A Little Bit More About Fire Danger Indices

Better understanding fire activity has always been a major issue for global fire risk assessments. Many efforts have been put on investigating fire ignition and behaviour using fire indices that depend on climate and weather variables. Thus, previous research has focused on describing fire weather conditions, and integrating different meteorological variables into fire indices. These efforts resulted in a wide array of fire danger rating systems and indices that can be used to assess wildfire hazard (e.g. Keetch and Byram 1968; Van Wagner, 1987; Goodrick 2002).

Most fire indices are empirical models. Therefore, their validity is often limited to the specific type of climate or vegetation where they were developed. It underlines the fact that transferring fire indices from one region to another should only be performed with caution and calls for careful analyses to evaluate the suitability of fire indices when applied in specific regions. It is recommended that the end-users should select the most feasible index according to their experience or following the options from experts. It is not necessary to apply all indices in a same fire risk assessment.

In Climate Insights, several fire danger indices are provided not only because there are clear thresholds for their classification, but also in order to show our capacity of calculating them on smaller scales, even a single time series at a specific station. It is worth noting that these indices are calculated from daily global reanalysis data. In many cases, such kind of data is hard to accurately describe fire danger at local-regional scales or highly temporal scales. It is always a good option to develop fire danger rating systems based on local-regional datasets.

The following indices could be provided as time series or transformed into categories with the thresholds by end-users as an offline service:

• Baumgartner Index

The Baumgartner index is a fire danger index developed by Baumgartner et al. (1967) in Bavaria (Germany), based on the concept that fire danger is mainly conditioned by fuel dryness which, in turn, depends on evapotranspiration. Baumgartner et al. (1967) thus designed an index consisting of the difference between potential evapotranspiration - after the Penman (1948) formulation - and precipitation.

• Canadian forest fire weather index system

The Canadian forest fire weather index (FWI) system was developed in Canada in the 1970s based on several decades of forest fire research. It was modified or improved several times since then

A Little Bit More About Fire Danger Indices

(Van Wagner 1987). The FWI system is based on weather data only. The different sub-indices require noon temperature, precipitation, relative humidity, and/or wind speed as input data. Although the weather variables have to be measured at noon, the indices represent fire danger at mid-afternoon (around 16:00).

• Fosberg Fire Weather Index

The Fosberg Fire Weather Index (FFWI) is a fire danger index developed by Fosberg (1978). It is based upon equilibrium moisture content and wind speed, and requires hourly observations of temperature, relative air humidity and wind speed as input data (Fosberg, 1978; Goodrick, 2002; Sharples, 2009a).

The fact that the FFWI does not take rainfall into account was considered as problematic, in particular for capturing spatial variations in fire potential in regions where spatial variability of rainfall is important (Goodrick 2002). Therefore, a rainfall component, in the form of a "fuel availability" factor (FAF) was added by Goodrick (2002) to the FFWI in order to take the impact of drought on fuels into account. The modified FFWI (mFFWI) is then obtained by multiplying the fuel availability factors with the FFWI.

• Sharples fuel moisture and fire danger rating indices

The forest fire danger rating index (F) and fuel moisture index (FMI, a sub-index of F) were developed by Sharples et al. (2009a, 2009b). They require temperature, relative humidity and windspeed (for F) as input variables. The purpose of these indices was to assess moisture content and fire danger in eucalypt forests in southern Australia in a very simple way and as effectively as with more sophisticated models (cf. FFDI and FFWI). The F index is based on the principle that fire danger is determined by the combined influence of wind speed and fuel moisture content. It increases when wind speed increases and decreases when fuel moisture content increases.

In fact, we already implemented the F index and mFFWI in Climate Insights. However, it was found that its performance was not as good as the FFDI. It is recommended using FFDI when all of its inputs are available. Just like the case of heat stress indices, only a single reanalysis data of PGF(v3) is applied at present. However, other reanalysis data, especially hourly data (e.g., ERA5) should be exploited in the future.