Università degli Studi di Padova | TESAF

Return

Forest fires simulation in the Alpine region. New data and innovative approaches needed

Luca Mauri[1*], Flavio Taccaliti[1], Emanuele Lingua[1]

[1]University of Padova, Dept. of Land, Environment, Agriculture and Forestry, Agripolis, 35020 Legnaro (PD), Italy

*luca.mauri@unipd.it

EGU European Geosciences Union

EGU23-11425

This presentation participates in OSPP — Outstanding Student & PhD candidate Presentation contest

Abstract

Among the predominant natural disturbances affecting Mediterranean regions, nowadays forest fires frequently occur in Central and Northern Europe, potentially leading to several issues in ecological, geomorphological, economic and social terms. In this regard, local authorities are becoming gradually confident with their management even where forest fires were historically scarce. In this context, semi-empirical models are particularly useful in estimating fire behaviour, in order to predict key factors related with wildfires risk (e.g., flames length, fire type, rate of spread). At the same time, accurate estimation of models inputs actually represents the principal limitation to outputs reliability, mainly due to the difficulty in retrieving specific data like canopy fuel characteristics or fire behaviour fuel models. In light with the above, there is a growing need to find new methods able to infer such simulation variables, for example starting from remote sensing data acquisition and elaboration, as well as by adapting already existing equations and workflows to European specific contexts. The project RETURN aims therefore to enhance the spatial mapping of fire simulators inputs layers within the Alpine region by coupling an extensive field data collection with high-resolution Light Detection and Ranging (LiDAR) and Unmanned Aerial Vehicle (UAV)-based data collection. The results of the Project could be useful in increasing the amount of information available for local administrations of the Alpine region, aiming to ease the application of fire behavior simulators to manage such a natural disturbance increasingly frequent in this mountain area.

Introduction

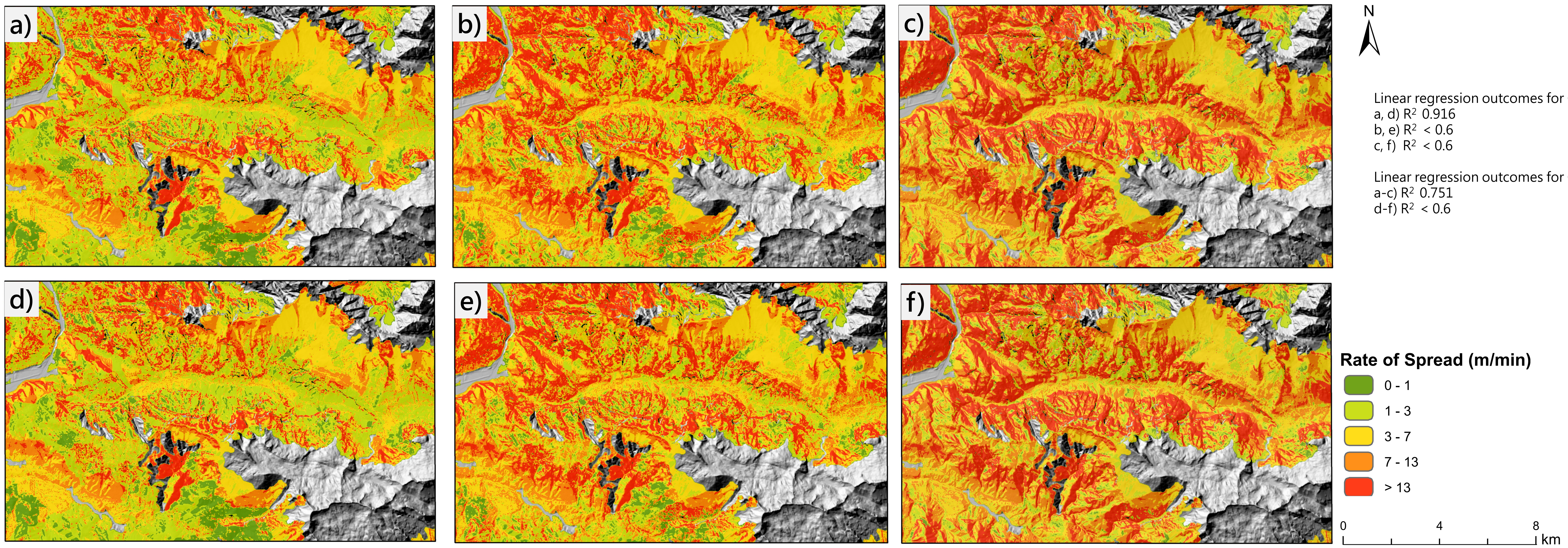
Fire behavior modeling strictly refers to several inputs, concerning forest characteristics and fuel model properties. Nowadays, remote sensing techniques, such as LiDAR, allow for deriving high-resolution forest input parameters needed for wildland fire modeling at the landscape scale over time. Moreover, machine learning and algorithms implementation can improve outcomes obtained from such a modeling procedure, to map and predict key factors related to wildland fire risk (such as flame length, fire type and rate of spread).

Research Objectives

The aim of this research is to improve the implementation of inputs data for wildfire modeling over a forested landscape, starting from LiDAR-derived forest metrics computation at the landscape scale.

Results

FlamMap-derived *Rate of Spread* comparison from LiDAR-derived metrics and R-based linear regression models



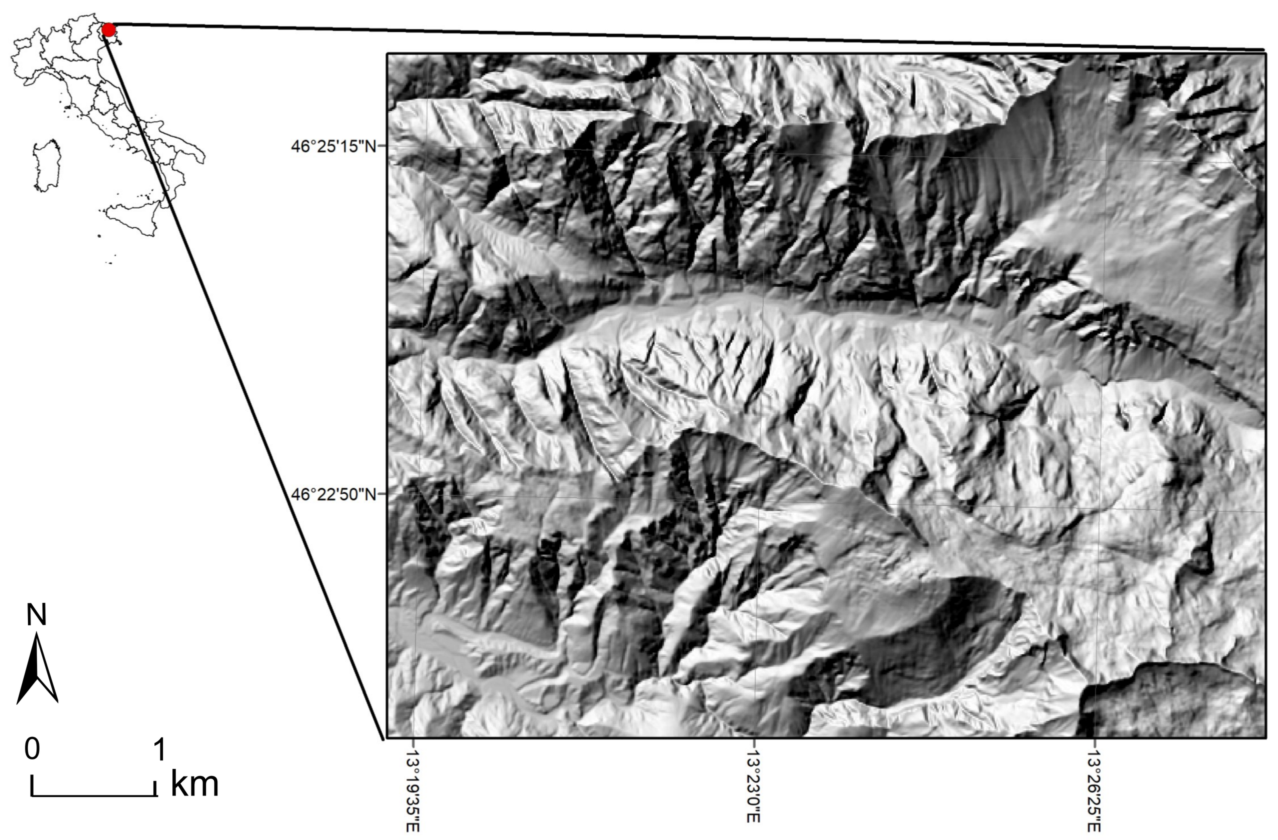
Linear regression outcomes for CH elaboration:
a, d) R^2 0.916
b, e) $R^2 < 0.6$
c, f) $R^2 < 0.6$

Linear regression outcomes for CBH elaboration:
a-c) R^2 0.751
d-f) $R^2 < 0.6$

LiDAR metrics used for CH computation: D, h_{max}, q25, q50, q75 (a, d); h_{max}, q90, D (b, e); h_{max}, q25, q90, D (c, f). LiDAR metrics used for CBH computation: cv, q25, q50, q75, D (a-c); q25, D (d-f)

** Zones with slope > 65 degrees were masked in RoS computation, in order to exclude bias and inaccuracies resulting from model outcomes at steep slopes rocky areas*

Study area



The study area is a forested zone located in the Raccolana valley (Friuli Venezia Giulia, northern Italy). It has an extension equal to 15094 ha, average slope equal to 35.90 degrees (ranging from a minimum of 0.1 and a maximum of 89.4 degrees). It is mainly composed by Norway spuce (*Picea abies* (L..) H. Karst) and secondary by European larch (*Larix decidua* Mill.).
Urban surfaces are located at the bottom of the study area, as well as widespread rocky areas.

Methods

Starting from field observations, LiDAR-derived metrics were computed to estimate regression coefficients through R-based linear model implementation. Different regression equations acquired from available literature were applied to calculate specific spatial inputs data (i.e., *Canopy Height* -CH- and *Canopy Base Height* –CBH-) for the entire study area. FlamMap model was applied at the landscape scale, focusing on *Rate of Spread* (RoS) spatial mapping looking at CHs and CBHs input data previously calculated. A comparison of RoS mapping was therefore proposed, depending on LiDAR-derived metrics and linear regression outcomes (see figure caption)

Final Remarks

- Usefulness of LiDAR-derived metrics to obtain spatial distributed input data for wildfire modeling at the landscape scale
- Relevance of intensive field data collection to obtain accurate regression equations and coefficients for accurate wildfire models 'input data implementation
- Low accuracy of regression models outcomes ($R^2 < 0.6$) for inputs acquisition involve a possible overestimation of Rate of Spread spatial mapping
- Possible integration of UAV-based data collection to increase accuracy of inputs implementation for wildfire modeling at both landscape and hillslope scale over time

References

- Andersen et al., 2004. *Estimating Forest Crown Fuel Variables Using Lidar Data.* ASPRS Annual Conference Proceedings (Denver, Colorado)
- Andersen et al., 2005. *Estimating forest canopy fuel parameters using LIDAR data.* Remote Sensing of Environment 94, 441-449. doi:10.1016/j.rse.2004.10.013
- Erdody and Moskal, 2010. *Fusion of LiDAR and imagery for estimating forest canopy fuels.* Remote Sensing of Environment 114, 725-737. doi:10.1016/j.rse.2009.11.002
- Wu et al., 2019. *Assessment of Individual Tree Detection and Canopy Cover Estimation using Unmanned Aerial Vehicle based Light Detection and Ranging (UAV-LiDAR) data in Planted Forests.* Remote Sensing 11, 1-21. doi:10.3390/rs11080908