3: Geographical Visualizations with Python

WorldRiskIndex

- Highest indexes on the African continent, with very high WRIs in Niger, Chad, Cameroon, Guinea Bissau, Gambia and Madagascar.
- Lowest indexes on the European continent, especially in Western, Central, and Northern Europe.
- Some countries stand out, such as the Netherlands, which has the highest WRI in Western Europe.
- Conversely, Paraguay and Mongolia have remarkably low WRIs while being surrounded by medium to high-risk countries. It's therefore interesting to see what differentiates these countries from their neighbors.
- Another observation is that most islands, especially those close to the equator such as the Caribbean, Central America, and Southeast Asia, are at the higher end of the risk scale.
- Overall, the tropics appear to be more vulnerable to disasters from extreme natural events and the adverse effects of climate change.
- Most countries in the Middle East (except Yemen) are at the lower end of the risk scale, which is also surprising given their proximity to high-risk African countries and their location surrounded by several oceans.
- Countries in Eastern and Southeastern Europe also have higher risk indices than Western Europe. It would be interesting to investigate whether this is due to their location between the Mediterranean and the Black Sea or to societal factors.
- Another country with a very high risk is Chile, probably due to its unique shape.

Exposure

Comparing the map of global exposure to natural hazards with the map of the overall WorldRiskIndex, some of the above observations begin to make sense.

- For example, the Netherlands has a very high exposure, while its Western European neighbors have very low to low exposure to natural hazards.
- Conversely, the very low WRIs for Paraguay and Mongolia can be justified by their equally low exposure indexes, probably due to their location in the middle of a continent that minimizes exposure to water-related hazards.

- Similarly, the (very) low WRIs for the Middle East can largely be explained by their low exposure. Nevertheless, it would be interesting to examine the hazards faced by other countries with similar geographical characteristics.
- As expected, tropical regions almost exclusively have very high exposure indices.
- Interestingly, Australia, New Zealand, China, Algeria, Peru, and Ireland all have high exposure indices but low overall risk indices, suggesting that these countries have low vulnerability and/or adequate coping and adaptation mechanisms.
- Immediately striking are the rankings of Canada and most of Central Europe relative to Russia (along with Kazakhstan). While the former have low exposure to natural hazards, their WRIs are very low. Conversely, Russia has a very low exposure to natural hazards but "only" a low WRI. This suggests higher vulnerability and/or a lack of coping and adaptation mechanisms in the world's largest country by area.
- On the other hand, several countries in West, East, and Central Africa (e.g. Mali, Nigeria, Tanzania, Angola, Zambia) and South Asia (e.g. India, Pakistan) have exposure levels that are actually lower than their overall WRI, suggesting high vulnerability and/or a lack of coping mechanisms in these regions.

Vulnerability

Further comparison of vulnerability levels with the previous two maps largely confirms the observations from the WRI and Exposure maps.

- For example, Australia, New Zealand, China, Algeria, Peru, and Ireland all have high exposure indexes, but their overall risk index is low. The Vulnerability Map confirms that low vulnerability and/or adequate coping and adaptation mechanisms help reduce their overall risk.
- This is particularly interesting for Australia, New Zealand, and Ireland, as their very low vulnerability reduces their high exposure to low overall risk.
- Similarly, it confirms observations that several parts of Africa and South Asia have exposure levels below the WRI. The vulnerability map clearly shows that these parts of the world have the highest levels of vulnerability.
- Another significant observation can be made for Chile, which has both very high WRI and exposure indices, but low vulnerability. This may indicate that despite having low levels of vulnerability and coping mechanisms, Chile is failing to reduce its overall risk from natural hazards.
- The vulnerability map also reflects quite similar patterns to another index, the Human Development Index (HDI), suggesting a correlation between a country's vulnerability and its HDI.

- The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, knowledge, and a decent standard of living. It is compiled by the United Nations Development Program (UNDP).
  (Source: https://hdr.undp.org/data-center/human-development-index#/indicies/HDI, accessed March 15, 2024).
- For example, the lowest levels of vulnerability are found in North America, Western, Central, and Northern Europe, and Australia, while very high levels of vulnerability predominate in Western, Central, and Eastern Africa. These patterns generally correspond to the highest and lowest development indices based on the HDI.
- Because the HDI includes indicators similar to the WRI's vulnerability dimension, such as life expectancy, education, and income, it allows for some further assumptions about the interplay among the three dimensions of vulnerability, namely, susceptibility, lack of coping capacity, and lack of adaptive capacity.
- If vulnerability is correlated with the HDI, then susceptibility may be a key driver of vulnerability and should be the focus of development approaches.

Research Questions

1. Which regions or countries are most exposed to natural catastrophes according to the WorldRiskIndex?
2. Are there patterns in risk index scores based on geographic factors such as proximity to coastlines, fault lines, or climate zones?

According to the WorldRiskIndex (WRI), the regions or countries most exposed to natural catastrophes are predominantly tropical. Countries in these regions often face a combination of hazards such as hurricanes, cyclones, floods, and tsunamis, contributing to their high exposure indices.

For example, countries in Southeast Asia, such as India and Pakistan, face high exposure levels due to their vulnerability to cyclones and floods. Similarly, countries in West, East, and Central Africa, including Mali, Nigeria, Tanzania, Angola, and Zambia, also have high exposure levels, mainly due to factors such as frequent droughts, floods, and tropical storms.

Tectonic activity also plays an important role in determining exposure levels. For example, countries located along fault lines or prone to volcanic activity face increased exposure to natural hazards. Regions such as the Pacific Ring of Fire, which includes countries such as Japan, Indonesia, and the Philippines, are particularly vulnerable due to high seismic activity and the threat of tsunamis.

Also located along the Pacific Ring of Fire, Chile is highly exposed to seismic activity, including earthquakes and volcanic eruptions. Its long coastline also makes it vulnerable to tsunamis. The country has experienced several devastating earthquakes in its history, including the 2010 earthquake, which was one of the largest ever recorded.

The Netherlands, as the only country in Western Europe, has a very high exposure to natural disasters, primarily due to its susceptibility to flooding. Its low-lying geography, with much of the country below sea level, makes it highly vulnerable to inundation from both storm surges and river flooding. In addition, the Netherlands is at risk of coastal erosion and land subsidence, further exacerbating its exposure to natural hazards.

Interestingly, some countries with high exposure indices manage to maintain low overall risk indices, indicating effective coping and adaptation mechanisms. For example, Australia, New Zealand, China, Algeria, Peru, and Ireland have high exposure indices but low overall risk indices, suggesting effective disaster preparedness, infrastructure resilience, and response capabilities.

Additional Questions

1. How does Vulnerability correlate with the Human Development Index (HDI) across different regions and countries, and what factors contribute to any observed patterns?
2. How effective are coping and adaptation mechanisms in reducing overall risk in countries with high exposure levels but low overall risk indices?