SATELLITE ASSISTED MAPPING OF ENVIRONMENTAL POLLUTANTS: A STUDY ON BURNING CROP RESIDUES

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INTRODUCTION

An increasingly common problem we are facing at the end of the agricultural season are intentional fires on agricultural plots caused by humans. Generally, this is the most common and easiest way of crop residue removal, which is why it is practiced by farmers worldwide [1]. Despite being very harmful to the environment overall, this method can limitedly mitigate some of the flaws in crop production such as presence of weeds, pests, and various diseases, which gives farmers a legitimate excuse to perform this type of action on their fields. According to previous research [2], at least 34% of the total emissions caused by the combustion of biomass is caused by burning of residues on agricultural plots. Considering the above, this procedure has a high negative impact on the environment, hence on humans [3].

METHODOLOGY

The method is based on change detection between two consecutive Sentinel-2 satellite images, one before the fire occurrence and the other after the fire. For this purpose, two satellite bands, namely B11 and B12, were used for calculating simple ratio (SR) [4] on pixel level following:

$$SR = \frac{\rho_{1610}}{\rho_{2190}}$$

where:

ρ_{1610} - the pixel value of the center wavelength channel
ρ_{2190} - the pixel value of the center wavelength channel

This ratio is characterized by high values in areas where a fire occurred and low values in those where it did not. Hence, if the difference of SR values between the two consecutive satellite images for the same location is small, we conclude that fire did not occur, otherwise it did. We foresee three possibilities:

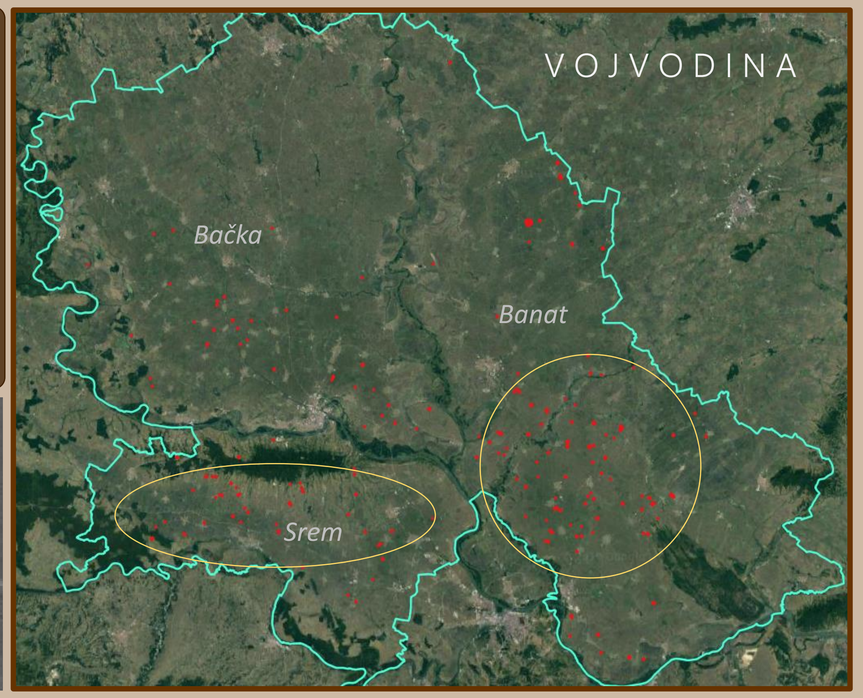
I. the difference lower than 0.35 means no area was burned,
II. the difference between 0.35 and 0.80 means potentially burned area
III. the difference greater than 0.80 means fire occurrence.

Values were determined by varying the thresholds followed by visual inspection. In order to assure the validity of the results, some of the additional constraints were introduced such as water, cloud, intensive growth, and crop masking.

RESULTS

The method was applied to the Vojvodina province in Serbia. The results showed that only those pixels that meet condition II or III, without being masked by one of the 4 previously mentioned masks, are marked as pixels on which the crop residues were ignited.

In the test period of three months (September to November 2020) more than 9000 parcels were detected that were subject to crop residue burning. According to spatial analysis, southern parts of the Vojvodina province were more prone to burning crop residues, in particular, the districts of Srem and South Banat. Comparatively, the district of North Bačka was the least affected by this phenomenon.



CONCLUSION

The results showed that Vojvodina is highly affected by the phenomenon of burning crop residues. Despite being relatively simple, the presented method showed its potential and that it can serve as the base for future steps in handling this problem by the local authorities. An obstacle that can prevent the application of the presented workflow is cloud coverage that can obscure satellite images and make them unusable. Usage of various satellite remote sensing sources (including commercial satellites or SAR sensors) with a higher temporal frequency of image acquisition can alleviate this issue.

REFERENCES
[1] Kaur, A., & Rani, J. (2016). An approach to detect stubble burned areas in Punjab by digitally analyzing satellite images. Journal for Research| Volume, 2(06).
[2] Streets, D. G., Bond, T. C., Lee, T. & Jang, C. On the future of carbonaceous aerosol emissions. J. Geophys. Res. Atmos.109, (2004).
[3] Singh, R., & Kumar, P. (2019). Potential of Remote Sensing in the Assessment of Crop Residue Burning and its Related Aspects: A Review. Our Heritage, 67(4), 62-69.
[4] Van Deventer, A. P., Ward, A. D., Gowda, P. H., Lyon, J. G. 1997. Using thematic mapper data to identify contrasting soil plains and tillage practices. Photogrammetric Engineering and Remote Sensing 63, 87-93.

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