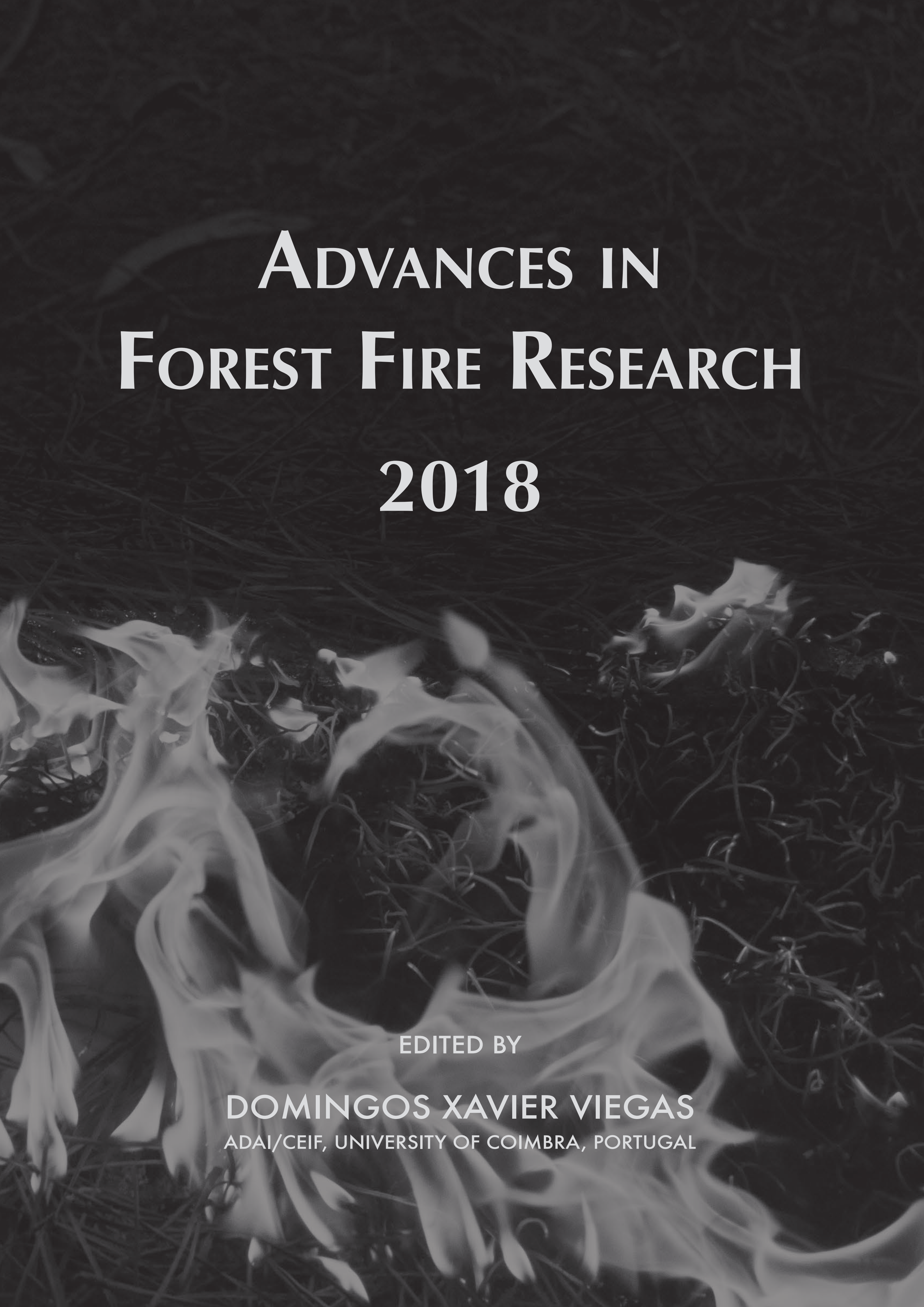

Advances in Forest Fire Research 2018

Edited by

Domingos Xavier Viegas
ADAI/CEIF, University of Coimbra, Portugal

https://doi.org/10.14195/978-989-26-16-506_138

Short contribution – Fire Risk Management

High Resolution Seasonal Forest Fire Danger mapping using WRF forecasts for Greece: A tool for forest fires prevention planning and fire risk management support

Vassiliki Varela *[1]; Diamando Vlachogiannis [1]; Athanasios Sfetsos [1]; Stelios Karozis [1]; Nikolaos Gounaris [1]; Angelos Sphyris [2]

[1]Environmental Research Laboratory, National Center for Scientific Research "DEMOKRITOS", Address: Patr. Gregoriou E & 27 Neapoleos Str, 15341 Agia Paraskevi, GREECE, {vvarela@ipta.demokritos.gr}*

[2] Independent Research, Athens, Greece

Abstract

The Fire Weather Index, FWI, which is part of the Canadian Forest Fire Danger Rating System(CFFDRS), has been validated and recognized worldwide as one of the most trusted and important indicators for fire danger mapping. The classic use of the FWI is associated with the daily fire danger mapping, based on meteorological measurements, while in recent research papers this indicator has been used with forecasted climatic data for studying the changes in the occurrence and intensity of natural disasters. (Climate change Impacts Study Committee, 2011. The purpose of this work is the calculation of the Canadian FWI system indices combined with a state-of-the-art seasonal meteorological forecasting model, for predictive high resolution fire danger mapping, as a tool to design medium-term prevention planning. More specifically, the current paper presents a methodology for the calculation of a series of seasonal forecasted maps of meteorological fire danger, for the fire season (May-October) 2018, for Greece, using the Fire Weather Index (FWI) of the Canadian System CFFDRS. To this end, five components that account for the effects of fuel moisture and wind on fire behaviour have been calculated and investigated, namely, the Drought Code (DC), the Fine Fuel Moisture Code (FFMC), the Built Up Index (BUI), the Initial Spread Index (ISI) and FWI for the referenced period. The meteorological data needed for the calculation of FWI are produced from high resolution simulations with the WRF model (v3.5.1), for a period of six (6) months, using a grid spacing of 5x5 km covering the whole country. The above referenced indices are calculated for every day of the fire season. Subsequently, from the mean value of the maps of seven (7) days, a weekly map is calculated, which constitutes the representative, final map for each index. The maps can be calculated at the beginning of the fire season and for its entirety. Hence, the FWI system values can be provided at three time levels as weekly, monthly and seasonal forecasts. Appropriate classification of FWI values yields estimation of the Forest Fire Danger. The calculated FWI system components and Forest Fire Danger are important to support decisions, about the prevention and management of forest fires, made by the local and central authorities of the country.
Acknowledgment: The current work is carried out in the framework of project SERV_FORFIRE funded through H2020 ERA4CS ERA-NET and the European Commission (Grant Agreement 690462).

Keywords: Seasonal meteorological forecast, FWI, fire danger mapping, fire prevention

1. Introduction

The digital mapping of Forest Fire Danger is important to support decisions about the prevention and management of forest fires. The dynamic danger mapping at the national, regional and local level, taking into account the meteorological conditions represents a valuable tool for more effective daily effective design by the local and central authorities. The Fire Weather Index FWI, which is part of the Canadian Forest Fire Danger Rating System (CFFDRS), has been validated and recognized worldwide as one of the most trusted and important indicators for meteorological fire danger mapping. The classic use of the FWI is associated with the daily fire danger mapping, based on meteorological measurements, while in a recent research paper by the Bank of Greece, this indicator has been used with forecasted climatic data for studying the changes in the occurrence and intensity of natural disasters. (Climate change Impacts Study Committee, 2011). The purpose of this work is the calculation of FWI system components, combined with a state-of-the-art seasonal meteorological forecasting model, for predictive fire danger mapping, as a tool to design medium-term planning, at the beginning of the fire period.

2. Calculation and Classification of FWI

FWI system is comprised of six components: three fuel moisture codes and three fire behaviour indices. Calculation of the components is based on daily observations made at noon of air temperature, relative humidity, 10-m open wind speed and 24-hour cumulative precipitation. The calculation algorithm of FWI is quite complex. (C.E. Van Wagner & T.L. Picket, 1985). According to the literature, FWI values range from 0 to above 100 and are categorized, for operational purposes, in four (4) to six (6) classes, depending on the application area, corresponding to different meteorological fire danger levels, (JRC-EFFIS system, Dimitrakopoulos et al., 2011). In the present study, a five (5) classes categorization of FWI values, developed by NCSRD researchers, has been adopted as more effective for operational purposes for Greece. The classification approach which is based on Percentile Indices provides suitably varying FWI boundaries of classes taking into account the specific physical characteristics of the country.

3. Methodology

3.1. Calculation and mapping of FWI system components

The FWI and the Daily Severity Rating (DSR) maps have been calculated at the beginning of the fire season 2018, based on the meteorological forecast for each day of the fire season. DSR maps were grouped into the final weekly, monthly and seasonal maps, based on the respective average value of the Indices. In addition, monthly and seasonal maps were calculated for Fine Fuel Moisture Code and Drought Code components. Below, a flowchart is presented, describing the processing of forecast fire danger mapping which is proposed in this paper (Figure 1).

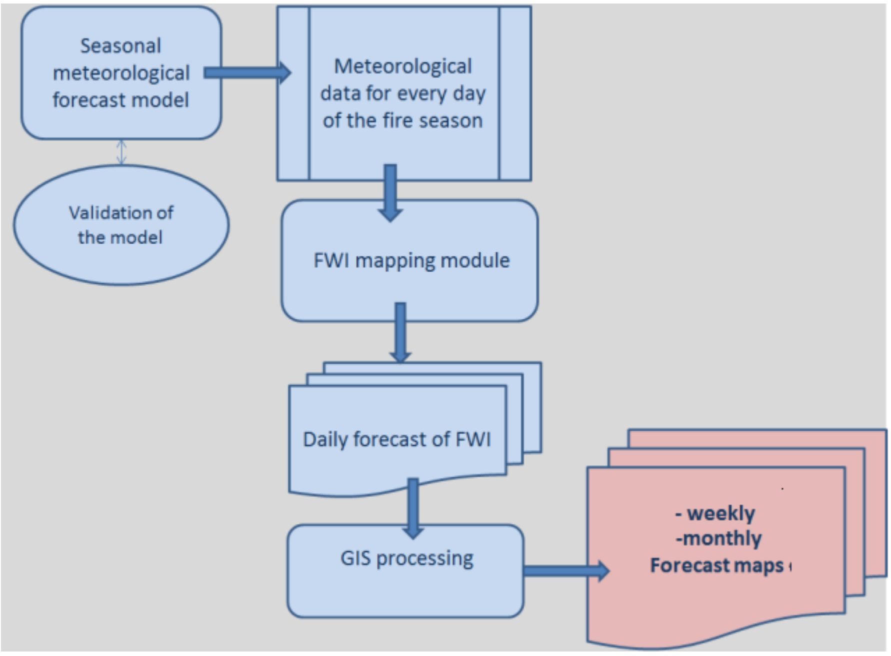

Figure 1 - Flowchart of seasonal forecast mapping of FWI system components

3.2. Seasonal forecast of meteorological parameters

WRF-ARW model (version 3.5.1) has been suitably parameterized for high resolution production medium-term (seasonal) forecasts for Greece. The creation of higher resolution data was established with a one-way nesting procedure. The horizontal resolution of the spatial domain of Greece is 5 x 5 km2.

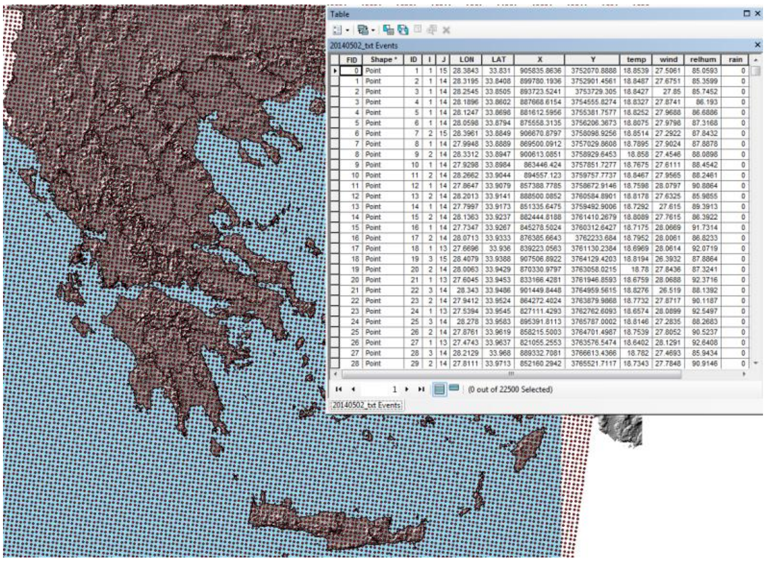

Figure 2 - High resolution grid of the Greek domain

Initial boundary conditions for the WRF model simulations, were determined by twelve-hour analyses provided by the Climate Forecast System of Environmental Prevention (National Center for CFSv2, Saha et al., 2010, 2013) at 00 and 12 UTC for the time period of interest. The ARW-WRF model was validated extensively by using data of temperature, wind and precipitation from meteorological stations all over Greece, for which data is available on the Internet (more than 100 meteo-stations http://www.metar.gr-http://weather.noaa.gov/pub/data/observations/metar/stations/).

4. Results-Conclusions

A series of seasonal forecasted maps of meteorological fire danger, for the fire season (May-October) 2018, for Greece, using the Fire Weather Index System of the Canadian System CFFDRS have been calculated and investigated. A sample of a set of weekly Severity Rating maps is presented in Figure 3.

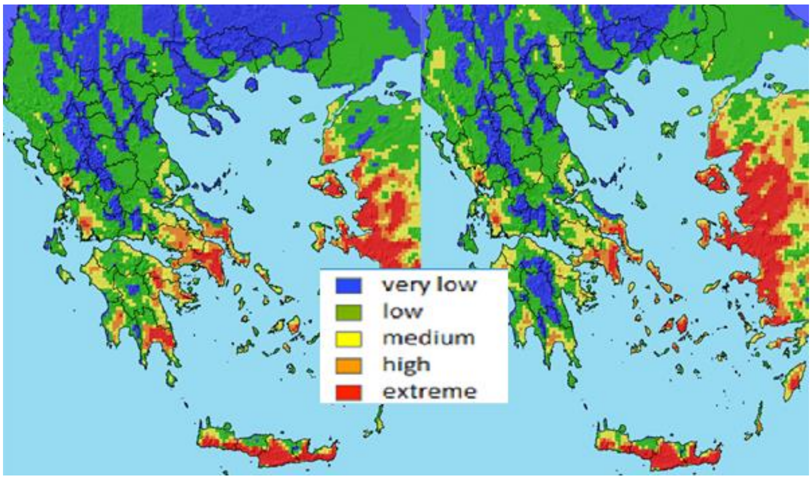

Figure 3 - Sample of a set of weekly Severity Rating maps

Five components of FWI system that account for the effects of fuel moisture and wind on fire behaviour have been calculated, namely, the Drought Code (DC), the Fine Fuel Moisture Code (FFMC), the Built Up Index (BUI), the Initial Spread Index (ISI) and FWI. Daily Severity Rating maps were also calculated from the respective FWI maps. The weekly, monthly and fire-season maps have been estimated and investigated for the Severity Rating, FFMC and DC indices of FWI system. Appropriate classification of the value maps yield a set of forecast maps for the evaluation of Meteorological Forest Fire Danger level for the respective time level.

The features provided by the modern seasonal model ARF-WRF and the capability of the forecast mapping of meteorological parameters which are related to the forest fire danger, we believe that are important for supporting prevention of forest fires. These forecasts can be used for the seasonal mapping of the Meteorological Fire Danger at the National, regional and local scale. The resulting maps can be proved a very useful tool for the effective exploitation of fire prevention means and personnel.

5. Acknowledgment

The current work is carried out in the framework of project SERV_FORFIRE funded through H2020 ERA4CS ERA-NET and the European Commission (Grant Agreement 690462).

6. References

Dimitrakopoulos, AP, Bemmerzouk, AM, Mitsopoulos ID (2011). Evaluation of the Canadian fire weather index system in an eastern Mediterranean environment. Meteorological Applications. 18, Issue 1, 83–93.

Joint Research Centre, EFFIS, Fire danger forecast, http://forest.jrc.ec.europa.eu/effis/about-effis/technical-background/fire-danger-forecast/

Saha, Suranjana, et al. (2010). The NCEP Climate Forecast System Reanalysis. Bull. Amer. Meteor. Soc., 91, 1015.1057. doi: 10.1175/2010BAMS3001.1

Van Wagner CE, Pickett TL (1985). Equations and FORTRAN program for the Canadian Forest Fire Weather Index. Forestry Technical Report FTR–35, Canadian Forestry Service: Chalk River,Ontario.