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Post-wildfire Emergency Intervention in Portugal: an Analysis of Public Reports and Policy

Renata Pacheco[1], João Claro[1]
[1] INESC TEC and Faculdade de Engenharia, Universidade do Porto
Campus da FEUP, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal
renatapacheco@fe.up.pt; jclaro@fe.up.pt

Abstract **-** Wildfires have been rising both in number and size, which is turning post-fire forest management into an ever more relevant topic. Often governments are the ones to first respond in case of a wildfire, as well as assess all the impacts that need to be mitigated. For this reason, public reporting and transparency play a vital role, as they are not only a legal requirement but also a tool for interacting with stakeholders. In Portugal, after a wildfire, the Institute for Nature Conservation and Forests (ICNF) assesses the main environmental impacts identified and proposes emergency stabilization measures, according to the guidelines presented in the Order No. 9716-A/2017, from the Ministry of Agriculture, Forestry and Rural Development. In this context, the objective of the present study is to analyse the content and characterize the main environmental impacts identified in the 122 emergency stabilization reports, currently available at ICNF's website, in terms of the ecosystem services they disrupt. Also, their accordance with Order No. 9716-A/2017 is verified. Next, these impacts are compared to the ones identified in three technical reports that propose mitigation measures for a longer time period. Lastly, suggestions for possible improvements in the reporting process are made regarding other fire-related environmental impacts that could be included in future assessments. Overall, the reports seem to be in accordance with the content legally required, and a few even address more impacts than the minimum. In the long-term, flora recovery appears to be the main issue to be addressed. However, some fire-related impacts such as the loss of climate regulation capacity have not yet been addressed by the reports, and there is likely an opportunity for collaboration with the academic community, which has an important role in pioneering impact assessment efforts.

Keywords**:** Wildfire; Content Analysis; Fire Reports; Fire Policies; Emergency Interventions

1. Introduction

Wildfires have risen in number and size recently, leading post-fire forest management to be an increasingly crucial topic [1]. Governments are often the ones to first respond in case of a wildfire, be it directly in combating it, or in the short term, assessing all the impacts that need to be mitigated. In this sense, public reporting and transparency play a vital role. Transparency practices tend to create public value, as they are not only a legal requirement for public managers but also a tool for interacting with stakeholders [2]. In Portugal, after each significant wildfire, the Institute for Nature Conservation and Forests (ICNF, Portuguese acronym) assesses the main environmental impacts identified as well as proposes emergency stabilization measures, according to the guidelines presented in the Order No. 9716-A/2017, from the Ministry of Agriculture, Forestry and Rural Development. This information is made public through reports that are available at ICNF's website [3]. The reports have the strategic objective of helping in mitigating environmental impacts, especially before the rainy season, namely in terms of combating erosion, torrential correction and to prevent the contamination of water-bodies by debris [4].

In this context, the present study aims to characterize the main environmental impacts identified in the 122 emergency stabilization reports currently available at ICNF's website [3], in terms of the ecosystem service they disrupt [5] by year and region of the country. In addition, the content of the report is analysed to verify if they are in accordance with Order No. 9716-A/2017. Next, the concerns acknowledged in the emergency stabilization reports are compared to the fire impacts identified in three technical reports that propose mitigation measures for a longer time period [6]. Finally, suggestions for possible improvements in the reporting process are made regarding other fire-related environmental impacts that could be included in future assessments.

2. Materials and Methods

Document analysis is a systematic procedure for reviewing or evaluating documents, such as institutional reports and public records. Institutional reports are potential sources of empirical data and can help the researcher to uncover meaning, develop understanding, and discover insights relevant to the research problem. As a research method, document analysis is particularly applicable to produce detailed descriptions of a single program or policy [7]. For this reason, in the present work, content analysis was used to help in identifying the main environmental concerns after a wildfire in Portugal. Currently, ICNF has 122 emergency stabilization reports available at their website, being that the oldest is from 2010 and the newest from 2019 [3]. These documents were analysed, and the main environmental impacts indicated in each report were extracted. To standardize the impact information, a coding system was used based on the ecosystem services proposed by The Economics of Ecosystem and Biodiversity (TEEB) [5]. This content will be presented grouped by region of the country and year of the fire, and a brief discussion is made regarding the consistency of this information presented in the reports and Order No. 9716-A/2017. Next, the impacts identified in three technical reports available at ICNF's website [6] that deal with fire impacts that need to be mitigated over a longer time period (more than 3 years after the fire) are similarly analysed, and the differences in short and long term environmental concerns are discussed. Finally, other wildfire impacts of notorious concern in Portugal are presented, and a few suggestions for future work are made.

3. Results and Discussion

The number of reports analysed by region of the country and year are shown in Table 1. The Centre and North region of Portugal account for almost 90% of the total number of reports, which is to be expected as these regions historically tend to experience more fires [8]. In terms of the year of the fire, 2017 accounts for almost 42% of the reports, as that year experienced a record in the total burnt area [9].

Table 1: Number of reports available according to the region of the country, by year.

Region of the country	Number of Reports Available								
	2010	2012	2013	2015	2016	2017	2018	2019	Total
Algarve	-	1	-	-	2	-	1	-	4
Centre	6	6	1	5	9	32	-	2	61
Lisbon	3	3	-	1	1	1	-	-	9
North	9	1	1	3	16	18	-	-	48

Of the available documents, 53 are made up only of the standard form proposed in Order No. 9716-A/2017, and 69 are more complete reports, usually containing maps and additional descriptions of the areas and fire impacts. Next, the content of the emergency stabilisation reports is analysed, followed by a brief comparison with the long-term environmental concerns presented three technical reports, other fire concerns are presented and some suggestions are made.

3.1. Emergency Stabilisation Concerns

The structure of the emergency stabilisation report is determined by Order No. 9716-A/2017. Its content must be systematised, based on uniform criteria and formats, that should be functional, objective, and simple [4]. Having this clear guideline helps in establishing positive citizen–agency relations, since they should to be long-term and developed prior to fire occurrences if post-fire actions are to be supported by communities [1].

Indeed, in terms of content and format, reports were seemingly standardized within every region of the country. Even the reports written before 2017, when the Order was instated, clearly had a structural pattern that varied only slightly according to the region of the country. Also, the complexity of the content seemed to increase with time, perhaps together with the experience of reporting wildfires by ICNF. It should be noted that of the 53 "incomplete" reports, 51 are from 2017, which was a year with many wildfires, including the one at Pedrógão Grande, the worst in

Portuguese history [9]. Perhaps, for this reason, the technical teams did not have enough time to elaborate fuller reports. As for the identified ecosystem services disrupted due to the fire, Table 2 shows the ones reported, according to the year of the fire and region of the country.

Table 2: Ecosystem services impacted by wildfires according to the region of the country, by year.

	Algarve	Centre	Lisbon	North
2010	-	- Raw materials - Erosion prevention - Regulation of water flows - Opportunities for recreation & tourism - Water - Maintenance of genetic diversity	- Raw materials - Erosion prevention - Regulation of water flows	- Raw materials - Erosion prevention - Regulation of water flows
2012	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of soil fertility - Opportunities for recreation & tourism	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Maintenance of soil fertility	- Raw materials - Erosion prevention - Water - Regulation of water flows	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity
2013	-	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity	-	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Maintenance of soil fertility
2015	-	- Raw materials - Erosion prevention - Water - Opportunities for recreation & tourism - Regulation of water flows	- Raw materials - Erosion prevention - Regulation of water flows	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Opportunities for recreation & tourism
2016	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Opportunities for recreation & tourism	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Opportunities for recreation & tourism	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Opportunities for recreation & tourism	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Opportunities for recreation & tourism
2017	-	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity
2018	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity - Opportunities for recreation & tourism	-	-	-
2019	-	- Raw materials - Erosion prevention - Regulation of water flows - Maintenance of genetic diversity	-	-

The information presented in Table 2 is a compilation of all the impacts presented on all reports for that region and year. Not necessarily all the ecosystem services presented for every region were disrupted in every fire. Nevertheless, all reports presented losses in terms of “Raw materials” since timber was always impacted, even if part of the fire also occurred on shrublands. Still, regarding the vegetation, many reports expressed the concern of the “Maintenance of genetic

diversity," since exotic and invasive species have a history of taking over the impacted region, decreasing the genetic diversity of that ecosystem.

As for erosion, all but one report recognised it to be a concern in terms of the loss of the "Erosion prevention" service, provided by the vegetation that covered the soil before the fire. In contrast, few reports expressed to be concerned with the "Maintenance of soil fertility," linked to the loss of nutrients caused by precipitation after the fire, with the soil still exposed. Perhaps it was judged that solving the erosion issue, also helps in mitigating this impact and, therefore, it was not explicitly addressed many times.

In terms of impacts on water, most reports showed concerns in terms of what effect the change in soil absorption properties would have on the "Regulation of water flows." However, a few fires occurred in regions that were near to water abstraction sites for public supply. In these cases, the ecosystem service "Water" was affected, and mitigation measures were even more urgent since the fire had not only compromised the water cycles but also more directly the supply for human consumption.

Lastly, in fewer cases, areas designated for hunting were impacted by the fires. In Portugal, hunting is mainly done for recreation and not as a primary source of food; for this reason, the ecosystem service of "Opportunities for recreation & tourism" was the one that suffered losses. In addition, a few of these sites are also used for ecotourism activities, which were also hurt by the fires.

As is required by Order No. 9716-A/2017, emergency measures to mitigate these impacts were always proposed in the reports, along with an initial estimation of the costs the interventions would have. Once emergency crews have finished stabilising hazardous conditions following a fire, forest agencies have several options for managing, including erosion control measures, replanting trees, seeding with grass or forbs, harvesting burned trees, managing for safety only, and even taking no action [1]. In this sense, this specific legislation is rather proactive in guarding the environment since it clearly pushes for recovery actions.

It should be mentioned, however, that Order No. 9716-A/2017 only explicitly addresses three environmental impacts: erosion control, contamination of water lines, and biodiversity loss. In many cases, the reports included more impacts than just the ones mentioned, which is perhaps an indication that the experts responsible for the reports were sensitive to other impacts, and the need for their mitigation, even if they are not listed in the official guidelines.

3.2. Long-term Environmental Concerns

From an exclusively biophysical standpoint, as mentioned in many of ICNF's reports, the recovery of burnt areas traditionally involves three distinct phases for forest systems of non-intensive silviculture, which are "emergency stabilization," "restoration and rehabilitation," and "long-term."

Emergency stabilization takes place right after the fire or, sometimes, even during the fire-fighting phase, and it aims to control erosion and protect the hydrographic network, as well as to defend infrastructure and the most sensitive stations and habitats. Restoration and rehabilitation take place in the two years that follow the fire. The damage and the reaction of ecosystems are assessed, salvage logging, biophysical recovery actions, and even reforestation of more sensitive areas might be performed. Finally, in the long-term phase, definitive recovery projects are planned and implemented; usually, three years after the fire has occurred. Currently, there are three technical reports available that deal with the long-term phase [6]. Table 3 shows the ecosystem services impacted mentioned in each report, according to the region of the country and year.

Table 3: Long-term concerns regarding ecosystem services recovery according to the region of the country and year.

Region of the country	2012	2013
Algarve	- Raw materials - Maintenance of genetic diversity	-
Centre	-	- Raw materials - Maintenance of genetic diversity
North	-	- Raw materials - Maintenance of genetic diversity

It should be emphasized that Portugal has a robust legal framework to address the recovery of burnt areas, such as the Resolution of the Council of Ministers No. 88/2012, that establishes procedures and measures to minimize the consequences of large and severe fires, with a high impact on the social and economic life of the populations of a given region. In this sense, the experts have legal and technical foundations to help them in proposing recovery measures to mitigate the fire impacts.

When comparing the content of the emergency stabilisation reports with the ones that deal with long-term impacts, it is clear that, at least in number, most environmental impacts are expected to be addressed in the short-term. As shown in Table 3, in environmental terms, the only impacts mentioned are on the flora. Specifically, they are represented in terms of the loss of "Raw materials" and "Maintenance of genetic diversity" ecosystem services.

This is likely due to the fact that measures to control erosion, for example, are more urgent and should be addressed in the short-term. Also, vegetation recovery, especially for timber, is a process that requires more time to present noticeable improvements.

3.3. Other Environmental Concerns

Several emergency stabilization reports addressed more environmental impacts than legally required, including concerns that were more specific to the area where the fire happened. Nevertheless, the wildfire literature in Portugal has identified other impacts on the ecosystem services that were not addressed by ICNF at all. A few examples are "Air quality" and "Climate regulation" [10], [11] ecosystem services, which are clearly impacted by the fires. Even services such as "Food" are likely to be impacted, since water quality alterations due to forest fires may considerably affect aquatic organisms [12].

These impacts are indeed more intangible and harder to quantify, and perhaps they go beyond the institutional duties of ICNF. Still, since they impact people's well-being, they should be at least indicated in the reports, so that other government bodies or the population, in general, can address them. Perhaps, here there is also an opportunity for cooperation between the academic community and the governmental institutions to develop methods to quantify and address these impacts more easily.

4. Conclusion

Post-fire planning and decision-making is a highly complex process, one that is affected by citizen trust, citizen–agency relations, and citizen acceptance of management strategies [1], as well as the best scientific knowledge available at the time. The fact that Order No. 9716-A/2017, makes the fire impacts reports public, and readily available is essential for transparency and engaging the population in general. Our analysis showed that several reports cover more than the minimum content defined by the Order, even before it was published in 2017. This is an indication that ICNF has been developing a consistent work in reporting the fire impacts, which was further boosted by this legal regulation.

The results also indicate that most fire impacts are expected to be addressed in the short-term after the fire, up to two years following its occurrence. This is sensible since issues like erosion need to be addressed, preferably before the rainy season, which usually comes after the wildfire season in the summer. In the long-term, the institutional focus seemed to be centred around the recovery of the flora, being that Portugal has legal mechanisms to help in this process.

Finally, Portuguese wildfire literature has identified significant impacts that are not addressed by the ICNF's reports. Perhaps issues such as the loss of the "Climate regulation" ecosystem services are more complex, and more interagency work would be valuable to tackle matters such as this. Moreover, there is likely an opportunity for collaboration between the academic community and the governmental institution in identifying the fire impacts that need to be addressed, developing methods to quantify them, and helping in creating the needed policy to protect the environment better and improve the quality of the lives of those impacted by wildfires.

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References

[1] C. S. Olsen and B. A. Shindler, "Trust, acceptance, and citizen agency interactions after large fires: Influences on planning processes," *Int. J. Wildl. Fire*, vol. 19, no. 1, pp. 137–147, 2010.

[2] S. Douglas and A. Meijer, "Transparency and Public Value—Analyzing the Transparency Practices and Value Creation of Public Utilities," *Int. J. Public Adm.*, vol. 39, no. 12, pp. 940–951, 2016.

[3] ICNF, "Recuperação de áreas ardidas e estabilização de emergência," 2020. [Online]. Available: http://www2.icnf.pt/portal/florestas/dfci/relat/raa. [Accessed: 15-Jun-2020].

[4] SEFDR, *Despacho n.º 9716-A/2017*, no. 2. 2017, pp. 25108(2)-25108(3).

[5] B. Fisher and M. Christie, *The Economics of Ecosystem and Biodiversity: Ecological and Economic Foundations.*, no. March. 2010.

[6] ICNF, "Relatórios Técnicos," 2020. [Online]. Available: http://www2.icnf.pt/portal/florestas/dfci/relat/raa/rel-tec. [Accessed: 17-Jun-2020].

[7] G. A. Bowen, "Document Analysis as a Qualitative Research Method," *Qual. Res. J.*, vol. 9, no. 2, pp. 27–40, 2009.

[8] F. Moreira, P. Vaz, F. X. Catry, and J. S. Silva, "Regional variations in wildfire susceptibility of land-cover types in Portugal : Implications for landscape management to minimize fire hazard Regional variations in wildfire susceptibility of land-cover types in Portugal : implications for landscape mana," no. January, 2009.

[9] R. M. Turco, Marco; Jerez, Sonia; Augusto, Sofia; Tarín-Carrasco, Patricia; Ratola, Nuno; Jiménez-Guerrero, Pedro; Trigo, "Climate drivers of the 2017 devastating fires in Portugal," *Sci. Rep.*, vol. 9, no. 1, pp. 1–8, 2019.

[10] S. Barreiro and M. Tomé, "SIMPLOT: Simulating the impacts of fire severity on sustainability of eucalyptus forests in Portugal," *Ecol. Indic.*, vol. 11, no. 1, pp. 36–45, 2011.

[11] E. Miranda, A. I.; Martins, V.; Schaap, M.; José, R. San Perez, J. L.; Monteiro, A.; Borrego, C.; Sá, "Numerical modelling of 2003 summer forest fire impacts on air quality over Portugal," *WIT Trans. Ecol. Environ.*, vol. 137, pp. 71–82, 2010.

[12] C. Mansilha, A. Carvalho, P. Guimarães, and J. E. Marques, "Water Quality Concerns Due to Forest Fires : Polycyclic Aromatic Hydrocarbons (PAH) Contamination of Groundwater From Mountain Areas," *J. Toxicol. Environ. Heal. Part A*, vol. 77, no. 14--16, pp. 806–815, 2014.