Team Name: Go, 3.141592…, Go!

Chosen theme: Life on Earth

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Introduction

One of the greatest problems that humanity faces is global warming caused by CO_2 increase. Forests play a key role since they are a sink of CO_2 and wildfires contribute more than it was supposed[1]. Drought – Wildfires – CO_2 warming – Drought…, this is an extremely dangerous cycle. Forests' preservation are essential for life on Earth. How are they doing? Are they healthy? Which ones? The hypothesis of our experiment was that forests located in active rural areas were healthier and better preserved than the ones sparsely populated. Earth surface pictures from the ISS provided a sample of Earth forests. We only got two useful pictures. However, we could spot Lost River State Park, located in the East border between EE.UU. and Canada, and Yosemite's National Park! It was unbelievable! Yosemite's valley is in an unpopulated area since it is in a mountainous remote region. Lost River Park is supposed to be in a densely-populated territory. We have studied both using satellite images and historical evolution of certain indexes.

Method

Software took pictures every 5 minutes, though we only got 18 (instead of 36). Maybe, there were unexpected issues with the time assigned. PI camera used blue filter to detect IR radiation. Every picture was stored associated to its

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[1] http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-2/More_of_Africa_scarred_by_fires_than_thought

date/time, location coordinates and whether it was oversea/land (it didn't work properly; maybe, more pixels should be processed).

Woodland should look quite brown because of blue filter. Only pictures 9 and 10 were useful (11.1%); the rest were dark (33.3%), unfocused (11.1%) or mainly water (45.5%). The program only returned positive coordinates (North/South latitude and East/West longitude might be obtained next time); providing dates/times to ISS-Tracker online software, we realized that ISS went over South Indian Ocean, Australia, North America and East Africa.
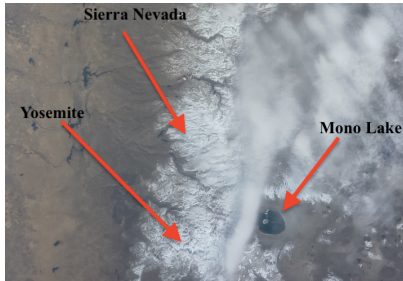

Figure 1. Yosemite (Picture 9).

Figure 2. Lost River (Picture 10).

Yosemite and Lost River were chosen as Earth forests sample; their evolution was analyzed using processed satellite (Sentinel) images according to different indexes: Normalized Difference Vegetation Index (NDVI), Moisture Index (MI), Normalized Difference Water Index (NDWI) and Normalized Difference Snow Index (NDSI). Perimeter '.kml' archives were used to consider each forest as a whole.

Results

1) Yosemite's valley:

Wildfires are natural processes, but in this area the period between them has been shortened drastically. Drought is having a deep impact in the forest, since trees are not able to fight back plagues like bark beetle[2]. Moreover, perpetual snows and mountain rocks occupy a great surface area. So that, Moisture Index (Figure 3) was best suited to show increasing dryness as we will mention afterwards. In addition, NDVI evolution showed inconclusive results.

Forests are going through different stages periodically due to seasons. So that, Moisture Index's function is, approximately, periodic and its period lasts a whole year. Worthy of note, in our case, that peaks' minimum values of Moisture Index graph (Figure 3, right) are decreasing every year. Figure 4 shows a graph using the average $\overline{X}$ for those peaks' minimum values.

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[2] https://www.sfgate.com/science/article/Yosemite-bark-beetle-Ferguson-fire-drought-13085413.php
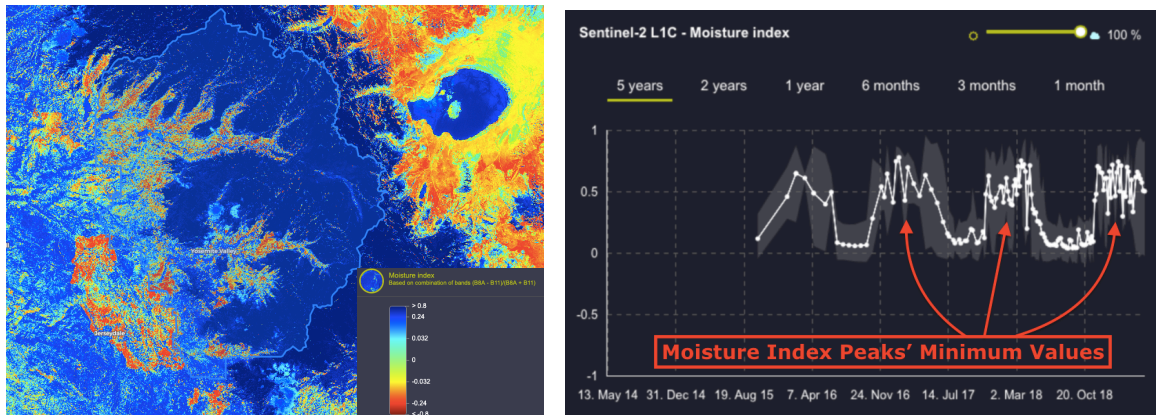
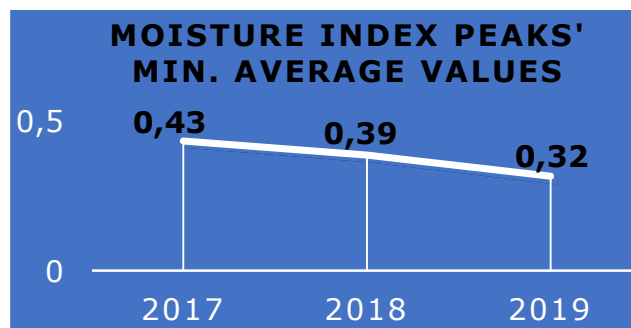*Figure 3. Yosemite's area (left) and its Moisture Index evolution (right).*

Figure 4. Peaks' minimum average values for Yosemite's Moisture Index graph

2) Lost River:

Like Yosemite's previous case, NDVI evolution showed inconclusive results. However, since NDWI is getting the content of water in plants and soil, it would be a measure of moisture in vegetation cover. Low values are indicating water stress possibly related to strong periods of drought. That's why NDWI was considered as the right index choice in this case. Similarly, to the above-mentioned case, it is important highlighting that valleys' minimum values of NDWI graph (Figure 3, right) follow a downward trend. A graph using averages $\overline{X}$ of those valley's minimum values is shown in Figure 6.
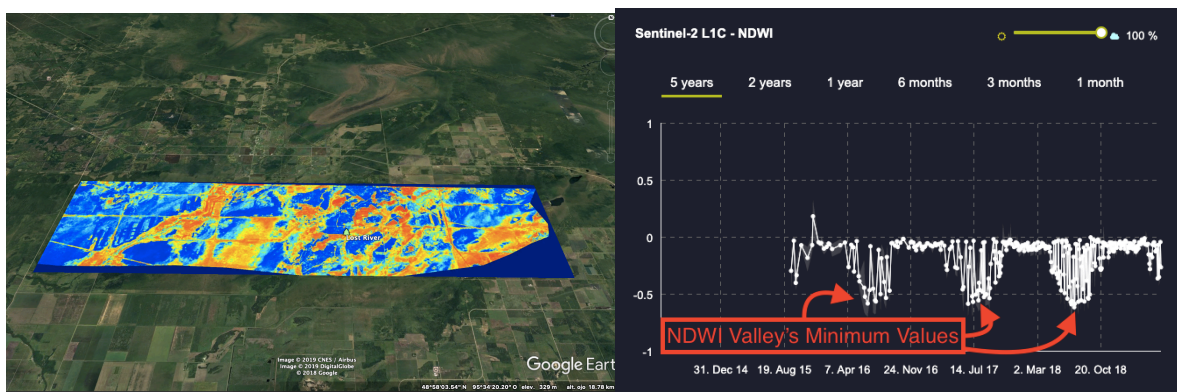

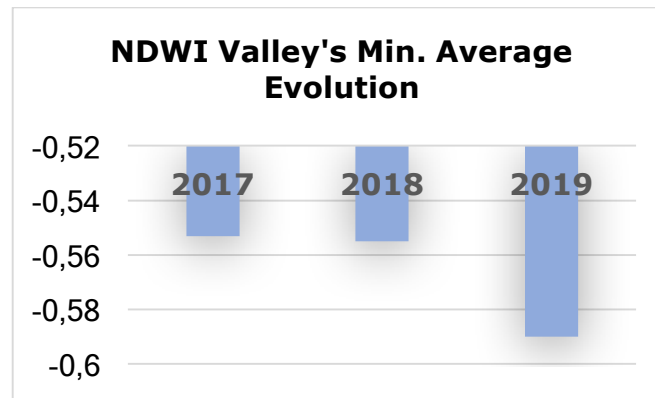*Figure 5. Lost River area (left) and its NDWI evolution (right).*

Figure 6. Valleys' minimum average values for Lost River NDWI graph

Conclusion

We expected that rural areas sparsely populated may foster vegetation growth or improve its health, though rural active areas may provoke just the opposite effect. Luckily, we could obtain adequate forest samples: Yosemite's valley, considered inaccessible and protected, and Lost River, located in an active rural zone. However, we read that thousands of trees were devastated in Yosemite's Valley. Shorter severe wildfire repetition periods, vulnerability increase against plagues…, might be caused by drought stress[3]. Concerning Lost River forest, it might also be suffering from a kind of global drought stress. This issue might coincide with our results.
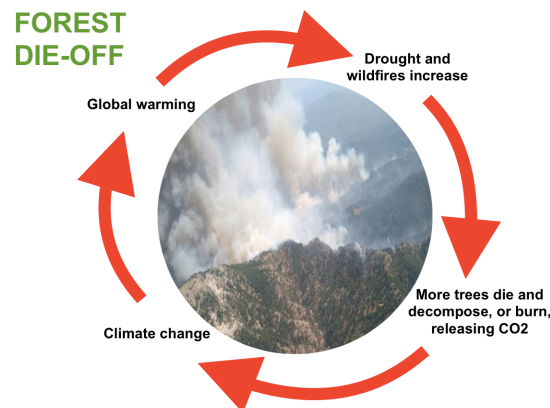

Figure 7. Action-reaction chain CO2-Droughtness-Global Warming

At the beginning, we were inclined to state that some areas might be strongly affected in a global warming context, but there might be others unaffected or over-compensated. Extrapolations of our survey suggest that forests all around the world might be suffering from the same global drought stress.

Images from the International Space Station helped us to feel part of the same unique world. We must assume that there are no exits. One way or another, this precious stone, where everything is linked up and connected to each other, must be preserved.

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[3] https://link.springer.com/article/10.1007/s10021-012-9596-1