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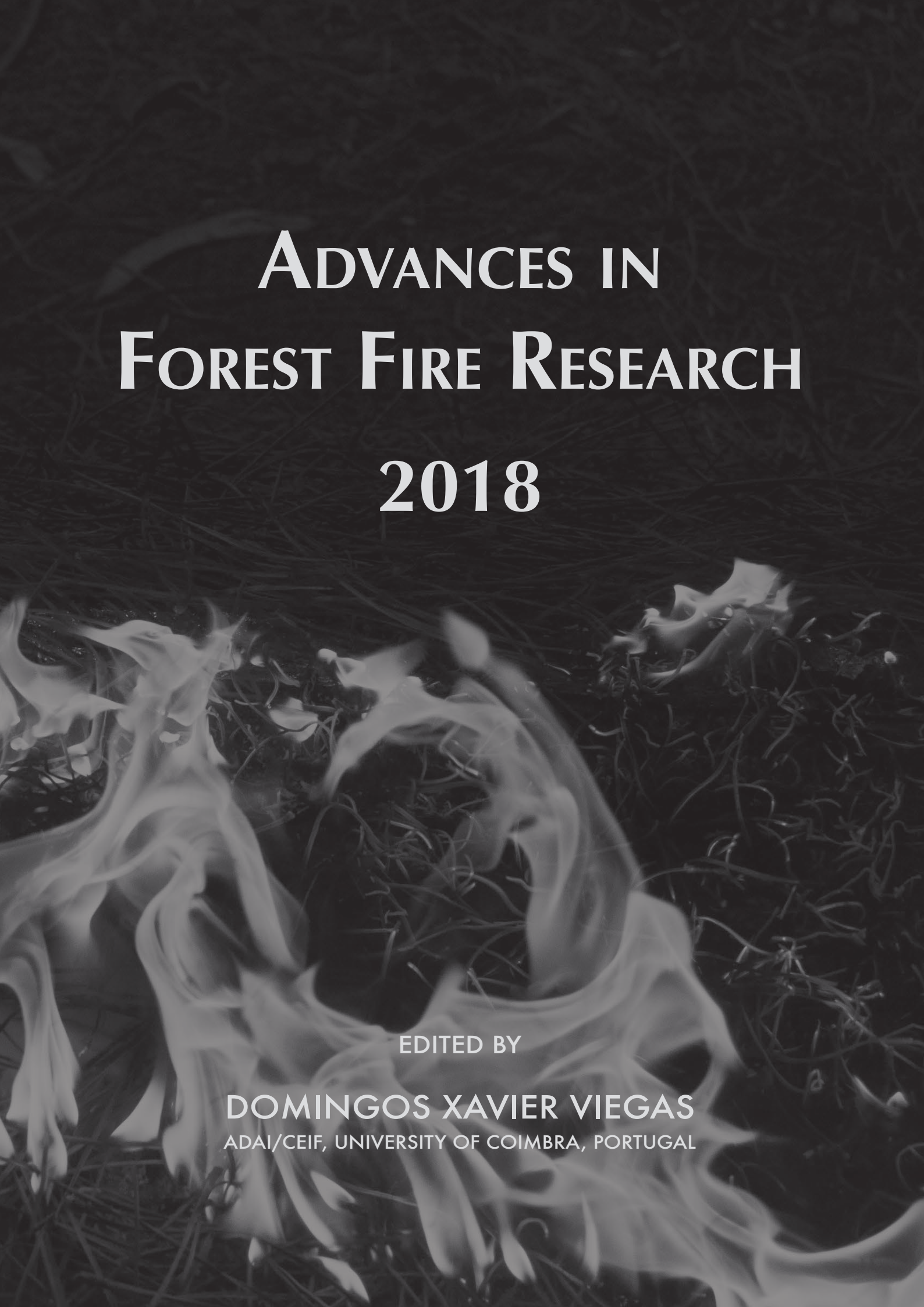

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Short contribution – Socio Economic Issues

Does it pay to invest in better suppression resources? – policy analysis of alternative scenarios with simulation

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Abstract

Rekindles (RKD) and false alarms (FA) are unusually high in the Portuguese wildfire management system. Together they represent a high burden on suppression resources in particular, and fire management resources in general. Indeed, e.g., during 2010, according to data provided by the Portuguese Institute for Nature Conservation and Biodiversity (ICNF), in 20,049 occurrences that the suppression system handled in the summer, 12.5% were FA and 15.0% were RKD.

During the fire season, it is usual to have large usage of suppression resources to combat wildfires and on peak days, firefighters are in a tight spot due to the pressure to move incessantly from one fire to the next one. In such occasions the system may not be able to effectively meet the needs, getting out of control. If there are fires waiting to be fought, suppression crews are pressured to prematurely abandon mop-up operations (moving towards the initial attack of new fires), without the needed time to use the appropriate tools to effectively carry out mop-up. When one of these fires with a bad mop-up rekindles, it is one more to join the other new ignitions or primary fires, and they are generally more aggressive than the latter.

We first developed a discrete-event simulation model of a wildfire suppression system, designed to analyze the joint impact of primary fires, RKD and FA on the system performance. Recently (unpublished), we explicitly closed the causal loop between primary fires and RKD, and modeled the suppression resources in greater detail, by distinguishing standard crews of volunteer firefighters (with and without training) from expert crews of professional firefighters. Using a Portuguese district as case study, with a set of scenarios, we analyzed the cost-effectiveness of investing in the training of standard and/or expert crews, considering different dispatch policies.

We found that reducing FA and RKD to benchmark values would significantly reduce pressure on firefighting teams, enabling more effective suppression operations, and that it pays to invest in better suppression resources.

Keywords: Forest Fire Suppression, Rekindles, False Alarms, Cost-Effective Analysis, Discrete Event Simulation

1. Introduction

Rekindles (RKD) and false alarms (FA) are unusually high in the Portuguese wildfire management system. Together, they represent a high burden on suppression resources in particular, and fire management resources in general. Indeed, e.g., during 2010, according to data provided by the Portuguese Institute for Nature Conservation and Biodiversity (ICNF), in 20,049 occurrences that the suppression system handled in the summer, 12.5% were FA and 15.0% were RKD (Pacheco *et al.* 2014c).

During the fire season, it is usual to have large usage of resources (human and material) to combat wildfires and, on peak days, firefighters are in a tight spot, due to the pressure to move incessantly from one fire to the next one (Beighley and Hyde 2009). In such occasions, the system may not be able

to effectively meet the needs, getting out of control. If there are fires waiting to be fought, they keep spreading, becoming harder to extinguish, with an increased likelihood of becoming mega-fires, reaching people, homes and animals, besides destroying the forest landscape (Lourenço and Rainha 2006). Consequently, pressured suppression crews prematurely abandon mop-up operations (moving towards the initial attack of new fires), without the needed time to use the appropriate tools to effectively carry out mop-up. When one of these fires with a bad mop-up rekindles, it is one more to join the other new ignitions or primary fires, and they are generally more aggressive than the latter (Pacheco *et al.* 2012; Pacheco *et al.* 2014a).

2. Materials and Methods

We first developed a discrete-event simulation model (implemented in ®ARENA) of a wildfire suppression system, designed to analyze the joint impact of primary fires, RKD and FA on the system performance (Pacheco *et al.* 2014b).

	STD crews *(not specialized)*		**EXPRT crews** *(specialized)*	**K**	**P**	**Description**
	without extra training (*as is*)	with more training				
Scenario 0	100%		0%	1	*not applicable*	100 crews
Scenario 1	100%		0%	1	*not applicable*	Variation in the number of crews
Scenario 2	0%	100%	0%	]0,1[	*not applicable*	100 crews (with training)
Scenario 3	80%		20%	1	1%, 3%, and 6%	Variation of the failure probability (p) of EXPRT crews
Scenario 3 (composition)	80% 60% 40% …		20% 40% 60% …	1	3%	Variation in the crew composition
Scenario 4	z%		1 – z%	1	3%	With different "z%", three dispatch policies tested

Figure 1 - Battery of tests performed with the ®ARENA simulation model.

This model contributes to fill a research gap concerning that impact, and features a novel application of simulation to suppression systems, as screening tools to support more holistic analyses. Recently (unpublished paper), we explicitly closed the causal loop between primary fires and RKD, and modeled the suppression resources in greater detail, by distinguishing standard crews of volunteer firefighters (with and without training) from expert crews of professional firefighters.

We use a Portuguese district as case study, and with a set of scenarios (please see Figure), we analyzed the cost-effectiveness of investing in the training of volunteer firefighters and/or using expert crews of professional firefighters, under different dispatch policies.

Our model aims to support the analysis of the impact of different forest fire suppression policies on rekindles and false alarms and these policies are based on the existence of different types of suppression crews: volunteers (as-is), volunteers with more training, and professional firefighters.

3. Results

We found that reducing FA and RKD to benchmark values would significantly reduce pressure on firefighting teams, enabling more effective suppression operations, and that it pays to invest in better suppression resources (Pacheco *et al.* 2014b).

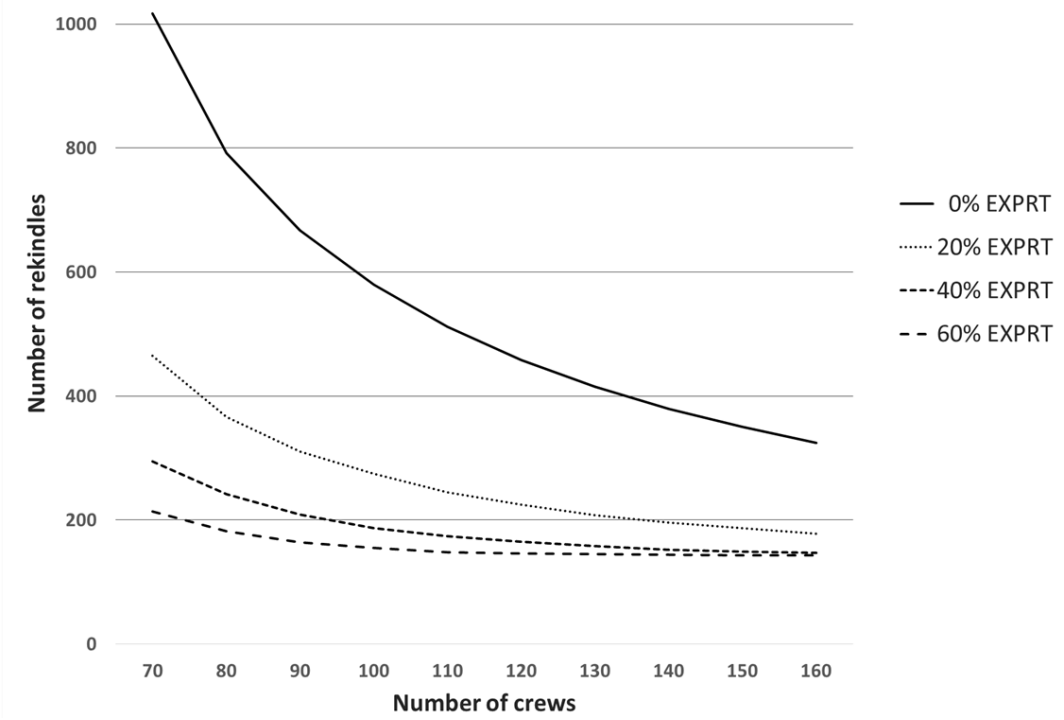

Figure 2 - Example of the kind of results obtained, in this case the evolution of rekindles by changing the percentage of professional crews (EXPRT).

The results of the cost assessment (e.g., Figure) for the different scenarios (in Figure) indicate that modifying the current (fixed) system design to a more flexible one, mixing volunteer firefighters with professional firefighters and/or investing in the training of the volunteers, appears to offer good prospects in terms of improving forest fire management, as more fires with a good mop-up will lead to fewer rekindles and thus, less pressure over the firefighting crews.

Finally, the eventual increase in the system costs must be weighed against the benefits resulting from the damage avoided with fewer rekindles.

4. Acknowledgements

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5. References

Beighley, M, Hyde, AC (2009) Systemic Risk and Portugal's Forest Fire Defense Strategy: An Assessment of Wildfire Management and Response Capability.

Lourenço, L, Rainha, M (2006) As mediáticas 'mãos criminosas dos incendiários'e algumas das 'lições dos fogos florestais de 2005 em álbum fotográfico. Contributo para a desmistificação dos incêndios florestais em Portugal. *Territorium* 71-82.

Pacheco, AP, Claro, J, Oliveira, T (2012) Rekindle dynamics: validating the pressure on wildland fire suppression resources and implications for fire management in Portugal. In 'Modelling, Monitoring and Management of Forest Fires III.' Vol. 3 pp. 258. (Wessex Institute of Technology: Ashurst, Southampton, UK)

Pacheco, AP, Claro, J, Oliveira, T (2014a) Rekindles or one-σ quality in forest fire fighting: validating the pressure on firefighters and implications for forest fire management in Portugal. In 'Advances in forest fire research.' (Imprensa da Universidade de Coimbra: Coimbra)

Pacheco, AP, Claro, J, Oliveira, T (2014b) Simulation analysis of the impact of ignitions, rekindles, and false alarms on forest fire suppression. *Canadian Journal of Forest Research* **44**, 45-55.

Pacheco, AP, Claro, J, Oliveira, T (2014c) Waste in non-value-added suppression activities: simulation analysis of the impact of rekindles and false alarms on the forest fire suppression system. In 'Advances in forest fire research.' (Imprensa da Universidade de Coimbra: Coimbra)