UNIL | Université de Lausanne
Faculté des géosciences
et de l'environnement

CIMA RESEARCH FOUNDATION

Wildfire susceptibility mapping via machine learning: the case study of Liguria Region, Italy

PAOLO FIORUCCI[1], MIRKO D'ANDREA[1], ANDREA TRUCCHIAI[1], MARJ TONINI[2]

(1)CIMA RESEARCH FOUNDATION, ITALY
(2)INSTITUTE OF EARTH SURFACE DYNAMICS, FACULTY OF GEOSCIENCES AND ENVIRONMENT, UNIVERSITY OF LAUSANNE, SWITZERLAND

EGU European Geosciences Union

Motivation & Objectives

The identification of areas most vulnerable to fire risk is a key tool in wildfire management, particularly in view of the limited availability of fire risk management resources.

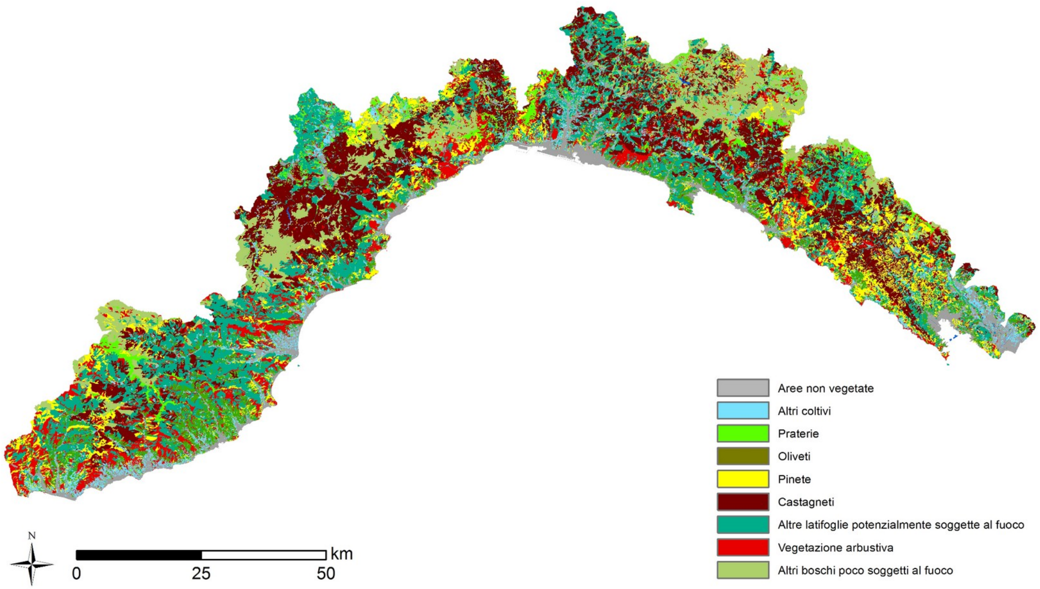
Wildfire susceptibility mapping allows to identify these areas, assessed defining a rank from low to high. These are elaborated taking into account two aspects: where the wildfires occur and which are the predisposing factors.

Objectives:

- Elaborate wildfire susceptibility mapping for Liguria region (Italy) with a Machine Learning approach (Random Forest)
- Identify the most influential factors in determining high susceptibility areas

Input Data

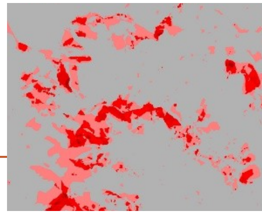
- DEM (digital elevation model) and derivatives (slope, northness,
- and eastness);
- Distance from anthropogenic features (urban areas, roads, pathways, crops);
- Vegetation type (categorical variable with 37 classes)
- % of neighboring vegetation type surrounding each pixel;
- Protected areas.



Ligurian Land Cover

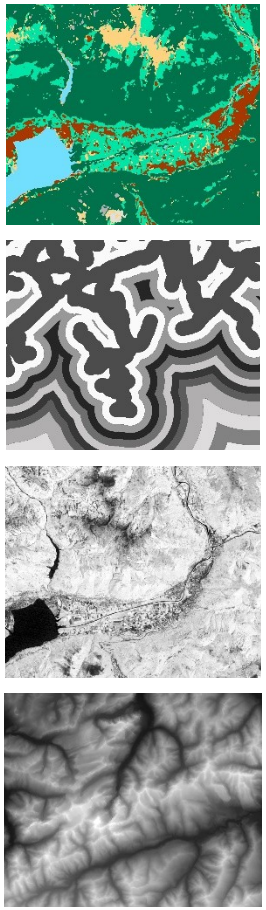
Machine Learning approach:Random Forest

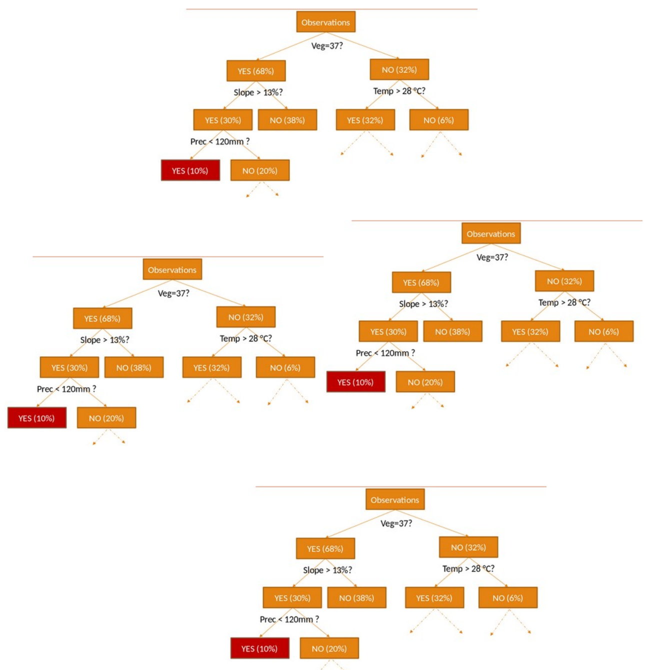
Observations



+

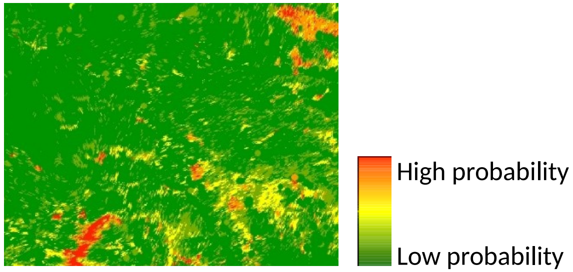
Input variables





Ensemble of decision trees

Output (susceptibility map)



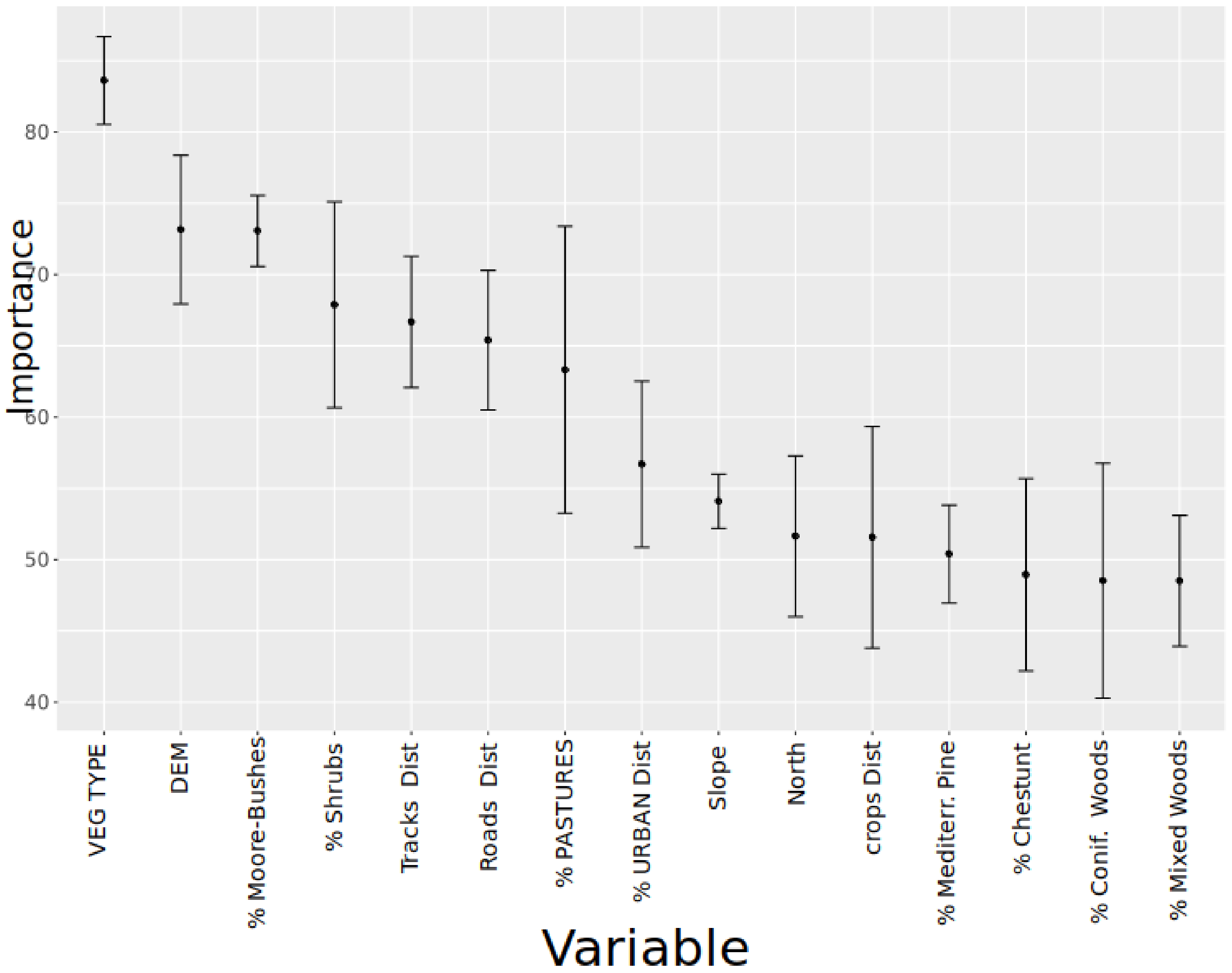
Variable - class importance

RF allows to measure the **relative importance of each variable** on the prediction.

This is obtained by looking at how much the tree nodes, which use that variable, reduce the mean square errors across all the trees in the forest.

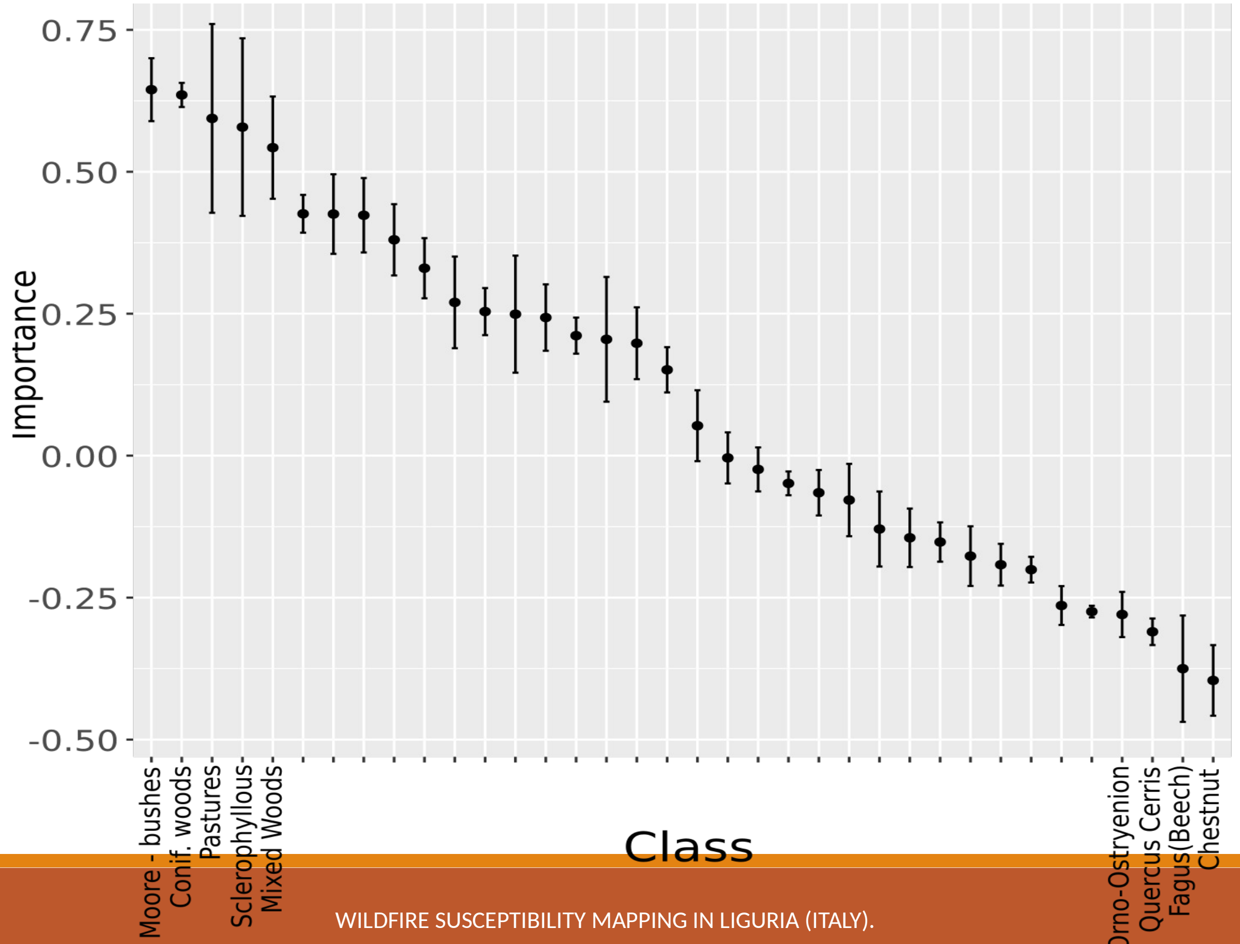
The **vegetation type** variable was a **categorical** one, composed of **37 different classes**. The importance of each class is validated through **Partial dependence plots**, which give a graphical depiction of the marginal effect of a single class on the class on the variable importance on overall susceptibility. Such marginal effect can be positive (class augmenting fire susceptibility) or negative (class decreasing fire susceptibility)

Variable importance

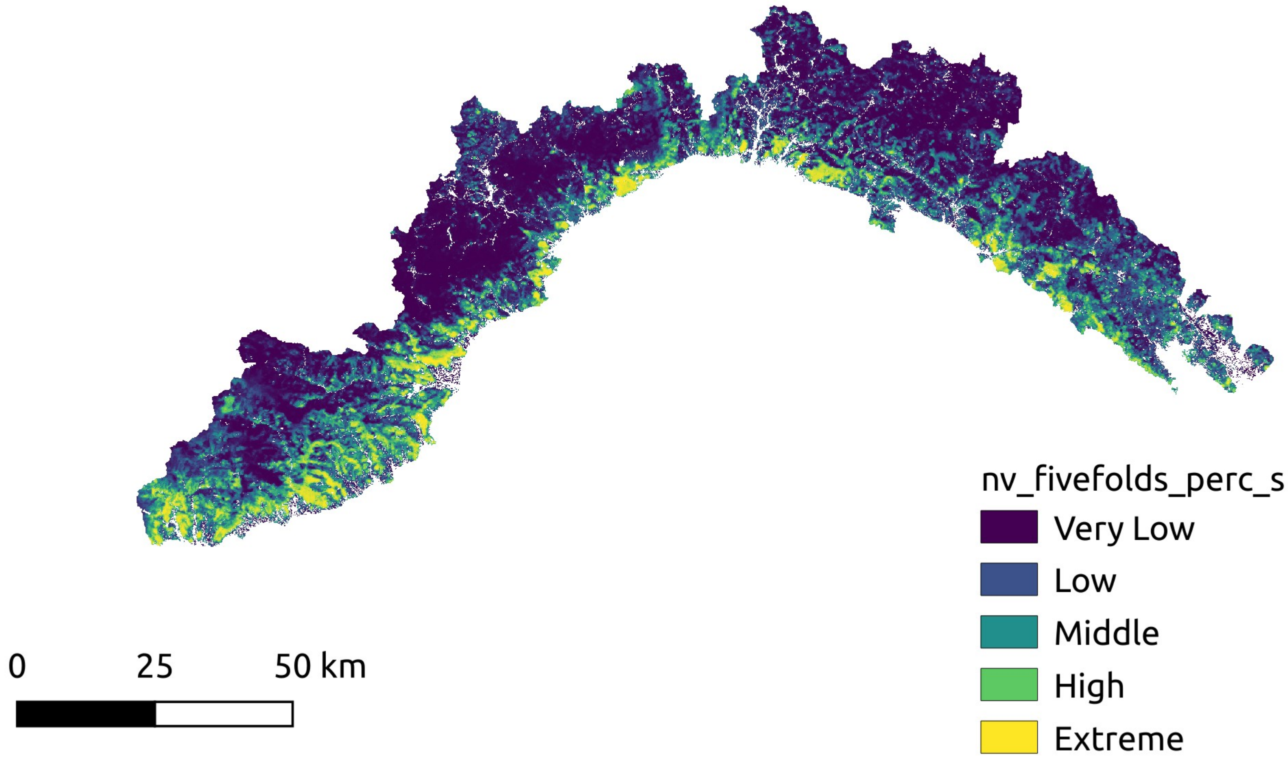


Insights on veg-type: class importance

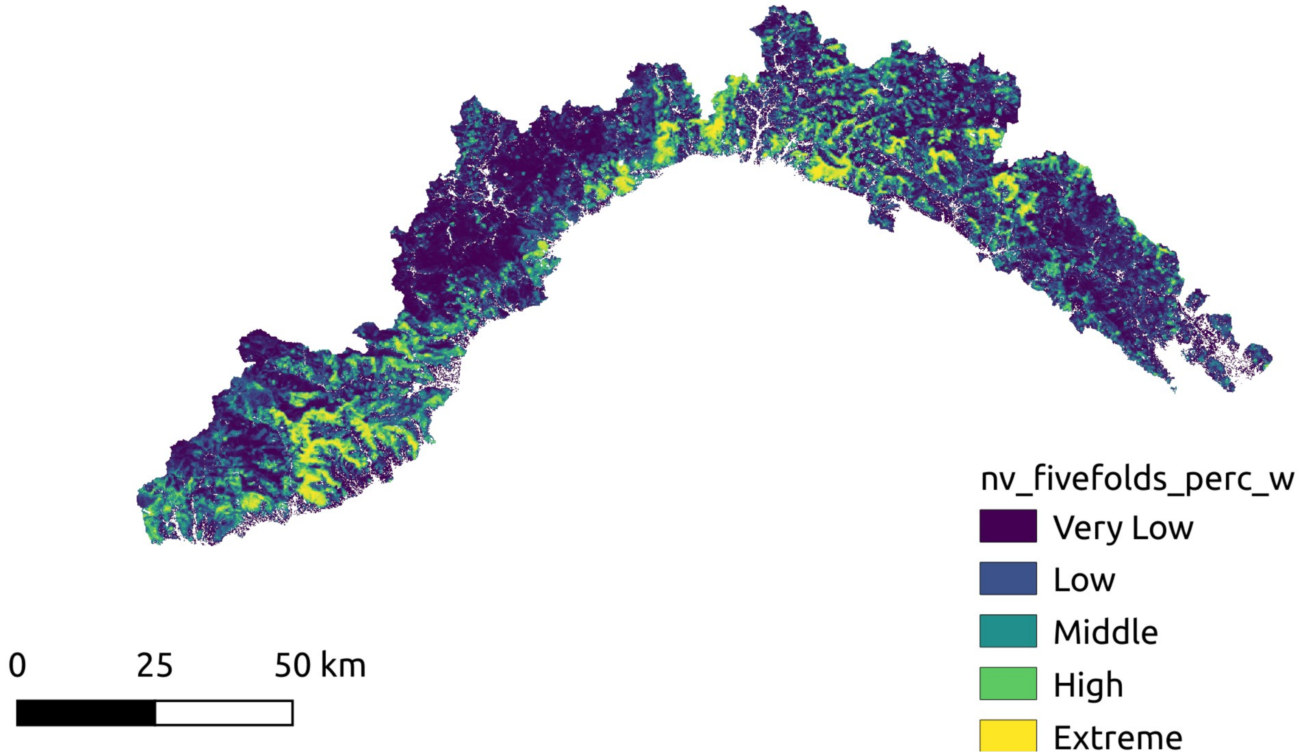
- Classes of vegetation **enhancing** susceptibility: bushes, Coniferous woods, pastures, *Sclerophyll*, mixed woods.
- Classes of vegetation **dampening** susceptibility: chestnut, *Fagus*, *Quercus Cerris*, *Orno-ostrietum*



Susceptibility maps: Summer season



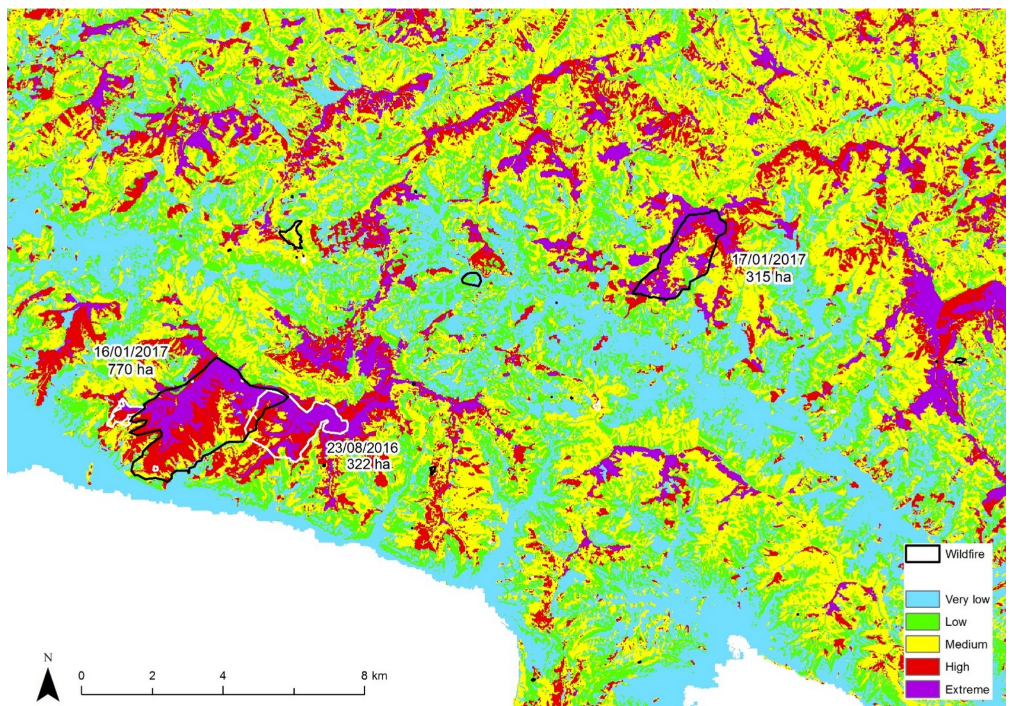
Susceptibility maps: Winter season



Validation

- For RF the prediction error is assessed by evaluating predictions on the “out-of-bag” data, which were not used in the training subset.
- The testing and the OOB mean squared error are in our case both equal to about 0.2 for winter season and to 0.17 for summer season, attesting the robustness of the model.
- To assess the methods prediction capabilities, an indipendent dataset (BA 2016-2017) was employed.

	Summer		**Winter**	
%	**2016**	**2017**	**2016**	**2017**
0.30	0.01	0.04	0.02	0.02
0.20	0.02	0.12	0.02	0.04
0.30	0.11	0.45	0.12	0.16
0.15	0.25	0.22	0.18	0.30
0.05	0.53	0.10	0.39	0.46



Conclusions

- Higher class match with the observed burned areas, which are closer to the coast in summer and develop along the interior in winter.

- The RF algorithm seems to achieve good performances and has the advantage of being able to extract knowledge and insights from data, and developing promising ranking of variables and categorical classes.

- In summary, RF seems to be a promising alternative to deterministic or statistical expert- based method for wildfire susceptibility mapping.

BIBLIOGRAPHY

Tonini, M.; D'Andrea, M.; Biondi, G.; Degli Esposti, S.; Trucchia, A.; Fiorucci, P. A Machine Learning-Based Approach for Wildfire Susceptibility Mapping. The Case Study of the Liguria Region in Italy. *Geosciences* 2020, 10, 105.