ASSESSMENT OF THE IMPACT OF THE FOREST FIRE POLLUTANTS ON VEGETATION AND CROP HEALTH IN NORTHEAST INDIA

Mira Shivani Sankar [1,2], Alka Singh[1], Nagesh K Subbanna[1], Raian V Maretto[2]*

[1]Center for Wireless Networks & Applications (WNA)Amrita Vishwa Vidyapeetham, Amritapuri, India

[2]Geo-Information Science and Earth Observation, ITC, University of Twente, Netherlands

1.Project Goals and Motivation

Primary Goal

To evaluate forest fire pollutants (FFP) and measure its impact on vegetation health.

Project Motivation

- Smoke generated from forest fire has the ability to travel far away and create disturbance in the ecosystem.
- It's impact on the vegetation will affect the local, regional and global productivity[1].
- The impact of FFP on human health is very pronouncing but, it is critical to understand the effect on vegetation health too.

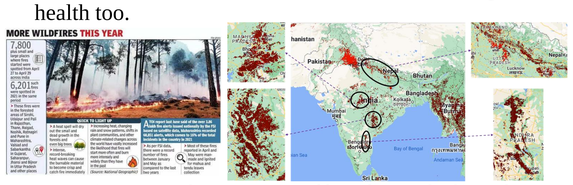

Figure 1: a)Newspaper showing statistics of forest fire in India, b) Fire hotspots of India from 2000 - 2022

2. Assumptions and Approach

- The study area (Fig-2a) is a small region of Mao east, district in Manipur, India which experienced a fire on March 23, 2021.
- The availability of PRISMA data and fire occurrence (Fig-2b) coincided for this region, thus this particular fire event was taken for the study.

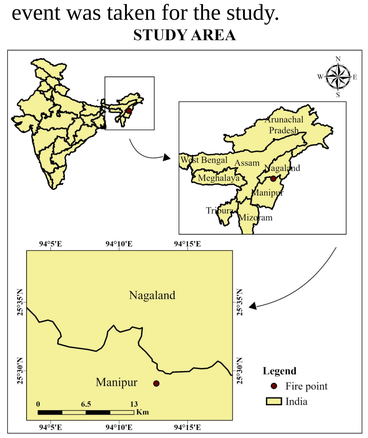

Figure 2: a)Study Area Map, b) Fire hotspot data from FIRMS

3. Methodology

Forest fire data was collected from FIRMS website and the location of the fire event was given as the input in NOAA – HYSPLIT model for simulation of the trajectory of FFP. From the fire location, a 3 Km buffer was made for analyzing the pollutant concentration. Time series of forest fire pollutants such as NO2, CO, HCHO and aerosols data were generated for the study from Sentinel – 5P through google earth engine. To analyze the vegetation health, PRISMA data was used. Then, the impact of FFP on vegetation health was assessed.

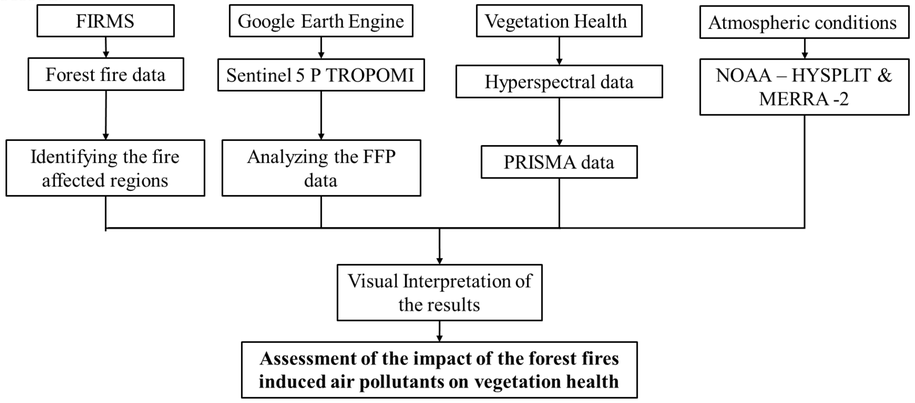

Figure 3: Methodology Flowchart

4. Results

This study has identified the flow of direction of FFP as north-west and north-east from Rose diagram (Fig-4a) and HYSPLIT trajectory frequency model (Fig-4b). Also, the concentrations of nitrogen dioxide (Fig-4c), carbon monoxide (Fig-4d), formaldehyde (Fig-4e) , aerosol index (Fig-4f) were high during the day of fire event which can be seen in the time series of sentinel data. The vegetation health was analyzed using PRISMA data in ENVI using "Forest health vegetation analysis" tool. The vegetation stress map clearly shows the impact of the vegetation due to FFP on the western side and eastern side as simulated by the HYSPLIT model.

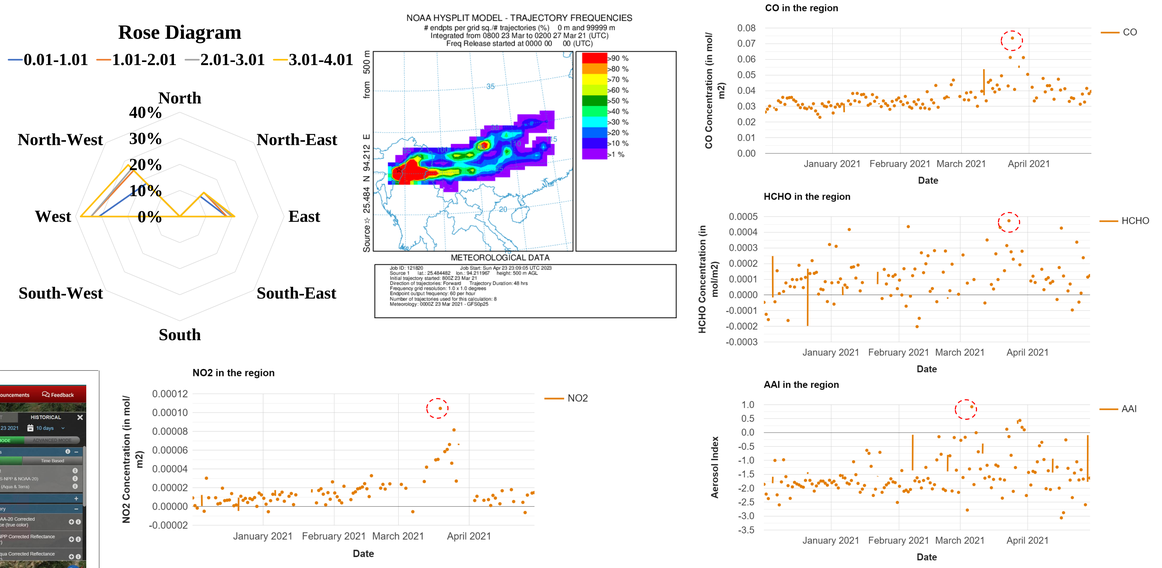

Figure 4:Left: a)Rose diagram, b) HYSPLIT trajectory frequency model, c) NO2 concentrations; Right: d)CO concentrations, e) HCHO concentrations, f) Aerosol Index

5. Conclusions

- In general, to assess the vegetation health using remote sensing data, different type of vegetation indices (VI) are utilized.
- This study has used the combination of Vogelmann red edge index (narrowband greenness), cartenoid reflectance index (Leaf Pigment) and photochemical reflectance index (Light use efficiency) to assess the health of the vegetation which is 3Km away from the fire incident.
- From Fig-5, it is evident that there is a high stress in the vegetation present in the western side compared to eastern side which can be due to the high movement of FFP in the northwest direction.
- A small fire has an impact as far as 3Km, then the high intensity fires which continuously burn for days can have a multiplied effect on the vegetation resulting in decreasing trend of the productivity.

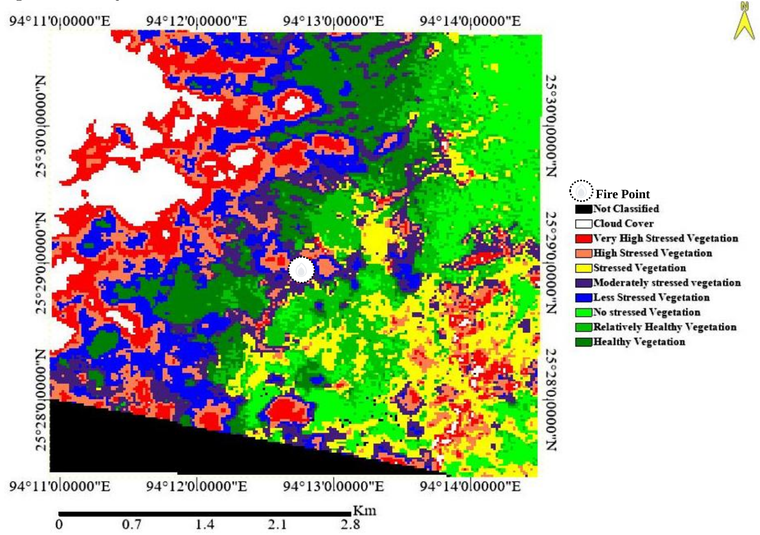

Figure 5: Forest vegetation health analysis map

6. Future Directions

- Incorporating ground sensor data to increase the accuracy of FFP data.
- Correlation studies between the FFP concentrations and vegetation health of the region.
- Implement the usage of multispectral data instead of hyperspectral data due to its global coverage.
- As India, has surficial fires the signals might not be strong enough to do the impact assessment of long range transported FFP's. Hence, high intensity fires that are recurring in Brazil, California and Australia can be analyzed.

References

1. Yue, X., Unger, N. Fire air pollution reduces global terrestrial productivity. Nat Commun 9, 5413 (2018). https://doi.org/10.1038/s41467-018-07921-4

*2. Stein, A.F., Draxler, R.R, Rolph, G.D., Stunder, B.J.B., Cohen, M.D., and Ngan, F., (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bull. Amer. Meteor. Soc., **96**, 2059-2077, http://dx.doi.org/10.1175/BAMS-D-14-00110.1*

*3. Rolph, G., Stein, A., and Stunder, B., (2017). Real-time Environmental Applications and Display sYstem: READY. Environmental Modelling & Software, **95**, 210-228, https://doi.org/10.1016/j.envsoft.2017.06.025*

Acknowledgement: The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and/or READY website (https://www.ready.noaa.gov) used in this publication. We also thank **Mr. Sivaganesh B** (Mtech Student, IIST, Thiruvananthapuram) for helping in handling hyperspectral dataset.