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Editorial: Spatial and temporal monitoring of wildfire hazard under a climate change environment: prevention, mitigation and management

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Editorial on the Research Topic
Spatial and temporal monitoring of wildfire hazard under a climate change environment: prevention, mitigation and management

Wildfire is a natural phenomenon that may become a disaster if it crosses the boundaries of natural and anthropogenic ecosystems. During the last 20 years (2001–2021), 119 million ha of tree cover have been consumed by fires on a global scale, accounting for almost 37% of total forest losses occurred in this period. Future projections predict that, under a climate change environment, the fire season, especially in Southern Europe, will be prolonged with higher duration and severity of droughts, leading to higher fire severity and burned area. The purpose of this Research Topic was to highlight recent research related to the spatio-temporal monitoring of wildfire hazards, linked with the climate change dimensions of wildfire hazard dynamics. This synergy can potentially allow the spatial determination and development of the most appropriate preventative measures in the most vulnerable regions. Within this context, interdisciplinary approaches over the broader field of wildfires were highly welcomed. This Research Topic accepted manuscripts that showcase unique empirical strategies and use of new and innovative data sources, novel theoretical contributions and the integration of findings and theories across multiple disciplines that deal with the topic of wildfires.

Fan et al. investigated the performances of traditional semi-physical models (Nelson method and Simard method), contemporary machine learning modeling (Random Forest model), generalized additive model, and a linear regression model to explore the dynamic change of fine fuel moisture content (FFMC) and its driving factors. Performance assessment was conducted on the values of the root mean square error (RMSE) and mean absolute error (MAE) of the models. Data were obtained from a mountainous and hilly study area that have dense forest cover in the Maoer Mountain Experimental Forest Farm of Northeast Forestry University in Harbin, China. Researchers collected surface litter from four different forest plantations and the real-time FFMC and meteorological data at half-hour intervals, spanning the full fall fire season. It was found that that the semi-physical models performed best, the machine learning model and generalized additive model performed slightly worse, and the linear regression model performed worst. The results of the model comparison in this study could be useful for forest fire management and prediction in Northeast China and have reference value for the future research direction of the FFMC prediction model, as well.

A solution was proposed by Yemshanov et al. in order to deal with a practical problem related to the effect of preventive treatments of vegetation against forest fires sustaining the provision of wildlife services. A network optimization approach was used to define locations across high-voltage power lines inside a forest proposed for fuel management of their understorey vegetation. The question was, what is the best location for fuel treatments allocation in order, from one hand, not to harm the crossing powerlines and the ecological connectivity of the populations of boreal woodland caribou, and from the other side to minimize fire risk caused by the high-voltage power lines. The authors developed a model that combined a Critical Node Detection (CND) problem with a habitat connectivity problem in the area surrounding Hydro-Québec's proposed connectivity corridor in northeastern Québec, Canada. The model identified the best locations to perform fuel treatments to reduce the threat of potential fire damage by 36–39% under the current and by 20–31% under the future climate for 2070, while maintaining a connectivity corridor. Limitations, mostly due to natural variability, are discussed and possible solutions were proposed.

Nowadays, the use of satellite image data is widely used in the assessment of forest fires impact. The KazEOSat-1 high-resolution satellite datasets were used by Suresh Babu et al. to map the burnt area in the regions of Kazakhstan. The KazEOSat-1 satellite is in a sun-synchronous orbit, consisting of four bands (blue, green, red, and NIR multispectral bands, in 4 m spatial resolution) while panchromatic data (in 1 m spatial resolution) are also obtained. Three spectral indices—Global Environmental Monitoring Index (GEMI), Ashburn Vegetation Index (AVI), and Burn Area Index (BAI) were tested for mapping burnt areas using datasets obtained by KazEOSat-1. The results of indices were compared based on a Discriminative Index (M) for quantifying the effectiveness of each index based on burned area. It was found that the BAI index had higher M values compared to the other tested indices, and this index had the higher capability to extract the burned area. A further accuracy analysis showed that the BAI has again the highest ability for extracting the burned area using the KazEOSat-1 satellite datasets. As the revisit time period of KazEOSat-1 is 3 days, this study will be useful to map the burnt area and fire progression in Kazakhstan.

Hu et al. investigated the characteristics of forest fire spread and the applicability of a coupled fire-atmospheric wildfire model (WRF-Fire) in China. The study simulated a high-intensity forest fire event in Xintian County, China. Authors used high-resolution geographic information, meteorological observation and fuel classification data to analyze wildfire behavior and compared the simulation results with the burned area observed by satellite remote sensing forest fire monitoring data. It was found that the simulated wind speed, direction and temperature trends are similar to the observation results. Authors also found that the simulated wind speed is overestimated, the dominant wind direction is from north (N), and the temperature is slightly underestimated. The simulation results showed that the spatio-temporal variation characteristics of the local wind field are found under complex terrain while obtaining the high-resolution wind field. The simulated burned area was generally overestimated. It is concluded that the model can accurately reproduce the real spread of fire, a finding that can be utilized by forest fire managers.

Overall, modern approaches and technologies accommodated in this Research Topic can be helpful to agencies and policy makers to set up robust strategies to prevent forest fires and reduce their negative impacts on nature and society.

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