**Integrating Deep Learning with eXplainable AI for Wildfire Severity Analysis Using USGS FIREMON dNBRs in Turkey**

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***ABSTRACT***

Wildfires are a major natural catastrophe that disrupts the normal cycle of ecosystems, causing significant loses in forested lands. Annually, a substantial amount of forest is devastated by wildfires around the globe. Utilising remote sensing and advance deep learning techniques provides significant advantages in the effectiveness of detecting burnt areas. This study examines the wildfires that occurred place during July 2023 around the Aegean region of Turkey. Pre- and post-fire Sentinel-2 images were classified using pixel-based Convolutional Neural Network (CNN). Prior to classifying the severity of the fire, the differenced (or delta) Normalized Burn Ratio (dNBR) values were computed and four distinct degrees of intensity were identified using the thresholds established considering the intervals determined by the USGS FIREMON project. Spectral indices (Burned Area Index-BAI and normalized difference vegetation index-NDVI) of pre- and post-fire Sentinel-2A images were also calculated and included in the data set during the classification process. As a result of the burn severity classification, the overall accuracy of 90.24% and the Kappa coefficient of 86.98% were estimated. The attained results demonstrate that the model produced high prediction accuracies across all test data. SHAP analysis with feature importance, a globally explainable artificial intelligence method, was used to understand the decision-making processes of the trained CNN model and to evaluate the effectiveness of each feature within the model. According to this analysis, both post-BAI (0.179) and pre-BAI (0.107), followed by pre-SWIR (0.100) and post-NIR (0.050) variables played an important role in the decision-making process of the model. The results of this study shows the effectiveness of CNN models in analyzing the forest fire and its severity, also the benefits of XAI methods, SHAP in this study, to put shed light on the interprebility and transparency of the trained black-box models.

**Keywords:** Convolutional neural networks, wildfire, SHAP, Forest fire, eXplainable AI