Taming wildfires in the context of climate change: The case of Portugal

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Acknowledgements

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1 Introduction: Wildfire risk in Portugal

The combination of Portugal's climate and land cover makes the country one of the most wildfire-prone in Europe (APA, 2017[1]) (Ganteaume et al., 2021[2]). Mainland Portugal is characterised by a Mediterranean climate, with moist winters followed by hot and dry summers (Maynard, Smith and Gonzalez, 2013[3]) (Government of Portugal, 2021[4]). Rural areas[1] take up more than 90% of the mainland territory, with forests representing the dominant land cover type[2] (Government of Portugal, 2021[4]) (APA, 2017[1]). This makes the near totality of Portugal's mainland territory exposed to wildfire risk[3] to some extent. The most wildfire-prone areas of the country are concentrated in the northern and central regions, which combine abundant flammable vegetation with a large wildland-urban interface (WUI)[4] (De Rigo et al., 2017[5]).

Over the past decades, the frequency and severity of extreme wildfires – i.e. wildfire events that are particularly severe in terms of their size, duration, intensity and impacts – have increased, along with the extent of burned area (República Portuguesa; Fundo Ambiental; APA, 2019[6]) (Government of Portugal, 2021[4]) (OECD, 2023[7]) (Figure 1.1). In 2017, area burned in Portugal exceeded 560 000 hectares, i.e. 56% of the total burned area in the whole European Union (EU) for that year (European Commission, n.d.[8]). The fire season, historically going from July to September, has extended beyond its traditional start and end dates, making extreme wildfires more likely to occur throughout the year. The most extreme wildfire events in the country's history have been recorded in the last twenty years, with particularly severe blazes in 2003, 2005 and 2017 (Council of Ministers, 2020[9]). The wildfires of June and October 2017 – by far the most extreme ever recorded in Portugal – caused more than 100 casualties and left more than 200 people injured (Council of Ministers, 2020[9]). The June 2017 wildfires alone damaged more than 500 buildings (San-Miguel-Ayanz et al., 2020[10]).

Thousand hectares
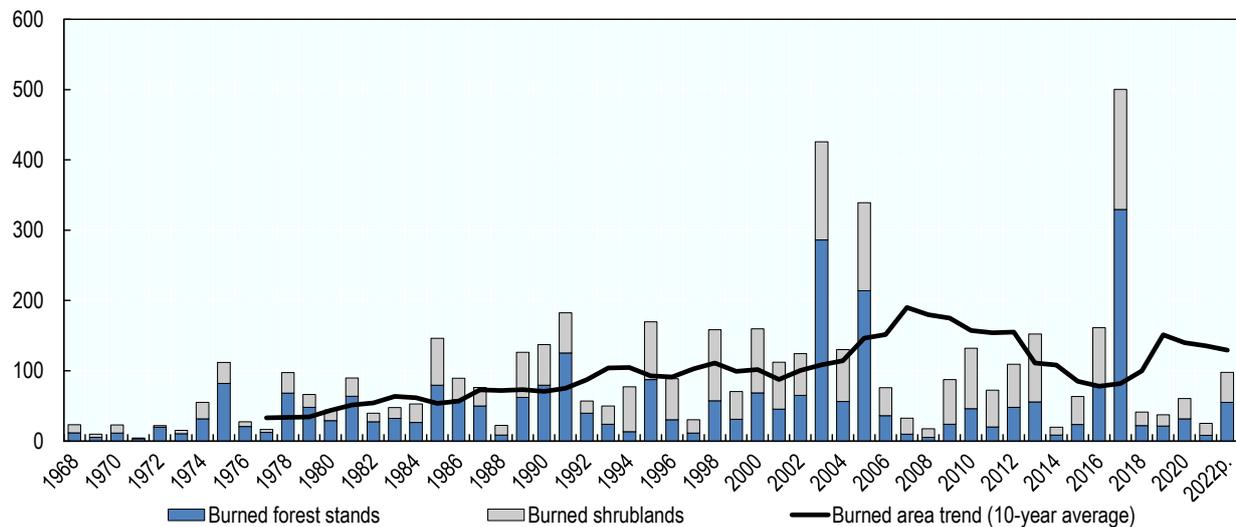
Source: Adapted from ICNF.

Growing wildfire risk in Portugal results from the interplay of several factors, including changing land-use and management practices, changing vegetation cover, as well as climate change (OECD, 2023[7]). Since the 1960s, Portugal has experienced a major demographic shift (Lourenço, 2018[11]), with rural population moving to coastal areas in search for better opportunities (Government of Portugal, 2021[4]). As a result, between 1960 and 2021, Portugal's rural population decreased from 5.7 million to 3.4 million, i.e. from 65% to 33% of the total population (World Bank, n.d.[12]). This has reduced the presence of agricultural plots (which can act as fuel breaks) and managed forests, leading to the accumulation and encroaching of fire-prone vegetation around rural settlements (Nunes, 2012[13]) (Council of Ministers, 2020[9]) (Nunes, Lourenço and Meira Castro, 2016[14]). These trends, which are strongest in mountainous areas (APA, 2017[1]) and in the northernmost regions, have been further exacerbated by the ageing of the rural population. Together, rural land abandonment and the ageing of the rural population have also reduced the number of people available on the ground to help contain and suppress wildfires when these occur. In addition to rural land abandonment, changes in vegetation cover have increased landscape flammability in some areas, further exacerbating existing risks (APA, 2017[1]). For example, the expansion of large, non-native eucalyptus plantations[5] might have facilitated the spread and intensity of some the most extreme wildfire events that have affected Portugal in recent years (Bowman et al., 2020[15]).

Climate change also contributes to growing wildfire risk in the country. The increased occurrence of extreme weather events has enhanced conditions for extreme wildfires and favoured the spread and intensity of wildfires on several occasions (APA, 2017[1]) (OECD, 2023[7]). For example, the unusually hot and dry weather recorded in recent years has been associated with the occurrence of the 2003, 2005, 2017 and 2018 extreme wildfire events (APA, 2017[1]) (Ross, Gannon and Steinberg, 2020[16]) (República Portuguesa; Fundo Ambiental; APA, 2019[6]). Indeed, heatwaves and drought enhance fuel dryness and flammability – a process that is only set to become more frequent going forward throughout the whole Iberian Peninsula (De Rigo et al., 2017[5]). Changing rain and wind patterns in Portugal have also been associated with the occurrence of more extreme fire seasons and with the increasing occurrence of wildfire events off-season (APA, 2017[1]) (República Portuguesa; Fundo Ambiental; APA, 2019[6]). Extreme weather conditions also make wildfires more difficult to control and more likely to affect vegetation that, under normal conditions, would not be susceptible to fire, such as cork oaks (Council of Ministers, 2015[17])

(OECD, 2023[7]). In the coming decades, climate change is projected to increase the number of days characterised by high-to-extreme wildfire risk (Figure 1.2), further enhancing the frequency and intensity of extreme wildfires in the whole country (Government of Portugal, 2021[4]) (Gomes Da Costa et al., 2020[18]). By 2040, the duration of the wildfire season is projected to grow by one month in the most fire-prone areas of the country (Ross, Gannon and Steinberg, 2020[16]).

Figure 1.2. Growing wildfire risk under different warming scenarios

Number of additional days per year characterised by high-to-extreme fire danger, compared to 1981-2010 levels
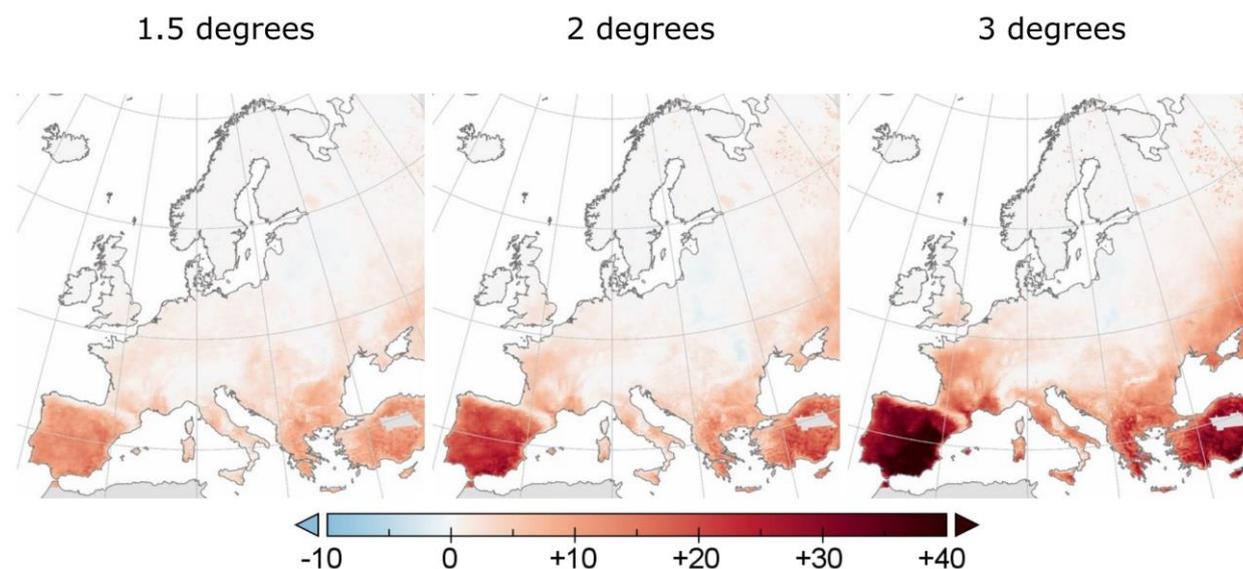
Note: The maps show the projected additional number of days per year characterised by a Fire Weather Index value ≥ 30 under three different warming scenarios (+1.5°C, +2°C, +3°C) above pre-industrial levels.
Source: Adapted from (Gomes Da Costa et al., 2020[18]).

Growing wildfire risk in Portugal poses increasing threats to human health and well-being. Wildfires have already affected hundreds of thousands of people, with single wildfire events, such as those of 2017, claiming 100 lives and leaving more than 2 700 people homeless (EM-DAT, 2023[19]). Wildfires are also associated with the surge of respiratory problems in the country. At the same time, with an average of 85 000 hectares of forestland burned annually over the last decade (APA, 2020[20]), wildfires represent a key threat to Portugal's forests and contribute to the growing problem of soil erosion, pest invasion and desertification (APA, 2017[1]). In addition, extreme wildfires undermine climate mitigation efforts by reducing land carbon storage capacity and emitting greenhouse gases (GHG) into the atmosphere. For instance, in 2017, the June and October wildfires alone released 15% of the country's annual carbon dioxide (CO_2) emissions (San-Miguel-Ayanz et al., 2020[10]), while the extreme wildfires of 2003 and 2005 – similarly to those of 2016 and 2017 – brought the land-use and forestry sector to emit more carbon than it absorbed, reverting a trend in place since 1991 (APA, 2017[1]). In 2017, extreme wildfires brought this sector to emit 23% of Portugal's total emissions (APA, 2022[21]).

All these impacts imply large and growing economic losses. In Portugal, the yearly cost associated with wildfires is estimated at EUR 60-140 million (Government of Portugal, 2021[4]). Yet, the growing occurrence of extreme wildfires is pushing this figure up. In 2017 alone, the total cost of the June and October wildfires was estimated to amount to nearly EUR 1.5 billion (San-Miguel-Ayanz et al., 2020[10]). Economic impacts and costs were particularly dire for the forestry sector (Table 1.1.). In the coming decades, the costs resulting from extreme wildfires are projected to grow. For example, by 2030, the tourism industry – which

today contributes to almost 10% of Portugal's gross domestic product (GDP) and employment (Otrachshenko and Nunes, 2022[22]), is expected to lose EUR 35-62 million annually due to reduced tourist arrivals as a consequence of wildfires. In 2050, such losses are expected to at least quadruple (Otrachshenko and Nunes, 2022[22]).

Table 1.1. Total estimated costs of the 2017 wildfires by type of damage

DAMAGE TYPE	ESTIMATED COSTS (Million EUR)
Agriculture	210
Forestry	634
Network infrastructure (water, transport, bridges, energy, telecommunications, etc.)	94
Private homes and assets	102
Public assets (airports, ports, hospitals, schools, etc.)	2
Commercial and industrial activities	311
Cleaning up	64
Emergency operations and rescue services	39
TOTAL	**1 456**

Source: Adapted from (San-Miguel-Ayanz et al., 2020[10]).

The policy community in Portugal increasingly recognises the complex challenges posed by growing wildfire risk (República Portuguesa; Fundo Ambiental; APA, 2019[6]) (APA, 2017[1]). The following sections explore how the policy and institutional framework have evolved in response to these challenges (Section 2) and highlight the key measures, successful practices and remaining challenges in Portugal's adaptation to changing wildfire risk (Section 3). In conclusion, Section 4 provides an overview of the key findings and outlines the way forward.

2 The enabling environment for adapting to growing wildfire risk

Since the early 2000s, Portugal has undertaken several reforms to strengthen the country's policy and institutional framework for wildfire management in response to growing wildfire risk (Council of Ministers, 2020[9]). While some reforms had already been introduced in the aftermath of the 2003 and 2005 wildfires, 2017 represents a turning point in the country's approach to wildfire management. Indeed, the devastation witnessed in 2017 shook the public opinion, building the political consensus necessary to trigger a major reform process (Council of Ministers, 2020[9]). The reforms were guided by two assessments undertaken by two Independent Technical Committees (ITC) created by the Portuguese Parliament in the aftermath of the 2017 wildfires (Council of Ministers, 2020[9]), which analysed the key gaps in the country's wildfire management system. The assessments identified a lack of co-ordination and dialogue among key stakeholders, an unclear distribution of roles and responsibilities, the underinvestment in wildfire prevention, and a generalised lack of awareness of existing levels of risk (Council of Ministers, 2020[9]). Leadership instability in key agencies and the insufficient level of knowledge and capacity to address growing wildfire risk were also identified as key challenges (Independent Technical Committee, 2017[23]) (Independent Technical Committee, 2018[24]).

2.1. The policy framework

One key outcome of the 2017 wildfire policy reform is the publication of the National Plan for Integrated Rural Fire Management 2020-30 (NPIRFM), a strategic plan that establishes an overarching framework for wildfire risk management[6] (Council of Ministers, 2020[9]). The NPIRFM comprises a Strategy and an Action Plan. The Strategy establishes the overall objectives for wildfire management, with a focus on valuing and actively managing rural areas, improving behaviours and effectively managing wildfire risk. It also includes a process chain, which lays out the roles and responsibilities, procedures and activities needed for the new system to produce the desired outcomes. In complement to the Strategy, the Action Plan includes concrete projects and timelines that contribute to achieve the NPIRFM objectives.[7] Overall, the NPIRFM framework promotes an Integrated Rural Fire Management System, bringing together all public actors involved in wildfire management (i.e. national and subnational entities (Table 2.1. and Table 2.2.), as well as landowners, infrastructure managers, forestry organisations and other private stakeholders (Council of Ministers, 2020[9]). Climate change plays a central role in this framework. The NPIRMF recognises climate change as a key driver of growing wildfire risk in Portugal and as one of the main challenges to the wildfire management model in place until 2017 (Council of Ministers, 2020[9]). The NPIRMF also requires that climate change be considered in the development of Action Plan projects and underlines the need for increased flexibility due to higher climate variability and uncertainty. Similarly, the links between climate change and wildfire risk are also highlighted in a number of other national plans and strategies (Box 2.1).

Box 2.1. Mainstreaming wildfire risk and management in climate change strategies

The links between climate change and wildfire risk are highlighted in Portugal's strategic documents on climate change. These include the National Climate Change Adaptation Strategy (ENAAC 2020), the Action Plan for Adaptation to Climate Change P-3AC (i.e. Portugal's National Adaptation Plan, NAP), the Portuguese Roadmap for Carbon Neutrality 2050 (RNC2050), the National Energy and Climate Plan 2021-30 (PNEC 2030) and Portugal's Adaptation Communication to the United Nations Framework Convention on Climate Change (UNFCCC). All these documents highlight both the effect of climate change on growing wildfire risk and how wildfires, in turn, make ecosystems and communities more exposed and vulnerable to other risks. They also highlight that wildfires threaten national carbon sinks and can become a source of carbon emissions themselves, thus hampering climate mitigation efforts. All these documents underline the need to strengthen wildfire prevention and adaptation to reduce wildfire risk and impacts while at the same time limiting GHG emissions and preserving Portugal's carbon sinks.

Most notably, the Action Plan for Adaptation to Climate Change P-3AC identifies wildfire prevention as a key priority for climate adaptation in the country. It highlights the relevant measures to strengthen wildfire prevention, i.e. reducing fuel accumulation; adapting infrastructures to wildfire risk; ensuring people and property's safety; valuing biomass; and ensuring fuel discontinuity to limit the spread of wildfires. The P-3AC also defines indicators and targets to monitor climate adaptation efforts, including the full engagement of municipalities to develop, by 2030, local climate adaptation plans8 and wildfire prevention plans that account for climate scenarios.

In addition, Portugal is currently developing the National Roadmap for Adaptation 2100 (RNA2100), to be finalised by the end of 2023, which aims to support climate change adaptation at different levels of government. The RNA2100 will provide climate projections, together with an overview of the likely risks and impacts associated with different climate scenarios, as well as estimates of the costs of inaction and of the investment needed to adapt to climate change. The project is supported by modelling exercises focused on key sectors, including one dedicated to wildfires, which will allow to characterise wildfire risk and burned areas under different climate scenarios.

Source: (Government of Portugal, 2019[25]) (Government of Portugal, 2021[4]) (República Portuguesa; Fundo Ambiental; APA, 2019[6]) (APA, 2015[26]) (República Portuguesa, 2019[27]) (IEA, 2021[28])

Wildfire risk and management in the context of climate change are also mainstreamed in several other sectoral strategies, including:

- The **National Forest Strategy 2030**, which recognises the challenges posed by climate change and aims at enhancing forest resilience to wildfires, among other risks. The Strategy, approved in 2006 and updated in 2015 on the basis of climate scenarios, is implemented through regional forest management programmes (PROFs) tailored to each region's forest cover and ownership structure. Altogether, these documents encourage the active management of forested lands, thus reducing the number of ignitions and the conditions for the spread of wildfires (APA, 2020[20]) (Council of Ministers, 2015[17]).

- The **National Strategy for Nature Conservation and Biodiversity 2030**, which aims at reducing the negative impacts of wildfires – as well as of other climate and environmental disturbances – on biodiversity. Following the 2016 wildfires in the Peneda-Gerês National Park, a pilot plan for wildfire prevention in the park was also developed, with a view to protecting and recovering its biodiversity (Council of Ministers, 2018[29])

- The **National Programme for Spatial Planning Policy** (PNPOT), revised in 2018, is an instrument for strategic territorial development. The programme acknowledges the key role of spatial planning in building resilience to wildfire risk (Government of Portugal, 2021[4]). It allows to identify the parishes most exposed to wildfire risk and outlines key adaptation actions to contain risks and impacts.

- In line with the three abovementioned strategies, the **Landscape Transformation Programme** (PTP) offers a longer term strategic plan that aims to enhance the resilience of fire-prone forests, not least by encouraging active land management on private lands. The PTP is financed through Portugal's Recovery and Resilience Plan, the European Agricultural Fund for Rural Development and the Environmental Fund and implemented through the measures outlined in Box 3.2.

2.2. Institutional arrangements

Today, several public agencies are involved in wildfire management at different levels of government. At the national level, key agencies include the Agency for the Integrated Management of Rural Fires (*Agência para a Gestão Integrada de Fogos Rurais,* AGIF), the National Authority for Emergency and Civil Protection (*Autoridade Nacional de Emergência e Proteção Civil*, ANEPC), the Institute for Nature Conservation and Forests (*Instituto da Conservação da Natureza e das Florestas,* ICNF), the Portuguese Institute for the Sea and the Atmosphere (*Instituto Português do Mar e da Atmosfera*, IPMA), the National Republican Guard *(Guarda Nacional Republicana,* GNR), the Portuguese Environment Agency (*Agência Portuguesa do Ambiente*, APA), the Ministry of Agriculture and Food's Cabinet for Planning, Policy and General Administration (*Gabinete de Planeamento, Políticas e Administração Geral*, GPP), the Directorate-General for Territorial Development (*Direção-Geral do Território,* DGT), the Environmental Fund (*Fundo Ambiental*), the Directorate-General for Agriculture and Rural Development (*Direção-Geral de Agricultura e Desenvolvimento Rural*), as well as several fire brigades. Among the actors operating at the national level (Table 2.1.), most agencies were already in place long before 2017, while the AGIF was established in 2019, as a result of the reform process (Box 2.2).

Table 2.1. The key public national agencies engaged in wildfire management

Agency	Risk assessment & communication	Prevention	Preparedness & response	Post-fire recovery	Funding
Agency for the Integrated Management of Rural Fires	X	X	X	X	
Cabinet for Planning, Policy and General Administration		(X)			(X)
Directorate-General for Agriculture and Rural Development	X	X		X	
Directorate-General for Territorial Development	(X)	X			
Environmental Fund					X
Fire brigades		X	X	X	
Institute for Nature Conservation and Forests	X	X	X	X	
National Authority for Emergency and Civil Protection	X	X	X	(X)	
National Republican Guard	(X)	X	X		
Portuguese Environment Agency	(X)			(X)	
Portuguese Institute for the Sea and the Atmosphere	X		X		

At the subnational level, mainland Portugal's territory is organised around municipalities and parishes (OECD, 2020[30]), as well as around five Commissions for Regional Coordination and Development (*Comissão de Coordenação e Desenvolvimento Regional*, CCDRs), which manage government services at the regional level and play a role in wildfire prevention.[9] Local administration also relies on 23 Inter-

Municipal Councils, which contribute to ensure cross-municipality co-operation. All these actors are involved in local wildfire management (Table 2.2.).

Table 2.2. The key public subnational agencies engaged in wildfire management

Agency	Risk assessment & communication	Prevention	Preparedness & response	Post-fire recovery	Funding
CCDRs		X		X	X
Municipalities	X	X	X	X	X
Parishes	X	X	X	X	
Inter-municipal councils	X	X	X	X	

Box 2.2. The institutional reform process and the emergence of AGIF

The 2017 wildfires highlighted a number of weaknesses in the wildfire management system in place in Portugal until that year. To address the identified institutional gaps, the Agency for the Integrated Management of Rural Fires (AGIF) was established, with a view to enhance clarity on existing roles and responsibilities; facilitate co-ordination and knowledge sharing across agencies; build capacity across levels of government; and improve decision-making through a lessons-learnt process (AGIF and IRFMS, 2020[31]). AGIF falls under the direct authority of Portugal's Prime Minister, which ensures its political empowerment as a cross-governmental agency independent from specific ministries. AGIF comprises a high-level co-ordination committee, presided by the Prime Minister, which integrates the top management of all public agencies active in wildfire management (Table 2.1. and Table 2.2.). AGIF is also involved in the technical co-ordination of a number of other committees – established through the Integrated Rural Fire Management System (see Section 2.1) – that bring together key stakeholders at different levels of government.[10] Overall, AGIF's committees facilitate dialogue and co-operation among actors (Presidency of the Council of Ministers, 2021[32]).

Source: (AGIF and IRFMS, 2020[31]) (Presidency of the Council of Ministers, 2021[32]).

Overall, in recent years, wildfire governance in Portugal has become more decentralised. The committees established under the Integrated Rural Fire Management System (Box 2.2) facilitate the engagement of subnational governments in wildfire management. Municipalities are increasingly involved in the management of wildfire risk, e.g. through enhanced forest management and civil protection competencies (Council of Ministers, 2015[17]). For example, municipalities develop local land-use plans and forest protection plans and administer fines for non-compliance with risk prevention practices (Council of Ministers, 2015[17]). Each municipality counts on local forestry technical offices and local fire departments. The key obstacle to the further decentralisation of wildfire management is the lack of financial resources and technical capacities available at the subnational level. In recent years, the increased focus on cross-agency co-operation observed at the national and subnational level has also been accompanied by similar efforts at the international level (Box 2.3).

Box 2.3. International co-operation for wildfire risk prevention

Portugal has signed several international agreements for mutual support and knowledge sharing for wildfire management. While until recent years international co-operation had solely focused on wildfire suppression, this is quickly changing, with a growing number of initiatives focusing on strengthened international co-operation for wildfire prevention. Between 2006 and 2010, the FIRE PARADOX project – an international initiative funded by the European Commission – focused on promoting wildfire prevention as part of an integrated approach to wildfire management (European Forest Institute, n.d.[33]). In 2014, the SPITFIRE platform – a cross-border service on weather and wildfire risk forecasting – was established to allow information-sharing between the Portuguese and Spanish civil protection and meteorological agencies (European Commission, 2018[34]) (European Commission, n.d.[35]). Portugal's National Plan for Integrated Rural Fire Management also foresees the creation of an Iberian Centre for Research, Prevention and Combating of Wildfires (AGIF and IRFMS, 2020[31]), which is set to further improve co-operation on wildfire risk assessment, prevention and climate change adaptation between Portugal and Spain. Most notably, the Centre will facilitate cross-border research and knowledge exchange to better understand wildfire drivers in the region; joint awareness-raising campaigns; and cross-border trainings on wildfire risk prevention and suppression (AGIF and IRFMS, 2020[31]). In addition, Portugal has developed several exchange programmes with experts in Australia, Chile, South Africa, Spain and the United States, which aim to enhance fuel management, community resilience and the recovery of burned areas.

Source: (European Forest Institute, n.d.[33]) (European Commission, 2018[34]) (European Commission, n.d.[35]) (AGIF and IRFMS, 2020[31]).

3 Wildfire risk reduction in Portugal: current measures, practices and existing challenges

The extreme wildfires of 2017 brought attention to the importance of wildfire prevention. While policy efforts until then had mostly relied on *ex post* response measures, the 2017 wildfires showed the need to adapt to changing wildfire risk by preventing risk and impacts, most notably through better risk assessment, enhanced risk awareness and communication, enhanced physical and organisational measures such as fuel and ecosystem management, land-use planning and building regulations, as well as through better emergency preparedness and post-fire recovery practices.

3.1. Wildfire risk assessment

In recent years, wildfire risk assessment methods and practices have significantly improved, thanks to technological advancements in data capture and processing and to the lessons learnt from recent extreme wildfires. Today, wildfire risk assessment in Portugal mostly relies on data collection on past wildfires and on hazard modelling and mapping efforts, undertaken in close co-operation by the Institute for Nature Conservation and Forests (ICNF), the Portuguese Institute for the Sea and the Atmosphere (IPMA), the National Authority for Emergency and Civil Protection (ANEPC) and the Agency for the Integrated Management of Rural Fires (AGIF).

The Portuguese database on wildfires, managed by the ICNF, provides data on past wildfire events that occurred on public land since 1943, allowing to track evolving wildfire activity trends over space and time. The database includes information on burned area, fire classification by fuel type, as well as on the resources used and lost during wildfire suppression. While some of these data are publicly available, others are only accessible to civil protection agents and researchers. The ICNF regularly publishes summaries of the key data entries, making them available to the public. Going forward, AGIF is set to co-ordinate the establishment of a new database to record losses and damages from wildfires.

Portugal has also developed a wildfire hazard map, which classifies the territory on the basis of its wildfire-proneness, using five hazard levels (i.e. "very low", 'low", "medium", "high" and "very high") (ICNF, 2022[36]) (Figure 3.1). The map is used to inform preventive measures in forest management, land-use planning and building regulation; to define the activities allowed on rural land; and to allocate fire monitoring and firefighting resources. Territories characterised by "high" and "very high" hazard levels constitute priority areas for prevention and are usually subject to stricter regulations (ICNF, 2022[36]) (see Section 3.3). The map is developed by the ICNF based on data on land cover, slope, elevation, and historical fire activity. It is regularly updated to take into account recent fires, as these are likely to reduce fuel availability and thus wildfire hazard in the short term. In addition to this nationwide map, each municipality – regardless of its proneness to wildfire risk – is required to have its wildfire hazard map. Municipal maps must be updated every ten years, together with the respective municipal plans. However, to date, national and municipal

hazard maps in Portugal do not integrate information on climate variability nor on the projected effects of climate change on future wildfire hazard. This represents a key gap in wildfire risk assessment.

Figure 3.1. The national wildfire hazard map for 2020-30
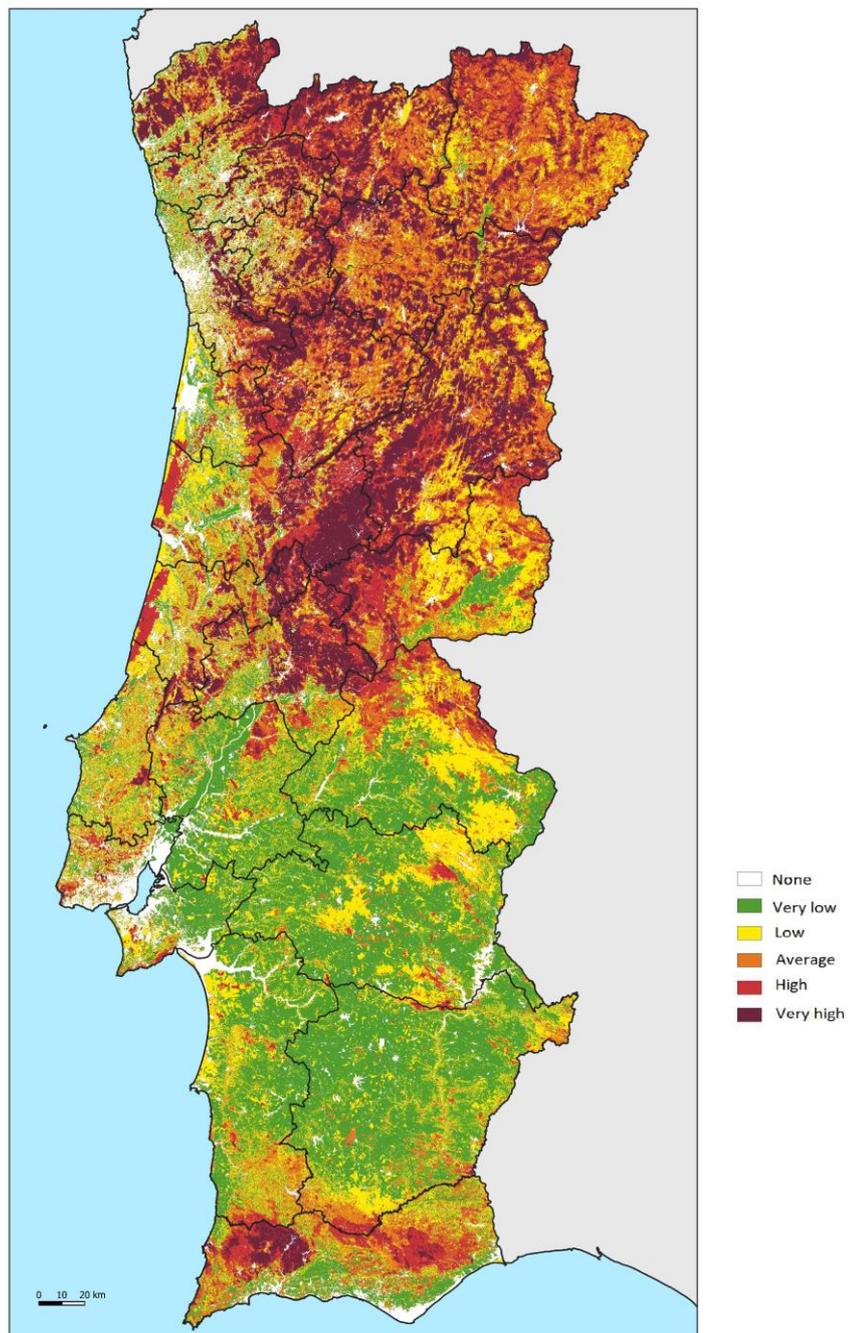
Source: Adapted from (ICNF, 2022[36]).

The unavailability of wildfire risk maps at the national level represents another key challenge to wildfire management in Portugal, as wildfire hazard maps, alone, do not provide a complete picture of wildfire risk in the country. While wildfire risk maps are legally required at the municipal level, these are not regularly updated and their reliability and comparability are thus limited. Currently, the ICNF is working to develop a nationwide wildfire risk map, which will incorporate data on the exposure, economic value and vulnerability of built assets, to the extent that these are available. Finally, another major challenge to wildfire risk assessment in Portugal is the lack of integration of the existing wildfire risk projections (available on the Portal do Clima) (Box 3.1) into risk assessment and planning processes. To address this gap, as part of the RNA2100 project (see Section 2.1), the Portuguese Environment Agency is currently working on updating the projections of wildfire risk under climate change and on providing guidance on how to best integrate them into risk maps and other planning instruments.

3.2. Wildfire risk awareness and communication

The level of awareness of wildfire risk varies significantly across stakeholders. While most actors tend to be highly aware of existing wildfire risk and drivers, there is scope to improve risk awareness and communication efforts, as highlighted by the two Independent Technical Committees' reports in the aftermath of the 2017 wildfires (Independent Technical Committee, 2017[23]) (Independent Technical Committee, 2018[24]). Raising risk awareness is particularly critical amongst private actors in rural areas (Council of Ministers, 2020[9]), as most wildfire ignitions in Portugal are caused by human activity (Meira Castro et al., 2020[37]) and almost 50% of all ignitions are due to careless human behaviour (GNR, 2022[38]).[11]

Today, wildfire hazard levels and recommended prevention measures are communicated to the public by the Civil Protection. The National Republican Guard, the Institute for Nature Conservation and Forests and the Ministry of Agriculture and Rural Development also play a role in raising the awareness of both citizens and local administrations in risk-prone areas. Their efforts mostly focus on raising awareness on effective fuel management techniques and the safe use of fire, with a view to minimising fuel loads and the number of ignitions during the fire season (Council of Ministers, 2020[9]). Portugal has recently launched several initiatives that aim at strengthening wildfire risk awareness and promoting wildfire risk reduction (Box 3.1).

> ### Box 3.1. Successful initiatives for wildfire risk awareness
>
> The **Portal do Clima** (Climate Portal) is an online platform developed by the Portuguese Institute for the Sea and the Atmosphere and the University of Lisbon to increase public awareness of climate risks. It provides easily accessible data on climate change in mainland Portugal, including on past and projected risk levels under different climate scenarios. This includes for example the projected number of days characterised by different wildfire risk levels under different emission scenarios (i.e. RCP 4.5 and RCP 8.5) for the periods 2011-40, 2041-70 and 2071-2100, as well as observed and projected data on temperature, rainfall, wind speed, drought conditions and relative humidity (Government of Portugal, 2021[4]) (IPMA and University of Lisbon, 2022[39]).
>
> The **Portugal Chama** (Portugal is Calling) campaign promotes wildfire risk reduction interventions at the local level. Targeted at both private and public stakeholders, it aims at raising awareness of the measures to reduce wildfire risk and impacts. For example, the campaign recommends not to accumulate firewood near buildings and to install strips of non-flammable flooring around private houses, which can serve as buffer zones (Portugal Chama, n.d.[40]). With a yearly investment of EUR 8 million and the support of private companies (AGIF and IRFMS, 2020[31]), the campaign has been disseminated on major media as well as on motorway billboards and digital screens.
>
> **Aldeia Segura Pessoas Seguras** (Safe Village Safe People) is a programme that promotes good practices to reduce wildfire hazard and exposure and to prepare for wildfire occurrence in fire-prone areas. Besides encouraging to avoid risky behaviours (e.g. the use of fire during the wildfire season), the programme also promotes interventions to support wildfire prevention and emergency preparedness and response (see Box 3.2 and Section 3.4) (ANEPC, 2018[41]). The programme mostly targets local communities in rural areas via information posters, videos, training programmes and information events.
>
> Source: (Portugal Chama, n.d.[40]) (AGIF and IRFMS, 2020[31]) (ANEPC, 2018[41]) (Government of Portugal, 2021[4]) (IPMA and University of Lisbon, 2022[39]).

3.3. Physical and organisational prevention measures

Historically, Portugal has mostly focused its wildfire management efforts on wildfire suppression. This only intensified after the extreme 2003 and 2005 wildfires, which led to additional investments in emergency response, widening the gap between wildfire suppression and prevention efforts (Council of Ministers, 2020[9]). The Independent Technical Committees (ITC)'s assessments highlighted this imbalance as a key weakness and identified the scarce wildfire prevention efforts in rural areas as a key driver of the losses suffered in 2017 (Council of Ministers, 2020[9]). Since then, awareness has grown in favour of a better balance between emergency response and prevention measures (AGIF and IRFMS, 2020[31]), with has also been reflected in public spending (see Section 3.6). Overall, wildfire prevention relies on a mix of structural measures, such as fuel and ecosystem management, and organisational measures, such as land-use regulations, building codes and standards and other sector-specific regulations (OECD, 2023[7]).

3.3.1. Fuel and ecosystem management for wildfire prevention

Over the past two decades, fuel and forest management measures and practices have evolved to strengthen wildfire prevention, embracing an increasingly proactive approach to land management (Council of Ministers, 2020[9]) (AGIF and IRFMS, 2020[31]) (Government of Portugal, 2021[4]). This trend

was most marked after the publication of the ITC assessments, which linked insufficient fuel management efforts to the outcomes of the 2017 wildfires.

Today, fuel management measures are supervised by the Institute for Nature Conservation and Forests (ICNF) and mostly rely on the use of fuel breaks and strictly regulated prescribed fires, as well as on the sustainable management of wildland ecosystems. The recent development of strategic fuel breaks, known as fuel mosaic areas (i.e. a complex network of lanes and patches alternating agriculture, grazing and forestry areas), has effectively contributed to contain wildfire risk (Presidency of the Council of Ministers, 2021[32]) (Corona et al., 2015[42]). Mosaic areas play a key role in isolating wildfire ignitions, containing the spread, extent and intensity of wildfires, and protecting built assets and land of particular value. In addition, by creating corridors where fire cannot ignite, they also facilitate emergency response operations (Presidency of the Council of Ministers, 2021[32]). The use of prescribed fires is allowed in Portugal, though subject to strict rules and specific conditions (OECD, 2023[7]). In addition, vegetation thinning efforts are also undertaken and encouraged by the National Republican Guard (GNR) to avoid excessive fuel accumulation. Recent efforts in ecosystem restoration have also contributed to reducing landscape flammability, as proven by the recent restoration of native cork oak belts in the Algarve region (UNEP, 2022[43]).

Portugal has also developed specific programmes to maintain and restore traditional fuel management practices, such as the Condomínio de Aldeia programme (Box 3.2) and the Mechanism to Support the Carrying out of Fires (Mecanismo de Apoio à Realização de Queimadas). The latter engages local herders to carry out prescribed burning to reduce wildfire risk while also improving pasture management. This Mechanism is a good example of inter-agency co-operation, as it foresees the co-ordinated effort of the ICNF, the National Authority for Emergency and Civil Protection, the National Republican Guard, fire brigades, forest associations and local authorities. Other initiatives to leverage traditional practices include a pilot project that encourages controlled grazing by rewarding local shepherds for undertaking grazing activity in public forests or around exposed settlements and assets. These practices can significantly reduce fuel loads in risk-prone areas (OECD, 2023[7]).

Compliance with fuel management requirements across the territory is monitored and enforced by the GNR through warnings and administrative fines (Council of Ministers, 2020[9]) (Komac, B. et al., 2020[44]). The monitoring system developed by the GNR also allows GNR agents to assess where fuel management is needed and to investigate violations of the relevant legislation through *ad hoc* inspections and cartographic technology.

Despite significant improvements in fuel management, major gaps and challenges remain. With only 3% of forested lands owned by the state (compared to an average of 40% in the EU) (APA, 2020[20]), fuel management in private lands is crucial for effective risk reduction. Yet, only 46% of forest areas are covered by a land registry and more than 20% of the forest lands has no or unknown owner (APA, 2020[20]) (Figure 3.2). This hampers the enforcement of fuel management regulations in private lands. In addition, in some regions, the highly fragmented land ownership structure limits the profitability of (and hence the incentives to) active land management. The ageing population and high rates of land abandonment in rural areas (see Section 1) only add to these challenges, as they leave behind a growing amount of unmanaged lands (Council of Ministers, 2020[9]) (Government of Portugal, 2021[4]). Finally, another challenge is posed by the lack of a strong regulation mechanisms for the collection, valorisation and management of the biomass waste generated by forestry and agricultural activities, which would reduce the use of fire in rural areas and incentivise active land management.

Figure 3.2. Forest land ownership structure

Forest area with no land registry
Land registry under development
Forest area covered by land registry
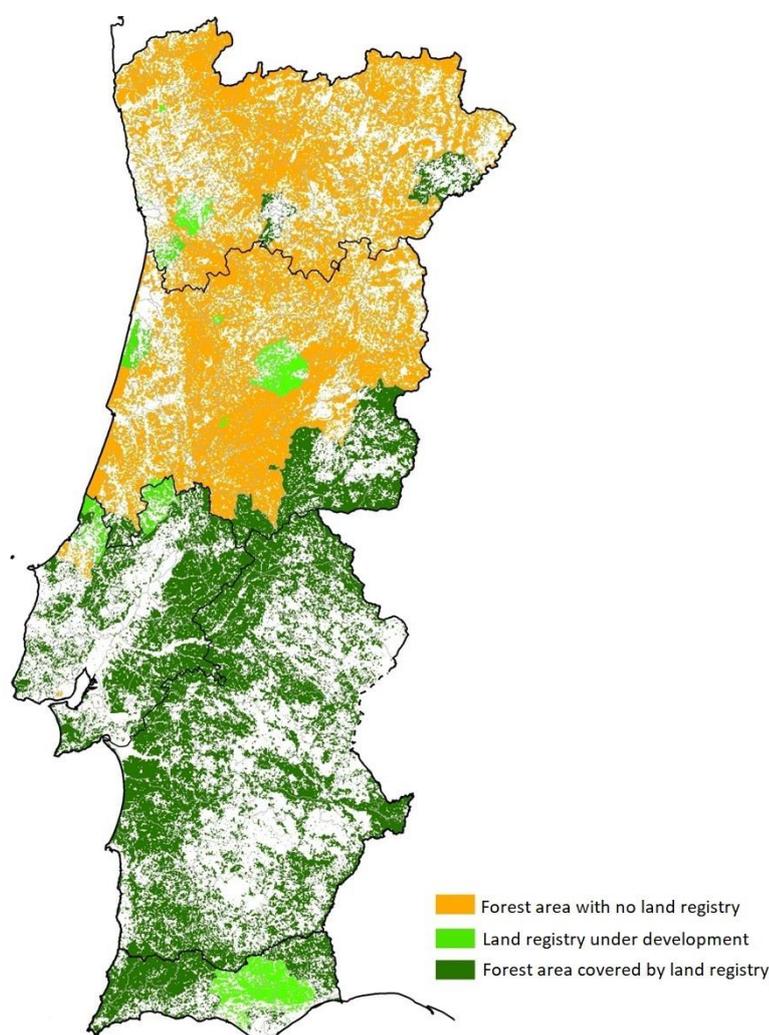
Note: White areas refer to other land-use types.
Source: Adapted from (ICNF, 2022[45]).

To address these challenges, various initiatives have been developed to enhance the financial viability of active land management on private lands (Council of Ministers, 2020[9]) (AGIF and IRFMS, 2020[31]) (Box 3.2). Since 2019, a pilot scheme of payment-for-ecosystem-services sets out a reward mechanism to encourage the plantation of native species on private rural lands, with a view to reducing landscape flammability (European Commission, 2021[46]). While reducing wildfire risk, the scheme also supports ecosystem conservation, thus contributing to climate mitigation, erosion control and other environmental goals. Portugal also relies on Forest Intervention Zones (ZIFs), i.e. areas that extend over private and public lands and that are managed by a single entity appointed by the relevant landowners, to ensure active and consistent land management (Valente et al., 2013[47]).[12] Active forest management is also encouraged by Forest Management Plans (PGFs), which regulate and detail the measures to be undertaken on forest and agricultural areas to protect and sustainably manage forest resources in the concerned areas. PGFs are mandatory for all Forest Intervention Zones as well as for all forests beyond a

certain size. Today, they cover 35% of mainland forested land. Yet, no national monitoring system for the implementation of PGFs is available, as 97% of the land covered by PGFs is private or community land.

Some initiatives have also been developed to address land ownership issues. For example, the Bolsa de Terras initiative, established in 2012 and managed by the Ministry of Agriculture and Rural Development, allows public and private lands to be made available for lease or sale in order to be employed for agricultural, forestry and silvipastoral activities (Direção-Geral de Agricultura e Desenvolvimento Rural, n.d.[48]). A recent law also establishes a regime of so-called "forced tenancy", which enables the state to carry out fuel management activities on private lands whose owner is unknown or where the owner fails to carry out the requested measures (Presidency of the Council of Ministers, 2021[49]). Under certain conditions, municipalities are also entitled to intervene in private lands to manage them and can ask landowners for the reimbursement of the expenses incurred.

Box 3.2. Emerging programmes to encourage active wildland management

The **Condomínio de Aldeia** programme aims to increase the resilience of settlements located in the wildland-urban interface. It encourages active fuel management practices (e.g. the reduction of fuel density and accumulation) around exposed WUI settlements and assets, promoting fire-resilient land-use changes and community engagement. The programme also aims to increase the profitability of private lands and to encourage tourism. Condomínio de Aldeia is financed through the Environmental Fund and currently includes 42 projects (DGT, n.d.[50]). Similarly, the programme **Aldeia Segura Pessoas Seguras** (Box 2.1) also encourages the implementation of buffer zones and fuel management measures to protect settlements and strategic infrastructure in the WUI.

Emparcelar para Ordenar is a support programme for rural property owners that aims to increase property size to enhance the profitability of active land management and, thus, the resilience of rural lands to wildfire risk. The programme is funded through the Recovery and Resilience Plan and the Forest Permanent Fund.

The **Landscape Planning and Management Programmes** (PRGP) are sectoral programmes falling under the Landscape Transformation Programme (see Section 2.1), which aim to enhance landscape-level resilience to wildfires. PRGPs entail projects to enlarge rural land ownership size and promote the active management of small land parcels. They also gather revenues that are used to finance payment-for-ecosystem-services schemes. Out of twenty planned PRGPs planned by 2024, one is already in place, three are waiting for approval and six others are under development (DGT, n.d.[51]).

Source: (DGT, n.d.[50]) (DGT, n.d.[51]).

3.3.2. Land-use planning and building regulations for wildfire prevention

Land-use measures and practices have evolved significantly over the past few decades in response to growing wildfire hazard. In 2005, 2017 and 2021, new land-use regulations introduced more stringent conditions for releasing building permits in wildfire risk-prone areas (Presidency of the Council of Ministers, 2021[32]). At the national level, spatial planning regulations are based on the hazard level identified by the national wildfire hazard map (see Section 3.1). In rural areas characterised by "high" and "very high" wildfire hazard levels, the construction of new permanent housing is forbidden. Exceptions to this ban can be granted under particular circumstances, i.e. for the construction of permanent housing when absolutely no alternative exists, and for paramount economic activities (e.g. industry and agriculture) when no alternative location exists.[13] Building under these two exceptions is only permitted when specific risk reduction measures are implemented, such as for example the development of buffer zones around the building

(Presidency of the Council of Ministers, 2021[32]). The creation and maintenance of buffer zones around built assets is also required in rural areas for all buildings located outside of rural settlements and within 50 metres from forested lands. This requirement applies to both new buildings and existing ones (Presidency of the Council of Ministers, 2021[32]).

Portugal has also developed building codes and standards that aim at strengthening the resilience of built assets in wildfire-prone areas. These include requirements on the use of non-flammable building materials, on the development of defensive measures such as fire barriers, and on building maintenance. Overall, protective measures that enhance the resilience of built assets to fire are mandatory for all assets located in areas characterised by "high" or "very high" wildfire hazard levels, as well as for buildings located in rural areas and within 50 metres from forested lands (Presidency of the Council of Ministers, 2021[32]). Existing building codes and standards are mandatory for both to new assets and to existing ones through retrofitting requirements. Furthermore, various national programmes, including the Portugal Chama campaign (Box 3.1), encourage the uptake of additional voluntary risk reduction measures by private stakeholders. These include for example the regular cleaning of roof surfaces, the use of spark-arresting nets, as well as the development of non-flammable flooring around the property to provide an additional buffer area around the building. Finally, specific requirements exist to guide the design and construction – as well as the operations and maintenance – of infrastructure assets (Box 3.3).

Box 3.3. Prevention measures in infrastructure planning and management

The Action Plan for Adaptation to Climate Change P-3AC identifies infrastructure management as a policy priority and sets sector-specific targets for the implementation of adaptive and preventive measures. For example, the P-3AC sets the ambition to have 50% of transport infrastructure companies in the country develop an adaptation or contingency plan for extreme events by 2030 (Government of Portugal, 2019[25]). Overall, risk assessment is increasingly considered in infrastructure design. To be approved, infrastructure project plans must consider climate scenarios and specific risk thresholds. Since 2021, new infrastructure projects must meet more stringent criteria for authorisation and have to be approved by municipal commissions, which, among other stakeholders, include representatives from the Institute for Nature Conservation and Forests. Once in place, infrastructure assets located in rural areas must be surrounded by buffer zones, whose size is adapted to the specific type of asset. For instance, recent legislation mandates the maintenance of ten-metre-wide buffer zones around main roads in rural areas to ensure sufficiently large escape routes and access routes for firefighters (Komac, B. et al., 2020[44]).

While in some cases critical infrastructure managers are legally required to manage wildfire risk around their assets (Council of Ministers, 2020[9]), in other cases risk reduction measures are undertaken on a voluntary basis. Recent legislation mandates the maintenance of ten-metre-wide buffer zones around main roads to ensure sufficiently large escape routes and access routes for firefighters (Komac, B. et al., 2020[44]). Portugal's largest generator and provider of energy, Energias de Portugal, has developed its own wildfire risk reduction plan, which includes interventions on fuel management, asset management, wildfire monitoring and awareness-raising activities. Since 2013, the plan has contributed to reducing the burned area in the Sabor valley from an average of 210 hectares per year to 14 hectares per year (UNDRR, 2021[52]). The energy company Redes Energéticas Nacionais (REN) also implements a number of prevention measures around its assets, including wildfire monitoring and the use of fuel breaks (Presidency of the Council of Ministers, 2021[32]).

In some cases, non-binding recommendations on wildfire risk reduction around infrastructure assets also exist. For example, the National Communications Authority has issued a series of recommendations for the protection and resilience of electronic communications infrastructure to wildfire risk. These includes recommendations for managers of electronic communication infrastructures to convert existing aerial cable routes to underground routes and for radio communication companies to manage fuel loads in the five-metre radius around their stations and to maintain buffer areas of 50 metres around their assets it recommends that (ANACOM, 2018[53]).

Source: (Government of Portugal, 2019[25]) (Komac, B. et al., 2020[44]) (Council of Ministers, 2020[9]) (ANACOM, 2018[53]) (Presidency of the Council of Ministers, 2021[32]) (UNDRR, 2021[52]).

3.4. Emergency preparedness

Effective emergency preparedness measures can significantly reduce the human cost of wildfires, while also helping to contain the losses and damages to assets and the economy (OECD, 2023[7]). Over the past decade, and most notably after the extreme 2017 wildfires, preparedness practices have evolved significantly in Portugal. The increased focus on preparedness efforts is reflected in the National Plan for Integrated Rural Fire Management (NPIRFM)'s process chain. The NPIRFM also mainstreams extreme wildfire risk and uncertainty into long-term wildfire management practices, making the case for enhanced emergency preparedness efforts. In this context, Portugal's civil protection services have developed

various programmes to scale up preparedness and safety in the event of a wildfire. For example, the programme Aldeia Segura Pessoas Seguras (Box 2.1) supports early-warning systems, simulates evacuation plans and contributes to identify safe places to be used as shelters in the event of a wildfire (ANEPC, 2018[41]). The programme also recommends structural measures for the protection of assets in the event of a wildfire.

To inform emergency preparedness and response activities, Portugal relies on a hazard monitoring system, which includes fire weather monitoring and forecast, as well as fuel load monitoring. These assessments, performed systematically by the Portuguese Institute for the Sea and the Atmosphere (Council of Ministers, 2020[9]), provide the input information to compute the Rural Fire Danger Index. Fire danger ratings are calculated for all mainland districts combining daily data on fire weather[14] with information on the periodicity of wildfire activity and on recent burned area (IPMA, n.d.[54]). The IPMA's website provides the forecast of Rural Fire Danger and of the Forest Fire Weather Index alongside its sub-indexes and the likelihood of wildfire extremes. This information is complemented by a wildfire outbreak, behaviour and propagation monitoring system, which relies on a network of lookout towers and monitoring cameras, as well as on surveillance brigades and aerial monitoring to be activated on the days considered at highest wildfire risk. Citizens can also contribute to signal wildfire outbreaks through national emergency numbers. This system is co-ordinated by the National Republican Guard.

Building on these monitoring practices, civil protection authorities operate an early-warning system, which sends out alert messages to all mobile phones located in or near areas identified as at high and imminent risk (ANEPC, 2018[41]). This system is subject to some limitations, as its effectiveness depends on whether cell towers are operational and whether mobile phones are switched on and have reception. In addition, the speed at which warnings are circulated also poses some challenges. The National Authority for Emergency and Civil Protection also co-operates with local radio stations, which can help further disseminate civil protection alerts.

3.5. Post-fire recovery and rehabilitation

Portugal places significant emphasis on the ecological recovery of burned areas, which is usually broken down into three different phases by the Institute for Nature Conservation and Forests (ICNF) (Pacheco and Claro, 2020[55]).

In the immediate aftermath of a wildfire (or even during its last phases), emergency stabilisation efforts aim at reducing or containing cascading impacts. During this phase, the ICNF assesses the ecosystem services impacted by the wildfire and recommends measures that can be implemented to stabilise the landscape in the short term (Pacheco and Claro, 2020[55]).[15] These interventions usually focus on the protection of fragile ecosystems and hydrographic networks, as well as on erosion control. In some cases, fuel breaks are also used to isolate the areas where extinguished wildfires are likely to reignite, a practice known as rekindle control. Thanks to increased efforts in rekindle control, the total area burned by rekindled fires decreased eightfold, going from 13 000 hectares per year in 2001-17 to 1 500 hectares per year in 2018-21 (ICNF, 2022[45]) (Figure 3.3).

Figure 3.3. The effect of rekindle control efforts
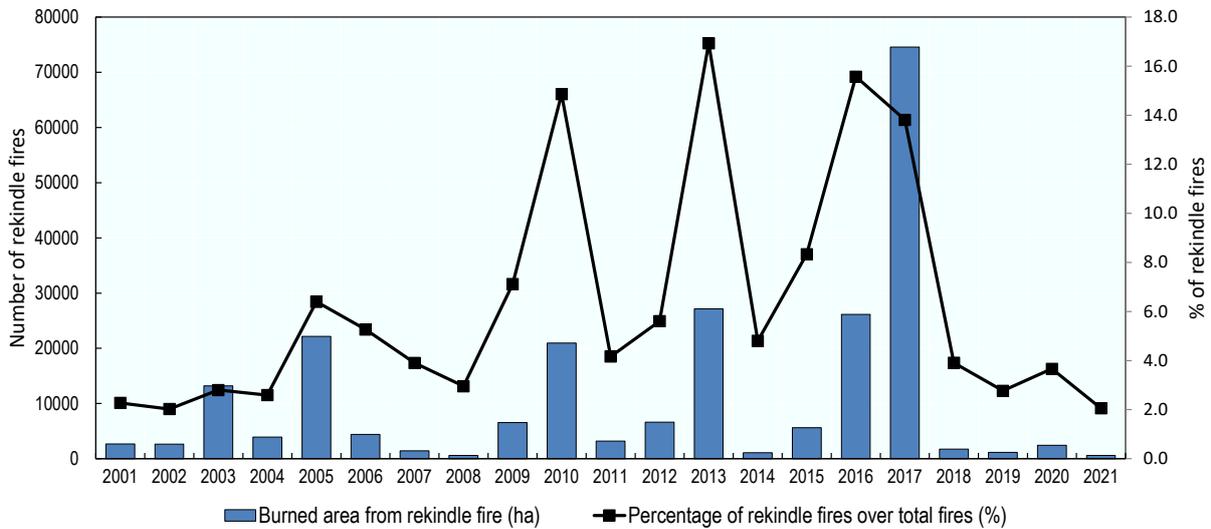
Note: The dotted blue area corresponds to the period during which rekindle control efforts have been implemented.
Source: Adapted from (ICNF, 2022[45]).

Within the two years following a wildfire, recovery efforts mostly focus on the restoration and rehabilitation of the landscape through the recovery of natural biophysical processes (Pacheco and Claro, 2020[55]). These interventions are usually undertaken by the Institute for Nature Conservation and Forests, as well as by the National Republican Guard and fire brigades. While official guidelines for landscape recovery only focus on biodiversity loss, erosion control and water contamination (Pacheco and Claro, 2020[55]), in most cases other recovery interventions are also undertaken. Key measures in this phase include removing dead biomass, replanting trees and grasses and analysing pest spread (Council of Ministers, 2015[17]). In some instances, after an extreme wildfire occurs, public agencies engage with private landowners to facilitate land-use and cover changes to reduce landscape flammability. Overall, Portugal can count on a strong legal framework to support the ecological recovery of burned areas (Pacheco and Claro, 2020[55]). Nonetheless, ecosystem regeneration to date mainly occurs through natural vegetation regrowth processes, which in many cases are unmanaged and lack monitoring.

Many recovery and rehabilitation measures taken in the aftermath of a wildfire can also contribute to build longer term resilience by reducing future wildfire hazard (OECD, 2023[7]). The Institute for Nature Conservation and Forests plays a key role in this phase by promoting the use of strategic mosaic areas and grazing activity as well as by overseeing reforestation processes. In recent years, some attempts have also been made to implement landscape-scale changes, e.g. by favouring the plantation of fire-resilient species, modifying land-use zoning and establishing fuel break networks. However, so far, these attempts have been limited in scope, largely due to the land property structure in place in Portugal (see Section 3.3).

In terms of post-fire asset reconstruction, land development is restricted in areas subject to high wildfire risk (see Section 3.3). In addition, a new set of regulations released in 2021 requires housing and other buildings to adhere to safety standards set by the National Authority for Emergency and Civil Protection. These standards apply to assets rebuilt after wildfires, as well as to other new constructions. In extreme cases, building relocation is considered.

3.6. Financing wildfire risk reduction

Wildfire risk management in Portugal is mostly funded via public budgets. At the national level, the main source of funding is the Environmental Fund, which supports forest management, landscape planning, nature conservation and other risk prevention measures. Overall, wildfire management accounts for about one-third of the available national funds for adaptation under the Action Plan for Adaptation to Climate Change P-3AC (OECD, 2023[56]). National funds are complemented by EU funds,[16] which to date represent the main source of funding for wildfire prevention and management in the country. Indeed, since 2017, EU funds for forest resilience have significantly increased. In particular, Portugal's Recovery and Resilience Plan developed under the EU Recovery and Resilience Facility (RRF) allocated EUR 1 billion to climate adaptation and resilience, of which EUR 615 million specifically targeted to scaling up the resilience of forested lands (APA, 2022[57]). In addition, in the event of an extreme wildfire, access to the EU Solidarity Fund can be requested (OECD/The World Bank, 2019[58]). Between 2002 and 2017, Portugal received EUR 134 million from this fund to respond to extreme wildfire and flooding events (European Commission, 2019[59]).

In recent years, both national and European funds have increasingly supported prevention measures (Box 3.4). This has contributed to close the gap between wildfire suppression and prevention funding (Figure 3.4) identified by the Independent Technical Committees (ITC), bringing wildfire prevention and suppression funding in Portugal to near parity.

Box 3.4. The recent increase in funding for wildfire risk prevention

Over the past decade, public funding for wildfire prevention has significantly increased in Portugal. At the national level, the extreme 2017 wildfires led Portugal to boost the public budget available for wildfire prevention. While in 2017 only 20% of wildfire management funding was allocated to prevention, this figure rose to 46% in 2021, for a total of EUR 145 million allocated to wildfire prevention activities (Figure 3.4) (Council of Ministers, 2020[9]) (AGIF and IRFMS, 2020[31]). Going forward, national funding for wildfire management is set to double by 2030 compared to 2021, reaching EUR 647 million per year by 2030 (AGIF and IRFMS, 2020[31]) (AGIF, 2021[60]). In the context of this budget increase, funding for preventive structural measures in forested and agricultural areas is also set to be reinforced by 2030 (Government of Portugal, 2021[4]).

Figure 3.4. The shifting focus from suppression to prevention in national public funding in Portugal, 2017-21

Million EUR
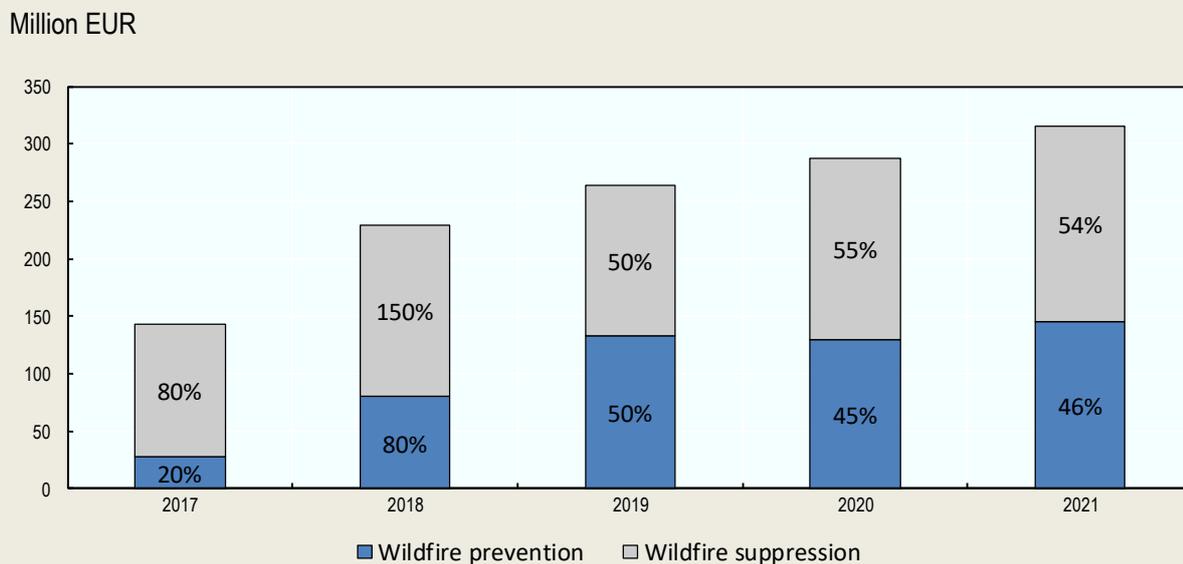
Source: Based on (AGIF, 2021[60]).

At the EU level, funding for wildfire prevention has increased thanks to a new body of EU policies on climate change and risk prevention. Most notably, since 2020, the Agriculture Fund has allocated a higher percentage of funding to EU territories vulnerable to wildfires. The Recovery and Resilience Facility funding for forestry-related risks, including wildfires, has also increased.

Source: (Council of Ministers, 2020[9]) (AGIF and IRFMS, 2020[31]) (Government of Portugal, 2021[4]) (AGIF, 2021[60]).

Despite these important improvements in wildfire prevention funding, some challenges remain. The lack of a specific financial envelope for the implementation of the National Plan for Integrated Rural Fire Management's projects is perceived as a key obstacle, as funding for the implementation of such projects needs to be negotiated on a project-by-project basis.

Private finance for wildfire risk reduction is also largely insufficient in most cases. To date, major private stakeholders with clear legal responsibilities – such as some infrastructure providers – invest significantly in risk reduction measures. Conversely, smaller private actors often lack the financial means and, in some cases, a clear understanding of existing risk levels and the role they can play in reducing wildfire risk. Overall, the engagement of private actors in wildfire risk reduction has proven rather challenging and, in many cases, wildfire risk prevention measures undertaken by private actors are mostly financed through public funds. This gap is only exacerbated by rural land abandonment, which entails lower private investment in land management, thus increasing the burden on public finances to manage the landscape.

3.6.1. Risk transfer mechanisms

To date, no overarching public compensation mechanism is available in Portugal to reimburse the wildfire-induced losses and damages suffered by public and private actors. While some public schemes are in place to compensate farmers and herders for the losses caused by extreme wildfires and to support the recovery of burned areas and farm infrastructure, these are often too slow in mobilising financial resources in the immediate aftermath of a wildfire.

Private insurance coverage for wildfire risk is not mandatory in Portugal. In 2021, the share of wildfire losses covered by insurance in Portugal was around 10% (OECD, 2021[61]). To date, most insurance schemes that cover wildfire risk in Portugal are available in less risk-prone areas (i.e. the centre-south and southern regions) and usually subscribed by large property owners that implement preventive measures and manage their lands proactively. In addition, such insurance schemes are characterised by high premiums, which hamper insurance penetration among smaller actors. The lack of affordable insurance schemes represents a major challenge to wildfire risk reduction in Portugal and hampers long-term resilience.

4 Conclusions

The combination of Portugal's climate, land cover and management makes wildfire risk a major and growing challenge in the country. In recent years, unprecedentedly extreme wildfires have caused negative impacts on human well-being, communities and ecosystems, highlighting the need for a paradigm shift in wildfire management. Following the extreme 2017 wildfires, Portugal has taken significant steps forward to strengthen its policy and institutional framework for wildfire management. One key outcome of this process is the publication of the National Plan for Integrated Rural Fire Management (NPIRFM), which establishes a strategic framework for wildfire risk management, inclusive of policy objectives and of a process chain detailing the relevant roles, responsibilities and procedures throughout the wildfire management cycle. In parallel, a new cross-governmental agency (i.e. AGIF), independent from specific ministries, has been established with the mandate to oversee wildfire management in the country and to enhance co-ordination across all the involved stakeholders. Together, these reforms succeeded in bringing wildfire prevention to the centre of wildfire management efforts in the country.

Today, the policy community in Portugal widely recognises the links between climate change and growing wildfire risk and the need to strengthen wildfire prevention and adaptation to reduce wildfire risk. These elements are mainstreamed in national climate plans and strategies, as well as in sectoral policy strategies on biodiversity, forests, spatial planning and landscape transformation, among others. National wildfire policy objectives are reflected and supported at the local level, thanks to the growing role and engagement of municipalities in wildfire management. The growing importance of wildfire risk prevention in the country is also increasingly reflected in international agreements between Portugal and other countries.

In recent years, wildfire management practices in Portugal have significantly improved. Risk assessments have become more thorough, thanks to technological advancements and the lessons learnt from recent extreme wildfires. The national wildfire hazard map, which identifies the areas most prone to wildfires, represents a key tool to identify priority areas for action. As this information alone is not sufficient to effectively assess wildfire risk, Portugal is currently working on developing a wildfire risk map, as well as projections of future wildfire hazard under different climate scenarios, as well as a system to record losses and damages from wildfires. In recent years, the country has also scaled up its risk communication efforts through several awareness-raising initiatives, which include successful campaigns such as Portugal Chama.

Since the extreme blazes of 2017, wildfire risk prevention has gained significant ground in Portugal. In order to reduce fuel loads and continuity, the country increasingly relies on the use of regulated prescribed fires and fuel breaks, including through the development of fuel treatment mosaic areas, thus implementing a planning process on a landscape scale. Working closely with local communities, Portugal has also developed specific programmes to promote traditional fuel management practices and scaled up efforts to monitor compliance with existing fuel management requirements. Successful initiatives have also been developed to strengthen the resilience of WUI areas. Nonetheless, the highly fragmented land ownership structure in the country, along with unclear or unknown land ownership in many rural areas, represents a major challenge to effective fuel management in private lands. While Forest Intervention Zones and recent initiatives such as Bolsa de Terras, Áreas Integradas de Gestão da Paisagem (AIGP), Landscape Integrated Management Areas. Condomínio de Aldeia and Emparcelar para Ordenar have helped to address these challenges, more efforts are needed in this direction in order to effectively reduce wildfire

risk in WUI areas. Wildfire risk reduction is also increasingly mainstreamed in land-use and building regulations, which have become more stringent, e.g. forbidding new development in high-risk areas and requiring the maintenance of buffer zones around new and existing buildings in fire-prone settlements. Risk prevention has also become an increasingly central consideration in post-fire recovery. Ecological recovery practices increasingly focus on the protection, restoration and rehabilitation of ecosystems with a focus on building long-term resilience, while a new set of regulations requires constructions rebuilt after extreme wildfires to adhere to enhanced safety standards. In addition, Portugal has also scaled up its emergency preparedness practices, through enhanced hazard monitoring systems, early-warning systems and evacuation plans. In this context, the Aldeia Segura Pessoas Seguras programme plays a key role in strengthening people's and settlements' resilience to wildfire risk.

Overall, following a series of particularly extreme wildfire events, adaptation to wildfire risk has significantly improved in Portugal, leading to a clearer and more integrated institutional setup as well as to a substantial increase in funding available for *ex ante* risk reduction. Going forward, future efforts could be directed towards further enhancing fuel management to reduce landscape flammability, e.g. by further investing in the maintenance of strategic fuel mosaic areas and fuel breaks, favouring more resilient land cover types and further promoting active land management on private lands. The establishment of a strong mechanism for the collection and valorisation of biomass waste would also contribute to limit ignitions and incentivise active land management. Initiatives that provide economic incentives to active land management and that allow public authorities or third parties to manage fuel accumulation on abandoned private lands remain a key priority to address land ownership issues. Fiscal incentives and insurance schemes could also play a key role in scaling up private investment in wildfire risk reduction. At the same time, strengthening the monitoring and enforcement of fuel management regulations, including on the use of fire during high-risk periods, remains critical to ensure compliance with existing regulations. Finally, strengthening wildfire risk assessment efforts – e.g. by developing wildfire risk maps and wildfire projections that account for the effects of climate change – is also pivotal to better inform wildfire management decisions and practices before, during and after a wildfire.

From an institutional perspective, while dialogue and information exchange across relevant actors have significantly improved in recent years, there is scope to further enhance co-ordination and collaboration on wildfire prevention at both the national and subnational level. In parallel, the technical and financial capacity of local governments and agencies should be further strengthened to ensure the effective implementation of wildfire prevention measures across the national territory. Finally, the simplification of bureaucratic mechanisms would contribute to implement solutions and initiatives and respond to the needs of local communities and economies, facilitating adaptation and long-term resilience to wildfire risk.

References

AGIF (2021), *Activity Report of the Integrated Rural Fire Management System – 2021*, Agency for the Integrated Management of Rural Fires, Portugal, https://www.agif.pt/pt/relatorio-de-atividades-sgifr-2021. [60]

AGIF and IRFMS (2020), *National Action Plan*. [31]

ANACOM (2018), *Medidas de proteção e resiliência de infraestruturas de comunicações eletrónicas: Relatório do grupo de trabalho dos incêndios florestais*, Autoridade Nacional de Comunicações, https://www.anacom.pt/render.jsp?contentId=1436120. [53]

ANEPC (2018), *Safe Village Safe People - Implementation Support Guide*, National Authority for Civil Protection, Portugal. [41]

APA (2022), *APA Presentation*. [57]

APA (2022), *National Emissions Inventory 2022*, Portugese Environment Agency, Amadora,, https://apambiente.pt/sites/default/files/_Clima/Inventarios/2022AgostoMemoEmissoes.pdf. [21]

APA (2020), *National Forestry Accounting Plan Portugal 2021-2025*, Portuguese Environment Agency, https://apambiente.pt/sites/default/files/_Clima/Mitiga%C3%A7%C3%A3o/Plano%20Contabilidade%20Florestal%20Nacional%202021-2025/National%20Forestry%20Accounting%20Plan_Revised%20version%20january%202020.pdf (accessed on 26 July 2022). [20]

APA (2017), *7th National Communication to the United Nations Framework Convention on Climate Change, 3rd Biennial Report to the United Nations Framework Convention on Climate Change, 4th National Communication in the Context of the Kyoto Protocol*, Portuguese Environment Agency, Amadora, https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/28410365_portugal-nc7-1-pt7cn3brfinal.pdf. [1]

APA (2015), *National Adaptation Strategy to Climate Change (ENAAC 2020)*, Portuguese Environment Agency. [26]

Bowman, D. et al. (2020), "Vegetation fires in the Anthropocene", *Nature Reviews Earth & Environment*, Vol. 1/10, pp. 500-515, https://doi.org/10.1038/s43017-020-0085-3. [15]

Corona, P. et al. (2015), "Integrated forest management to prevent wildfires under Mediterranean environments", *Annals of Silvicultural Research*, Vol. 39/1, pp. 1-22, https://www.researchgate.net/publication/271074753_Integrated_forest_management_to_prevent_wildfires_under_Mediterranean_environments. [42]

Council of Ministers (2020), *2020-2030 National Plan for Integrated Rural Fire Management*, https://www.agif.pt/app/uploads/2020/12/20-30_NPIRFM_littledoc.pdf. [9]

Council of Ministers (2018), *Resolução do Conselho de Ministros n.º 55/2018*, https://files.dre.pt/1s/2018/05/08700/0183501880.pdf. [29]

Council of Ministers (2015), *National Forestry Strategy*. [17]

De Rigo, D. et al. (2017), "Forest fire danger extremes in Europe under climate change: variability and uncertainty", *Publications Office of the European Union, Luxembourg*, https://doi.org/10.2760/13180. [5]

DGT (n.d.), *Desenhar a paisagem e programar a transformação*, https://www.dgterritorio.gov.pt/paisagem/ptp/prgp (accessed on 27 July 2022). [51]

DGT (n.d.), "Estratégia para uma intervenção integrada nos territórios da floresta", https://www.dgterritorio.gov.pt/paisagem/ptp. [50]

Direção-Geral de Agricultura e Desenvolvimento Rural (n.d.), *Bolsa de Terras*, https://www.bolsanacionaldeterras.pt/. [48]

EM-DAT (2023), *Natural Disasters 2000-2023 (database)*, https://www.emdat.be/ (accessed on 5 October 2022). [19]

European Commission (2021), "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: New EU Forest Strategy for 2030", *COM/2021/572 final*, https://eur-lex.europa.eu/resource.html?uri=cellar:0d918e07-e610-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF. [46]

European Commission (2019), *Evaluation of the European Union Solidarity Fund (2002-2017)*, https://ec.europa.eu/regional_policy/sources/evaluation/eusf_2002_2016/eusf_2002_2016_swd_en.pdf (accessed on 17 June 2022). [59]

European Commission (2018), *Forest Fires – Sparking Firesmart Policies in the EU*, European Commission, Brussels, https://op.europa.eu/en/publication-detail/-/publication/0b74e77d-f389-11e8-9982-01aa75ed71a1/language-en/format-PDF/source-91693190. [34]

European Commission (n.d.), "EU Research and Innovation to support forest fire management", https://research-and-innovation.ec.europa.eu/system/files/2018-11/eu_research_and_innovation_to_support_forest_fire_management_.pdf. [8]

European Commission (n.d.), *Spanish-Portuguese Meteorological information system for trans-boundary operations in forest fires (SPITFIRE)*, https://civil-protection-humanitarian-aid.ec.europa.eu/funding-evaluations/financing-civil-protection/prevention-and-preparedness-projects-civil-protection/overview-past-track-i-and-track-ii-projects/spanish-portuguese-meteorological-information-system-trans-boundary-operations-forest-fires-spitfire_en (accessed on 12 July 2022). [35]

European Forest Institute (n.d.), "FIRE PARADOX: An Innovative Approach of Integrated Wildland Fire Management Regulating the Wildfire Problem by the Wise Use of Fire", https://efi.int/projects/fire-paradox-innovative-approach-integrated-wildland-fire-management-regulating-wildfire. [33]

Ganteaume, A. et al. (2021), "Understanding future changes to fires in southern Europe and their impacts on the wildland-urban interface", *Journal of Safety Science and Resilience*, Vol. 2/1, pp. 20-29, https://doi.org/10.1016/j.jnlssr.2021.01.001. [2]

GNR (2022), *GNR presentation*. [38]

Gomes Da Costa, H. et al. (2020), *European wildfire danger and vulnerability under a changing climate: Towards integrating risk dimensions*, Publications Office of the European Union, Luxembourg, https://publications.jrc.ec.europa.eu/repository/handle/JRC119980. [18]

Government of Portugal (2021), *Portugal's Adaptation Communication to the United Nations Framework Convention on Climate Change*, https://unfccc.int/sites/default/files/resource/2021%20Portugal%20ADCOM_UNFCCC.pdf. [4]

Government of Portugal (2019), *National Adaptation Plan (NAP) for Climate Change (P-3AC)*. [25]

ICNF (2022), *Rural Fires in Portugal*. [45]

ICNF (2022), *The national wildfire hazard map*, Instituto da Conservação da Natureza e das Florestas, https://www.icnf.pt/api/file/doc/ad1416ee10981cce. [36]

ICNF (2021), "Forestry Profile", *Institute for Nature Conservation and Forests, Portugal*. [62]

IEA (2021), *Portugal Climate Resilience Policy Indicator*, International Energy Agency, Paris, https://www.iea.org/articles/portugal-climate-resilience-policy-indicator (accessed on 8 August 2022). [28]

Independent Technical Committee (2018), *Assessment of the fires that occurred between 14 and 16 October 2017 on continental Portugal: Final Report*, Assembly of the Republic, Lisbon. [24]

Independent Technical Committee (2017), *Analysis and determination of the facts surrounding the Pedrógão Grande, Castanheira de Pera, Ansião, Alvaiázere, Figueiró dos Vinhos, Arganil, Góis, Penela, Pampilhosa da Serra, Oleiros and Sertã fires, between 17 and 24 June 2017*, Assembly of the Republic, Lisbon. [23]

IPMA (n.d.), *Fire risk*, Instituto Português do Mar e da Atmosfera, https://www.ipma.pt/resources.www/light/index.html (accessed on 15 September 2022). [54]

IPMA and University of Lisbon (2022), "Portal do Clima", http://portaldoclima.pt/pt/. [39]

Komac, B. et al. (2020), *Evolving Risk of Wildfires in Europe – The Changing Nature of Wildfire Risk Calls for a Shift in Policy Focus from Suppression to Prevention*, European Science & Technology Advisory Group (E-STAG), https://www.undrr.org/media/47703/download?startDownload=true. [44]

Lourenço, L. (2018), "Forest fires in continental Portugal: Result of profound alterations in society and territorial consequences", *Méditerranée* 130, https://doi.org/10.4000/mediterranee.9958. [11]

Maynard, T., N. Smith and S. Gonzalez (2013), *Wildfire: A burning issue for insurers?*, Lloyd's, https://assets.lloyds.com/assets/pdf-risk-reports-wildfire-final/1/pdf-risk-reports-Wildfire-FINAL.pdf. [3]

Meira Castro, A. et al. (2020), "Mapping the causes of forest fires in Portugal by clustering analysis", *Geosciences*, Vol. 10/2, p. 53, https://doi.org/10.3390/geosciences10020053. [37]

Nunes, A. (2012), "Regional variability and driving forces behind forest fires in Portugal: An overview of the last three decades (1980–2009)", *Applied Geography*, Vol. 34, pp. 576-586, https://doi.org/10.1016/j.apgeog.2012.03.002. [13]

Nunes, A., L. Lourenço and A. Meira Castro (2016), "Exploring spatial patterns and drivers of forest fires in Portugal (1980–2014)", *Science of The Total Environment*, Vol. 573, pp. 1190-1202, https://doi.org/10.1016/j.scitotenv.2016.03.121. [14]

OECD (2023), *OECD Environmental Performance Reviews: Portugal 2023*, OECD Environmental Performance Reviews, OECD Publishing, Paris, https://doi.org/10.1787/d9783cbf-en. [56]

OECD (2023), *Taming Wildfires in the Context of Climate Change*, OECD Publishing, Paris, https://doi.org/10.1787/dd00c367-en. [7]

OECD (2021), *Enhancing Financial Protection Against Catastrophe Risks: The Role of Catastrophe Risk Insurance Programmes*, OECD, Paris, https://www.oecd.org/daf/fin/insurance/Enhancing-financial-protection-against-catastrophe-risks.pdf (accessed on 8 July 2022). [61]

OECD (2020), *Decentralisation and Regionalisation in Portugal: What Reform Scenarios?*, OECD Multi-level Governance Studies, OECD Publishing, Paris, https://doi.org/10.1787/fea62108-en. [30]

OECD/The World Bank (2019), *Fiscal Resilience to Natural Disasters: Lessons from Country Experiences*, OECD Publishing, Paris, https://doi.org/10.1787/27a4198a-en (accessed on 14 June 2022). [58]

Otrachshenko, V. and L. Nunes (2022), "Fire takes no vacation: Impact of fires on tourism", *Environment and Development Economics*, Vol. 27/1, pp. 86-101, https://doi.org/10.1017/S1355770X21000012. [22]

Pacheco, R. and J. Claro (2020), *Post-wildfire emergency intervention in Portugal: An analysis of public reports and policy*, Proceedings of the International Conference on Environmental Science and Applications (ICESA'20), https://doi.org/10.11159/icesa20.118. [55]

Portugal Chama (n.d.), *Portugal Chama*, https://portugalchama.pt/en/ (accessed on 29 July 2022). [40]

Presidency of the Council of Ministers (2021), *Decree-Law No. 52/2021 of 15 June 2021*. [49]

Presidency of the Council of Ministers (2021), *Decree-Law No. 82/2021 of 13 October 2021*, https://dre.pt/dre/en/detail/decree-law/82-2021-172745163. [32]

República Portuguesa (2019), *National Energy and Climate Plan for 2021-2030 (NECP 2030)*. [27]

República Portuguesa; Fundo Ambiental; APA (2019), *Roadmap for Carbon Neutrality 2050 (RNC2050): Long-term strategy for carbon neutrality of the Portuguese economy by 2050*, https://www.portugal.gov.pt/download-ficheiros/ficheiro.aspx?v=%3D%3DBAAAAB%2BLCAAAAAAABACzMDexBAC4h9DRBAAAAA%3D%3D. [6]

Ross, L., C. Gannon and N. Steinberg (2020), *Climate Change and Wildfires: Projecting Future Wildfire Potential*, Four Twenty Seven. [16]

San-Miguel-Ayanz, J. et al. (2020), "Forest fires in Portugal in 2017", in *Science for Disaster Risk Management 2020: Acting Today, Protecting Tomorrow*, Publications Office of the European Union, Luxembourg, https://drmkc.jrc.ec.europa.eu/portals/0/Knowledge/ScienceforDRM2020/Files/supercasestudy_04.pdf. [10]

UNDRR (2021), "Words into Action: Nature-based Solutions for Disaster Risk Reduction, United Nations Office for Disaster Risk Reduction". [52]

UNEP (2022), "Spreading Like Wildfire – The Rising Threat of Extraordinary Landscape Fires, United Nations Environment Programme", https://www.unep.org/resources/report/spreading-wildfire-rising-threat-extraordinary-landscape-fires (accessed on 31 May 2023). [43]

Valente, S. et al. (2013), "Forest Intervention Areas (ZIF): A New Approach for Non-Industrial Private Forest Management in Portugal", *Silva Lusitana*, Vol. 21/2, pp. 137-161. [47]

World Bank (n.d.), "Rural Population – Portugal", https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=PT. [12]

Notes

[1] Portugal identifies rural areas as areas where forests, scrubland, farmland or pastureland are the dominant land cover types.

[2] Forests cover 39% of the territory, followed by agriculture (26%), wildwoods (12%), agroforestry (8%) and pasture (7%).

[3] Wildfires are fires that occur in wildland areas and whose occurrence or development is unintended or uncontrolled (OECD, 2023[7]).

[4] The wildland-urban interface is the area where the built environment and wildland vegetation meet.

[5] Between 1990 and 2017, the extent of eucalyptus forests in Portugal grew by 62% (i.e. from 530 000 hectares to 860 000 hectares) (APA, 2020[20]). Today, eucalyptus forests represent approximately 26% of total forest area in mainland Portugal (ICNF, 2021[62])

[6] The NPIRFM covers mainland Portugal's territory. It does not apply to the two autonomous regions of the Azores and Madeira.

[7] The Action Plan foresees that 70% of NPIRFM regional and local objectives be implemented by 2030. Intermediate targets foresee 20% of implementation by 2020 and 50% of implementation by 2025 (AGIF and IRFMS, 2020[31]).

[8] Thanks to significant efforts to increase adaptive capacity at the municipal level, the number of municipalities that developed climate adaptation strategies and plans went from 3 in 2015 to 271 in 2020 (i.e. from 1% to 88% of the country's municipalities), thus over-achieving the target of 60% coverage by 2020 outlined in the P-3AC (Government of Portugal, 2021[4]). In 2022, 96% of the country's municipalities were covered by climate adaptation strategies and plans.

[9] Portugal does not have a regional government level in mainland territories, though it recognises the autonomous regions of Azores and Madeira, which have developed their own wildfire policy (OECD, 2020[30]).

[10] AGIF is responsible for the technical co-ordination of these committees, while political co-ordination falls under the responsibility of regional and subregional co-ordination councils.

[11] Other causes of wildfire ignition include arson (16%) and rekindle fires (3%). The cause of wildfire ignition is unknown for 35% of all wildfires in the country (GNR, 2022[38]).

[12] ZIFs currently cover 1.7 million hectares and encompass more than 23 000 voluntary members (ICNF, 2021[62]).

[13] Other foreseen exceptions include maintenance works or minor urban works and non-residential works which cannot have alternative locations, such as for example fire defence infrastructure and road networks.

[14] Fire weather is assessed on the basis of the Canadian Forest Service's Fire Weather Index (FWI), taking into account meteorological variables such as atmospheric temperature, relative humidity, wind and precipitation (IPMA, n.d.[54]).

[15] These are published in the ICNF's emergency stabilisation reports, which are made publicly available after each wildfire (Pacheco and Claro, 2020[55]). AGIF also plays a role in assessing information on the damages and relative costs that result from each wildfire event (Council of Ministers, 2020[9]).

[16] The EU funds supporting wildfire management include the Recovery and Resilience Facility (RRF), the European Agricultural Fund for Rural Development (EAFRD), the European Regional Development Fund (ERDF) and the Cohesion Fund.

Taming wildfires in the context of climate change: The case of Portugal

The frequency and severity of extreme wildfires are on the rise in Portugal, causing unprecedented disruption and increasingly challenging the country's capacity to contain losses and damages. These challenges are set to keep growing in the context of climate change, highlighting the need to scale up wildfire prevention and climate change adaptation. This paper provides an overview of Portugal's wildfire policies and practices and assesses the extent to which wildfire management in the country is evolving to adapt to growing wildfire risk under climate change.

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