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Abstract

Regional Variability and Driving Forces behind Forest Fires in Sweden †

Reinis Cimdins [1,*], Andrey Krasovskiy [2] and Florian Kraxner [2]

[1] School of Forest Sciences, University of Eastern Finland, 80101 Joensuu, Finland
[2] Agriculture Forestry and Ecosystem Services (AFE) Group, Biodiversity and Natural Resources (BNR) Program, International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361 Laxenburg, Austria
* Correspondence: reinic@uef.fi
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Extreme forest fires have been a historic concern in forests in Canada, the Russian Federation, or the USA, and are now becoming an increasing threat in boreal Europe where recent fire events in 2014 and 2018 caught the attention of those in Sweden. Our study objective was to understand the vulnerability of Swedish forests to fire by spatially analyzing historical burned areas and linking fire events with weather, landscape, and fire-related socioeconomic factors.

We developed an extensive database at 1×1 km^2 homogenous grid, where monthly areas burned in a forest were derived from the MODIS FireCCI51 dataset. Spatial factors, including camping sites, lakes, and roads, topographic features, including aspect, slope, and mean elevation, population density, forest management intensity, and forest stand volume, were collected from various sources and pre-processed. Monthly Fine Fuel Moisture Code (FFMC) values over 2011–2018 were calculated from daily weather data by IIASA's FLAM model. To include new factors into FLAM, we developed a random forest model to assess the spatial probabilities of burned areas. Due to Sweden's geographical diversity, the fire dynamics vary between six biogeographical zones. Therefore, the model was applied to each zone separately.

As an outcome, we obtained probabilities of burned areas in the forests across Sweden and optimized thresholds. Observed burned areas were well captured by the model. Result accuracy differs with respect to zones; area under the curve (AUC) was 0.875 and 0.94 for zones with a few fires, but above 0.95 for zones with a higher number of fire events.

Feature importance analysis and its variability across Sweden provide important information to understand the factors behind forest fires. FFMC, population and road densities, slope and aspect, and forest stand volume were found to be among the key fire-related factors in Sweden. Our modeling approach can be extended to hotspot mapping in other Boreal regions.

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