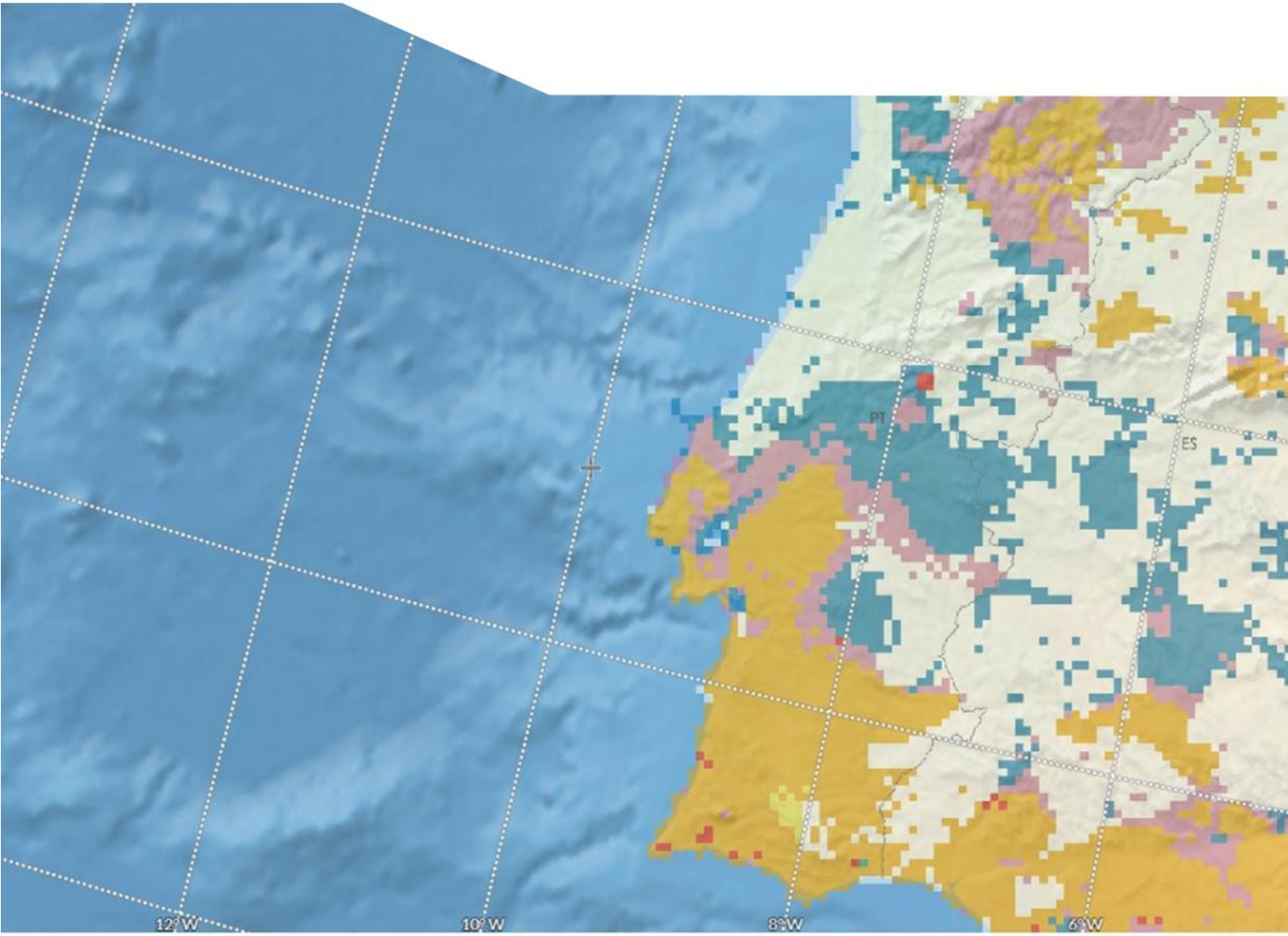
National Roadmap for Adaptation 2100

Portuguese Territorial Climate Change Vulnerability Assessment for XXI Century

WP8D - Guidelines and good practices for mainstreaming climate change adaptation into Municipal Master Plans

November 2023



Technical sheet

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For the 2014-2021 period, a total contribution of 2.8 billion euros has been agreed for 15 beneficiary countries.
Portugal will receive 102.7 million euros.

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Tables

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Acronyms

SEA	Strategic Environmental Assessment
ANEPC	National Emergency and Civil Protection Authority
APA	Portuguese Environment Agency
CCDR	Regional Coordination and Development Commission
CCDR LVT	Lisbon and Tagus Valley Regional Coordination and Development Commission
CCIAM	Climate Change Impacts, Adaptation and Modelling
EC	European Commission
CEDRU	Centre for Regional Studies and Development, Lda.
DGT	General Directorate of Territory
DGT	General Directorate of Territory
EEM	Municipal Ecological Structure
EMAAC	Municipal Climate Change Adaptation Strategy
ENAAC	National Strategy for Adaptation to Climate Change
ERSAR	Water and Waste Services Regulatory Authority
WASTEWATER TREATMENT PLANT	Wastewater Treatment Plant
ICNF	Institute for Nature Conservation and Forests
IGT	Land management instrument
INE	National Institute of Statistics
IPCC	*Intergovernmental Panel on Climate Change*
P-3AC	Action Programme for Adaptation to Climate Change
PDM	Municipal Masterplan
PEAP	Protected Areas Special Programmes
PGRI	Flood Risk Management Plan
PIAAC	Intermunicipal Climate Change Adaptation Plan
PLAAC	Local Climate Change Adaptation Plan
PMAAC	Municipal Climate Change Adaptation Plan
PMAAC-AML	Metropolitan Plan for Adaptation to Climate Change in the Lisbon Metropolitan Area
PMAAC-AMP	Metropolitan Plan for Adaptation to Climate Change in the Porto Metropolitan Area
PMDFCI	Municipal Forest Fire Defence Plan
PMEPC	Municipal Emergency and Civil Protection Plan
PNPOT	National Spatial Planning Policy Programme
POC	Special Coastal Programmes
POOC	Coastal Zone Management Plans
PRGP	Landscape Redevelopment and Management Programmes

PRODER	Rural Development Programme
PROF	Regional Forest Management Programme
PTP	Landscape Transformation Programme
REN	National Ecological Reserve
RJIGT	Legal Framework for Land Management Instruments
RNA 2100	National Adaptation Roadmap 2100
SIAM	*Scenarios, Impacts and Adaptation Measures*
EU	European Union
ZIF	Forest Intervention Zones
ZMP	Maritime Protection Zone

Abstract

This document was drawn up as part of the EEA Grants project "National Roadmap for Adaptation 2100 - RNA 2100" to establish guidelines and good practices for setting up adaptation in Portugal. It is organised as a guide designed to facilitate the integration into Municipal Master Plans of adaptation measures for the hazards covered by the RNA 2100, namely droughts, water scarcity, rural fires, coastal erosion and coastal overtopping and flooding in and is part of a follow-up phase to the previous work of reviewing the current panorama of adaptation to climate change in territorial plans and programmes (WP7B). It was coordinated by the Directorate-General for Territory and developed by the Centre for Regional and Urban Studies and Development (CEDRU) technical team.

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Introduction

Portugal has been identified as one of the most vulnerable countries to climate change on the European scene as a result of its more southerly location, sharing with the countries of Southern Europe and the Mediterranean basin the trends of reduced rainfall, rising temperatures, worsening heatwaves and increased fire risk, and, with the countries of the Atlantic seaboard, the combined effects of rising mean sea levels and regressive dynamics resulting from a coastline characterised by a growing sediment deficit and particularly energetic sea waves.

Over the last two decades, in line with the guidelines of the Intergovernmental Panel on Climate Change (IPCC) and the European Union (EU), Portugal has pursued a policy of adaptation to climate change at national, regional and local levels, supported by the best scientific evidence. The project "Climate Change in Portugal. Scenarios, Impacts and Adaptation Measures" (SIAM, 2002 and 2006), the ClimAdaPT project - Municipal Strategies for Adaptation to Climate Change (2014), the National Strategy for Adaptation to Climate Change (Council of Ministers Resolution no. 56/2015, of 30 July), and the Action Programme for Adaptation to Climate Change (P-3AC, Council of Ministers Resolution no. 130/2019, of 2 August).

The growing importance of climate adaptation has also been reflected in spatial planning policy and territorial plans and programmes. Although the existence of a precautionary culture about hydrological risks, soil desertification and coastal occupation has long been present in national legislation and Territorial Management Instruments (IGT), climate adaptation in its diversity and breadth has been given an increasingly effective response, with particular emphasis on the importance given to it in the first revision of the National Spatial Planning Policy Programme (Law no. 99/2019, of 5 September).

The National Roadmap for Adaptation 2100 - Assessment of the Vulnerability of the Portuguese Territory to Climate Change in the 21st Century aims to give new impetus to knowledge of the impacts of climate change and to the planning process, defining narratives of the evolution of vulnerabilities and effects of climate change, as well as assessing investment needs for adaptation and the socio-economic costs of inaction. RNA 2100 thus supports and responds to public policy exercises on climate change adaptation at the various territorial intervention levels.

In this context, this document aims to structure and disseminate guidelines and good practices for integrating adaptation into Territorial Management Instruments (IGT), specifically Municipal Master Plans, considering the centrality of this instrument in the current Territorial Management System, not only because it covers the entire national territory, but also because it is the only instrument that can determine the classification and qualification of land use. At this level, the territorial development guidelines arising from national, regional and sub-regional programmes are adapted, and the rules establishing permitted, conditioned or prohibited actions relating to land occupation, use and transformation, defined by the Special Programmes, are integrated.

In this context, this document is a guide designed to facilitate the integration of adaptation to the climate hazards of the RNA 2100 in the drafting and revision of Municipal Master Plans and is organised into two parts. The first part sets out a framework for climate change, its dangers and how land use planning can contribute to climate resilience. The second part explains how Municipal Master Plans can promote adaptation to drought and water scarcity, rural fires and coastal erosion, overtopping and flooding.

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How to use this document

This practical guide is aimed primarily at decision-makers and technicians involved in the preparation of Municipal Master Plans (PDM) to support them in integrating climate adaptation into these territorial planning instruments, particularly concerning the hazards that are the subject of the National Roadmap for Adaptation 2100 (RNA2100), such as drought, water scarcity, rural fires, coastal erosion and coastal overtopping and flooding.

To introduce the user to the subject of adaptation to climate change and how spatial planning and its instruments can contribute to this mission, the first part of the guide answers the main questions that arise in these areas. Thus, the leading climate hazards to which the country is exposed are identified, the concept of adaptation to climate change is introduced, the main types of adaptation response to the effects of climate change are named, the broad categories for aggregating adaptation measures established by the European Environment Agency (EEA) are pointed out, the role of spatial planning in climate adaptation is explained, and the main ways of integrating adaptation into Territorial Management Instruments (IGT) are explored.

In the second part of the guide (chapters 2, 3 and 4), guidelines are offered to facilitate the adaptation of municipalities in mainland Portugal to the climate hazards covered by RNA2100, grouped into three groups[1] of hazards - drought and water scarcity, rural fires and coastal erosion, overtopping and flooding.

For each group of climate hazards, the guide offers guidance on identifying the most appropriate adaptation responses for each municipality and how to do this through the Municipal Masterplan, presenting sheets and matrices that answer the following sequential set of questions.

Which NUTS III should be prioritised for adaptation?

In a country characterised by significant geographical contrasts, between the coastline and the inland territories, and between a region with an Atlantic hue, especially in the western north, and another with more Mediterranean characteristics in the northern sector, the territorial expression of climate hazards is diverse.

Based on the cartographic information produced in the studies of the National Roadmap for Adaptation 2100, namely in "WP2. Climate projections and indexes"[2] and "WP4. Sectoral impacts modelling"[3][4][5][6] , and concerning the spatialisation of climate hazards in the RCP 8.5 scenario, the NUTS III (the scale at which the essential information is found) were classified into three priority levels: high, medium and low.

This classification is indicative and does not dispense with its more precise verification on the scale of each municipality based on a more accurate cartographic analysis of climate risk and the various variables that make it up, such as hazard, vulnerability and exposure.

[1] Because it was found that the adaptation measures recommended in the adaptation instruments and the IGTs address some of the Roadmap's climate hazards in an aggregated manner.
[2] FCUL, CE3C, Instituto D. Luiz (2022) WP2 Climate projections, extremes, and indices; https://rna2100.apambiente.pt/sites/default/files/inline-files/wp2a_climate_projections_extremes_and_indices_mainland_portugal_1.pdf
[3] FCUL, CE3C, Instituto D. Luiz (2024) WP4 - Sectoral Impacts Modelling - Droughts, https://rna2100.apambiente.pt/sites/default/files/inline-files/wp4c3_sectoral_impacts_modelling_droughts_0.pdf
[4] FCUL, CE3C, Instituto D. Luiz (2024) WP4 - Sectoral Impacts Modelling - Forest Fires, https://rna2100.apambiente.pt/sites/default/files/inline-files/wp4c4_sectoral_impacts_modelling_forest_fires_0.pdf
[5] FCUL, CE3C, Instituto D. Luiz (2024) WP4 - The impact of climate change on the Portuguese coastal areas: from sea level rise to coastal erosion, https://rna2100.apambiente.pt/sites/default/files/inline-files/wp4c5_sectoral_impacts_modelling_coastal_areas_from_sea_level_rise_to_coastal_erosion_0.pdf
[6] FCUL, CE3C, Instituto D. Luiz (2024) WP4 - Hydrological Balance & Agroforestry. https://rna2100.apambiente.pt/sites/default/files/inline-files/wp4c2_sectoral_impacts_modelling_hydrological_balance_agroforestry_0.pdf

How can municipalities adapt to climate change?

Adaptation to climate change is accomplished in multiple ways through adopting measures that mitigate the potential impacts that may occur due to climate hazards and permanently or temporarily affect natural, urban, and infrastructure systems and heritage or social and economic values.

Based on the survey of adaptation measures included in climate change adaptation plans and strategies promoted by municipalities, inter-municipal communities and metropolitan areas in recent years in Portugal and systematised in "WP7C Review of guidelines on adaptation to climate change in spatial planning plans and programmes, including sub-national strategies and plans"[7] , a set of adaptation measures was selected for each climate hazard. This survey was then compared and supplemented with the measures and options suggested in the various "WP4. Sectoral impacts modelling".

The list of measures produced and included in this manual is not intended to be exhaustive. Instead, they indicate the primary practices adopted, particularly those that could most easily be implemented through the PDM.

Each of the measures was then categorised in terms of the type of response (see point 1.3 What are the main types of adaptation response?) and the type of measure (see point 1.4 What types of adaptation measures can be adopted?), which allows them to be framed both on the scale of the response cycle and in the monitoring process being implemented by the European Environment Agency.

How can climate change adaptation be mainstreamed into the PDM?

The mainstreaming of adaptation to change in the PDM implies, depending on the type of climate hazard and measure, that it be duly considered in the methodological process of producing the Plan.

To facilitate this process, fact sheets have been drawn up for each adaptation measure, in which the following can be consulted: (i) the concept of the adaptation measure, clarifying its understanding of the work in question; (ii) the methodology for integrating the measure with the identification of the steps and contents to be included in each of the plan documents; (iii) examples of (iii) examples of good practice, both in the formulation of this type of measure at the level of local climate change adaptation instruments, and in its integration into PDMs, allowing those interested in identifying experiences and subsequently making contact with implementation experiences.

Which adaptation measures are most appropriate according to the classification and classification of the soil?

Under the terms of Law no. 31/2014, of 30 May, which establishes the general bases for public policy on soil, land use planning and urbanism, and Decree-Law no. 80/2015, of 14 May, which concerns the Legal Framework for Territorial Management Instruments, although the municipal or inter-municipal master plan is an instrument for defining municipal or inter-municipal strategy, defining the strategic framework for territorial development at local or sub-regional level, it is also decisive for establishing the land use regime, by classifying and qualifying the soil.

In this context and based on the provisions of Regulatory Decree no. 15/2015 of 19 August regarding land classification and reclassification criteria, an attempt was made to fit each of the adaptation measures into the

[7] CEDRU, DGT (2023) WP7C Revision of guidelines on adaptation to climate change in spatial plans and programmes, including sub-national strategies and plans

various classes of land use categories, facilitating dialogue between the discipline of climate adaptation and land use planning, so that practitioners can maximise their integration.

To this end, the functional typology of spaces that are commonly affected by each of the climate hazards and the preferred location of adaptation measures were taken into account, thus establishing a spatial relationship between the adaptation measures and the land use classification categories that the PDM should provide for according to the functional and physical reality of the territory it covers.

What are the main constraints in adopting adaptation measures?

The consultation of local authorities located in mainland Portugal as part of the preparation of "WP7C Review of guidelines on adaptation to climate change in spatial planning plans and programmes, including sub-national strategies and plans" provided an insight into the main obstacles that have been encountered in integrating adaptation into the PDMs.

Some of these constraints coincide with the conclusions and reflections shared throughout the seven editions of the seminar on local adaptation to climate change promoted by adapt. Local - Network of Municipalities for Local Adaptation to Climate Change[8] , as well as in other international documents, namely the initiative of the Intergovernmental Panel on Climate Change (IPCC) and the European Environment Agency (EEA).

The high financial costof the measures, their low legal effectiveness as a result of the existence of consolidated prior rights, the dependence on technological and innovation solutions that are not always accessible, the existence of political and governance challenges, their indirect environmental impacts, or the need to be supported by cultural changes, are some of the main obstacles that have been identified.

Within the scope of this manual and based on all this knowledge, an assessment was made of each of the measures, signalling the main obstacles that could be encountered in their implementation, allowing users to find the most effective solutions best suited to their technical, financial and institutional reality.

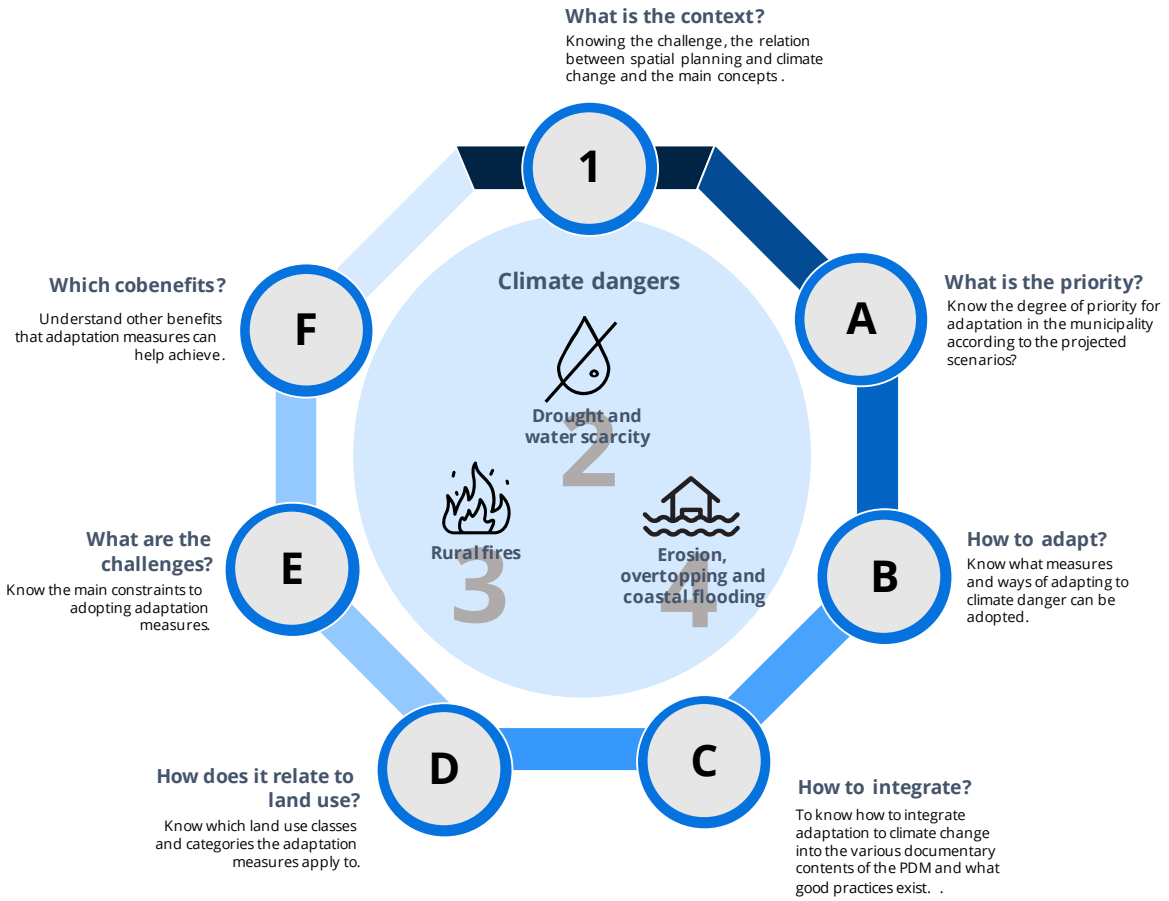
What other benefits can be gained from mainstreaming adaptation?

Climate adaptation offers a range of opportunities to obtain secondary benefits or co-benefits beyond the mere adaptive response. These co-benefits can include improvements in public health, increased biodiversity and greater socio-economic resilience, making the territory even better prepared to deal with climate change by reducing its vulnerability. For example, adaptation strategies such as increasing urban green areas not only help to increase water infiltration and aquifer recharge, such as moderating local temperatures and reducing the effects of heatwaves but can also improve air quality and provide recreational spaces that contribute to people's physical and mental well-being. On the other hand, integrating climate adaptation into development policies can speed up the realisation of the Sustainable Development Goals (SDGs).

In this context, each of the adaptation measures was assessed to provide users with an indication of the potential co-benefits that their adoption could generate at the local level in the fight against poverty and social exclusion, the promotion of the circular economy, renaturalisation and ecological restoration and the mitigation of the effects of climate change, as well as for the local implementation of the 2030 Agenda.

[8] https://www.adapt-local.pt/

The following figure illustrates the stages of a process intended to be sequential: stage 1 corresponds to the first part of the guide, stages A to F correspond to the guidelines in the second part of the guide, set out by each of the three groups of hazards.



Source: CEDRU (2023)

The document also contains a glossary, which supports understanding the second part, and the different bibliographical sources that can be consulted to obtain a more in-depth knowledge of climate adaptation.

1. Spatial planning and climate adaptation

1.1 What are the primary climatic hazards in Portugal?

Portugal has a wide range of climate hazards and is one of the countries in Europe with the most significant climate vulnerability. By the end of the century, the country will face considerable changes in climate, including rising temperatures, changes in rainfall patterns and reductions, and more frequent and intense extreme events.[9]

These changes will have diverse impacts affecting biodiversity, agriculture and forests, water resources, human health and coastal zones. Sustainable resource management and adaptation strategies are expected to mitigate these climate changes' adverse effects.

Table 1. Main climate hazards in Portugal

Typology	Acute	Chronic
Temperature	• Heat waves • Forest fires	• Changes in air and water temperature • Heat *stress* • Temperature variability
Wind	• Storms • Cyclones	-
Water	• Droughts • Excessive rainfall • Floods • Snowfall	• Rainfall or hydrological variability • Ocean acidification • Salt intrusion • Sea level rise • Water scarcity
Solid mass	• Mass movements on slopes	• Coastal erosion • Soil degradation and desertification • Soil erosion

Source: APA; ANEPC; CCIAM

The climate change scenarios for Portugal until the end of the 21st-century point to progressively more unfavourable conditions for agricultural activity, resulting from a reduction in rainfall and an increase in temperature, a worsening in the frequency and intensity of extreme events and an increase in susceptibility to desertification.

Reduced water availability and irrigation capacity, loss of soil fertility and worsening erosion, and changes to plant and animal health systems due to increased favourable conditions for organisms harmful to crops, plants, and animals are critical factors for adapting agriculture to climate change (ENAAC 2020).

Although Portugal has an average rainfall of around 900 mm, the spatial-temporal distribution could reduce water availability in certain regions, especially the more southerly ones, and at certain times of the year, generating water shortages. This scenario will affect most agricultural activity, which depends on the weather.

[9] FCUL, CE3C, Instituto D. Luiz (2022) WP2 Climate projections, extremes, and indices; https://rna2100.apambiente.pt/sites/default/files/inline-files/wp2a_climate_projections_extremes_and_indices_mainland_portugal_1.pdf

As for the impact on the distribution of ecosystems, a marked change in the structure and composition of vegetation is expected, with consequences for biodiversity. In the northern and central coastal regions, dominated by mixed hardwood forests, the most moisture-demanding species are expected to decline, with an increase in the mortality of older, less resistant trees. The Minho/Douro Litoral regions and mountain areas could benefit from increased biological diversity. Eucalyptus groves in the interior could be abandoned and replaced by scrub due to their low capacity to regenerate naturally. Pine forests may persist or tend to be replaced by scrub due to the recurrence of fires, in which case biodiversity is expected to be preserved. A drastic reduction in biological diversity is anticipated in cork oak forests due to the intensification of desertification processes in the most arid regions[10] .

Rising temperatures and prolonged periods of drought are also likely responsible for increased rural fires and substantial forest fires (covering areas of 10,000 ha or more), which spread by canopy and can be virtually uncontrollable under certain weather conditions. The risk associated with these events has increased dramatically, imposing substantial social and economic costs on the country.

The coastline already has high levels of vulnerability due to the sediment deficit and the strong erosion dynamics of the low, sandy stretches. Rising sea levels, the hourly rotation of the average wave direction on the west coast and changes in the storm regime (despite uncertainty about future developments on this last point) will exacerbate the current problems, facilitating an increase in overtopping and coastal flooding.

The effects of coastal erosion and overtopping are further fuelled by the occupation of the territory's coastal strip, which substantially increases the socio-economic costs of climatic phenomena. Despite the uncertainty, rising sea levels by the end of the 21st century are expected to be 0.65 metres higher (RCP4.5) and could reach values of 0.85cm (RCP8.5) above the 1990 level[11] . This trend will aggravate the risks and vulnerabilities associated with coastal flooding and overtopping, potentially exacerbated by *storm surges*. Rising sea levels will also increase the risk of saline contamination of coastal aquifers, estuaries and the final stretches of rivers, which will also impact some water supply systems (ANEPC, 2019).

The reduction in annual rainfall, the increase in its variability, and the consequent change in the flow regime will reduce river flows and affect aquifer recharge. These changes could be accompanied by problems in terms of water quality, intensification of drought events and more significant pressure for desertification, promoting the loss of biodiversity associated with changes in the structure and dynamics of ecosystems (ANEPC, 2019). This reduction in rainfall will also affect the recharge of aquifers, fuelling the degradation of the quality of surface and groundwater resources. Given the tendency for heavy rainfall days to contribute more to annual rainfall, the territory will remain vulnerable to flooding.

This guide only addresses the five climate hazards that are the subject of RNA2100: drought, water scarcity, rural fires, coastal erosion, coastal overtopping and flooding, as explained above.

1.2 What is adaptation to climate change?

Climate change adaptation refers to the adjustment process in natural or human systems in response to current or expected climate stimuli and their effects or impacts. This concept encompasses how societies, economies and ecosystems can respond to aspects of the climate that are changing or prepare for those that are likely to change,

[10] Climate Change in Portugal Scenarios, Impacts and Adaptation Measures - SIAM II Project (2006)

[11] FCUL, CE3C, Instituto D. Luiz (2024) WP4 - SECTORAL IMPACTS AND MODELLING WP4.5/6 - The impact of climate change on the Portuguese coastal areas: from sea level rise to coastal erosion indices; https://rna2100.apambiente.pt/sites/default/files/inline-files/wp4c5_sectoral_impacts_modelling_coastal_areas_from_sea_level_rise_to_coastal_erosion_0.pdf

including extreme events such as floods, droughts and heatwaves, as well as gradual changes in temperature, precipitation or mean sea level.

Adaptation can involve a range of actions, from changes in agricultural practices to cope with new rainfall patterns to strengthening infrastructure to withstand more frequent or severe extreme weather events. It can also include urban planning for coastal areas in response to rising sea levels or modifications to public health systems to deal with new risks of climate-related diseases.

The main goal of adaptation is to reduce vulnerability and increase the resilience of systems to climate change, protecting and improving people's lives and the health of ecosystems. Different adaptation strategies can be applied at various scales, from specific local interventions to national policies and international agreements.

Adaptation is a critical component of the global response to climate change, complementing mitigation efforts aimed at reducing greenhouse gas emissions to limit the degree of climate change. While mitigation addresses the causes of climate change, adaptation focuses on managing the impacts.

Integrating climate justice into climate adaptation efforts is essential to ensure that the actions undertaken reduce vulnerability to climate change and promote fairness, equality and human rights.

Promoting climate adaptation should be realised within sustainable development, helping to introduce corrections and adjustments to systems, making them more resilient to climate change and capable of supporting sustainable human and environmental development.

Based on the methodology defined by the ClimAdaPT.Local projects, most of the municipal and inter-municipal climate change adaptation strategies and plans conducted in Portugal[12] followed the adaptation concept established in 2007 in the 4th Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). This report centralised vulnerability assessment, understood as the propensity or predisposition that a specific element or set of elements have to be negatively impacted, adding a variety of concepts such as exposure, sensitivity and adaptive capacity.

However, since 2012, the IPCC has been reformulating the concept of adaptation to climate change, which is now centred on risk rather than vulnerability. This change was intended to harmonise the concepts used by the communities of researchers and technicians working on climate change adaptation and disaster risk management. This change was expressed in the 5th Assessment Report (AR5), published in 2014, where the risk of climate change impacts replaced the concept of climate vulnerability.

By adopting this concept of risk, the IPCC (i) recognised that a large proportion of the impacts related to climate change are triggered by *hazard events, which are* best addressed by the concept of risk; (ii) encouraged the climate change research community to determine the potential consequences of climate change within the framework of risk assessment; (iii) and, contributed to the integration of two complementary research areas: *climate* change adaptation and *disaster risk reduction*.

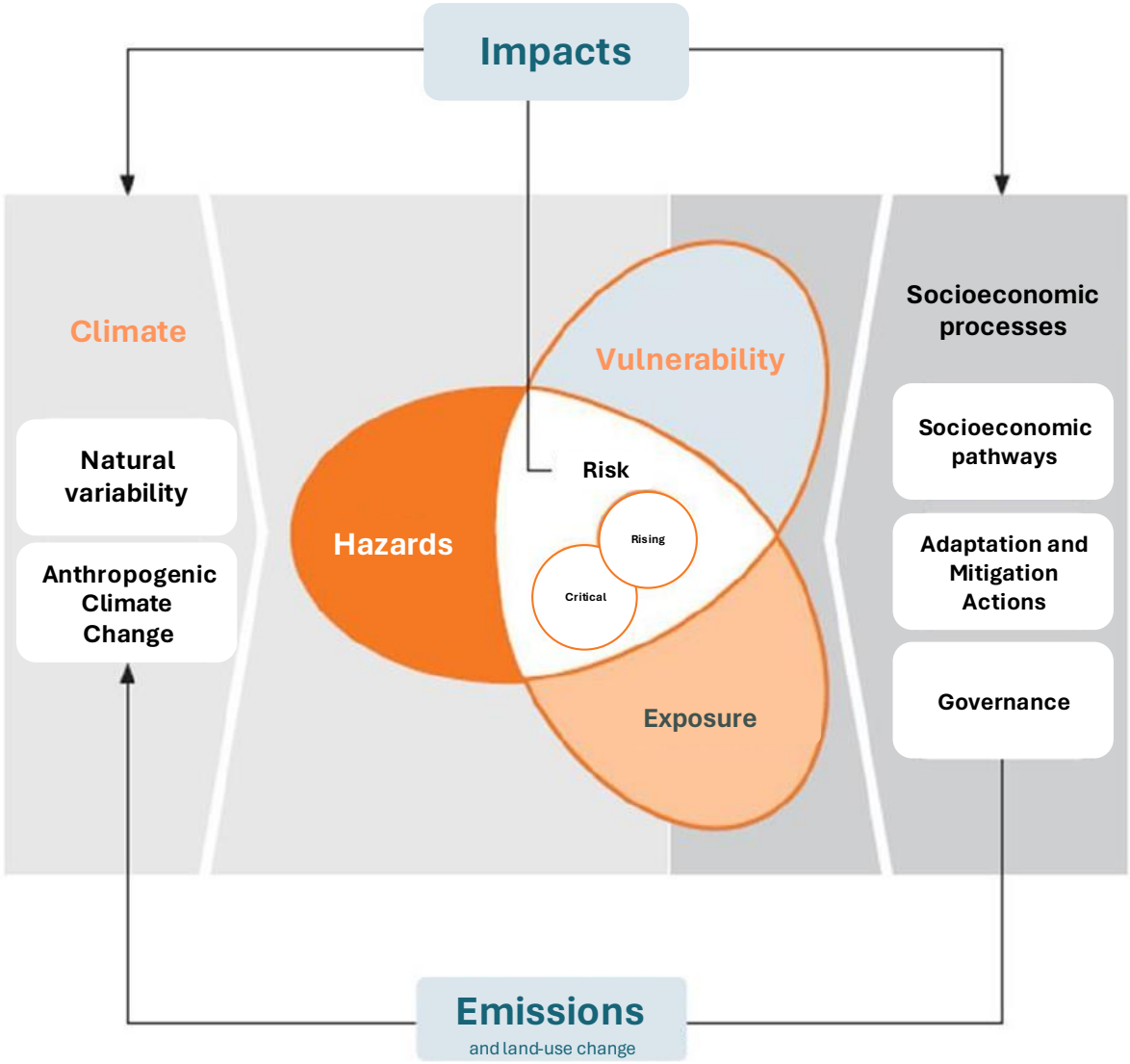
The risk considered in AR5 is of central importance for climate adaptation, equating to the potential for specific climate-related consequences (climate impacts) to occur on something of value, such as people, ecosystems, assets or cultural values. Risk is thus the result of the interaction between vulnerabilities, exposure and danger.

Hazard corresponds to the potential occurrence of a climatic event (e.g. an intense rainfall event or a heatwave) or a trend (e.g. a reduction in average rainfall volumes) or its impact (e.g. a flood or inundation) that could cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, services,

[12] CEDRU, DGT (2023) WP7C Revision of guidelines on adaptation to climate change in spatial plans and programmes, including sub-national strategies and plans

ecosystems and environmental resources. Exposure equates to the presence of people, livelihoods, species or ecosystems, ecological functions, services and resources, infrastructure or economic, social or cultural assets in places that could be negatively affected by a climate hazard. Finally, vulnerability is the propensity or predisposition to be negatively affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to damage and lack of capacity to respond or adapt.

Conceptual outline of climate risk according to IPCC AR5



Source: IPCC (2014)

Thus, while the hazard is determined by the climate of a given region (both its variability and the way it is changing as a result of anthropogenic climate change) and the ability to mitigate upstream factors by reducing greenhouse gas (GHG) emissions and increasing carbon sequestration through land use change, vulnerability and exposure are the result of future social and economic developments, the adoption of adaptation measures and governance capacity.

1.3 What are the main types of adaptation responses?

The breadth of the adaptive process allows for various forms of action and intervention which, although interconnected, cover an extensive time horizon, characterised by the prediction of the effects of climate change, as well as increased knowledge regarding the form and areas of occurrence of extreme weather events and their impacts. The table below systematises the types of adaptive response that serve as the basis for the approach proposed in this document.

Table 2. Types of adaptation response to the effects of climate change

Types	Framework
 **PREVENT the effects of climate change**	• Adopting measures and actions aimed at reducing exposure to climate risks and thus mitigating potential effects on people and property. • Producing and updating knowledge is fundamental to understanding and mitigating risks. • This typology includes actions to identify and spatialise risks and the distribution of vulnerable population groups, equipment, services and exposed activities, especially if developed as part of an adaptation strategy for locating strategic investments or restricting the use and occupation of land in risk areas.
 **accommodating the effects of climate change**	• Adopting measures and actions to make the occupation of vulnerable territories compatible with the potential risks. • Behavioural change and a predictive culture make it possible to make uses compatible during a specific period and within the limits of adaptive capacity. • This typology includes improving the construction rules and standards of buildings and infrastructures, optimising drainage networks, installing green roofs, afforesting urban spaces, and raising the height of roads or electrical infrastructures.
 **PROTECT against the impacts of climate change**	• Adopt measures and actions to deal with specific risks to ensure that vulnerable territories remain occupied and used as they are today. • Within certain limits of effort (financial and structural), certain areas at risk must be protected due to their structural or strategic importance. • This typology includes the creation of dykes and protection walls, retention basins or coastal defence works.
 **REMOVE from territories in danger**	• Adopting measures and actions aimed at removing and vacating a territory vulnerable to the effects of climate change. • When the financial and infrastructural capacity cannot cope with the effects of climate change, exposed areas should be cleared by relocating the elements that are there. • This typology includes the planned retreat of services, equipment, buildings, infrastructures or economic activities exposed to risk.
 **SOURCE effectively and RECOVER quickly**	• Adopting measures and actions to increase response and recovery capacity in emergencies related to extreme weather events. • Given the expected increase in the destructive capacity and frequency of extreme weather events, ensuring the capacity of the means of response is necessary. • This category includes planning and capacity building for disaster response and recovery and acquiring and reinforcing response resources.

Source: CEDRU (2023)

1.4 What types of adaptation measures can be adopted?

The development of an adaptation policy or strategy presupposes the implementation of a wide range of measures and actions of a diverse nature and with a specific focus on various sectors (e.g. agriculture and forestry, the coastline, water resources, the safety of people and goods, land use planning, human health,...).

The main climate change adaptation measures reported by the member countries of the European Environment Agency (EEA) under the Energy Union Governance Regulation have been systematised in the report "Using Key Type Measures to report climate adaptation action in the EEA Members" (EEA, 2021), and have been organised around five large sets of measures or options (*Key Type Measures*), which are broken down into eleven *sub-key* types *of measures* (Table 3).

The main advantage of creating this system was improving the quality of pan-European monitoring and harmonising languages between the players involved, making the data more usable and enabling greater clarity in the design, implementation, and communication of adaptation at multiple levels.

Table 3. Types of Adaptation Measures

Key Type of Measures	Sub-Key Type of Measures	Examples of adaptation measures
 **A. Governance and Institutions**	• A1: Policy instruments	• Creation / revision of public policies • Creation / revision of regulations
	• A2: Management and planning	• Integrating adaptation into other sectors • Creation/revision of technical rules, codes and standards
	• A3: Coordination, cooperation and networks	• Creation/revision of ministerial coordination formats • Creation/revision of stakeholder networks
 **B. Economics and Finance**	• B1: Financing and incentive instruments	• Creation/review of incentive mechanisms • Creation / revision of funding schemes
	• B2: Insurance and risk-sharing instruments	• Creation/revision of insurance schemes and products • Creation/revision of emergency funds for emergencies
 **C. Physics and Technology**	• C1: Grey options	• New physical infrastructure(s) • Rehabilitation, updating and/or replacement of physical infrastructure
	• C2: Technological options	• Early warning systems • Hazard/risk mapping • Service applications/processes
 **D. Nature-based solutions and ecosystem-based approaches**	• D1: Green options	• Creation of new green infrastructure/improvement of existing infrastructure • Natural and/or semi-natural land use
	• D2: Blue options	• Creation of new blue infrastructures/improvement of existing ones • Management of natural and/or semi-natural aquatic and marine areas
 **E. Knowledge and behaviour change**	• E1: Information and awareness-raising	• Research and innovation • Communication and dissemination • Decision support tools and databases
	• E2: Capacity building, training and lifestyle practices	• Identifying and sharing good practices • Training and knowledge transfer • Reports on lifestyle practices and behaviours

Source: Adapted from EEA (2021)

1.5 What role does land-use planning play in climate adaptation?

Spatial planning plays a crucial role in adapting to climate change. For this reason, not only have climate issues been gaining significant importance in the analyses and proposals of territorial planning instruments at the most diverse levels, but adaptation strategies and plans at regional, inter-municipal and local levels give great importance to IGTs as vehicles for promoting adaptation.

This is **particularly evident in various guiding documents for drawing up PDMs**, such as "Spatial Planning in Response to climate change: contribution to PDMs" (CCDRLVT, 2019) or "PDM GO - Good Practices for Municipal Master Plans" (DGT, 2020), **as well as in the methodological guides for local adaptation documents to climate change in Portugal**, such as "ClimAdaPT.Local – Manual for Integrating Adaptation Options into Municipal Territorial Management Instruments" (Barroso, S., Gomes, H. et al. (2016) or the "Specific Guide for Implementing the Integration of Climate Change into the Strategies of Territorial Management Instruments" (Barroso, S., Gomes, H. Telha, J., Porteiro, J. (2022).

Achieving climate adaptation, among other aspects, depends on how land is used and occupied, namely the arrangement and organisation of human, natural and technological resources throughout the territory, highlighting the link between land **use** planning and adaptation. Indeed, land use planning plays a fundamental role in achieving adaptation to climate change. In this area, options are defined that determine the territory's and society's capacity to adapt to the effects of climate change.

Spatial planning makes an exception**al contribution to increasing resilience to extreme climate events**, particularly by identifying areas that are especially vulnerable to events such as floods, coastal gales, heatwaves or forest fires, making it possible to strategically plan the use and occupation of land and the development of infrastructures to mitigate impacts and increase the resilience of communities and ecosystems.

At the coastal level, with the rise in the average sea level and the increase in coastal erosion due to climate change, **the territorial planning of the coastline, namely through the Coastal Zone Management Plans (POOC) and the Coastal Zone Programmes (POC), is essential to protect these areas,** allowing for the implementation of sustainable coastal defence strategies, the early relocation of vulnerable assets and the protection of natural habitats. Similarly, for **flood risk management, Municipal Master Plans and the National Ecological Reserve (REN), in conjunction with Flood Risk Management Plans (PGRI), are highly effective instruments** that not only prevent the occupation of areas prone to flooding but also provide for the establishment of flood areas, wetlands and green spaces that can absorb excess water during heavy rainfall events, or limit the extent of impervious areas in particularly critical river basins.

Planning also **plays an essential role in adapting biodiversity to climate change, mainly through the Special Protected Areas Programmes (PEAP)**, which identify and protect biodiversity hotspots and safeguard corridors that facilitate species migration as temperatures rise.

Integrating adaptation to climate change into spatial planning

Climate change represents an additional challenge for territorial planning, which is added to other challenges that are not climate related. Integrated land use planning fully recognises climate change and can help prevent climate impacts due to floods, droughts, water scarcity or heat stress, and can reduce the exposure of valuable assets to risks related to such hazards. Spatial planning can also help prevent and mitigate the impacts of other climate-related and non-climate-related natural disasters. For example, it can be advantageous in the case of flooding or coastal gales, where zoning is used to restrict new construction in areas prone to these hazards.

In other words, through land use planning, local and regional governments can increase resilience to climate change and ensure that communities are equipped to deal with it. Integrated land use planning that recognises and addresses the impacts of climate change integrates a more strategic and long-term approach than traditional land use planning instruments. To respond adequately to climate change, mapping the vulnerability of current and future climate conditions must underpin the planning process. Alternative uses must be identified once the most vulnerable areas have been identified, and spatially based adaptation options must be defined. These measures should then be discussed with stakeholders and agreed upon with the support of experts (e.g. from the biodiversity, forestry or agriculture sectors).

Thus, territorial planning tools can be used to reduce climate risks in different ways: (i) by limiting development in risk-prone areas; (ii) by ensuring that the built environment is resilient to natural disasters; (iii) by helping to preserve natural ecosystems, protecting communities from hazards (e.g. dunes that cushion the effects of coastal storms); (iv) by promoting nature-based adaptation measures; (v) by educating stakeholders and decision-makers about risks and opportunities; (vi) by promoting dialogue on adaptation.

Measures to avoid exposing valuable elements to climate risks generally involve zoning, setting building codes (such as minimum floor heights and sealing measures) and land use permits. Land management instruments can also act more broadly on land cover, for example, in planning afforestation and reforestation, conservation and restoration of ecosystems (e.g. wetlands and rivers) and rural or urban areas capable of retaining water. Spatial planning can also provide strategic directions that prioritise adopting green, nature-based solutions wherever possible. In this case, many co-benefits are obtained for the environment and society, including leisure opportunities, liveability, and well-being, especially in urban spaces, which improve biodiversity and provide ecosystem services.

Source: Adapted from https://climate-adapt.eea.europa.eu/

In the context of **promoting the adaptation and resilience of** human and natural systems to climate change, the **Landscape Reordering and Management Programmes** (PRGP), enshrined in the Landscape Transformation Programme (PTP), are aimed at **planning, programming and transforming the landscape** identified as vulnerable forest territories, seeking to **guide public policies and private interventions** towards the consolidation of a more resilient and biologically and ecologically valued landscape. To this end, a strategic vision identifies the most appropriate landscape model for the territory.

This interdependence between policies is also fundamental to the realisation of adaptation to climate change since adaptation is necessarily a territorially specific response, adjusted not only to the possibility of a given climate hazard occurring in a given location but to the exposure to that hazard but also to the ecological, social, economic and cultural characteristics of that location, which determine its vulnerability. **An approach recognising diversity and assuming local specificity is indispensable for good adaptation**. In this context, the planning instruments that define land use planning have a specific spatial focus and make it possible to address the different particularities of that territory **by proposing measures, rules and interventions adjusted to that particular reality, constituting an effective vehicle for promoting climate adaptation**.

In this sense, an approach that integrates adaptation to climate change and land-use and urban planning policies is possible:

- **identify and take care of the particularities of each territory**, framing them within the dynamics related to climate change;
- **preventing land uses and occupations that may prove problematic in the context of climate change**, promoting more sustainable use of the territory, as well as adaptive capacity and taking advantage of potential opportunities that may be identified;
- **accommodate and integrate climate change mitigation and adaptation components**, promoting synergies and complementarities;
- **observing the needs and expectations of territorial actors at different levels** due to the integration of consultation, involvement and participation mechanisms.

This highlights the role of spatial planning as a mechanism for promoting adaptation by embracing and integrating adaptation into its objectives and adapting its provisions and guidelines to the challenges that climate change is already posing.

1.6 How can adaptation be integrated into the IGT?

The broad themes and scale of the IGTs, set out in the Law on the General Basis of Public Land, Spatial Planning and Urban Planning Policy (Law no. 31/2014, of 30 May) and in the Legal Framework for Territorial Management Instruments (Decree-Law no. 80/2015, of 14 May), mean that **various ways of integrating adaptation to climate change into their provisions have to be defined**.

The fact that the IGTs are made up of different documentary contents (reports, regulations, maps), even though they complement each other, also affects how adaptation is integrated. Nevertheless, **four main dimensions of integration have been** identified, as shown in the table below.

Table 4. Dimensions of adaptation integration in territorial management instruments

Strategic Dimension

Form of realisation	Stages and parts with the most significant potential for reception
• Defining territorial development scenarios; • Establishing medium- and long-term sustainable development visions integrating the climate change component; • Defining new principles of land use and occupation; • Developing best practice benchmarking; • Implementing territorial organisation guidelines that consider the location of buildings, infrastructures and elements of the ecological network; • Consecrating guidelines for organising urban spaces, considering the uses and morphologies of urban complexes, buildings and public spaces.	• The reports define climate adaptation strategies, measures and actions as strategic options assumed in the land-use planning model. Reports evaluating the implementation of PDMs are also included; • Within the scope of **primary studies**, developing specific assessments for the territory covered by the IGTs, contributing to the definition of adaptation options (bioclimatic assessments, climate hazard modelling, climate vulnerability assessment); • In **environmental reports**, weighing up the importance and impact of climate change as a criterion associated with the critical factors for the decision; • In **environmental reports**, assessing the significant effects (positive, negative or neutral) on the environment caused by adaptation actions; • E**nvironmental reports** provide for adaptation actions as planning and management measures to mitigate adverse environmental effects or accentuate positive effects.

Regulatory Dimension

Form of realisation	Stages and parts with the most significant potential for reception
• Defining legal and regulatory provisions regarding land use and occupation; • Deepening the building regulatory framework (fostering building resilience and energy efficiency).	• In the **regulations**, altering indices and/or indicators and/or reference, urban planning and/or zoning parameters following strategic options, measures and climate adaptation actions; • Transposing the principles and/or rules of the Territorial Management System instruments at the national (including sectoral and special programmes), regional and inter-municipal levels into **regulations;** • In **regulations**, identifying areas of public interest for expropriation based on the spatialisation of danger or the need to relocate equipment; • In the **graphic pieces** (**planning/zoning/planning plans**), reclassifying the land according to the modelling of the evolution of climate hazards, strategic options, climate adaptation measures and actions, as well as considering the exceptional processes of reclassification from rural to urban land with associated economic potential, and vice versa.

Operational Dimension

Form of realisation	Stages and parts with the most significant potential for reception
• Identifying provisions for the implementation of priority interventions; • Ensuring that projects are appropriate in the context of climate change; • Identify the public investments needed to valorise, qualify and protect the territory; • Realising public policies and economic and financial regimes.	• In the **implementation programmes**, the municipality or central government projects that implement the strategic options, measures and climate adaptation actions set out in the planning model, as well as involving private investment in urban infrastructure, are highlighted as priorities; • In the **financing plans**, providing for the investments associated with the projects that implement the strategic options, measures and climate adaptation actions, promoting their effective implementation; • In the **models for redistributing** benefits and burdens, providing for the realisation of investments associated with projects that implement climate adaptation strategic options, measures and actions; • The written and graphic documents supporting land transformation operations identify the operations implementing strategic options, measures, and climate adaptation actions.

Territorial Governance Dimension

Form of realisation	Stages and parts with the most tremendous potential for reception
• Stimulating *awareness*, empowerment and generalised participation of citizens and relevant services at the various levels of administration (local, regional and national) and other interested *stakeholders;* • Integrating the various fields of knowledge, experience and practice; • Promoting the articulation and coordination of policies.	• During the **drafting/revision of** the IGTs, developing public participation and consultation processes that guarantee the monitoring, articulation and incorporation of contributions from the public administration, regional and local development agents and the population in general; • During the **drafting and implementation/monitoring of** the IGTs, developing actions to raise awareness among the public administration, regional and local development agents and the population in general of the climate adaptation strategies adopted and their implications (potential or actual) for land use planning; • During the **drafting/revision** and **implementation/monitoring of** the IGTs, promoting multi-level coordination of climate adaptation strategies with an impact on land use planning.

Source: CEDRU (2023)

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2. Integrate adaptation to drought and water scarcity into the PDM

A. Which NUTS III regions are prioritized for adaptation to drought and water scarcity?

Source: CEDRU, based on interpreting the aridity index data in the RCP8.5 scenario for the 2071-2100 time horizon.

B. How can municipalities adapt to drought and water scarcity?

#	Adaptation measure	Type of response					Type of measure				
		Prevention	Accommodate	Protect	Relocate	Rescue and recovery	A. Governance and Institutions	B. Economics and Finance	C. Physics and Technology	D. Nature-based solutions	E. Knowledge and behaviour change
1	Restrictions and incentives to protect and promote the efficient use of water resources	●					●	●			●
2	Reuse water resources and use alternative sources.		●				●		●	●	●
3	Rehabilitating distribution and storage systems		●						●		
4	Efficient urban irrigation		●				●		●		●
5	Urban design and *water-sensitive* construction		●				●		●	●	●
6	Urban green infrastructure		●				●		●	●	
7	Retain water for agricultural uses and adapted agricultural practices.		●				●	●	●	●	●
8	Use native or adapted species.		●				●			●	●
9	Rehabilitate, naturalise or conserve watercourses and riparian galleries.			●				●		●	

C. How can adaptation to drought and water scarcity be integrated into a PDM?

1 Restrictions and incentives to protect and promote the efficient use of water resources

Concept

Adopting regulatory restrictions or establishing incentives for the efficient use of water resources are measures adopted to promote sustainable water management by consumers, especially those with higher consumption levels.

Restrictions refer to limitations or regulations imposed on water consumption, such as restrictions on use at certain times of the year, restrictions on the volumes of water abstracted, restrictions on the quality level of the water rejected and restrictions on use in activities that use a large amount of water, such as agricultural irrigation.

Incentives, on the other hand, are incentives offered to promote practices that lead to a more efficient use of water (for example, drip irrigation). This can include financial incentives, such as subsidies for installing water reuse systems, discounts for consumers who adopt water-saving practices, or even environmental education programmes to raise public awareness of the importance of conserving water resources and offering solutions for saving water in everyday activities.

Methodology for mainstreaming adaptation into the PDM

Adopting restrictions and incentives to protect and promote the efficient use of water resources cannot be fully realised through the PDM. If, on the one hand, measures to protect water resources, which have an eminently spatial scope and a framework in different legal regimes, such as the National Ecological Reserve (REN) or the Water Law, find in the PDM a central vehicle for their implementation, the adoption of incentives and restrictions on consumption must be achieved through specific regulations to be applied by the water management entities. Notwithstanding this fact, the PDM, at the level of its strategic framework, can signal this priority, helping to raise awareness among all consumers and operators of the need to increase efficiency, savings and rationalisation in water use.

In specific situations, namely, when there is a significant reduction in the availability of surface and groundwater bodies or an impact on water quality, the PDM may provide for restrictions on land use and occupation in specific areas, a ban on certain activities that use the resource more intensively, or an obligation to comply with sound environmental practices.

It should also be noted that the lack of licensing or inspection mechanisms at the municipal level hampers the realisation of this adaptation measure through the PDM.

Nature	Integration document	Adaptation integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • In the PDM's specific objectives, the strategic priority is to adopt restrictions and incentives that protect and promote the efficient use of water resources.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues in the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
Regulate	Regulations	• Define provisions for water-intensive activities that take their water from the surface or groundwater bodies that are less available. • Defining provisions for protecting and safeguarding water resources, particularly the safeguarding and protecting the water domain, by		●	

Nature	Integration document	Adaptation integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		prohibiting the use and occupation of the water domain and protective strips.			
	Conditioning plan	• Map water resources and catchments. • Integrate surface water bodies into the ecological structure by defining buffer strips. • Identify in the characterisation studies the industrial and agro-industrial activities that could potentially harm the quality of water bodies. • Identify the major water consumers in the characterisation studies.	●	●	
 Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives that encourage the efficient use of water resources (e.g. prizes), their schedule, the associated investment amounts and the entities to be involved.	●	●	
 Territorial governance		• Hold thematic sessions to raise awareness and discuss the need to adopt measures within the regulatory framework or private investments that promote the sustainable use of water resources with specific stakeholder groups from the agriculture, industry and tourism sectors.		●	●

Reference Practices

Form of integration	Measures	Instruments
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
 Regulate	• Introduction of criteria for selective differentiation of water prices for agricultural and agri-food use.	• PMAAC Leiria • PIAACs Alentejo Central
	• The progressive urban-use water pricing is revised according to the volume consumed.	• PMAACs Leiria, Loures • PLAAC Palmela
	• Adoption of a tariff system to incentivise efficient water use.	• EMAACs Montalegre, Porto • PMAAC AML
	• Increased benefits/incentives for water reuse. Reduction/exemption of urban planning fees.	• PLAACs Setúbal, Sesimbra
	• Adoption of restrictions on filling swimming pools and washing vehicles and patios in critical areas.	• PIAAC Dão Lafões
	• Revision of the requirements for licensing abstractions and polluting discharges into the water environment, with a view to integrated management of the region's water resources.	• PMAAC AML
	• Establishment of water cost ranges according to the water efficiency associated with each type of crop, soil and climatic region	• PLAACs Sesimbra, Setúbal • PMAAC AML
	• Control and monitoring with possible limits or quotas for surface and groundwater abstraction.	• PLAACs Palmela, Sesimbra, Setúbal
 Operational	• Survey, with the APA, of licences for the extraction of river water for irrigation by private individuals (defining levels of use and target audiences for awareness-raising actions and seeking to monitor/identify other extractions that are not licensed).	• PMAAC Águeda
	• Drawing up and publicising reports on the quantity and quality of water for public supply, particularly in drought situations, to condition its use for agricultural purposes.	• EMAAC Coruche

Reference Practices		
Form of integration	**Measures**	**Instruments**
	• Installation of meters in all water sources that supply consumption in public urban spaces.	• EMAAC Évora
	• Identification of watercourse diversions and illegal dams.	• PIAAC Alentejo Central
	• Supporting and rewarding projects that promote water efficiency and the sustainability of water catchments.	• PIAACs Alentejo Central
	• Making flow, piezometric level and water quality monitoring data available on SNIRH.	• PMAAC AML
	• Adoption of integrated systems for monitoring and evaluating the amount of water retained and transferred for irrigation.	• PIAAC Dão Lafões
	• Supervising or conditioning water consumption during extreme and/or prolonged drought.	• PIAACs Alentejo Central, Beiras e Serra da Estrela, Cávado, Dão Lafões, Oeste
	• Create or preserve strategic areas of infiltration and aquifer protection and recharge outlined in the PDMs, ensuring the replenishment of aquifers.	• EMAAC Matosinhos • PLAACs Palmela, Sesimbra, Setúbal
	• Inspection of private water abstractions to detect illegal boreholes.	• EMAAC Arruda dos Vinhos • PMAAC Leiria • PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
Regulate	• Article 35 1 - The following activities are prohibited in Type II Silvopastoral Multiple Use Spaces: d) Implementation or conversion of cultivation using irrigation.	• PDM Alandroal (Regulation)
	• Article 72 4 - The opening of wells or boreholes intended to collect water for domestic consumption is also prohibited in the protection strip referred to in the previous paragraph.	• PDM Penamacor (Regulation)
	• Article 55 2 - The following activities are prohibited in natural and landscaped areas: b) The installation and extension of irrigation systems or irrigated crops.	• Montemor-o-Novo MDP (Regulation)
	• Article 101 1 - The following activities are prohibited in type II partial protection areas: e) Installing public facilities, including golf courses.	• PDM Loulé (Regulation)
	• Article 17 2 - No new groundwater abstractions may be opened in this area (Critical Area for Groundwater Extraction), except those intended to replace existing ones or which are to be used for human consumption where there is no public water supply network. • Article 13 1 - The following protection perimeters are established for underground water catchments: a) Close protection perimeters defined by a 50 m radius around the catchment;	• PDM Lagoa (Regulation)

2 Reuse water resources and use alternative sources

Concept

Water reuse is considered an adaptation measure that reduces pressure on water resources and increases the security and resilience of the territory.

Reusing water is the process by which wastewater is recovered from various sources and treated appropriately for a second purpose. Any wastewater (domestic, municipal or industrial) can be considered for reuse and, depending on its quality, can be effectively reused for various secondary purposes, including, for example, agricultural irrigation, groundwater recharge, industrial processes, drinking water supply and non-potable urban applications (park irrigation, toilet flushing, etc.).

Water reuse is increasingly being applied to agricultural irrigation, as it is a reliable source that can be used during periods of limited water availability. Using nutrient-treated wastewater for agriculture can also reduce (or eliminate) fertiliser application or contribute to increased productivity and food security.

Methodology for mainstreaming adaptation into the PDM

Reusing water resources and diversifying new water supply sources are two priority measures for dealing with water scarcity. The implementation of this measure implies, on the one hand, public investment in retention, collection, supply and treatment systems, which should be included in the PDM's Implementation Programme, and, on the other hand, the establishment of rules, both general, for the construction sector, and specific, for activities that are significant consumers of water, such as industry, tourism or agriculture, forcing the reuse of water in these sectors.

These measures must be included in the Plan's Strategy, highlighting their indispensability for the sustainable development of the municipality. If desalination is planned, the various options must be assessed within the scope of the SEA.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • In the PDM's specific objectives, the priority is to promote the strategic reuse and diversification of water sources.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
Regulate	Regulations	• Define in the PDM regulations the normative provisions relating to adopting technical solutions that promote water infiltration into the subsoil through retention basins and infiltration wells and technical solutions that facilitate the storage of rainwater within the intervention area for reuse. • Defining normative provisions regarding adopting rainwater reuse solutions to be observed in construction and urbanisation works. • Define normative provisions regarding adopting water reuse solutions through significant consumer activities (e.g., agriculture, industry, and tourism).		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives aimed at reusing water resources or diversifying water sources (for example, construction of retention basins, construction or modernisation of wastewater treatment plants, water production, adduction and storage systems for reuse, or interventions to increase the water efficiency of public facilities), as well as their schedule, the associated investment amounts and the entities to be involved.		●	
Territorial governance		• As part of drawing up the Plan, hold thematic sessions to raise awareness and discuss the need to adopt measures within the regulatory framework or private investments that promote the reuse of water resources with specific stakeholder groups from the agriculture, construction, industry and tourism sectors.		●	●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Promoting alternative water supplies and the recovery, improvement and conservation of water infrastructures for public human consumption, particularly in urban areas with concentrated populations.	• EMAAC Guarda, Póvoa de Varzim • PLAAC Palmela • PMAAC AML
Operational	• Developing a Plan to Harness Rainwater and Reuse Treated Wastewater for Multiple Uses.	• EMAAC Porto • PIAAC Douro
	• Creation of rainwater retention systems for municipal or private use to feed irrigation and cooling systems, including designing streets and pavements to help channel it to water trees and garden areas in urban areas - *water harvesting*.	• EMAAC Águeda, Aveiro, Évora, Viseu, Trofa • PMAAC Loures, Vila Franca de Xira
	• Treating urban wastewater for urban uses compatible with its final quality (e.g., watering green spaces, cleaning roads and vehicles).	• EMAAC Águeda, Arruda dos Vinhos, Aveiro, Braga, Cascais, Guarda, Leiria, Loures, Trofa,...
	• Construction of retention basins, water storage structures, dams, and use of rainwater, watercourse water, or swimming pool discharge water for various purposes.	• EMAAC Almeirim, Alpiarça, Aveiro, Azambuja, Barreiro • PLAAC Sesimbra, Setúbal
	• Definition and dissemination of good practices for the installation of rainwater utilisation systems.	• EMAAC Arruda dos Vinhos
	• Identification and promotion of aquifer recharge, including artificial recharge at times of more significant water availability, through the conversion of impervious surface areas; using infiltration barriers or retention basins in riverbeds based on the collection and storage of surface run-off on the slopes of sub-basins or based on alternative water sources.	• EMAAC Guarda • PMAACs Leiria, Vila Franca de Xira • PLAACs Palmela, Sesimbra • PIAACs Algarve, Oeste
	• Promoting the efficient use of water and water reuse systems.	• EMAAC Aveiro, Braga, Bragança,
	• Evaluation of the potential for reusing rainwater drainage.	• PMAAC Loures
	• Promoting the efficient use of water in industry. Incentives for the use of clean and water-efficient technologies in industry. Promoting the	• PMAAC Sesimbra, Setúbal, AML

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
	reuse of wastewater in industry and the installation of rainwater utilisation systems.	
	• Replacement of single-unit rainwater drainage systems with separate systems.	• PIAAC Oeste
	• Creating alternative water supplies.	• PIAAC Beiras and Serra da Estrela, Cávado
	• Study of the feasibility of using local groundwater for municipal outdoor uses.	• PMAAC AML
	• Reassess the feasibility of a desalination plant and promote its construction.	• PIAAC Algarve
Examples of integrated adaptation measures Municipal Master Plans		
 **Strategy**	• Article 10 1 - A sustainable intervention that qualifies public space implies, whenever possible and simultaneously, the following actions aimed at improving the urban environment: b) Promoting the collection and storage of rainwater and its reuse, and garden areas, whether public or private, should, whenever available, be watered with systems that exclusively use reused water;	• PDM Sintra (Regulation)
 **Regulate**	• Article 6 2 - To improve climatic conditions and the functioning of the water system, the following should be considered in an integrated manner: b) Promote the collection and storage of rainwater and its reuse;	• PDM Celorico da Beira (Regulation)
	• Article 33 1 - All types of tourist resorts must also comply with the following quality parameters: a) Efficiency in the management of water resources, promoting the treatment and reuse of wastewater and rainwater, following the criteria set out in the National Plan for the Efficient Use of Water and the respective operational instruments that may be drawn up;	• PDM Leiria (Regulation)

3 Rehabilitating water distribution and storage systems

Concept

Optimising water distribution and storage systems ensures the efficient use of water resources, reducing losses and increasing sustainability. It also generates greater resilience to fluctuations in demand and supply, guaranteeing consistent access during peak times or emergencies.

Well-maintained distribution systems help minimise water losses due to leaks or inefficiencies, conserving a valuable resource. Reliable distribution systems provide residents with drinking water, which is crucial for hygiene, sanitation, and disease prevention, and fulfil industrial, commercial, and residential needs, supporting economic activities.

Methodology for mainstreaming adaptation into the PDM

Reducing water losses is critical in responding to water scarcity, considering that the Water and Waste Services Regulatory Authority recorded total losses of 175 million cubic metres in low-level networks in 2021.

The realisation of this measure requires an increasingly precise assessment process by the management entities upstream, which involves data collection, cadastral surveys, measurements of flows, pressures, consumption and repairs, and downstream rehabilitation of water distribution and storage systems.

The PDM should focus on the operational dimension, where public decision and investment are fundamental, signalling the need for this at a strategic level and enshrining the investments to be made. In addition, it must help ensure that the development of relevant interventions related to improving the efficiency of supply systems is gradually realised while also focusing on defining strategic storage areas for non-consumptive purposes.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • In the PDM's specific objectives, the priority is to rehabilitate water distribution and storage systems.		●	
Operational	Implementation programme and financing plan	• Describe, in the characterisation studies, the state of maintenance of the low-level distribution and storage infrastructures and the volume of actual water losses through the system. • Identify the projects and initiatives to rehabilitate water supply and storage infrastructures in the Implementation Programme, their schedule, the associated investment amounts, and the entities involved.	●	●	
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote the rehabilitation of supply infrastructures for irrigation perimeters with specific groups of actors from the agricultural sector.		●	●

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Regulate	• Revision of the thresholds for the characterisation classes of actual water losses stipulated.	• PMAAC AML
Operational	• Redimensioning the public sewerage/rainwater network (increasing the section), creating separate rainwater and sewerage networks in urban areas, and increasing the public water and sewerage network coverage to mitigate the effect of flash floods and improve water distribution/quality.	• EMAAC Rio Maior, Salvaterra de Magos, Santarém
	• Study of economically viable solutions to reduce evaporation in reservoirs.	• PMAAC Loures • PIAAC Alentejo Central
	• Maintaining a gravity water supply system for the city of Porto.	• EMAAC Porto
	• Construction, remodelling or improvement of surface and underground water catchments.	• PIAAC Dão Lafões
	• Construction and improvement of municipal water storage infrastructures.	• PMAAC Cascais
	• Monitoring and control of natural and apparent losses throughout the collection, treatment, supply and distribution process.	• EMAAC Arruda dos Vinhos • PMAACs Leiria, Loures, Vila Franca de Xira
	• Remodelling or optimising water supply systems to reduce losses.	• EMAACs Aveiro, Braga, Castelo de Vide, Ferreira do Alentejo
Examples of integrated adaptation measures Municipal Master Plans		
Strategy	• Improving supply infrastructures throughout the municipality	• PDM Estremoz (Implementation Programme)
Operational	• Replacement of water supply networks in the accumulations of Lameira de Cima and Lameira de Baixo, Casal Novo/ Mata, Casmilo, Zambujal and Ega	• Condeixa-a-Nova MDP (Implementation Programme)
	• Execution of the water supply network (to be built/renewed)	• PDM Espinho (Implementation Programme)
	• Drawing up a register of wastewater supply and drainage infrastructures	• PDM São João da Pesqueira (Implementation Programme)

4 Efficient urban irrigation

Concept

Efficient urban irrigation saves water consumption and is a multi-faceted solution encompassing sustainability, climate resilience, environmental health and economic benefits for metropolitan areas.

In the context of climate change and reduced water availability, efficient irrigation practices ensure the sustained growth of vegetation, which contributes to heat mitigation and climate adaptation strategies in cities.

Optimising water use, particularly in urban irrigation, allows for more efficient use of resources and simultaneously reduces water stress, which is particularly critical in regions facing increasing scarcity. Reduced water consumption also minimises run-off, reducing the contamination of water bodies with fertilisers and pesticides used in urban green spaces for collective use.

Methodology for mainstreaming adaptation into the PDM

Urban green spaces, whether for collective or private use, offer a wide range of benefits for cities and their inhabitants, such as improved air quality, thermal insulation (essential in a climate change scenario), the physical and mental well-being of the population, biodiversity, noise reduction and the control and filtering of rainwater (necessary in a climate change scenario).

However, maintaining these green spaces is particularly demanding regarding water consumption through irrigation systems, especially in drought and water scarcity areas. This situation applies not only to public green spaces, which are the responsibility of town and parish councils but also to significant tourist developments, particularly resorts, where the extent of green spaces for recreation is substantial.

The implementation of this measure by the MDPs should, therefore, have four dimensions: (i) strategic, within the framework of promoting the sustainable use of water resources; (ii) normative, namely for tourist developments; (iii) operational, for application in urban green spaces; (iv) governance, making tourist operators aware of the need to rehabilitate and modernise irrigation systems.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • In the PDM's specific objectives, the priority is to promote the efficient watering of urban green spaces.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.			
Regulate	Regulations	• Define the normative provisions for adopting technical solutions that promote the efficient watering green spaces for collective or private use in the PDM regulations. • Define the normative provisions relating to adopting technical solutions for pavements that promote increased water infiltration into the ground in the PDM regulations.		●	
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives in urban green spaces for collective use that aim to increase the efficiency of urban irrigation - for example, installation of intelligent programming systems, installation of sensing systems (soil moisture, meteorological sensors, etc.), upgrading of irrigation systems to distribute water evenly and precisely, to integrate	●	●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		drip technology; integration of recycled or stored rainwater into irrigation systems - as well as their schedule, the associated investment amounts and the entities to be involved.			
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote efficient urban irrigation with groups of actors specific to the tourism sector.		●	●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Reducing water requirements in urban green spaces and promoting biodiversity.	• EMAAC Aveiro • PIAAC Dão Lafões
	• Promoting efficient water use in washing floors, vehicles, gardens, sports fields and other recreational or similar green spaces, swimming pools, lakes, and water mirrors.	• PLAAC Sesimbra • PMAAC AML
	• Promoting the use of treated wastewater for watering public spaces, green spaces and sports centres. Reusing water by improving infrastructures and reducing networks.	• PLAAC Sesimbra • PMAAC Vila Franca de Xira • PIAAC Middle Tagus
Operational	• Adequate soil management in gardens and similar.	• EMAAC Évora
	• To implement the rational use of water in municipal activities through implementing methodologies to reduce its consumption and use alternative sources in urban uses that are compatible with its quality.	• PLAAC Setúbal
	• Optimisation and creation of good practices for irrigation systems.	• EMAAC Figueira da Foz
	• Increasing the efficiency of urban green space irrigation systems.	• EMAACs Évora, Guarda, Oliveira de Azeméis, Seia • PIAAC Algarve
	• Implement a programme to automate irrigation systems to reduce water consumption.	• EMAACs Maia, Porto, Vale de Cambra, Viseu
	• Creation of integrated systems for monitoring and evaluating the amount of water retained/stored and transferred for irrigation.	• EMAAC Arruda dos Vinhos
Territorial Governance	• Raising awareness of the need to reduce watering of gardens and vegetable plots and appropriately use less water-intensive techniques/technologies.	• PIAAC Dão Lafões
Examples of integrated adaptation measures Municipal Master Plans		
Regulate	• Article 87 5 - The vegetation installed in green spaces must dominantly require low water availability.	• PDM Cascais (Regulation)
	• Article 77 3 - In Green Spaces, planting or replacing existing vegetation with other vegetation must be subject to introducing native species.	• PDM Penalva do Castelo (Regulation)
Operational	• Awareness-raising campaign among the community and local players to reduce energy and water consumption.	• PDM Viana do Alentejo (Implementation Programme)

5 Urban design and *water-sensitive* construction

Concept

Water-sensitive urban design and construction aims to protect and reuse water quality and ecosystems and can be implemented at various scales, from a single building to larger urban areas, helping to realise the concept of the "sponge city".

The fundamental principles are the consideration, during the urban planning process, of all the elements of the water cycle and their interconnections to achieve a healthy natural environment that meets human needs.

This measure also aims to optimise the sustainable integration of the water cycle into urban planning and management. Recognising the potential impact of drought and water scarcity as a climate hazard reinforces the expression of measures to promote water efficiency in climate change adaptation instruments. These reflect a substantial focus on reusing rainwater and wastewater and improving or constructing water retention and distribution efficiency infrastructures.

Methodology for mainstreaming adaptation into the PDM

Water-sensitive buildings and urban planning are buildings or areas designed to manage the water cycle and promote water sustainability efficiently.

This measure includes a comprehensive and integrated range of interventions such as green roofs for buildings; the creation of porous pavements and the depaving of artificialized areas; the creation of the green areas designed to capture, filter and store rainwater, usually through basins or depressions in the ground planted with native or adapted vegetation; the construction of water reuse systems that collect, treat and reuse grey water (from sinks, showers, etc.) or rainwater for non-potable purposes, such as watering gardens, swales and retention basins.) or rainwater for non-potable purposes such as watering gardens, flushing toilets and cleaning; and green drainage systems such as infiltration ditches, swales and retention basins.

Its breadth and the diversity of ways in which it can be accomplished means that it can be achieved in multiple ways within the scope of the PDM, both at a regulatory level, through the regulation of construction and urbanisation works, and at an operational level, through the creation/renovation of public spaces and facilities.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• Emphasising the need to save, rationalise and use water more efficiently in the strategic principles and objectives, highlighting the importance of achieving this objective within urbanisation, regeneration and urban rehabilitation processes.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
Regulate	Regulations	• Define the normative provisions regarding adopting technical solutions that promote urban design and water-sensitive construction concerning public spaces and facilities in the PDM regulations. • Define the normative provisions regarding adopting technical solutions that promote urban design and water-sensitive construction in subdivisions and urban planning operations in urbanisation works in the PDM regulations. • Establish urban planning parameters that allow for the most significant possible permeability of the		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		soil and the maintenance and creation of permeable green spaces.			
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives that aim to increase the water sensitivity of public buildings (for example, the installation of green roofs, the paving of patios, the integration or adaptation of water reuse systems that collect, treat and reuse grey water from sinks, showers, etc. or rainwater), as well as their schedule, the associated investment amounts and the entities to be involved. • Identify the municipality's priority interventions in the Implementation Programme. • Identify in the Implementation Programme the interventions aimed at increasing the water-sensitivity of urban spaces (for example, the paving of artificialized areas; the integration or adaptation of water reuse systems that collect, treat and reuse rainwater; the creation of the green areas designed to capture, filter and store rainwater; the creation of green drainage systems, such as infiltration ditches, *swales* and retention basins), as well as their schedule, the associated investment amounts and the entities to be involved.		●	
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote greater sensitivity to water in the construction sector.	●	●	

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Promote the implementation of rainwater recovery systems in new buildings.	• EMAAC Guarda
Regulate	• Incorporate measures to reduce consumption and reuse grey and/or rainwater in urban regeneration processes.	• PIAAC Alentejo Central, Oeste
Regulate	• Introduction of materials/technologies in buildings and/or public spaces to promote resource efficiency and well-being (e.g. irrigation, water, waste, energy and air quality management systems; wastewater/rainwater reuse; shading solutions); development of pilot projects in various areas.	• EMAACs Almeirim, Alpiarça, Azambuja, Benavente, Cartaxo, Chamusca
Operational	• Promoting more efficient use of water in building systems and collective installations.	• PMAACs Cascais, Vila Franca de Xira • PMAAC AML
	• Recovering rainwater for irrigation, including by promoting the design of streets and pavements so that it can be used to irrigate trees and garden areas in urban areas - water harvesting.	• PMAAC Loures, Vila Franca de Xira • PIAAC Alto Alentejo, Baixo Alentejo

Examples of integrated adaptation measures Municipal Master Plans		
 **Strategy**	• Definition of measures aimed at eliminating and controlling sources of disturbance to environmental quality from industrial, agricultural and urban sources, particularly in terms of water pollution.	• PDM Tomar (Implementation programme)
 **Regulate**	• Article 19 1 - Tourist resorts must comply with requirements aimed at optimising environmental efficiency, namely: d) Adequate wastewater treatment and reuse of wastewater and rainwater, namely in green spaces and gardens or washing floors, and installation of devices that promote the reduction of water consumption in buildings and outdoor spaces, following the criteria of the National Programme for the Efficient Use of Water and its operational instruments.	• Castelo de Paiva PDM (Regulation)

6 Urban green infrastructure

Concept

Urban green infrastructure refers to systems that use natural elements and ecosystems to improve the quality of life in urban areas, promote environmental sustainability and reduce the negative impacts of human activities in urban environments. Urban green infrastructure includes parks and green areas, community gardens, green roofs, sustainable drainage systems, ecological corridors, footpaths and cycle paths, and recreational and leisure spaces that promote interaction with nature.

Urban green infrastructure can play an essential role in reducing the impacts of water scarcity and drought in cities. This can be achieved by implementing sustainable drainage systems that capture, store, and reuse rainwater, combined with indigenous and adapted vegetation to reduce irrigation needs. In this context, green pavements, which reflect less heat, can also reduce the temperature and the need for irrigation and contribute to water absorption.

On the other hand, restoring riparian areas and creating buffer zones surrounding water bodies can improve water quality and increase retention capacity. At the same time, creating urban green spaces can also contribute to the absorption and filtering of rainwater, promoting groundwater recharge and reducing the amount of water that flows into storm drainage systems, reducing the pressure on them at peak times.

Methodology for mainstreaming adaptation into the PDM

Urban green infrastructure is made up of a wide variety of natural elements integrated into the urban environment, namely parks and green areas for collective use; green roofs and canopies; ecological corridors; squares and other public spaces; strips of vegetation along tree-lined streets; gardens and retention basins designed to capture and filter rainwater; wetlands and urban water bodies.

This infrastructure is critical in promoting sustainability, resilience and health in cities by improving air quality, regulating the urban climate, controlling rainwater, biodiversity, recreation and well-being and retaining and preserving water resources.

The integration of this measure into the PDM is based, on the one hand, on defining and safeguarding the urban ecological structure and, on the other, on extending, preserving and adapting the green infrastructure, both through public and private investment, reinforcing its strategic importance.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The Plan's strategic principles and objectives include enhancing and preserving ecosystems and urban green spaces, highlighting the importance of this objective for the climate adaptation of urban spaces.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
Regulate	Regulations	• Define the parameters for the sizing of areas to be transferred to the municipal domain, intended for the implantation of green spaces and spaces for collective use, considering the need to increase the size of the green infrastructure. • Define the normative provisions relating to maintaining, preserving, and expanding urban green infrastructure in the PDM regulations.		●	
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives aimed at increasing or upgrading the green infrastructure (for example, the creation of parks and gardens, the creation of		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		green roofs for public buildings, the rehabilitation of ecological corridors, the creation and qualification of squares and other public spaces; urban afforestation interventions; the creation of gardens and retention basins designed to capture and filter rainwater; interventions for the ecological regeneration of wetland margins or the qualification and creation of urban water bodies), as well as their schedule, the associated investment amounts and the entities to be involved.			
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote the strengthening of the urban green structure with players in the construction sector.		•	

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Strategy for implementing naturalised parks and green areas and adapting existing ones.	• PLAAC Cascais
Operational	• Manual of good practices for green space projects.	• PLAAC Cascais
	• Encourage intervention operations in urban areas to increase naturalised green areas.	• PLAAC Cascais
	• Introducing indigenous and adapted plant species with lower water consumption requirements in public spaces.	• EMAACs Castelo de Vide, Figueira da Foz, Santa Maria da Feira
	• Promote natural/autochthonous vegetation (adapted to the climate), eliminating grass planting through specific norms/regulations (political commitment) in public green spaces. Use of low-water-demanding and native plant species in gardens and other public green spaces.	• PLAAC Sesimbra
	• Reinforce the importance and operating conditions of green corridors, especially those that form part of urban systems.	• EMAAC Torres Vedras
Examples of integrated adaptation measures Municipal Master Plans		
Strategy	• Article 10 1. A sustainable intervention that qualifies public space implies, whenever possible and simultaneously, the following actions aimed at improving the urban environment: c) Encouraging the creation, maintenance and use of plant material, either through the construction of spaces for urban horticulture or public gardens, in which the use of native species and others adapted to the soil and climate conditions of the area is favoured;	• PDM Sintra (Regulation)
Regulate	• Article 87 3 - The design of new green spaces or the requalification of existing ones should promote an increase in their resilience, as well as contribute to an increase in biodiversity, preferably using permeable paving, terrain modelling that allows infiltration in situ and a vegetation structure adapted to soil and climate conditions, to reduce installation and maintenance costs.	• PDM Cascais (Regulation)

7 Retain water for agricultural uses and adapted agricultural practices

Concept

Promoting water retention in agricultural areas and using adapted agricultural practices can help mitigate floods, alleviate drought, reduce soil erosion and improve environmental quality. Water retention capacity of farming areas can be enhanced by practices such as cultivation lines according to contour lines; maintenance or reconstruction of pre-existing drainage systems; establishment of different water flow regimes; restoration of natural or artificial water retention spaces (ponds, lakes, reservoirs) or expansion/restoration/ adaptation of flood plains; tilling or keeping crop residues between the rows or adopting no-tillage or reduced-tillage systems combined with permanent soil cover and crop rotation; planting barriers or small forest areas in arable areas; changing cultivation operations.

On agricultural land, water storage allows water to be conserved in case of abundance and made available in case of scarcity, either by storing moisture in the soil (encouraging the infiltration of water into the ground) or groundwater (allowing aquifers to be recharged); or surface water (through ponds, natural or artificial tanks).

On the other hand, agricultural practices adapted to water scarcity that maximises water use can be adopted, such as drip irrigation, the use of organic or inorganic materials to cover the soil around plants, the choice of crops that are more resistant to water scarcity, crop rotation and polycultivation.

This measure should be integrated with other measures that preserve soil moisture, minimise soil erosion and degradation in agricultural areas (conservation agriculture), and improve the natural functions of rivers and floodplains.

Methodology for mainstreaming adaptation into the PDM

The realisation of the measure to adapt water retention for agricultural uses and the adoption of adapted agricultural practices through the PDM comes up against the limitation that there are no licensing or inspection mechanisms at the municipal level to ensure the effectiveness of any regulatory norms to be established in the PDM.

Without prejudice, the regulation should signal the principles and good practices adopted by agricultural activities to help retain water in the soil and efficiently use water resources.

In addition, both at a strategic level and in terms of territorial governance, particular importance should be given to promoting efficiency, savings and rationalisation in the use of water, firstly by signalling this priority for the future of agricultural activities and secondly by raising awareness among sectoral players by holding sessions and meetings on this subject during the drafting of the PDM.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • The PDM's specific objectives prioritise promoting water retention for agricultural uses. • In the PDM's specific objectives, the strategic priority is to provide agricultural practices adapted to worsening droughts and water scarcity.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
Regulate	Regulations	• Define provisions in the PDM regulations, particularly regarding principles and objectives, which glorify and promote soil preservation and water retention for agricultural uses. • Define provisions in the PDM regulations, particularly for agricultural areas, to guide the implementation of certain practices that promote		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		the preservation and increase of soil humidity, namely: cultivation lines according to contour lines; maintenance or reconstruction of pre-existing drainage systems; establishment of different water flow regimes; restoration of natural or artificial water retention spaces (ponds, lakes, reservoirs) or expansion/restoration/ adaptation of flood plains; tilling or keeping crop residues between the rows; adopting no-tillage or reduced-tillage systems, combined with permanent soil cover and crop rotation; planting barriers or small forest areas in arable areas; changing cultivation operations.			
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote the adoption of good practices that contribute to soil preservation with players in the agricultural sector.	●	●	●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Regulate	• Creation of legal mechanisms to guide and control the cultivation of water-intensive crops in areas with suitable potential for other crops.	• PLAACs Palmela, Sesimbra, Setúbal
	• Establishing restrictions on the use of water-consuming plants that pose a danger of invading natural ecosystems.	• PIAAC Oeste
Operational	• Adopt and promote good agricultural and forestry practices, namely soil conservation and efficient water use in annual and permanent crops, reducing nitrogen fertilisers, and adapting crops to species with lower water demand.	• EMAAC Aveiro • PLAACs Águeda, Palmela, Sesimbra, Setúbal • PMAAC AML
	• Support the promotion of the construction of small private dams and ponds to retain water for agricultural/agroforestry use.	• EMAACs Arruda dos Vinhos, Aveiro
	• Strengthening water availability through irrigation and storage promotes the efficient use of water in agriculture.	• PIAACs Algarve, Cávado, Região de Coimbra
	• Financial support and incentives are needed for farmers who adopt more efficient irrigation solutions (sustainable water and energy use), more precision farming methods, and irrigation warning systems.	• PMAAC Loures • PLAACs Palmela, Sesimbra, Setúbal
	• Creation of adaptation measures for the agricultural sector.	• EMAAC Vila Franca do Campo
	• Support for research and technical vulgarisation of plant varieties is needed to make them more resilient and adapted to water scarcity and high temperatures, particularly in vines, vegetables, fruit, and cut flowers.	• PMAAC AML
	• Support farmers in identifying efficient solutions for watering animals, particularly by avoiding the spread of new catchments.	• PIAAC Dão Lafões
	• Reactivation, remodelling or completion of hydro-agricultural schemes already built or planned.	• PIAAC Oeste
Territorial governance	• Promote training and awareness-raising activities for entrepreneurs and small farmers on water efficiency and good agricultural practices.	• PLAAC Sesimbra • PIAACs Alto Alentejo, Douro
Examples of integrated adaptation measures Municipal Master Plans		

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
 **Operational**	• Irrigation and irrigation infrastructure in the municipality	• PDM Mêda (Implementation Programme)
 **Regulate**	• Article 25 3 - Traditional collective irrigation systems should be favoured, promoting good agricultural practices and maintaining rural heritage.	• PDM Celorico da Beira (Regulation)
	• Article 8 3 - To maintain and/or promote the favourable conservation status of natural values in the areas of the municipality included in the Natura 2000 Network and the National List of Sites, the following actions, activities and land uses and respective management guidelines should be particularly favoured: s) Maintenance of extensive agricultural and pastoral practices;	• PDM Oliveira do Bairro (Regulation)
	• Article 6 2 - To improve climatic conditions and the functioning of the water system, the following should be considered in an integrated manner: i) Adopt agricultural practices that benefit the climate and the environment by promoting greening.	• PDM Celorico da Beira (Regulation)

8 Use native or adapted species

Concept

Native agricultural species are well adapted to local environmental conditions, making them more resilient to the impacts of climate change, such as droughts, floods or temperature fluctuations. They also tend to exhibit better yields and stability in the event of changes in climatic conditions, guaranteeing food production despite environmental challenges.

They are also crops with cultural and social significance in communities. They promote local food traditions and support livelihoods by encouraging the adoption local farming practices that have evolved to suit specific environmental conditions, guaranteeing sustainable farming methods.

Methodology for mainstreaming adaptation into the PDM

Implementing the adaptation measure of using native species or those better adapted to climate change through the PDM is extremely difficult, given its limited effectiveness and the lack of licensing or inspection mechanisms at the municipal level to ensure its implementation. In this context, its integration should only be seen strategically in terms of principles and within the framework of the territorial governance process.

The higher levels of adaptation of native species to local soil and climate conditions make it possible to reduce pressure on resources. This is also due to their lower demand for water, making farming more dependable in the context of growing climatic uncertainty. It should also be noted that local and traditional crop varieties preserve biodiversity, safeguarding genetic resources that could be crucial for future breeding programmes.

In the context of southern Portugal, it may be necessary to assess the cultivation of new varieties that are better adapted to water scarcity, such as holm oaks and cork oaks, namely through genetic deposits that are more resistant to drought, in line with the scenarios projected for the region and the country.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
 Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • In the PDM's specific objectives, the strategic priority is to promote using native or adapted species in agriculture.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
 Regulate	Regulations	• Define provisions in the PDM regulations, particularly regarding principles and objectives, which enshrine and promote the need to boost local food basins using indigenous species or those adapted to climate change.		●	
 Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote the adoption of good practices that contribute to using native species or species adapted to climate change by the agroforestry sector.	●	●	●

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
 **Regulate**	• Creation of legal mechanisms to guide the cultivation of water-intensive crops in areas with potential for other crops.	• PMAAC AML
 **Operational**	• PRODER renaturalisation.	• PMAAC Cascais
	• Use of native plant species adapted to the soil and climate conditions.	• PMAAC Lagos
	• Promoting the adoption of more resilient and adapted plant varieties.	• PMAAC Vila Franca de Xira
	• Replace forest species with more drought-tolerant ones, preferably indigenous.	• PIAAC Algarve
	• Support for crop conversion initiatives, promoting the use of less water-intensive crops.	• PIAAC Coimbra Region
Examples of integrated adaptation measures Municipal Master Plans		
 **Regulate**	• Article 11 8 - The following actions or activities are prohibited in the EEM: b) The destruction, cutting, uprooting or replacement of native vegetation and the planting of non-native species, except in cases of obvious need for the installation of compatible uses and activities, duly justified, with the opinion of the ICNF, for example, when phytosanitary problems are involved.	• PDM Vidigueira (Regulation)

9 Rehabilitate, renaturalise and conserve watercourses and riparian galleries.

Concept

Riparian galleries are linear strips of permanent natural or semi-natural vegetation adjacent to watercourses.

The rehabilitation of riparian galleries is an adaptation option capable of (i) preventing flooding: riparian buffers provide space for the natural dynamics of a river, allow the flow to slow down and create sinuous flow paths, which contributes to reducing the potential for river channel erosion and therefore the potential for downstream flooding; (ii) mitigating drought: by improving groundwater recharge, increasing the permeability and contact time of water with soils or through shading effects provided by trees and shrubs that improve microclimatic conditions; and (iii) decrease temperature: the shading effect of riparian buffers helps create a microclimate that serves to cool water bodies, increasing air humidity and stabilising temperatures.

Riparian galleries are also a natural filter for pollutants and prevent eutrophication: they function as a shield against the overland flow of agricultural fields, reducing the amount of sediment and pollutants that reach the watercourse. They are a natural corridor connecting habitats and species that facilitate the dispersal of natural species. Given the range of benefits, riparian galleries and adjacent areas are essential for maintaining and restoring the landscape.

Methodology for mainstreaming adaptation into the PDM

The measure to rehabilitate, renaturalise and conserve watercourses and riparian galleries has multiple benefits and can be implemented in various ways, namely by defining land use and occupation rules that safeguard riparian zones and ensure the preservation of the natural cover of the banks and riparian gallery; public interventions to preserve, renaturalise and ecologically restore the banks and riparian galleries, promote the continuity of the corridor and stabilise the banks using natural engineering techniques; raising awareness among landowners of best agroforestry practices.

It should be noted that a substantial part of Portugal's riparian galleries is suffering from loss of structural integrity, a reduction in their original width and disappearance or fragmentation of the natural cover. In the assessment conducted as part of the National Water Plan in 2001, out of around 17,000 km of mapped riparian galleries, only 7,500 km had well-developed galleries on both banks (Moreira et al., 2002).

The integration of this measure into the PDM could be accomplished on several levels, namely, at a strategic level, reinforcing the imperative of protecting water resources; at a regulatory level, establishing provisions to safeguard the use and occupation of land on the banks of water lines; at an operational level, providing for active management and restoration interventions; and at a territorial governance level, raising awareness among landowners.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The PDM's strategic objectives highlight the need to promote efficiency, savings and rationalisation in water use. • In the PDM's specific objectives, the strategic priority is to rehabilitate, renaturalise and conserve watercourses and riparian galleries.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to the dangers of drought and water scarcity as strategic issues of the Plan. • Identify Resilience to Drought Hazards and Water Scarcity as a Critical Decision Factor in the Scoping and Environmental reports. • Consider the projected reduction in precipitation and water availability by the end of the century in the scenarios.		●	
Regulate	Regulations	• Define the provisions for safeguarding watercourses and their banks in the PDM regulations.		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Operational	Implementation programme and financing plan	• In characterisation studies, characterise the conservation status of riparian vegetation and water lines. • Identify in the Implementation Programme the projects and initiatives aimed at preserving, renaturalising and ecologically restoring the banks and riparian galleries, promoting the continuity of the corridor and stabilising the banks using natural engineering techniques, as well as their schedule, the associated investment amounts and the entities to be involved.	●	●	
Territorial governance		• Thematic sessions raise awareness and debate the need to promote good agroforestry practices that help preserve the banks of watercourses and riparian galleries.	●	●	●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Create a Strategic Plan for the Rehabilitation of Water Lines, focusing on rehabilitating riparian vegetation corridors.	• EMAAC Arruda dos Vinhos
	• Promoting the protection of water lines: municipal Green and Blue Lines.	• EMAACs Coruche, Leiria
Operational	• Promoting the conservation/rehabilitation of streams, riparian galleries and wetlands, clearing invasive species and preserving ecosystems.	• EMAACs Chamusca, Coruche, Golegã, Gondomar, Loulé, Maia, Matosinhos, Montalegre
	• Valorisation and recovery of native riparian vegetation.	• PMAACs Lagos, Leiria
	• Promoting the cleaning and regularisation of water lines and the recovery, improvement and conservation of water retention infrastructures, particularly agricultural irrigation systems.	• PIAAC Cávado
Examples of integrated adaptation measures Municipal Master Plans		
Regulate	• Article 80 2 - The municipal ecological structure must guarantee the following functions: b) The defence of agroforestry systems integrated into the determinants for fulfilling the tasks of recharging aquifers and protecting strategic water reserves;	• Mirandela PDM (Regulation)
	• Article 65 2 - In the areas covered by the Municipal Ecological Structure, in addition to the provisions for the different subcategories of space, the following requirements must be complied with c) Preservation of the riparian gallery of the watercourses, which in the event of degradation must be recovered with an autochthonous floristic cast;	• PDM Oleiros (Regulation)
Operational	• Conducting work to clean watercourses and restore traditional weirs	• Mondim de Basto PDM (Implementation programme)
	• Reconstruction of the Choupal weirs on the Rio da Serra. The reconstruction of these weirs, located close to the city of Anadia, is intended to once again provide this area of the river with the retention of bodies of water essential for favouring aquifers and rehabilitating riparian galleries and fauna. Maintaining the flows, especially during the summer, will also allow the water to be used for	• PDM Anadia (Implementation Programme)

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
	rinsing neighbouring agricultural areas and boosting the creation of recreational and leisure spaces.	

D. Which adaptation measures are most appropriate according to the classification of the soil??

Adaptation measures to drought and water scarcity are more appropriate according to soil classification

	Adaptation measure	Soil classification											
		Urban						Rustic					
		A - Centres	B - Housing	C - Economic	D - Green	E - Low Density	F - Special Use	A - Agricultural	B - Forestry	C - Energisers	D - industrial	E - Natural	F - Other
1	Restrictions and incentives to protect and promote the efficient use of water resources	●	●	●				●	●	●	●		
2	Reuse water resources and use alternative sources	●	●	●	●	●	●	●		●	●		
3	Rehabilitating water distribution and storage systems	●	●	●	●	●	●	●	●			●	●
4	Efficient urban irrigation				●								
5	Urban design and *water-sensitive* construction	●	●	●	●	●	●						
6	Urban green infrastructure	●	●	●	●	●	●						
7	Retain water for agricultural uses and adapted agricultural practices							●					
8	Use native or adapted species				●			●	●			●	
9	Rehabilitate, renaturalise or conserve watercourses and riparian galleries				●			●	●			●	

Caption:
Urban land: a) Central Spaces, corresponding to mixed-use urban areas that integrate residential functions and a diversified concentration of tertiary activities, performing, due to their characteristics, centrality functions; b) Residential Spaces, corresponding to areas that are preferably intended for residential use, but may accommodate other uses compatible with residential use; c) Economic Activity Spaces, corresponding to areas that are preferably intended to accommodate economic activities with special needs for the allocation and organisation of urban space, namely industrial activities, storage and logistics, commerce and services; d) Green Spaces, corresponding to areas with environmental balance, landscape enhancement and outdoor recreational, leisure, sports and cultural activities, coinciding in whole or in part with the municipal ecological structure; e) Low Density Urban Spaces, corresponding to peri-urban areas, partially urbanised and built up, showing fragmentation and hybrid characteristics of an urban-rural occupation, with the permanence of agricultural uses intertwined with urban uses and the existence of equipment and infrastructures, to which the territorial plan assigns prevailing urban functions and which are subject to a land use regime that guarantees their urban planning from a perspective of sustainability and flexibility of use, as well as their infrastructure using appropriate solutions. f) Special Use Spaces, corresponding to areas destined for equipment spaces, structuring infrastructure or tourist spaces).
Rustic soil: a) Agricultural areas; b) Forest areas; c) Areas for the exploitation of energy and geological resources; d) Areas for industrial activities directly linked to the uses referred to in the previous paragraphs; e) Natural and landscape areas; f) Other categories of rustic soil, corresponding to cultural areas, areas for tourist occupation, areas for equipment, infrastructures and other structures or occupations, rural settlements and areas of dispersed building.

E. What are the main constraints on the adoption of Adaptation Measures?

#	Adaptation measure	Type of Constraints					
		High financial cost	Reduced legal effectiveness	Dependence on technology and innovation	Political and governance challenges	Indirect environmental impacts	Cultural change
1	Restrictions and incentives to protect and promote the efficient use of water resources	●	●	●	●	●	●
2	Reuse water resources and use alternative sources	●	●	●	●	●	●
3	Rehabilitating distribution and storage systems	●	●	●	●	●	●
4	Efficient urban irrigation	●	●	●	●	●	●
5	Urban design and *water-sensitive* construction	●	●	●	●	●	●
6	Urban green infrastructure	●	●	●	●	●	●
7	Retain water for agricultural uses and adapted agricultural practices	●	●	●	●	●	●
8	Use native or adapted species	●	●	●	●	●	●
9	Rehabilitate, renaturalise or conserve watercourses and riparian galleries	●	●	●	●	●	●

The extent of embarrassment:					
High	●	Medium	●	Bass	●

F. What other benefits can be gained from integrating adaptation to droughts and water scarcity into the PDM?

	Adaptation measure	Synergies				Contribution to the SDGs															
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Restrictions and incentives to protect and promote the efficient use of water resources	●	●	●	●	o	o	o	o	o	+	o	o	o	o	o	+	+	o	o	o	o
2	Reuse water resources and use alternative sources	●	●	●	●	+	o	o	o	o	+	o	+	o	o	o	o	+	-	o	o	o
3	Rehabilitating water distribution and storage systems	●	●	●	●	o	o	+	o	o	+	o	+	+	o	o	o	o	o	o	o	o
4	Efficient urban irrigation	●	●	●	●	o	o	o	o	o	+	o	o	+	o	+	o	+	o	o	o	o
5	Urban design and *water-sensitive* construction	●	●	●	●	o	o	+	o	o	o	o	o	o	o	+	o	+	o	o	o	o
6	Urban green infrastructure	●	●	●	●	o	o	+	o	o	o	o	o	+	o	+	o	+	o	+	o	o
7	Retain water for agricultural uses and adapted agricultural practices	●	●	●	●	+	+	o	o	o	+	o	+	o	o	o	+	+	o	o	o	o
8	Use native or adapted species	●	●	●	●	+	+	o	o	o	o	o	o	o	o	o	+	+	o	+	o	o
9	Rehabilitate, renaturalise or conserve watercourses and riparian galleries	●	●	●	●	o	+	o	o	o	o	o	o	o	o	o	o	+	o	+	o	o

Caption

Relationship with the Sustainable Development Goals

1 Eradicating poverty
2 Eradicating hunger
3 Access to quality healthcare and promoting well-being
4 Access to inclusive, quality and equitable education
5 Gender equality
6 Availability and sustainable management of drinking water and sanitation
7 Reliable, sustainable and clean energy for all
8 Inclusive and sustainable economic growth
9 Resilient infrastructures, inclusive and sustainable industrialisation and innovation
10 Reducing inequalities
11 Inclusive, safe, resilient and sustainable cities
12 Sustainable consumption and production
13 Climate action
14 Conserving the oceans
15 Protecting terrestrial ecosystems
16 Effective, accountable and inclusive institutions
17 Partnerships for sustainable development

Relations with Sectors and Risk Groups

Combating poverty and exclusion
Circularity
Renaturalisation
Mitigation

Type of relationship

\+ With benefits
\- With losses
o No evidence / Mixed

Degree of synergy

● High
● Medium
● Bass

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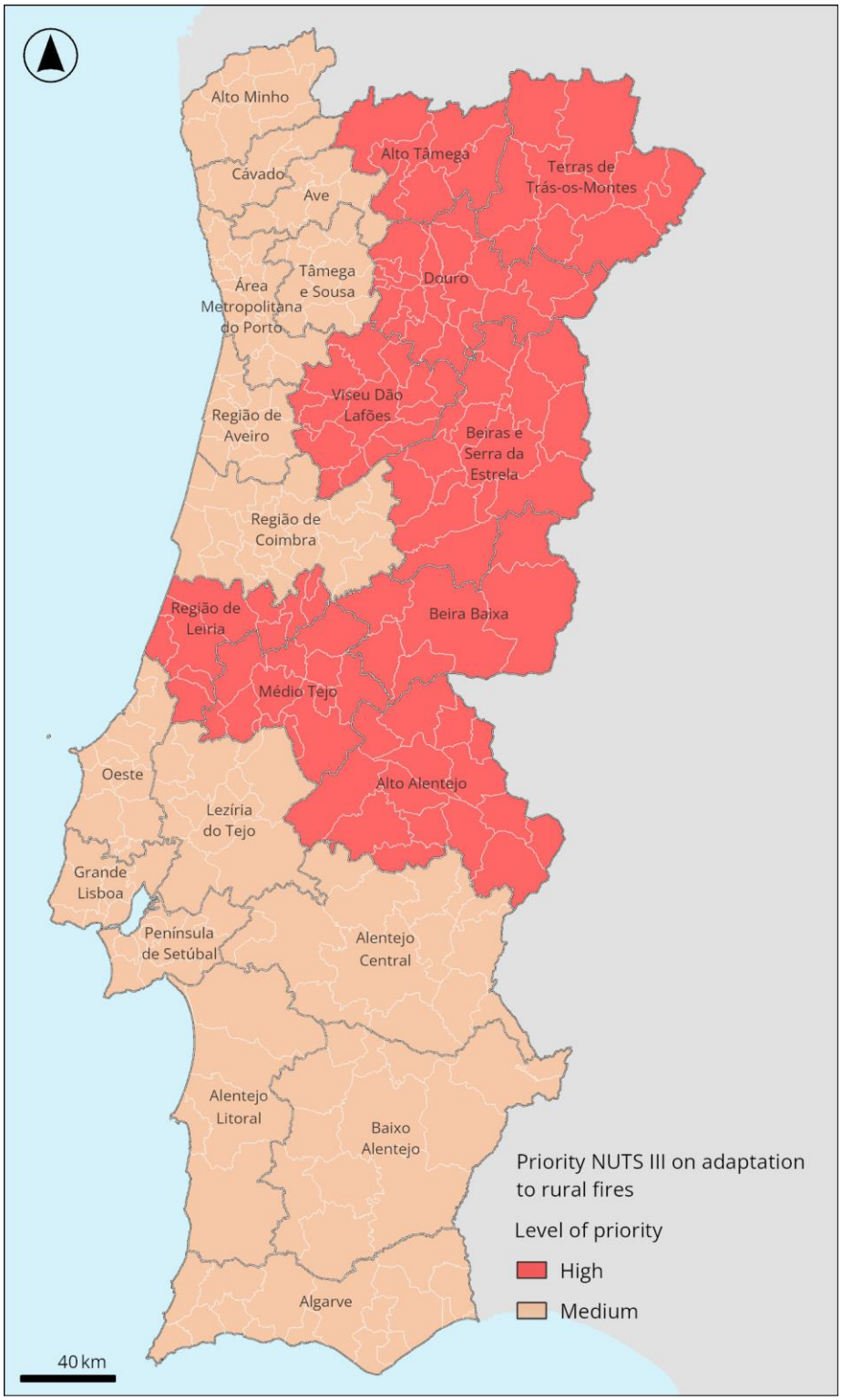
3. Integrate adaptation to rural fires into the PDM

A. Which NUTS III are prioritised on adaptation to rural fires?



Source: CEDRU, based on the interpretation of data relating to the anomalous number of days with extreme fire risk within the Fire Weather Index in the RCP4.5 scenario for the 2071-2100 time horizon.

B. How can municipalities adapt to rural fires?

#	Adaptation measure	Type of response					Type of measure				
		Prevention	Accommodate	Protect	Relocate	Rescue and recovery	A. Governance and Institutions	B. Economics and Finance	C. Physics and Technology	D. Nature-based solutions	E. Knowledge and behaviour change
1	Fuel management strips	●					●				
2	Controlling and utilising forest biomass		●				●	●		●	●
3	Promoting agroforestry activity		●				●	●		●	●
4	Promoting forest mosaics		●				●	●		●	●
5	Reforest and use native or adapted forest species		●				●			●	●
6	Adapting and protecting infrastructure			●					●		
7	Install surveillance resources and reinforce fire-fighting resources					●			●		

C. How can adaptation to rural fires be integrated into a PDM?

1 Fuel management strips

Concept

Fuel management strips are strategically designated and maintained to reduce the risk of rural fires and minimise fire spread. The primary purpose of these strips is to form a defensive barrier, interrupting the continuity of fuel available for fire, such as dry vegetation, fallen branches and other flammable materials, particularly in the vicinity of roads and buildings, as well as rural settlements.

These strips play a crucial role in preventing and controlling rural fires and are an essential practice in areas prone to such events. Effective fuel management contributes to the safety of communities, the protection of ecosystems, and the preservation of forest resources. It can also contribute to establishing and consolidating agroforestry resources, constituting a barrier to spreading fires.

Methodology for integrating PDM adaptation

The implementation of the adaptation measure relating to fuel management strips within the scope of the PDM is conditioned by the fact that the execution of the primary and secondary networks of fuel management strips is the responsibility of the various entities responsible for the infrastructures located in the strips, and the ANEPC is responsible for supervising them. In this context, municipalities are responsible for implementing fuel management strips on municipal roads, which in some cases are of considerable length, and monitoring the actions conducted to manage these strips. It should also be noted that, in the event of non-compliance on the part of the entities responsible for the infrastructures in fuel management strips, it is up to the municipalities to replace them in this role.

For this reason, the realisation of this measure is centred on territorial governance actions that contribute to its realisation by public entities and private individuals and should have a reference in the strategic framework of the PDM.

Without prejudice to this, the regulation should signal principles and guide territorial actors towards the need for efficient management of fuel strips, safeguard the non-occupation of these areas of the territory, provide for the enforcement of the management of fuel strips in the secondary network and ensure that territorial management is linked to municipal programmes for the implementation and integrated management of rural fires.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• Emphasise the importance of creating and safeguarding fuel management strips in the plan's strategy. • Signalling its strategic priority in the context of climate change, which tends to worsen the conditions associated with rural fires.		●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to fire danger as a strategic issue of the Plan. • Identify resilience to fire danger as a Critical Decision Factor in the Scoping and Environmental reports.			
Regulate	Regulations	• Define provisions restricting the occupation of areas designated for the implementation of fuel management strips. • Ensure that land use restrictions are aligned and consistent with the provisions of the Municipal Forest Fire Protection Plan (PMDFCI)I, municipal integrated rural fire management implementation programmes and the Regional Forest Management Programme (PROF). • Enforcing the management of fuel strips in the secondary network.		●	

Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives that aim to monitor and supervise the management of fuel management strips, their schedule, the associated investment amounts and the entities to be involved.		●	
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote private individuals' maintenance of fuel management strips.	●	●	●

Reference Practices

Planned form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Operational	• Increase/maintain fuel management strips and support proper cleaning techniques to reduce the risk and effect of fire.	• EMAAC Almeirim, Alpiarça, Azambuja, Benavente, Cartaxo, Chamusca, Golegã.
	• Creation of forest fuel management strips near urban/rural/forest interface areas.	• PMAAC Cascais
	• Promote the implementation of a primary and secondary network of fuel management strips.	• EMAAC Aveiro • PLAAC Águeda
Examples of integrated adaptation measures Municipal Master Plans		
Regulate	• Article 20 c) The forest fire protection strip) The forest fire protection strip shall consist of a forest fuel interruption strip with a minimum width of 10 metres in the area closest to the buildings, made up of inert, non-impermeable material or herbaceous vegetation, and a fuel reduction strip, with a width of no less than 50 metres, where the spread of fire is slowed down by maintaining the vertical and horizontal discontinuity of the shrub and tree stratum through the obligatory distance of at least 4 metres between the tops of the trees and maintaining the cleanliness of the ground cover.	• PDM Carrazeda de Ansiães (Regulation)
	• Article 74 4 - Any changes to the soil that increase the fuel load of an area, which could aggravate its classification as a high or very high fire risk class, must guarantee fuel management in a protective surrounding strip with a minimum width of 100 metres for urban land and rural settlements and 50 metres for pre-existing buildings on rural land.	• PDM Mafra (Regulation)
	• Article 8 b) New buildings in rural areas must safeguard a protection strip of no less than 50 metres, which, preferably and whenever possible, should be protected within the property's boundaries.	• PDM Santa Maria da Feira (Regulation)

2 Controlling and utilising forest biomass

Concept

The control and utilisation of forest biomass involves practices and strategies for the sustainable management of biomass resources from forests, including forest residues such as branches, leaves, wood chips and other forestry by-products for various purposes. This includes leftover elements from clearing and deforestation activities, including those associated with creating and maintaining fuel management strips. This presupposes the development of effective systems for managing forestry waste, minimising disordered accumulation, and promoting the rational use of these materials, including implementing forestry practices aimed at storing carbon and helping mitigate climate change's effects.

The control and utilisation of forest biomass, within a framework of ecological balance and the enhancement of this environment, presupposes sustainable harvesting practices aimed at the controlled extraction of forest biomass, guaranteeing the regeneration and preservation of ecosystems. Opportunities are also identified regarding enhancing soil and water quality through using plants to remove or neutralise pollutants, contributing to the recovery of degraded areas. There are also possibilities for energy production (such as biomass for direct burning, *pellet production* or biogas generation), fertiliser, and paper production.

The integrated approach of these practices contributes to the sustainable use of forest resources, promoting economic, social, and environmental benefits, allowing for integrated forest management, and considering the long-term impacts on ecosystems.

Methodology for mainstreaming adaptation into the PDM

Implementing the adaptation measure regarding the control and utilisation of forest biomass is particularly complex to implement within the scope of the PDM, as it corresponds to the development of economic activity for which there are no licensing or inspection mechanisms at the municipal level to ensure its implementation. Its integration must, therefore, be promoted within the strategic framework of the PDM and the framework of the territorial governance process.

The growing importance of creating and managing fuel strips tends to increase the availability and collection of forest biomass, which, together with agricultural and agroforestry waste, is a potential source of energy that can be valorised. On the other hand, developing biomass control mechanisms also contribute positively to increasing territorial resilience to rural fires.

In this way, priority should be given to sending leftovers from the creation and maintenance of fuel management strips, as well as other activities related to agriculture and forestry, to centres for the recovery of this material, and short supply circuits should be favoured, opting, where possible, for recovery centres closer to the collection areas.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
 Strategy	Plan strategy	• Identify, within the framework of the PDM strategy, the potential associated with the control and utilisation of forest biomass, especially considering its potential as an energy source and the existence or proximity of infrastructures dedicated to this purpose, seeking to close the cycle of the cleaning process sustainably.		●	
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to fire danger as a strategic issue of the Plan. • Identify resilience to fire danger as a Critical Decision Factor in the Scoping and Environmental reports.		●	
 Regulate	Regulations	• Define the provisions of the PDM regulations regarding the accumulation or deposition of waste and forest biomass on rural land. • Defining provisions in the PDM regulations favour making biomass and surplus materials available for recovery and sustainable use.		●	
 Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote the adoption of good practices that contribute to the correct control and utilisation of forest biomass with owners and	●	●	●

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		relevant agents in the agricultural and forestry sector.			

Reference Practices

Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans

Form of integration	Measures	Instruments (Examples)
 Strategy	• Promote the disposal of waste without burning.	• EMAAC Amarante • PLAAC Águeda
	• Promote the installation of residual forest biomass plants.	• PIAAC West
 Operational	• Incentives for ruminant livestock production are associated with the maintenance of fuel management networks.	• PMAAC Leiria • PIAAC Oeste • PMAAC AML
	• Encourage private individuals to manage the fuel load on forest land.	• PMAAC Vila Franca de Xira
	• Design and installation of an inter-municipal system for collecting and storing leftover biomass from agricultural and forestry activities.	• PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
 Strategy	• Biodiversity and forest management Biomass utilisation associated with forest risk control - implementation of a public or private project	• PDM Terras de Bouro (Implementation Programme)
 Regulate	• Article 11 3 - Outside the consolidated built-up areas, new buildings and extensions that entail an increase in the implantation area must safeguard, in their implantation on the ground, the legislation in force and the rules defined in the São João da Pesqueira PMDFCI: j) There must be no accumulation of combustible substances, such as firewood, wood forestry agricultural waste, or other highly flammable substances.	• PDM São João da Pesqueira (Regulation)
 Operational	• Operationalisation Plan - Promotion of Voluntary Fuel Management Actions	• PDM Batalha (Implementation Programme)

3 Promoting agroforestry activities

Concept

Agroforestry activity is of significant importance for sustainable agriculture and the environment, as it takes place in a context that is favourable to biodiversity through the integration of trees and various plant elements in its dynamics, enhancing the development of habitats for multiple species of birds, insects and mammals.

The combined approach, which integrates forestry and agriculture, contributes to the improvement and balance of soils, preventing erosion, increasing organic matter and improving nutrient cycling, which promotes higher levels of productivity, enabling income diversification while promoting the conservation of endogenous resources. Agroforestry also generates synergies with other relevant elements of climate dynamics, as it helps to mitigate climate change by sequestering carbon dioxide, offering climate resilience through diversified agricultural systems, and creating natural barriers to the spread of fire.

Lastly, agroforestry is intricately linked to community livelihoods, establishing an economic relationship potentially supported by shorter supply cycles. It is also associated with sustainable agricultural practices that positively influence the resilience of ecosystems, mitigating the impact of agriculture on the environment.

In this context, it is essential that the PDM safeguards areas with agroforestry potential, especially in the rural-urban interface, generating gains that go beyond the dimension of preventing rural fires and that reach the social and economic dimension in a context of more excellent environmental balance.

Methodology for mainstreaming adaptation into the PDM

The measure to promote agroforestry activity is limited in scope under the PDM, as this is an economic activity that depends on private initiative. Nevertheless, potential contributions are identified in safeguarding land use with good agricultural and forestry potential, which can be used for this purpose. In any case, this option should also be considered strategically, based on the principles and within the framework of the territorial governance process.

Agroforestry is traditionally associated with non-intensive uses that combine endogenous agricultural and forestry resources in an integrated way. It, therefore, has a solid local, territorial component, resulting in potential positive impacts for the territory, making it more adapted to climate change. An example is the use of traditional plant and animal species, which have higher adaptation rates to the current and future local climate. Mobilising forest land for this activity also reduces the potential for fires.

It should be noted that restrictions and bans on activities on rural land, mainly agricultural and forestry activities, can only be implemented through coordination between the local authority and the CCDR, given that the former does not have powers in this area. Therefore, a set of indirect incentives must be developed to safeguard the sustainability of this activity.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• Agroforestry activity presupposes the availability of areas large enough and suitable for development. Therefore, the strategic approach of the PDM must safeguard urbanisation processes and rural land, especially that with a vocation for developing this activity.	●	●	●
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to fire danger as a strategic issue of the Plan. • Identify resilience to fire danger as a Critical Decision Factor in the Scoping and Environmental reports.		●	●
Regulate	Regulations	• Define in the PDM regulations the preferential development of agroforestry activities in areas with favourable conditions for their implementation. • Define the provisions of the PDM regulations to safeguard land use that allows the development of agroforestry activities, especially in areas at the interface between rural land and urbanised regions.		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		• Define in the PDM regulations the impossibility of using land with agricultural or forestry potential for other purposes.			
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives designed to encourage agroforestry activity (for example, financial support for exemplary adaptation practices; support for research and the dissemination of good practices and adapted plant and animal species; the creation of collective spaces for local production; support for the creation of small units for the concentration, processing and/or marketing of local agri-food products obtained in sustainable farming systems; the creation and promotion of structures and initiatives for the disposal and enhancement of local agri-food production), as well as their schedule, the associated investment amounts and the entities to be involved.		●	
Territorial governance		• Holding thematic sessions aimed at encouraging local *stakeholders to* take advantage of or create favourable conditions for agroforestry, contributing to this activity's predictability and economic and social sustainability.	●		●

Reference Practices

Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans

Form of integration	Measures	Instruments (Examples)
Strategy	• To provide technical and financial support to small forest owners to update the forest register and conduct forest clearance and maintenance operations.	• PIAACs Dão Lafões, Oeste, • PMAAC AML
Operational	• Creation of incentives for more sustainable forest management (at the level of small producers).	• PLAACs Águeda, Sesimbra, Setúbal • EMAAC Coruche
	• Enhancing biodiversity-supporting habitats and agro-sylvo-pastoral spaces by increasing the soil's water retention capacity and reducing the risk of desertification.	• EMAAC Odemira
	• Drawing up/updating forestry registers, promoting forestry associations and valorising forestry products, and setting up companies geared towards intensively exploiting forestry resources.	• PIAAC Cávado

Examples of integrated adaptation measures Municipal Master Plans

Strategy	• Programme for the maintenance, development and agricultural and forestry use of municipal land.	• PDM Sintra (Implementation Programme)
	• Agroforestry investment projects under Community Programmes (PRODER and others).	• PDM Paredes de Coura (Implementation Programme)
Regulate	• Article 16 4 - To maintain and/or promote the favourable conservation status of natural values of community interest, the following actions, activities and land uses should be favoured in the areas included in the Natura 2000 Network: d) The maintenance of dead trees, old trees and decaying wood to ensure the existence of habitats for various species, without prejudice to phytosanitary conditions and forest fire prevention measures;	• PDM Castanheira de Pêra (Regulation)

Reference Practices		
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
	• Article 40 2 - Intervention in Conservation Forest Areas must take the following objectives into account: c) The installation of extensive agroforestry activities with an appropriate level of stocking for the physical environment without jeopardising the protection of water lines and the regeneration of queries;	• Castelo de Vide PDM (Regulation)

4 Promoting agroforestry mosaics

Concept

Promoting the agroforestry mosaic consists of articulated practices aimed at creating diverse landscapes that integrate various types of vegetation and ecosystems, thus contributing to the resilience and biodiversity of forests. This approach allows for more significant environmental and landscape enhancement, and the diversification of species in forest and rural areas, in an orderly context, constitutes a natural barrier to the spread of fire, reducing its impacts. In this context, native species that are suitably adapted to the local climate and tend to have lower water requirements should be favoured.

The planting and natural regeneration of various plant species, generating a mosaic of diverse forest occupations marked by trees, shrubs and plants of different ages and characteristics, as well as greater natural dynamism in ecosystems, can be achieved through selective thinning and natural regeneration processes, which should take into account the ecological corridors established and connect different forest areas, facilitating the flow of organisms and promoting genetic exchange between plant and animal populations.

The cohesive agroforestry mosaic makes it possible to create buffer zones around protected or potentially sensitive areas, reducing human activities' adverse effects on ecological restoration and the maintenance or reintroduction of biodiversity. In this context, classifying and respecting soil suitability is fundamental.

Promoting the agroforestry mosaic aims to create more resilient landscapes capable of facing environmental challenges such as climate change, pests and rural fires. This approach contributes to preserving biodiversity, protecting water resources and promoting ecosystem balance.

Methodology for mainstreaming adaptation into the PDM

Promoting the measure related to the agroforestry mosaic is challenging to implement within the scope of the PDM, given its low effectiveness and the lack of licensing or inspection mechanisms at the municipal level to ensure its implementation. In this context, its integration is pursued at the strategic level, in terms of principles and within the framework of the territorial governance process. It should also be noted that the PROFs play an essential role in this matter, and it is up to the PDM to consider the strategic consideration of areas subject to forestry or ecological value in the municipal green infrastructure.

Land use using a balanced agroforestry mosaic made up of native species or species better adapted to climate trends contributes to territorial resilience to rural fires since these species have characteristics that tend to make them more resistant to fire, which is an obstacle to its progression.

In this context, it is up to the PDM to adopt the necessary provisions to promote the use of plant species that are suited to current and future climatic patterns and that contribute to mitigating the effects of rural fires, thus constituting a diverse and balanced agroforestry mosaic, in line with the availability and characteristics of the soil available to the municipality.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• To approach the promotion of the agroforestry mosaic in a considered way and a context of competition and harmonisation between practices and land uses, making this a strategic goal of the PDM. In this context, ways of managing and safeguarding the forest and contiguous spaces should be identified, in conjunction with the relevant ecosystems, in an integrated approach that both qualifies the territory and can promote its resilience to rural fires.	●	●	
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to fire danger as a strategic issue of the Plan. • Identify resilience to fire danger as a Critical Decision Factor in the Scoping and Environmental reports.	●	●	
	Regulations	• Defining provisions to safeguard forest areas of strategic importance, both as mitigating elements			

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Regulate		against the occurrence and impact of rural fires and as promoters of biodiversity and ecosystem services. • Define provisions that prevent the reduction of forest diversity or promote the dominant presence of species that consume more water or have less potential for diversifying and qualifying ecosystems. • Define provisions limiting afforestation or reforestation with fast-growing species.			
Territorial governance		• Hold sessions to highlight the agroforestry mosaic and its potential and opportunities through an integrated approach that mobilises the players involved in the forestry sector and industry.	●		●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Promoting the reorganisation of the spatial pattern of forest species.	• EMAACs Seia, Viseu • PMAAC Lagos • PIAAC Algarve
	• Promotion of Forest Intervention Zones (ZIF), forest mosaics, preventive forestry and other measures to support forestry production.	• EMAACs Almeirim, Benavente, Cartaxo, Chamusca, Rio Maior, Santarém
Operational	• Implementation of fuel management mosaics and Multiple Use Forests.	• EMAAC Santa Maria da Feira • PLAAC Águeda • PMAACs Leiria, Vila Franca de Xira
	• Reinforcing the importance of the forest mosaic within the framework of territorial management instruments.	• PMAAC Lagos • PIAACs Alentejo Central, Dão Lafões • PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
Regulate	• II - Forest defence measures - Forestry, 1 - Forestry within the scope of forest fire defence encompasses the set of measures applied to forest stands, scrub and other spontaneous formations in terms of their specific composition and structural arrangement, with the aims of reducing the danger of fire and ensuring maximum resistance of the vegetation to the passage of fire. 2 - Forest management instruments must specify forestry and infrastructure measures for rural areas that guarantee the horizontal and vertical discontinuity of forest fuels and alternating plots with different flammability and combustibility within the regional planning guidelines for forest fire defence.	• PDM Esposende (Regulation)
	• Article 70 4. In the category of agricultural spaces, no uses or activities are permitted that jeopardise the use of the rustic soil and the	• PDM Sintra (Regulation)

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
	development of farming, livestock, forestry or silvopastoral activities (...) The following actions and uses are permitted (...): d) Protection of existing natural vegetation clusters made up of native hardwood forest species adapted to soil and climate conditions;	
	• Article 9 4 - The management guidelines for this Natura 2000 site are primarily aimed at maintaining its high diversity and the natural characteristics that make it unique and that allow it to harbour the natural values that exist within it: a) Promotion and monitoring of a multiple-use management model to promote extensive agriculture and pastoralism in mosaics with native forest patches;	• PDM Baião (Regulation)

5 Reforest and use native or adapted forest species

Concept

The changes in climatic variables caused by climate change put significant pressure on forests. Whether through reduced rainfall, consequent water availability, or an increase in average temperatures, the reference conditions for the profitability and productivity of forest-related activities and sectors are affected. There is also a worsening of conditions related to rural fires, reinforcing the already high disruptive potential of these events in various areas of the country.

Promoting forest protection and the reforestation process is an opportunity to increase the resilience levels of this element. In this sense, reforestation plays a significant role in climate adaptation, as it involves re-occupying deforested, degraded or burnt areas, which must be done using species better adapted to future reference conditions. The integrated approach to this process also makes it possible to create forest mosaics that are more resistant to fire, strengthening the capacity of ecosystems to support them, mitigating the impacts of climate change and promoting environmental sustainability.

Methodology for mainstreaming adaptation into the PDM

The reforestation process is an opportunity to correct problems related to forest organisation and management. Native species should be favoured, which, on the one hand, contributes to territorial resilience and reducing the effects of rural fires, and on the other, contributes to diversifying the forest mosaic, pursuing the remit of an adaptive strategy integrated with different areas, namely drought and water scarcity or desertification and soil erosion.

Some opportunities for intervention have been identified in terms of land use planning and the PDM, including the strategic component, in which the issue of reforestation should be seen as an opportunity to recover territorial quality, as well as in terms of territorial governance, sensitising the relevant thematic players to the relevance of using forest species that are capable of coping with the effects of climate change.

This situation may be particularly relevant in strategic areas from the point of view of environmental and landscape quality or in those whose forms of occupation pose an increased risk to people and property in the event of a forest fire. In this context, the PDM regulations should also include provisions on the species favoured in reforestation processes, limiting the use of fast-growing species that are more demanding of water or less fire-resistant.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• Indicate, in the PDM strategy, the direction to be pursued in terms of reforestation, indicating the opportunities to be capitalised on, namely the plant species to be favoured in the processes of qualifying forest areas and the reforestation of burnt areas, which must be aligned with the provisions of the PROF.	●	●	
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to fire danger as a strategic issue of the Plan. • Identify resilience to fire danger as a Critical Decision Factor in the Scoping and Environmental reports.		●	
Regulate	Regulations	• Define in the PDM regulations the provisions relating to suitable species for reforestation processes, considering the reasons for the need to recover or requalify the forest area to be intervened. Conversely, the species or characteristics to be avoided in reforestation processes should also be identified. • Define the provisions relating to the prevalence of native forest species that are less vulnerable to fire in the composition of the local forest mosaic in the PDM regulations.		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
 Territorial governance		• To organise awareness-raising sessions and involve local, municipal and regional players to share efforts to rehabilitate and enhance the forest, especially after the occurrence of rural fires or other destructive events for the forest.	●	●	●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
 Strategy	• Promote planting with native species that are better adapted and less explosive, creating species diversity.	• EMAACs Alfândega da Fé, Aveiro, Bragança, Castelo de Vide • PLAAC Águeda • PIAAC Cávado
	• Preserving biodiversity as a way of improving prevention against extreme events (storms or forest fires), pests and invasive species	• EMAAC Arouca
	• Drawing up integrated recovery strategies for burnt areas	• PMAAC Lagos, Leiria • PIAAC Dão Lafões
 Operational	• Monitoring areas of great ecological value and areas affected by fires for invasion by exotic species	• EMAAC Montalegre
	• Increasing stands of hardwood species	• PLAAC Águeda, Cascais
	• Planting more fire-resistant trees and shrubs (with lower thermal conductivity) along transport and communications infrastructure channels	• PMAAC Leiria
	• Surround all olive groves and stone pine forests with firefighting equipment.	• PLAAC Sesimbra
	• Rehabilitating and restoring post-fire ecosystems	• EMAAC Maia, São João da Pesqueira • PIAAC Dão Lafões, Central Alentejo
	• Rehabilitation of abandoned forest areas	• EMAAC Paredes • PMAAC Cascais
 Regulate	• Create municipal regulations with tax incentives to encourage private individuals to use species resistant to drought and fire.	• PLAAC Palmela, Sesimbra, Setúbal • PIAAC Alentejo Central
Examples of integrated adaptation measures Municipal Master Plans		
 Strategy	• Encouraging forest management by promoting the felling of weeds and replacing them with native species	• PDM Terras de Bouro (Implementation Programme)
 Operational	• Define a programmed afforestation policy, restoring the incentive to plant noble trees.	• PDM Santa Maria da Feira (Implementation Programme)
	• Afforestation campaigns with native species and the elimination of invasive species to promote biodiversity while at the same time covering the forest with more fire-resistant species.	• PDM Braga (Implementation Programme)
	• Article 21 4 - The burnt areas must be reforested, giving preference to the native species indicated for the homogeneous sub-regions of the PROF Nordeste Transmontano.	• Mirandela PDM (Regulation)

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Regulate	• Article 24 5 - Without prejudice to what is stated in the previous paragraph, the following conditions must be observed in these spaces: a) Only plantations with native species or species adapted to local ecological conditions and traditionally used are permitted;	• PDM Monforte (Regulation)
	• Article 36 3 - The following uses or actions of public or private initiative are prohibited in the Natural Area: g) The introduction of non-indigenous species, with the exceptions provided for in specific legislation, or repopulation with invasive and/or fast-growing species;	• PDM Ansião (Regulation)

6 Adapting and protecting infrastructure

Concept

Adapting or protecting infrastructures to rural fires aims to reduce the risk of damage caused by fires in rural areas and protect critical facilities and infrastructures in the event of their occurrence. Given that rural fires can traditionally represent a significant threat to properties, communities and infrastructure and that the conditions associated with their occurrence are expected to worsen, contributing to an increase in their destructive potential, it is crucial to implement practices that improve resilience against such events.

In this context, the approaches contributing to this end are diverse. In the case of this measure, they focus on the protection of communication and building infrastructures and benefit from an integrated approach with other measures, such as those related to the diversification of the forest mosaic based on plant species that are more resilient to fire, or the creation and maintenance of fuel management strips. In this case, we highlight possibilities such as the installation of physical barriers, such as firewalls, which can help slow down or prevent the spread of fire towards infrastructure, the implementation of irrigation systems and the strategic use of water to create wetlands around infrastructure, reducing the flammability of the surrounding area, and the use of fire-resistant building materials in the construction or renovation of structures to minimise the vulnerability of buildings.

These measures aim to strengthen the capacity of infrastructures and communities to resist rural fires, reducing the likelihood of losses and increasing the overall safety of people and property. A practical approach in this area requires a combination of risk mitigation practices, emergency planning and cooperation between local authorities, communities and other *stakeholders*.

Methodology for mainstreaming adaptation into the PDM

The need to adapt and protect infrastructure is particularly relevant in the context of worsening conditions associated with rural fires, which tend to increase their destructive potential and impact on people and property. To cope with this deterioration, exposed structures must be equipped with the conditions to withstand this event.

In addition to active means of protection to prevent fire development, such as fuel management strips, infrastructures can also be equipped with passive protection mechanisms to increase their infrastructural resistance in the event of a fire. An example of this is using non-combustible or fire-retardant materials in new constructions or rehabilitation in areas with higher levels of exposure while restricting construction in areas of high danger is also permissible.

The definition of these regulations must be developed in parallel with a strategic reference that promotes the precautionary principle and the prevention of rural fires, as well as a governance policy that promotes awareness and understanding of the adoption of habits and techniques to strengthen the capacity to deal with fires.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• Emphasise the need to adapt and protect infrastructures strategically, clarifying the PDM's design. Even though the principle of security is a fundamental value in the development of the PDM,		●	
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to fire danger as a strategic issue of the Plan. • Identify resilience to fire danger as a Critical Decision Factor in the Scoping and Environmental reports.		●	
Regulate	Regulations	• Define in the PDM regulations the provisions relating to construction and refurbishment standards to increase the resistance of buildings and infrastructures (communication, supply and sanitation networks) in areas particularly exposed to fire. The type of materials to be used, as well as any construction techniques for means of protection, should be developed in line with the Municipal Regulations for Urbanisation and Building while also following the relevant provisions of the PMEPC and the PMDFCI. • For situations of particular risk and essential strategic infrastructures located in exposed areas,		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		determine in the PDM regulations the implementation of protection mechanisms (green or grey infrastructure) that mitigate their impacts.			
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives to adapt and protect infrastructures in the face of fire danger, their schedule, the associated investment amounts, and the entities involved. • Identify in the Implementation Programme the strategic infrastructures for economic and social activity in a situation of exposure, determining the development of concrete and appropriate actions to reduce the level of susceptibility to the occurrence of rural fires.		●	
Territorial governance		• Holding sessions to promote the safety of people and goods and awareness-raising or training sessions to increase local communities' adaptive capacity levels.			●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Operational	• Creation of buffer zones to protect settlements, isolated buildings, infrastructures or economic spaces.	• PMAAC Leiria, Loures • PLAAC Palmela • PMAAC AML
	• Deforestation operations in areas adjacent to road and railway structures.	• PLAACs Palmela, Sesimbra, Setúbal
	• Reconversion and reconfiguration of linear transport structures that cross forest areas.	• PLAACs Palmela, Sesimbra, Setúbal
	• Assess the possibility of burying electricity and gas transmission infrastructure in fire-risk zones.	• PLAAC Sesimbra
	• Establishing fire protection and safety mechanisms for buildings and equipment.	• PIAACs Alentejo Central, Oeste
	• Enforcement of deforestation and land clearing near housing estates and infrastructure channel spaces (road and railway).	• PIAAC Oeste
	• Provision of fire protection and safety mechanisms in buildings and equipment used for economic activities in fire-risk zones.	• PMAAC AML
Regulate	• Promote the use of fire-resistant construction materials and techniques. Create municipal regulations with tax incentives to encourage private individuals to use these measures.	• PLAACs Palmela, Sesimbra, Setúbal
	• Condition the installation of infrastructures in places with a fire hazard level equal to or greater than that indicated in the legislation in force.	• EMAACs Arruda dos Vinhos, Castelo de Vide • PIAACs Alentejo Central, Dão Lafões, Oeste
	• Establishment in the Municipal Urbanisation and Building Regulations that buildings in rural-urban interface zones be built using fire-resistant materials.	• PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
	• Article 20 All road and energy transport infrastructures adjoining or inserted in forest areas must ensure and maintain, at the	• PDM Carrazeda de Ansiães (Regulation)

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Regulate	expense of the managing body, a fire protection strip no less than 10 metres wide;	
 **Regulate**	• Article 12 All buildings, infrastructures, equipment and support structures that fall under the construction regime laid down for the categories of spaces in Rural Soil must comply with the Forest Fire Defence Measures defined in the legal framework in force, as well as those described in these Regulations, namely: c) Construction works on rural land outside consolidated built-up areas must safeguard the rules set out in the respective Municipal Forest Fire Protection Plan when they are implemented on the ground, in particular, ensuring that a protective strip is never less than 50 metres away from the edge of the property and that special measures are taken to make the building resistant to the passage of fire and to contain possible sources of fire ignition in the building and its accesses;	• PDM Lamego (Regulation)
 **Regulate**	• Article 34 1. Building in the forest and agricultural space categories may only be authorised if: i. Complying with the legal constraints on fire risk protection, namely restricting themselves to buildings where construction is not prohibited; ii. Comply with the provisions of the PMDFCI;	• PDM of Penacova (Regulation)

7 Install surveillance resources and reinforce fire-fighting resources

Concept

Given the expected climate dynamics, rural fires may occur with greater intensity and frequency. In this context, in addition to defining preventive mechanisms, it is also necessary to strengthen the response dedicated to fighting fires. This measure is, therefore, related to the availability and effectiveness of resources (equipment and strategies) for preventing, controlling, monitoring and fighting fires. These resources are essential for safeguarding people and property and also play an important role in terms of environmental conservation in the event of rural fires.

Prevention resources need to be strengthened, namely identifying and safeguarding strategic areas for pre-positioning resources, as well as *scooping* areas, installing remote monitoring and sensing networks for essential elements such as wind speed, air temperature or humidity, providing relevant information for surveillance and firefighting, maintaining and safeguarding adequate access for emergency vehicles, ensuring the rapid mobilisation of resources. With a greater focus on firefighting activities, the availability of material and human resources for firefighting and the provision of appropriate resources and equipment, including personal protective equipment (PPE), should be emphasised.

The right combination of these action areas is fundamental to ensuring an adequate response, helping to mitigate damage, guaranteeing the safety of communities, and minimising the impact of fires on the environment. On the other hand, prevention and preparedness are critical aspects of integrated fire risk management. In this context, the PDM plays a more relevant role, especially when considering its synergistic role with other appropriate plans and instruments, namely the PMEPC and the PMDFCI.

Methodology for mainstreaming adaptation into the PDM

Promoting the installation of surveillance resources and reinforcing fire-fighting resources are wide-ranging adaptive measures, including issues such as infrastructure for preventing and fighting fires. Although the role of spatial planning and, consequently, the PDM is limited, this issue can be approached strategically to reduce the effects of fires, which includes strengthening prevention and firefighting.

On the other hand, some opportunities have been identified regarding active prevention, namely by identifying relevant areas for pre-positioning combat or monitoring resources and surveying essential elements such as water points or reservoirs and the network of rural roads.

Also, within territorial governance, fire prevention and firefighting should be the subject of awareness-raising and consultation sessions to spread the word about this need and gather potential contributions that can be mobilised within the PMOT.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• Establish strategic links with other reference documents in terms of fighting rural fires within the scope of the PDM, namely the PMDFCI, the PMEPC and the PROFs. The development of specific measures to contain the effects of rural fires must be observed strategically and transversally throughout the development of the PDM.		●	
	Environmental Report (SEA)	• Evaluate, within the scope of the SEA, the contribution of the PDM to adaptive capacity in terms of fires, namely through an integrated analysis of the forms of land use and occupation (mosaic and plant species and economic utilisation) and the preventive and mitigating measures of their effects (fuel management strips).		●	
	Zoning plan	• Identify the network of rural roads on the Planning Map, which is an essential element for fire prevention and firefighting operations.		●	
Operational	Implementation programme and financing plan	• Identify in the Implementation Programme the projects and initiatives to install remote monitoring and detection systems, their schedule, the associated investment amounts and the entities to be involved.		●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		• Identify in the Implementation Programme the projects and initiatives to open up and maintain rural areas and paths for pre-positioning and developing the fire-fighting response, their time schedule, the associated investment amounts and the entities to be involved.			
 Territorial governance		• Crossing competencies with organisations in the Civil Protection system is fundamental to territorial governance. In this context, liaison sessions should be developed between municipal and regional bodies with competencies in this area, helping to strengthen the synergies that the PDM can establish with other instruments and mechanisms such as the PMDFCI, the PMEPC or the PROF.	•		

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
 Operational	• Construction of support infrastructures/purchase of firefighting/prevention and forest defence equipment.	• EMAACs Rio Maior, Almeirim, Alpiarça, Azambuja, Benavente, Cartaxo, Chamusca, Golegã, Salvaterra de Magos, Santarém
	• Ensuring the appropriate sizing and management of the water storage points/systems network for fighting forest fires.	• EMAACs Arruda dos Vinhos, Viseu • PMAAC Loures • PLAACs Palmela, Sesimbra, Setúbal
	• Ensure that the forest road network is adequately dimensioned and managed.	• EMAACs Seia, Viseu • PMAAC Leiria
	• Forest surveillance actions and means.	• EMAACs Arruda dos Vinhos, Seia, Viseu • PLAACs Águeda, Cascais • PMAAC Vila Franca de Xira • PIAAC Oeste
	• Reinforcement of the means and systems for preventing or fighting forest fires.	• EMAACs Arruda dos Vinhos, Évora, Seia • PMAACs Lagos, Leiria • PIAACs Alentejo Central, Lezíria do Tejo, Oeste • PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
 Strategy	• Focusing on rigorous monitoring of forest areas.	• PDM of Santa Maria da Feira (Implementation programme)

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
 **Operational**	• Construction of firebreaks, water points, access roads and lookout posts.	
 **Regulate**	• Article 115 Protection of the Forest Fire Defence Network: 2 - An area free of trees must be kept around the lookout posts to safeguard visibility. Installing any equipment that could interfere with visibility and radio communication quality at the lookout posts or within 30 metres of them requires the prior opinion of the National Republican Guard.	• PDM of Ourém (Regulation)
	• Article 8 e) In the cases referred to in the previous paragraphs, additional measures must also be adopted concerning the availability of complementary fire-fighting means, as well as fuel management in the respective buffer strip and accesses, namely: i - Availability of water to supply rescue vehicles during the critical fire period; ii - The water point must have a minimum capacity of 10 m³ of usable water, a discharge mouth and allow the entry of pumping instruments; vii - No accumulations of combustible substances, such as firewood, wood or forestry or agricultural waste, or other highly flammable substances, may occur in the buffer strip; ix - Buildings and premises must be served by access routes suitable for rescue vehicles in the event of a fire, which, even if they are in the private domain, must have a permanent connection to the public road network and allow for a reversing zone around the building; x - The building above rules and constraints do not exempt compliance with the provisions of Decree-Law no. 220/2008 of 12 November and other applicable legislation.	• PDM of Santa Maria da Feira (Regulation)

D. Which adaptation measures are most appropriate according to the classification of the soil?

#	Adaptation measure	Soil classification											
		Urban						Rustic					
		A - Centres	B - Housing	C - Economic	D - Green	E - Low Density	F - Special Use	A - Agricultural	B - Forestry	C - Energisers	D - industrial	E - Natural	F - Other
1	Fuel management strips							●	●	●	●	●	●
2	Controlling and utilising forest biomass							●	●				
3	Promoting agroforestry activities							●	●				
4	Promoting forest mosaics				●	●		●	●			●	
5	Reforest and use native or adapted forest species				●				●			●	
6	Adapting or protecting infrastructure					●	●	●	●	●	●	●	●
7	Install surveillance resources or reinforce fire-fighting resources					●	●		●				

Caption:
Urban land: a) Central Spaces, corresponding to mixed-use urban areas that integrate residential functions and a diversified concentration of tertiary activities, performing, due to their characteristics, centrality functions; b) Residential Spaces, corresponding to areas that are preferably intended for residential use, but may accommodate other uses compatible with residential use; c) Economic Activity Spaces, corresponding to areas that are preferably intended to accommodate economic activities with special needs for the allocation and organisation of urban space, namely industrial activities, storage and logistics, commerce and services; d) Green Spaces, corresponding to areas with environmental balance, landscape enhancement and outdoor recreational, leisure, sports and cultural activities, coinciding in whole or in part with the municipal ecological structure; e) Low Density Urban Spaces, corresponding to peri-urban areas, partially urbanised and built up, showing fragmentation and hybrid characteristics of an urban-rural occupation, with the permanence of agricultural uses intertwined with urban uses and the existence of equipment and infrastructures, to which the territorial plan assigns prevailing urban functions and which are subject to a land use regime that guarantees their urban planning from a perspective of sustainability and flexibility of use, as well as their infrastructure using appropriate solutions. f) Special Use Spaces, corresponding to areas destined for equipment spaces, structuring infrastructure spaces or tourist spaces).
Rustic soil: a) Agricultural areas; b) Forest areas; c) Areas for the exploitation of energy and geological resources; d) Areas for industrial activities directly linked to the uses referred to in the previous paragraphs; e) Natural and landscape areas; f) Other categories of rustic soil, corresponding to cultural areas, areas for tourist occupation, areas for equipment, infrastructures and other structures or occupations, rural settlements and areas of dispersed building.

E. What are the main constraints on the adoption of Adaptation Measures?

#	Adaptation measure	Type of Constraints					
		High financial cost	Reduced legal effectiveness	Dependence on technology and innovation	Political and governance challenges	Indirect environmental impacts	Cultural change
1	Fuel management strips	●	●	●	●	●	●
2	Controlling and utilising forest biomass	●	●	●	●	●	●
3	Promoting agroforestry activities	●	●	●	●	●	●
4	Promoting forest mosaics	●	●	●	●	●	●
5	Reforest and use native or adapted forest species	●	●	●	●	●	●
6	Adapting or protecting infrastructure	●	●	●	●	●	●
7	Install surveillance resources or reinforce fire-fighting resources	●	●	●	●	●	●

The extent of embarrassment:					
High	●	Medium	●	Bass	●

F. What other benefits can be gained from integrating adaptation to rural fires into the PDM?

#	Adaptation measure	Synergies				Contribution to the SDGs																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Fuel management strips	●	●	●	●	o	o	o	o	o	o	o	o	+	o	+	o	+	o	+	o	o
2	Controlling and utilising forest biomass	●	●	●	●	+	o	o	o	o	o	+	+	o	o	+	o	+	o	+	o	o
3	Promoting agroforestry activity	●	●	●	●	+	+	o	o	o	+	o	+	o	o	+	+	+	o	+	o	o
4	Promoting forest mosaics	●	●	●	●	+	o	o	o	o	+	o	+	o	o	+	+	+	o	+	o	o
5	Reforest and use native or adapted forest species	●	●	●	●	o	o	o	o	o	+	o	o	o	o	+	o	+	o	+	o	o
6	Adapting or protecting infrastructure	●	●	●	●	o	o	o	o	o	o	o	o	+	o	+	o	+	o	+	o	o
7	Install surveillance resources or reinforce fire-fighting resources	●	●	●	●	o	o	o	o	o	o	o	o	+	o	+	o	+	o	+	o	o

Caption

Relationship with the Sustainable Development Goals

1	Eradicating poverty
2	Eradicating hunger
3	Access to quality healthcare and promoting well-being
4	Access to inclusive, quality and equitable education
5	Gender equality
6	Availability and sustainable management of drinking water and sanitation
7	Reliable, sustainable and clean energy for all
8	Inclusive and sustainable economic growth
9	Resilient infrastructures, inclusive and sustainable industrialisation and innovation
10	Reducing inequalities
11	Inclusive, safe, resilient and sustainable cities
12	Sustainable consumption and production
13	Climate action
14	Conserving the oceans
15	Protecting terrestrial ecosystems
16	Effective, accountable and inclusive institutions
17	Partnerships for sustainable development

Relationship with Sectors and Risk Groups

	Combating poverty and exclusion
	Circularity
	Renaturalisation
	Mitigation

Types of relationships

+	With benefits
-	With losses
o	No evidence / Mixed

Degree of synergy

●	High
●	Medium
●	Bass

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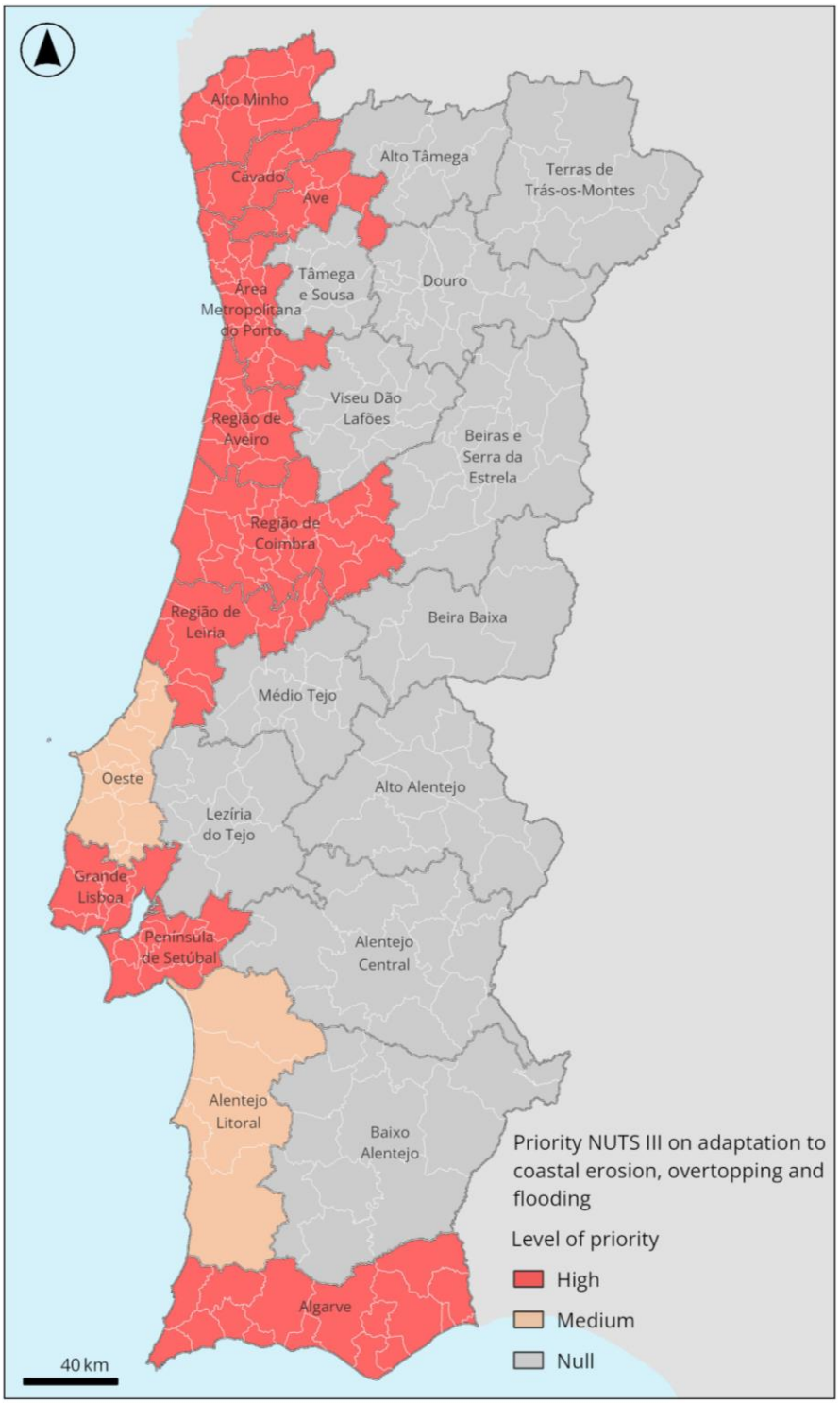
4. Integrate adaptation to coastal erosion, overtopping and flooding in the PDM

A. Which NUTS III are prioritised for adaptation to coastal erosion, overtopping, and flooding?



Source: CEDRU, based on interpreting data relating to the Coastal Vulnerability Index in the RCP4.5 scenario for the 2071-2100 time horizon.

B. How can municipalities adapt to coastal erosion, overtopping and flooding?

#	Adaptation measure	Type of response					Type of measure				
		Prevention	Accommodate	Protect	Relocate	Rescue and recovery	A. Governance and Institutions	B. Economics and Finance	C. Physics and Technology	D. Nature-based solutions	E. Knowledge and behaviour change
1	Prohibit and condition the use and occupation of land in areas exposed to danger	●	●			●	●				●
2	Accommodate infrastructure and buildings		●				●		●		●
3	Nourishing beaches and rehabilitating and conserving dune systems			●						●	●
4	Stabilising cliffs			●						●	
5	Renaturalising coastal areas			●						●	
6	Building and accommodating coastal protection works		●	●					●		●
7	Backing off in a planned way					●	●	●	●	●	●

C. How can adaptation to coastal erosion, overtopping and flooding be integrated into a PDM?

1 Ban and condition the land use in areas exposed to danger

Concept

Prohibiting and regulating the use and occupation of land in areas exposed to coastal hazards consists of implementing regulations and administrative actions aimed at people's safety and property protection, minimising or preventing an increase in climate vulnerability. These measures are applied in places prone to the retreat of the coastline, as well as to episodes of flooding and coastal overtopping.

Land use and occupation bans mean construction or urbanisation is prohibited in high-risk areas. This prohibition is a drastic measure, usually adopted when the danger is based on coastal dynamics or the area's fragility is so high that any occupation is unwise. On the other hand, conditioning establishes limitations on the development and use of these vulnerable areas, requiring, for example, the use of adapted construction methods, the definition of limits for population density, restrictions on specific uses or activities, as well as the implementation of adaptation strategies to reduce the associated risks.

These guidelines are established after detailed zoning of the areas affected by coastal hazards through the identification of hazard bands, which are classified according to the temporal projection of phenomena and the increasing probability of occurrence of events capable of negatively impacting use and activities in the area.

Methodology for mainstreaming adaptation into the PDM

The country's coastline is covered by Coastal Zone Programmes that already determine Low and Sandy Coastal Safeguard Bands, which are designed to safeguard and mitigate the impacts resulting from the mobility and dynamics of the coastline (erosion, shoreline retreat, overtopping and coastal flooding) for a time horizon of 50 (Level I) and 100 years (Level II), including the impacts resulting from climate change. Furthermore, under the terms of the RJIGT, these strips and the associated specific rules must be integrated into the Municipal Master Plans.

Implementing this adaptation measure in this context involves ensuring swift and effective coordination between the Special Programmes and the Municipal Master Plans.

However, because of the projected worsening of the erosion phenomenon and its non-linear evolution, the PDMs of coastal municipalities may establish more restrictive bands and rules than those provided for in the POC regarding land use and occupation in areas exposed to the dangers of erosion and coastal overtopping and flooding, as a result of the conclusions drawn by the characterisation studies. On the other hand, considering the importance of coastal adaptation in these municipalities, this imperative must also be considered strategically.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The precautionary principle of coastal hazards should be emphasised in the plan's strategic model's basic principles. • The PDM's strategic objectives emphasise reducing exposure to climate hazards and increasing coastal resilience. • The characterisation studies analyse coastal dynamics, the impacts recorded in recent years due to overtopping and flooding events and future vulnerability scenarios considering the projected rise in mean sea level.	●	●	
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to coastal hazards as a strategic issue of the Plan. • Identify Resilience to Coastal Hazards as a Critical Decision Factor in the Scoping and Environmental reports.	●	●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		• Consider projections of the evolution of coastal retreat and flood overtopping over 50 and 100 years in the scenarios.			
Regulate	Regulations	• Integrate the restrictions and constraints defined in the POC for the determined Low and Sandy Coastline Safeguard Bands into the regulation. • Adopt new restrictions and constraints when those of the POC prove insufficient.		●	
	Zoning plan	• Have an up-to-date map of the Low and Sandy Coastal Safeguard Bands on the land-use plan.	●	●	

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Regulate	• Conditioning the use and occupation of the coastline.	• PMAAC Leiria • EMAACs Matosinhos, Póvoa de Varzim, Porto
	• Definition of a legal and economic model for possible seafront relocation measures.	• PMAAC Leiria
	• Delimit risk zones.	• EMAAC Aveiro • PIAAC Algarve
Operational	• Making the use and occupation of areas exposed to risk compatible.	• PMAAC Vila Franca de Xira PIAAC Oeste
	• Implementation and monitoring of measures to safeguard coastal zones.	• EMAAC Loulé
	• Identify structures located in risk areas and relocate them.	• EMAAC Torres Vedras • PIAAC Oeste
	• Removal of Seveso industries exposed to coastal risks.	• PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
Regulate	• Article 80 3 - The delimitation of a risk zone as an area threatened by the sea shall be accompanied by measures aimed at considering, where appropriate, the gradual removal of existing buildings in that area.	• PDM Espinho (Regulation)
	• Article 6g (new) Protection and safeguard regime 2 - New buildings, extensions and infrastructure are prohibited in the Complementary Protection Strip, except for the following situations: g) Relocation of equipment, infrastructures and constructions determined by the need for demolition for safety reasons related to coastal dynamics, as long as it can be shown that there are no alternatives to locating them within the urban perimeter and they are located in areas contiguous to it and outside the Safeguard Bands;	• PDM Mira (Regulation)

2 Accommodate infrastructure and buildings

Concept

Adapting infrastructure and buildings to the dangers of coastal erosion and flooding is a series of measures and interventions designed to minimise the damage caused by extreme events such as storms and rising sea levels, which can result in flooding and coastal erosion.

These adaptations can include: elevating buildings and critical infrastructure above predicted water elevation levels to prevent damage; using retaining walls, dykes and breakwaters to protect vulnerable areas from the direct impact of waves and reduce the likelihood of flooding; improving or installing effective drainage systems to facilitate the rapid removal of water from flooded areas, minimising the damage caused; in the construction or rehabilitation of buildings, using materials that resist exposure to salt water and humidity, preventing long-term structural damage; reconfiguring public spaces, increasing the capacity to dissipate sea energy.

Methodology for mainstreaming adaptation into the PDM

The integration of the measure to adapt infrastructures and buildings to the dangers of overtopping and coastal flooding in the PDM can be realised in four dimensions: (i) revealing the strategic importance of promoting the climate resilience of urban spaces and infrastructures in the face of worsening exposure to coastal hazards; (ii) adopting regulatory norms to ensure that new constructions are adapted to the hazards; (iii) through the definition, in the Implementation Programme, of accommodation interventions, namely for buildings, critical infrastructures and urban spaces; (iv) raising awareness in the construction sector of the need to integrate solutions that mitigate impacts into the construction and urban rehabilitation processes.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Strategy	Plan strategy	• The precautionary principle of coastal hazards should be emphasised among the basic principles of the Plan's strategic model. • The PDM's strategic objectives emphasise the need to increase coastal resilience. • The characterisation studies analyse coastal dynamics, the impacts recorded in recent years due to overtopping and flooding events and future vulnerability scenarios considering the projected rise in mean sea level.	●	●	
	Environmental Report (SEA)	• The Scoping Report emphasise resilience and adaptation to coastal hazards as a strategic issue of the Plan. • Identify Resilience to Coastal Hazards as a Critical Decision Factor in the Scoping and Environmental reports. • Consider projections of the evolution of coastal retreat and flood overtopping over 50 and 100 years in the scenarios.	●	●	
Regulate	Regulations	• Define the provisions relating to the construction and rehabilitation of buildings and infrastructures that mitigate the impacts of coastal erosion and flooding in PDM regulations.		●	
	Zoning plan	• Have an up-to-date map of the Low and Sandy Coastal Safeguard Bands on the land-use plan.	●	●	
Operational	Implementation programme and financing plan	• The characterisation studies identify the infrastructures and public buildings exposed to coastal climate hazards. • Identify in the Implementation Programme the municipality's priority interventions aimed at adapting	●	●	

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		infrastructures, buildings and public spaces (e.g. hollowing out ground floors, raising structures and critical infrastructures above the predicted levels of water elevation; building retaining walls, dykes and breakwaters; improving or installing effective drainage systems, or reconfiguring public spaces, increasing the capacity to dissipate sea energy), as well as their schedule, the associated investment amounts and the entities to be involved.			
Territorial governance		• Hold thematic sessions to raise awareness and debate the need to promote the adaptation of buildings to coastal hazards with players in the construction sector.	●		●

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Operational	• Feasibility studies for infrastructural adaptation actions on the coast.	• EMAAC Ílhavo
	• Adaptation of the public space on the seafront.	• PMAAC Leiria • PIAAC Oeste
	• Accommodating buildings (leaking ground floors or changing uses).	• PMAAC Vila Franca de Xira • PMAAC AML
	• Accommodating transport, energy and communications infrastructures (raising quotas, ...).	• PMAAC Vila Franca de Xira • PLAAC Sesimbra
	• Create floodable multifunctional open spaces.	• PMAAC Vila Franca de Xira • PMAAC AML
	• Adaptation of economic activities and respective infrastructures in risk areas.	• PLAACs Sesimbra, Setúbal
	• Elevated accesses (footbridges, among others).	• PMAAC Leiria • PLAAC Setúbal • PMAAC AML
	• Adapting drainage and wastewater and rainwater treatment infrastructures to the rise in the average level of coastal and estuarine waters.	• PLAACs Palmela, Sesimbra, Setúbal • PMAAC AML
	• Promoting the adaptation of port infrastructures to coastal flooding and intensified coastal erosion.	• PIAAC Coimbra Region
	• Implementation of construction solutions and rehabilitation of structures adapted to coastal risks.	• EMAAC Aveiro • PIAAC Algarve • PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
	• Article 26 6 - In the Coastal Overtopping and Flooding Safeguard Strip - Level II and the Coastal Erosion Safeguard Strip - Level II: b)	• Figueira da Foz Municipal

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
 **Regulate**	On urban land, new buildings, extensions, reconstructions and alterations to existing legally-built buildings are permitted, provided that constructive or infrastructural solutions are adopted to adapt/accommodate to the advance of sea waters, which make it possible to increase resilience to the advance of the waters.	Development Plan (Regulation)
	• Article 34g Protection and safeguard regime i) New buildings, extensions, reconstructions and alterations to existing legally constructed buildings are permitted, provided that the buildings or urban areas in which they are located incorporate constructive or infrastructural solutions for adapting/accommodating to the advance of sea waters, defined in the Municipal Spatial Planning Plan, which make it possible to increase resilience to the advance of waters, namely: ii) The use of construction techniques and materials on the outside of buildings that are resistant to the presence of water; iii) On the ground floor of buildings, the provision of solutions that favour rapid water drainage; iv) Permeable materials should be used to pave outdoor spaces.	• PDM Leiria (Regulation)

3 Nourishing beaches and rehabilitating and conserving dune systems

Concept

Beach nourishment and dune reinforcement, as well as the rehabilitation and conservation of dune systems, are techniques used in coastal management to combat erosion and restore the natural characteristics of beaches and dunes, ensuring that they naturally provide shoreline protection services.

Dune nourishment and reinforcement involves the controlled addition of sand or sediment to the coastal zone, aiming to increase the width of the beach or strengthen the dunes. Beaches and dunes function as natural barriers against erosion, absorbing wave energy and reducing the impacts caused by storms and coastal flooding. Strengthening beaches and dunes by adding sand contributes to the preservation of the coastal ecosystem and the sustainability of the surrounding areas.

It should be noted that beach nourishment is a practice that should be conducted with great care, ensuring the preservation of local ecosystems and minimising potential adverse effects on marine and terrestrial biodiversity.

The rehabilitation and conservation of dune systems involve another diverse set of techniques such as (i) planting native plant species adapted to dune conditions, (ii) removing non-native plants that compete with native vegetation, altering the structure and function of dune ecosystems, (iii) installing fences to limit human access and prevent trampling; (iv) laying raised wooden walkways to direct the flow of people and minimise environmental impact.

Beach nourishment, dune reinforcement and the rehabilitation and conservation of dune systems should preferably be conducted in combination, increasing the effectiveness of the interventions.

Methodology for mainstreaming adaptation into the PDM

Beach nourishment, dune reinforcement, and rehabilitating and conservating dune systems are eminently operational interventions in natural spaces, most often in areas subject to the public maritime domain.

Given their nature and location, these interventions are the responsibility of the Portuguese Environment Agency. They can be conducted in partnership with the local authority, particularly concerning the rehabilitation and conservation of dune systems.

In this context, their integration into the MDP involves including interventions of this type in an Implementation Programme. However, considering these are multi-actor interventions with prolonged duration, they must be prioritised in the Plan's strategy and be the subject of consultation and strategic commitment due to Territorial Governance.

Form of integration	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Operational	Implementation programme and financing plan	• Identify the beach nourishment and dune reinforcement interventions to be conducted by the Portuguese Environment Agency, their schedule, the associated investment amounts, and the entities involved. • Identify the interventions for rehabilitating and conserving dune systems, their timetable, the associated investment amounts, and the organisations involved.		●	
Territorial governance		• Promote broad reflection on the long-term strategy for adapting the municipality's coastline with the involvement of relevant local (concessionaires, fishers, NGOs, ...) and national (APA, ICNF, CCDR) organisations.	●		●

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
 **Operational**	• Strengthening the dune cordon.	• EMAACs Aveiro, Ílhavo, Torres Vedras • PLAAC Cascais • PMAAC Leiria • PIAACs Algarve, Oeste, Região de Coimbra
	• Artificial beach nourishment.	• EMAACs Ílhavo, Figueira da Foz • PMAAC Leiria • PLAACs Sesimbra, Setúbal • PMAAC AML • PIAACs Algarve, Coimbra Region
	• Bank recovery.	• EMAACs Aveiro, Ílhavo
Examples of integrated adaptation measures Municipal Master Plans		
 **Regulate**	• Article 21 C 1 - The following actions and activities are permitted in the Coastal Protection Zone (CPZ), subject to authorisation by the legally competent authorities: g) Ecological restoration of dunes,	• PDM Peniche (Regulation)
	• Article 69 F 2 - The following actions and activities are permitted in the Coastal Protection Strip, subject to authorisation by the legally competent authorities: l) Ecological restoration of dunes, provided that: i) Protecting its biophysical balance by installing fences, where necessary, to prevent access by vehicles, people or animals. ii) Restore the equilibrium profile whenever works have altered it. iii) Consolidation is achieved through sand retention actions, using artificial systems, or planting suitable species.	• PDM Lourinhã (Regulation)

4 Stabilising cliffs

Concept

Cliff stabilisation refers to measures or techniques to make slopes or embankments safer and more resistant to erosion, landslides or collapses.

These measures can include (i) implementing drainage systems to reduce water infiltration; (ii) planting native vegetation to help stabilise the soil; (iii) building retaining structures, such as retaining walls or barriers, to prevent landslides; (iv) shaping slopes to a more stable incline, followed by covering with materials that protect against erosion and sliding; (v) the installation of anchors in the ground, including the insertion of ties or nails; (vi) the application of nets or wire mesh, to prevent rockfall and the movement of debris; (vii) the placement of monitoring systems, such as sensors and remote analysis, to continuously assess the stability of the cliff.

Cliff stabilisation is commonly conducted in areas where the natural topography is prone to earth movements or where human activities, such as construction, can increase the risk of soil instability.

Methodology for mainstreaming adaptation into the PDM

The stabilisation of cliffs is eminently operational and is conducted in natural spaces in areas subject to the Public Maritime Domain.

Given their nature and location, these interventions are the responsibility of the Portuguese Environment Agency and can be conducted in partnership with the local authority.

In this context, their integration into the PDM is achieved by including interventions of this type in the Implementation Programme. However, considering these are multi-actor interventions with prolonged duration, they must be prioritised in the Plan's strategy and be the subject of consultation and strategic commitment due to Territorial Governance.

Nature	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Operational	Implementation programme and financing plan	• Identify the cliff consolidation interventions (to be conducted by the Portuguese Environment Agency), their schedule, the associated investment amounts, and the entities involved. • In the characterisation studies, the physiography of the coastline is portrayed, and the slope movements of coastal cliffs are identified.		●	
Territorial governance		• Where appropriate, promote broad reflection on the municipality's long-term coastal adaptation strategy with the involvement of relevant local (concessionaires, fishers, NGOs, ...) and national (APA, ICNF, CCDR) organisations.		●	

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Operational	• Stabilisation of coastal cliffs in situations with a risk to people, property and/or infrastructure.	• PLAACs Cascais, Sesimbra, Setúbal • PMAAC AML • PIAAC Algarve
	• Promote controlled cliff collapse and protect against falling blocks.	• PIAAC Algarve

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
	• Recolonisation of cliffs particularly affected by landslides with halocasmophytic plants.	• PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
 **Regulate**	• Article 62 B 2 - The following actions and activities are permitted in the Coastal Protection Zone (CPZ), subject to authorisation from the legally competent authorities: d) Extraction, mobilisation or deposition of sediments for coastal protection, including the protection of cliffs and the reinforcement of dune systems;	• PDM Nazaré (Regulation)
	• Article 130 1 - The following actions and activities are permitted in the coastal protection strip of the maritime protection zone, subject to authorisation by the legally competent authorities: d) Consolidation of cliffs, provided that the respective environmental impacts are minimised	• PDM Sesimbra (Regulation)
	• Article 68 C 2 - The following actions and activities are excepted, without prejudice to authorisation from the competent authorities: e) Consolidation of the cliff, provided that the respective environmental impacts are minimised and one of the following grounds is met: i) Safety of people and goods; ii) Protection of heritage and cultural values; iii) Improvement or conservation of port infrastructures provided for in the Programme;	• PDM Mafra (Regulation)

5 Renaturalising coastal areas

Concept

The renaturalisation or ecological regeneration of coastal zones refers to approaches to restoring, preserving or improving natural ecosystems along the coastal strip. The main aim of these approaches is to strengthen the resilience of coastal ecosystems, promote biodiversity and mitigate the negative impacts of human activities and climate change.

Some of the most common practices that fall under this Adaptation Measure are (i) the reintroduction or promotion of natural processes to restore degraded areas, which may include the replanting of native vegetation, the recovery of aquatic habitats and the restoration of dunes; (ii) the strategic use of coastal vegetation, such as grasses and adapted and native plants, to stabilise the soil and reduce coastal erosion; (iii) the preservation and restoration of coastal wetlands, such as estuaries, which play a crucial role in protecting against storms, purifying water and supporting marine life; (iv) the creation and maintenance of natural buffer zones between developed areas and sensitive coastal ecosystems to reduce the load of pollutants and protect biodiversity.

Methodology for mainstreaming adaptation into the PDM

The renaturalisation or ecological regeneration of coastal zones are eminently operational interventions, taking place in natural spaces that are the natural extension of beach-dune or estuary systems.

In this context, their integration into the PDM involves including priority interventions that fall within these typologies in the Implementation Programme, and characterisation studies must support selecting these areas.

Considering that the degradation of these spaces is the result of countless human activities, such as trampling and motorised traffic in natural spaces, it is essential that, alongside active management interventions, environmental education, awareness-raising, monitoring and planning actions (signposting, limiting roads and fencing off critical spaces) are conducted.

Form of integration	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Operational	Implementation programme and financing plan	• Identify interventions to consolidate the renaturalisation and regeneration of coastal zones, their schedule, the associated investment amounts, and the entities involved. • The characterisation studies should identify coastal habitats and critical areas that warrant priority intervention due to their poor conservation status, vulnerability to coastal hazards, and scenic value.	●	●	

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Operational	• Renaturation of the dunes with native species.	• EMAAC Ílhavo
	• Ecological restoration of dune ecosystems. Creating conditions for the creation of dune systems.	• PLAACs Palmela, Sesimbra, Setúbal
	• Ecological restoration of wet ecosystems. Creating conditions for the creation and migration of salt marshes.	• PLAACs Palmela, Sesimbra, Setúbal
	• Renaturalising unoccupied areas following the removal of occupation in vulnerable coastal zones.	• PLAAC Setúbal

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
	• Creation of green infrastructures and multifunctional spaces adapted to/compatible with coastal hazards, facilitating urban drainage and promoting infiltration.	• PLAAC Sesimbra
Examples of integrated adaptation measures Municipal Master Plans		
 **Regulate**	• Article 68 C 2 - The following actions and activities are excepted, without prejudice to authorisation from the competent authorities: f) Actions to rehabilitate coastal ecosystems.	• PDM Mafra (Regulation)
	• Article 39 The following activities are prohibited in the coastal protection strips and the Complementary Protection Strip: a) Destruction of native vegetation and introduction of invasive non-indigenous species, particularly those listed in current legislation;	• PDM Marinha Grande (Regulation)

6 Building and accommodating coastal protection works

Concept

Coastal protection works are grey infrastructure built along coastal areas to protect against the adverse effects of erosion, flooding and storms. They aim to minimise damage caused by the advancing sea, wind, ocean currents and other coastal phenomena.

Some common examples of coastal protection work include dykes and barriers, structures built at sea to dissipate wave energy before it reaches the coast, and drainage systems to prevent coastal flooding and protect inhabited areas. Accommodating these infrastructures involves changing their characteristics to fulfil their functions just as effectively in a more severe context generated by climate change.

It is important to note that although these structures can provide immediate protection, they often have environmental impacts and impacts on coastal dynamics, and their use should be realised as a last resort and be accompanied by other measures to adapt to climate change and promote long-term coastal resilience, particularly those that rehabilitate beach-dune systems.

Methodology for mainstreaming adaptation into the PDM

The construction and accommodation of coastal protection works are eminently operational interventions in areas subject to the Maritime Public Domain or the Water Public Domain.

Given their nature and location, these interventions are responsible for or require authorisation from the Portuguese Environment Agency. They can be conducted in partnership with the local authority, especially when they are adherent defences to protect the margins of urban spaces.

In this context, their integration into the PDM involves including interventions of this type in an Implementation Programme, and the PDM's characterisation studies must support the selection of these spaces.

Form of integration	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
Operational	Implementation programme and financing plan	• Identify the interventions to build coastal protection works and/or accommodate existing works, their schedule, the associated investment amounts, and the organisations involved. • In the characterisation studies, the coastline of urban areas is characterized, and critical situations of coastal overtopping and flooding are identified, with a survey of events and respective damage over the last ten years.	●	●	

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Operational	• Implementing and maintaining longitudinal protection structures against flooding and overtopping events for urban frontages.	• EMAACs Aveiro, Barreiro, Espinho • PMAACs Leiria, Vila Franca de Xira • PLAACs Sesimbra, Setúbal • PMAAC AML • PIAAC Algarve, Oeste
	• Creation of bank protection structures.	• PMAAC Leiria

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
	• Protecting transport, energy and communications infrastructures.	• PMAAC Vila Franca de Xira
	• Implementation of submerged defence structures to reduce the intensity of the erosion process.	• PMAAC Leiria
	• Increasing the resilience of infrastructures through combined protection.	• EMAAC Aveiro • PIAAC Algarve
	• Actions to protect cultural heritage exposed to coastal and estuarine risks.	• PMAAC AML
	• Placing structures on mudflats to retain sediment.	• PMAAC AML
Examples of integrated adaptation measures Municipal Master Plans		
 **Regulate**	• Article 11 7 - Coastal defence works, and ecosystem rehabilitation actions are permitted in the safeguard zones when there is: a) a need to protect heritage and cultural values; b) a risk to people and property; c) protection of the biophysical balance.	• PDM Caminha (Regulation)
 **Regulate**	• Article 72 4 - The following actions and activities are subject to demonstration of the absence of more advantageous alternatives in the ZMP's Coastal Protection Strip, without prejudice to authorisation by the legally competent authorities: c) The construction of new coastal defence works, such as spurs and detached breakwaters;	• PDM Espinho (Regulation)

7 Back off in a planned way

Concept

The planned retreat of coastal occupation is a coastal management strategy that involves the removal and relocation of infrastructures and human activities from the coastal strip, namely from spaces currently or in the future exposed to situations of flooding, overtopping or submersion due to the threat of coastal erosion, rising sea levels and extreme events such as storms.

This approach recognises the dangers associated with the permanence of construction and occupation in vulnerable zones and seeks to minimise the negative impacts on the environment and coastal communities.

Planned retreat often includes implementing measures such as removing buildings, restoring coastal ecosystems, establishing protection areas and relocating communities to safer places. This strategy aims to promote adaptation to climate change and reduce the damage caused by extreme events in coastal areas.

The realisation of these interventions presupposes a wide range of activities such as (i) identification of areas with the greatest vulnerability due to coastal hazards; (ii) involvement of local communities, property owners and other stakeholders in the planning process to ensure that their needs and concerns are addressed; (iii) development of building and infrastructure relocation plans; (iv) acquisition of areas on urban land for reception and relocation; (v) implementation of facilitating regulatory mechanisms such as *Transfer of Development Rights*; (vi) where possible, interventions to restore unoccupied coastal areas to their natural state, increasing coastal resilience and biodiversity.

Methodology for mainstreaming adaptation into the PDM

The planned retreat of coastal occupation is an Adaptation Measure with hybrid characteristics. For this reason, its integration into the PDM requires a wide range of solutions. Firstly, at a strategic level, this initiative with a significant impact should be identified as a priority and duly considered in the Strategic Environmental Assessment.

Given that removing buildings, re-naturalisation or acquiring land to relocate housing or equipment involves public investment, these actions should be described in the Implementation Programme.

On the other hand, if the intervention involves facilitating regulatory mechanisms, such as the *Transfer of Development Rights,* these solutions must be included in the Plan's Regulations.

Finally, given that this is a large-scale intervention with multiple impacts and wide-ranging involvement, initiatives to involve local communities, landowners and other stakeholders in the planning process should be promoted within the framework of Territorial Governance to ensure that their needs and concerns are considered.

Form of integration	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
 Strategy	Plan strategy	• The precautionary principle of coastal hazards should be emphasised among the basic principles of the Plan's strategic model. • The PDM's strategic objectives emphasise the need to promote the planned retreat of built-up areas exposed to danger and to increase coastal resilience. • The characterisation studies analyse coastal dynamics, the impacts recorded in recent years as a result of overtopping and flooding events and future vulnerability scenarios considering the projected rise in mean sea level and the identification of built areas exposed to danger that should be removed.	●	●	
	Environmental Report (SEA)	• The Scoping Report emphasises resilience and adaptation to coastal hazards as strategic issues of the Plan. • Identify Resilience to Coastal Hazards as a Critical Decision Factor in the Scoping and Environmental reports.	●	●	

Form of integration	Integration document	Integration methodology	Development phase		
			Character studies.	Proposed Plan	Public discussion
		• Consider projections of the evolution of coastal retreat and overtopping in the 50- and 100-year scenarios.			
Regulate	Regulations	• Define the provisions relating to transferring building rights for areas to be removed in the PDM regulations.		●	
	Zoning plan	• Define the UOPG for the built-up areas to be removed and, if appropriate, for the recessed area that should accommodate the buildings.			
Operational	Implementation programme and financing plan	• Identify the interventions to be conducted as part of the planned retreat processes (e.g. removal of buildings, renaturalisation of built-up areas, acquisition of land for relocation, appropriation, etc.), their schedule, the associated investment amounts and the entities involved.		●	
Territorial governance		• Hold thematic sessions to raise awareness and debate the implementation of planned retreat interventions with the participation of the relevant bodies and local communities.	●	●	

Reference Practices

Form of integration	Measures	Instruments (Examples)
Examples of measures envisaged in Municipal or Intermunicipal Adaptation Plans		
Strategy	• Planning the relocation and construction of infrastructure and equipment in vulnerable areas, such as the coastline.	• EMAAC Torres Vedras
Operational	• Programming the relocation of equipment and services.	• PMAACs Leiria, Vila Franca de Xira • PMAAC AML
	• Programming the relocation of residential buildings.	• PLAACs Sesimbra, Setúbal • PMAAC Vila Franca de Xira PMAAC AML
	• Programming the relocation of transport, energy and communications infrastructures.	• PMAACs Leiria, Vila Franca de Xira • PLAAC Sesimbra
	• Remove/remove transport, energy and communications infrastructure.	• PMAAC Vila Franca de Xira
	• Relocation of residential buildings and sensitive infrastructure located in areas of coastal overtopping and flooding due to the rise in mean sea level, based on a cost-benefit analysis. Assessment and programming of the relocation of residential buildings and infrastructure exposed to coastal erosion, cliff instability or submergence due to sea level rise.	• PLAACs Setúbal and Sesimbra
Regulate	• Definition of no-build areas and avoidance of permanent beach occupation solutions.	• PIAAC Coimbra Region
	• Defining a legal and economic model for possible measures to relocate the seafront	• PMAAC Leiria

Reference Practices		
Form of integration	**Measures**	**Instruments (Examples)**
Examples of integrated adaptation measures Municipal Master Plans		
 **Regulate**	• Article 83 3 - The delimitation of a risk zone as an area threatened by the sea shall be accompanied by measures aimed at considering, where appropriate, the gradual removal of existing buildings in that area.	• PDM Esposende (Regulation)
 **Regulate**	• Article 116 3 - Programmed removal of existing buildings must be planned in these strips (prohibited occupation strips).	• PDM Loulé (Regulation)

D. Which adaptation measures are most appropriate according to the classification of the soil?

	Adaptation measure	Soil classification											
		Urban						Rustic					
		A - Centres	B - Housing	C - Economic	D - Green	E - Low Density	F - Special Use	A - Agricultural	B - Forestry	C - Energisers	D - industrial	E - Natural	F - Other
1	Prohibit and condition the use and occupation of land in areas exposed to danger	●	●	●	●	●	●	●	●	●	●	●	●
2	Adapting infrastructure and buildings	●	●	●	●	●	●					●	
3	Nourishing beaches and rehabilitating and conserving dune systems											●	
4	Stabilising cliffs											●	
5	Renaturalising coastal areas											●	
6	Building and accommodating coastal protection works	●	●	●	●	●	●					●	
7	Back off in a planned way	●	●	●	●	●	●			●	●		●

Caption:
Urban land: a) Central Spaces, corresponding to mixed-use urban areas that integrate residential functions and a diversified concentration of tertiary activities, performing, due to their characteristics, centrality functions; b) Residential Spaces, corresponding to areas that are preferably intended for residential use, but may accommodate other uses compatible with residential use; c) Economic Activity Spaces, corresponding to areas that are preferably intended to accommodate economic activities with special needs for the allocation and organisation of urban space, namely industrial activities, storagee and logistics, commerce and services; d) Green Spaces, corresponding to areas with environmental balance, landscape enhancement and outdoor recreational, leisure, sports and cultural activities, coinciding in whole or in part with the municipal ecological structure; e) Low Density Urban Spaces, corresponding to peri-urban areas, partially urbanised and built up, showing fragmentation and hybrid characteristics of an urban-rural occupation, with the permanence of agricultural uses intertwined with urban uses and the existence of equipment and infrastructures, to which the territorial plan assigns prevailing urban functions and which are subject to a land use regime that guarantees their urban planning from a perspective of sustainability and flexibility of use, as well as their infrastructure using appropriate solutions. f) Special Use Spaces, corresponding to areas destined for equipment spaces, structuring infrastructure or tourist spaces).
Rustic soil: a) Agricultural areas; b) Forest areas; c) Areas for the exploitation of energy and geological resources; d) Areas for industrial activities directly linked to the uses referred to in the previous paragraphs; e) Natural and landscape areas; f) Other categories of rustic soil, corresponding to cultural areas, areas for tourist occupation, areas for equipment, infrastructures and other structures or occupations, rural settlements and dispersed building areas.

E. What are the main constraints on the adoption of Adaptation Measures?

#	Adaptation measure	Type of Constraints					
		High financial cost	Reduced legal effectiveness	Dependence on technology and innovation	Political and governance challenges	Indirect environmental impacts	Cultural change
1	Prohibit and condition the use and occupation of land in areas exposed to danger	🟢	🟠	🟢	🔴	🟢	🔴
2	Accommodate infrastructure and buildings	🔴	🟢	🟢	🔴	🟢	🔴
3	Nourishing beaches and rehabilitating and conserving dune systems	🔴	🟢	🟠	🟢	🟠	🟠
4	Stabilising cliffs	🟠	🟢	🟠	🟢	🟠	🟢
5	Renaturalising coastal areas	🟠	🟢	🔴	🟢	🟢	🔴
6	Building and accommodating coastal protection works	🔴	🟢	🟠	🟢	🔴	🟢
7	Back off in a planned way	🔴	🟠	🔴	🔴	🟢	🔴

The extent of embarrassment:					
High	🔴	Medium	🟠	Bass	🟢

F. What other benefits can be gained from integrating adaptation to erosion, coastal erosion, and flooding into the PDM?

	Adaptation measure	Synergies				Contribution to the SDGs															
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Prohibit and condition the use and occupation of land in areas exposed to danger	●	●	●	●	o	o	o	o	o	o	o	o	+	o	+	o	+	o	+	o	o
2	Accommodate infrastructure and buildings	●	●	●	●	o	o	o	o	o	o	o	o	+	o	+	o	+	o	o	o	o
3	Nourishing beaches and rehabilitating and conserving dune systems	●	●	●	●	o	o	o	o	o	o	o	+	+	o	+	o	+	+	+	o	o
4	Stabilising cliffs	●	●	●	●	o	o	o	o	o	o	o	o	+	o	+	o	+	+	-	o	o
5	Renaturalising coastal areas	●	●	●	●	o	o	o	o	o	o	o	+	o	o	+	+	+	+	+	o	o
6	Building and accommodating coastal protection works	●	●	●	●	o	o	o	o	o	o	o	+	+	o	+	o	+	o	-	o	o
7	Back off in a planned way	●	●	●	●	o	o	o	o	o	o	o	+	+	+	+	o	+	+	+	o	o

Caption

Relationship with the Sustainable Development Goals

1	Eradicating poverty
2	Eradicating hunger
3	Access to quality healthcare and promoting well-being
4	Access to inclusive, quality and equitable education
5	Gender equality
6	Availability and sustainable management of drinking water and sanitation
7	Reliable, sustainable and clean energy for all
8	Inclusive and sustainable economic growth
9	Resilient infrastructures, inclusive and sustainable industrialisation and innovation
10	Reducing inequalities
11	Inclusive, safe, resilient and sustainable cities
12	Sustainable consumption and production
13	Climate action
14	Conserving the oceans
15	Protecting terrestrial ecosystems
16	Effective, accountable and inclusive institutions
17	Partnerships for sustainable development

Relationship with Sectors and Risk Groups

- Combating poverty and exclusion
- Circularity
- Renaturalisation
- Mitigation

Types of relationships

+	With benefits
-	With losses
o	No evidence / Mixed

Degree of synergy

- High
- Medium
- Bass

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5. Glossary

Adaptation - In human systems, it is adapting to the current or expected climate and its effects to moderate damage or exploit beneficial opportunities. Natural systems adjust to the current climate and its effects; human intervention can facilitate adjustment to the expected climate and its impact.

Conservation Agriculture - an agricultural method focused on sustainability and environmental protection, with three fundamental principles: minimal soil disturbance, maintenance of permanent vegetation cover and crop rotation. This system aims to improve and conserve soil quality, water and biodiversity while promoting the economic efficiency of agricultural activities. Reducing soil disturbance aims to preserve soil structure and minimise erosion, while constant vegetation cover helps maintain moisture, reduce compaction and increase carbon sequestration. Crop rotation contributes to soil health, preventing pests and diseases and improving soil fertility in the long term.

Climate change - Climate change refers to a change in the state of the climate that can be identified (e.g. through statistical tests) by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or more. Climate change can be due to natural internal processes or external forcings, such as modulations of solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or land use. It should be noted that the UNFCCC, in its Article 1, defines climate change as "a change in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is additional to the natural climate variability observed over comparable periods". The UNFCCC thus distinguishes between climate change attributable to human activities that alter atmospheric composition and climate variability attributable to natural causes.

Climate anomaly - Difference in the value of a climate variable in a given period compared to the reference period. For example, considering the average temperature observed between 1961/1990 (reference period), an anomaly of 2ºC more for a future period means that the average temperature will be 2ºC higher than in the reference period.

Artificialized areas are significantly modified or built-up spaces that replace the natural environment with urban structures such as buildings, roads, and other infrastructure. These areas are characterised by altering the original ground cover, reducing green spaces and soil permeability, and directly impacting local ecosystems, hydrological cycles, and biodiversity.

Risk assessment - Corresponds to the qualitative and/or quantitative scientific estimation of risks.

Hydrological balance - Water balance results from the amount of water entering and leaving a certain portion of the soil over a given period.

Adaptive (or adaptive) capacity - The ability of a system, institution, man or other organisms to adjust to different potential impacts, taking advantage of opportunities or responding to the consequences. Capacity in the context of climate risk assessment refers to the ability of societies and communities to prepare for and respond to current and future climate impacts. Capacity includes two components: response capacity - the ability of people, institutions, organisations, and systems to face, manage and overcome adverse conditions in the short and medium term, using available skills, values, beliefs, resources and opportunities (e.g. early warning systems); adaptive capacity - the ability of systems, institutions, humans and other bodies to adjust to potential damage, take advantage of opportunities, or respond to consequences.

Sponge City - an urban planning strategy that aims to increase the absorption capacity and sustainable management of rainwater in urban spaces, mitigating flood risks and promoting aquifer recharge. It is based on green infrastructure principles and nature-based solutions such as parks, gardens, green roofs and permeable pavements. Sponge cities seek to mimic the absorption capacity of a natural ecosystem by retaining, storing and purifying rainwater.

Climate - In a strict sense, climate is generally defined as the average climate or, more strictly, as the statistical description in terms of the average and variability of the relevant quantities over a period ranging from months to thousands or millions of years. The classic period for the average of these variables is 30 years (climatological normal), as defined by the World Meteorological Organisation. The relevant quantities are mostly surface variables such as temperature, precipitation and wind. Climate, in the broadest sense, is the climate system's state, including its statistical description.

Co-benefits - Positive effects a policy or measure defined for a particular objective can have on other objectives, regardless of the net impact on overall social welfare. Co-benefits are often uncertain and depend on local circumstances and management practices. Co-benefits are also referred to as secondary benefits.

Disaster - Serious changes in the normal functioning of a community or society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread human, material, economic or environmental effects that require immediate emergency response to meet critical human needs and may require external support for recovery.

Rainy days - According to the World Meteorological Organisation, these are days with more than 0.1 mm rainfall in a 24-hour period.

Frost days - According to the World Meteorological Organisation, these are days when the minimum temperature is less than or equal to 0ºC.

Summer days - According to the World Meteorological Organisation, these days have a maximum temperature greater than or equal to 25ºC.

Very hot days - According to the World Meteorological Organisation, these days have a maximum temperature of 35ºC or more.

Carbon dioxide (CO2) - A natural gas, CO_2 is also a by-product of burning fossil fuels (such as oil, gas and coal) and biomass, land use change (LUC) and industrial processes (e.g. cement production). The main anthropogenic greenhouse gas (GHG) affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and has a Global Warming Potential (GWP) of 1.

CO2 equivalent emission (CO2-eq) - The amount of carbon dioxide emissions (CO_2) that would cause the same integrated radiative forcing or temperature change over a given time horizon as an amount emitted from a greenhouse gas (GHG) or a mixture of GHGs. Various ways of calculating these equivalent emissions and choosing suitable time horizons exist. Typically, the CO equivalent emission$_2$ is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for a 100-year time horizon. A mixture of GHGs is obtained by adding up the CO_2 equivalent emissions of each gas. The CO equivalent emission$_2$ is a standard scale for comparing the emissions of different GHGs, but it does not imply the equivalence of the corresponding responses to climate change. Generally, there is no link between CO_2 equivalent emissions and the resulting CO_2 equivalent concentrations.

Evapotranspiration - How water from the earth's surface passes into the atmosphere in the vapour state (loss of water from the soil by evaporation or loss of water from the plant by transpiration). The evapotranspiration rate is usually expressed in millimetres (mm) per unit of time.

Extreme weather event - An extreme weather event is an event that is rare in a particular place and time of year. Definitions of rarity vary, but an extreme weather event would usually be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of an extreme weather event can vary from place to place in an absolute sense. When an extreme weather pattern persists for some time, such as a season, it can be classified as an extreme weather event, especially if it yields an average or total that is in itself extreme (for example, drought or severe rainfall over a season).

Slow onset events - Slow onset events include, for example, temperature rise, sea level rise, desertification, glacial retreat and related impacts, ocean acidification, land and forest degradation, average precipitation, salinisation and biodiversity loss. Concerning the statistical distribution of a climate variable (and how it can change in a changing climate), slow onset events often reflect how the average value changes (while extreme events are related to the tail ends of the distribution).

Exposure - The presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social or cultural assets in locations that may adversely affect (climatic) hazards.

Climate extreme (extreme weather event) - The occurrence of a value of a meteorological or climatic variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. Extreme weather and climate events are collectively called "climate extremes".

Greenhouse gases (GHG) - Greenhouse gases are the gaseous constituents of the atmosphere, both natural and anthropogenic, which absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and clouds. This property causes the greenhouse effect. Water vapour (H_2 O), carbon dioxide (CO_2), nitrous oxide (N_2 O), methane (CH_4) and ozone (O_3) are the main GHGs in the Earth's atmosphere. In addition, several entirely human-caused GHGs are in the atmosphere, such as halocarbons and other substances containing chlorine and bromine, treated under the Montreal Protocol. In addition to CO_2, N_2 O and CH_4, the Kyoto Protocol deals with sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Risk management - Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to the consequences.

Impacts (consequences, outcomes) - Consequences on natural and human systems resulting from extreme weather events and climate change. Impacts refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate change or hazardous weather events with the vulnerability of an exposed society or system.

Grey infrastructure - Better physical or engineering interventions are needed to prepare buildings and other infrastructure for extreme weather events.

Green infrastructures - Green infrastructures are strategically planned networks of natural and semi-natural areas with other environmental elements designed and managed to provide a wide range of ecosystem services, such as water purification, air quality, recreational space and climate mitigation and adaptation. This network of green (land) and blue (water) spaces can improve environmental conditions and citizens' health and quality of life. It also supports a green economy, creates job opportunities and enhances biodiversity. The Natura 2000 network is the backbone of the EU's green infrastructure. Green infrastructure planning is a successfully tested tool for delivering environmental, economic and social benefits through natural solutions. In many cases, it can reduce reliance on "grey" infrastructure that can harm the environment and biodiversity and is often more expensive to build and maintain.

Climate model - A numerical representation (with different levels of complexity) of the earth's climate system based on the properties, interactions and responses of its physical, chemical and biological components, taking into account all or some of their known properties. Models with different levels of complexity can represent the climate system for any of these components or their combination. They can differ in various aspects such as the number of spatial dimensions, the extent of physical, chemical or biological processes that are explicitly represented or the level of empirical parameterisations involved. The most reliable models currently available to describe the climate system are the Atmosphere-Ocean Global Climate Models (AOGCM). These are used to study and simulate the climate and provide representations of the climate system as well as monthly, seasonal, and interannual projections.

Regional climate model (RCM) - These are models with a higher resolution than global climate models (GCM), although they are based on them. Global climate models contain climate information on a grid with resolutions between 300 km and 100 km. In contrast, regional models use a higher spatial resolution, with the grid size varying between 11 km and 50 km (UKCIP, 2013).

Climate neutrality is a state in which human activities have no net effect on the climate system. Achieving such a state would require balancing residual emissions with the removal of emissions (carbon dioxide) and accounting for regional or local biogeophysical effects of human activities that, for example, affect surface albedo or local climate.

Tropical nights - According to the World Meteorological Organisation, these are nights with a minimum temperature greater than or equal to 20ºC.

Climatological normal - Designates the average value of a climatic variable, considering the values observed in a given location over 30 years. This period begins in the first year of a decade, an example for Portugal being the 1961/1990 climatological normal.

Heatwave - When, over six days, the maximum air temperature is 5ºC higher than the average daily maximum temperature for the reference period (1961-1990).

Adaptation options - A set of available and appropriate strategies and measures to address adaptation. They include a wide range of structural, institutional, ecological or behavioural actions.

Hazard - The potential occurrence of a physical event (e.g. heavy precipitation) or physical impact (e.g. flooding due to heavy rainfall) of natural or human-induced origin, which may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, ecosystems, environmental resources and disruption to the provision of essential services.

Global Warming Potential (GWP) - An index based on the radiative properties of GHGs, measuring the radiative forcing following a pulse emission of a unit mass of a given greenhouse gas in the current atmosphere, integrated over a chosen time horizon relative to carbon dioxide. GWP represents the combined effect of the different times these gases remain in the atmosphere and their relative effectiveness in radiation. The Kyoto Protocol is based on GWP from pulse emissions over 100 years.

Climate projection - A climate projection is the simulated response of the climate system to a scenario of future emissions or concentrations of GHGs and aerosols, usually derived from climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which in turn is based on assumptions regarding, for example, future socio-economic and technological developments that may or may not be realised.

RCP2.6 - A representative concentration trajectory in which radiative forcing peaks at around 3 W/m² and then declines to be limited to 2.6 W/m² by 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant

emissions after 2100). The RCP 2.6 trajectory will likely keep the global temperature increase below two °C by 2100.

RCP4.5 and RCP6.0 - Two concentration trajectories representative of intermediate stabilisation in which the radiative forcing is limited to approximately 4.5 W/m² and 6.0 W/m² in 2100 (the corresponding ECPs have constant concentrations after 2150).

RCP8.5 - A representative high concentration trajectory leading to > 8.5 W/m² in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250). Generally taken as the basis for the worst-case climate change scenario, RCP8.5 emissions continue to increase throughout the 21st century. This scenario is considered very unlikely but still possible since the feedback is poorly understood.

Planned retreat - a coastal management strategy aimed at mitigating the impacts of erosion and the advance of the sea on built-up areas through the **scheduled** relocation of infrastructure and housing to areas further from the coastline.

Risk - The potential for consequences [= impacts] resulting from one or more hazardous processes. Risk results from the interaction of vulnerability, exposure and hazard.

Meteorological drought - A measure of the deviation of precipitation from the expected value, characterised by the lack of water induced by the imbalance between precipitation and evaporation, which depends on other elements such as wind speed, air temperature, humidity, and sunshine. The definition of meteorological drought should be considered region-dependent since the atmospheric conditions resulting in precipitation deficiencies can differ from region to region.

Sensitivity - Sensitivity is determined by factors that influence the magnitude of the consequences of a hazard. Sensitivity can include physical attributes of a system (e.g., construction material of houses, soil type in agricultural fields) and social, economic, and cultural attributes (e.g., age structure and income structure).

Territorial sensitivity - Determines the degree to which a system is affected (beneficially or adversely) by a given exposure to the climate. Sensitivity or susceptibility is conditioned by the natural physical conditions of the system and by the human activities that affect the natural and physical conditions of that system. The assessment of sensitivity also includes aspects related to current adaptive capacity.

Monitoring System - A mechanism for monitoring and evaluating the dynamics, trends, and developments in relevant components, such as the development of climate indicators, the impact of extreme weather events, and the implementation of recommended adaptation measures and actions. It involves the systematic and standardised collection of information to enable comparative and trend analyses.

Nature-based solutions (NBS) - Solutions inspired and supported by nature that are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. These solutions bring more nature and diverse natural elements and processes into cities, landscapes and marine environments through locally adapted, resource-efficient and systemic interventions. Nature-based solutions should benefit biodiversity and support providing a range of ecosystem services.

Representative concentration pathways (RCP) - Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs), aerosols, and chemically active gases, as well as land use/land cover. The word 'representative' means that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term 'trajectory' emphasises that not only the long-term concentration levels but also the trajectory taken over time to achieve that result are of interest.

Vulnerability - The propensity or predisposition to be negatively affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity to harm and lack of capacity.

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Document:
WP8D - Guidelines and good practices for mainstreaming climate change adaptation into Municipal Master Plans

General coordination:
Direção Geral do Território (DGT)

Technical coordination:
CEDRU – Centro de Estudos e Desenvolvimento Regional e Urbano

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