environmental sciences proceedings

MDPI

Abstract

Using the Rothermel Package in R to Test Standard and Custom Fuel Models against Global Fire Behavior Data †

Davide Ascoli [1,*], Jose Moris [1], Ângelo Sil [2] and Paulo Fernandes [3]

[1] Department of Agriculture, Forestry and Food Sciences, University of Torino, 10095 Torino, Italy
[2] InBIO/CIBIO—Centro de Investigação em Biodiversidade e Recursos Genéticos, 4485-661 Vairão, Portugal
[3] Centre for the Research and Technology of Agro-environmental and Biological Sciences (CITAB), University of Trás-os-Montes and Alto Douro, 5000-801 Vila Real, Portugal
* Correspondence: d.ascoli@unito.it
† Presented at the Third International Conference on Fire Behavior and Risk, Sardinia, Italy, 3–6 May 2022.

Keywords: Rothermel; fuel model; prediction; R; BONFIRE; global

Rothermel-based decision support systems are widespread for fire behavior prediction and wildfire risk analysis. The majority of these systems simulate the rate of spread (Ros) of a surface fire, and linked models (e.g., MTT), using as the input a set of Standard Fuel Model (SFM) parameters. However, the selection of the best SFM for a given fuel complex is rarely based on the expected fire behavior, but on an expert assessment of the main "fire-carrying fuel type" (GR—grass, GS—grass–shrub, SH—shrub, TU—timber understory, TL—timber litter, and SB—slash). Although individual studies assess the fitness of SFM predictions against the observed Ros, a general validation of SFM is missing. Here, we linked the computational skills of the Rothermel Package in R [1,2] to a unique global fire behavior database developed by the BONFIRE project (including approximately 6000 individual entries extracted from datasets at 600 locations in 33 countries). After removing datasets with less than 10 Ros observations and selecting the highest-quality data (as scored by BONFIRE), we analyzed 123 datasets (mean observations per dataset = 17) distributed among fuel types (21% GR, 9% GS, 20% SH, 20% TU, 20% TL, and 9% SB), as assigned by BONFIRE according to fuel characteristics information. In this study we:

(i) Test if the best SFM (i.e., the lowest root mean square error against observed Ros) for each dataset falls within the same "fuel type" (GR, . . . , SB) assigned by BONFIRE;
(ii) Check if fire behavior datasets sharing the same best SFM are grouped according to meaningful and consistent fuel complex flammability characteristics;
(iii) Test if custom fuel models calibrated with the "gaRoth" function in R improve predictions (i.e., lower RMSE) when compared to the best SFM, and if a new grouping emerges from cluster analysis, which is more meaningful and consistent with fuel complex characteristics.

Author Contributions: Conceptualization, D.A. and P.F.; methodology, D.A., J.M. and P.F.; software, D.A. and J.M.; formal analysis, D.A. and J.M.; resources, P.F. and D.A.; data curation, P.F., Â.S. and D.A.; writing—original draft preparation, D.A. and P.F.; writing—review and editing, D.A., P.F., Â.S. and J.M.; supervision, P.F.; project administration, P.F.; funding acquisition, P.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research received funding from the Portuguese Foundation for Science and Technology (FCT) under Project BONFIRE—gloBal-scale analysis and mOdelliNg of FIRE behaviour potential (PTDC/AAG-MAA/2656/2014). P.F. was also funded by FCT under Project UIDB/04033/2020.

Conflicts of Interest: The authors declare no conflict of interest.

Citation: Ascoli, D.; Moris, J.; Sil, Â.; Fernandes, P. Using the Rothermel Package in R to Test Standard and Custom Fuel Models against Global Fire Behavior Data. *Environ. Sci. Proc.* **2022**, *17*, 86. https://doi.org/10.3390/environsciproc2022017086

Academic Editors: Pierpaolo Duce, Donatella Spano, Michele Salis, Bachisio Arca, Valentina Bacciu, Grazia Pellizzaro and Costantino Sirca

Published: 17 August 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. Ascoli, D.; Vacchiano, G.; Motta, R.; Bovio, G. Building Rothermel fire behaviour fuel models by genetic algorithm optimisation. *Int. J. Wildland Fire* **2015**, *24*, 317–328. [CrossRef]
2. Vacchiano, G.; Ascoli, D. An implementation of the Rothermel fire spread model in the R programming language. *Fire Technol.* **2015**, *51*, 523–535. [CrossRef]