Daily Forest Fire Prediction modeling and Forest Fire Information System (FFIS)

Apostolakis Alexis[1], Girtsou Stella[1] and Kontoes Charalampos[1]

1, National Observatory of Athens, Athens

*corresponding author: Apostolakis Alexis e-mail: alex.apostolakis@noa.gr

Abstract. Forest fires in recent years are becoming increasingly devastating for ecosystems, human lives and infrastructures as they follow the climate change impact. In this context the fire monitoring and risk prediction is crucial to support Civil Protection Agencies in charge of the protection of natural ecosystems against fires. Embracing the advancements in remote sensing the fire monitoring task is more and more contributed from automated systems that exploit satellite sensors data, while in the fire risk prediction field, machine learning tends to become the most applied methodology. In this short manuscript we briefly present the development of a daily wildfire risk prediction model based on machine learning techniques and a monitoring system (Forest Fire Information System) for active fires and burn scar mapping that exploits MODIS and VIIRS remote sensing data.

Keywords: Fire monitoring, wildfire predictive modeling

1. Daily Forest Fire Prediction modeling

Next Day fire risk prediction aims to characterize the areas of higher risk for fire occurrence, exploiting the data that could be obtained up to the day before. In the presented work the problem of next day wildfire prediction is handled on grid cells of a territory, considering a particularly fine-grained resolution, with cells 500m wide. A fire inventory for the years 2010-2019 was constructed for Greece after processing data from several fire monitoring systems like FIREHUB, EFFIS and NASA [1]. The fire driving factors that were used as features within the deployed ML algorithms comprised of weather, landscape, land cover and remote sensing parameters explained in detail in [1]. A set of state of the art algorithms (Random Forest, XGBoost, LogitBoost and Neural Networks) were tuned by searching their hyperparameter spaces via cross-validation on a historical training dataset [2]. The best performing models were selected with respect to different evaluation measures (AUC, F-score and harmonic means of sensitivity and specificity). These models were assessed on a separate real-world test set, which is a differentiation from existing works [3] and the reported results demonstrated the applicability of the proposed method in real-world deployment. The best balanced models for sensitivity - specificity achieved a correct prediction of fire areas (sensitivity) with a >87% rate for the most challenging month of the year, August, while they characterized up to 42% low risk or "no fire" areas (specificity) [2]. As the study of this modeling continues, preliminary results of the latest experiments, based on an extended feature set, more complicated training methodology and models, are showing the potential of even better predictive accuracy.

2. Forest Fire Information System (FFIS)

FFIS (http://ffis.beyond-eocenter.eu/) is an operational system that provides the most up to date information on the current active fires and burn scar mapping in South Eastern Europe and the East Mediterranean area. The burned area detection is based on a 3 steps prototype Algorithm for Burnt Scar Mapping (BSM) classification and Land Use/Land Cover filtering based on [4]. The first step is the preprocessing of the VIIRS image acquired in the NOA Ground Segment: generation of cloud and sea masks and enhanced histogram matching of pre and post fire images by applying innovative techniques. Temporal changes are detected in the second step by analyzing a number of diverse spectral features for base and reference image. Finally a custom spatial database post-processing chain stores, attributes, validates and keeps track of the BSM polygons that are about to be published in the WebGIS platform.

The FFIS platform is available to the public authorities and the Emergency Management Services to support the protection of forest against wildfires. Furthermore, within FFIS a validated database of fire events is costructed for the area and during the next years we will be able to analyze these data and achieve better understanding of new wildfire patterns and behaviour.

References

[1] A. Apostolakis, S. Girtsou, C. Kontoes, I. Papoutsis, and M. Tsoutsos, "Implementation of a Random Forest classifier to examine wildfire predictive modelling in Greece using diachronically collected fire occurrence and fire mapping data" in MMM 2021, Prague, Czech Republic, June 22–24, 2021, Proceedings, Part II

[2] S. Girtsou, A. Apostolakis, Giorgos Giannopoulos, C. Kontoes, "A Machine Learning Methodology for next day wildfire prediction" in IEEE IGARSS 2021, Brussels, Belgium, July 12–14, 2021, Proceedings (forthcoming)[4] Liu et al, 2014:"Study of Burn Scar Extraction Automatically Based on Level Set Method using Remote Sensing Data"

[3] P. Jain, S. C. P. Coogan, S. G. Subramanian, M. Crowley, S. Taylor, and M. D. Flannigan, "A review of machine learning applications in wildfire science and management," 2020.

[4] Liu et al, 2014:"Study of Burn Scar Extraction Automatically Based on Level Set Method using Remote Sensing Data"