**Application of Hybrid Forest Fire Modelling (FLAM-Net) in South Korea's Planted and Managed Forests**

Forest fires represent a growing global concern, particularly exacerbated by heat waves induced by climate change. In addition to the shifting climate conditions, the complex interaction of natural factors and human activities underscores the pressing need for advanced predictive models. While existing models offer either interpretability through process-based approaches or automatic feature identification via machine learning, they each have inherent strengths and limitations. This research aims to bridge these gaps by integrating human expertise, essential for understanding forest fire dynamics, into a machine learning framework. Introducing FLAM-Net, a neural network derived from the wildfire Climate Impacts and Adaptation Model (FLAM) developed by IIASA, this study combines the insights of FLAM's process-based approach with the capabilities of machine learning. Tailored specifically for South Korea, where 27% of its forest is planted and 61% is managed forest, novel algorithms within FLAM-Net decipher national-specific forest fire patterns. Additionally, employing U-Net-based deep neural networks (DN-FLAM) enables multi-scale applications, resulting in downscaled predictions. The adapted FLAM-Net and DN-FLAM models reveal spatial concentration of forest fires near metropolitan areas and the eastern coastal region, with temporal peaks occurring in spring. Evaluation of model performance yields high Pearson's r values of 0.943, 0.840, and 0.641 for temporal, spatial, and spatio-temporal dimensions, respectively. Projected scenarios based on Shared Socioeconomic Pathways (SSP) suggest an increasing trend in forest fires until 2050, followed by a decline attributed to rising precipitation. This study underscores the advantages of hybrid models like FLAM-Net and DN-FLAM, seamlessly integrating process-based insights with artificial intelligence for enhanced interpretability, accuracy, and optimization. The findings provide substantial scientific evidence for understanding forest fire dynamics, particularly in planted and managed forests that are also vulnerable to human disturbances.

***Keywords****: hybrid modeling, neural networks, forest fire, climate change*