Mission Space Lab Phase 4 report outline

Team name: PizzaDev

Chosen theme: Life on Earth

Country: Italy

1. Introduction

Desertification is a critical issue that poses significant threats to ecosystems and human livelihoods.

This process, if left unchecked, can have catastrophic consequences, including the loss of biodiversity, deteriorating living conditions for various species and reduced agricultural yields. Addressing desertification is crucial to ensure sustainable development and mitigate the potential impacts on both the environment and society.

Our team embarked on an investigation aimed at detecting geographical areas affected by desertification and determining the underlying causes, specifically focusing on the potential overexploitation of natural resources.

By identifying the regions impacted by desertification and understanding the factors driving this phenomenon, we aimed to contribute to the analysis of this pressing environmental problem.

We established an alternative goal as a contingency plan in case the acquired satellite images were compromised due to factors such as excessive cloud or water coverage. In such a scenario, we planned to utilise the compromised images to develop algorithms to estimate the average cloud coverage and thickness and average sea surface temperature.

Through this comprehensive investigation, our team aspired to shed light on the extent and causes of desertification, thereby fostering effective strategies for fighting this global challenge and promoting the sustainable use of natural resources.

2. Method

We used the Astro Pi IR camera to take images of Earth during daylight.

For our analysis we also decided to record position and time, which was accomplished through image metadata, which later provided a versatile extraction of information.

To ensure data quality, we employed algorithmic filtering, removing 97 dark, 124 cloudy, and 187 sea images out of the 463 taken. Following this, we selected the best image for analysis which was taken over Andhra Pradesh, Karnataka and Maharashtra in South India.

For the selected region of interest (ROI), we employed a customised GSD algorithm considering Earth's curvature, resulting in improved accuracy of corner coordinate estimation.

Our estimation is still subject to some degree of error due to the fact that it does not take into account the rotation of the image.

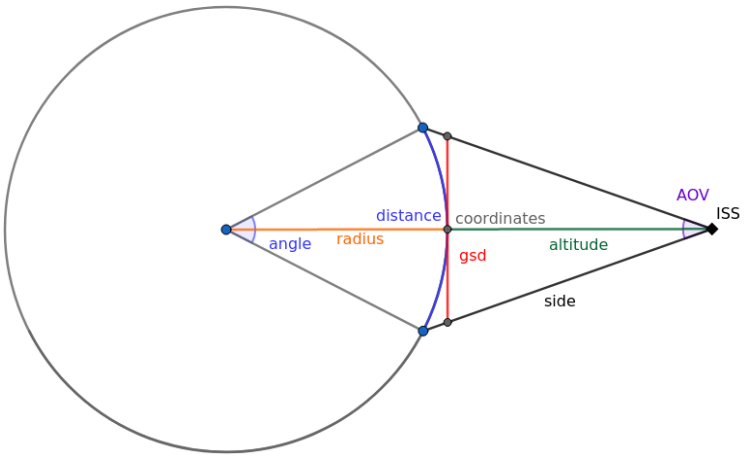

Figure 1: Improved Ground Sampling Distance

$$side = \frac{2(radius + altitude)cos(\frac{AOV}{2}) - \sqrt{(2(radius+altitude)cos(\frac{AOV}{2}))^2 - 4((radius+altitude)^2 - radius^2)}}{2}$$

$$angle = 2sin^{-1}(\frac{side \cdot sin(\frac{AOV}{2})}{radius})$$

$$distance = radius \cdot angle$$

We managed to visualise the average NDVI evolution over ROI using historical data from 2019 onwards (obtained with google earth engine) as well as the image selected.

This allowed us to gain valuable insights into the vegetation's condition over a specific time period. Additionally, we calculated the average VCI by utilizing the collected data used for the NDVI evolution representation.

To facilitate our data analysis, we developed various programs and scripts which are available here.

Figure 2: Image selected

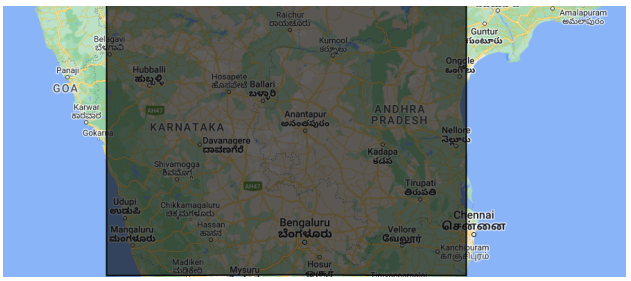

Figure 3: Bounding box of ROI

3. Experiment results

In this experiment, our initial objective was to explore the relationship with urban areas near the area of interest. However, due to complications arising from the lack of images for VCI application, we decided to gradually proceed with a study of the current NDVI using the image captured from the ISS.

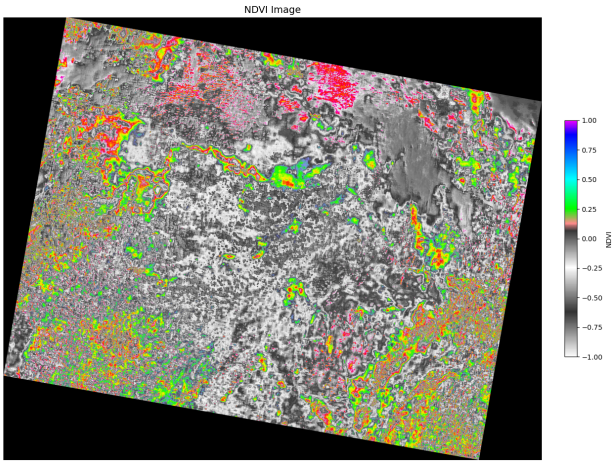

Figure 4: NDVI calculated over ROI (fastiecm colormap)

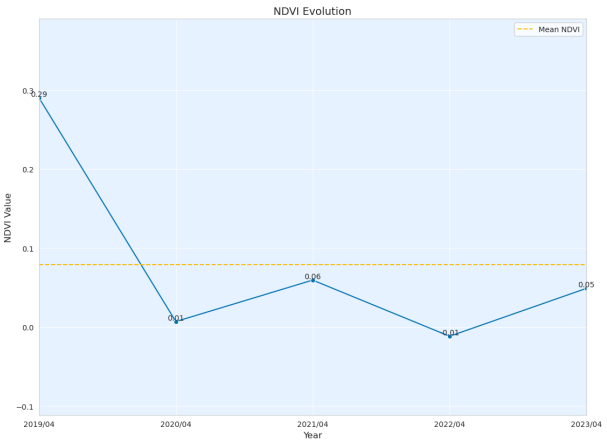

Figure 5: NDVI evolution from 2019 to 2023

Subsequently, using the Google Earth Engine API, we extracted the average NDVI values (starting from 2019) for the area of interest in order to graphically represent an NDVI evolution chart.

As shown in the image, the area of interest exhibits a general decline in NDVI values from 2019 to 2022, suggesting a decline in vegetation health. However, in the past year, there appears to be a slight recovery, indicating a potential reversal in this trend.

To work with more data and make use of the image for VCI calculation, we decided to calculate an average VCI to identify the average vegetation condition of the area of interest.

Value	Category
90-100%	No drought
80-90%	No drought
70-80%	No drought
60-70%	No drought
50-60%	No drought
40-50%	No drought
30-40%	Light drought
20-30%	Moderate drought
10-20%	Severe drought
0-10%	Extreme drought

Figure 6: Average VCI over ROI (20.08%)

As depicted in the image and supported by our previous data, the area of interest displays a moderate level of desertification. The obtained value reinforces the need for further investigation and potential interventions.

These findings highlight the importance of monitoring and addressing the environmental changes in the area of interest. Overall, our experiment successfully employed the NDVI and VCI indices to assess vegetation health and detect environmental changes in the area of interest.

4. Learnings

Working as a team on Mission Space Lab has been a valuable experience for us.

We focused on organising the work in a fair manner, leveraging the abilities of each team member.

Throughout this journey, we learned how to conduct a scientific experiment and work effectively as a team. We also studied and utilised data analysis libraries, which taught us the intrinsic value of data within images.

We encountered several challenges along the way, such as coordinating schedules, managing different skill levels, and integrating diverse ideas. To overcome these challenges, we maintained open communication, fostered a supportive environment, and encouraged collaboration and knowledge sharing.

In future projects, we would implement stricter deadlines, enhance our planning process, and allocate more time for unexpected issues. We would also ensure that our objectives align more closely with the available data sources.

5. Conclusion

Our experiment aimed to identify relations between desertification affected areas and nearby cities through the capture of pictures with Near Infrared that allowed for NDVI calculations. We weren’t certain if our goals would be successful due to the scale of the images, as well as the potential for obstruction by weather events.

The analysis of the NDVI data revealed a general decline in vegetation health from 2019 to 2023, indicating a gradual onset of desertification in the area of Andhra Pradesh, Karnataka and Maharashtra in South India.

However, there was a slight recovery in vegetation health observed in the last year, suggesting a potential reversal of this trend. The average VCI calculations further supported the presence of a moderate level of desertification in the area.

Overall, our experiment has deepened our understanding of desertification and its implications. It serves as a foundation for future investigations, emphasising the importance of continuous monitoring and intervention to combat desertification and promote sustainable land management practices.