO<sub>2</sub>. As CO<sub>2</sub> dissolves in seawater, it forms carbonic acid, lowering pH and making the ocean more acidic.
- Studies show Indonesian waters have seen pH decrease impacting sensitive species like corals and shellfish.

# Causes

- Rising Sea Temperatures
- Increased CO<sub>2</sub> Levels

# Outcome

- Coral Reef Bleaching
- Decline in Fish Stocks
- Imbalance in Aquatic Life



THANK

YOU