Universidade Federal do Paraná
Setor de Ciências Agrárias
Pós-graduação em Engenharia Florestal
Revista Floresta

COST MANAGEMENT: THE USE OF FIRE FOR PASTURE RENEWAL IN ALTO MINHO

Paulo Barreiro[1*], Paulo Rodrigues[2]

[1*]Instituto Politécnico de Viana do Castelo – Portugal - paulobarreiro@gmail.com*
[2] Instituto Politécnico de Viana do Castelo - Escola Superior de Tecnologia e Gestão – Portugal - prodrigues@estg.ipvc.pt

Received for publication: 25/03/2021 - Accepted for publication: 28/11/2022

Resumo

Gestão de custos: O uso do fogo para renovação de Pastagens no Alto Minho. Portugal tem sido alvo de incêndios de grandes dimensões nos últimos anos. Não há exceção para o Alto Minho, que ano após ano é devastado pelo fogo. Este território pauta-se pelo infortúnio de ocupar recorrentemente um lugar de destaque em número de ocorrências e de área ardida. Não obstante, congrega em si algumas peculiaridades, o que o tornam num território único. É em relação ao uso do fogo e a uma das suas particularidades que este estudo incide: os fogos para renovação de pastagens no Alto Minho. Esta causa de uso de fogo ronda anualmente os 10% do número total de ocorrências, mas pode ser responsável por mais de 50% de área ardida. Quantificar o custo relativo ao combate destes fogos poderá ser uma forma inicial para alertar e tentar inverter um processo de centenas de anos e cujos resultados são cada vez mais catastróficos. Os valores encontrados nesta investigação mostram-se elevados quanto ao valor de referência, pelo que urge uma alteração ao procedimento como um todo, enquanto solução dentro do próprio território.
Palavras-chave: Território, incêndio, custo, recursos.

Abstract

Portugal has been the target of large fires in recent years. There is no exception for the Alto Minho region, which year after year is ravaged by fire. This territory is characterized by the misfortune of occupying a prominent place in number of occurrences and burned area. Nevertheless, it brings together some peculiarities, which make it a unique territory. It is in relation to fire and one of its particularities that this study focuses: the fires for renovation of pastures in Alto Minho. Annually this cause of fire is around 10% of the total number of occurrences, but it may be responsible for more than 50% of the burnt area. Quantifying the cost of fighting these fires could be an initial way to alert and try to reverse a process with hundreds of years whose results are increasingly catastrophic. The values found in this investigation are high in relation to the reference value, so a change to the procedure as a whole is urgent, as a solution within the territory itself.
Keywords: Territory, fire, cost, resources.

INTRODUCTION

In a world increasingly driven by economic concerns, cost is a crucial ever-present aspect when it comes to undertaking a certain action or task; cost may impact even political decision. When change is devised, cost assumes a predominat role, as the process can only occur if it is also economically feasible, and if it meets all the other variable requirements that may be added to the equation.

It is within this reasoning that this work is developed. It intends to attempt to quantify the cost of a certain action carried out in a specific territorial space; to compare it to reference values of/for an alternative process; and to consider the possibility of changing the process if there are means to do so.

The work is the result of a master's thesis presented at the end of the *Mestrado de Gestão das Organizações* (master's programme in organizational management) of the *Instituto Politécnico de Viana do Castelo* (Polytechnic Institute of Viana do Castelo) in 2017/2018. The thesis work included a study, and the analysis and evaluated strategies for sustainable land management in relation to fires. The main objective was to verify whether or not ecological, economic, social, and cultural aspects are connected to the annual fires, identified and validated by the competent entity as being for pasture renewal. The study area was Alto Minho (Figure 1 - Map of Portugal marking the study area).

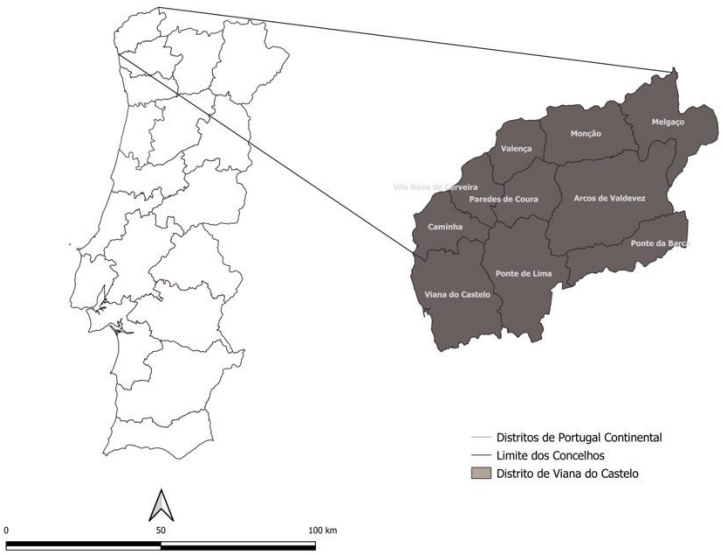

Figure 1 - Map of Portugal marking the study area.
Figura 1 - Mapa de Portugal a assinalar a área de estudo.

Additionally, we sought to identify the cost of firefighting in pasture renewal areas in Alto Minho, on a per-hectare scale, by calculating the cost of the reactive action that is firefighting compared to the preventive action using the same scale (hectare). The value per hectare is already defined and in use in Portugal, and it includes all costs associated with its implementation.

Ultimately, the proposal intended to recommend alternative processes to the ones that have historically prevailed and are currently in use, based on the values found.

The recent major wildfires in our country have instigated the paramount need to reflect on these occurrences. The fact that wildfires are a "by-product" of repeated and thoughtless actions, insofar as at its origin are applied and/or ignored measures, demands a systemic approach to this discussion.

The District of Viana do Castelo (Alto Minho) has, historically, been affected by a very high number of wildfires. In fact, the *Instituto da Conservação da Natureza e das Florestas, I.P.*, also known as ICNF (Portuguese Institute for Nature Conservation and Forestry)'s annual report indicates that it is one of the districts with more wildfires in the country. One of the reasons for this prominent position in the ranking lays in pasture renewal. These fires are responsible for a significant burned area every year. In 2017, a total of 1470 fires were registered in the District of Viana do Castelo; 151 were caused by pasture renewal. In 2016, there were 122 fires for pasture renewal for a total of 1466 fires. In 2015, there were1666 fires; 161 for pasture renewal (DGAPPF, 2018).

In Alto Minho there are many animals. According to the data collected in the "Agriculture Statistics" compendium in 2016, with the help of the *Direção Geral de Alimentação e Veterinária*, also known as DGAV, (General Directorate of Food and Veterinary), there were 69 994 animals registered, including horses, cattle, sheep, and goats. These are either the main source of income or a complement source of income for families.

Is there a connection between wildfires and pastoralism in Alto Minho? This connection may be traced back to ancestral customs, where controlled burns were used to renew pastures to feeds the animals, however, this ancestral custom also brings ancestral problems.

Therefore, we have a centuries-old conflict: on the one hand, there is the need to renew pastures using prescribed burning and, on the other hand, the great risk of doing so at certain times of the year, when many variables cannot be controlled.

This reflection leads us to the following initial questions:

a) Is sustainable cost management for pastures possible?

b) Could the integration of ecological, economic, and social aspects, in the form of sustainable management of annual fires associated with pasture renewal in Alto Minho, and the possibility of calculating their cost in terms of firefighting per hectare, enable a better use of controlled fires?

c) Could an annual value per hectare (firefighting for pasture renewal) and a reference value, used for comparison, change reaction and enhance prevention?

In view of the above, the following research questions emerged:

1. Is the cost per hectare in firefighting higher than the current reference value used by the ICNF for prescribed burning per hectare?

2. Does the use of prescribed burning allow for efficient management at a lower cost when compared to firefighting for pasture renewal?

3. In wildfires are the risks higher than in prescribed burning operations, both for firefighters and for the equipment?

4. Are there feasible combinations of social, economic, and ecological states to maintain the intervention procedures in firefighting for pasture renewal in Alto Minho?

After presenting the research questions, we list the intended objectives presented below as general and specific objectives.

General objectives:

a) Verify the added value of prescribed burning in pasture renewal management in Alto Minho.
b) Describe the real costs of wildfires associated with pasture renewal in Alto Minho.
c) Georeference pasture renewal-related occurrences and their consequences.

Specific objectives:

a) Describe the connection between the existence of animals and pasture renewal.
b) Quantify the value per hectare for firefighting associated with pasture renewal.
c) Quantify equipment costs.
d) Quantify operational costs in firefighting.
e) Quantify the costs of operational logistics.
f) Georeference the point of ignition in pasture renewals in Alto Minho.
g) Georeference the areas burnt by ignitions associated to pasture renewal in Alto Minho.

In order to answer the questions presented within the framework of the objectives, we temporally limited our study from January 2015 to December 2017 (3 years).

The land and the people in alto minho

The uniqueness of the landscapes and the authenticity of the culture in Alto Minho, coupled with its vast and rich environmental heritage are values that highlight its rural landscape as a social, ecological, cultural, and economic infrastructure. Despite its uniqueness and relevance which needs to be identified, it is important to detail its potentials and its vulnerabilities. Addressing the theme of this work, controlled burning can coexist in order to maintain and make this landscape more productive and resilient (BENEDITO, 2017).

Similar to the information that we can find pertaining to the national landscape, the district of Viana do Castelo was also the stage of major fires described in the work of Quintanilha and Moreira da Silva (1965), *"A partir de 1960, nos Perímetros Florestais, o valor dos prejuízos processou-se num ritmo alarmante (2500, 4000 e 9500 contos naquele ano e nos dois seguintes) e só em 1962, num incêndio, se perderam, apesar de todos os esforços, quase 5000ha de pinhal e sentiu-se a inoperância do ataque logo que o sinistro atingisse determinadas proporções*" (QUINTANILHA, SILVA MOREIRA 1965 *apud* LEITE, *et al*. , 2014, p.191). From 1960, in the Forest Perimeters, the value of the losses was processed at an alarming rate (PTE 2500, 4000 and 9500 in that year and the two following years), and in 1962 alone, in a fire, despite all efforts, almost 5,000 hectares of pine forest were lost and the inoperability of the attack was felt as soon as the disaster reached certain proportions[1].

It was from the 1960s onwards that the serious impact, related to seasonality, of the scourge of major forest fires in "*Portugal continental, alinhados com o êxodo da população serrana e o progressivo abandono da atividade florestal, intimamente ligada à atividade agrícola, que paulatinamente iria deixar os pinhais entregues a si próprios. As florestas deixaram de ser geridas, porque os matos não eram roçados e a lenha deixou de ser utilizada como fonte de energia. Tanto as transformações sociais e económicas verificadas, como a alteração de hábitos e costumes das populações, delas decorrentes, vieram alterar profundamente o relacionamento entre as comunidades e a floresta, outrora íntimo, equilibrado e interligado, que pouco a pouco foi deixando de existir, abrindo campo aos grandes incêndios florestais*." (LEITE, FLORA C. FERREIRA *et al*. 2014, p.194). Mainland Portugal, aligned with the exodus of the mountain population and the progressive desertion of forestry activities, closely linked to agricultural activities, would gradually leave the pine forests to their own devices. The forests ceased to be managed because the scrub was not cleared, and firewood was no longer used as a source of energy. Both the social and economic transformations that took place and the resulting changes in people's habits and customs deeply changed the once close, balanced, and interconnected relationship between the communities and the forest, opening the field to large forest fires[2].

Cultural, social and economic aspects

In Portugal, when the rural population migrated to urban areas and to some European countries, there was a generalised abandonment of the traditional use of the land, which was based on the trio agro-silvo-pastoral

[1] Our Translation
[2] Our Translation

activities. As a result of these practices, a large amount of biomass was produced, but it was also collected by the population and used as a source of fuel or in animal bedding. A large part of the pine resin and plaggen was also collected in the pine forests.

Bento Gonçalves (2010) refers to this phenomenon, especially during the 50s and 60s, when the fields of the villages and towns in the interior of Portugal began to reveal a low population density, associated with an ageing rural population, the absenteeism of forest owners, an increase of the forest area (either due to reforestation or the progressive abandonment of the fields), and a poorly prepared and uncontrolled forest.

As time went by, other sources of domestic energy such as gas and electricity appeared, breaking the customary use of firewood that maintained the "natural" balance between what was produced by the forests and human use, thus leading to the accumulation of large quantities of biomass fuel (CARVALHO *et al.*, 2008).

More recently, the European Union, with its agricultural policies, has also contributed to the breakdown of the productive structure and a mass abandonment of traditional agricultural activities and methods. The plantation of dense shrub and trees in old fields fosters the growth of horizontal and vertical fuel. Thus, in high-risk seasons, where the high temperatures are coupled with scarce precipitation, flame propagation is easy. This explains, in part, the increase in the magnitude and frequency of fires (CARVALHO *et al*., 2008). Lourenço (1986) states that fires are like links of a long chain; their causes and consequences are so many that some may still be unknown.

Pastoralism and extensive livestock production represent an irreplaceable way of enhancing the value of less-productive land. From a socio-economic point of view, extensive grazing is still the only profitable way to exploit a significant part of our land. Additionally, this activity generates productions that are easy to market, especially if we consider the quality of the products and the growing demand for certified products (CASTRO, 2008). It is essential for the population to participate in an explanatory, clear and objective dialogue, so that they understand what is intended, and allowing their problems and expectations to be heard (MIRANDA, 2000).

Fire for pasture renewal / existence of grazing animals

"Manter a qualidade e quantidade de forragem e a composição da vegetação constituem os objetivos de gestão em áreas de pastoreio extensivo. O uso do fogo é obrigatório, mas num regime de aplicação cuidadoso, e que permita estabelecer um mosaico vegetativo, vantajoso tanto para o gado como para a prevenção de incêndios. A resposta da vegetação ao fogo resulta num incremento da palatabilidade, da quantidade e qualidade das herbáceas e arbustivas. Fogos de baixa ou moderada intensidade resultam em mais e melhor forragem para o pastoreio dos animais" (FERNANDES, *et al.* 2002, p.6). Maintaining the quality and quantity of forage and the composition of the vegetation constitute the management objectives in extensive grazing areas. The use of fire is compulsory, but should be carefully implemented, and in a way that that create a vegetative mosaic, advantageous both for livestock and for fire prevention. The response of the vegetation to fire results in an increase in tastiness, quantity, and quality of the herbaceous and shrubby plants. Low or moderate intensity fires result in more and better forage for grazing animals[3].

The aim of this work is to verify/validate the existence of fire occurrences caused by pasture renewal and its connection to the number of animals that graze the study area.

MATERIAL AND METHODS

This is an exploratory and descriptive study. According to Gil (2017), a study with these specificities involves literature research and data collection in order to provide greater familiarity with the problem in order to make it more explicit. An exploratory study is characterized by flexibility, creativity, and informality. This is how we sought to discover the reality to be researched.

The descriptive study emerges after acquiring knowledge on the topic and trying to describe the phenomenon. According to Triviños (2009), descriptive studies present facts and phenomena of a given reality. Research questions were formulated based on this knowledge in order to search for answers that would help clarify the initial questions.

Our option for a case study represents the preferred strategy when questions are raised in which the researcher has little control over events and when the focus is on contemporary phenomena embedded in a real-life context (YIN, 2015). It is an appropriate research methodological approach when we seek to understand, explore, or describe complex events and contexts, in which several factors are simultaneously involved (ARAÚJO *et al*., 2008).

This research involves a quantitative approach which consisted of collecting observable and quantifiable data from ICNF's *Sistema de Gestão de Informação de Incêndios Florestais*, also known as SGIF (Forest Fire Information Management System), where we searched burnt areas, burnt stands, and causes of fires. Information

[3] Our Translation

regarding commitment times, kilometres travelled, pump hours, resources involved (including the number of elements, types of vehicles and aircraft), operational logistics and damage was retrieved from *Sistema de Apoio à Decisão Operacional*, also known as SADO (Operational Decision Support System), the database that belong to *Autoridade Nacional de Emergência e Proteção Civil*, also known as ANEPC (National Authority for Emergency and Civil Protection).

RESULTS

The presence of fires per parish is crucial to interpret the consequences that fires have on pasture renewal, namely in order to enable field interventions and to enable macro level conciliations.
The graphs in the two following figures (Figure 2 and Figure 3) show SPSS's results when the variable presence of fires for pasture renewal was divided by the set of municipalities of the study area. The first illustrates the presence of fires for pasture renewal per municipality (Figure 2) and the second the absence of fires for pasture renewal (Figure 3). Thus, the four municipalities (Figure 2) that suffer more of this type of occurrence are: Arcos de Valdevez, Ponte da Barca, Ponte de Lima and Melgaço.

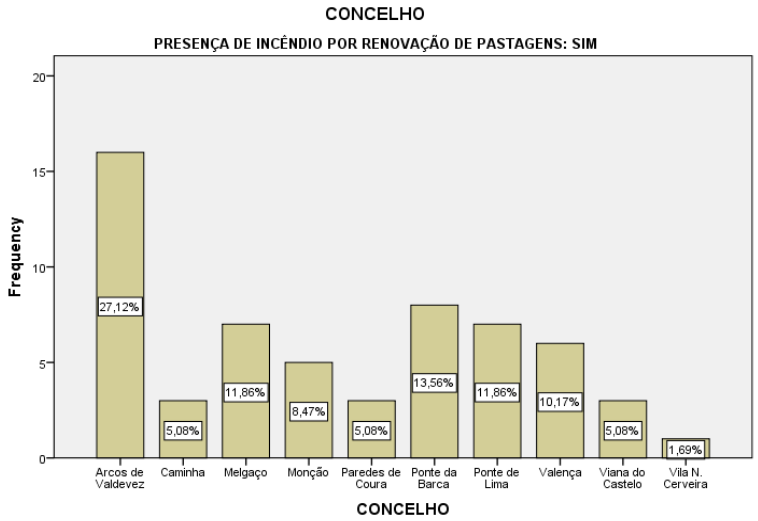

Figure 2 - Frequency of fires due to pasture renewal by municipality.
Figura 2 - Frequência de incêndios para renovação de pastagens por concelho.

Figure 3 depicts the parishes of the ten municipalities that do not suffer from fires due to pasture renewal, resulting in the identification of the municipalities that have no occurrences: Ponte de Lima, Viana do Castelo, Arcos de Valdevez and Monção. On opposing stances (yes and no) we have repeated municipalities: Ponte de Lima and Arcos de Valdevez.

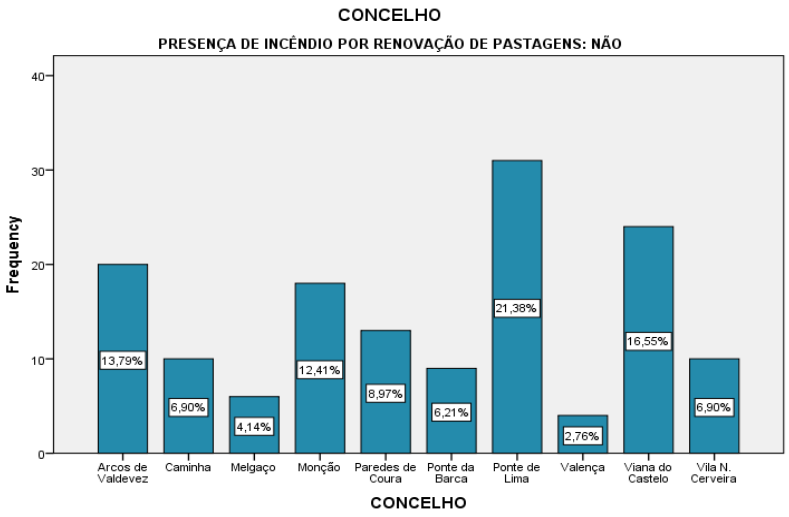

Figure 3 - No frequency of fires due to pasture renovation by municipality.
Figura 3 - Não frequência de incêndios para renovação de pastagens por concelho.

Levene's test was applied, with a p-value =0.262 (>α=0.05). This is a statistically significant value, thus assuming equality of variances. The t-test for equal means, with a p-value =0.573 (>α=0.05), reveals that there are no statistically significant differences between the number of occurrences in the years under analysis.

In the year 2016, the correlation coefficient value R=0.192 allows us to conclude that there is a very weak positive relationship between the two variables. Therefore, the number of animals may not have implications on the number of occurrences of fires for pasture renewal.

Having checked the overall significance of the model (ANOVA), with a p-value= 0.270(>α=0.05), we established that the model is not significant.

In the year 2017, we verified a correlation coefficient value R= 0.323. We can conclude that there is a weak positive relationship between the two variables, thus the number of animals may not have implications on the number of occurrences of fires for pasture renewal.

Having checked the overall significance of the model (ANOVA), with a p-value= 0.013(<α=0.05), we established that the model is significant.

Thus, from the analysis of the characteristics of the study are, the municipalities of Arcos de Valdevez, Ponte da Barca and Melgaço stand out as being the municipalities with the highest number of occurrences for pasture renewal (138, 90 and 25, respectively), and with considerably higher percentages in comparison with other municipalities, with due consideration of the parishes. We note a localized pattern on the map, *i.e.*, they are the three municipalities furthest from the coast of the district and they border each other. This fact may suggest some type of erratic pattern by the different social agents.

On the other hand, despite having a large number of animals, the municipalities of Viana do Castelo and Ponte de Lima do not have a significant number of occurrences, which may be the result of management policies, order and organization in the feeding of grazing animals, or because it is only related to the specific breeding/grazing that does not occur in the other municipalities.

As to the positive or negative connection between the number of grazing animals and fires, the results demonstrate that this is not linear nor is the connection strong. However, a trend was effectively found in the sample that revealed that the probability of fires occurring is influenced by a higher number of grazing animals.

Ignitions and burnt areas for pasture renewal

In 2015, there were 161 ignitions for pasture renewal, with a burnt area of 1457.8 ha. In 2016, there were 122 ignitions, but the corresponding area was 2891 ha. In 2017, there were 151 ignitions, and the burnt area was 6730.5 ha (Source: SGIF).

DISCUSSION

The cost of fire for pasture renewal in Alto Minho

Operating costs may be as all those costs that contribute to the day-to-day maintenance and administration of an activity. Here, costs related to direct labour, use or rental of tangible fixed assets, and costs associated with logistics and claims are presented.

Regarding the human resources involved in the occurrences, there is an inherent cost, referring to the period in which they are committed to the occurrence. These days and hours represent a heavy "slice" of expenses that must be quantified.

The time, in hours, of commitment relative to the different structures in combat and their operatives assigned to fires for pasture renewal in Alto Minho in the period under study (Table 1), reflect a significant increase for the years under study.

Table 1 - Hours Engagement.
Tabela 1 - Horas Empenhamento.

Year	Hours Occurrence	Fire Brigade	Forestry Firefighters	GNR – GIPS*	GNR/PSP*	Other
2015	824:41	10487.13	949.55	168.75	438.77	889.52
2016	639:27	22120.53	2996.10	930.87	214.40	1168.25
2017	946:54	32432.60	4566.25	1369.42	3841.13	4347.70

*Republican National Guard (GNR) and Police Force (PSP) and Members of the Intervention, Protection and Rescue Group (GIPS)
Fonte: SADO e SGIF 2019/ Source: SADO and SGIF 2019.

The commitment of the different workers represents a cost, which is indexed to the salaries established for those on call (Table 2), whose values accompany the increase noted in Table 1.

Table 2 - Human Resources Cost.
Tabela 2 - Custo de Meios Humanos.

Year	Fire Brigade	Forestry Firefighters	GNR - GIPS	GNR/PSP	Other	TOTAL
2015	35 091.55 €	3 177.34 €	1 072.94 €	2 789.77 €	2 976.47 €	45 108.07 €
2016	74 018.70 €	10 025.41 €	5 918.61 €	1 363.19 €	3 909.14 €	95 235.06 €
2017	108 524.47 €	15 279.38 €	8 706.98 €	24 422.50 €	14 548.07 €	171 481.40 €

Fonte: SADO e SGIF 2019/ Source: SADO and SGIF 2019.

The fires for pasture renewal in Alto Minho also aggregate other costs, which were considered and listed briefly.

The aerial resources operating in firefighting in Portugal are characterised by being fixed-wing resources (aircraft) or rotary-wing resources (helicopters). There are different models for each of the identified types, with different water-load capacities and different specificities, namely scooping capacity, and different cost per hour values.

The types of vehicles used in firefighting are varied, so they have to be grouped according to their specificities, namely whether they have a water pump or not. Thus, the distances travelled and the operating hours of the pumps in fires for pasture renewal in Alto Minho were analysed together.

According to the different types of vehicles, there are also different fuel consumptions. For the values to be the closest to reality as possible, the average values of fuel prices at the time were considered. The wear and tear factor associated to these vehicles was considered to be 10% of the cost of the fuel used. We are aware that this is a low value given the conditions in which these vehicles work.

In the analysed occurrences for the years under study, we noted the intervention of Bulldozers in some. Thus, the respective costs were also considered.

Expenses related to logistics, damage and repairs resulting from firefighting during this period, that were quite large, were also considered individually. Due to the losses identified in 2017, a Military Logistics Platform was set up in Monção to support the population for 49 days. The total cost was 237 270.67€, including military personnel, vehicles, and food. The particular reference to this action is due to the fact that it was unprecedented in Alto Minho; the costs were included in logistics.

Every year, besides the areas identified as scrub, these fires sometimes reach undesirable proportions or areas, and are also responsible for burning stands, as can be seen in Table 3 (Burned stands).

Table 3 - Burnt stands.
Tabela 3 - Povoamentos queimados.

Year	Burnt stands (hectares)	Media m3/ha	Average price/ha	TOTAL Reference value
2015	266,46	250	8 750.00€	2 331 525.00 €
2016	821,69	250	8 750.00€	7 189 787.50 €
2017	1526,23	250	8 750.00€	13 354 512.50 €

Fonte/Source: ICNF, 2019.

Considering an average price per hectare of 8 750€, the loss of stands in the years under study is 2 331 528€ for 2015, 7 189 787.50€ for 2016, and 13 354 512.50€ for 2017. No values were considered for scrub, or areas of higher value stands, or values for ecosystems lost forever.

It is also necessary to analyse the total costs of the means allocated, logistics and damages caused by fires for pasture renewal (Table 4), in order to obtain the final cost of firefighting for pasture renewal in Alto Minho in the years under study (Table 5), both of which reflect a considerable increase over the years.

Table 4 - Total costs of the committed means.
Tabela 4 - Custos totais dos meios empenhados.

Year	Workers	Aerial resources	Vehicles	Bulldozers	Logistics Damage	TOTAL
2015	45 108.07 €	14 860.13 €	6 302.47 €	0.00€	30 747.87 €	97 018.54 €
2016	95 235.06 €	286 847.55 €	5 245.90 €	4 521.00 €	46 171.25 €	438 020.76 €

2017	171 481.40 €	57 728.45 €	9 457.16 €	2 910.67 €	458 047.04 €	699 624.72 €

Source/Source: SADO, 2015,2016 and 2017.

Table 5 (final cost of firefighting) presents the final cost of fire fighting for pasture renewal in Alto Minho in the years under analysis.

Table 5 - Final cost of firefighting.
Tabela 5 - Custo final do combate aos incêndios.

Year	Total firefighting	Value Burnt Stand	Burnt area/ha	Final cost/ha	No cost burnt stand
2015	97 018.54 €	2 331 525.00 €	1457,805	1 665.89 €	66.55 €
2016	438 020.76 €	7 189 787.50 €	2891,398	2 638.10 €	151.49 €
2017	699 624.72 €	13 354 512.50 €	6730,563	2 088.11 €	103.95 €

Fonte/Source: SADO, 2015, 2016 and 2017.

The value for the final cost found for the hectare in firefighting for pasture renewal in Alto Minho is 1665.89€ for the year 2015; 2 638.10€ for the year 2016; and 2 088.11€ for the year 2017. This significant increase in the value comes from the fires that caused stand losses and undesirable consequences.

When we only consider the value of the committed means in these operations, exempting the huge economic losses with regard to stand - 65.55€ in 2015; 151.49€ in 2016; and 103.95€ in 2017 - these do not compensate for the possible risk, although it is mostly below the reference value for the hectare (120€).

This reference value excludes losses of intangible assets, possible risks in each occurrence, as well as other losses generated by the committed means, when the cause is the pasture renewal. Another disadvantage is that, eventually, these fires may delay help for the population, if we consider that the committed means could otherwise be free, if this was not a reactive process, but rather more preventive in nature.

It is necessary note that fire for pasture renewal in Alto Minho is in urgent need of change. Given its importance, its predictability, and its need, concrete and rapid changes of attitude are urgent given that the tools are already available.

In this process, the involvement and inclusion of the population is mandatory, an added value in the process of change. Populations are sources of knowledge, holders of knowledge.

CONCLUSION

It is possible to conclude that:

- All the initial questions were confirmed. It is not economically feasible to maintain the current situation - waiting for fires to begin and then fight them. There is a Portuguese saying that goes “correr atrás do prejuízo” (chasing after your losses) is not feasible. It is necessary to carry out new procedures in order to counteract the need to fight fires to renew pastures.
- It is not feasible, as the initially indicated, for Alto Minho to perpetuate the current logic of fighting fires, which can and should be anticipated. Awareness campaigns to avoid risky behaviour do not seem to have any effect, nor is it possible to expect a celestial resolution for the pasture paradox, or even to expect the repopulation of the land to have the desired effect.
- Many occurrences noted throughout history present enough facts that prove that, currently there are no effective guidelines that could possibly indicate changes to the process to achieve different results. On the contrary, with all the social and economic changes experienced in the last half of the last century in our study area, it tends to get worse. It is therefore not possible have confidence on empiricisms when, over the last 800 years of history, the process has proved to be of little or no use and has not achieved positive results.
- The issue must be addressed clearly, without taboos. It has always existed.
- The proposals and guidelines are missing.
- It is essential to work upstream with the populations. They will know where to do it.
- It should be a continuous, credible process, implemented locally, and not just isolated measures where abandonment leaves the population unresponsive, discredited, and angry.
- It should be an aid which does not clash with other measures in force by the Ministry of Agriculture and which represent income for the population.
- Ministry of Agriculture should be in the process from the very beginning.
- It requires responsibility, commitment, and involvement of all agents involved.
- Special consideration should be given to protected areas, whose conflict-generating problems need to be resolved by the organisations that eventually created and/or perpetuate them.

- The intervention will have to be systematised and involving the population. Working in the field, listening to their needs, meeting the population, gaining their trust and, above all, developing actions that are sustainable, because isolated acts and inconstant measures bring harmful consequences to the processes and organisations.
- The possibility of insisting on the empowerment of the population is a solution which has been tested over the years and, given its ineffectiveness, it is a method to be abandoned. The almost 70 000 animals in Alto Minho are a reality, those that prevail over the years will strengthen the forest's defence against fires because they reduce the fuel. It is necessary to guarantee the presence of the population and animals, but in such a way that it is economically feasible, otherwise abandonment is certain, and within a short period of time.
- The need to responsibly reduce the drama fires cause in Portugal will have to pass through real solutions, and by discussing them clearly, openly, continuously, and cohesively. It is necessary to put an end to the constant accusations and assumptions, made by those that, in the last decades, have not contributed in any way to the reduction of the scourge. Portugal is a small country that has room for everyone.

REFERENCES

ARAÚJO, Cidália *et al.* **Estudo de Caso. Métodos de Investigação em Educação**. Instituto de Educação e Psicologia, Braga, Universidade do Minho, 2012. Available at: http://grupo4te.com.sapo.pt/estudo_caso.pdf Accessed: 21 May 2019.

BENEDITO, S. **A ecologia do fogo: uma proposta de ação**. 2017 Available at: https://www.publico.pt/2017/12/21/sociedade/opiniao/a-ecologia-do-fogo-uma-proposta-de-acao-para-arquitetura-arquitetura-paisagista-e-urbanismo-1796553. Accessed: 20 February 2019.

BENTO-GONÇALVES, ANTÓNIO; VIEIRA, ANTÓNIO; MARTINS, CARLA; FERREIRA-LEITE, FLORA E COSTA, FRANCISCO. **A desestruturação do mundo rural e o uso do fogo – O caso da serra da Cabreira (Vieira do Minho). Caminhos nas Ciências Sociais**. Memória, mudança social e razão – Estudos de homenagem a Manuel da Silva Costa, Grácio Editor, Universidade do Minho, 2010, p.110, 115.

CARVALHO, A., FLANNIGAN, M. D., LOGAN, K., MIRANDA, A. I., e BORREGO, C. Fire activity in Portugal and its relationship to weather and the Canadian Fire Weather Index System. **International Journal of Wildland Fire**, v. 17, 2008, p. 328-338.

CASTRO, M. A utilização dos pequenos ruminantes na prevenção dos incêndios rurais: estratégia pró-ativa e promoção silvopastoril. **A silvopastoricia na prevenção dos fogos rurais**, Lisboa, Instituto Superior de Agronomia press, 2008.

DEPARTAMENTO DE GESTÃO DE ÁREAS PÚBLICAS E DE PROTEÇÃO **Florestal** (DGAPPF)/ Divisão de Defesa da Floresta e Valorização de Áreas Públicas (DDFVAP) Número 6ºRIR/DDFVAP, 2018, Available at http://www2.icnf.pt/portal/florestas/dfci/Resource/doc/rel/2018/6-RIR-1jan-5set2018.pdf Accessed: 17 September 2018.

FERNANDES, P. **Mitigar os efeitos dos incêndios rurais**. Vila Real, Departamento Florestal, Universidade de Trás –os-Montes e Alto Douro, 2021. Available at https://www.researchgate.net/publication/351412885_Mitigar_os_efeitos_dos_incendios_rurais Accessed: 11 May 2021.

FERNANDES, P., BOTELHO, E. e LOUREIRO, C. **Manual de Formação para a Técnica do Fogo Controlado**. Vila Real, Departamento Florestal, Universidade de Trás-os-Montes e Alto Douro. 2002, p.145.

LEITE, F. C. F.; GONÇALVES, A. J. B.; LOURENÇO, L. Grandes incêndios florestais na década de 60 do séc. XX, em Portugal continental. **Territorium - Revista da Associação Portuguesa de Riscos, Prevenção e Segurança**, n. 21, 2014, p.189-195.

LEITE, F.; C. Ferreira; Gonçalves, António José Bento; Lourenço, Luciano, **Grandes Incêndios Florestais na Década de 60 do Seculo XX, em Portugal Continental**. Associação Portuguesa de Riscos, Prevenção e Segurança. Impactum Coimbra University Press, 2014, p.191.

LOURENÇO, L. **Consequências geográficas dos incêndios florestais nas serras de xisto do Centro de Portugal**. Actas. IV Colóquio Ibérico de Geografia, Coimbra, 1986, p. 943-957.

GIL, A. C. **Como elaborar projetos de pesquisa**. S. Paulo: Atlas, 6th ed., 2017, p. 175.

MIRA, M.; LOURENÇO, L. Grandes incêndios florestais de 17 de junho de 2017 em Portugal e exemplos da determinação das respetivas causas. **Territorium - Revista da Associação Portuguesa de Riscos, Prevenção e Segurança** n. 26, 2019, p.49-60.

MIRANDA, J. Contributos para a definição de uma estratégia de intervenção em zonas de montanha, **Cadernos da Montanha Peneda – Gerês II**. Arcos de Valdevez, Câmara Municipal de Arcos de Valdevez, 2000, p. 101 – 107.

RODRIGUES, A. S. **O Impacto Socioeconómico dos Incêndios Florestais no Concelho de Seia**. Dissertação de mestrado, Coimbra: Faculdade de Economia da Universidade de Coimbra, 2014.

TAVARES, A. F. Q. Incêndios florestais, o contributo da GNR para o sucesso da missão. Lições a retirar dos incêndios de 2017. **Territorium - Revista da Associação Portuguesa de Riscos, Prevenção e Segurança**, n. 26, 2019, p. 167-179

TRIVIÑOs, A. N. **Introdução à pesquisa em Ciências Sociais**. S. Paulo: Atlas, 2009, p. 175.

YIN, R. K. **Estudo de caso: Planejamento e Métodos**. Bookman: Porto Alegre, 5th ed., 2015, p. 205.