

Forest Fires in Protected Areas in Portugal and in the State of Santa Catarina (Brazil): Comparative Analysis of Policies of Prevention and Recovery of Burned Areas

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ABSTRACT

Protected areas are intended at the protection and maintenance of the ecological diversity and its natural and cultural resources through legal or other effective means. However, the forest fires which recurrently affect these areas have contributed to the degradation of the landscape, the destruction of their ecosystems and to a change in terms of their ecological and economic value.

Despite all prevention and combat measures which have been implemented over the last few years, recent data suggest that both Portugal and Brazil have seen an increase in the number of forest fires in protected areas.

In Portugal the number of forest fires in protected areas has increased considerably since 1992. The maximum number of occurrences was reached in 2003 and 2005. Between 1992 and 2005 the annual average area burned was 10,418 ha and in the period 2001-2005 16,025 ha.

In Brazil the number of forest fires in protected areas has also increased significantly. According to Soares, Batista and Santos (2005), based on a sample of about 50% of the Brazilian states, the number of forest fires increased from 1,754 in the period 1983-1987 to 19,337 between 1998 and 2002, although there was at the same time a decrease in terms of average burned area per fire. Throughout this period the Brazilian state of Santa Catarina stands out as the state recording not only a decrease in the number of fires, but also the lowest number of occurrences – from 36 fires in the 1980s to 22 between 1998 and 2002, which represents 0.1% of the protected areas of the country.

Based on these facts the main objectives of the present research are: analyse the incidence, severity and causes of forest fires in protected areas in both countries characterised by different geographic and cultural realities; assess the impacts of prevention and combat policies as well as the strategies and models implemented in the recovery of burned areas.

The methodology adopted was the administration of a survey to all protected areas of both countries intended at, from the analysis of the collected data, establish partnerships based on successful experiences.

Introduction

Protected areas are designed for the protection and maintenance of the ecological diversity and the natural and cultural resources featured in these areas through legal or other effective means. However, the forest fires which recurrently affect these areas have contributed to the degradation of the landscape, the destruction of their ecosystems and to a change in terms of their ecological and economic value. In addition to these consequences, forest fires contribute to global warming due to greenhouse gas emissions. Brazil, for instance, contributes with 3% of the total greenhouse gas emissions according to the parameters of the Kyoto Protocol (Pereira; et al., 2004) and out of this, 65% come from deforestation and forest fires¹.

Despite all prevention and suppression measures implemented over the last few years, recent data suggest that both Portugal² and Brazil have seen an increase in the number of forest fires in protected areas. Based on these facts the main objectives of the present research are: analyse the incidence, severity and causes of forest fires in protected areas in Portugal and Brazil, characterised by different geographical and

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cultural realities; assess the impacts of prevention and suppression policies as well as the strategies and models implemented in the recovery of burned areas. Given the larger extension of the Brazilian territory when compared to Portugal, we opted for taking into consideration in this study only the state of Santa Catarina³.

The National Network of Protected Areas in Portugal is constituted by protected areas of national interest comprising the categories of national park, natural reserve, natural park, natural monument, and also by protected areas of regional or local interest designated protected landscapes. There are also private protected areas, which are commonly named «sites of biological interest».

In Brazil nature conservation units are divided into Integral Protection Conservation Units and Sustainable Use Conservation Units. Integral Protection Conservation Units include the categories of Ecological Station, Biological Reserve, Park, Natural Monument and Wildlife Refuge. These aim basically at promoting nature conservation while allowing the indirect use of the units' natural resources⁴. The Sustainable Use Conservation Units are designed to combine nature conservation with the direct use of part of the units' natural resources. This group includes Environmental Protected Area, Relevant Ecological Interest Reserve, National Forest, Extractive Reserve, Fauna Reserve, Sustainable Development Reserve, Private Natural Heritage Reserve. In the State of Santa Catarina there are 14 federal conservation units (Table 1) and 9 state conservation units (Table 2).

Table 1 – Total Number of Federal Conservation Units in the State of Santa Catarina

Conservation Unit	Area (ha)	Establishment Date
Mata Preta Ecological Station(4)		
Carijó Ecological Station (2)	712,00	Decree n. 94.656/87
Serra do Itajaí National Park	57,475,00	Decree 04/06/2004
São Joaquim National Park	42,837,00	Decree n. 50.922/ 61
Araucárias National Park (3)	12,841,00	Decree 19/10/2005
Arvoredo Maritime Biological Reserve (1)	17,600,00	Decree n. 99.142/ 90
Anhatomirim Environmental Protection Area (1)	3,000,00	Decree n. 528/92
Baleia Franca Environmental Protection Area (1)	156,100,00	Decree n. 14/09/2000
Serras das Abelhas e Rio da Prata Relevant Ecological Interest Reserve	5,025,00	Decree 005/90
Caçador National Forest	710,44	Implementing Order n. 560/68
Chapecó National Forest	1,606,00	Implementing Order 560/68
Ibirama National Forest	570,58	Decree n. 95.818/88
Três Barras National Forest	4,458,00	Implementing Order n. 560/1968.
Pirajubaé Maritime Extractive Reserve (1)	1,444,00	Decree n. 533/92
Total	304,379,02	

Source: Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute of Environment and Renewable Natural Resources), 2006.

- (1) Not included in the study because this is a marine conservation unit; (2) This is a mangrove area; (3) Although the unit has returned the questionnaire, it has not been considered as the unit was only established in 2005 and is yet to record a forest fire; (4) No data available;

Table 2 - Total Number of State Conservation Units – State of Santa Catarina

Conservation Unit	Area (ha)	Decree/Established
Serra do Tabuleiro State Park	87,405,00	Decree n. 1.260/75
Serra Furada State Park	1,329,00	Decree n. 11.233/80
Sassafrás State Biological Reserve	5,223,00	Decree n. 2.221/77
Canela Preta State Biological Reserve	1,899,00	Decrees 11.232/80
Aguai State Biological Reserve	7,672,00	Decree n. 19.635/83
Araucárias State Park	612,00	Decree n. 293/03,
Fritz Plaumann State Park	740,00	Decree n. 797/03
Rio Canoas State Park	1,200,00	Decree n. 1.871/04
Acaraí State Park	6,667,00	Decree 3.517/05
Total	112,747,00	

Source: IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis [Brazilian Institute of Environment and Renewable Natural Resources], 2006

A questionnaire was sent out by e-mail to all protected areas of both countries, except areas constituted exclusively by marine reserves. The questionnaire was structured in 5 sections: dimension and causes of forest fires, fire prevention measures, fire surveillance, fire suppression, recovery of burned areas, amounting to a total of 50 questions.

In Portugal a total of 29 questionnaires were sent to all parks, protected landscapes and natural reserves (Table 3); we have excluded from this study the remaining protected areas, since they are in principle less vulnerable to forest fires. Only 14 questionnaires were returned, representing a coverage ratio of 48%. The response from the conservation units of the State of Santa Catarina was extraordinary, since all state and federal units returned the questionnaire amounting to a total of 17 questionnaires⁵.

Table 3 – Identification of the protected areas in Portugal which have returned the questionnaire

Protected Area	Area (ha)	Establishment Date
Peneda-Gerês National Park	69,592,50	Law Decree n. 187/71
Alvão Natural Park*	7,202,66	Law Decree n. 237/83
Vale do Guadiana Natural Park*	69,669,30	Reg. Decree n. 28/95
Serras d' Aire e Candeeiros Natural Park	38,392,53	Law Decree n. 118/79
Serra de São Mamede Natural Park	56,058,87	Law Decree n. 121/89
Sudoeste Alentejano e Costa Vicentina Natural Park*	60,485,05	Law Decree n. 241/88
Sintra-Cascais Natural Park*	14,450,85	Law Decree n. 292/81
Montesinho Natural Park	74,544,62	Law Decree n. 355/79
Litoral Norte Natural Park*	1,316,64	Law Decree n. 357/87,
Ria Formosa Natural Park	17,900,92	Law Decree n. 45/78
Serra da Estrela Natural Park	99,478,05	Law Decree n. 557/76,
Arrábida Natural Park*	11,054,74	Law Decree n. 622/76
Douro Internacional Natural Park	87,011,26	Law Decree n. 8/98
Tejo Internacional Natural Park	23,728,05	Reg. Decree n. 9/00
Serra do Açor Protected Landscape*	373,40	Law Decree n. 67/82
Albufeira do Azibo Protected Landscape*		Reg. Decree n. 13/99
Corno do Bico Protected Landscape		Reg. Decree n. 21/99
Lagoas de Bertandos e São Pedro dos Arcos Protected Landscape		Reg. Decree n. 19/00
Arriba Fóssil da Costa da Caparica Protected Landscape	1,551,50	Law Decree n. 164/84
Serra de Montejunto Protected Landscape		Reg. Decree n. 11/99
Serra da Malcata Natural Reserve*	16,158,66	Law Decree n. 294/81
Dunas de São Jacinto Natural Reserve*	733,52	Law Decree n. 41/79
Paul de Arzila Natural Reserve*	586,76	Law Decree n. 219/88
Berlengas Natural Reserve*		Law Decree n. 264/81
Paul do Boquilobo Natural Reserve	817,62	Law Decree n. 198/80
Sapal de Castro Marim e Vila Real de Santo António Natural Reserve*		Law Decree n. 162/75
Lagoas de Santo André e da Sancha Natural Reserve	3,123,39	Reg. Decree n. 10/00
Estuário do Sado Natural Reserve*	17,206,06	Law Decree n. 430/80
Estuário do Tejo Natural Reserve*	9,846,48	Law Decree n. 565/76

* So far this protected area has not returned the questionnaire.

The incidence of forest fires in protected areas in Portugal and Santa Catarina (Brazil)

In Portugal the number of forest fires in protected areas has increased considerably since 1992. The maximum number of occurrences was reached in 2003 and 2005. These were also the years with the largest burned area recording 28,272,90 ha and 20,432,44 ha, respectively (MAOTDR, 2006:9). Between 1992 and 2005 the annual average area burned was 10,418 ha and in the period 2001-2005 about 16,025 ha.

Although the concern with the protection of the natural heritage against fire arose effectively with the establishment of protected areas, the results of the questionnaire show us that in most of the protected areas the largest fires to affect them occurred after 2000 (Table 4). We should point out that in the natural parks of Montesinho, Douro Internacional and Serra da Estrela the annual average area burned is higher than 1,000 ha. Emphasis should also be laid on the fact that some of these fires to have hit protected areas were ignited outside the perimeter of these areas and when the areas were hit the fires were out of control.

The data available concerning the causes of fires in protected areas are inconclusive, since the great majority of occurrences were not investigated or the results of the investigation were inconclusive. However, it is clear that the causes of forest fires are clearly human, such as accident, negligence and arson.

Table 4 – *Largest Fires, per year of occurrence, in Portugal*

Protected area	Year(1)	Area(1) (ha)	Average Area Burned (1992-2004)(2)
Serra de S. Mamede Natural Park	2003	13,350	829
Douro Internacional Natural Park	2003	1,300	1,396
Serra da Estrela Natural Park	2005	4,772	3,619
Peneda-Gerês National Park	2006	3,945	741
Serras d'Aire e Candeeiros Natural Park	2006	2,997	791
Montesinho Natural Park	1998	1,185,51	1,491
Ria Formosa Natural Park	2004	173	33
Tejo Internacional Natural Park	2002	293,2	163
Corno do Bico Protected Landscape	2006	150	No data
Lagoas de Bertandos e São Pedro dos Arcos Protected Landscape	-	0	0
Arriba Fóssil da Costa da Caparica Protected Landscape	1996	65	9
Serra de Montejunto Protected Landscape	2003	2,230	No data
Paul do Boquilobo Natural Reserve	2003	12,8	1
Lagoas de Santo André e da Sancha Natural Reserve	2006	0.006	1

Source: (1) Survey, 2007; (2) Ministry for Environment, Spatial Planning and Regional Development, 2006.

In Brazil the number of forest fires in protected areas⁶ has increased significantly from 1,754 fires in the period between 1983 and 1987 to 19,337 between 1998 and 2002 (Santos et al.,2006). Over that period the State of Santa Catarina, with a total area of 95,985km² corresponding to 1.12 % of the Brazilian territory, has not only been the Brazilian state that recorded a decrease in the number of forest fires, but also the state with the smaller number of occurrences, decreasing from 36 in the 1980s to 22 between 1998 and 2002, which corresponds to 0.11% of fires in protected areas in all Brazilian states.

In the state of Santa Catarina 7 out of the conservation units under study recorded fire occurrences; among these we should point out the Três Barras National Park with 12 occurrences, which affected areas between 1 and 13 hectares with pine vegetation and agricultural lands and Serra do Tabuleiro State Park, the largest conservation unit of the state, comprising 1% of the state's territory, with 3 occurrences, which affected approximately 4 ha of herbaceous vegetation. Among the probable causes we should point out pasture renovation, followed by unknown causes and arson.

In balance, the incidence of forest fires in protected areas in Portugal differs from the incidence in Santa Catarina. Still, we were able to identify common causes as in both case-studies the human causes are predominant.

The prevention of forest fires in protected natural areas

From the answers to the questionnaire it becomes clear that all protected areas in Portugal acknowledge the existence of a policy of protection of forests against fire which includes prevention and surveillance measures as their main priorities. The active participation of the protected areas in fire suppression is not so evident since only nine of the protected areas have initial attack teams properly equipped. This is definitely the weak link as far as the recovery of burned areas is concerned as little attention is paid to this in the protection of forests. The implementation of recovery measures is funded either by public budget or EU funds.

The management of protected areas of national interest in Portugal is a competency of the Institute for Nature Conservation (ICN). The Institute established in its report for 2005 the following topics as the main priorities in terms of the protection of the forests against fire: decrease the burned area, especially in priority areas for nature conservation as the most valuable ecological areas, reduce the number of ignitions, reduce of vulnerability of these areas and, finally, monitor and restore burned areas. These objectives are effectively acknowledged as priorities by protected areas (Table 5), which also aim at improving suppression efficacy and promoting a more effective organisation process.

Table 5 - Objectives of the forest fire policy in Portugal

	Number	%
Decrease burned area	10	71
Reduce number of ignitions	9	64
Reduce vulnerability of the areas	9	64
Increase resilience of forest	9	64
Improve efficacy of suppression	8	57
Promote a more effective organisation process	8	57
Restore burned areas	6	43
Did not answer	1	7

Source: Survey, 2007

There is a generalised belief that there have been improvements in forest fire prevention over the last few years, especially due to the availability of a greater number of surveillance and detection means. In fact, we should emphasise a greater awareness and commitment of public and private institutions in promoting a greater surveillance effort, especially through mobile teams, and providing them with better training and equipment, resulting in a persuasive and pedagogical action in removing the possible causes of forest fires (Table 6).

There is also a greater collaboration between the entities involved in fire prevention and consequently a better coordination of the means and human resources. This collaboration involves not only several public institutions and civil protection agents, but also many private entities. Among the latter, we should point out entities such as scout associations, hunting associations, fishermen's associations, foresters associations, farmer associations, environmental associations, common land managers, all terrain clubs. Thus, it is possible to conclude that there is a great participation of Community Based Organisations in forest fire prevention.

Other factors such as changes to legislation, namely as far as the control of offences is concerned, have also been considered positive. The respondents have also indicated two other factors which are considered important, yet not effective enough: 1) forest management, both in terms of fuel removal and the choice for fire resistant plant species, which is a measure of particularly difficult implementation. The use of prescribed use was only mentioned by the natural parks of Montesinho, Peneda-Gerês and Serra d'Aires e Candeeiros. This practice is designed to meet specific objectives, especially pasture renovation and not so much in terms of fuel removal; 2) the awareness of the local communities to fuel removal and reduction of potential fire risk behaviour is still not a widespread concern among Portuguese protected areas. Currently, public education relies heavily on making information available to people. However the fact that simply providing people with information is not sufficient to encourage preparedness, because people do not necessarily accept this information at face value. Rather, it is how people interpret their risk and the information available that determines whether they prepare for forest fires. While some people appear predisposed to prepare, but need to be guided in this endeavour, others decide not to prepare. This means

that, when planning public education, it is not enough to know that levels of preparedness are low. It becomes necessary to find out if levels are low because people have decided not to prepare, or if levels are low because people need guidance to know what to do. The education campaigns should be directed at the general audience but also to specific groups such as shepherds.

Table 6 – Prevention measures

Prevention measures	Nº
Land Mobile Surveillance	14
Risk Areas Identification	13
Fuel Removal	9
Education and Awareness Campaigns	8
Construction of water points	8
Track Construction and Improvement	8
Forest Management	7
Definition and Maintenance of Buffer Zones	6
Preventive siveiculture	6
Land Fixed Surveillance	6
Clearance for using Prescribed Burning	3
Use of Prescribed Burning	2
Fire Hazard Information	2
Information Signs	1
Restricted Access by cars to high risk areas	1
Removal of barbecues from picnic parks	1
Contact with shepherds	1

Source:Survey, 2007

The Portuguese fire prevention system is qualified by the majority of the Portuguese protected areas as good. Only the Douro Internacional Natural Park, the Tejo Internacional Natural Park, the Paul do Boquilobo Natural Reserve and the Ria Formosa Natural Park believe the system could be improved.

In the State of Santa Catarina only the São Joaquim National Park and the National Forests Três Barras and Caçador and the Serra do Tabuleiro State Park have adopted policies of protection of forests against fire, implemented respectively in 2004, with the establishment of the unit, in 2005 and 1992 with the establishment of the Environmental Military Police. These policies focus on prevention, surveillance and alert measures and the main objectives of the policy are the reduction of vulnerability to the deflagration of forest fires. The core measures adopted in terms of prevention in Santa Catarina include the identification of risk prone areas, the construction or opening of internal and external buffer zones; the use of prescribed fire, the purchase of specific equipment for fire suppression; purchase of surveillance vehicles; the promotion of education and awareness campaigns and information to the population about fire risk through the media,

especially intended at the resident owners in conservation units. The level of efficiency attributed to prevention system was fair and the monetary resources for prevention measures in federal conservation units are funded by PREVFOGO⁷ and IBAMA. At the state level we should point out the resource to projects financed by the Bank for Reconstruction and Development – IBRD⁸ and the German Development Bank – KfW Bankengruppe⁹. In forest protection against fire there has been established a good cooperation between public and private entities, such as Civil Defence and Environmental Protection Military Police, although a lot can still be done as far as the involvement of the local community is concerned. Among the four conservation units which have adopted a policy of protection of the forest against fire, three answered that fire prevention has improved over the last years due to: stricter environmental legislation, greater efficacy of the fire-fighters, a greater awareness of the population and their past experience dealing with fires and the instructions and material given the staff of the protected areas.

Fire Detection and Suppression

Surveillance in the detection of fires plays a vital role in the reduction of ignitions and burned area. There is a general consensus about the recent improvement of surveillance in Portugal, since besides fixed surveillance (in lookout towers) which still remains active in six of the protected areas, mobile surveillance has evolved tremendously. This type of surveillance is highly effective in dissuading possible criminal actions, but is also pedagogically efficient as it alerts the populations to risk behaviour. Surveillance teams are constituted by staff of the protected area, members of the Portuguese Republican National Guard, fire-fighters and brigades of “sapadores florestais” (forest guards). In the Peneda-Gerês National Park, for instance, twelve teams of “sapadores florestais” were established by the managers of common lands and foresters associations and are in charge of the surveillance of the park. Only the Serra de Montejunto Protected Landscape disposes of video surveillance.

All the effort put in the constitution, equipment and training of these surveillance teams explains the opinion of eight of the protected areas that their surveillance system is effective. The remaining believe their system to be “fair”, although they believe it is possible to improve the system, in particular because they do not dispose of a number of surveillance teams adequate to the fire risk of the area, or still because it is necessary to better train and equip the brigades. Since the decrease of the burned area is intimately related with a fast, effective initial attack, in some protected areas surveillance teams also dispose of a first intervention kit.

While some of the protected areas dispose of initial attack teams equipped with varied resources such as booster units or even a backhoe, other protected areas depend completely upon external means to suppress the fires.

These initial attack teams are generally very effective because they are highly trained, extremely professional experts, who keep regularly updated on the latest techniques; in addition, most of the staff possesses already practical experience. Nevertheless, some protected areas mentioned the fact they only

dispose of teams constituted by seasonal staff which reduces significantly the efficacy of the team, since the stability of staff would be desirable for promoting stability as well as regular training actions.

With regard to the suppression itself, most protected areas believe that the suppression has improved over the last few years thanks to a more effective action by initial attack teams, to a better coordination of suppression, to the disposal of more means and to better fire-fighter training. However, there are still negative aspects that need to be overcome such as the lack of knowledge of the territory and the existing infrastructures (tracks, water points), excessive use of water or the choice of other suppression techniques by the staff member in charge of the operations. There has been also mentioned that mop-up is sometimes deficiently handled promoting re-ignitions

In the state of Santa Catarina only two conservation units dispose of fire detection systems, promoting local monitoring through land mobile surveillance; other two dispose of aerial and satellite monitoring. According to the conservation units, the efficacy of surveillance actions has increased. Surveillance missions are carried out by staff members of the conservation units and of the environmental police, but other entities, for instance fire-fighters, armed forces, private companies, may also join the missions. Most conservation units is of the opinion that fire detection has not improved over the last few years. The main factors explaining this are staff cuts, lack of a fire suppression policy and lack of implementation of proposals aimed at fire suppression. The conservation unit that has adopted PREVFOGO disposes of a considerably more effective fire detection system.

The recovery of burned areas: current situation

In Portugal the monitoring and recovery of burned areas is one of the objectives set out in the policy implemented by the Institute for Nature Conservation. In 1989¹⁰ the Portuguese government established for the first time the need to ensure the management of burned areas through specific rules. However, the need to implement this policy has been so far disregarded. Concerning this policy, it is possible to summarise the different procedures adopted by the protected areas in the following topics:

- five of the protected areas declared to have implemented the recovery procedures right after a large fire, although with different motivations: recover the forest, native or of high ecological value; minimise the effects of erosion and provide shelter and food to several fauna groups. The oldest experiences date back from the period after the 2003 fires as it happened in the Douro Internacional Natural Park and the Serra de São Mamede Natural Park in which the area burned amounted to 1,300 ha and 13,350 ha respectively;
- three of the protected areas already have experience in the recovery of burned areas resulting from an intervention carried out by the Portuguese Forest Service, because within the protected areas some properties are owned by the Portuguese state and the common lands are under public management regime, therefore managed by the Portuguese Forest Service;
- five of the protected areas declared that they did not have any type of intervention planned for the recovery of burned areas; one of them shows no interest carrying out recovery actions;

- the Lagoas de Bertandos e S. Pedro de Arcos Protected Area foresees in its policy of forest protection against fire the recovery of burned areas, but since its establishment no forest fire has hit the protected area, thus it was not possible for them to answer the topic of recovery of burned areas.

The intervention in burned areas aims fundamentally at controlling erosion (4 answers), restoring the forest (3 answers), preventive silviculture (2 answers) and harvesting burned timber (2 answers).

By mentioning the recovery of burned areas, we are not advocating the compulsory artificial recovery of these areas, but the possibility of after a fire monitoring the areas affected and take advantage of them and improve their resilience to forest fires, ensuring its economic, ecological, environmental (for instance, carbon sequestration) and recreative value. The choice for mechanical means should just be taken in cases clearly identified and based on a strategy clearly defined and only when natural regeneration is not doable or when there is a clear need to perform changes in vegetation in order to promote its restoration.

There is widespread consensus regarding the advantages of the natural regeneration in the recovery of burned areas (Table 7) and a great concern with the removal of invasive species. Reforestation actions using species of higher environmental value are less prevalent.

Table 7 - Recovery techniques

Techniques	Nr. of cases
Natural regeneration	7
Control of natural regeneration removing invasive species	4
Improve natural regeneration using species of high economic value	1
Improve natural regeneration using species of high environmental value	4
Reforestation using species of high economic value	1
Reforestation using species of high environmental value	5
Establishment of permanent pastures	1

Source: Survey 2007

There are several difficulties of structural, political, organisational, technical and scientific nature involved in the recovery of burned areas.

One of the main difficulties stems from the fact that most of land is private and divided in small properties; to this we can add the lack of organisation of Portuguese foresters and the incapacity of many landowners to properly promote the social, environmental and economic value of the rural world and in particular of their own lands. The insufficiencies of the Portuguese forest land register complicate the contact and negotiation with private landowners.

Most forest lands included in the protected areas are private, thus the recovery of burned areas is the responsibility of the land owners; in public and common lands the recovery is competency of the National Forest Service. The protected area is responsible for issuing an opinion with regard to the actions which these entities intend to carry out. With regard to this we should point out the lack of coordination between the entities with the objective of envisaging the best strategy of intervention in the burned areas.

Other difficulties concern the lack of human and financial resources, the extensive cattle breeding and the lack of bush and tree species on the Portuguese market.

The monitoring of burned areas is not considered a priority action and it is the competency of the Conselho Nacional de Reflorestação (National Reforestation Council) to set out the general strategic guidelines for the recovery of burned areas, respecting the objectives and prevailing functions of the forest spaces. The guidelines of the National Reforestation Council specifically for the protected areas include assessing the capacity of natural regeneration of the areas hit by fires, followed, complementarily and whenever necessary, the restoration of the native plant species and the control of the invasive exotic plants. (Conselho Nacional de Reflorestação, 2005:9).

The National Plan of Forest Protection Against Fire (Council of Ministers n. 65/2006 of 26 May) includes the recovery and restoration of ecosystems as one of its priorities. Its core objective is the assessment and mitigation of the impacts caused by fire and the implementation of long-term restoration strategies. It is clearly stated in the Plan that the recovery of burned areas should aim at the future increase of resilience¹¹.

The recovery of burned areas should be understood as an opportunity to re-organise the rural landscape increasing their social, economic and environmental value, but always bearing in mind the strategies of forest protection against fire.

In the State of Santa Catarina none of the conservation units promote the recovery of the burned areas. There is a clear choice for the natural recovery of the burned areas. With the establishment of the military police, in the Serra do Tabuleiro National Park offenders have been identified with the help of the State Attorney. The offenders have been charged with civil and procedure actions and have to repair the environmental damage inflicted.

Conclusion

The incidence and severity of forest fires in protected areas in Portugal and Santa Catarina are very different. Despite the low record of fires in Santa Catarina, the results of the questionnaires in the conservation units reveal a great concern with possible occurrences and in this sense the managers claim a greater participation of the government and the society in looking for solutions in the area of fire prevention and suppression.

In Portugal forest fires constitute a serious problem which has worsened in the first years of the 2000s.

In both countries the causes of most part of fires remain unknown, either because no investigation is conducted or because the result of the investigation is inconclusive. In order to achieve more effective fire prevention and surveillance, it is essential to promote a better understanding of the causes of forest fires.

There have been improvements in forest fire prevention over the last few years, especially due to the availability of a greater number of surveillance and detection means and not due to fuel removal. Little attention has been paid to educating and raising awareness among the population, especially when it comes

to natural and humanised landscapes with a great environmental and cultural value. In the state of Santa Catarina conservation units were selected as priority areas for the establishment of PREVFOGO, whereas in Portugal no special attention is paid to protected areas. In terms of cooperation between Portugal and the state of Estado de Santa Catarina within the scope of the prevention and management of fire in protected areas we should point out the participation by members of the Brazilian environmental police in training sessions held in Portugal.

In the state of Santa Catarina the intervention in the recovery of burned areas is not significant, since the first option has been natural regeneration. In Portugal although the first experiences in burned area recovery date back from the 1980s, this type of intervention is still very incipient in the protected areas.

The experiences that are being carried out in Portugal are different. For example, in the Douro Internacional Natural Park it is currently underway the recovery of a 360 ha public forest through natural regeneration and environmental promotion with extremely positive results. The director of the park is of the opinion that in this type of intervention the focus should not be entirely on environmental promotion, but on the economic development of the burned area. In the Serra de São Mamede Natural Park the experience has been based on natural regeneration and on the reforestation using species of high environmental value, while still promoting measures of protection against fire. All planned measures have been carried out, although it is still not possible at this time to assess their results. In the Peneda Gerês National Park the recovery began after the large fire that hit the park in 2006 and in which 3,945 ha burned. This is the first time this type of experience is carried out in the Peneda Gerês National Park. The selected procedures are natural regeneration, removal of invasive species and improvement of the natural regeneration using species of high environmental value. In the areas which are being reforested the main concern is with the environmental promotion of these spaces. The experiences described above are very recent, thus it is still early to assess the intervention in order to define and validate the principles and practices of recovery of burned areas as well as its impacts on rural landscape and on the promotion of fire resilience.

Some managers of protected areas aspire at the elaboration of a code of good practices on burned area recovery. We should also point out that although the recovery of burned areas is not many times regarded as a priority to nature conservation, this topic is an important opportunity for social, economic and environmental enhancement of the rural landscape and also the opportunity to turn these areas more resilient to forest fires.

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¹ According to the Environmental Research Institute of Amazonia carbon dioxide emissions resulting from deforestation and forest fires in Amazonia amount to more than the double of the emissions due to the burning of fossil fuels in the entire country. 20 million tons of carbon dioxide are released annually into the atmosphere from the burning of fossil fuels, while forest fires and deforestation release 95 million tons.

² We only included in this paper protected areas in mainland Portugal.

³ The area of the State of Santa Catarina is 95,985 km², whereas the area of mainland Portugal is 88,500 km².

⁴ Except for the cases laid down in the National System of Conservation Units.

⁵ However, the sample will consider only 16 conservation units, since the Araucárias National Park was only established in 2005 and has no records of forest fires.

⁶ Based on a sample of approximately 50% of the Brazilian states (Santos et al., 2006).

⁷ National System for Wildfire Prevention and Suppression. This system was established in Brazil in 1989 and also deals with prescribed burning. The actions of research, prevention, control and suppression of prescribed burning are coordinated by IBAMA, which has established agreements with fire-fighter brigades of several Brazilian states. Conservation units were selected as priority areas for the development of the System, including the State Conservation Units which are coordinated by the state institutions for the environment (OEMAs). The system PREVFOGO together with the National Institute for Space Research (INPE) implemented in 1990 the monitoring and control of fires in Brazil using the satellites NOAA, Land Sat ,spot.

⁸ Micro-Bacia Projects.

⁹ Project for the Protection of the Atlantic Forest

¹⁰ Law Decree n.180/89 of 30 May

¹¹ It is the Portuguese Government's intention in accordance to the National Plan of Forest Protection Against Fire to publish by the end of 2007 a Code of Good Practices on Recovery of Burned Areas, competency of the National Forest Service and prepared jointly with other public entities including the Institute for Nature Conservation.