

Towards an integrated forest fire danger assessment system for the Alpine region



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INTRODUCTION

Wildfires in the European Alpine region are an emerging issue that can lead to high damages in protection forests, increasing natural hazards and resulting in high costs up to millions of euros for fire suppression and restoration measures. The Alps are one of the regions worldwide most affected by climate change with a temperature increase nearly twice as high as the global average. Improving forest fire danger assessment is therefore needed to prevent and anticipate the occurrence of fires. While predicting fire danger with fire weather indices based on meteorological data are common, other relevant factors as vegetation data, topography, lightning occurrence, human impact and vulnerability to fire are often ignored.

MATERIAL & METHODS

We introduce an integrated forest fire danger assessment system (IFDS) for the European Alpine context (Fig. 1). Based on the approach proposed by Chuvieco et al. (2010) and San-Miguel-Ayanz et al. (2018) it includes i) daily fire weather index data, ii) a high resolution danger assessment of the vegetation, iii) topography information, iv) a lightning fire occurrence model and v) a regression analysis of human fire ignition danger. All datasets were compiled in several research activities (Arndt et al. 2013, Arpaci et al. 2011, Müller et al. 2013) with a spatial resolution of 100 x 100 m and applied for Austria. Datasets were homogenized, stored and made accessible via a web GIS application (Fig. 2). The system allows the end-user to work with different weighting scenarios (Fig. 3).

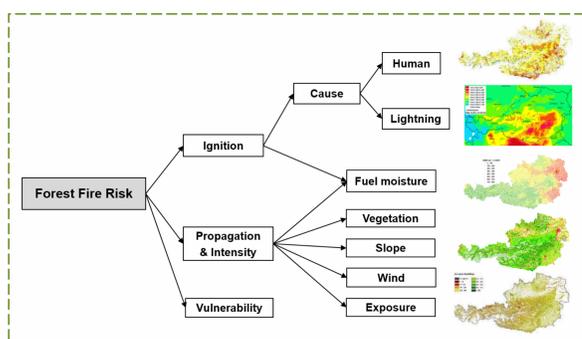


Figure 1: Elements of an integrated forest fire danger assessment system.

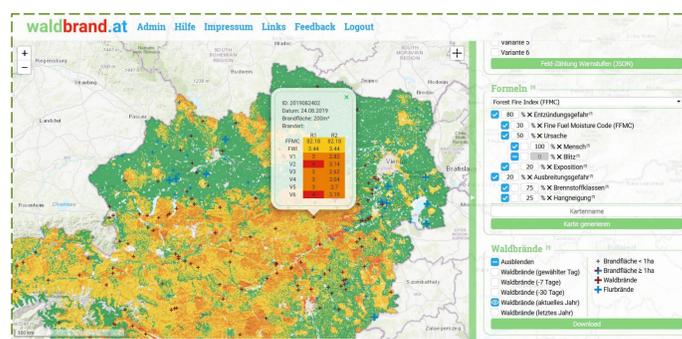


Figure 2: Screenshot of the online prototype of the IFDS, available under waldbrand.at („forestfire.at“)

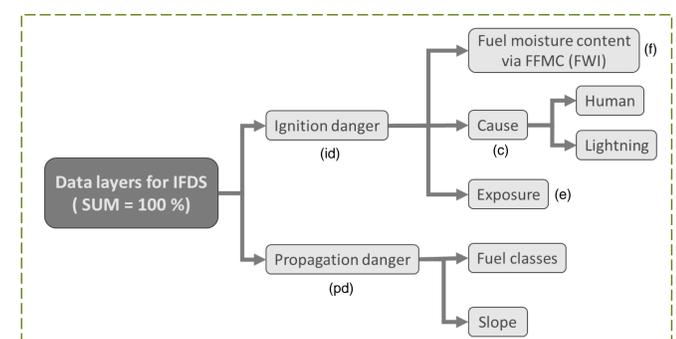


Figure 3: Data layers used for the current version of the IFDS. Weighting sum has to be 100%.

RESULTS

A first validation study of the IFDS was done with observed forest fires ($n=128$) of 2018. It was found that the stand-alone Canadian FWI model had a slightly better overall prediction accuracy than the combination of several factors. However, when considering the number of false alerts across Austria, IFDS model variants performed better, especially those with stronger focus on fuel moisture content (Fig. 4). The inclusion of the human factor did not produce better results in this validation.

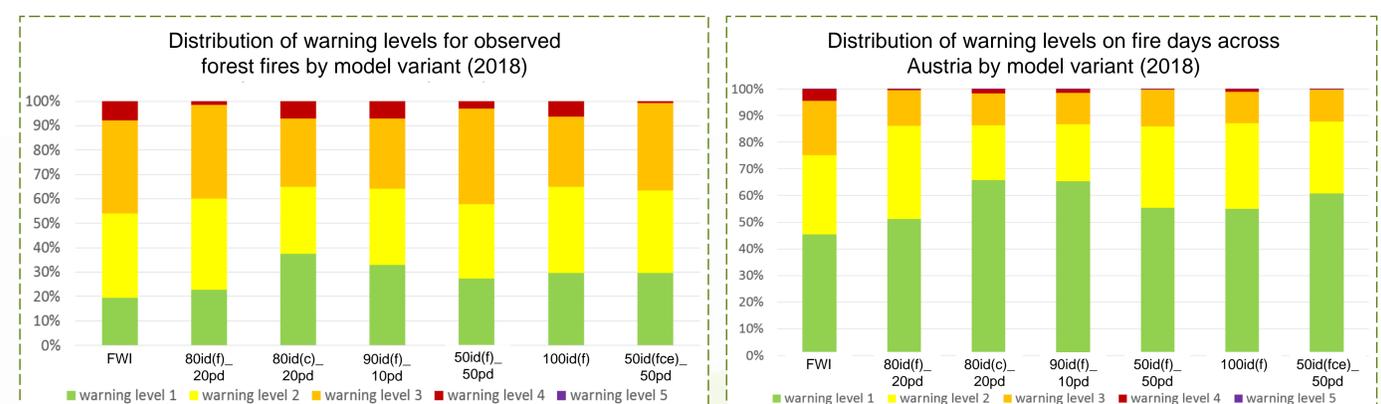


Figure 4: The FWI model had the best performance (45% of fires under warning level 3 or higher) in predicting fire danger (left). However, false alert rate considering whole Austria was higher using FWI (25%) than all other models (right). The model 90id(f)_10pd performed best considering both, prediction accuracy of observed fires and false alert rate (15%). Model codes: *id* (ignition danger), *f* (fuel moisture content), *c* (ignition cause), *e* (exposition), *pd* (propagation danger); numbers represent weight of the data layers; between brackets is shown the main parameter considered within *id*; main parameter within *pd* is fuel class in all models except 50id(fce)_50pd, where fuel class and slope were given same weight.

DISCUSSION

The aim of the current Web-GIS application is to understand and learn about the role of the ignition and propagation data in fire danger rating. Using several years of observation will allow to conduct a regression analysis to identify the significance of the different parameters. This should lead to improved weighting algorithms and a high performance system. Since fire ignition is highly influenced by random factors (e.g. human activity) and the heterogenic, small scaled forest structure, it may be difficult to improve fire danger assessment by an integrated system. However, we think that future trends and changes in climate and recreational activities in Austria and other mountainous regions will lead to better predictable high fire danger situations.

CONCLUSION

The IFDS is a new and innovative approach to improve daily forest fire danger assessment in mountainous landscapes. The overall performance is strongly driven by the included data layers and the resolution of the data. First results indicate that the IFDS has a slightly better performance than a stand-alone application of Fire Weather Indices. Further improvements of the data layers, in particular the probability for human caused ignitions and the characterization of the fuel type, are needed.

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