

Forecast danger of vegetation fires in the open countryside in the Czech Republic

Martin Možný^{1, 2}, Daniel Bareš¹

1) *Czech Hydrometeorological Institute, Doksany Observatory, 41182
Doksany*

2) *Mendel University in Brno, Zemědělská 1, 61300 Brno*

Abstract

Forecast dangers of vegetation fires are used to assess the potential for fire occurrence in the countryside, fire spread and difficulty of fire suppression. Typically, the fire danger forecast systems combine the meteorological information with estimates of the moisture content to produce a simple fire danger index. The Czech Hydrometeorological Institute generates daily maps of 1 to 6 days projected fire danger level in the Czech Republic using weather forecast data. The simple fire danger index *FD* is used for forecasting purposes. Input data are the air temperatures, wind speeds, air humidity and soil moistures. The system is active from 15th of March to 15th of October. Fire danger is mapped in five classes (very low, low, medium, high and very high).

Key words: Forecast; fire danger; fire weather; biometeorology

Introduction

Chandler et al. (1983) define fire danger as the resultant of some factors that affect the inception, spread and difficulty of control of fires and the damage they cause. These factors include topographic attributes, fuel characteristics and weather variables as well as random factors such as arson. Many of these factors are difficult to quantify numerically.

Simple fire danger indices are used throughout the world. These indices combine information about the current weather and drought. These indices are used, for example, in the United States, Canada and Australia (Cheney and Sullivan, 1997; Gill et al., 1987; Goodrick, 2002; Van Wagner, 1987).

Within the EU has created the European forest fire information system (EFFIS). This system generates the predictive maps for the whole of Europe using meteorological data from French and German meteorological services (Meteo-France and DWD). For modeling, the risk of forest fires is used the Canadian forest fire weather index (FWI).

Warning against extreme weather conditions is available on the website MeteoAlarm (www.meteoalarm.eu). Information's are provided by the individual national meteorological service for their country. The topic of this paper is a description of the fire danger warnings generate by the Czech Hydrometeorological Institute (CHMI) for territory of Czech Republic.

Materials and methods

Since 2006, the fire danger in the open countryside in the Czech Republic is modeled with the fire danger index *FD* (Možný and Bareš, 2013). *FD* incorporated the wind speed, soil moisture, air temperature and humidity. The model used equation:

$$FD = (b_1U - b_2F) / (b_3T - b_4H)$$

where *T* the air temperature in °C, *H* the air humidity in %, *U* the wind speed in m/s, *F* the soil moisture in % of AWC, and *b*₁, *b*₂, *b*₃, *b*₄ are coefficients to be estimated.

Index *FD* was successfully validated with data on the frequency of fires in the Czech Republic and Germany. The following are the *FD* values used as thresholds of the fire danger classes in the Table 1.

Table 1 Fire danger classification thresholds for *FD*

FIRE DANGER CLASSES	FD RANGES (UPPER BOUND EXCLUDED)
Very low	< 0.9
Low	0.9 – 1.7
Moderate	1.7 – 3.0
High	3.0 – 6.0
Very high	≥ 6.0

For analysis were used meteorological data from the database CLIDATA of CHMI and data generated by the system ALADIN. We used in this study the data in the Doksany station (50° 27' 31" N, 14° 10' 14" E, 158 m a.s.l.), in the northwestern Czech Republic. This station represents a warm, dry region; during 1961–1990 its average annual air temperature was 8.5 °C and the average annual total precipitation was 456 mm.

Results and discussion

To obtain information about changes in fire danger, we analyzed the average daily indices *FD* for the period 2000–2013 at Doksany station. The average daily indices *FD* began to gradually increase immediately after the winter (early March), reaching a peak at the late April and June to August. The daily indices *FD* values declined the late August, and in winter the *FD* stabilized (Fig. 1). Very similar annual course in *FD* values we also recorded on other stations of CHMI.

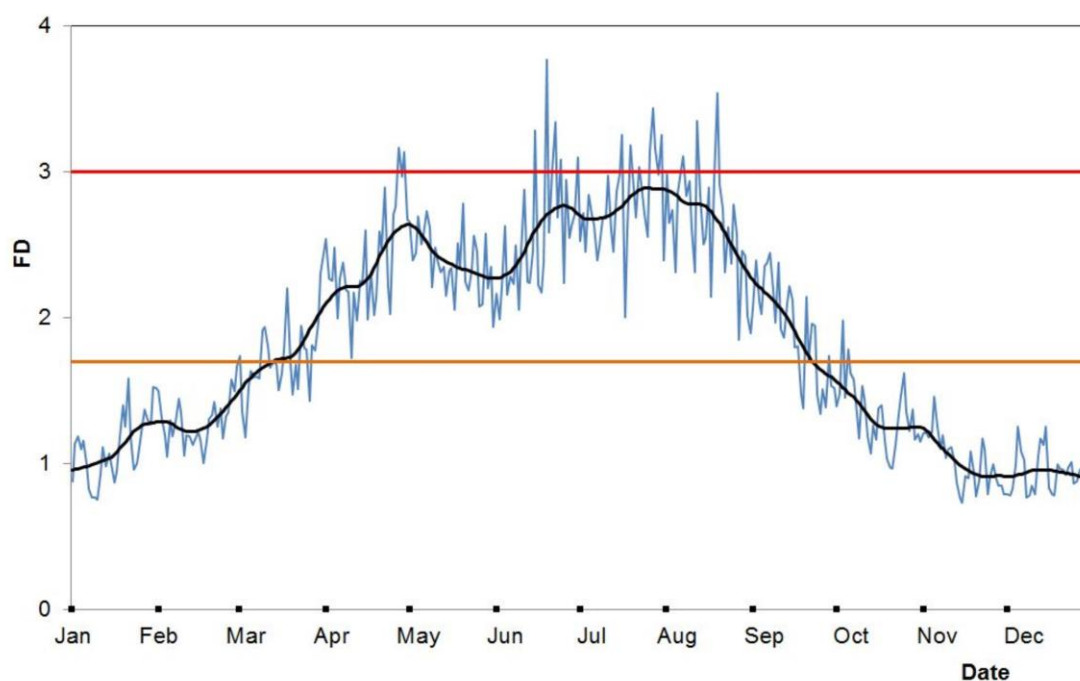


Fig. 1 Average daily indices *FD* for the period 2000–2013 at Doksany station.

Daily indices $FD \geq 3$ and <6 occurred in the period 2000–2013 quite often. The maximum number of days was recorded at lowland stations. At the Doksany station varied this number of days from 18 (2010) to 97 (2012). Daily indices $FD \geq 6$ occurred rarely in the form of individual warm waves of one to several days. At the Doksany station varied this number of days from 0 (2004) to 8 (2012, Fig. 2).

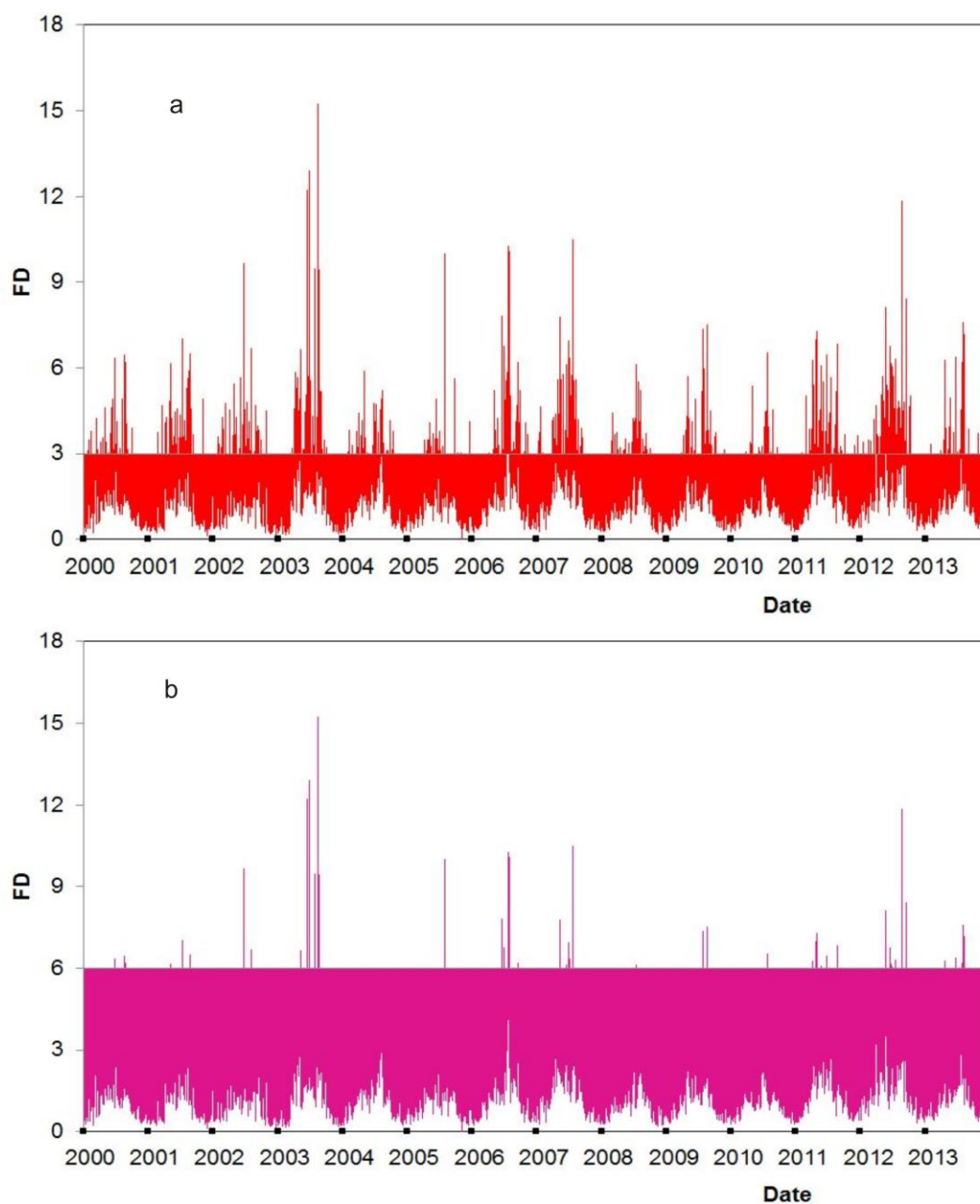


Fig. 2 Variation of daily indices FD for the period 2000–2013 at Doksany station. Bars indicate deviations from the indices $FD \geq 3$ (a) and $FD \geq 6$ (b).

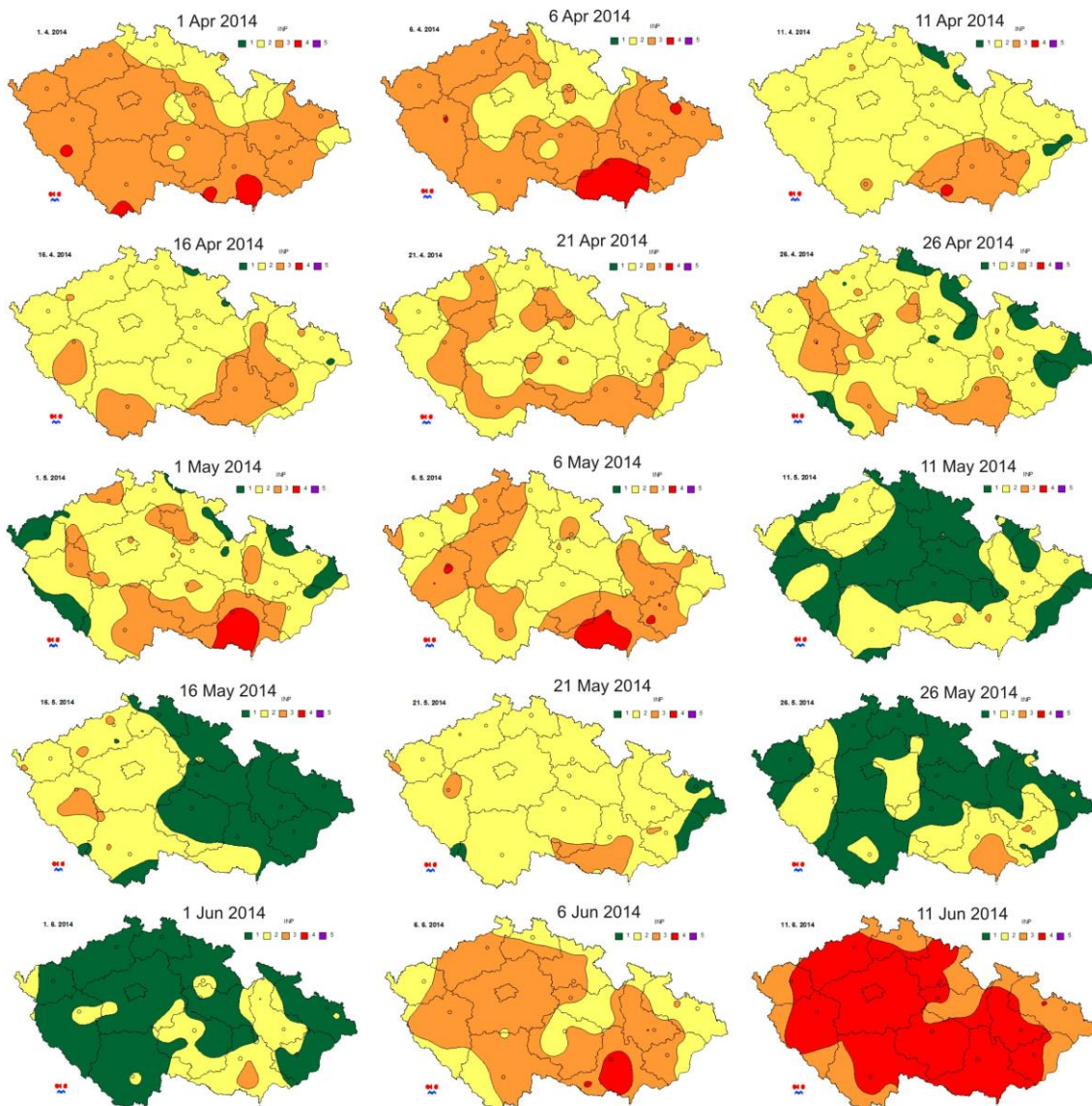


Fig. 3 Examples of daily maps predicted fire danger level in the Czech Republic. Fire danger is mapped in five classes - very low (green), low (yellow), medium (orange), high (red) and very high (purple).

We generate daily maps of 1 to 6 days projected fire danger level in the Czech Republic using daily indices FD . Maps show a harmonized picture of the spatial distribution of fire danger level throughout the Czech Republic. The system is active from 15th of March to 15th of October (<http://www.chmi.cz>). Fire danger is mapped in five classes (very low, low, medium, high and very high) defined in

Table 1. If it is a forecast that the *FD* will be greater than 3 for the next three days at least half of the regions, we will declare warning of fires.

The largest forest fire in the last 15 years in the Czech Republic was recorded in Bzenec. The fire was reported on 24th May 2012, during the fire burned 160 hectare of forest. The fighting took part in nearly 1,500 firefighters. Figure 4 shows the fluctuations of daily indices *FD* in the period from 20th March to 30th June 2012 in Bzenec. The peak of daily indices *FD* was reached on 23rd May ($FD = 8.1$) and 24th May ($FD = 6.9$).

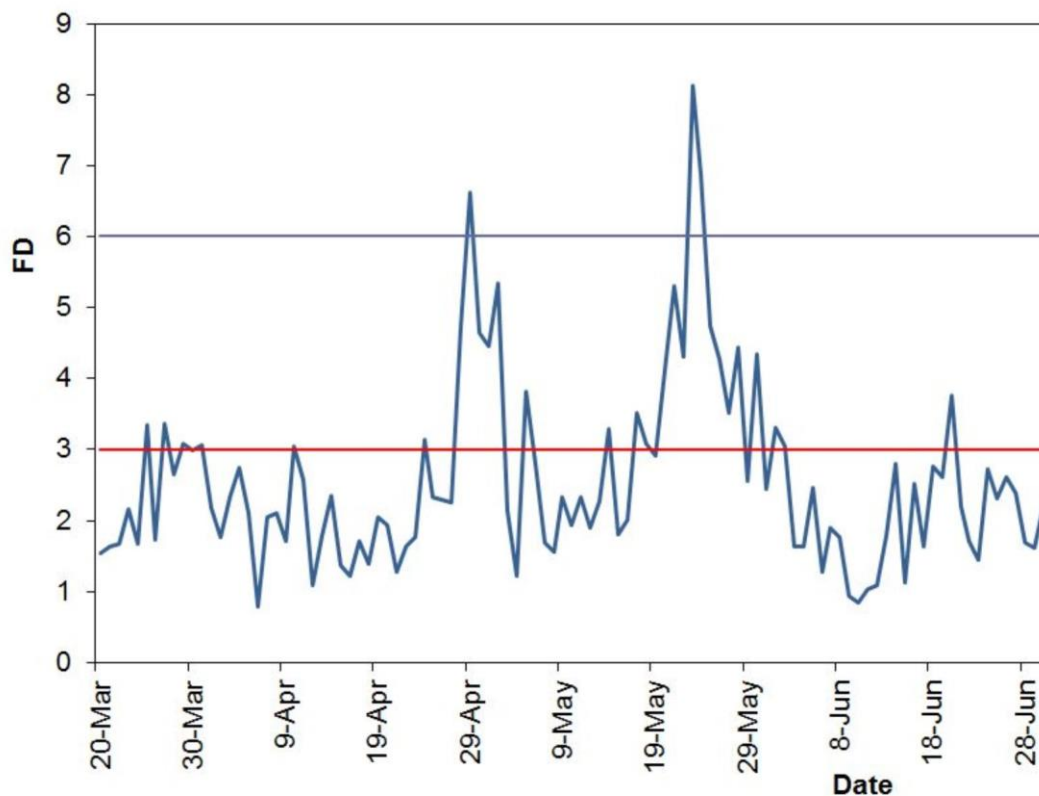


Fig. 4 Variation of daily indices *FD* for the period from 20th March to 30th June 2012 in Bzenec.

In Central Europe the incidence of drought and fire danger as pronounced as in the Mediterranean, but recent studies show the growth rate of these phenomena and that the risk is going to increase dramatically to the future (e.g. Wastl et al., 2012; Venäläinen et al., 2013). Pan-European study (e.g. a project WaterGAP European Commission SEC2007-993) show that Central Europe in

the future climatic conditions will have to contend with the increasing water deficit.

Conclusion

In this study, we describe the system warning for vegetation fires in the open countryside in the Czech Republic using the index *FD*. A benefit of the proposed simple index *FD* is that it is intuitive and easy to calculate. Every day, we generate maps of 1 to 6 days projected fire danger level in the Czech Republic using the index *FD*. The results are used within the Czech integrated warning service system (<http://www.chmi.cz>) and the European warning system for extreme weather (<http://www.meteoalarm.eu>).

References

- Chandler, C., Cheney, P., Thomas, P., Trabaud, L., Williams, D., 1983. Fire in forestry. In: Forest Fire Behaviour and Effects, Vol. I. John Wiley and Sons, New York.
- Cheney, N.P., Sullivan, A., 1997. Grassfires: Fuel, Weather and Fire Behaviour. CSIRO Publishing, Australia.
- Wastl, C., Schunk, C., Leuchner, M., Pezzatti, G.B., Menzel, A., 2012. Recent climate change: Long-term trends in meteorological forest fire danger in the Alps. *Agricultural and Forest Meteorology*, 162–163, 1–13.
- Gill, A.M., Christian, K.R., Moore, P.H.R., Forrester, R.I., 1987. Bushfire incidence, fire hazard and fuel reduction burning. *Australian Journal of Ecology* 12, 299–306.
- Goodrick, S.L., 2002. Modification of the Fosberg fire weather index to include drought. *International Journal of Wildland Fire* 11, 205–211.
- Možný, M., Bareš, D., 2013. Czech Fire-Danger Rating System. The Integrated Warning Service System. Czech Hydrometeorological Institute, Praha.
- Van Wagner, C.E., 1987. Development and structure of the Canadian forest fire weather index system. Canadian Forestry Service 35 Ottawa, Canada.
- Venäläinen, A., Korhonen, N., Koutsias, N., Xystrakis, F., Urbiet, I.R., Moreno, J. M., 2013. Temporal variations and change of forest fire danger in Europe in 1960–2012. *Nat. Hazards Earth Syst. Sci. Discuss.*, 1, 6291–6326.

Acknowledgement

We gratefully acknowledge the support of the Ministry of Education, Youth and Sports project CZ.1.07/2.3.00/20.0248.

Summary

Předpovědi nebezpečí požárů se používají k varováním před výskytem požárů vegetace ve volné krajině, k posouzení podmínek pro šíření požárů a obtížnosti hašení. Nejčastěji předpovědní systémy požárního nebezpečí využívají jednoduchý index nebezpečí požárů, který kombinuje meteorologické podmínky s odhady vlhkosti půdy. Od roku 2006 využívá Český hydrometeorologický ústav (ČHMÚ) v operativním provozu hodnocení požárního nebezpečí podle indexu FD. Index FD byl úspěšně validován na datech o výskytu požárů v České republice a Německu. Od 15. března do 15. října jsou generovány mapy požárního nebezpečí na 1 až 6 dnů dopředu. Požární nebezpečí je rozděleno do pěti tříd podle velikosti indexu FD. Mapy jsou dostupné na webových stránkách ČHMÚ. Výsledky jsou využívány v rámci Systému integrované výstražné služby ČR a Evropského systému varování před extrémním počasím.

Contact:

Ing. Martin Možný, Dr.

Czech Hydrometeorological Institute

Doksany Observatory, 41182 Doksany

Phone: 420416861112, e-mail: m.mozny@seznam.cz