

WILDFIRE RISK IN CROATIA USING THE CANADIAN FOREST FIRE WEATHER INDEX SYSTEM

Marko Vučetić*

Croatian Meteorological and Hydrological Service, Zagreb, HR, mvucetic@cirus.dhz.hr

Višnja Vučetić

Croatian Meteorological and Hydrological Service, Zagreb, HR, vucetic@cirus.dhz.hr

Introduction

Weather conditions such as long-lasting dry spells and insolation duration, high values of air temperature and strong wind essentially increase the potential risk of forest fire starting and spreading. All these hazardous factors have been observed on the Croatian Adriatic coast and islands. Therefore, the Adriatic area is the most vulnerable region to wildfires in Croatia. The reasons are the joint effects of weather conditions, easily flammable Mediterranean vegetation (pine forests and Mediterranean shrubs), very steep and inaccessible terrain along the Adriatic coast, which complicates extinguishing the fires (e.g. Omazić and Vučetić, 2017) and increasing population during the tourist season in summer. Wildfires inflict serious damage to agricultural sites and forests and, in the warm season, often endanger settlements and human lives. Therefore, since 1982 the forest fire protection programme using the Canadian Forest Fire Weather Index System (CFFWIS, Van Wagner and Pickett, 1985) has been running along the Croatian coastal region by the Croatian Meteorological and Hydrological Service (DHMZ) as part of the Government Programme of Open-Air Fire Prevention (Bertović et al., 1987). The Canadian model is applied to the fire weather indices (FWI) once a day, from April to October, based on real-time meteorological data from 40 synoptic stations using the SYNOP report and predicted for the following day using the products of the ALADIN/HR limited area numerical weather prediction model. Both actual and predicted fire weather indices are sent automatically to the Fire Department each day during the fire season. The actual fire weather indices are also publicly available on the DHMZ website (<http://www.meteo.hr>).

Material and method

One of the Canadian model products is mean seasonal severity rating (SSR), which represents the potential risk of forest fire from June to September (Vučetić, 2001, 2002). The burned area has doubled in the Adriatic, and the number of fires has increased almost six times over the last decade compared to the period 1997–2006 (Tab. 1). Therefore, the main goal in this study is to determine the wildfire risk changes in Croatia in the period 1960–2018 because of increasingly frequent extreme dry and warm weather events (Meehl and Tebaldi, 2004). For the 82 climatological stations, the meteorological data: air temperature, relative humidity and wind speed at 13 UTC and 24-hour precipitation amount at 6 UTC were used for the SSR spatial distribution. The secular SSR changes have been analysed for the Hvar station in the mid-Adriatic in the period 1867–2018.

* Grič 3, HR-10000 Zagreb, mvucetic@cirus.dhz.hr, <http://www.meteo.hr>

Table 1: Number of wildfires with total burned area $\geq 20,000$ ha on the Adriatic coast and islands in the period 2001–2018

Extreme warm years	Burned area (ha)	Number of wildfires
2017	86.558	4.154
2015	23.927	3.378
2012	41.305	3.690
2011	37.491	3.757
2007	33.990	2.662
MEAN 2006–2016	18.383	2.509
MEAN 1997–2006	7975	439

Results and discussion

The long-time series of SSR in Hvar has shown increase in potential wildfire risk by 2.4 in the period 1981–2010 in regards to the period 1891–1917 (Fig. 1). The spatial distribution of SSR in Croatia from July to September in the period 1960–2018 indicates that the absolute maximal value of SSR (28.5) was recorded in the mid-Adriatic in 2017 (Fig. 2). When SSR is greater than 7, the weather conditions are favourable for the occurrence of large wildfires. The absolute maximum SSR shows how extreme weather, dry and warm conditions, prevailed in the Adriatic area in 2017. The above average warm spring and summer of 2017 and lack of precipitation in the winter, spring and summer periods, the longest and most pronounced warm periods (daily maximum temperature $\geq 30^{\circ}\text{C}$) occurred in the mid-Adriatic from the end of June to the first half of July and from the end of July to the first half of August 2017. Such extreme weather condition caused about 4,000 wildfires with the largest burned area of about 90,000 ha. SSR greater than 12 appeared in as much as 15 fire seasons in the 21st century and only five times in the period 1960–2000.

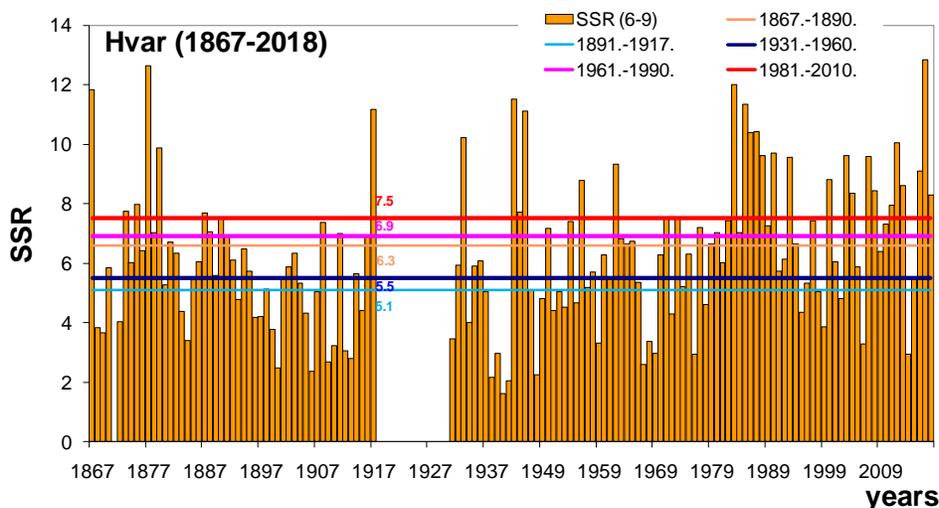


Figure 1: Seasonal severity rating (SSR) for the Hvar station in the mid-Adriatic in the period 1867–2018

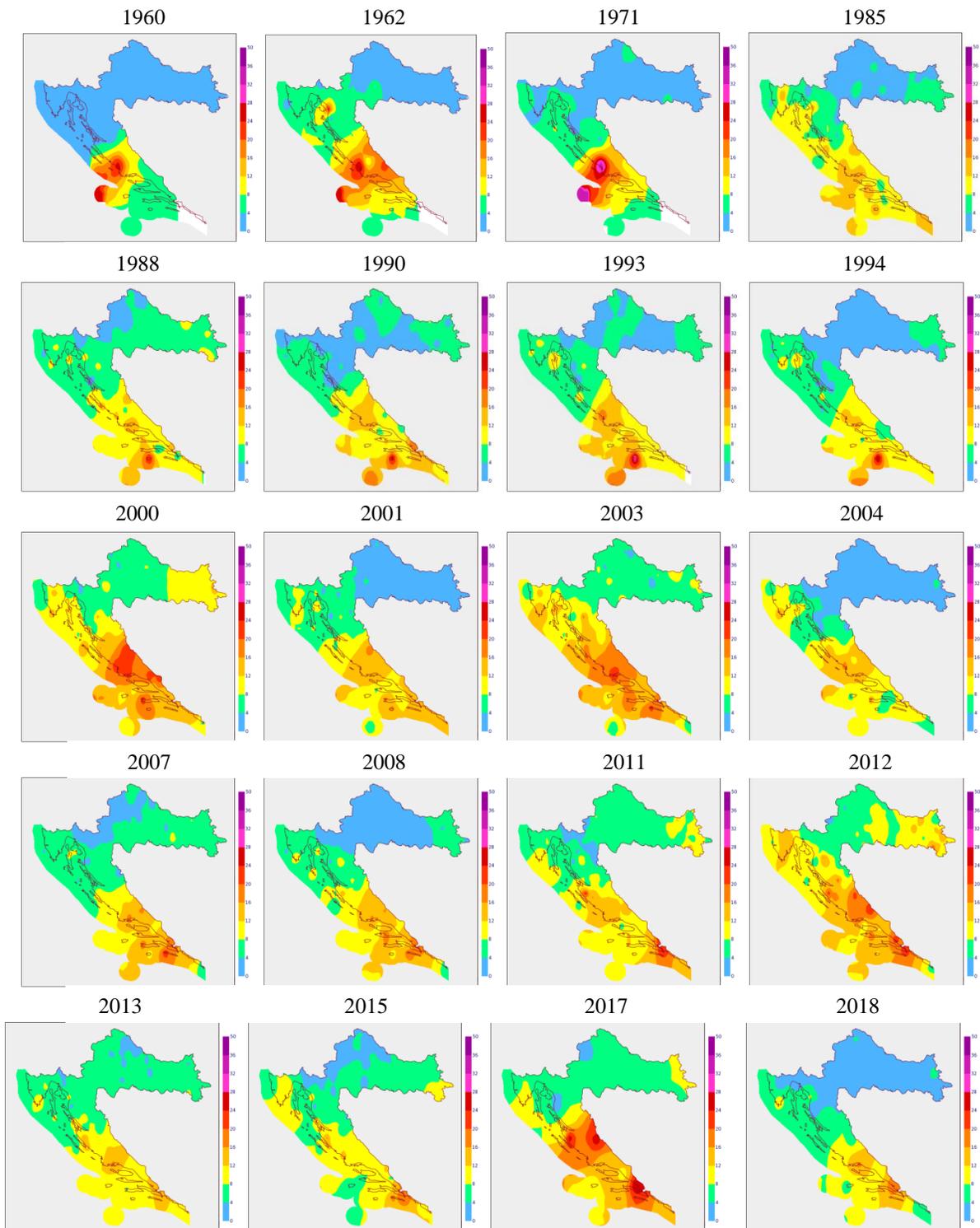


Figure 2: Spatial distributions of seasonal severity rating (SSR) using the Canadian model in Croatia in extreme weather conditions in the period 1960–2018. Source: Croatian Meteorological and Hydrological Service (DHMZ)

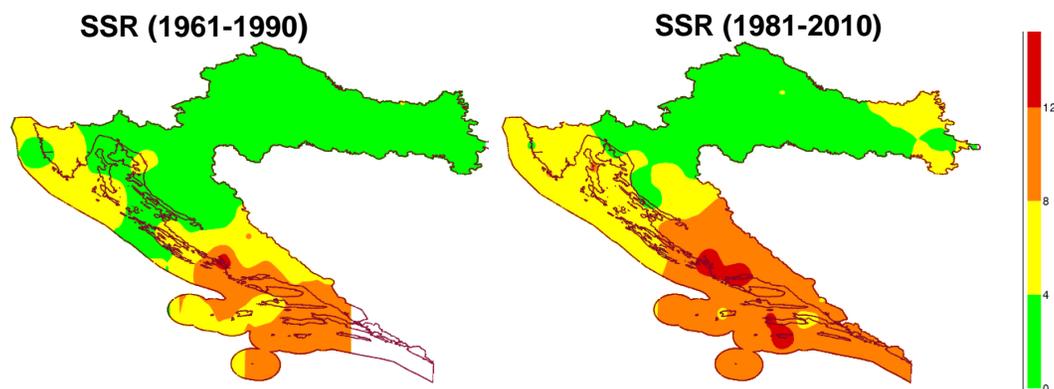


Figure 3: Mean seasonal severity rating (SSR) in Croatia in the periods 1961–1990 (left, white area – there are not the meteorological data in digital format in that period) and in the period 1981-2010 (right)

The comparison of SSR maps between the two periods 1981–2010 and 1961–1990 (Fig. 3) also point out the spreading of high fire risk from the mid-Adriatic to the northern Adriatic, and to the inland of Croatia in the last decades (Kuraži and Vučetić, 2015). The reason for higher risk is a significant increase in the mean monthly air temperature and a decrease in the monthly precipitation amount in summer months due to the climate change. A specific problem following forest fires in the Adriatic area is also the biological recovery of large burnt areas on karstic terrain, where forests and shrubs have a very important ecological role in retaining the soil. Burnt soil is exposed to faster wind erosion and stronger water erosion during heavy rains. Because of such adverse conditions along the Adriatic coast and the islands, forest-fire prevention and fire fighting have been practised in the area for over a hundred years by volunteer and professional fire brigades.

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