Detailed Report

1. How does your visual inform a decision or action that furthers one or more of the key competition SDGs (zero hunger, clean water and sanitation, climate action)?

Our visualization maps aridity zones in Brazil, highlighting the evolution of desertification in the Northeastern region. aridity is a climatic characteristic resulting from the lack of water due to inadequate precipitation in relation to potential evapotranspiration in a specific region. Aridity indices are numerical measures that indicate the level of dryness of the climate in a given area. These indicators are valuable for identifying, locating or delimiting regions with water deficit, a condition that can significantly impact land use for purposes such as agriculture and livestock. In the long term, this condition can contribute to desertification. Desertification can lead to the loss of arable land, affecting food production and contributing to hunger. By highlighting the most affected areas, the project can encourage the adoption of sustainable agricultural practices to achieve the Zero Hunger goal. In addition to motivating actions for water conservation and the development of sustainable water infrastructures, contributing to the Clean Water and Sanitation goal. Finally, desertification is intrinsically linked to climate change, as greenhouse gas emissions increase average temperatures and thus the evapotranspiration of land and vegetation. By highlighting this relationship, informing climate change mitigation policies and promoting actions for the sustainable management of land and forests, supporting the Climate Action goal. Therefore, our visualization has the potential to inform and promote actions towards the 3 UN SDGs of this competition.

2. How did you create your submission? Include the tools you used (e.g., Python, Excel, specific python packages), how you processed the data, and (if applicable) how you managed your codebase. If you have a public repository with code, you can share a link here.

Public repository: https://github.com/Erickjonatthan/PaleBlueDot-DuneDivers

Our visualization was created using a Jupyter Notebook in Python. The MODIS Evapotranspiration data (MOD16A3GF.061) was obtained from the AppEEars API by HTML requests and the Precipitation data (IMERG) was obtained from the ClimateSERV API (via the climateservAccess package). Our long-term goal is to develop an automated system that can plot desertification indicators, such as precipitation, evaporation and aridity indices, from data

obtained from different sources. The system should also be able to generate images that show the spatial distribution of desertification hotspots in the study area.

To carry out this work, we followed the following steps:

- We reviewed the literature on the concept, causes, effects and ways of measuring desertification, based on scientific articles published in specialized journals.
- We defined the study area, which consists of a square of variable size, centered on a point of latitude and longitude provided by the user, located in an arid or semi-arid region of the world. We collected the precipitation, evaporation and aridity index data from the study area, for a period of time also defined by the user, using the Python climateservaccess and request libraries. For this, it was necessary to register on NASA's Earthdata, which is the portal that provides the remote sensing data from the American space agency.
- We analyzed the data collected, using the pandas, matplotlib, rasterio and folium libraries, which allow manipulating, visualizing and processing tabular, graphical, raster and geospatial data, respectively. We generated graphs that show the annual and monthly variation of precipitation, evaporation and aridity index in the study area, and also an image that shows the location of desertification hotspots in the study area, using a color scale that indicates the aridity index.
- We interpreted the results obtained, comparing them with the initial hypothesis that the study area is undergoing a desertification process. We discussed the implications of the results for the understanding and combating of desertification, as well as the limitations and challenges of the proposed methodology.

3. What motivated you to choose this topic?

The motivation to create a tool to visualize desertification zones in Brazil, more specifically in the Northeast, was defined by several factors. First of all, as we live in a semi-arid region in Brazil, we witness the potential damages that the lack of water and the dry climate can cause to people's lives, the economy and the environment. Moreover, a recent study by INPE (National Institute for Space Research) in partnership with Cemaden (National Center for Monitoring and Alerting of Natural Disasters), identified, for the first time, the occurrence of arid climate stretches in a region of almost 6 thousand km² in the north of Bahia. The studies indicated that in the last 60 years, every two decades, the average growth rate of these regions is 75,000 km², happening at an accentuated level in Brazil.

In this context, the increase of desertification in Brazil becomes very worrisome. Unlike the droughts that can be common in some regions of the country, desertification has a permanent state, which can cause significant impacts on agriculture and national energy production. Due to the aspects shown, we believe that it would be of great importance to enable residents to identify if their city or region is undergoing a desertification process, so we decided to create a tool that allows us to visualize how the aridity indices are in a region based on its geographical coordinates. With this information, it would be possible to promote initiatives that contribute to reducing the impacts of the problem.

4. How did you learn about the broader context of your chosen issue (e.g., historical, social, political)? This could include drawing on the lived experiences of team members, reading articles and literature, conducting interviews with community members, etc. Did what you learned change your approach?

The Brazilian northeast is composed largely of regions with semi-arid characteristics, these regions are historically marked by the stigma of drought, which is the deficiency of the total rainfall in relation to the normal indices during a period of time, among the damages of drought are severe economic losses and great social problems such as hunger and migration. Thus, the study indicating the increase of arid regions in Brazil, more specifically, in the northeast region, drew the attention of the team to address as the theme of the competition, since a desertification process can be permanent, bringing much worse damages to the population than the temporary droughts. Therefore, to understand more broadly the context of the problem, various sources of information were sought and taken into consideration, such as reading news, technical notes, scientific articles and the opinion of experts in the area, in order to deepen the theme of desertification.

Due to the learnings obtained, it was possible to observe that the aridity index of a region is under the influence of several factors, among the main ones are the precipitation and evapotranspiration indices of the soil, being possible to determine the aridity index by performing the ratio between them. Thus, the NASA satellite catalog was used to obtain the precipitation and evapotranspiration data of a region based on its geographical coordinates. In possession of the data, the necessary calculations were performed to estimate the aridity index of a region. Based on these indices, a visualization was created to enable easy interpretation of the data.

5. What are the ethics and/or equity issues you considered? What are some possible strategies or approaches for addressing them?

Here are some ethical and/or equity issues that we consider:

- How does desertification disproportionately affect the most vulnerable populations, such as indigenous peoples, small farmers, women, and children, who depend on natural resources for their survival and well-being?
- How can desertification threaten biological and cultural diversity, such as the loss of species, ecosystems, traditional knowledge, and practices, which are fundamental for nature conservation and sustainable development?
- How can desertification harm global development goals, such as the United Nations Sustainable Development Goals (SDGs), which aim to eradicate poverty, reduce inequalities, promote peace and justice, and protect the planet?

Here are some possible strategies or approaches to deal with these issues:

- Adopt a participatory and inclusive perspective, involving local communities, affected groups, decision-makers, researchers, and other relevant actors, in defining, implementing, monitoring, and evaluating actions to combat desertification and recover degraded areas.
- Promote environmental education, awareness, capacity building, and social mobilization, to sensitize and engage people about the importance and urgency of addressing desertification and adopting sustainable practices for the use and management of natural resources.
- Apply the principles of environmental justice, shared responsibility, precaution, prevention, and reparation, to ensure that the costs and benefits of actions to combat desertification are distributed equitably, and that the damages caused are avoided or minimized.

6. Would your team like to share the URL of an interactive visualization?

No, we didn't have time to create one.