Analysis of the Effect of Leaf Rust in Jeju using Satellite-Based NDVI Index

Team Korea Final Presentation

By Juyeon, Freesia, Ashley, Cathy, Jimin, Jungseo

01

Introduction

On what Leaf Rust is and the reason to why we are investigating its effect to the subalpine zone of Halla mountain.

Leaf Rust

Spore-producing structures pustules commonly found on the lower leaf surface which severely affected leaves that often turn yellow and fall prematurely.

Photos of Leaf Rust on Korean Firs

Symptom and sign of leaf rust on Korean Fir leaves

Shield Ferns living in the native fir trees

Why are we Investigating this?

- The Korean fir, listed as an endangered species (2010) by the IUCN experienced significant number of deaths since 2017 to 2021 onwards
- Total number of deaths: **12,957**
- Change in vegetation cover area: **638ha to 606ha**
- **Reason for death:** weakened by the various natural disasters (i.e. typhoon, drought, extreme temperatures and weathers) brought on by climate change, they are strongly affected by the secondary attack by various pathogens of plant disease
  → main reasons to explore in the project are **rain and extreme temperature fluctuations**

HOME > 사회

'멸종위기' 한라산 구상나무, 식물병도 감염...방제 시급

홍창빈 기자 headlinejeju@headlinejeju.co.kr | 승인 2024.01.18 15:08 | 댓글 0

제주세계유산본부, 구상나무 관련 병해 연구 체계화

멸종위기종인 한라산 구상나무에서 식물병 감염이 확산되면서 방제가 시급한 것으로 나타나, 제주특별자치도가 방제법 개발에 나선다.

제주특별자치도 세계유산본부는 올해 한라산 구상나무에서 확인된 병에 대한 확산 대비 방제법 개발 등 선제적으로 대응하기 위한 연구를 추진한다고 18일 밝혔다.

구상나무 자생지 내 병해조사는 국내 최초로 시도됐으며, 확인된 병은 2022년에 처음으로 조사된 구상나무 잎녹병을 포함해 총 11종으로 한라산 영실지역에서 확인됐다.

Korean Fir (*Abies koreana*) - Leaf Rust, Phomopsis Canker, Chestnut Blight

Image Source (from above, left to right): Headline Jeju, '멸종위기' 한라산 구상나무, 식물병도 감염...방제 시급, 2024 / Naver Blog 동지 #3 구상나무 / 한국일보, 한라산 대표 생물종 '구상나무' 최근 4년간 1만그루 넘게 고사, 2022

Time period of Investigation

→ 2019~2023 June/August

- 63% of plant deaths occur between spring and summer
- Plant diseases affected vegetation in Halla Mountain from year 2017 ~ 2021, but because GK2A didn't operate in 2017~2018, limited time scope
- NDVI analysed by 1 week period in order to see a clearer change in vegetation cover area

Image Source: [보도자료] 지리산 구상나무 집단 고사 지도 작성, 기후위기로 인한 집단고사 가속화 확인 돼, 녹색연합 "구상나무 고사 진행 빨라…멸종위기종 등재 서둘러야"

Place being investigated

Between two cities in Jeju (Seogwipo city and Jeju City), we chose Seogwipo city as the place to investigate as our school is located in Seogwipo city, more specifically on the area of the subalpine zone of the Halla mountain, the main and tallest mountain of the Jeju Island.

02

Method

What factors did we investigate? What satellite data did we use? What indicator did we use to analyse this data?

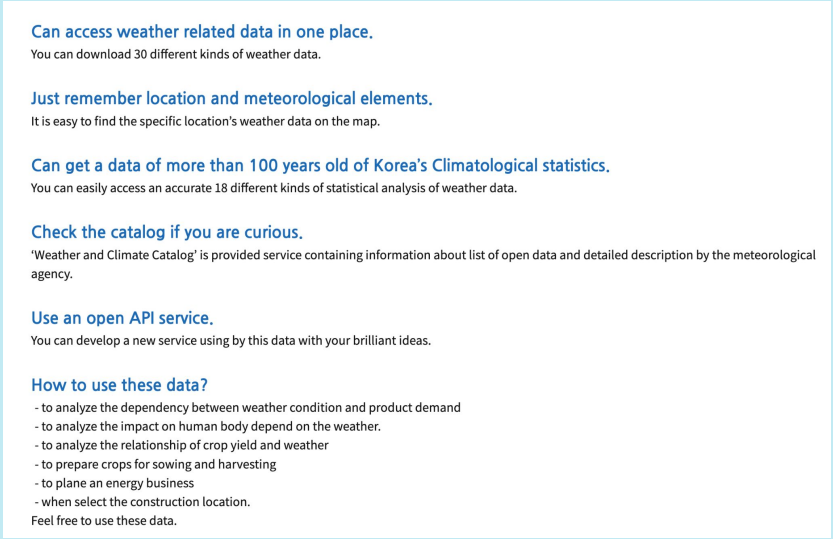
Our First Selection for Source

Korea Meteorological Administration Open MET Data Portal

(Link here)

Features:

- Open data portal to public including their analysed data of ..
- The number of rainy days
- The number of snow days
- The number of heat wave days / cold wave days
- The number of tropical days



Can access weather related data in one place.
You can download 30 different kinds of weather data.

Just remember location and meteorological elements.
It is easy to find the specific location's weather data on the map.

Can get a data of more than 100 years old of Korea's Climatological statistics.
You can easily access an accurate 18 different kinds of statistical analysis of weather data.

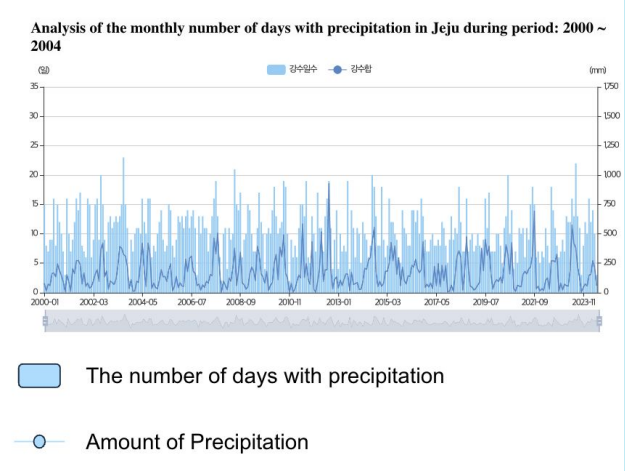
Check the catalog if you are curious.
'Weather and Climate Catalog' is provided service containing information about list of open data and detailed description by the meteorological agency.

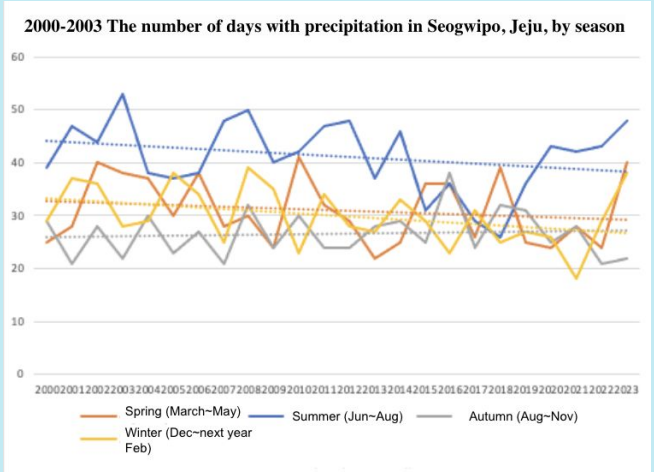
Use an open API service.
You can develop a new service using by this data with your brilliant ideas.

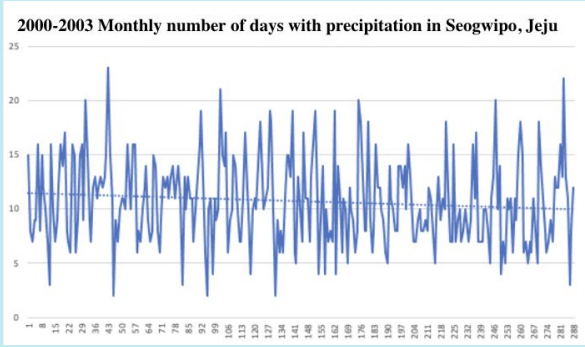
How to use these data?
- to analyze the dependency between weather condition and product demand
- to analyze the impact on human body depend on the weather.
- to analyze the relationship of crop yield and weather
- to prepare crops for sowing and harvesting
- to plane an energy business
- when select the construction location.

Feel free to use these data.

1. Number of Days with Precipitation



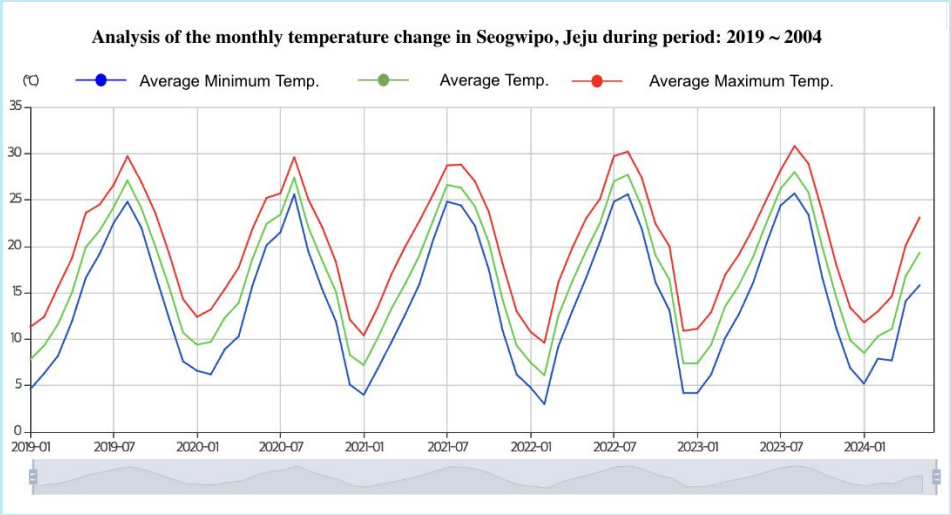


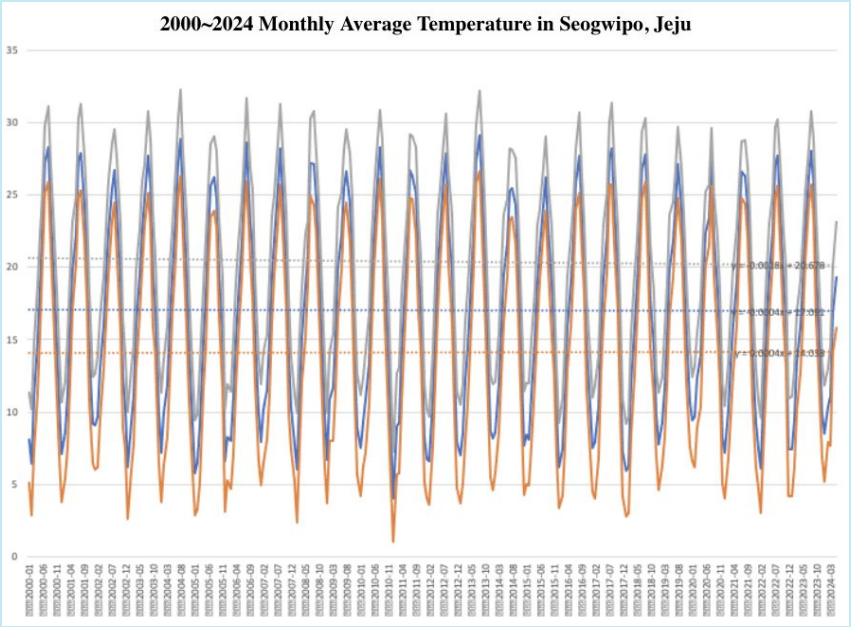


With the exception of autumn, the trend of seasonal precipitation days is decreasing

The trend of monthly precipitation days is also decreasing

2. Monthly Temperature Change





The monthly average temperature change doesn't show significant increase or decrease

Satellites Used

NASA – Aqua MODIS

Orbital period: 98.8 minutes

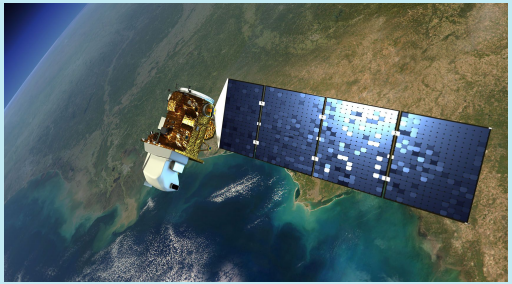
Temporal resolution: Twice a day

Spatial resolution: 250m resolution

Launched in 2002,

20 years of continuous data

Landsat 9



Orbital period: 99 minutes

Temporal resolution: 16 days

Spatial resolution: 30m

Launched in 2021 September,

mission lasts 15 years

GK2A

Orbital period: 24 hours

Temporal resolution: 10 minutes

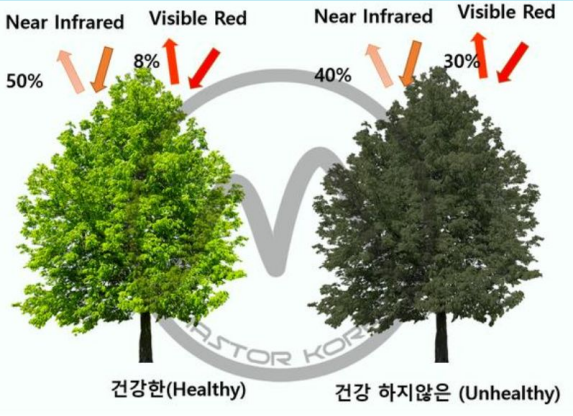
Spatial resolution: 2 km

Launched in 2018 September,

mission lasts 10 years

NDVI

- Normalized Difference Vegetation Index
- Satellite-based tool used to assess plant health
- Spectral index calculated from satellite image data of red visible light and near-infrared light (NIR)
- Shows vegetation vs non-vegetation, vegetation type, leaf area, and cover rate



$$NDVI = \frac{0.5-0.08}{0.5+0.08} = 0.72 \qquad \frac{0.4-0.3}{0.4+0.3} = 0.14$$

*Value closer to 1 = healthier plant

$$NDVI = \frac{\rho_{NIR} - \rho_{Red}}{\rho_{NIR} + \rho_{Red}}$$

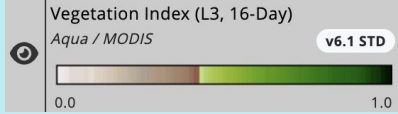
$$(Range : 0 \sim 1)$$

03

Analysis

On the satellite data collected and our analysis on the results

1. NASA Aqua MODIS



	Jun	July	August
2021			
2022			
2023			

Vegetation Index (L3, 16-Day)
Aqua / MODIS
v6.1 STD
0.0 1.0

	Jun	July	August
2003			
2004			
2005			

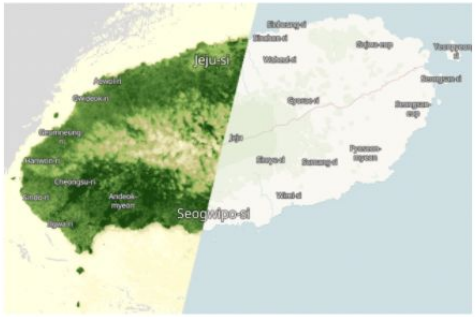
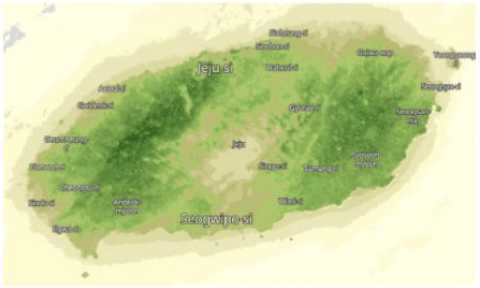
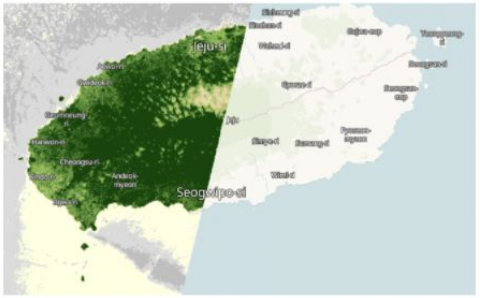
Analysis

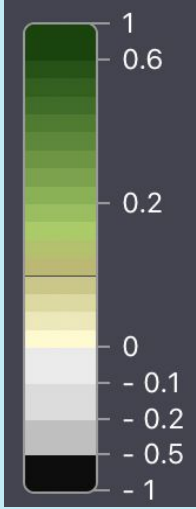
- Decided to take images of past and most recent data to make comparisons
  - Summer season
  - Past (2003~2005)
  - Recent (2021~2023)
- Lowest NDVI values near Mt. Halla during **2004 July** → potentially reflecting the limitations of the model (contradicts what was written on the News)
- Second lowest NDVI values near Mt.Halla during **2023 August**
- Highest NDVI values near Mt.Halla during **2005 August**
- **Overall no huge difference in NDVI values on Jeju island between summer in the past and present.**

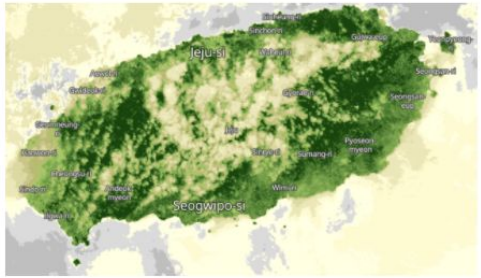
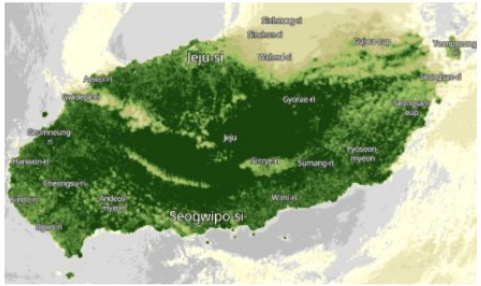
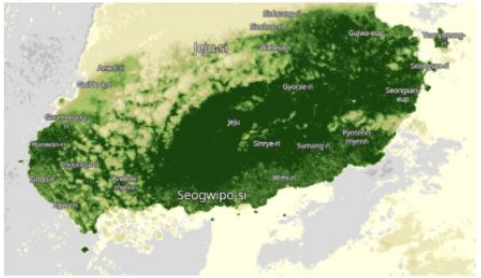
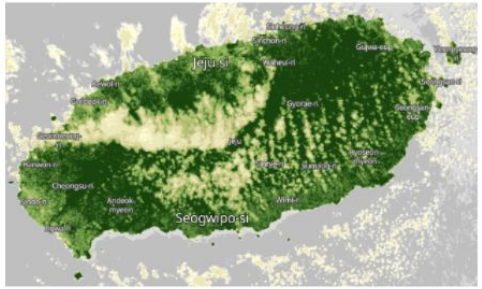
Evaluation of NASA Aqua MODIS Imagery

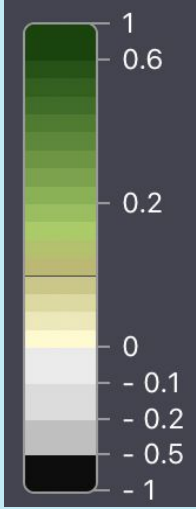
- High spatial resolution images were taken
- Still, there were limitations:
  - Cloud coverage - obstructing satellite view resulting in missing or inaccurate NDVI values
  - Low time resolution / Infrequent updates - not good for short-term data collection
    - Although indicated to have temporal resolution of twice a day, the worldview site didn’t display updated data representations for some dates

2. USGS/NASA - Landsat 9

	June	July	August
2019			
2020			



2021			
2022			
2023			



Analysis

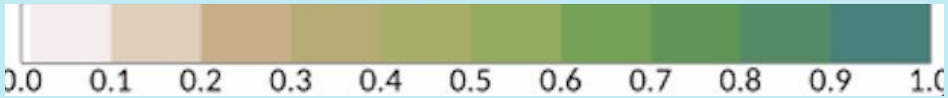
- Decided to take images from 2019 to 2023 to make comparisons in NDVI
    - Summer season (June, July, August)
- Lowest NDVI values near Mt. Halla during **2019 August** → considering the limitations of Landsat imagery (cloud coverage)
- Second lowest NDVI values near Mt.Halla during **2021 August**
- Highest NDVI values near Mt.Halla during **2023 June**
- **Overall: Difficult to observe significant changes and patterns of each month in NDVI values in the summer seasons of 2019 to 2023**

Evaluation of Landsat Imagery

- High resolution images were taken
- Still, there were limitations:
  - Low Temporal Resolution: 16 days of revisit time
    - Relatively long interval
    - Difficult to monitor landsat images of a desired date (inadequate for short-term data observation)
  - Cloud Cover: Obstruction by clouds
    - The optical sensors of Landsat Satellite can’t penetrate the clouds
    - Results in significant data gaps → Limits data usage / difficult to analyse
  - Frequent Typhoons during summer season
    - Impossible to measure NDVI when precipitation is too high (which also increases cloud coverage)

GK2A - Method Used for Calculation

- Used color picker to discern specific colors in the satellite image, then compared to key for NDVI values



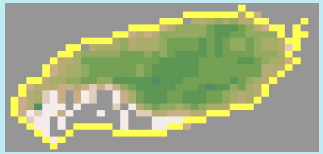
- Approximate NDVI value was calculated (with middle value between NDVI range, ex. If value of colour between 0.0 and 0.1, value approximated to 0.05) to create smooth line graph to depict the change in vegetation area

→ *Why did we approximate the values?*

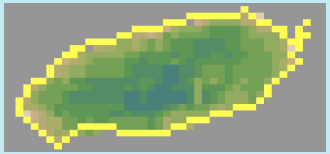
GK2A image is pixelated (low resolution), so exact value cannot be discerned

< 2019 >

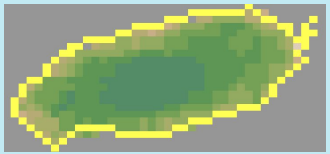
2019.7.29



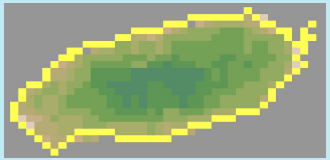
2019.8.12



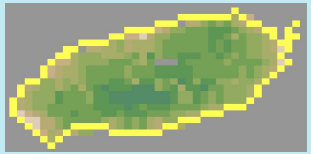
2019.8.5

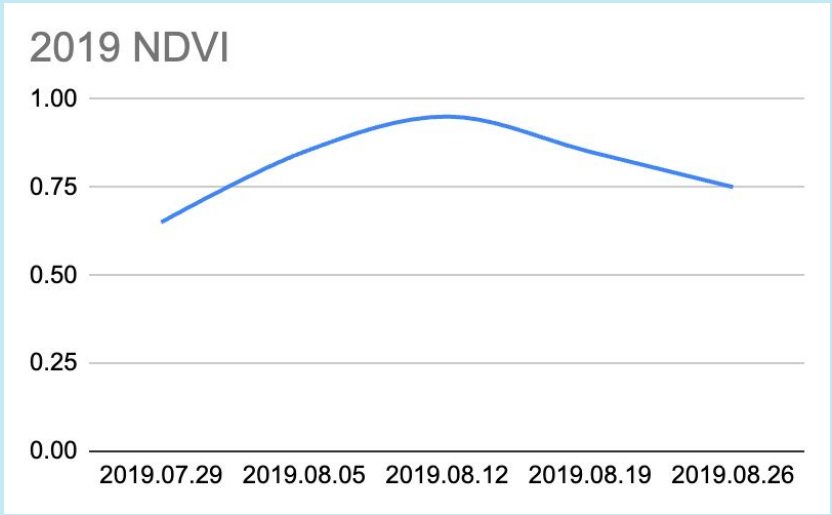


2019.8.19



2019.8.26

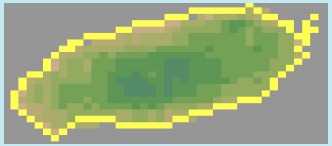




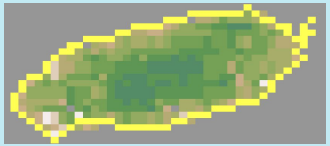
(all images from 9:00am KST & 0:00 UDT)

< 2020 >

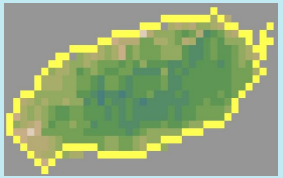
2020.06.01



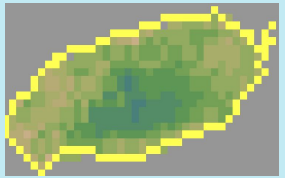
2020.06.15



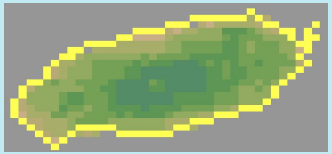
2020.07.06



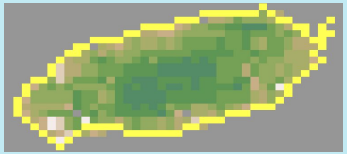
2020.07.20



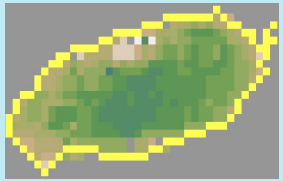
2020.06.08



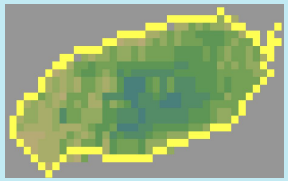
2020.06.22



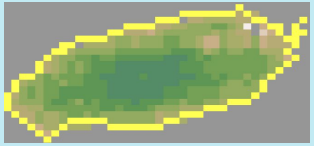
2020.07.13



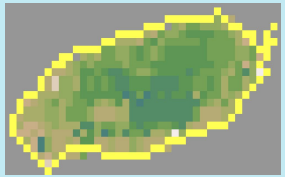
2020.07.27



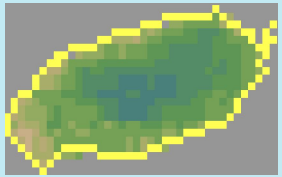
2020.06.29



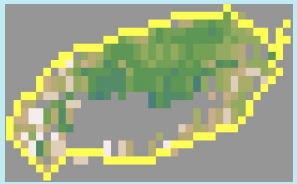
2020.08.03



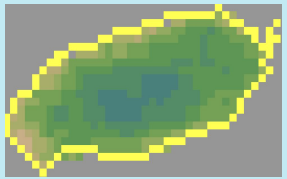
2020.08.17



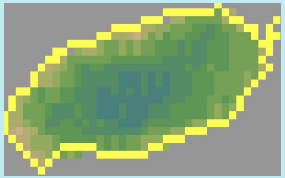
2020.08.10

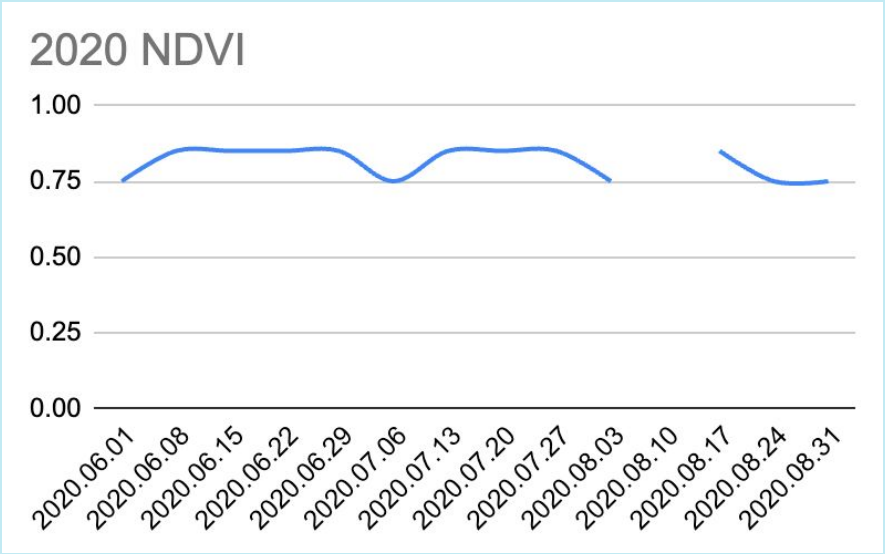


2020.08.24



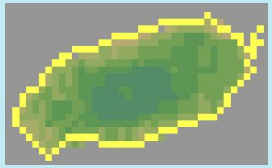
2020.08.31



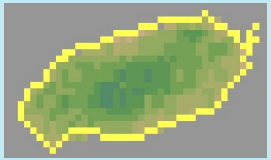


< 2021 >

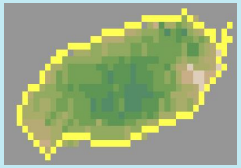
2021.06.01



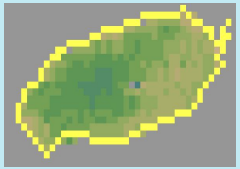
2021.06.15



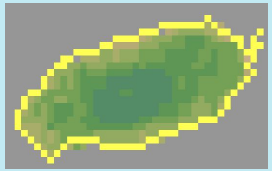
2021.07.06



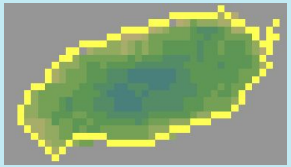
2021.07.20



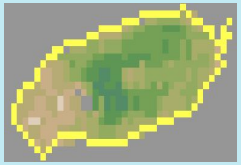
2021.06.08



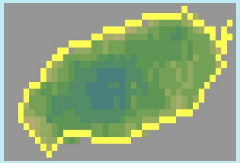
2021.06.22



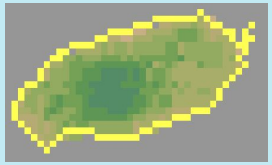
2021.07.13



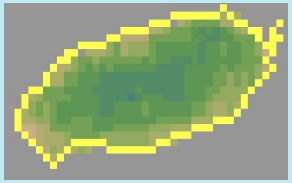
2021.07.27



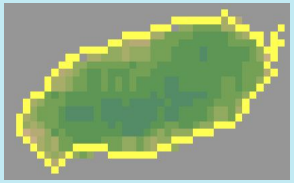
2021.06.29



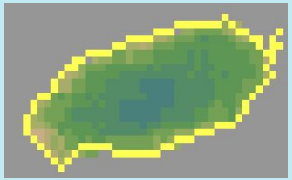
2021.08.03



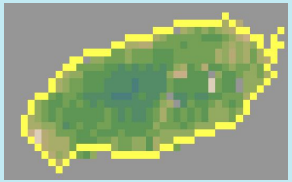
2021.08.17



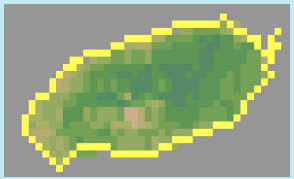
2021.08.10

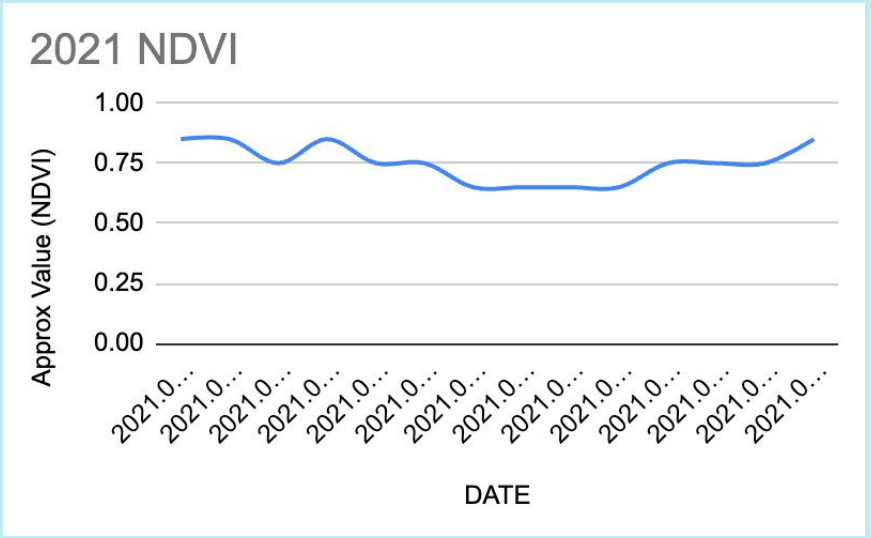


2021.08.24



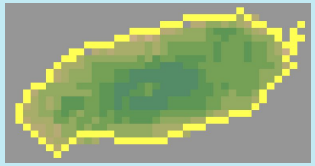
2021.08.31





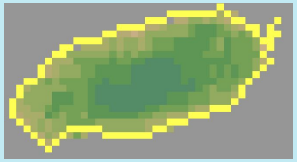
< 2022 >

2022.06.01

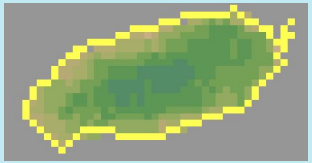


2022.06.15

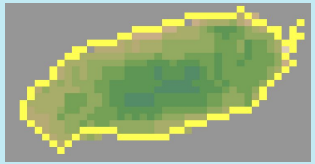
2022.07.06



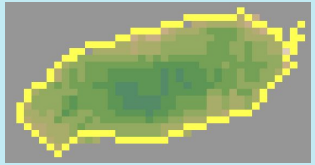
2022.07.20



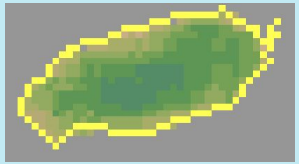
2022.06.08



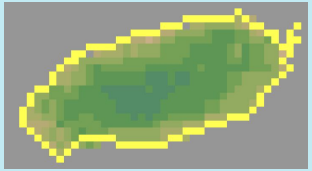
2022.06.22



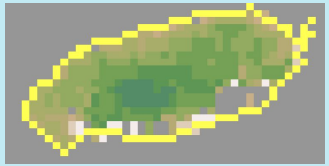
2022.07.13



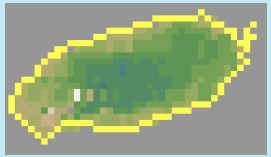
2022.07.27



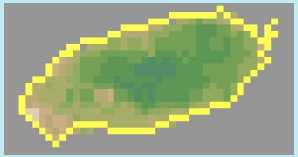
2022.06.29



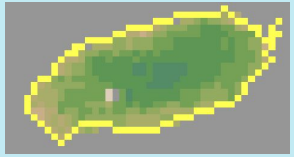
2022.08.03



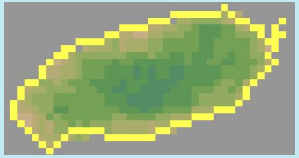
2022.08.17



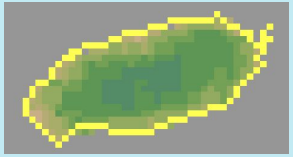
2022.08.10

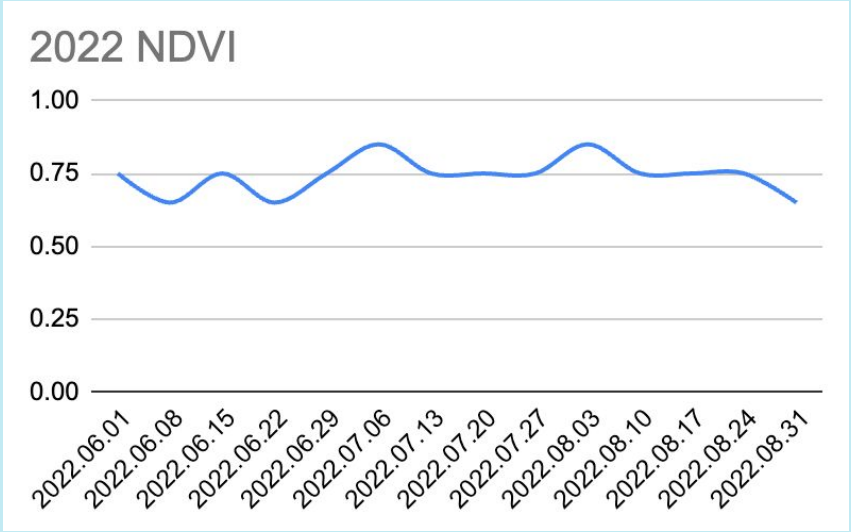


2022.08.24



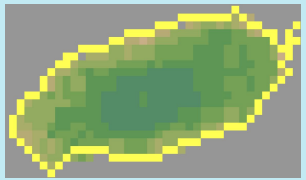
2022.08.31



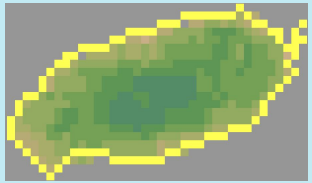


< 2023 >

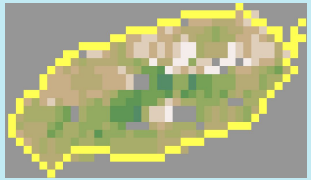
2023.06.05



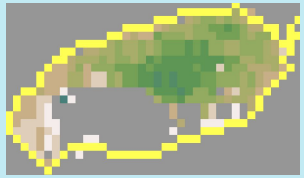
2023.06.19



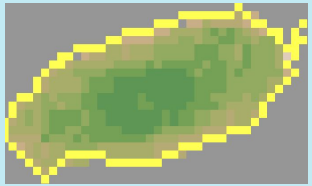
2023.07.03



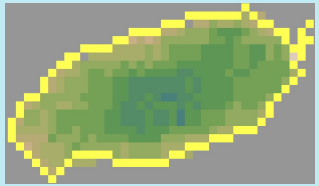
2023.07.17



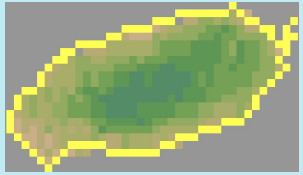
2023.06.12



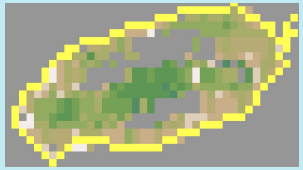
2023.06.26



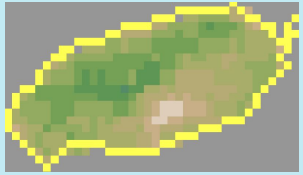
2023.07.10



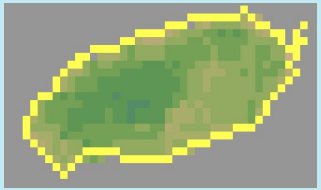
2023.07.24



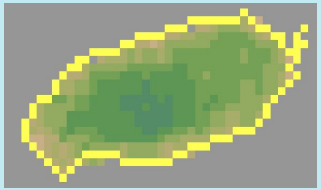
2023.07.31



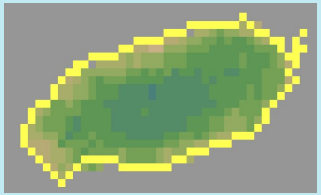
2023.08.03



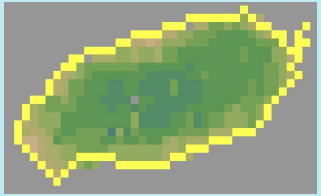
2023.08.17



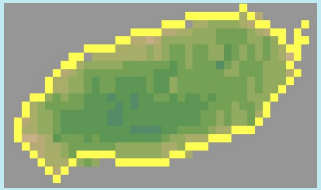
2023.08.10

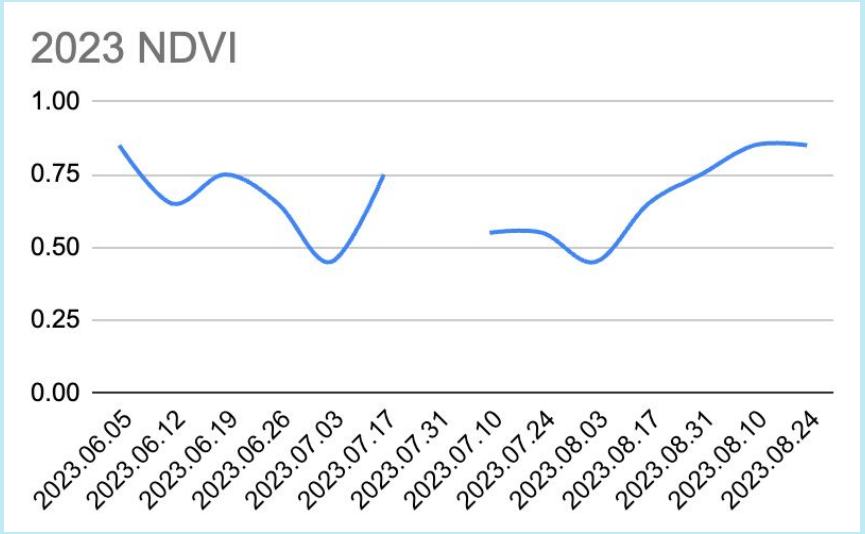


2023.08.24

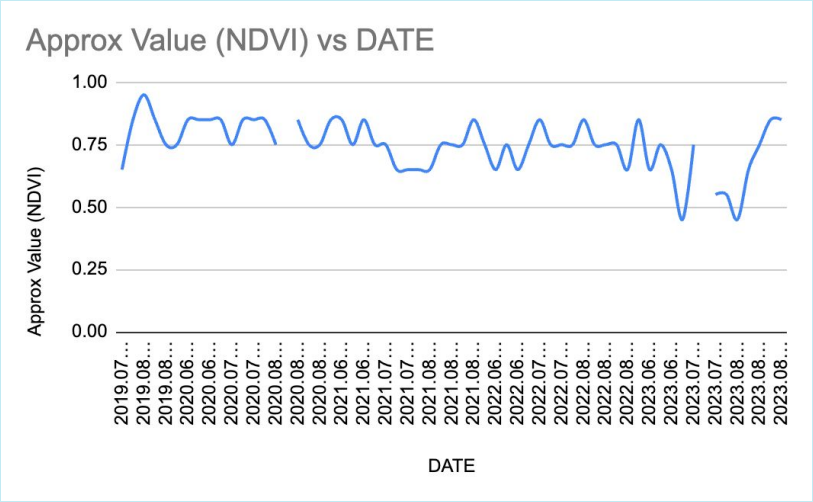


2023.08.31





Analysis



- Decided to take images from 2019 to 2023 to make comparisons in NDVI
  - Summer season (June, July, August)
- Able to observe a trend where the average value of NDVI is descending overtime
  - Highest NDVI in **2019 August**
  - Lowest NDVI in **2023 June & August**
- More fluctuating pattern of NDVI value is observable in 2023
- **Overall: Difficult to observe clear patterns in the fluctuation of NDVI values and has contrasting patterns with data observed from other satellites**

Limitations of GK2A Imagery

- Despite the precision and strong reliability of the data updated every 2 minutes, there were some limitations to the data collected from GK2A:
  - Low Spatial Resolution: 2km
    - Very low compared to the spatial resolution of 250m(Aqua MODIS) and 30m (Landsat 9)
    - Unable to analyse the specific locations and identify the Halla mountain as accurately as the other satellites, bringing limitations to the collected data and its analysis
  - Cloud Cover: Obstruction by clouds
    - Led to some gaps in the data of some regions of the island
  - Limit of Availability: Launched in 2018, with data available from July 2019
    - Unable to collect NDVI data from the GK2A prior to July 2019, leading to limitations of the analysis of the overall trend

04

Conclusion

Conclusion we drew from the analysis and evaluation of the method used

Conclusion

The three different satellites that we chose to use for the investigation showed incongruous results:

- ***NASA Aqua MODIS***
  - Lowest NDVI in 2004 July, 2003 August
  - Highest NDVI in 2005 August
- ***Landsat 9***
  - Lowest NDVI in 2019 August, 2021 August
  - Highest NDVI in 2023 June
- ***GK2A***
  - Lowest NDVI in 2023 June/July
  - Highest NDVI in 2019 August

Although we couldn't conclude that **the effect of leaf rust on Mt. Halla was the biggest factor contributing to changes of NDVI in the subalpine zone on Jeju Island**, we have learned that NDVI fluctuates more frequently than we expected during summer season in Jeju.

We think this was due to several reasons:

- Each satellite's potential limitations affecting the data
- Jeju's extreme weather during the summer which overlaps with the period of investigation
  - E.g. Frequent typhoons in summer affecting Landsat 9 Imagery
  - E.g. Frequent monsoon seasons
- Jeju island is too small that satellites cannot show nuanced changes of NDVI in the subalpine zone around Mt. Halla / Seogwipo area

Thank you!

CREDITS: This presentation template was created by **Slidesgo**, and includes icons by **Flaticon**, and infographics & images by **Freepik**