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The implementation of the Forest Canopy Density (FCD) model for Coniferous ecosystems in Cyprus forests, using Landsat-8 and Sentinel-2 satellite data.

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Outline

- Introduction
- Objectives
- Study Area
- Methodology
- Preliminary Results
- Conclusion

Introduction – *Forest Fires*

- Fires are a widespread ecological factor since ancient times.
- It has a negative impact not only on the environment but on the economy, society and people.
- A forest fire can lead to a change in land surface, the destruction of large areas of vegetation and soil erosion.

➢As a result, the economy is negatively affected, the balance of ecosystems is disturbed, and the flora, fauna and natural beauty is destructed. Also, the large quantities of trace gases and aerosol particles that are emitted, lead to global climate change and play a significant role in troposphere chemistry.

In respect to fire management, recording and mapping burned areas are importance for planning and monitoring vegetation restoration.

A fundamental tool for forest fire management is the science of **REMOTE SENSING**

Introduction – *Canopy density*

- The canopy of trees plays a very important role in forest ecosystems and acts as a regulator, as it is a factor that affects the microclimate and the soil conditions.

- The density of the forest canopy is associated to the forest development and can be used as an indicator of forest degradation.

- Additionally, forest density is one of the most important parameters, used in the design and implementation of programs for forest restoration, especially in cases of areas affected by fires.

Objectives

Determination of the disturbance that occurred in the **canopy density** of the Paphos and Adelphi National Forests in Cyprus after the fire events that occurred on June, 2016.

Forest Canopy Density model (FCD)

The FCD model is an affordable and less costly method and less time-consuming compared to other methods and besides that, it provides very good accuracy based on previous studies.

Comparison the results from Sentinel-2 and Landsat-8 satellite images

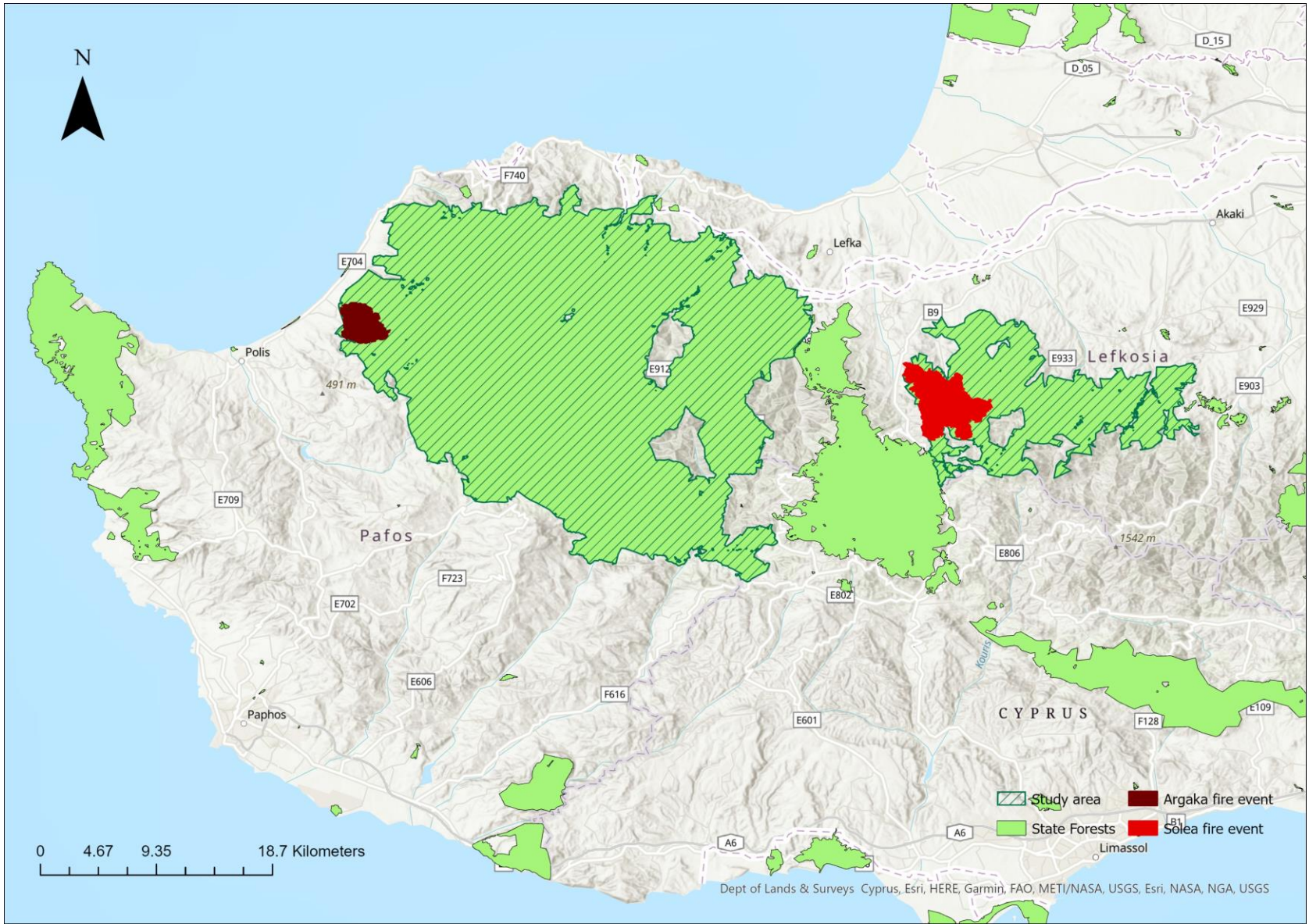
Sentinel 2A and Landsat 8 satellite images, before and after the fire event, were used to assess the damages on the canopy density caused by fire.

Study Area

The fire events in Paphos Forest and in Adelphi forest in Cyprus (the central coordinates: 35.050°N, 32.300°E) has been studied.

Study Area

Study Area	Date of Fire event	Burnt area (Estimation) (ha)
Argaka	18/6/2016	739.87
Solea	19/6/2016	1875.29



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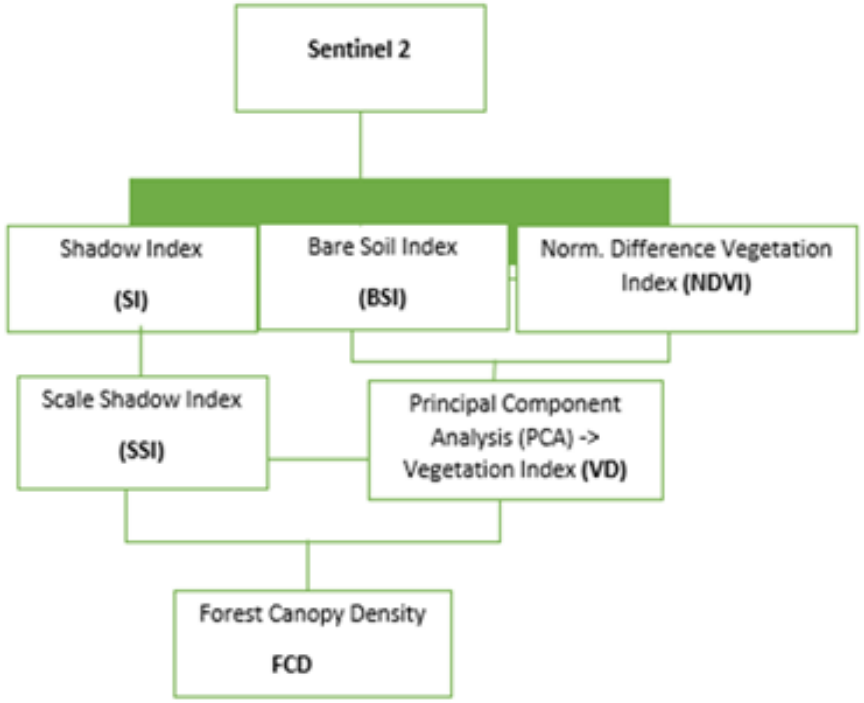
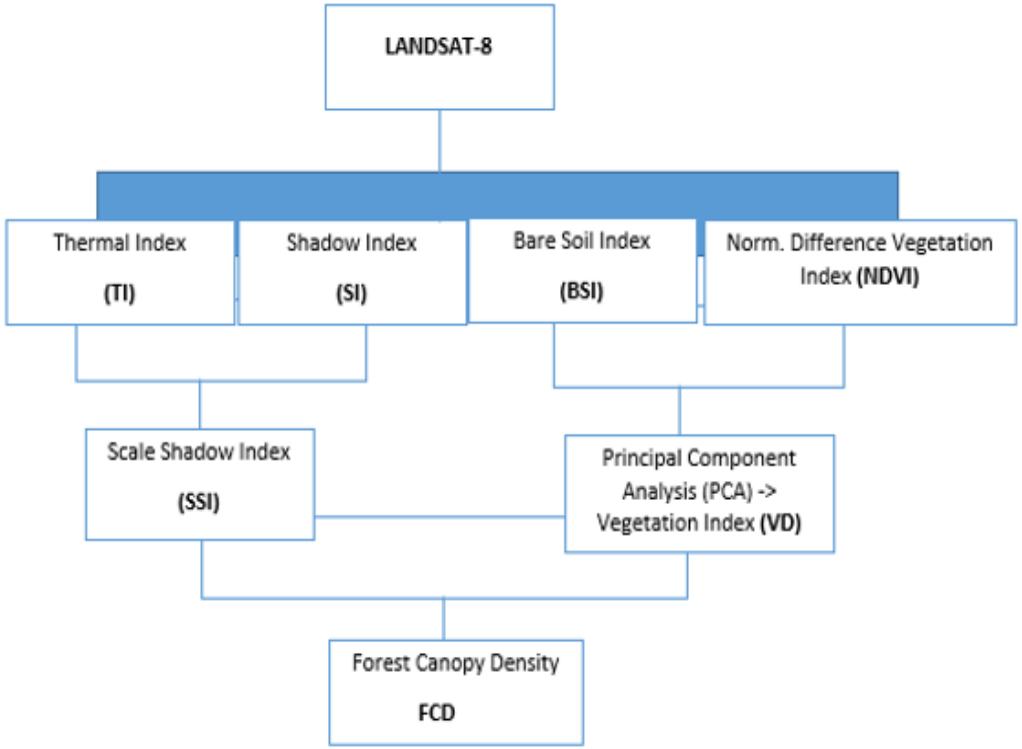
Methodology

FCD model is a combination of four biophysical indices which are NDVI, BSI, SI and TI. The calculation of the FCD is given from the following equation.

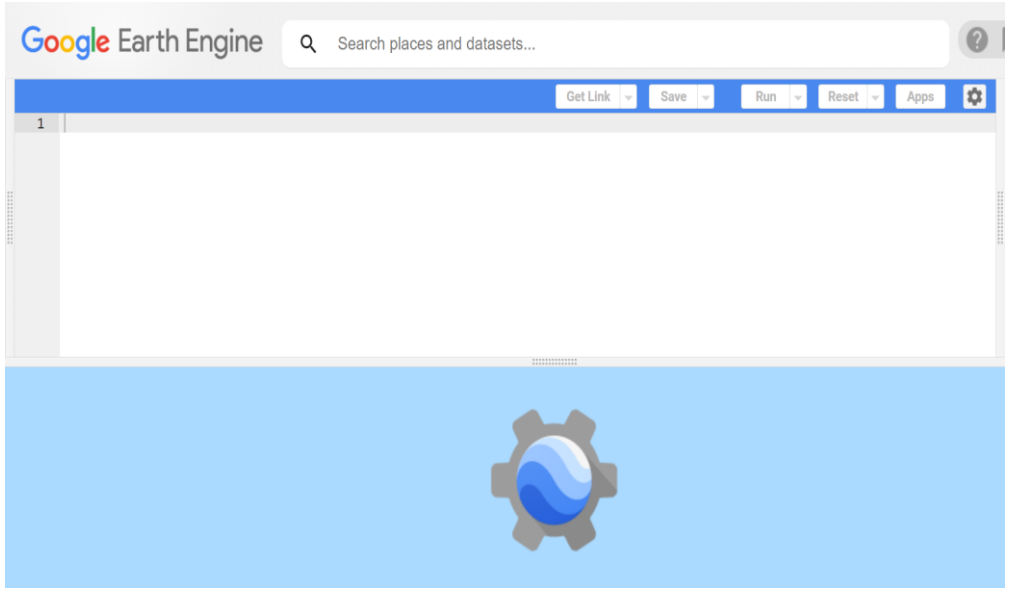
$$FCD = \sqrt{VD * SSI + 1} - 1$$





Methodology

The image processing for the estimation of FCD was made in the Google Earth Engine (GEE) Platform and the statistical analysis was made using the ArcGIS pro.



Preliminary results and discussion

After the estimation of the FCD index, the pixel values were classified based on the thresholding technique according to the bellow levels

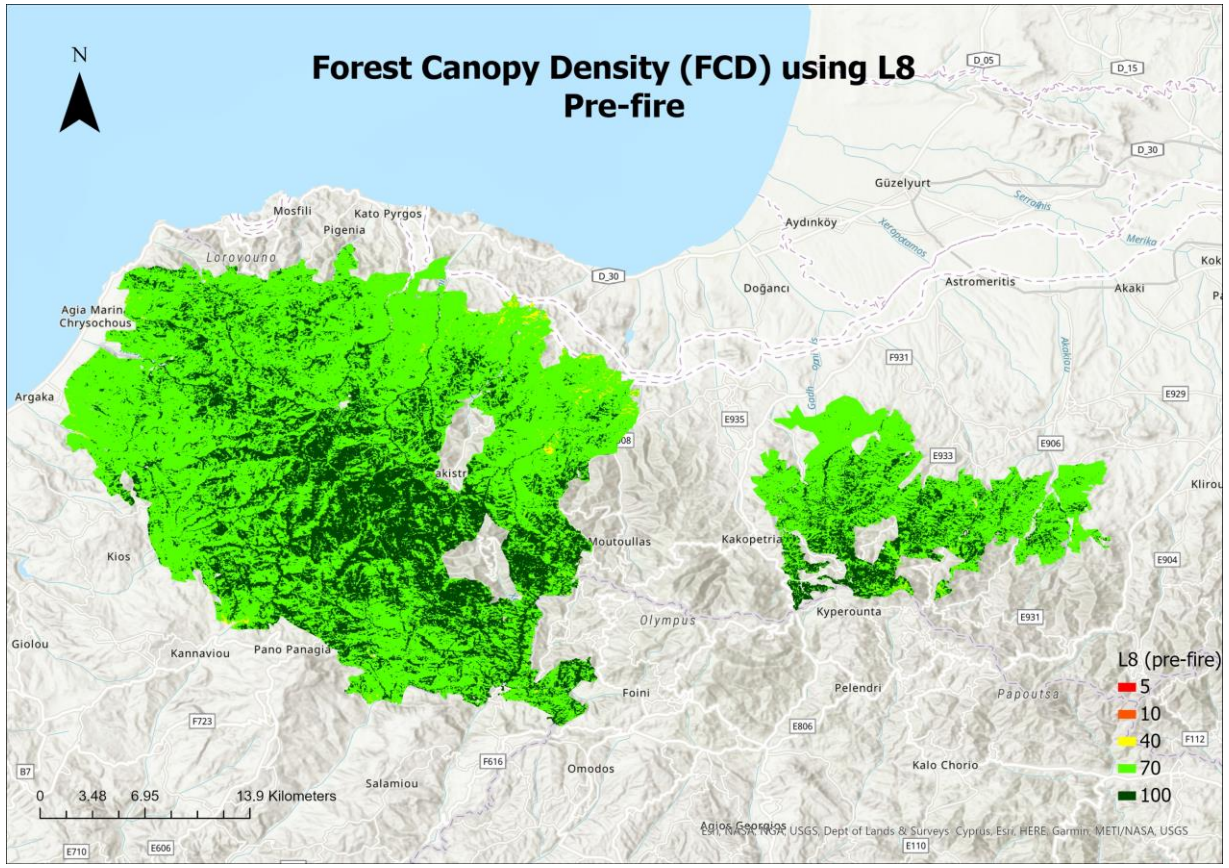
<u>The values of the index were divided into 5 categories:</u>

Non Forest	<5%
Scrub	5% < FCD <10%
Open Forest	10% ≤ FCD <40%
Moderately Sense Forest	40% ≤ FCD< 70%
Very Dense forest	≥70%

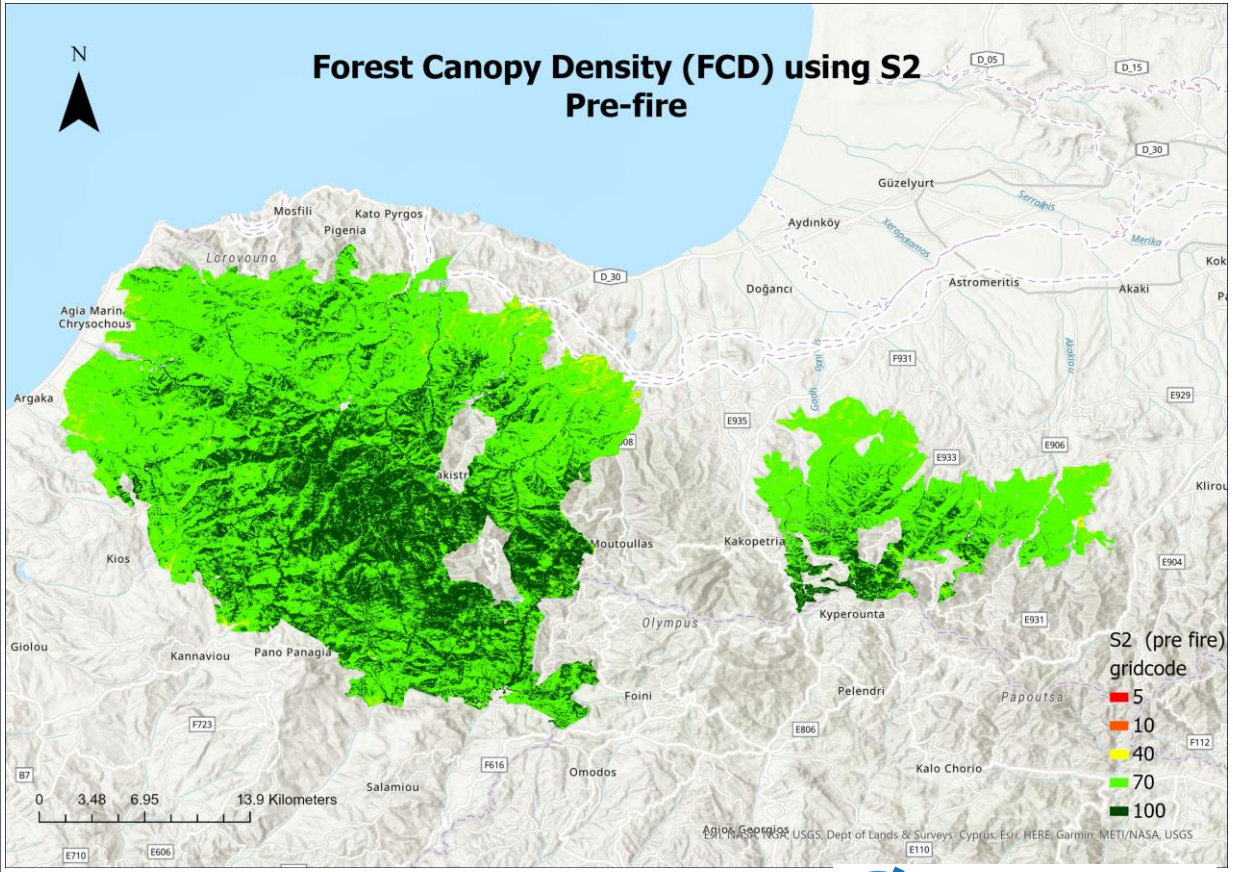
Preliminary results and discussion

Pre-fire

Landsat-8



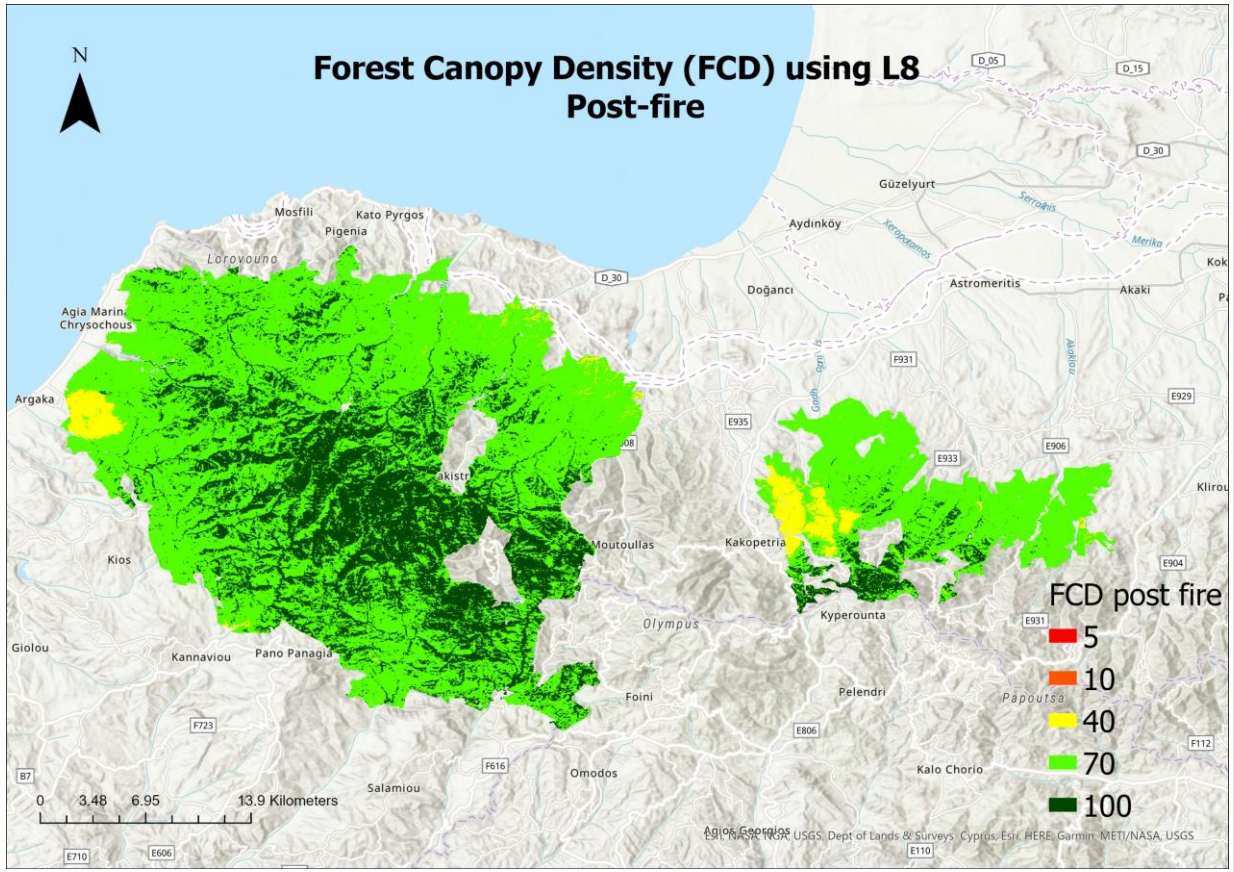
Sentinel-2



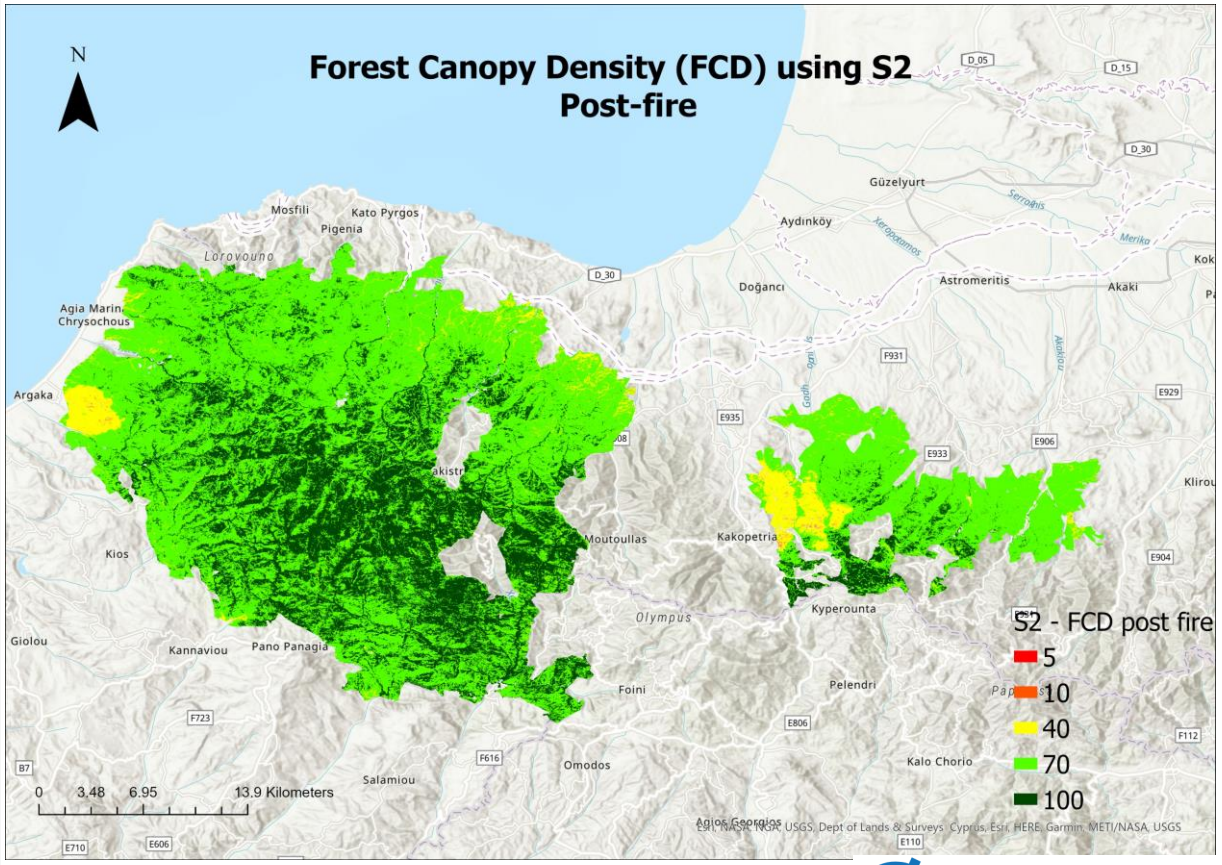
Preliminary results and discussion

Post-fire

Landsat-8

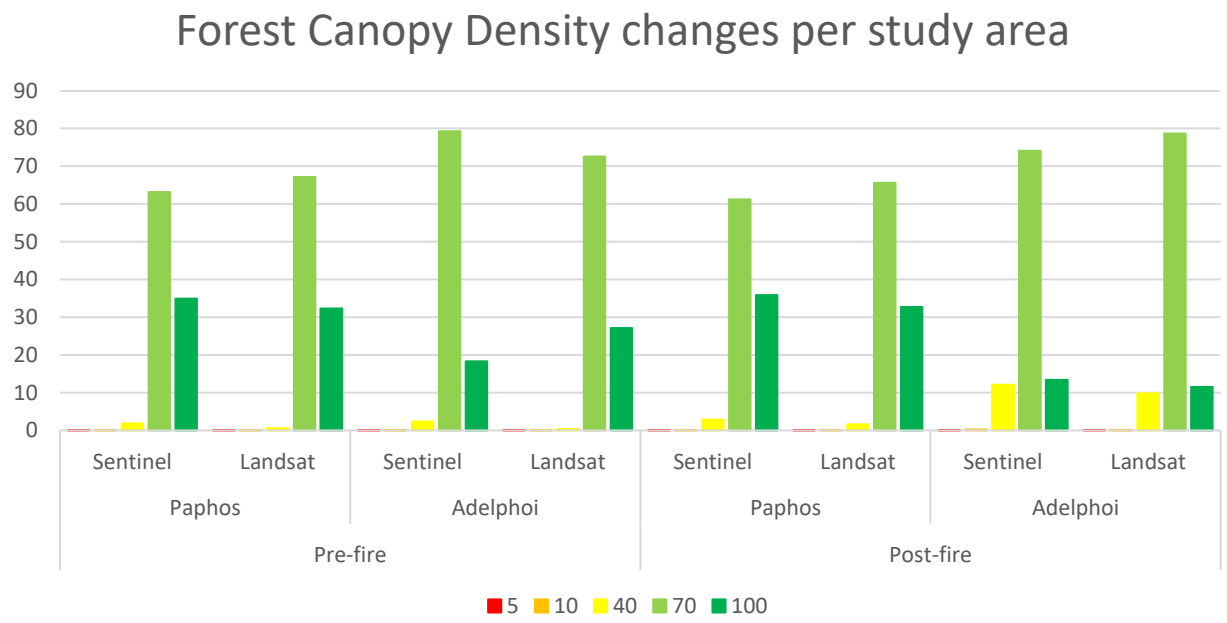


Sentinel-2



Preliminary results and discussion

As mentioned above the FCD index for each satellite sensor was divided into 5 categories.
The total area per class were calculated.



- The Paphos and Adelphi forest are mainly characterized by **Moderately Dense Forest before.**
- The Non Forest and Scrub classes has a very small percentage which have a small increase after the fire events
- After the fire events there is a decrease in the moderate and dense forest percentage areas

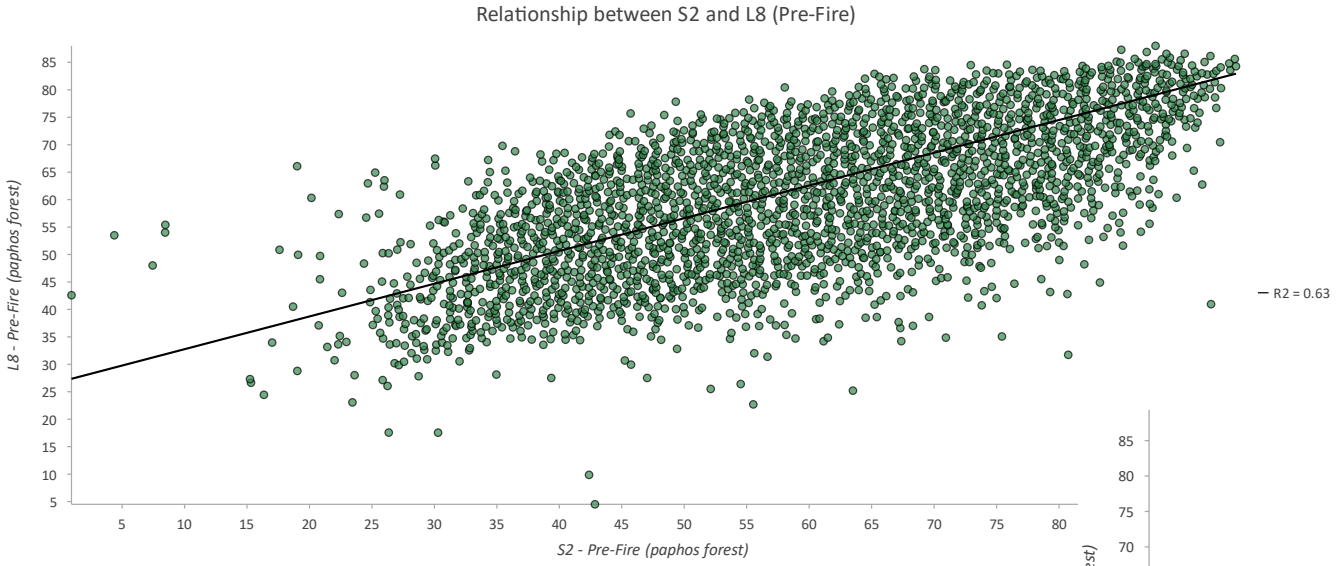
Preliminary results and discussion

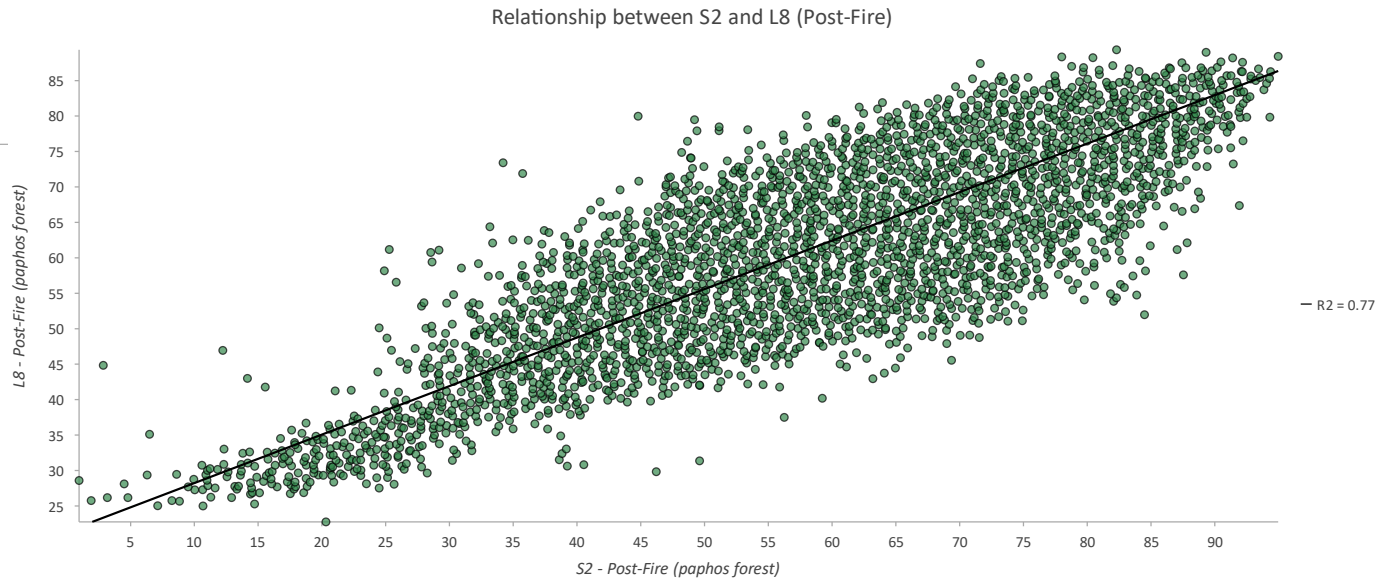
In addition, in order to better estimate the relationship between the values derived from each satellite sensor the correlation coefficient was estimated using the Pearson method.

	Correlation coefficient for L8 and S2	
	Pre-fire	Post-fire
Paphos forest	0.794823	0.878175
Adelphi forest	0.932353	0.676403

Preliminary results and discussion

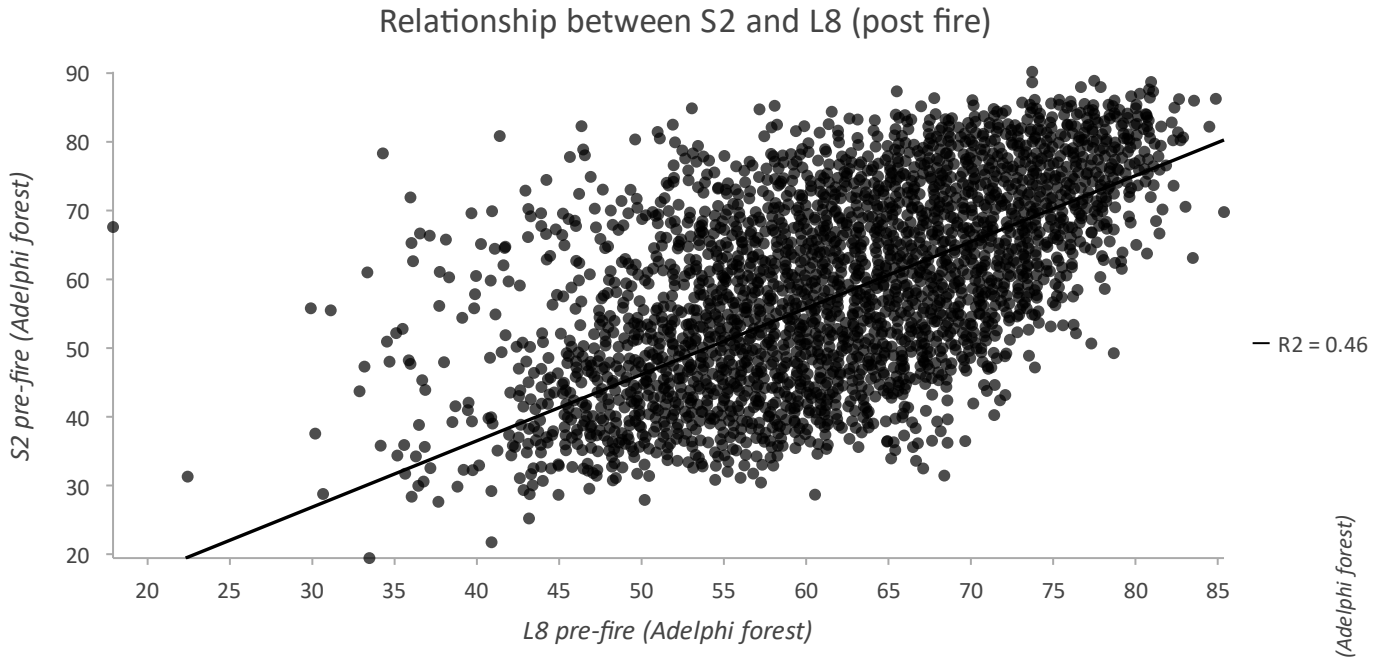
Correlation between S2 and L8 results for Paphos Forest

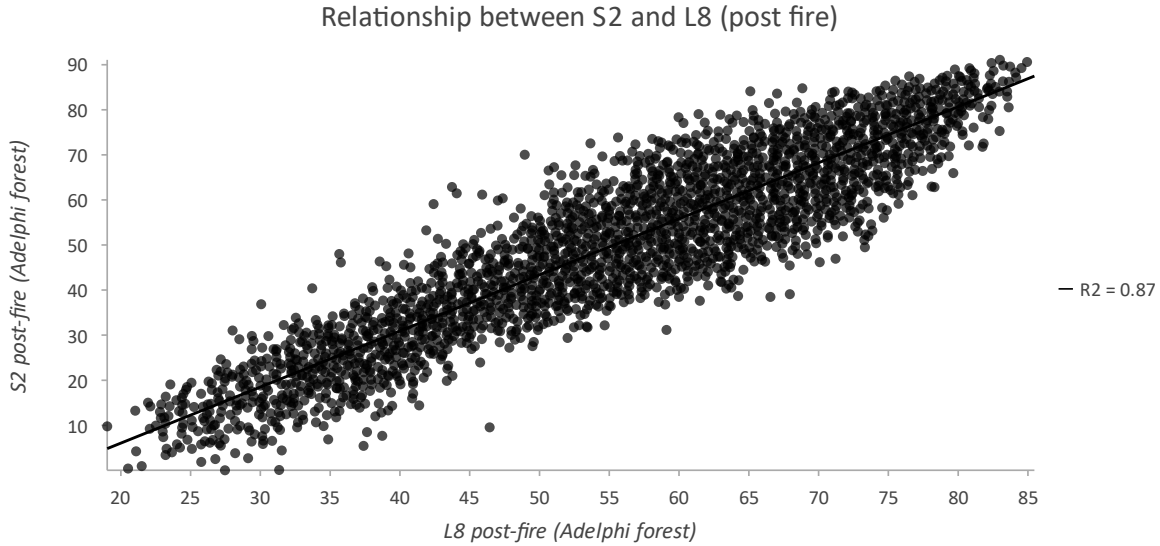




Preliminary results and discussion

Correlation between S2 and L8 results for Adelphi Forest





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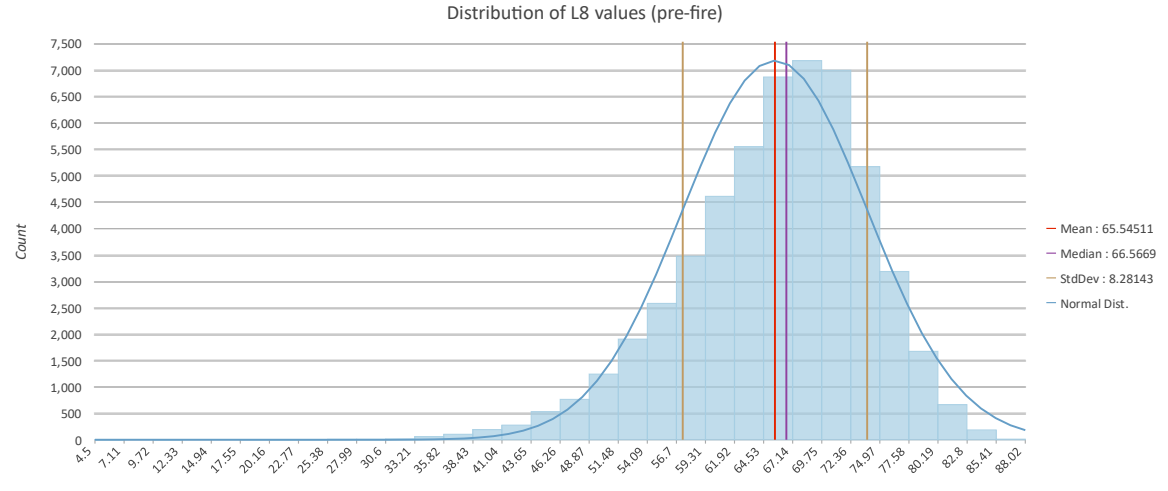
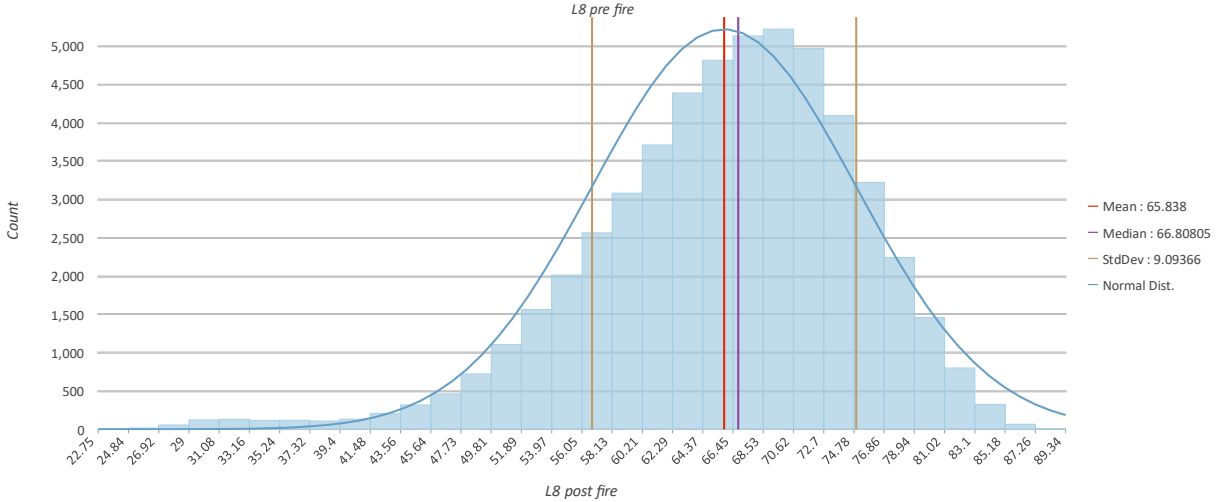
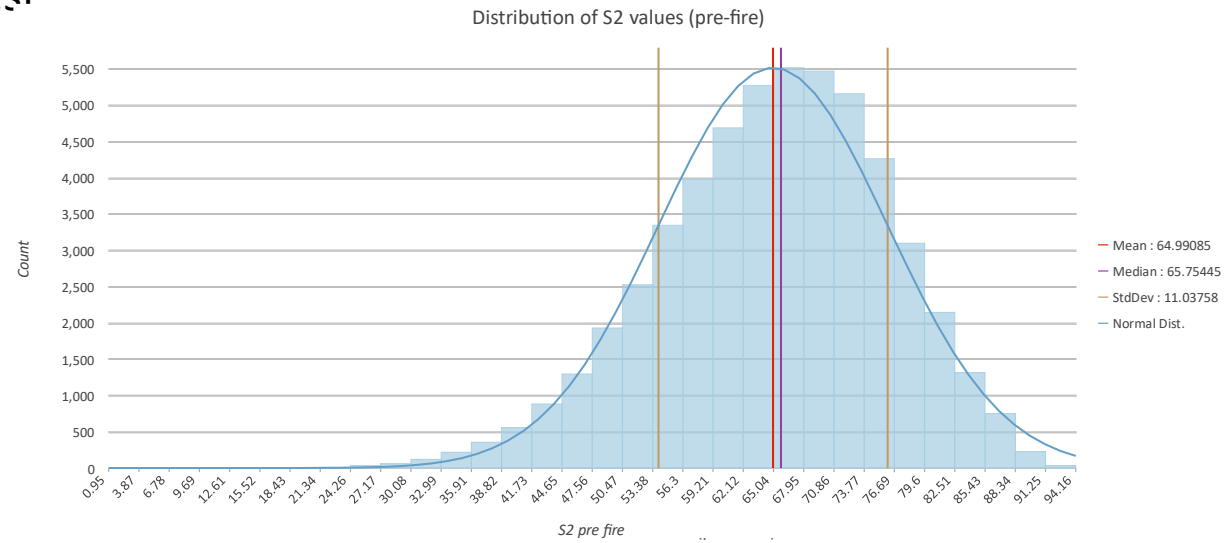
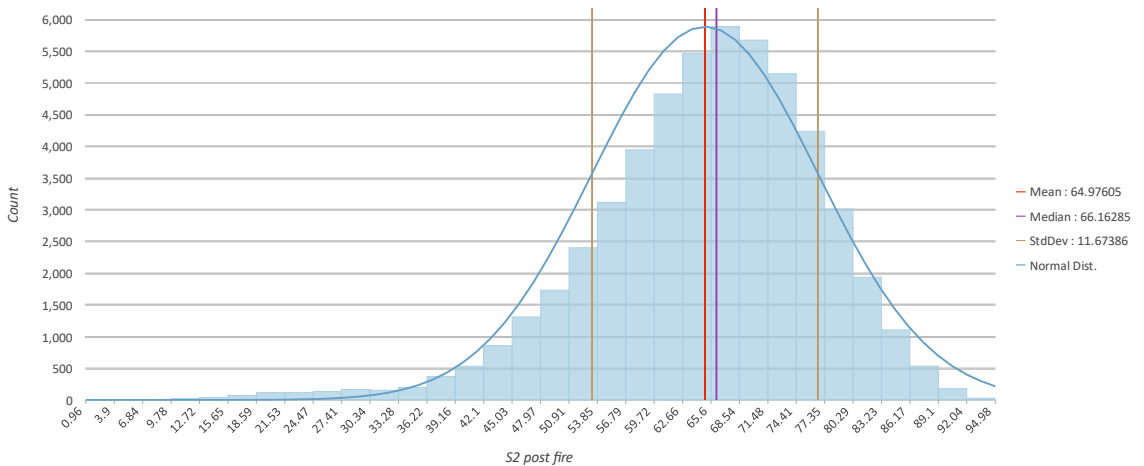
Preliminary results and discussion

Distribution of values or each satellite sensor – Paphos Forest



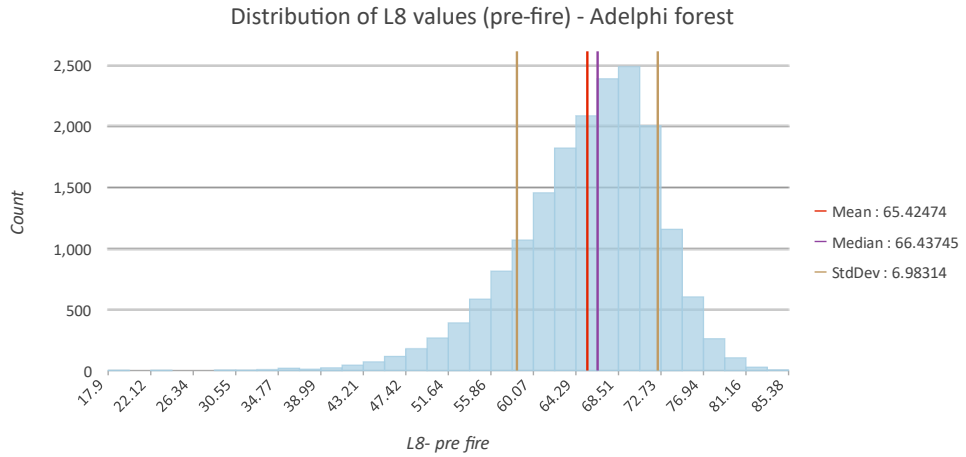


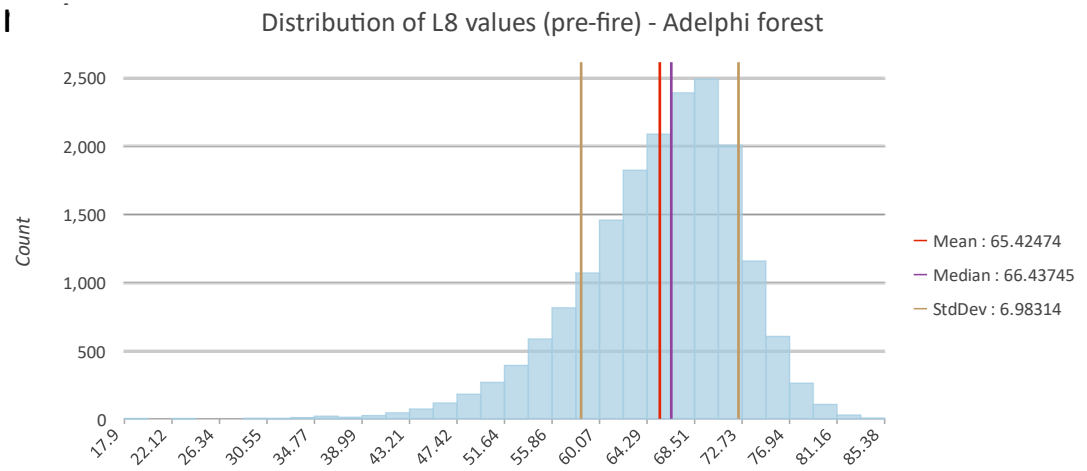


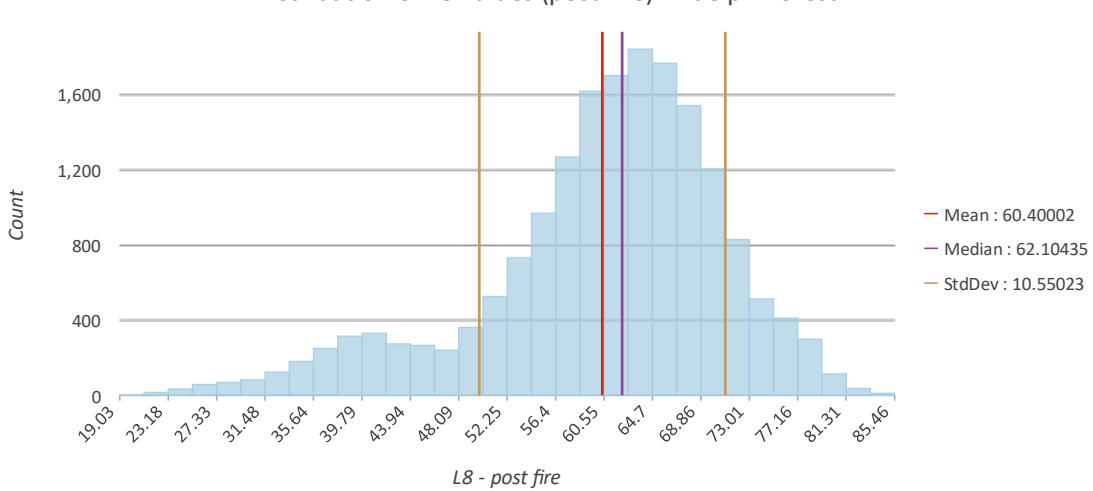


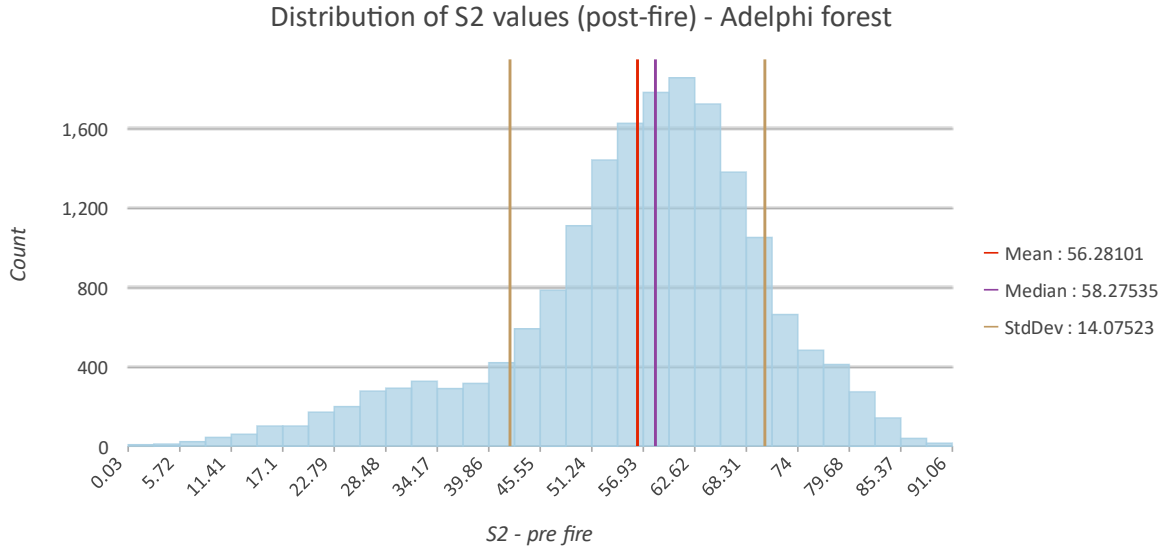
Preliminary results and discussion

Distribution of values or each satellite sensor – Adelphi For









Conclusions

- FCD model is a combination of four biophysical indices which are NDVI, BSI, SI and TI .
- The FCD model has been used in several studies using mainly Landsat satellite data that have a thermal channel for the calculation of TI. However, in this study, it was attempted to estimate the FCD using Sentinel-2 data without the TI in order to map the damage caused from fire.
- This model was useful for investigating the effects of fire on canopy density. Based on the preliminary results the use of both satellite sensors (Landsat-8 and Sentinel-2) showed similar variations in canopy density changes. Through this study, the Sentinel-2 satellite showed very promising results for the estimation of FCD with **better spatial resolution** than Landsat 8.
- As shown by the correlation coefficient analysis, the estimated values for the FCD values per pixel where obtained from each satellite image, showed an essensial to very strong uphill-positive linear relationship. Based on this, in cases that a Spatio-temporal analysis is needed to study the forest canopy density changes and create a time series, the combination of Sentinel-2 and Landsat-8 images can be utilized.

Next Steps

- Validation of the results
- Time series analysis

Thank you for your attention!

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