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Trends and changes of fire danger in Italy and its relationships with fire activity (1985-2008)

Valentina Bacciu\textsuperscript{a,b}, Francesco Masala\textsuperscript{b}, Donatella Spano\textsuperscript{b,a}, Costantino Sirca\textsuperscript{b,a}

\textsuperscript{a} CMCC, Euro-Mediterranean Center on Climate Change, IAFENT Division, via E. de Nicola 9 (Sassari), valentina.bacciu@cmcc.it
\textsuperscript{b} DipNeT, Dipartimento di Scienze della Natura e del Territorio, University of Sassari, via E. de Nicola 9 (Sassari), cosirca@uniss.it

Abstract
The comprehensive understanding of trends in fire activity and associated drivers is crucial to anticipate future trends and regulate fire potential impacts, by means of efficient fire and fuel management strategies. A valuable tool to examine past changes on fire potential and danger across fire regions is represented by fire weather indexes. In this study, spanning from 1985 to 2008, recent trends and patterns of fire danger and the relationships between the Canadian Fire Weather Index (FWI) System components and fire activity were investigated across Italy. Although time series trend analysis revealed a statistically significant increase in temperature, no clear pattern of fire danger increase was unveiled, while the number of days with high fire danger level increased significantly, especially in central and southern Italy. Monthly fire activity was modeled using as explanatory variables FWI components and significant coefficient of determination were obtained. The applied statistical approach (multiple linear regression) explained a consistent part of the fire occurrence variance all year long (p<0.001), although relevant differences across Italy were found.

Keywords: fire danger indexes, percentile analysis, trend analysis

1. Introduction

According to the last Intergovernmental Panel on Climate Change (IPCC, 2014), observed climate trends showed a variation in temperature and rainfall over Europe. There are different degrees of confidence that future climate will show an increase in high temperature extremes (high confidence) and meteorological drought (medium confidence), but small or no changes in wind speed extremes (low confidence), with diverse patterns varying considerably within and between regions.

It is well known that extreme weather events, such as extended drought and heat waves, facilitate and promote forest fire activity in Southern Europe. For example, during the dry spells in 2005, 2007 and 2009 a high number of large wildfires were recorded in South European countries (Pereira et al., 2005; EEA, 2010c; Koutsias et al., 2013; Salis et al., 2013). Future fire risk is projected to increase in Southern Europe (Carvalho et al., 2011; Dury et al., 2011; Vilén and Fernandes, 2011; Lung et al., 2013), along with the occurrence of high fire danger days (Arca et al., 2012) and fire season length (Pellizzaro et al., 2010). In this framework, the analysis of past conditions and the factors that shaped fire pattern plays a crucial role for the comprehensive understanding of trends in fire activity, so as to anticipate future fire potential and changes (e.g., Carvalho et al., 2010; Zumbrunnen et al., 2011; Amatulli et al., 2013), and to assess the ecological effects of forest fires, thus reaping the benefits (Moreno and Chuvieco, 2012).

During the last decades, fire weather indexes were often used to examine past changes on fire potential and danger across fire regions (e.g. Camia et al., 2008; Carvalho et al., 2008; Mäkelä et al., 2012; Wastl et al., 2012). These systems, combining relevant weather variables into suitable indexes, are usually valuable tools to estimate potentially dangerous conditions, as fire intensity or large size fires, and to help forest fires services in effective prevention and response to forecasted danger. A clear comprehension of the relationships between these indexes and fire occurrence features, as well as their