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Foreword

Fire regime and ecosystem responses: adaptive forest management in a changing world (Part 1)

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Abstract. Although fire is an intrinsic factor in most terrestrial biomes, it is often perceived as a negative disturbance that must be suppressed. The application of successful fire prevention policies can lead to unsustainable fire events for ecosystems adapted to a specific fire regime. In addition, new climate and land use scenarios are influencing fire parameters and ecosystem services. Consequently, adaptive forest and landscape management must include knowledge on vulnerability, resistance and resilience of terrestrial ecosystems.

To help address this need, we convened a special issue (divided in two separate parts) to synthesise ongoing research focused on obtaining a better understanding of wildfire response decisions and actions, including preventive management and post-fire restoration. We conceived a collection of research studies covering a wide diversity of geographical settings characterised by different climates and forest types, under scenarios of changing climate and land use.

Here, we summarise the key findings from the six papers published in the first section of the special issue. They deal with diverse topics and assessments, such as adaptions to fire regimes, the effects of burn severity on the plant–soil interface, and post-fire management taking advantage of indices obtained from satellite images (dNBR, NDVI), dendrochronology, soil sampling and analysis of biological indicators. We highlight the new knowledge developed to enhance fire management decision making in a time of rapidly changing scenarios around the world.

Additional keywords: burn severity, fire effects on ecosystems, post-fire management, resilience, resistance of ecosystems, soil erosion, vulnerability.

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Introduction

Fire is an intrinsic environmental factor in most biomes, but people often perceive it as a dangerous disturbance with lasting negative repercussions, something to be eliminated or suppressed. This perception is related in part to a widespread expansion of the wildland-urban interface. With a higher number of people and structures exposed to fire hazards has come an obvious higher demand for fire suppression to protect human lives and properties. In some ecosystems, however, suppression of natural fires may lead to ongoing fuel accumulation with resultant increases in highly severe fires, which forces a reassessment of common 'paradigms' of fire control (Stephens *et al.* 2016). At the same time, climate change and increases in human-induced disturbances have altered natural fire regimes, resulting in an ongoing increase in large-scale fires (Bowman *et al.* 2009). Human interference in fire regimes often alters the historical range of variability for fire parameters such as fire frequency, fire pattern, fuels consumed and fire intensity, even resulting in vegetation shifts (Keeley and Pausas 2019). Such changes may have very negative consequences for the conservation of forests and their soils (Lentile *et al.* 2007) and in some cases require massive and expensive post-fire soil management (Pereira *et al.* 2018).

Currently, a main goal of adaptive forest management is to increase the long-term resistance and resilience of forests to wildfires, considering the ongoing and future changes in land-use and climate, and the related effects on fire dynamics. Science-based tools are essential to support landscape-scale management aimed at maintaining sustainable fire regimes and ecosystem services. A large body of knowledge is needed for this purpose, mainly based on examples of the effects of fire on a variety of ecosystems to provide reliable data for fire risk mitigation, restoration, rehabilitation and future management focused on conservation of ecosystem functions and services.

Fire is a unifying theme both in ecological and social terms, which interests researchers from around the world. The current special issue was conceived to collect research studies covering a wide diversity of topics and geographical settings. The array of topics ranges from the ecological effects of fire to the effectiveness of different management tools. In addition, novel methods and tools to mitigate fire damage and post-fire

impacts on ecosystem services (e.g. prescribed burning, mechanical fuel load reduction, and stabilisation and emergency post-fire actions), are presented for different scenarios in terms of diverse climates and forest types, climate change, and land use change.

Contents

This special issue is being published in two separate parts. The current section (Volume 28, issue 5 of *International Journal of Wildland Fire*) includes six papers on topics such as adaptions to fire regimes, the effects of burn severity on ecosystems (mainly at the plant–soil interface) and post-fire management for restoration and mitigation of negative effects. The assessments and research methodologies were diverse, ranging from indices obtained from satellite images (dNBR, NDVI), to dendrochronology, to soil sampling and analysis of biological indicators.

Camarero *et al.* (2019) reconstructed historical fire dynamics in the Mediterranean Basin, by combining paleoecological proxies, historical fire records, and tree-ring width data in Central Spain. They documented an abrupt regime shift in the fire record during the 1890s. High fire incidence reduced the growth rate of pine forests, although growth recovered quickly after fire. Also, in the Iberian Peninsula, Madrigal *et al.* (2019) studied adaptations supporting fire resistance of the stone pine (*Pinus pinea* L.). They developed models to predict the critical threshold of bark thickness for the survival of mature pine trees. After validation, these models were applied to evaluate wildfire damage and possibly reduce the negative effects of prescribed burning.

Burn severity, one of the most studied fire variables, was evaluated in *Pinus pinaster* ecosystems of Spain by Fernández-García *et al.* (2019) using various soil indicators. They identified pH, β-glucosidase and C : N ratio as key properties for assessing impacts on the soil immediately after a fire, because these variables were particularly responsive to fire severity and easily measured.

Post-fire management strategies can affect both vegetation recovery and soil erosion. Urretavizcaya and Defossé (2019) studied regeneration following high-severity fire in Patagonia, Argentina. They found complete seedling mortality of *Austrocedrus chilensis* where post-fire salvage logging was carried out. In contrast, over 75% of seedlings survived on unlogged sites due to shading from dead trees. To balance the economic needs of society and the ecological requirements of *A. chilensis* they proposed leaving ~50% of burned snags. Zituni *et al.* (2019) studied the effects of post-fire forest management on soil erosion rates 3 and 4 years after a wildfire on Mount Carmel, Israel. Tree clearing and skid trail creation had led to increased erosion rates, but mulching with wood chips on bare burned ground significantly limited soil erosion, which helped with rehabilitation and recovery of conditions similar to those before fire. Finally, Meyer *et al.* (2019), working in red fir forest in the Sierra Nevada of California, showed how the reestablishment of natural fire regimes can be beneficial to forest ecosystems through restoration of their fundamental structural, compositional, or functional attributes.

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