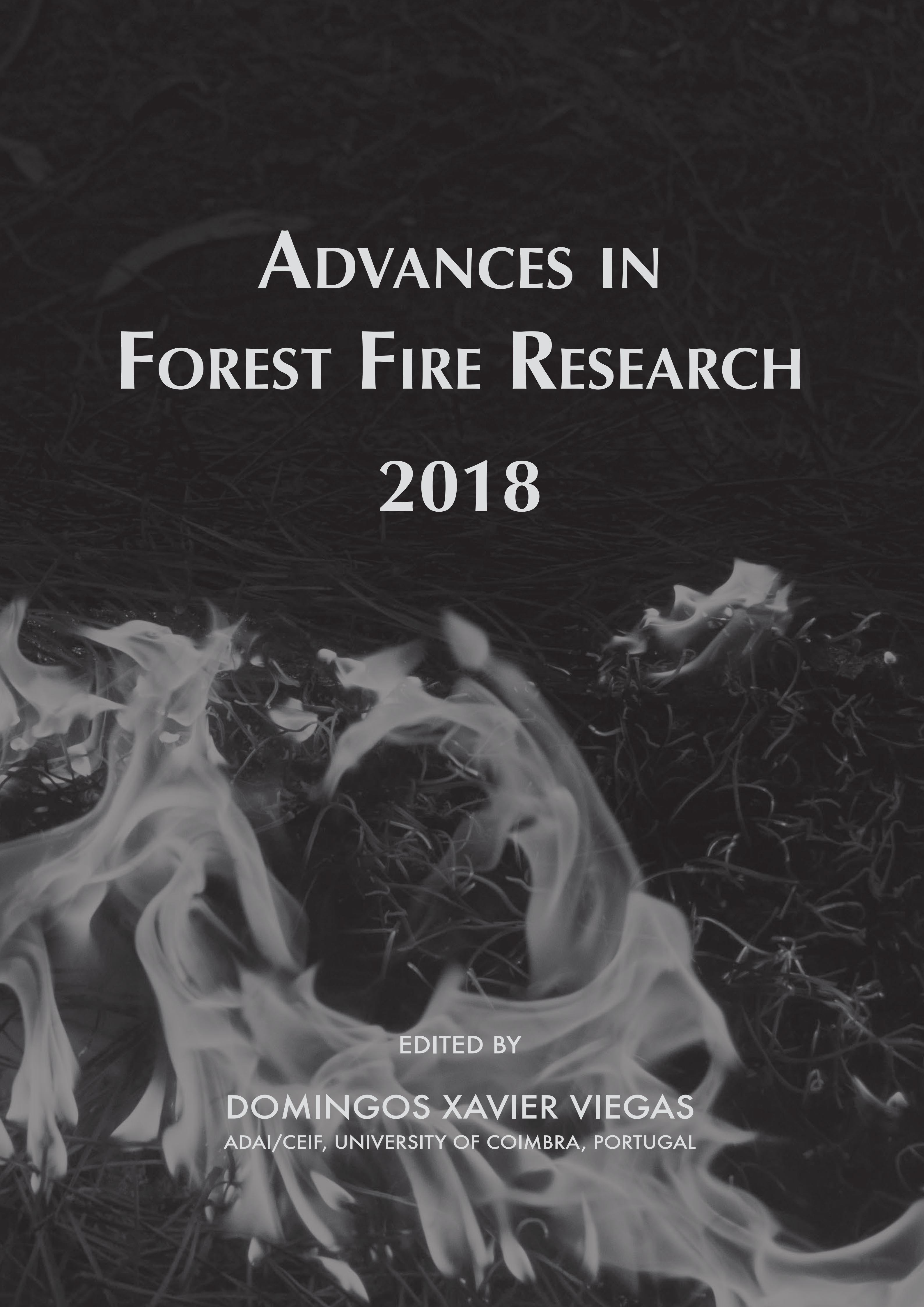

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Short contribution – Fuel Management

FireCaster Decision Support System: on the need for a new fuel description approach

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Abstract

The goal of the FireCaster project is to develop a new generation national (French) scale Wildfire Decision Support System (FCDSS) to provide operational agencies more efficient ways to forecast fire danger and handle ongoing crisis. A key task of the project concerns fuel, defined as dead and live biomass. On the one hand, fuel characteristics are required inputs for fire behavior models, which are used in the framework of the project to predict the fire front evolution and to compute probabilistic risk by means of mass ensemble simulations. On the other hand, one of the objectives of the project is developing the methods and procedures to predict fuel state (e.g. live and dead fuel moisture content, fuel loading) and its spatiotemporal evolution across the landscape from an operational land surface model. To respond to these needs it is primary necessary to determine which fuel variables are needed and at which scale and level of detail, and to conceive the data structure to store the geo-referenced fuel variables. Fuel description systems have been traditionally developed to match input variables of a particular fire behavior model. However, advances in computing capabilities and simulations techniques have opened up new possibilities for modelling fire behavior and fuels at finer scales. FCDSS has been designed with genericity and evolvability in mind, in order to match a variety of uses and sources of fuel data. In order to tackle these challenges, the FireCaster Fuel Descriptions System (FCFDS) has been defined based on the review of existing fuel classification and descriptions systems, fuel input parameters of the current fire behavior models and the goals of the FireCaster project. In the FCFDS a vegetation stand is composed by one or more structurally distinct pseudo-homogeneous geo-referenced fuel layers, which in turn are composed by fuel elements (i.e. individual plant of a stand, e.g. tree, shrub) or fuel particle arrangements (e.g. herb patch) sharing the same structural, physical, chemical and physiological response characteristics. Fuel elements are in turn composed by different sizes and types of fuel particles (i.e. leaves, twigs, branches). A set of fuel layer attributes has been defined to describe the state, structure and arrangement of fuel. Fuel layer attributes related to fuel state will be predicted by using the operational land surface model SURFEX, which takes into account the soil-vegetation-atmosphere interactions. Correspondingly, a set of fuel elements and fuel particles attributes has been defined. These attributes can be shared by elements and particles in fuel layers located at different positions in the landscape. The way fuel data is structured in FCFDS allows to consider different levels of detail, from the stand scale to the particle scale. Moreover, linkages to different fire behavior models will be developed by means of adaptors. This paper introduces the framework for the definition of the FCFDS, as well as the structure, the associated fuel attributes and the range of spatial scales considered. Moreover, an example of application will be presented.

Keywords: Fuel modelling, Fuel attributes, Fuel Description System, Wildfires

The goal of the FireCaster project is to develop a new generation national (French) scale Wildfire Decision Support System (FCDSS) to provide operational agencies more efficient ways to forecast fire danger and handle ongoing crisis. A key task of the project concerns fuel, defined as dead and live biomass. On the one hand, fuel characteristics are required inputs for fire behavior models, which are used in the framework of the project to predict the fire front evolution and to compute probabilistic risk by means of mass ensemble simulations. On the other hand, one of the objectives of the project is developing the methods and procedures to predict fuel state (e.g. live and dead fuel moisture content, fuel loading) and its spatiotemporal evolution across the landscape from an operational land surface model. To respond to these needs it is primary necessary to determine which fuel variables are needed and at which scale and level of detail, and to conceive the data structure to store the geo-referenced fuel variables.

The way fuel is described, this is the set of categories, components and fuel variables used for describing fuel, depends on the intended application (i.e. fire management, fire behavior, fire ecology), the spatial and temporal resolution scale and the available resources (i.e. data, technology, fuel sampling techniques). Fuel description systems have been traditionally developed to match input variables of a particular fire behavior model. However, it is necessary to reconsider fuel description across the landscape in order to take into account advances in the knowledge on fire behavior and its modelling, fire risk, pollutants emissions, fuel ecology and fuel dynamics (Keane, 2013). Moreover, advances in computing capabilities and simulations techniques have opened up new possibilities for modelling fire behavior and fuels at finer scales (Parsons et al., 2011). In the same way, progresses in remote sensing (e.g. LIDAR, satellite) have led to the improvement of the quality and resolution of available fuel-related data but also to the increase in the volume of data to manage and store.

FCDSS has been designed with genericity and evolvability in mind, in order to match a variety of uses and sources of fuel data. In order to tackle these challenges, the FireCaster Fuel Descriptions System (FCFDS) has been defined based on the review of existing fuel classification and descriptions systems (e.g. Ottomar et al., 2007; Hollis et al., 2015), fuel input parameters of the current fire behavior models and the goals of the FireCaster project. The FCFDS will be firstly implemented and tested in the Corsican Region by re-analysis of past fire events and mass ensemble simulations. Moreover, in the FCFDS linkages to different fire behavior models (i.e. semi-physical, physics-based) will be developed by means of adaptors (Figure 1).

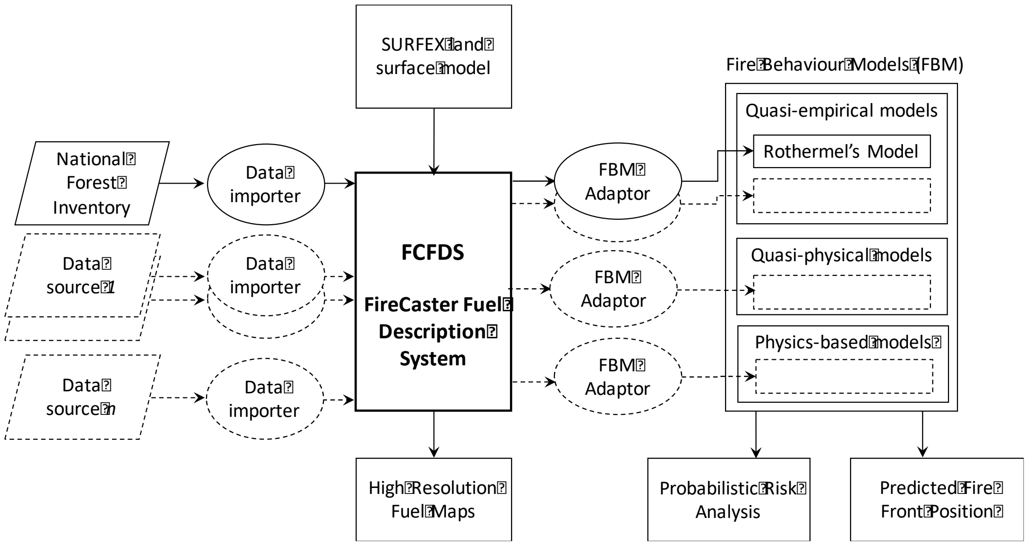

Figure 1 - Overall view of the FireCaster Fuel Description System (FCFDS) and its interactions to other elements of the FireCaster Decision Support System (FCDSS).

This paper introduces the framework for the definition of the FCFDS, as well as the structure, the associated fuel attributes and the range of spatial scales considered. An example of application to a fuel stand will be presented as well.

The way fuel data is structured in the FCFDS allows to consider different levels of detail, from the stand scale to the particle scale. In the FCFDS a vegetation stand is composed by one or more structurally distinct pseudo-homogeneous geo-referenced fuel layers (spatial resolution ranging from 50 m to 5 m), which in turn are composed by fuel elements (i.e. individual plant of a stand, e.g. tree, shrub) or fuel particle arrangements (e.g. herb patch) sharing the same structural, physical, chemical and physiological response characteristics (Figure 2). It is important to note that a fuel layer does not necessarily corresponds to a vegetation stratum, and that a vegetation stratum can be described by several fuel layers. Fuel elements are in turn composed by different sizes and types of fuel particles (i.e. leaves, twigs, branches).

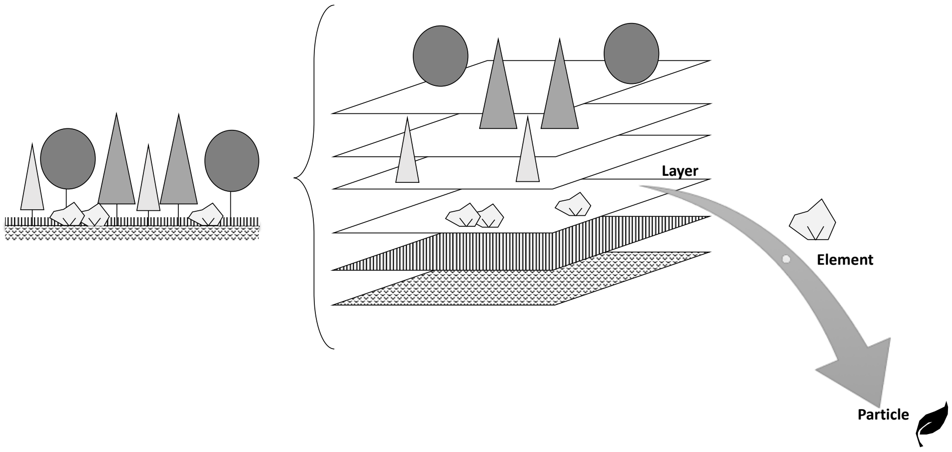

Figure 2 - Example scheme of the different layers composing a fuel stand.

A set of fuel layer attributes has been defined to describe the state, structure and arrangement of fuel. These fuel layer attributes are unique for a certain point in the landscape and time evolving. Fuel layer attributes related to fuel state will be predicted by using the operational land surface model SURFEX (Masson et al., 2013), which takes into account the soil-vegetation-atmosphere interactions. The number of fuel layers to cosider in a certain point in the landscape will be partly derived from the French Forest Inventory. Correspondingly, a set of fuel elements and fuel particles attributes has been defined. These attributes (i.e. physical, chemical and ecophysiological properties) can be shared by elements and particles in fuel layers located at different positions in the landscape. Fuel elements and fuel particle attributes, obtained from the literature, include data values, but also allometric relationships and other simple fuel models describing spatiotemporal variations of fuel attributes.

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