BRAGA MUNICIPAL CLIMATE ACTION PLAN (PMAC-Braga)

Volume I
Technical Report

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In partnership with

May 2024

MESSAGE

The Municipality of Braga presents its first **Municipal Climate Action Plan (PMAC-Braga)**. This document, rather than fulfilling the legal obligations established by the Basic Climate Law, represents the corollary of a path that has been consistently trodden over the last decade. A path effectively translated into municipal policy instruments based on climate response at local level. Examples of this are the Municipal Strategy for Adaptation to Climate Change (one of the first at a national level and centred on adaptation - published in 2016) or the Sustainable Energy and Climate Action Plan (with a main focus on mitigation - published in 2022). This rigorous path has allowed us to make ambitious and mobilising commitments such as reducing greenhouse gas (GHG) emissions by 55% by 2030, achieving carbon neutrality by 2050 and reducing energy poverty in the municipality.

The **PMAC-Braga is** an opportunity to articulate and put into a holistic, integrated and coherent perspective the municipal response to this global challenge. From this perspective, we are committed to making Braga a territory that is increasingly reactive to climate change.

We want to continue to be a public example of responsibility, ambition and transparency in the field of climate action. Based on this kind of maxim, we want to unite the community in this cause and encourage everyone's active participation.

Despite the immense amount of work that has already been done, the labour never ends. That's why we're committed to continuing the process of improving the climate sphere by strengthening the basic information; refining the analyses; monitoring the results achieved and, in particular, keeping the focus on the safety and quality of life of residents, with special attention to the most vulnerable. This is a project and endeavour of the municipal executive. However, we are certain that it is also a goal of the entire population of Braga. We are counting on everyone in this 'journey' of labour that can only continue to be successful with everyone's help and contribution.

Altino Bessa

Councillor for the Environment and Climate Change at Braga City Council

EXECUTIVE SUMMARY

More than mere compliance with the Basic Climate Law (approved by Law no. 98/2021, of 31 December), the objectives of drawing up the **Braga Municipal Climate Action Plan (PMAC-Braga)** are the result of the Municipality of Braga's interest in programming its climate policy for the coming years, in coherence with other sectoral policies and territorial management instruments.

In this context, the **PMAC-Braga** is an opportunity to articulate and put into a holistic, integrated and coherent perspective the municipal response to this global challenge, considering four dimensions that will be strategic to guarantee environmentally effective, economically competitive and socially fair action: the reduction of greenhouse gas (GHG) emissions in the municipal territory (**mitigation)**, the resilience of the territory to changes in climate patterns and the occurrence of extreme weather events (**adaptation**), the preparation of municipal structures and other stakeholders for climate action on a local scale (**management and governance**) and the increase in knowledge about climate risks and their impacts and responses (**knowledge and capacity building**).

Strategic sectors for intervention in the area of **mitigation were** energy, industrial processes and product use, agriculture, forestry and other land use, and waste and wastewater management; and in the area of **adaptation**, ecosystems and biodiversity, water resources, agriculture, tourism, land use planning, industry, infrastructure and human health and safety.

It is estimated that the **GHG emissions** associated with the territory of Braga represent around 821,535 t $_{CO2eq}$. ***per*** year, which, considering an annual sink capacity of 137,796 t **CO2eq,** totals a **net balance of annual emissions of 683,739 t $_{CO2eq}$.** (which represents **3.5 t $_{CO2eq}$. per *capita***, 3,728 t CO2eq per km^2 and 188 t $_{CO2eq}$ per million euros of GDP). A scenario of carbon neutrality in 2050 will require a very significant effort to reduce emissions and capture carbon in the municipality.

In order to respond to this challenge and the need to increase the territory's resilience to the foreseeable intensification of the most relevant climate risks identified in the territory (heat waves, droughts, floods, slope movements, extreme weather events and forest fires), **37 climate actions were designed** to be implemented by 2030 (13 mitigation, 14 adaptation, 5 management and governance and 5 knowledge and capacity building).

STRUCTURE OF PMAC-BRAGA

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The objectives of drawing up the Braga Municipal Climate Action Plan (PMAC-Braga) stem from the need for the Municipality of Braga to programme climate policies within the scope of its attributions and competences, in coherence with territorial management instruments.

The Basic Climate Law, approved by Law 98/2021 of 31 December, introduced the recognition of climate emergencies into the national legal system and established the following objectives for public climate policies:

- **a)** Promote a rapid and socially balanced transition to a sustainable economy and a greenhouse gas-neutral society;
- **b)** Guarantee climate justice by ensuring the protection of communities most vulnerable to the climate crisis, respect for human rights, equality and collective rights over common goods;
- **c)** Ensure a sustainable and irreversible path towards reducing greenhouse gas emissions;
- **d)** Promote the use of renewable energies and their integration into the national energy system;
- **e)** Promote the circular economy by improving energy and resource efficiency;
- **f)** Develop and strengthen existing sinks and other carbon sequestration services;
- **g)** Strengthen national resilience and capacity to adapt to climate change;
- **h)** Promoting climate security;
- **i)** Stimulate education, innovation, research, knowledge and development and adopt and disseminate technologies that contribute to these ends;
- **j)** Combating energy poverty, in particular by improving housing conditions and giving citizens fair access to energy use;
- **k)** Fostering prosperity, green growth and social justice, fighting inequalities and generating more wealth and jobs.

In terms of planning, the Basic Climate Law established that municipalities must approve a Municipal Climate Action Plan (PMAC), which is an action plan for local climate policies.

This is an innovative approach that requires the objectivisation of concrete measures and actions in the strategic sectors of intervention that are defined for this purpose, covering both **mitigation** and **adaptation**.

While it is true that a municipality's contribution to the global reduction of GHG emissions is potentially small, within a framework of commitment to the major global climate goals and the affirmation of a sustainable growth strategy, where the transition to a low-carbon economy will have to be a priority, municipalities cannot fail to contribute, to the extent of their competences and possibilities, while decarbonisation must be seen as an opportunity for economic and technological reconfiguration, since reducing the carbon intensity of the economy can add competitiveness and sustainability.

On the other hand, there is a need for action to promote local adaptation, so that it is possible to predict the effects of climate change and take appropriate measures to prevent or minimise the impacts. In this sense, local adaptation must be prioritised in the municipal sphere, due to the inevitability that the impacts of climate change have produced and will continue to produce, affecting people, goods and ecosystems.

The PMAC-Braga should therefore include, in line with the provisions of Law 98/2021 of 31 December, a set of climate policy principles, among which the following stand out:

- "Transversality" ensuring that climate change mitigation and adaptation are taken into account in other global and sectoral policies;
- "Subsidiarity" ensuring an integrated and efficient multi-level administration, integrating the autonomous regions and local authorities in the planning, decision-making and evaluation processes public policies;
- "Integration" considering the impacts of climate change on investments and economic activities, both public and private.

2. Strategic Framework

2.1. The Problem of Climate Change

The physical and biological dynamics that occur on Earth depend on the greenhouse effect, a natural mechanism that regulates the planet's temperature and prevents extreme thermal amplitudes throughout the day. In short, the elements that make up the atmosphere, by acting as a selective filter, allow short-wavelength radiation from the sun to pass through relatively easily, but offer an obstacle and absorb part of the heat and energy emitted by the Earth's surface, keeping the Earth warm and in stable patterns. Some of the gases that make up the atmospheric mixture are particularly effective in this mechanism and are therefore identified as Greenhouse Gases (GHGs).

Since its genesis, the Earth has undergone significant climatic variations, with many of these changes resulting from mechanisms or phenomena on an astronomical scale, others from the planet's internal and external geodynamics. The density and characteristics of solar radiation, the orientation of the Earth's axis and the shape of its orbit, cataclysms, relief, the distribution of glaciers and oceans and the formation and evolution of the characteristics of the atmosphere, among other phenomena and factors, have influenced the planet's climate over the last 4.5 billion years.

Since the beginning of the industrial revolution, but especially since 1940, the concentration of GHGs in the atmosphere has increased exponentially due to human interference, causing an imbalance in the natural mechanism of the greenhouse effect, which causes more heat and energy to be absorbed in the atmosphere and transferred to the oceans, leading to global warming of the planet, which is occurring at an unprecedented rate.

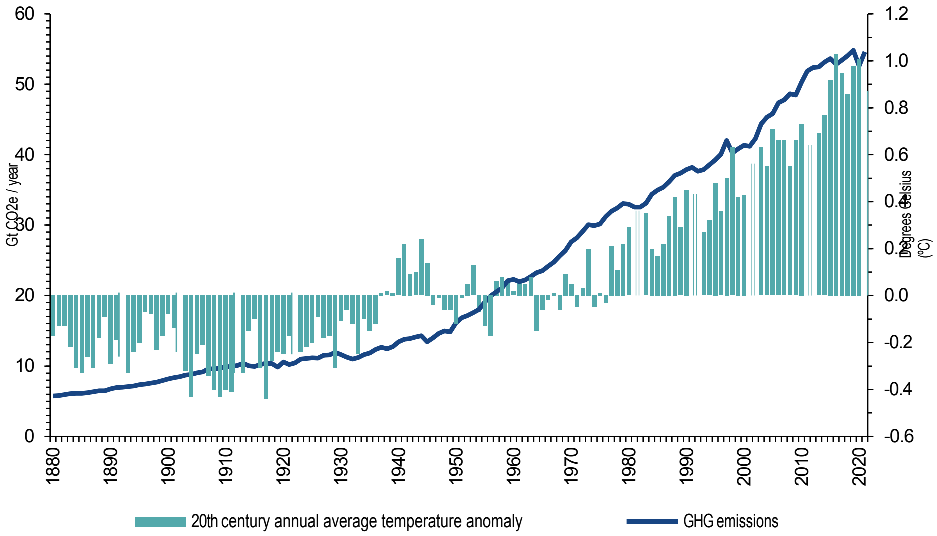


Figure 2.1. GHG emissions and global warming

Sources: National Oceanic and Atmospheric Administration (NOAA) and Our World In Data

Atmospheric concentrations of GHGs reflect the balance between emissions from human activities and natural sources and captures by the biosphere and the ocean. Increasing levels of GHGs in the atmosphere due to anthropogenic emissions have been the main cause of climate change in recent decades.

According to the World Meteorological Organisation (WMO), in 2020 the average temperature on the Earth's surface was 1.2°C above pre-industrial era temperatures (the average of the years from 1850 to 1900), while the last six years have been the warmest recorded since 1880. The same organisation predicts that the average annual surface temperature for each year between 2023 and 2027 could be between 1.1°C and 1.8°C higher than pre-industrial levels.

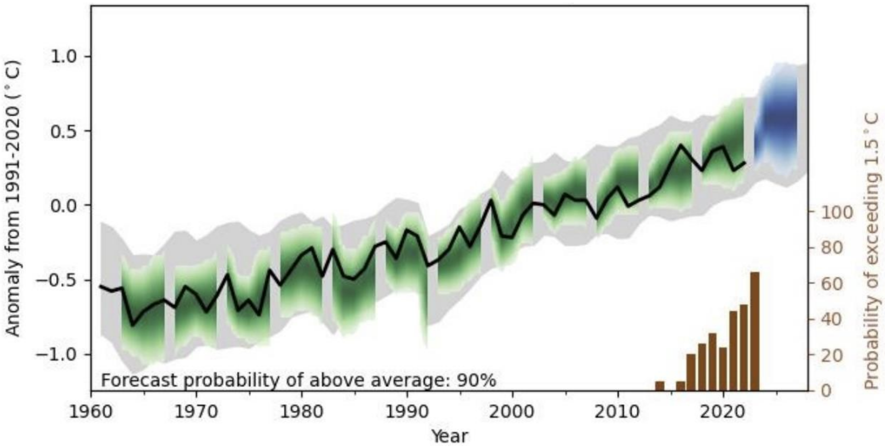


Figure 2.2. Global average temperature at the Earth's surface

Source: World Meteorological Organisation (WMO)

Although it is an asymmetrical and non-linear phenomenon in space and time, and its consequences differ according to geography, the effects of climate change are already being felt all over the world (e.g. more intense and frequent natural disasters, rising sea levels, ocean acidification, loss of biodiversity) and the imbalance will be greater the more global temperatures rise. Particularly sensitive to these changes, although with varying degrees of vulnerability, are the small islands distributed throughout the world's oceans.

The Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) shows that in order to maintain the goal set by the Paris Agreement of stopping global warming at 1.5°C above pre-industrial temperatures, GHG emissions would have to stop growing in 2025 and then fall by 43 per cent by 2030 (compared to 2019 levels).

Despite some signs of progress, global efforts to mitigate climate change are still far from what is needed, and we are approaching a point of no return at a truly frightening speed (global warming of more than 2°C compared to pre-industrial levels), which could result in more severe climate impacts with irreversible effects.

Humanity is therefore facing an unprecedented challenge that requires rapid transformation in all sectors and on a global scale to avoid the worst climate impacts, including the threat to its survival.

Changes in behaviour and lifestyle, with an emphasis on new patterns of consumption and mobility, are absolutely critical to success in combating climate change, requiring public policies that make these changes less disruptive, facilitating and encouraging the necessary adjustments.

But changes in behaviour and lifestyle are not enough; we also need to invest in removing carbon from the atmosphere, through conventional approaches that include restoring and increasing natural carbon sinks (e.g. forests, wetlands, marine and coastal ecosystems), as well as developing carbon removal technologies.

On the other hand, even if global efforts to reduce GHG emissions are effective, some of the impacts and vulnerabilities of climate change are unavoidable, and complementary actions need to be developed for effective adaptation, i.e. to understand and predict the effects of climate change and take appropriate measures to prevent or minimise these impacts and ensure resilient development.

According to the National Inventory of Emissions by Sources and Removals by Sinks of Atmospheric Pollutants (INERPA), in 2021, GHG emissions in Portugal totalled 56.5 mega tonnes o f carbon dioxide equivalent (Mt $_{CO2e}$), without accounting for emissions from land use, land use change and forestry (LULUCF) and 50.5 Mt $_{CO2e}$, with their inclusion.

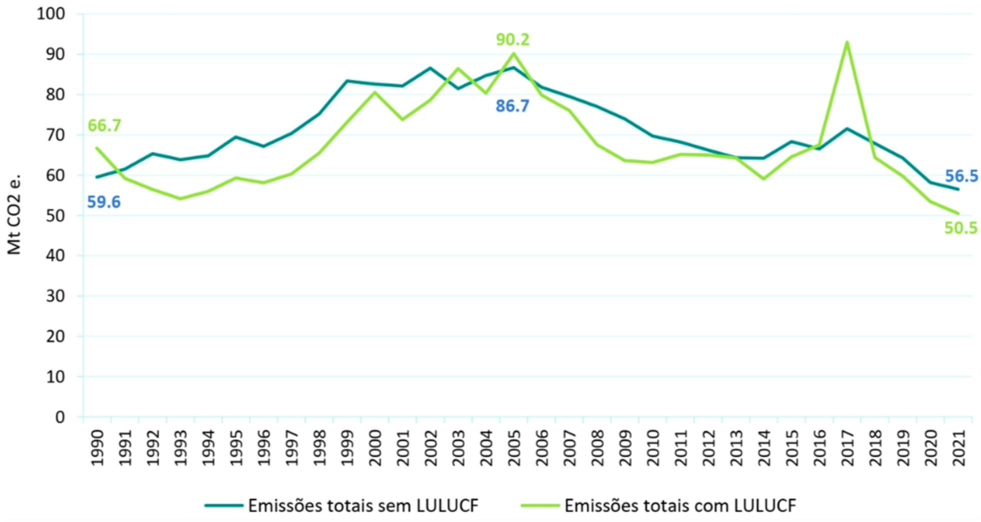


Figure 2.3. Total GHG emissions in Portugal

Source: National Inventory of Emissions by Sources and Removal by Sinks of Atmospheric Pollutants (INERPA)

The data for 2021 represents a reduction in GHG emissions of around 5.1 per cent compared to 1990 and 34.8 per cent compared to 2005, without accounting for LULUCF emissions. Considering the LULUCF sector, total emissions in 2021 correspond to a decrease of 24.3 per cent compared to 1990 and 44.0 per cent compared to 2005.

In 2021, the energy sector, including transport, accounted for 65.6 per cent of the country's total GHG emissions, without LULUCF, with a reduction of 9.2 per cent compared to 1990 and 42.2 per cent compared to 2005.

In the industrial processes and product use (IPPU) sector, GHG emissions increased by 12.6 per cent between 1990 and 2021, although they fell by 14.9 per cent between 2005 and 2021.

The GHG emissions recorded in the agricultural sector in 2021 corresponded to a decrease of 1.1 per cent compared to 1990 and an increase of 4.7 per cent compared to 2005.

For its part, the waste and wastewater sector recorded a reduction in GHG emissions in 2021 of 2.0 per cent compared to 1990 and 30.7 per cent compared to 2005.

The balance between emissions and removals of carbon from the atmosphere in the LULUCF sector shows significant fluctuations from year to year, mainly due to the impact of forest fires.

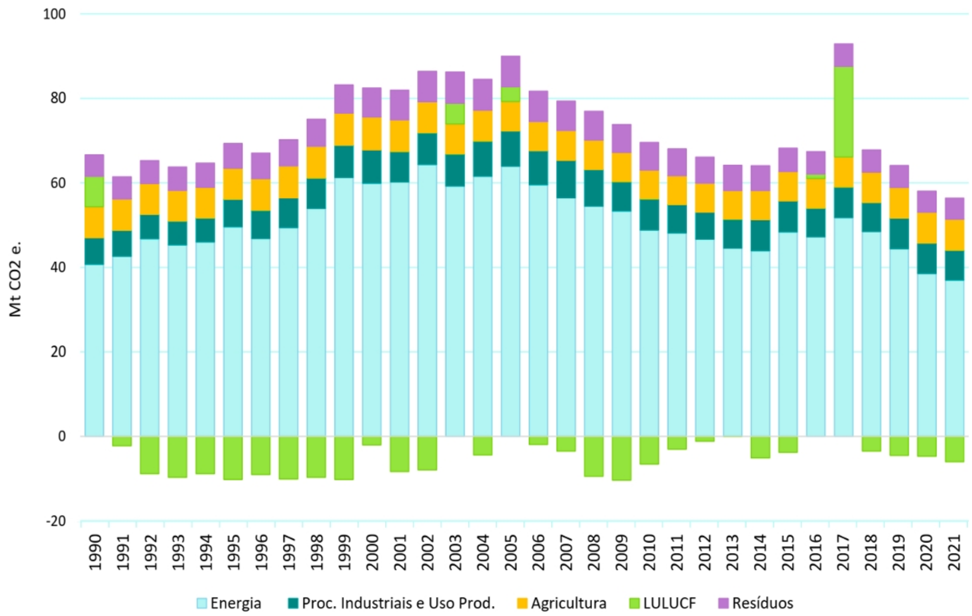


Figure 2.4. GHG emissions by sector in Portugal

Source: INERPA

Figure 2.5 shows sectoral GHG emissions, without LULUCF, in 2021, as well as a breakdown of the energy sector by its main subsectors, with transport accounting for 28.2 per cent of national emissions.

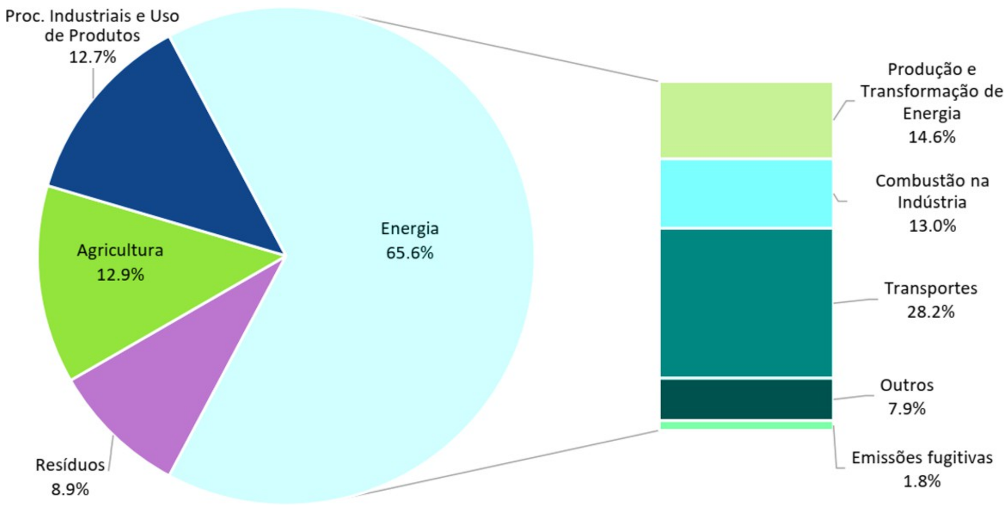


Figure 2.5. GHG emissions by sector in Portugal (2021)
Source: INERPA

As the following figure shows, the main GHG emitted in Portugal in 2021 was carbon dioxide (CO_2), which accounted for around 71 per cent of total annual emissions (without LULUCF), followed by methane (CH_4), fluorinated gases (F-gases)1 and nitrous oxide (N_2O).

[1] These include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Emissions of nitrogen triflouride (NF_3) are non-existent in Portugal.

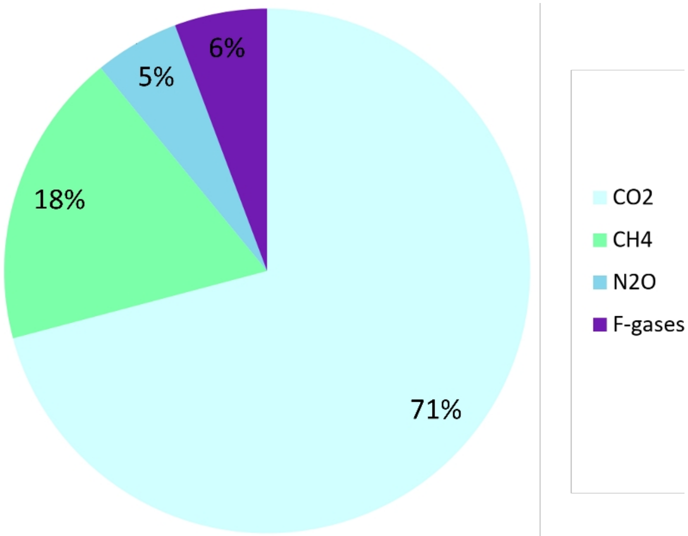


Figure 2.6. Total emissions by type of GHG in Portugal (2021)

Source: INERPA

2.2. Strategic and Normative Benchmarks

2.2.1 Strategic Framework

There are a number of policy instruments and strategic documents at supranational, national, regional and municipal level which, due to their relevance, should be considered in the context of climate action planning and public policies.

The Kyoto Protocol was the first international legal treaty to impose limits on the quantified GHG emissions of developed countries, which undertook the commitment to reduce their emissions globally by at least 5 per cent in the period 2008-2012 compared to the emissions recorded in 1990.

Adopted on 11 December 1997 at the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol only came into force on 16 February 2005, after being ratified by more than 55 countries representing at least 55% of GHG emissions in 1990.

Although there were already cases of the application of economic and financial instruments (e.g. subsidies, taxes, tax benefits) for environmental policy at national level, the introduction of emissions trading in the Kyoto Protocol architecture represented an important development in international environmental policy, because it was the first application of an economic environmental policy instrument on a global scale.

After several failures to build a successor to the Kyoto Protocol, which expired on 31 December 2012, the Paris Agreement was adopted on 12 December 2015 and entered into force on 4 November 2016, specifically 30 days after ratification by at least 55 countries representing at least 55% of GHG emissions.

The Paris Agreement, which represents a worldwide commitment to keep the global average temperature increase below 2°C compared to the pre-industrial period and to continue efforts to limit the temperature increase to 1.5°C, as well as being ratified by 191 of the 197 member countries of the UNFCCC, has renewed hope in multilateralism in the fight against climate change and points to the need for a profound decarbonisation of the world economy.

Europe has led the world's efforts to reduce GHG emissions, having presented the first international proposal for a coordinated policy to reduce emissions in 1992, through a tax on carbon dioxide emissions, which was not supported by the main competing blocs.

The first European Climate Change Programme (ECCP), launched by Commission Communication COM(2000) 88 of 8 March 2000, emerged as a participatory process for drawing up the climate policies with which the European Union (EU) intended to meet the challenge of the Kyoto Protocol, and would be complemented by a set of measures including the European Emissions Trading Scheme (EU ETS), approved by Directive no. 2003/87/EC of the European Parliament and of the Council of 13 October 2003.2003/87/EC of the European Parliament and of the Council of 13 October 2003, which has become the largest global carbon emissions market.

The European Green Deal, set out in Commission Communication COM(2019) 640 of 11 December 2019, embodies the EU's current roadmap for a new strategy for sustainable, climate-neutral growth in 2050.

In Portugal, the first Climate Change Strategy was approved in 2001 (Resolution of the Council of Ministers no. 59/2001, of 30 May), in the context of the work carried out by the Climate Change Commission, created by Resolution of the Council of Ministers no. 72/98, of 29 June, and in 2004 the National Climate Change Programme (PNAC) was approved by Resolution of the Council of Ministers no. 119/2004, of 31 July.

Over the course of its validity, the PNAC has undergone several changes and revisions, and its latest version (PNAC 2020/2030) was revoked, with effect from 1 January 2021, by Council of Ministers Resolution 53/2020 of 10 July, which approved the National Energy and Climate Plan 2030 (PNEC 2030).

The PNEC 2030 is currently the main energy and climate policy instrument in Portugal and comes under the obligations established by Regulation (EU) 2018/1999 of 11 December 2018 (Regulation on the Governance of the Energy Union and Climate Action). It establishes national energy and climate targets for 2030, aligned with a carbon neutrality trajectory by 2050:

- Reduce greenhouse gas emissions by between 45 % and 55 % compared to 2005;
- Incorporate 47 per cent of energy from renewable sources into gross final energy consumption;
- Reduce primary energy consumption by 35 per cent with a view to improving energy efficiency;
- Achieve 15 per cent electricity interconnections.

The importance of meeting the following sectoral targets for reducing greenhouse gas emissions, with reference to emissions recorded in 2005, is emphasised:

- 70 % in the service sector;
- 35 % in the residential sector;
- 40 % in the transport sector;
- 11 % in the agricultural sector;
- 30 % in the waste and wastewater sector.

The Roadmap to Carbon Neutrality 2050 (RNC 2050), approved by Council of Ministers Resolution no. 107/2019 of 1 July 2019, aims to promote the decarbonisation of the economy and the energy transition towards carbon neutrality in 2050, as an opportunity for the country, based on a democratic and fair model of territorial cohesion that boosts wealth generation and the efficient use of resources. To this end, it sets the goal of reducing Portugal's GHG emissions by between 85 % and 90
% by 2050, compared to 2005, and the compensation of the remaining emissions through land use and forests, to be achieved through an emissions reduction trajectory between:

- 45 per cent and 55 per cent by 2030;
- 65 % and 75 % by 2040;
- 85 per cent and 90 per cent by 2050.

In conjunction with the RNC2050 objectives, the National Energy and Climate Plan (PNEC 2030), which is the main national energy and climate policy instrument for the 2021-2030 decade, has set targets for the 2030 horizon for the other sectors of the economy, not restricted to the energy sector, which should contribute to achieving these emission reductions. According to the PNEC 2030, the sector's emissions are expected to be reduced by 30 per cent by 2030, compared to the emissions recorded in 2005. This strategic document assumes that priority will be given to reducing waste production, followed by strengthening selective collection of waste, prioritising biological treatment of bio-waste and intensive exploration of solutions for reusing and recycling materials.

It is also important to mention the future strategy of the National Waste Management Plan 2030 (PNGR 2030), still in public consultation, which, by having the recognition of waste as a resource as a fundamental pillar, will help to meet the high level of ambition set by the new European targets, particularly those relating to landfill, preparation for reuse and recycling of municipal waste (MW), recycling of packaging or reduction of plastic, especially single-use plastic, as well as the obligation for selective collection of flows such as bio-waste, hazardous waste produced in households or textiles, and the need to combat food waste.

Sectoral policies should therefore favour solutions that contribute to carbon neutrality and avoid options that limit the achievement of decarbonisation objectives in the future, and recognising that the greatest efforts to reduce GHG emissions should be concentrated in the 2021-2030 decade, the National Waste Management Plan 2030 (PNGR2030), which is the main national waste policy instrument for the 2021-2030 decade, establishes ambitious targets in conjunction with the objectives of the RNC2050, and similarly to the PNEC2030.

The new Strategic Plan for Municipal Waste (PERSU 2030), still in public consultation, focuses on implementing the waste hierarchy, centred on prevention as a priority objective, promoting a sharp reduction in waste production, namely through measures that encourage reuse and/or extending the life of products. With regard to the production of waste that cannot be avoided, the Plan provides for a substantial increase in the amount of selectively collected waste, with a view to increasing the quality of recovered waste, an essential condition for obtaining products with greater added value, a key factor in the transition to a circular economy with a high level of efficiency in the use of resources. This Plan also sets targets for each Municipal Waste Management System (SGRU) in terms of preparing for reuse and recycling (PRR).

The National Strategy for Adaptation to Climate Change 2020 (ENAAC 2020), extended by Council of Ministers Resolution 53/2020 (PNEC 2030) until 31 December 2025, has as its vision: a country adapted to the effects of climate change, through the continuous implementation of solutions based on technical-scientific knowledge and good practices.

The Action Programme for Adaptation to Climate Change (P -3AC), approved by Council of Ministers Resolution no. 130/2019 of 2 August, establishes lines of action and measures to reduce vulnerabilities to climate change and thus constitutes a benchmark for national action on adaptation to climate change. It aims to fulfil the second objective of ENAAC 2020 - to implement adaptation measures - essentially by identifying physical interventions with a direct impact on the territory. To this end, it establishes the lines of action and the priority adaptation measures, identifying the organisations involved, the monitoring indicators and the potential sources of funding.

The nine lines of action established aim to reduce the main impacts and vulnerabilities of the territory, namely:

- Increased frequency and intensity of rural fires;
- Increased frequency and intensity of heat waves;
- Increased frequency and intensity of periods of drought and water scarcity;
- Increased susceptibility to desertification;
- Increase in maximum temperature;
- Increased frequency and intensity of extreme precipitation events;
- Rising sea levels;
- Increased frequency and intensity of extreme phenomena causing coastal erosion and overtopping.

In this context, **Table 2.1** identifies the strategic benchmarks that will be taken into account when drawing up the PMAC-Braga.

Table 2.1. Strategic benchmarks for drawing up PMAC-Braga

Instrument	Publication
United Nations Framework Convention on Climate Change (UNFCCC)	Decree 20/93 of 21 June 1993 (amended by Decree 14/2003 of 4 April 2003)
Paris Agreement	Resolution of the Assembly of the Republic no. 197-A/2016, of 30 December September 2016
2030 Agenda for Sustainable Development	Resolution A/RES/70/1 of the General Assembly of the United Nations (UN) of 25 September 2015
European Green Deal	Commission Communication COM(2019) 640 of 11 December 2019 2019
Objective 55" package	Commission Communication COM(2021) 550 of 14 July 2021
Sustainable and Intelligent Mobility Strategy	Commission Communication COM(2020) 789 of 9 December 2020
EU Strategy for Adaptation to Climate Change	Commission Communication COM(2021) 82 of 24 February 2021
EU Strategy for the Outermost Regions	Commission Communication COM(2022) 198 of 3 May 2022
EU Biodiversity Strategy for 2030 (EB2030)	Commission Communication COM(2020) 380 of 20 May 2020
EU Forest Strategy 2030	Commission Communication COM(2021) 572 of 16 July 2021
Farm to fork strategy	Commission Communication COM(2020) 381 of 20 May 2020
Strategy for the Bioeconomy	Commission Communication COM(2018) 673 of 11 October 2018
EU Soil Protection Strategy for 2030	Commission Communication COM(2021) 699 of 17 November 2021
Energy Performance of Buildings Directive	Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018
European Strategy for Plastics in the Circular Economy	Commission Communication COM(2018) 28 of 16 January 2018
EU Action Plan Towards Zero Pollution	Commission Communication COM(2021) 400 of 12 May 2021
Circular Economy Action Plan	Commission Communication COM(2020) 98 of 11 March 2020
National Spatial Planning Policy Programme (PNPOT)	Law no. 99/2019 of 5 September 2019
National Energy and Climate Plan 2030 (PNEC 2030)	Council of Ministers Resolution no. 53/2020, of 10 July 2020

Instrument	Publication
National Strategy for Adaptation to Climate Change (ENAAC2020)	Council of Ministers Resolution no. 56/2015, of 30 July 2015
Roadmap to Carbon Neutrality 2050 (RNC 2050)	Council of Ministers Resolution no. 107/2019, of 1 July 2019
National Hydrogen Strategy (EN-H2)	Council of Ministers Resolution no. 63/2020, of 14 August 2020
National Air Strategy (ENAR)	Council of Ministers Resolution no. 46/2016, of 26 August 2016
National Strategy to Combat Food Waste (ENCDA)	Council of Ministers Resolution no. 46/2018, of 27 April 2018
National Strategy for Nature Conservation and Biodiversity 2030 (ENCNB 2030)	Council of Ministers Resolution no. 55/2018, of 7 May 2018
Long-Term Strategy for Building Renewal (ELPRE)	Council of Ministers Resolution no. 8-A/2021, of 3 February 2021
Action Programme for Adaptation to Climate Change (P-3AC)	Council of Ministers Resolution no. 130/2019, of 2 August
National Strategy for Preventive Civil Protection (ENPCP)	Council of Ministers Resolution no. 112/2021, of 11 August
Strategic Transport and Infrastructure Programme (Peti3+)	Resolution of the Council of Ministers 61-A/2015, of 20th August
Sustainable Cities 2020" strategy	Council of Ministers Resolution no. 61/2015, of 11 May 2015 2015
Strategic Plan for the Common Agricultural Policy 2023-2027 (PEPAC)	https://www.gpp.pt/index.php/pepac/pepac-plano-estrategico-da-pac-2023-2027
Entre Douro e Minho Regional Forest Management Programme	Ordinance no. 58/2019 - DR no. 29/2019, Series I of 11 February, rectified by Declaration of Rectification no. 14/2019 - DR no. 73/2019, Series I of 12 April.
River Basin Management Plan for Hydrographic Region 2 (RH2) 3rd Cycle - PGRH do Cávado, Ave e Leça 2022-2027	Public consultation phase (https://participa.pt/pt/consulta/3-ciclo-2022-2027-project-of-pgrh-do-cavado-ave-and-leca-rh2)
Braga Municipal Masterplan	Notice no. 11741/2015 in Diário da República no. 201, 2nd Series, of 14th October 2015

Instrument	Publication
	https://pdmbraga.cm-braga.pt/index.php
Braga's Municipal Climate Change Adaptation Strategy (EMAAC)	https://www.cm-braga.pt/pt/1101/viver/ambiente/valorizacao-e-environmental-promotion/item/item-1-10117
Braga Municipal Forest Fire Defence Plan, 2021-2030	https://www.cm-braga.pt/pt/0101/viver/protecao-e-security/civil-protection-division/forest-technical-office
Cávado Intermunicipal Climate Change Adaptation Plan (PIAAC Cávado)	https://www.cimcavado.pt/estrategia-intermunicipal-de-adaptacao-the-climatic-changes-of-nut-iii-cavado/
Braga Sustainable Energy and Climate Action Plan (PAESC)	Not applicable
Strategic Plan for the Economic Development of Braga 2014-2026	https://www.cm-braga.pt/pt/0101/viver/inovacao/plano-estrategico-para- o-development

Of the references listed, the Intermunicipal Strategy for Adaptation to Climate Change of NUT III Cávado, the Municipal Strategy for Adaptation to Climate Change - Municipality of Braga and the Braga Sustainable Energy and Climate Action Plan (PAESC) are briefly presented, considering their relevance to the PMAC-Braga:

Intermunicipal Climate Change Adaptation Strategy for NUT III CÁVADO (includes Braga municipality)

The Cávado Intermunicipal Community identified the need to intervene in the face of climate change in order to adapt locally as fundamental, which meant determining a set of actions aimed at adapting to or mitigating the effects of these changes. These actions reflect the sub-region's concern for sustainable development and relate to the sectors of environmental education and awareness, awareness-raising for the general population, monitoring, evaluation and surveillance, green infrastructures, sustainable forest management, river resource planning and management and also forest and agricultural species, control of agroforestry pests and diseases, among others.

To summarise, the climate adaptation strategy aims to raise awareness of the changes climate and its impacts, keep scientific knowledge up to date and available and, in an integrated manner, define the measures to be adopted with a view to minimising the effects of climate change.

The adaptation measures considered for the NUT III Cávado region were as follows:

- Support, promote and collaborate in research / studies on the identification and control of invasive species;
- Support, promote and collaborate in research / studies into new crops (species) that are more resistant to adverse climatic phenomena;
- Support, promote and collaborate in research into new agricultural and wine-growing practices that are better suited to the new climatic conditions and water availability;
- Support, promote and collaborate in research into land use management practices (agricultural and forestry) that are suited to current and future climate conditions;
- Promote awareness-raising activities for the population on the importance of saving water;
- Promote awareness-raising actions for the population on climate change and the risks (current and future impacts and consequences), adaptation, mitigation and self-protection measures to adopt;
- Promote awareness-raising activities for the business sector on climate change (vulnerabilities and opportunities);
- Promote awareness-raising activities for the hotel sector on climate change (vulnerabilities and opportunities);
- Promote awareness-raising activities for political decision-makers on climate change (vulnerabilities and opportunities);
- Support, promote and collaborate in research / studies to identify the main negative impacts (threats) and positive impacts (opportunities) of existing / new dams, in a context of climate change;
- Develop and implement a contingency plan for heat waves;
- Assessment of the main negative (threats) and positive (opportunities) impacts of climate change and identification of adaptation strategies for the tourism sector;
- Develop and implement a programme of soil protection measures to mitigate climate change to mitigate climate change;
- Develop a programme of measures to make use of rainwater, reuse wastewater and increase water storage capacity;
- Implement a system for acquiring and monitoring the vulnerabilities of NUT III Cávado to climate change;

- Promote training actions for municipal technicians to integrate adaptation and draw up municipal strategies;
- Promote training on financing adaptation to climate change;
- Promote training sessions on efficient irrigation systems and good agricultural practices;
- Promote awareness-raising activities for the agroforestry sector on climate change (vulnerabilities and opportunities);
- Develop a guide to good practice in sustainable construction and/or refurbishment;
- Develop a municipal guide to good practices for the efficient use of water.

Municipal Strategy for Adaptation to Climate Change - Municipality of Braga (EMAAC Braga)

The Braga EMAAC aimed to promote a coherent response in the municipality of Braga to the many problems related to climate change.

Climate projections for the municipality of Braga point to a potential decrease in total annual rainfall and a potential increase in temperatures, particularly maximum temperatures in summer and autumn, intensifying the occurrence of hotter and drier summers. An increase in the frequency of heat waves and intense or very intense precipitation events is also projected.

These changes could have a number of impacts on the municipality's territory, as well as on natural and human systems. Even if we consider responses based on planned adaptation to future climate scenarios, there will always be climate risks that will affect the municipality in multiple environmental, social and economic aspects.

The results obtained indicate that the main climate impacts observed in the municipality are generally associated with the following climatic events:

- Excessive rainfall/flooding and damage;
- Excessive rainfall/slides;
- High temperatures and heatwaves;
- Strong wind.

Table 2.2 summarises the main impacts associated with climatic events observed for the municipality of Braga.

Table 2.2. Summary of the main impacts associated with climatic events with observed consequences for the municipality of Braga

1.0 Excessive rainfall / flooding and damage
1.1 Damage to buildings and their contents
1.2 Traffic restrictions
1.3 Damage to health
1.4 Damage to vegetation and changes in biodiversity
1.5 Power supply failures
2.0 Excessive rainfall / landslides
2.1 Damage to vegetation
3.0 high temperatures and heatwaves
3.1 Increased fire risk and fire occurrence
3.2 Damage to health
4.0 Strong wind
4.1 Damage to buildings and their contents
4.2 Damage to vegetation

Braga's EMAAC therefore focused on identifying planned adaptation options and actions aimed at minimising the effects of climate change. Based on the identification and prioritisation of climate vulnerabilities and risks and their projection until the end of the century, the Municipality of Braga sought to promote an integrated set of adaptation options to respond not only to the future climate, but also to the different climate impacts already observed. Thus, 29 adaptation options were established:

- Creation of a Municipal Civil Protection Centre;
- Creation of a monitoring system for river flows and flood zones (tunnels);
- Monitoring of air quality parameters (O3) and meteorology;
- Monitoring the health of the tree park;
- Production of a municipal manual of good practices;
- Promotion of the study and definition of a set of tree and shrub species to be preferentially used in both local authority and private initiative projects, within the scope of the preparation of the Good Practices Manual;
- GIS preparation of a "Climate Change Susceptibility Map" for the municipality;
- Implementation of an annual training and awareness-raising plan;

- Construction of retention basins upstream of the city (Sete Fontes Park; Este River Valley), Torto River (Real, Dume and Frossos);
- De-silting of water lines and optimisation of preventive processes at the beginning of autumn with regard to rainwater drainage: collection of foliage, cleaning of ditches and gutters,
etc;
- Rehabilitation of riparian galleries;
- Integration between sustainable drainage systems (bio-swales or others) and the existing or planned rainwater network;
- Promoting the development of urban design options: creation of infiltration gardens/retention basins/conversion of impermeable pavements;
- Creation of buffer strips with shrub vegetation on the slopes most susceptible to water erosion;
- Introduction of shading elements, based on vegetation, in the most open and busy streets;
- Promoting the increase and diversification of green spaces, including vertical gardens and landscaped roofs;
- Promotion of shading zones in artificial structures built in critical areas;
- Introduction of evaporative cooling solutions (such as water mirrors, sprinklers and sprays) in green spaces and public open spaces;
- Maintenance of natural ventilation corridors (wooded banks of water courses, especially along the slopes of the main local reliefs) and urban corridors (tree-lined streets, with
orientation of the prevailing winds, north-south and north-west-south-east);
- Promoting bioclimatic and energy-efficient construction;
- Promotion of a programme to improve the use of treated and free water (boreholes, wells, mines, etc.);
- Recovery, conservation and extension of water storage infrastructures;
- Re-use of treated water from the WWTP for irrigation;
- Promoting the utilisation of forest biomass (water heating, pellets, etc.);
- Promoting forest planning and management - favouring native species, making mosaics and opening firebreaks, installing water points, etc;
- Promoting the control of invasive species, pests and diseases;
- Implementation of an integrated mobility plan to effectively reduce the use of individual motorised transport, promoting travel by public and private transport.
soft modes (cycling and walking);

- Promoting the cultivation of alternative agricultural species adapted to climate change;
- Promoting an increase in the area of agricultural land worked.

Braga Sustainable Energy and Climate Action Plan (PAESC)

The Municipality of Braga signed the Covenant of Mayors for Climate and Energy, launched in 2008 in Europe, with the ambition of bringing together local governments voluntarily committed to achieving and surpassing the EU's climate and energy targets. In 2016, the Covenant of *Mayors* took on new objectives by merging with the *Mayors Adapt* initiative, aimed at adapting to climate change, giving rise to the new Covenant of Mayors for Climate and Energy.

In order to translate the political commitment into measures and projects, the signatories undertook to present the Braga Sustainable Energy and Climate Action Plan (PAESC), which defines the various energy sustainability measures, for each energy-consuming sector and across the board, whose implementation is intended to fulfil the commitment to the Covenant of Mayors, namely a reduction in their CO_2 emissions by at least 55% by 2030 and achieving climate neutrality by 2050.

It is with this in mind that the Municipality of Braga published its 2022 EEAP, with a total of 70 energy sustainability projects, forecasting a 42 per cent reduction in consumption in 2030 and a 56 per cent reduction in CO_2 emissions, distributed among the following energy sustainability measures:

- Efficient lighting in buildings;
- Energy audits, efficient construction and building certification;
- Open energy management systems;
- Integrated renewable generation;
- Sustainable water management;
- Awareness-raising and education for climate sustainability;
- Green public procurement;
- Optimisation of professional performance;
- Other actions to improve energy sustainability;
- Efficient air conditioning and ventilation systems;
- Efficient office equipment;

- Optimised management of public lighting;
- LED and efficient luminaires in public lighting;
- Solar thermal energy;
- Natural gas;
- Efficient industrial equipment and processes;
- Efficient vehicles and fleets;
- Electric mobility;
- Optimisation of the public transport network;
- Urban regeneration and optimising the energy and climate aspects of urban planning;
- Increased "pedestrianisation" and bicycle use;
- Optimising professional and commuter mobility;
- Carbon sequestration.

In addition to the most relevant benchmarks identified in **Table 2.1**, elements and results from the following strategic benchmarks and municipal initiatives will also be analysed and articulated, where applicable:

- Parishes Environmental Enhancement Programme;
- Braga Walking Route Network;
- ClimAdaPT.Local Project;
- CDP Questionnaire for Cities;
- Three4climate;
- Camélias Urban Park - Laboratory for the Braga EMAAC;
- Creation and provision to schools of "Rios Laboratories";
- Walking Science - Rivers theme, among others;
- Inside the Parretas Urbanisation block;
- Picoto Park afforestation project as part of the Monte do Picoto Park Detail Plan;
- Study to Evaluate Braga's Solar Potential and Bio-Roofs;
- Municipal Manual of Good Practices for adapting to climate change (CIM);

- Eco XXI Municipal Green Flag;
- Oxygenating Braga;
- Environmental Education Campaign on Climate Change;
- Laboratory for Decarbonisation.

2.2.2 Normative Framework

The legal framework in the field of climate action includes a number of European, national and regional laws and regulations, the most relevant of which are highlighted below:

- Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing a scheme to achieve climate neutrality and amending Regulation (EC) No 401/2009 and (EU) 2018/1999 ("European Climate Law");
- Law no. 98/2021, of 31 December 2021 (Basic Climate Law), which defines the bases of climate policy;
- Decree-Law no. 86/2021, of 19 October 2021, which establishes the legal framework for the promotion of clean road transport vehicles in favour of low emission mobility. emissions;
- Decree-Law no. 50/2021, of 15 June 2021, establishing the legal framework for energy efficiency management contracts to be concluded between the state and service companies energetic;
- Decree-Law no. 12/2020, of 6 April 2020, which establishes the legal regime applicable to greenhouse gas emission allowance trading, transposing Directive (EU) 2018/410.

Within the scope of this plan, we highlight the Basic Climate Law, approved and published by Law no. 98/2021, of 31 December, which recognises the climate emergency situation and defines the bases of climate policies in Portugal, aimed at ecological balance and combating climate change.

3. Biophysical and Socioeconomic Characterisation

3.1. Territory

The municipality of Braga (**Figure 3.1**) is administratively in NUTS II - Norte and NUTS III - Cávado. The municipality is made up of 37 parishes/unions of parishes[2] (**Figure 3.2**), with a total area of around 183 km^2, with Amares and Vila Verde (to the north), Barcelos (to the west), Vila Nova de Famalicão and Guimarães (to the south) and Póvoa de Lanhoso (to the east) as neighbouring municipalities.

Figure 3.1. Territorial framework map of the municipality of Braga

Source: CAOP, DGT (2021)

[2] Adaúfe; Braga (São Vicente); Braga (São Vítor); Espinho; Esporões; Figueiredo; Gualtar; Lamas; Mire de Tibães; Padim da Graça; Palmeira; Pedralva; Priscos; Ruilhe; Sequeira; Sobreposta; Tadim; Tebosa; União das freguesias de Arentim e Cunha; União das freguesias de Braga (Maximinos, Sé e Cividade); Union of the parishes of Braga (São José de São Lázaro and São João do Souto); Union of the parishes of Cabreiros and Passos (São Julião); Union of the parishes of Celeirós, Aveleda and Vimieiro; Union of the parishes of Crespos and Pousada; Union of the parishes of Escudeiros and Penso (Santo Estêvão and São Vicente); Union of the parishes of Este (São Pedro and São Mamede); Union of the parishes of Ferreiros and Gondizalves; Union of the parishes of Guisande and Oliveira (São Pedro); Union of the parishes of Lomar and Arcos; Union of the parishes of Merelim (São Paio), Panoias and Parada de Tibães; Union of the parishes of Merelim (São Pedro) and Frossos; Union of the parishes of Morreira and Trandeiras; Union of the parishes of Nogueira, Fraião and Lamaçães; Union of the parishes of Nogueiró and Tenões; Union of the parishes of Real, Dume and Semelhe; Union of the parishes of Santa Lucrécia de Algeriz and Navarra and Union of the parishes of Vilaça and Fradelos.

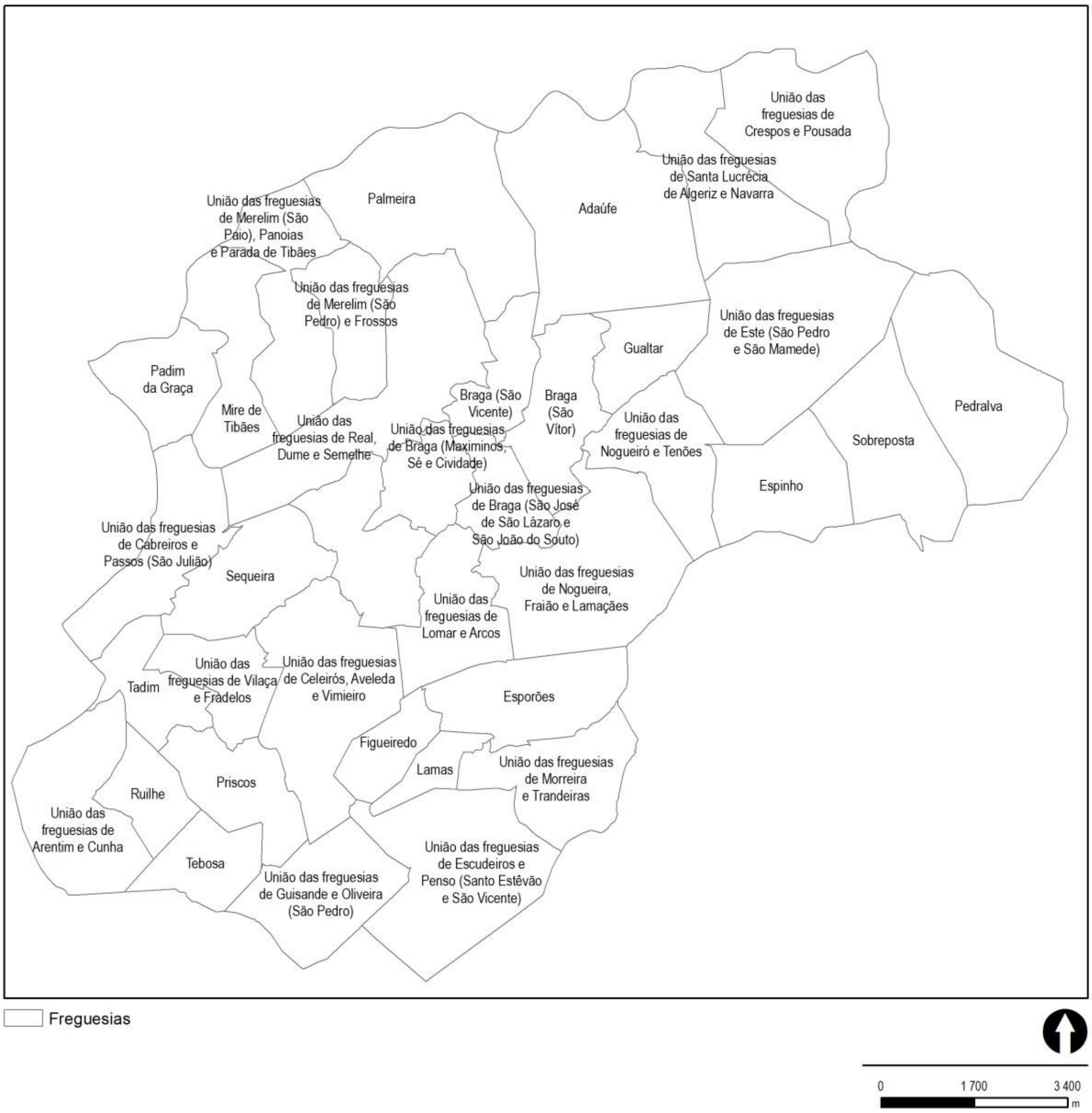


Figure 3.2. Parishes in the municipality of Braga

Source: CAOP, DGT (2021)

3.2. Land occupation

The municipality of Braga has heterogeneous characteristics in terms of land use, reflected in a concentration of urbanised land in the central core of the municipality, surrounded by more rural parishes where land use is more in keeping with this rurality.

According to the 2018 Land Use Map, the municipality of Braga (**Figure 3.3.** and **Table** 3.1) is predominantly dominated by Forests (6,721 ha; 36.7% of the municipality) which are mainly distributed in the southeast, running from the source of the river Este to Monte da Santa Marta das Cortiças. The Artificialised Territories (5,708 ha; 31.1% of the municipality) are mainly located in the centre of the municipality and along the main communication routes. Agriculture covers around 27% (4 882.6 ha) of the municipality and is associated with rural centres and watercourses. The classes of woodland, surface water bodies, pastures, open spaces and agroforestry have smaller areas of occupation.

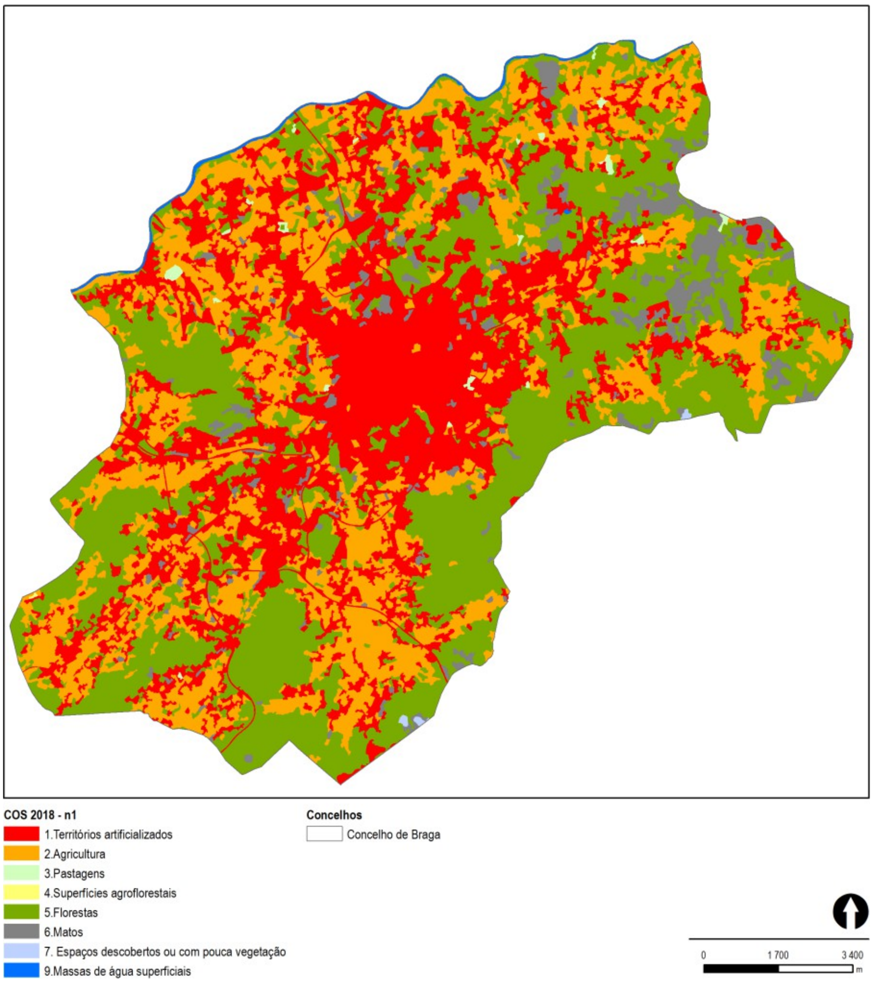


Figure 3.3. Land Use Map 2018 for the municipality of Braga

Source: DGT (2018)

Table 3.1. Land Use Classes in the municipality of Braga (ha, %).

COS class 2018 - level 1	Area	
	ha	%
1. artificialised territories	5 708,5	31,1
2. Agriculture	4 882,6	26,6
3. Pastures	55,7	0,3
4. agroforestry areas	1,3	0,01
5. Forests	6 721,9	36,7
6. Matos	869,1	4,7
7. Open spaces with little vegetation	11,6	0,06
9. Surface water bodies	89,2	0,5
Total	**18 339,9**	**100,0**

The concentration of the building stock is intrinsically linked to population concentration, with a clear majority of buildings in the centre of the municipality (**Figure 3.4**).

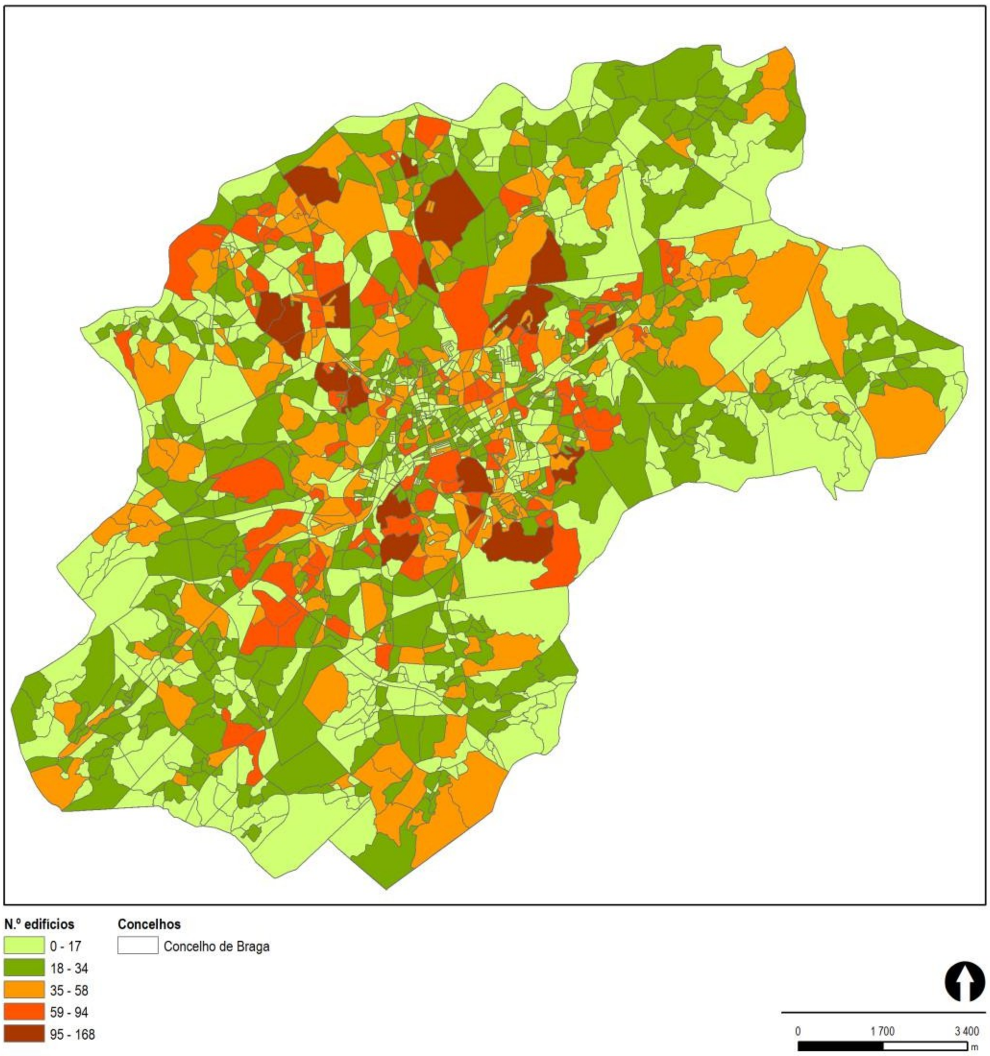


Figure 3.4. Number of buildings in the municipality of Braga

Source: INE (2021)

According to the results of the latest general population census of 2021 (**Table** 3.2), there were 40,214 buildings in Braga, of which around 99 per cent were exclusively residential buildings, which corresponds to an increase of around 12 per cent compared to the last census period. The increase in exclusively residential buildings in the municipality is even higher than the growth seen in NUT II Norte - 9.5 per cent and NUT III Cávado - 11.7 per cent.

It should be emphasised that there are very few buildings in the municipality with a function other than residential, the vast majority of which are industrial buildings, warehouses and shops.

Table 3.2. Buildings according to their function in the municipality of Braga (ha, %).

Type of buildings	NUT II North			NUT III Cávado			Braga municipality		
	2001	2011	2021	2001	2011	2021	2001	2011	2021
Exclusively residential (100%)	989 860	1 116 665	1 222 321	94 390	115 923	129 429	29 148	35 485	39 860
Mainly residential (50-99%)	99 918	85 088	5 374	10 335	7 525	500	3 300	3 060	341
Mainly non-residential (up to 49%)	10551	8 158	299	698	966	17	333	347	13
Total	1 100 329	1 209 911	1 227 994	105 772	124 414	129 946	32 780	38 892	40 214

Source: INE, 2023

With regard to school facilities, in the municipality of Braga there are 102 pre-schools, 74 primary schools, 21 secondary schools, 27 secondary schools, 10 secondary schools, 3 art schools, 4 vocational schools and 3 special education schools (**Table 3.3**).

Table 3.3. School network by level of education in the municipality of Braga, school year 21/22 (ha, %).

Level	NO.
Pre-school	102
1st cycle	74
2nd cycle	21
3rd cycle	27
Secondary	10
Artistic	3
Professional	4
Special	3
Total	**102**

Source: DGEEC, 2023

The municipality of Braga has 28 primary health care centres, largely distributed among 19 family health units, and six hospitals, one of which is public, as well as five (5) private hospitals. There are also 38 pharmacies in the municipality (**Table 3.4**).

Table 3.4. Health facilities in the municipality of Braga (ha, %)

Level		NUT II North	NUT III Cávado	Braga
*Hospitals	Total	79	14	6
	Public	34	2	1
	Private	45	12	5
**Primary health care	Grouping of health centres	-		1
	Health centres	-	-	2
	Personalised healthcare units	-	-	2
	Community care units	-	-	3
	Shared care resource units	-	-	1
	Family health units	-		19
*Pharmacies		907	90	38
*Doctors		20 602	2 346	1 643
*Nurses		27 975	2 934	1 755

Source: *INE (2021); **SNS (2023)

In terms of civil protection, the municipality has two (2) fire stations, staffed by 144 firefighters. In terms of public security forces, the municipality has four (4) GNR posts, two of which are in the municipality.

(2) PSP police stations, one (1) PJ police station, one (1) SEF police station and one (1) Municipal Police station (**Table 3.5**).

Table 3.5. Civil protection agents in the municipality of Braga (no.)

Civil protection agents		Number
Civil protection equipment	Corporations	2
	Fire Brigade	144
	Red Cross	1
Public security equipment	GNR	4
	PJ	1
	PSP	2
	SEF	1
	PM	1
Armed forces		1
Civil protection equipment - other		2

Source: PMEPCB, CMB, 2018.

The municipality's network of solidarity and social security facilities is made up of 96 social facilities, of which daycare support accounts for 40 facilities (around 42%) and residential facilities for the elderly (homes and day centres) 38 facilities (**Table 3.6**).

Table 3.6. Solidarity and social security facilities in the municipality of Braga (no.)

Civil protection agents		Number
Children and young people	Crèche, kindergarten and nursery school (IPSS)	40
	Children's home	7
Elderly	Day centres	11
	Nursing or retirement home	15
	Nursing home and day centre	10
	Nursing home and crèche and EB1/2	2
General population	Rehabilitation and integration of people with disabilities	7
	Rehabilitation and integration of drug addicts	4

Source: PDM Braga (2014)

The municipality of Braga has a wide range of cultural facilities, mainly in the city centre, totalling 29 (**Table 3.7**).

Table 3.7. Cultural facilities in the municipality of Braga (no.)

Equipment	Number
Theatre	1
Municipal auditorium	2
Showground	2
Venue rooms/spaces	6
Libraries	2
Museums	8
Video library/Internet space	3
District archive	1
Exhibition room	4

Source: PDM Braga (2014)

The municipality of Braga has 872 sports facilities. Around 43 per cent of these facilities are owned by the municipal administration, while around 23 per cent are managed by parish councils and 34 per cent by others. The most representative infrastructures are small pitches and playgrounds, with 29 and 26 per cent of the total (**Table 3.8**).

Table 3.8. Sports facilities in the municipality of Braga (no.)

Equipment	Number
Large fields	60
Small fields	256
Pavilions	47
Sports halls	105
Athletics tracks	18
Swimming pools	47
Playgrounds	230
Fitness parks	80
Other [3]	29

Source: Braga Sports Charter (2014)

3.3 Accessibility and Mobility

The population living in Braga and the neighbouring municipalities has very diverse travel needs. However, it is possible to observe commuting trends for the majority of the population. The latest census results for 2021 show that 81 per cent of the population living in Braga works within the municipality (**Figure 3.5**), with the majority working in another parish in the municipality (61 per cent), and 20 per cent in another parish. Only 18 per cent work outside the municipality. Even so, 50 per cent of the resident population use the light car as their preferred means of travel as a driver and 19 per cent as a passenger. The rest of the population prefers to walk (16%) and only 10% use public transport as their mode of transport. In terms of changes compared to previous census results, the use of walking and public transport fell by 13% and 12% respectively. The use of cars increased by 10 per cent between 2011 and 2021. The use of soft modes such as cycling has changed very little since 2011, continuing to show shares of cycling in modal journeys of approximately 0.3% (**Figure 3.6**).

[3] Extreme Parks; River Beaches; Ecotracks; Ecovias; Maintenance Circuits; Cycle Routes; Equestrian Infrastructures; Aerodrome; Aeromodelling Track; Golf Course; Autodrome; Karting Track; Shooting Ranges; among others.

There are already some cycle routes in the city, such as the Ecovia do rio Este and other existing cycle routes in the urban context, which are the initial step towards promoting this sustainable mode of transport, but they don't have the characteristics of permeability to the different areas of the city. The city of Braga has a compact character, with distances that are reflected in relatively short journey times that encourage the use of cycling. The significant number of roads with a gradient compatible with cycling and the percentage of commuter journeys made within the urban perimeter are relevant indicators that make it feasible to implement measures to encourage cycling. The lack of a dedicated cycle route to most of the centres that generate journeys is one of the factors that contributes to the existence of a frankly residual percentage of journeys made by cycle, along with the perceived danger of travelling by car, exposure to air and noise pollution or long journey distances.

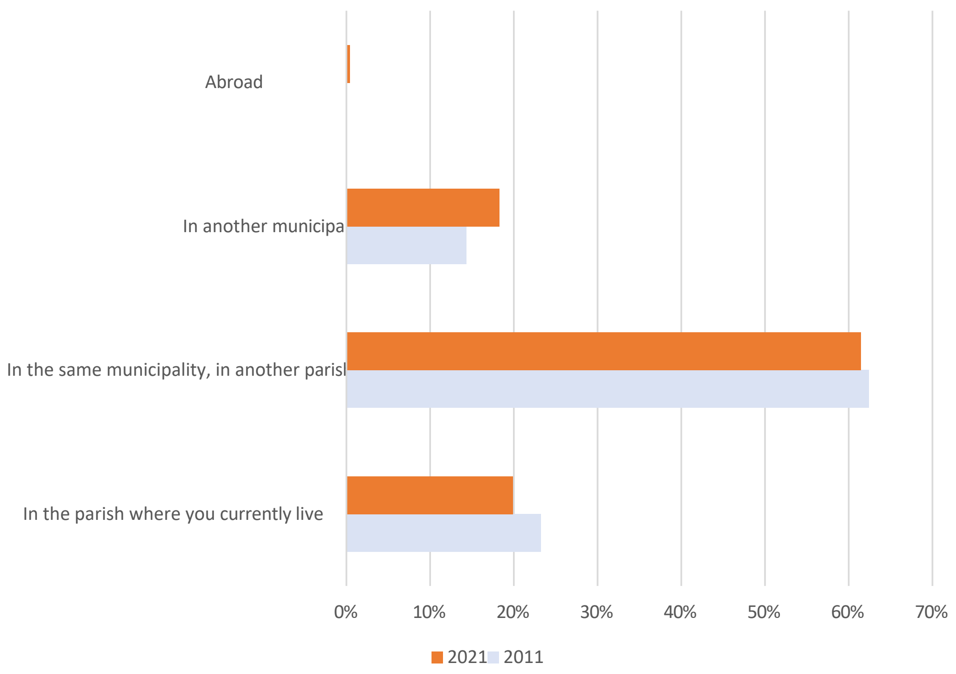


Figure 3.5. Modal journeys by means of transport and place of work or study in the municipality of Braga

Source: Censos2021 /INE, 2022

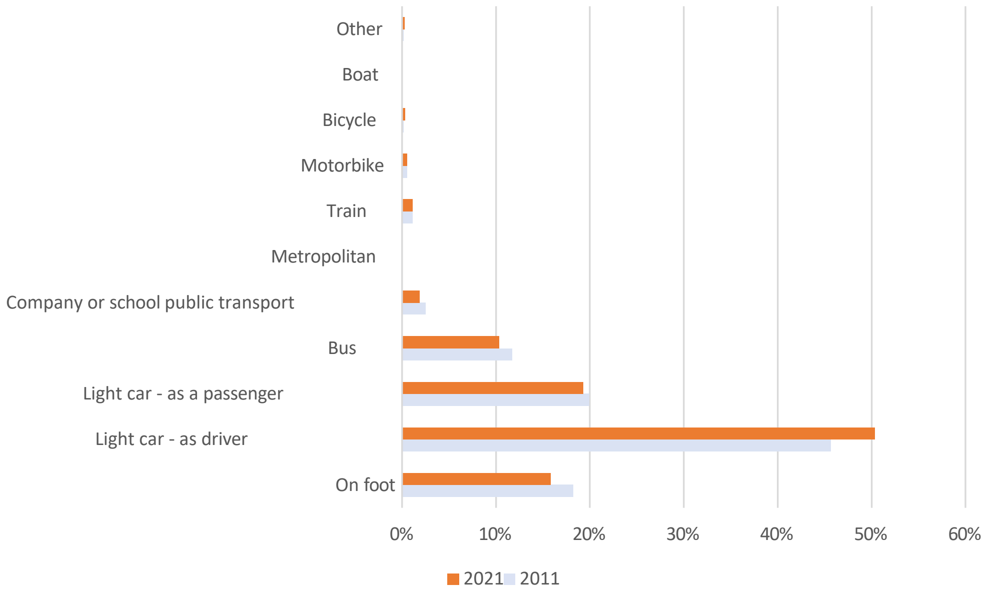


Figure 3.6. Modal journeys by means of transport and place of work or study in the municipality of Braga, by type of transport

Source: INE, 2022. Census2021

The cycling network proposed in the Braga Municipal Master Plan - Notice no. 11741/2015 in Diário da República no. 201, 2nd Series, of 14 October 2015 - was defined taking into account the desires of users of this mode of transport, as well as the location of the centres that generate and attract mobility. The proposal sought to:

- Achieve a 10 per cent modal index for the use of bicycles as Braga's means of transport in the next decade;
- Improving safety for cyclists;
- Develop and maintain a safe, connected and attractive cycling network in the city of Braga;
- Provide support facilities to make cycling a more convenient mode of transport;
- Identify partners to provide education, enforcement and incentive programmes for cycling.

To this end, the document provides for the consolidation of a structuring cycling network, estimated at 76 kilometres (**Figure 3.7**) and which provides for the "restructuring of the road network, including the creation of coexistence zones, as well as 10 km/h zones and 30 km/h zones" (in Municipal Master Plan Report, 2015).

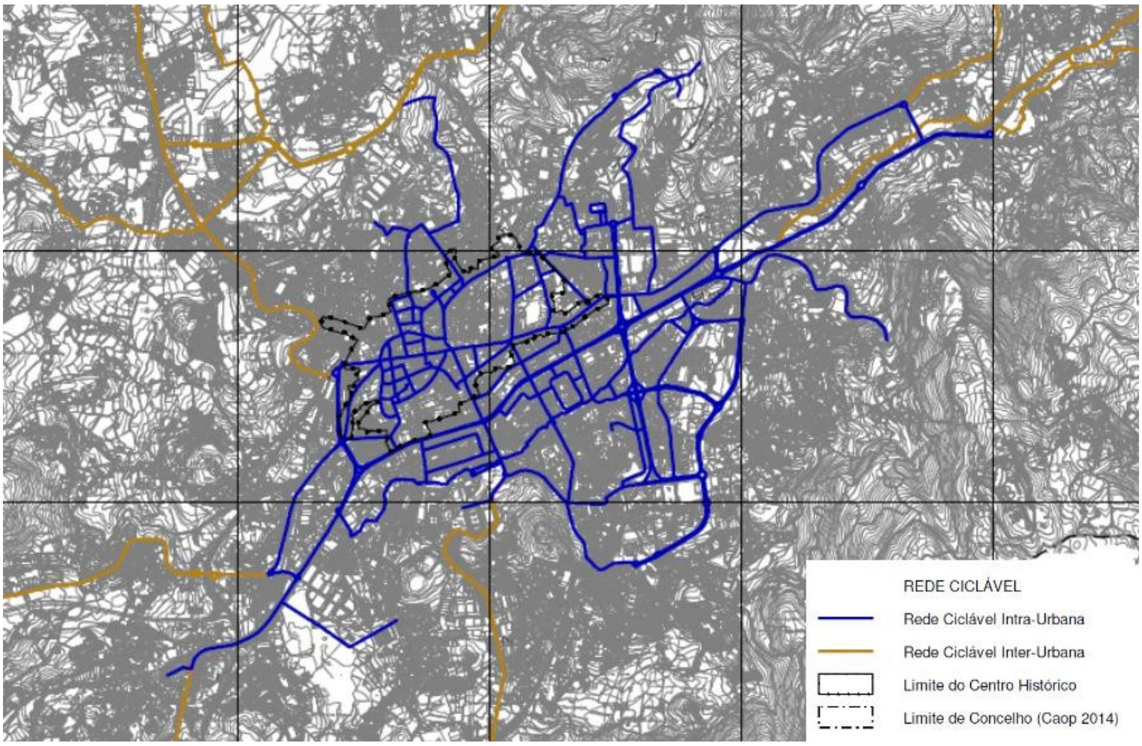


Figure 3.7. Urban cycle network in the municipality of Braga

Source: Braga City Council, PDM 2015

As relevant interventions to be carried out in the short term for the expansion of the cycling network, the municipality has defined:

- The redevelopment of the Encosta - Lamações bypass and its extension to provide an effective link to the University of Minho, but also to adjacent structuring roads such as Avenida António Palha and Robert Smith Avenue, providing a logical expansion of the network;
- The implementation of a cycle route on Av. 31 de Janeiro;
- The implementation of cycle routes around the Infias roundabout, allowing for a safer and more comfortable connection between Rua Conselheiro Bento Miguel and Rua Dr. Domingos Soares;
- The implementation of a cycle path on the western section of the Fojo bypass and on the southern section of Avenida da Liberdade (southern section), as well as the repaving and insertion of a cycle path on the central section of the bypass.
Fojo.

More recently, Braga council approved the Sustainable Urban Mobility Plan (SUMP), an essential tool for promoting more sustainable mobility in the municipality, with lower costs and environmental impacts. The document aims to establish a strategy for sustainable mobility, reduce the carbon footprint, promote soft mobility and public transport, with the consequent improvement in citizens' quality of life.

The vision of this Plan is to realise a "Zero Carbon" municipality, whose mission is to improve the quality of life of its citizens. To this end, this Plan favours pedestrianisation first and foremost, in order to promote sociability, the local and traditional economy, thus promoting the city and its livability, which is the primary mode of transport for all citizens. To this end, the SUMP provides for the expansion of the predominantly pedestrianised and/or urban coexistence area.

Secondly, the SUMP considers it essential to highlight cycling, as it is a sustainable mode of transport that is favourable for longer distance journeys than pedestrians, above all because of the speed it achieves. The potential for using a bicycle is highest for journeys of up to 5 or 7 kilometres in urban areas, and since a high percentage of journeys made by individual transport are shorter than this distance, cycling is the most favourable mode of travel. From the perspective of mobility as a service, the aim is to introduce a system of shared public bicycles, promoting the provision of cycling infrastructure that allows this mode of travel to become a real alternative to individual motorised transport.

The third priority of mobility policies is to improve public transport by improving its territorial and temporal coverage, user convenience and providing more and better information to the public, not forgetting energy efficiency by opting for vehicles with reduced pollutant emissions. In this area, the strategy should focus on promoting a territorially equitable and universally accessible offer of road and rail public transport services, with a view to boosting intra- and inter-city relations.

Equally fundamental in this SUMP is the promotion of integration between the various modes of transport - intermodality - in other words, complementarity between different modes through travel chains, whereby citizens use the mode that, considering their specific characteristics, is best suited to each journey.

Finally, the document states that it is important to reduce the need for individual motor vehicles and rationalise their use by creating conditions for sustainable travel, optimising the road system and balancing urban logistics actions.

In this way, the strategy defined by the SUMP is aimed at a more sustainable, equitable and healthy city. It involves the articulation between mobility and public space, through the promotion of pedestrian accessibility throughout the urban environment, the suitability of routes or areas for cycling, the use of different modes of transport in increasingly long and complex movements, and also the City's ability to provide good conditions for becoming more comfortable and greener.

The SUMP will be an essential tool for planning the actions to be implemented in the territory, alongside other strategic documents of the municipality, such as the PDM. In this sense, this Plan is defined as a reference tool to support decision-making by the municipality within the scope of its competences regarding transport and mobility. This strategic document should not b e regulatory in nature, but it does produce guidelines that can be integrated into municipal regulations in the areas of planning and managing mobility, transport and public space.

The municipality of Braga has a vast accessibility network, allowing for quick inter-regional and international connections. Highlights include access via the road network (IP1-A3, IP9-A11 and IC14-A11) and the Braga railway branch, as well as its proximity to Francisco Sá Carneiro Airport (Porto) and Vigo Airport.

The municipality of Braga has a considerable number of road infrastructures, which can be consulted in drawing No. 4 of the Braga PDM - Road Network Administrative Hierarchy Plan, an extract of which can be seen in **Figure 3.8**.

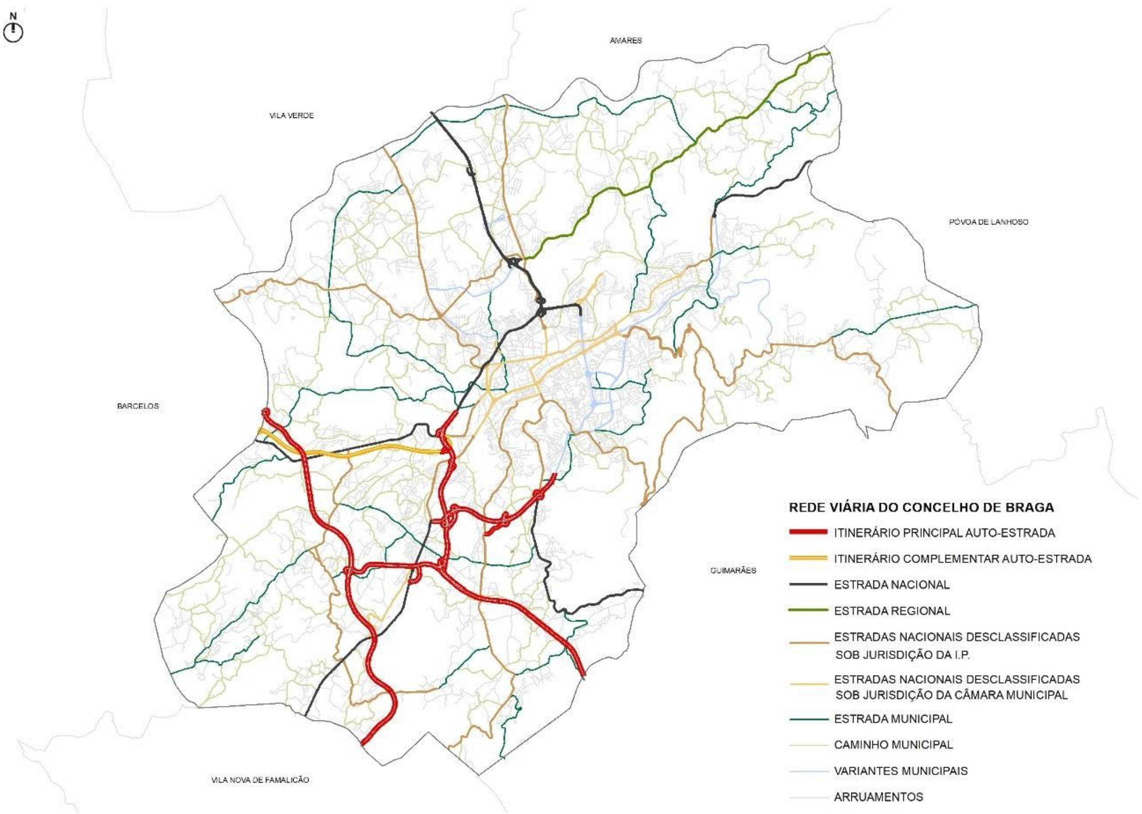


Figure 3.8. Administrative hierarchy of Braga's road network

Source: Braga City Council, Braga PDM Revision, 2015

According to the revision of Braga's PDM (adapted from the National Road Plan 2000), the national network that crosses the municipality is made up of the following main national and regional roads that directly serve the municipality of Braga (**Table 3.9**).

Table 3.9. Road network in the municipality of Braga

Hierarchy		Name
National Network	National Fundamental Network	IP1 (A3); IP9 (A11)
	Complementary National Network	IC14; (A11)
	National Network	EN14; EN101; EN103; EN201
	Regional Network	EN205; EN205-4
	Declassified Network	Section of EN101; Section of EN103, EN103-2; EN103-3; EN205-4; EN309; EN585
	Variants under Article 8 of Decree-Law 222/98 of 17th July	South ring road; North ring road; EN101/201 bypass
Municipal Network	Municipal roads	EM561; EM562; EM562-1; EM563; EM564; EM565; EM569; EM569-1; EM584; EM584; EM584-1; EM585; EM587; EM588; EM588-1; EM589; EM590; EM591; EM591; EM591-1; EM594; EM597; EM627; EMEM628;
	Municipal paths	CM1084; CM1084-1; CM1221; CM1277; CM1277-1; CM1277-2; CM1278; CM1278-1; CM1278-2; CM1278-3; CM1279; CM1280; CM1281; CM1281-1; CM1282; CM1282-1; CM1282-2; CM1283; CM1283-1; CM1283-2; CM1284; CM1285; CM1286; CM1286-1; CM1286-2; CM1287; CM1288; CM1289; CM1289-1; CM1290; CM1291; CM1292; CM1293; CM1294; CM1295; CM1296; CM1296-3; CM1297; CM1298; CM1299; 1299-1; CM1300; CM1301; CM1302; CM1302-1; CM1303; CM1303-1; CM1303-2; CM1304; CM1305; CM1306; CM1307; CM1308; CM1308-1; CM1309; CM1310; CM1311; CM1312; CM1313; CM1313-1; CM1314; CM1314-1; CM1315; CM1316; CM1316-1; CM1317; CM1318; CM1319; CM1319-1; CM1320; CM1321; CM1321-1; CM1322; CM1322-1; CM1323; CM1324; CM1325; CM1325-1; CM1325-2; CM1326; CM1326-1; CM1327; CM1328; CM1329; CM1330; CM1331; CM1332; CM1333; CM1333-1; CM1333-2; CM1334; CM1335; CM1336; CM1336-1; CM1337; CM1338; CM1338-2; CM1339; CM1340; CM1341-1; CM1341; CM1341-1; CM1343; CM1343-1; CM1343-2; CM1344; CM1345; CM1346; CM1347; CM1348; CM1349
	Municipal Variants	Avenida do Estádio; Via do Alto da Vela; Variante Sul; Variante do Fojo; Variant of Real;
	Municipalised Roads	Stretches of EN14; EN103; EN201; EN101; EN585

Source: Braga City Council, Braga PDM Revision, 2015

In order to resolve the situation and improve circulation, the intention is to create an external road structure, known as the Circular Exterior, which has been partially built. This will be made up of new municipal bypasses and an existing one (Variante do Fojo), above all, they will be roads for passing and circulation.

- Eastern Bypass: This runs through the eastern part of the municipality, between the junction of the South Circular, in the parish of S. Paio de Arcos, and ends at the junction of the Fojo Bypass;
- EN103 bypass: Starts at the last junction north of the Fojo bypass, in the direction of Póvoa de Lanhoso (EN103), in the direction of the new Braga Hospital and the University of Minho.
  do Nordeste and the extension of Alameda do Hospital;
- Nordeste Bypass: This starts in the north-eastern part of the municipality and connects the Cávado Bypass to the EN103 Bypass;
- Cávado bypass: connects the existing parishes to the north to the existing structural network, namely the A3 and A11;
- Cones Bypass: This will connect to the Cávado Bypass and will be located to the north of the existing junction of the EN103 with the EN14 Bypass (North Circular) in the parish of Ferreiros;
- Route linking to the EN309 in Nogueira: Develops in a south/north direction in the parish of Nogueira, starting from a junction on the Eastern Route, distributing traffic.
  from the south to the urban centre.

The Braga PDM Revision, taking into account the criteria described above, suggests the functional classification of roads based on five typologies (**Figure 3.9**).

- Arterial Routes (Level I);
- Main Distribution Routes (Level II);
- Secondary Distributor Routes (Level III);
- Local Distribution Routes (Level IV);
- Local Access Routes (Level V).

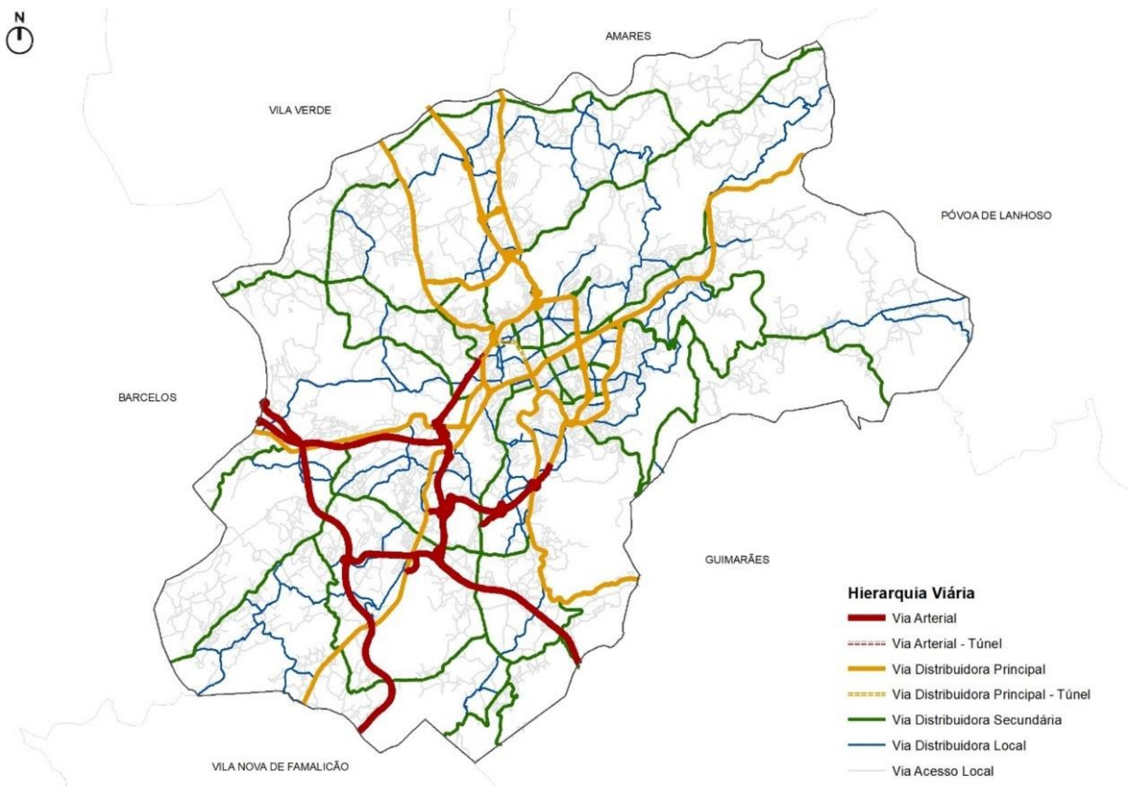


Figure 3.9. Road hierarchy in the municipality of Braga

Source: Braga City Council, Braga PDM Revision, 2015

The municipality's total road network is around 1,267 km long and has a density of around 7 km/km² (**Table 3.10**). The upper level and collector roads account for around 5.5% of the road network in the municipality of Braga, representing 70 km of the total road length and providing connections to Porto, Guimarães, as well as crossing the municipality and its main settlements. The rest of the network covers the municipality of Braga. It should be noted that local access roads total 1,058 km, representing around 83.5% of the municipality's network.

Table 3.10 Extension and density of the road network, by hierarchical level, in the municipality of Braga

Road hierarchy	Extension		Density (km/km2)
	km	%	
Higher education	38	3	0,21
Collector road	32	2,5	0,17
Main distribution route	54	4,3	0,29
Secondary distribution route	58	4,6	0,32
Local distribution routes	27	2,1	0,15
Local access routes	1.058	83,5	5,77
Total	**1.267**	**100%**	**6,91**

Source: Braga City Council, 2015, Braga PDM Review MPT

For the road system to function properly, there must be a clear correspondence between the characteristics of the road and the desired characteristics for each level. As such, it will be pertinent to overcome the existing constraints and intervene in the road infrastructures of the municipality of Braga, giving them greater urbanity, efficiency and sustainability.

It is considered essential to create lanes that allow for healthy coexistence between cars, pedestrians and cyclists, which at present, on certain routes, is somewhat impractical.

There is also a need to reconfigure some road junctions, as their layout channels car traffic into the city centre, promoting through traffic. Therefore, the reconfiguration should orientate road traffic in a natural way so that it can bypass the city of Braga, i.e. so that traffic can travel along the existing and planned bypasses without passing through the centre of the municipality.

The most important constraint, which directly influences the others, is the traffic coming from the north of the municipality which, due to the lack of alternatives on the outskirts of the city, is forced to cross the city centre to connect to the national core network. Two types of traffic coexist in the city centre, local access and through traffic, which use the same junctions, and there is growing congestion.

In order to solve this problem, the construction of the Cávado bypass is crucial, as it crosses the municipality to the north and connects to the IC14/A11. The traffic generated by the main traffic generating centres in the area in question, such as the Braga Municipal Stadium, Braga Central Hospital, Pitancinhos, Adaúfe, Frossos and Navarra Industrial Zones, will flow through the new bypass, considerably reducing the costs of traffic.

traffic volumes in the city centre.

Thus, the reduction in traffic in the centre will make it possible to redesign the roads, giving them a more humanised layout, allowing these axes to move down a hierarchical level. In fact, these roads were designed to achieve good levels of fluidity and circulation, sometimes adopting a motorway profile within the urban fabric of the city of Braga. Examples include Avenida João XXI, Avenida da Liberdade and Avenida Frei Bartolomeu dos Mártires.

Redesigning these roads will enable them to accommodate soft flows, integrating into these roads, which are now intrusive for vulnerable users, circulation channels dedicated to soft modes. If you look at the avenues mentioned above, you can see that there are barriers that restrict pedestrians and bicycles from crossing, such as central dividers, raised pedestrian crossings and subways. By introducing soft modes into road layouts, people will be able to travel through certain sections of the city using pedestrian or cycling routes, avoiding unwanted road complexity and vehicle traffic that produces a multitude of harmful impacts on the urban environment.

According to the PAESC, around 40 per cent of the municipality's emissions come from transport, making it the most representative sector in the municipality's overall emissions. In this sense, sustainable mobility plays an important role as a factor in energy and environmental efficiency, making a decisive contribution to the reduction of gaseous emissions in urban areas and the progressive replacement of fossil fuels with alternative energy sources. In fact, sustainable mobility is one of the main vectors contributing to achieving the goal set by the 2019 European Green Deal: reaching carbon neutrality by 2050.

In order to respond to this global challenge, the European Commission has come up with a series of strategic packages, namely the Climate 2030 Energy Package, the Clean Mobility Package and the Clean Energy for All Europeans Package. At national level, the Integrated National Energy and Climate Plan (PNEC) was approved, which is the main energy and climate policy instrument for the decade 2021-2030. Among the various objectives and targets defined by the PNEC for the various sectors of activity, it is worth highlighting the objective of reducing greenhouse gas emissions by 40 % in the transport sector by 2030 compared to 2005.

At municipal level, a series of measures have been implemented to improve sustainable and smooth mobility in the municipality. For example, a system of electric bicycles and shared scooters has been implemented, and

The Braga Business Mobility Pact (PMEB) has been drawn up with the aim of involving companies and institutions in contributing to more sustainable mobility in the city of Braga through 28 specific actions:

- Decarbonisation and dematerialisation of the company's internal fleet and operations;
- Promoting a diverse mobility *mix* and encouraging shared mobility;
- Promoting the use of public transport and reducing the number of journeys;
- Promoting inclusive mobility and accessibility for all.

In terms of electric mobility, there have also been positive developments in the availability of charging stations for electric cars.

Based on the MOBI.E electric mobility platform (www.mobie.pt), there is a vast network of electric charging points in the Braga municipality - 40 stations and 126 sockets (**Figure 3.10**) - with one ultra-fast charger with three sockets available and 54 fast charging sockets **(Figure 3.11**).

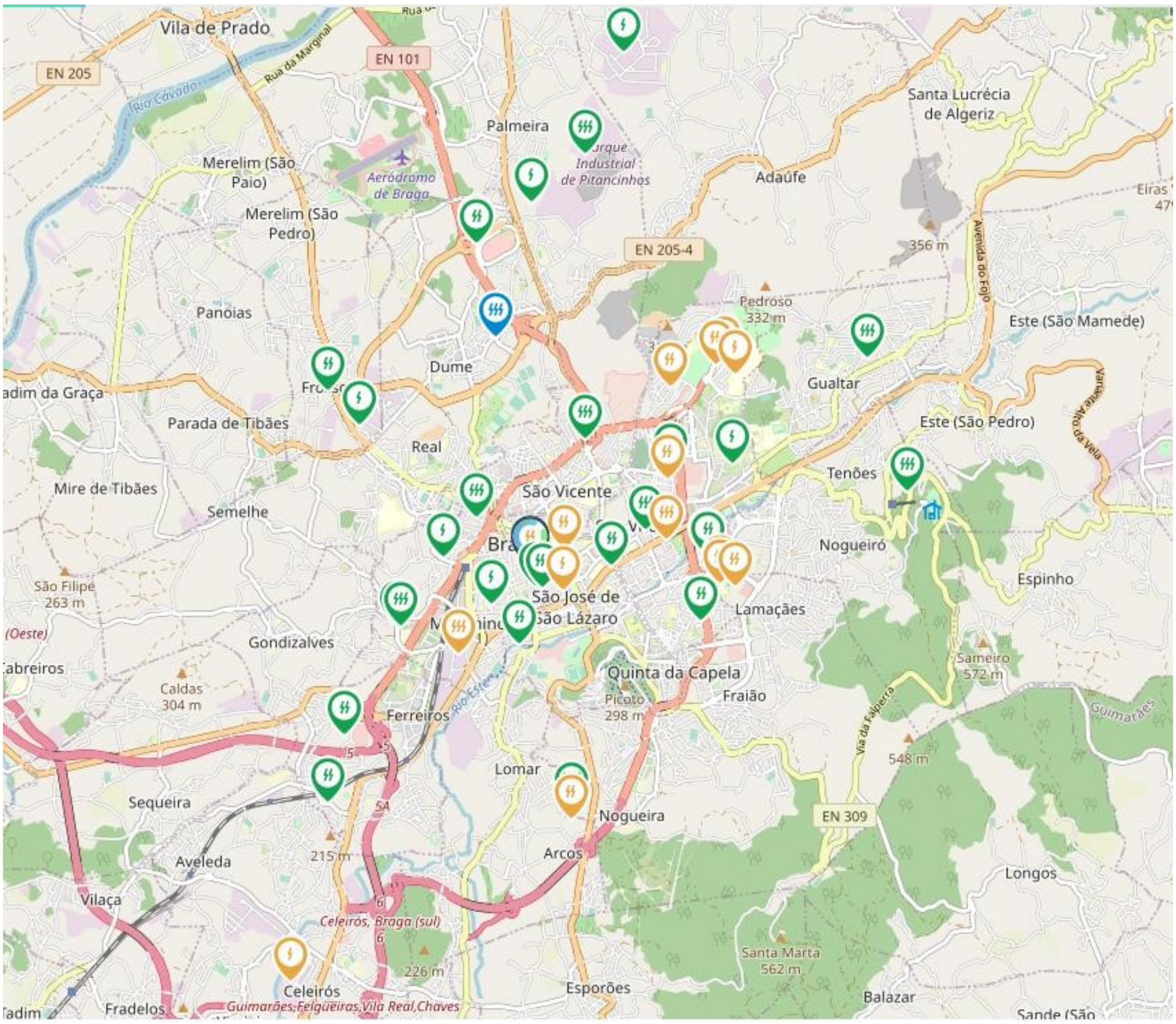
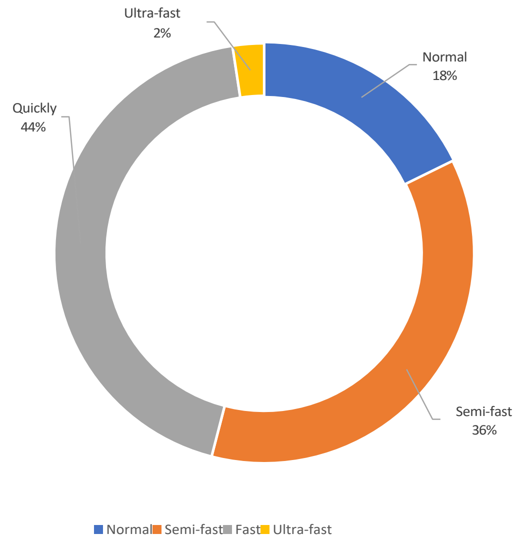


Figure 3.10. Availability of charging stations for electric cars

Source: MOBI.E, 2022



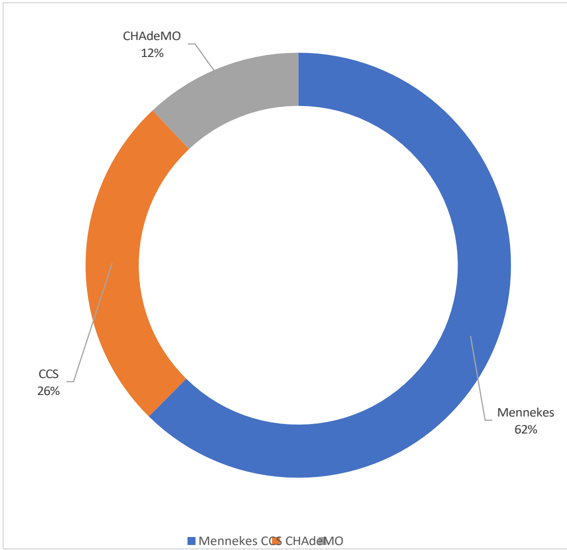


Figure 3.11. Types of sockets and chargers in the Braga municipality

Source: MOBI.E, 2022

The rail system together with the road system make up the land communication network, so the importance of the rail system in accessibility to the main regional, national and international urban centres cannot be overstated, as well as a development factor for the municipality of Braga and the sub-region.

The municipality of Braga is served by a single branch line, the Ramal de Braga, which connects Nine Station, part of the Minho Line, to the city of Braga. It includes Intercity, Regional/Urban and Alfa Pendular train services. Its articulation with the Minho Line connects it to the Oporto metropolitan area, allowing wider access to services, as well as connections to the north and south of the country and to Spain.

The Braga branch line (**Figure 3.12**) belongs to the National Railway Network and has a total length of 15.5 kilometres. The transport services are provided by CP - Comboios de Portugal and the infrastructure is managed by Infraestruturas de Portugal. The entire length of the branch line is electrified double track. Traffic is regulated using pure automatic cantonment (RCAP), and the ground-to-train radio system is used throughout the branch with data transmission. The speed levels used are between >120 km/h- <=160 km/h, which has significantly reduced the connection time to Oporto and the rest of Portugal.

The branch line has a total of nine stations and halts in service, seven of which are located in the municipality of Braga (**Figure 3.12**) - Arentim, Ruilhe, Tadim and Braga and the halts of Aveleda, Mazagão and Ferreiros. The branch is also served by a freight terminal located at Tadim station, managed by Adremor.

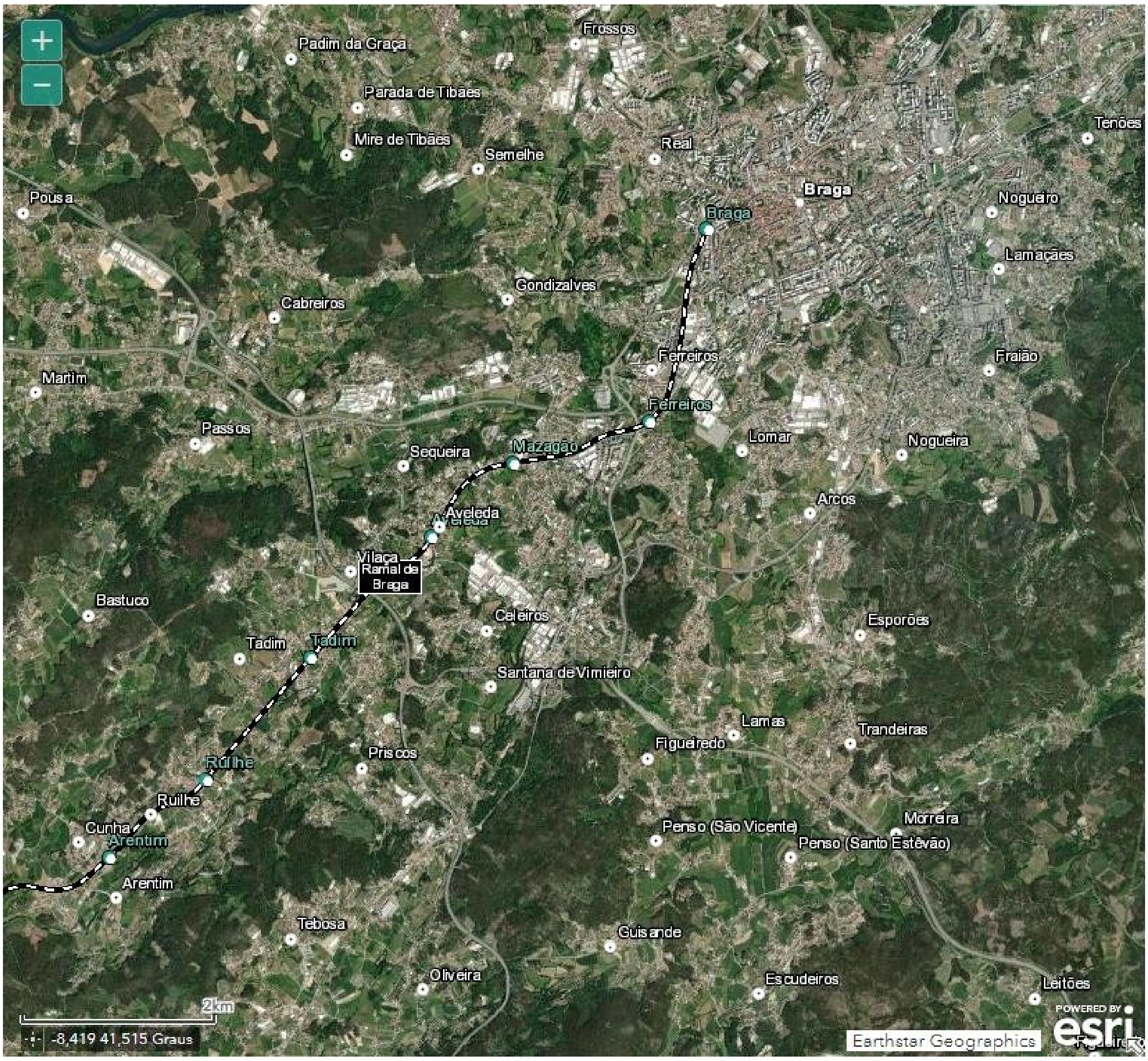


Figure 3.12. Existing railway network in the municipality of Braga

Source: IP, 2022

With regard to the Minho line, a line with a particular impact on the municipality of Braga, the modernisation and electrification of 93 km of this track has been completed since 2021, part of which is between Nine Station and Valença, which will allow the use of electric traction and eliminate load shedding in Nine.

The main deficiencies in Braga's rail network are due to the lack of intermodal links with other modes of transport. Only the city centre and Ferreiros stations are intermodal with road transport.

Overall, Braga Railway Station has good conditions for the user and is free of obstacles, in good condition and with adequate lighting that is proportionate to the space, offering a waiting area and food services and toilets adapted for people with reduced mobility. Its three boarding platforms are well signposted, with audible information about the services in operation and seating furniture to support waiting.

Public road transport in the municipality is provided by Transportes Urbanos de Braga (TUB). Currently, TUB transports more than 50,000 passengers a day, and almost 12.5 million passengers a year, and is actively responsible for territorial cohesion since it operates in all the parishes of the municipality, providing 147 vehicles and 74 public transport circuits, covering the main urban centres such as the historic centre, the university / INL, the hospital, and new routes have been created to satisfy tourist and commercial routes, such as Noite Branca or Nova Arcada. In 2018/2019, TUB presented the first 6 new vehicles powered by 100% electricity (CMB, Sustainability Report 2019).

One of the main challenges in managing the public transport network in the municipality of Braga is to increase its commercial speed, making it more attractive to individuals and to potential users. In fact, on the road network in the municipality of Braga, it is possible to identify some constraints that influence the commercial speed of public transport, which is lower than would be desirable.

Thus, factors such as high levels of traffic congestion or the amount of space dedicated to cars, either in car parks or in oversized road widths, are seen as determining factors in the level of service provided by public transport and, consequently, in its competitiveness in relation to other modes.

As far as airport infrastructures are concerned, the municipality of Braga has one, the Braga Aerodrome (**Figure 3.13**). Located to the north, in the Palmeira Complex, owned by Braga City Council, it houses the Braga Aero Club. It is easily accessible via the N-101, with a later connection to the A11 and A3 motorways.

It currently fulfils functions mainly related to sports and educational aviation. However, the length of its runway allows recreational, fire-fighting and passenger aeroplanes of up to 25 seats to land. The facilities host various operators, such as Civil Protection and the Minho Parachute Association.

In addition to the aerodrome, the short distances between the municipality and Francisco Sá Carneiro Airport and Vigo Airport, both international, make it easier to move people and goods. Francisco Sá Carneiro Airport is thirty-five minutes from Braga, around 50 kilometres away, while Vigo Airport is one hour and ten minutes away, around 100 kilometres away.

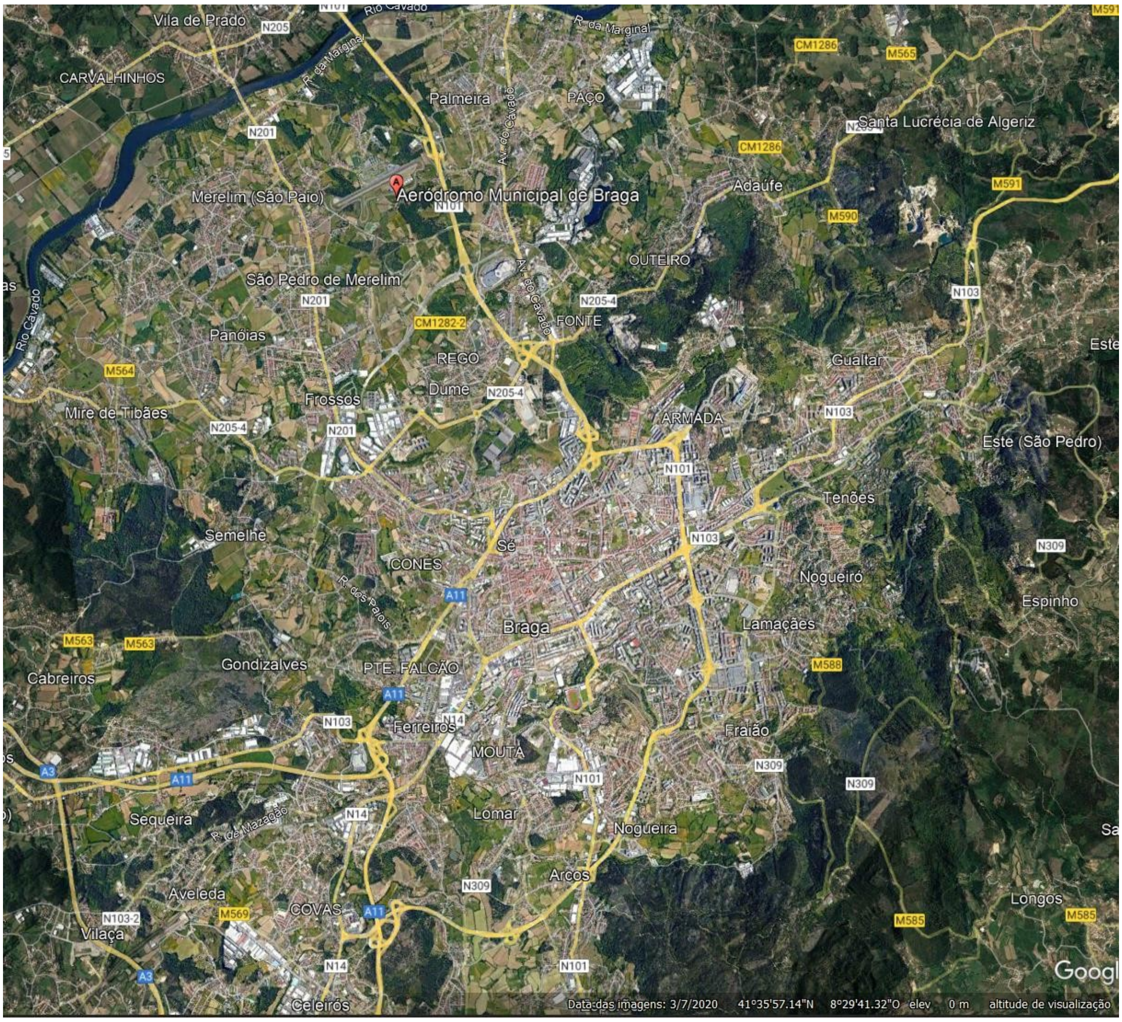


Figure 3.13. Location of Braga municipal aerodrome

Source: GoogleMaps, 2022

Finally, it is important to mention some of the projects promoted by the municipality and related to the theme of accessibility and mobility:

- Eu Já Passo Aqui!" project - aims to eliminate architectural barriers in areas associated with educational establishments and other facilities that generate traffic, in order to ensure a free, comfortable and inclusive space with cohesive and continuous routes;
- UMOB Braga (Urban + Mobility + Bio) project - with the aim of assimilating various technologies, the intervention on the urban front, where Braga's Central Bus Station is located, combines the the inclusive component, the mobility component and the environmental/technological component, emphasising the concept of "Mobility for All".

The work resulting from these projects has made it possible to resolve some existing problems in the city of Braga, but it is still necessary to expand this work and strengthen the strategy for Accessibility for All, working on cross-cutting areas such as public space, buildings, transport, info-accessibility, communication and design, so that it is possible to change mentalities and foster a new perspective on public space.

3.4 Population

According to data from the 2021 Census, the municipality of Braga has a resident population of 193,324 (**Figure 3.14**), which represents around 46 per cent of the total population of NUT III Cávado and around 5 per cent of the population of the northern region.

Braga is part of the Norte region and the Cávado sub-region, and has experienced more intense demographic growth than the territorial units to which it belongs. In 2011, the North region totalled 3,689,713 individuals, 11% of whom belonged to the Cávado sub-region (410,608 individuals). In turn, the municipality of Braga represents 44 per cent of the population of Cávado, demonstrating its important weight in relation to the region (**Table 3.11**).

Table 3.11. Changes in the resident population

Territory	Resident Population				
	1981	1991	2001	2011	2021
North	3 410 099	3 472 715	3 687 293	3 689 713	3 586 586
Cávado	328 938	353 267	393 063	410 608	416 605
Municipality of Braga	125 472	141 256	164 192	181 494	193 324

Source: INE, General Population Census

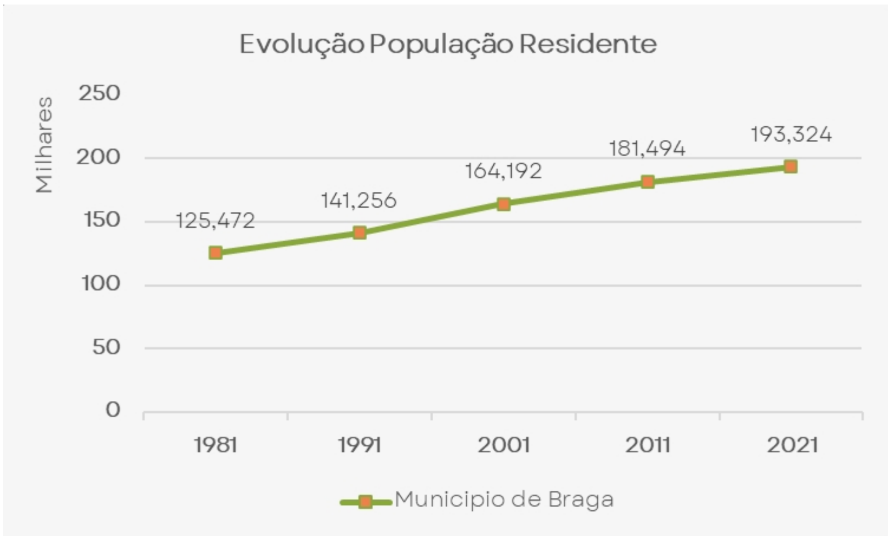


Figure 3.14. Evolution of the resident population in the municipality of Braga

Source: National Statistics Institute, 2022

Despite the demographic increase in all territorial units, there was a slowdown in growth rates compared to the previous decade, which was more marked in the north (**Figure 3.15**).

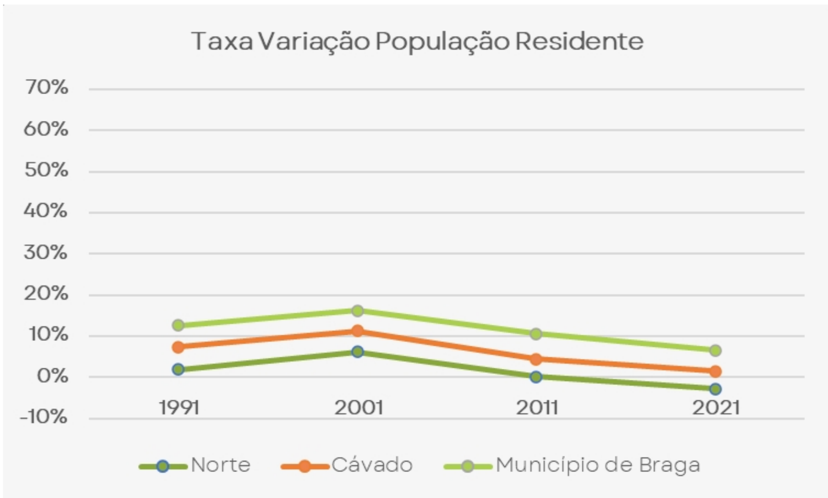


Figure 3.15. Rate of change in the resident population (%)

Source: INE, General Population Census

In the context of the municipalities shown in **Table 3.12**, the municipality of Braga is the only one to show positive demographic growth, while the remaining municipalities show negative growth with the exception of the municipality of Famalicão.

Table 3.12. Evolution of the resident population (no.) and rate of change of the resident population (%)

Counties	Resident Population				
	1991	2001	2011	2021	Rate of change 2011/2021
Braga	141 256	164 192	181 494	193 324	7%
Guimarães	143 984	159 576	158 108	156 830	-1%
Vila Nova de Famalicão	114 338	127 567	133 804	133 534	0%
Barcelos	111.733	122.096	120.492	116.752	-3%
Vila Verde	44.056	46.579	47.768	46.444	-3%
Póvoa de Lanhoso	21.516	22.772	21.895	21.775	-1%
Amares	16.715	18.521	18.886	18.595	-2%

Source: INE, General Population Census

Table 3.13 shows the breakdown of the resident population by age group and sex in the municipality o f Braga (INE, 2021). The predominance of the population in the 25-64 age group stands out, accounting for 57 per cent of the population, followed by the 0-14 age group with 14 per cent of residents. In turn, the younger population, aged between 0 and 24, accounts for around 25% of the population, with only 11% of the population in the older age group (65 or over).

Table 3.13. Distribution of the resident population by age group (no. and %)

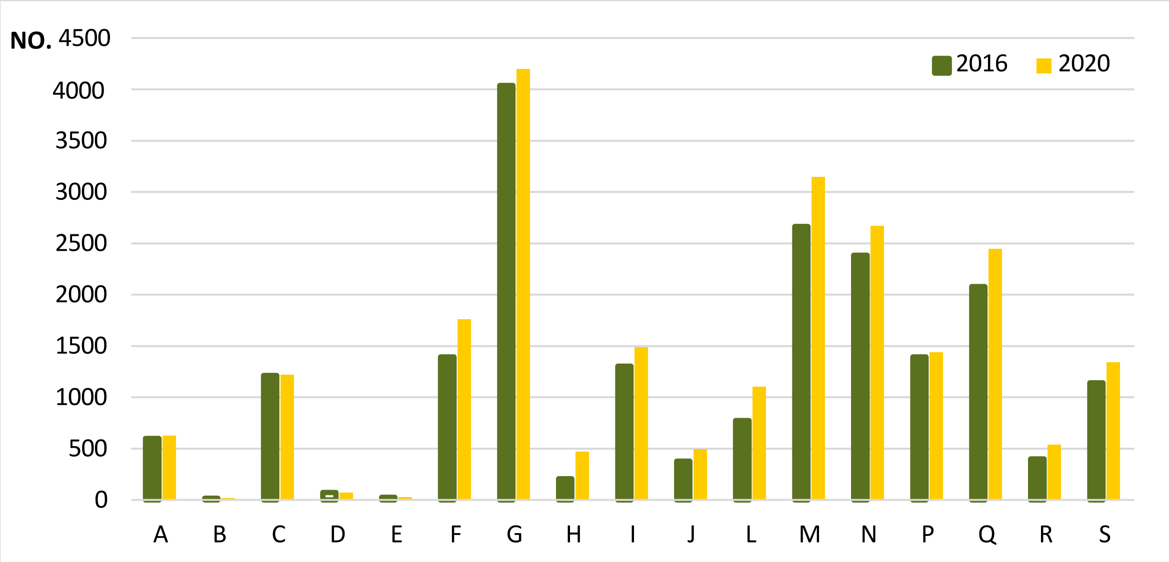
Age Groups	Resident Population	
	No.	%
0-14	26.753	14
15-24	21.976	11
25-64	109.422	57
65+	35.173	18

Source: INE, Census 2021

3.5 Economy

The distribution of gross value added by the different branches of activity is a reflection of the whole process of affirming Braga as the district capital and as a centre of dynamism for the entire north-western region, with a growing capacity to attract companies and investments in various activities, especially the provision of individual and collective services.

Between 2016 and 2020 there was a 15 per cent increase in the number of companies (2,964 more), with a particular focus on the transport, trade and services sectors (**Figure 3.16**).

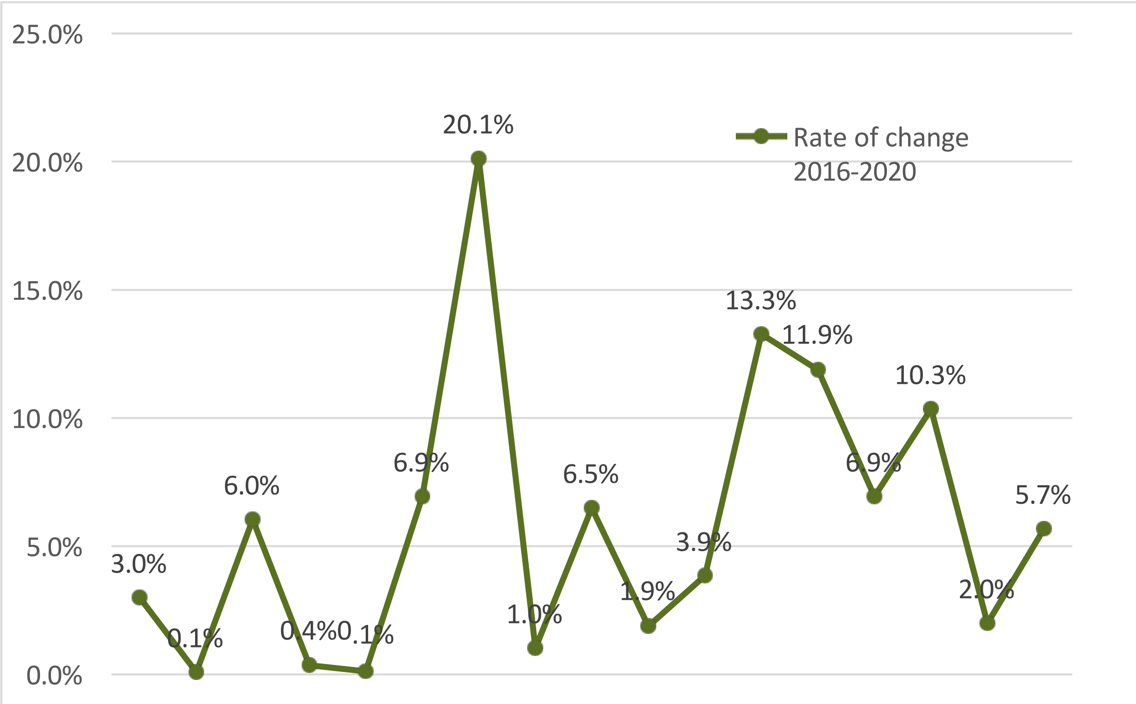


Caption: A - Agriculture, animal production, hunting, forestry and fishing; B - Mining and quarrying; C - Manufacturing; D - Electricity, gas, steam, hot and cold water and air conditioning; E - Water collection, treatment and distribution; sanitation, waste management and remediation; F - Construction; G - Wholesale and retail trade; repair of motor vehicles and motorbikes; H - Transport and storage; I - Accommodation, food service and similar activities; J - Information and communication activities; L - Real estate activities; M - Professional, scientific and technical activities; N - Administrative and support service activities; P - Education; Q - Human health and social support activities; R - Arts, entertainment, sporting and recreational activities; S - Other service activities

Figure 3.16. Companies by economic activity in 2016 and 2020

Source: INE, 2022. Integrated company accounts system.

Figure 3.17 shows the change in companies, as a percentage, between 2016-2020 by sector of economic activity.



Caption: A - Agriculture, animal production, hunting, forestry and fishing; B - Mining and quarrying; C - Manufacturing; D - Electricity, gas, steam, hot and cold water and air conditioning; E - Water collection, treatment and distribution; sanitation, waste management and remediation; F - Construction; G - Wholesale and retail trade; repair of motor vehicles and motorbikes; H - Transport and storage; I - Accommodation, food service and similar activities; J - Information and communication activities; L - Real estate activities; M - Professional, scientific and technical activities; N - Administrative and support service activities; P - Education; Q - Human health and social support activities; R - Arts, entertainment, sporting and recreational activities; S - Other service activities

Figure 3.17. Rate of change (2016 - 2020) of companies by economic activity

Source: INE, 2022. Integrated company accounts system.

Braga's economic activity (**Figure 3.18**) is centred on the wholesale and retail trade sector; repair of motor vehicles and motorbikes (18.2%; 4,198 companies). The administrative and support services sector also has a significant weight (1,738 companies; 40.3%) in the municipality's economy. Education companies account for 6.2 per cent, the health sector accounts for 10.6 per cent of companies, industry for 5.4 per cent (compared to 6 per cent of companies in 2016), construction for 7.6 per cent and the accommodation and catering sector accounts for 6.4 per cent of companies in the municipality of Braga. The agriculture sector, despite registering a 4% increase between 2016-2020, represents only 2.7% of the municipality's companies in 2020, while in 2016 it represented 3% of the municipality's companies.

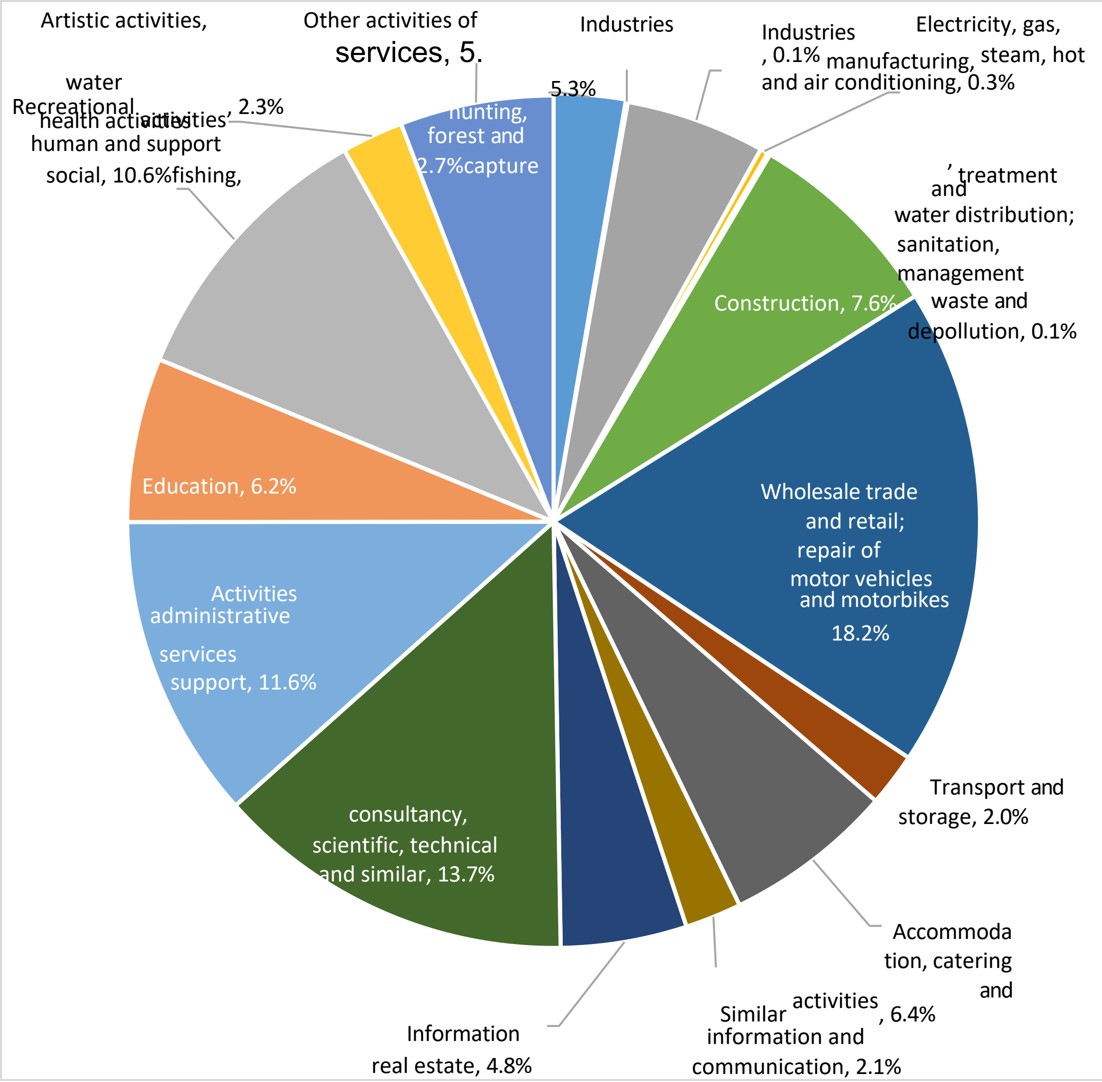


Figure 3.18. Distribution of companies by sector of activity (%) in 2020

Source: INE, 2022. Integrated company accounts system.

The gradual disappearance of the primary sector is the result of the progressive abandonment of agricultural activity. The rural population is mostly elderly, and the decline in those working in the primary sector is expected to continue over the coming decades.

The increased importance of farming for family or subsistence purposes, done *part-time* as a complement to income from other activities in other sectors, has led to a decrease in the number of people employed in this sector.

The abandonment of agricultural activity has enabled and accelerated the process of urbanisation in these peripheral territories, helping to accentuate the process of urban dispersal.

In 2021, industry represents 26.7 per cent of the gross value added generated by companies in the municipality, while the accommodation and catering sector represents just 2.6 per cent of the wealth generated (with an 8 per cent increase in GVA between 2016-2021). Despite the reduction in the representativeness of industry in the municipality, in 2021 there is a 42 per cent increase in the wealth generated compared to 2016 (**Figure 3.19**).

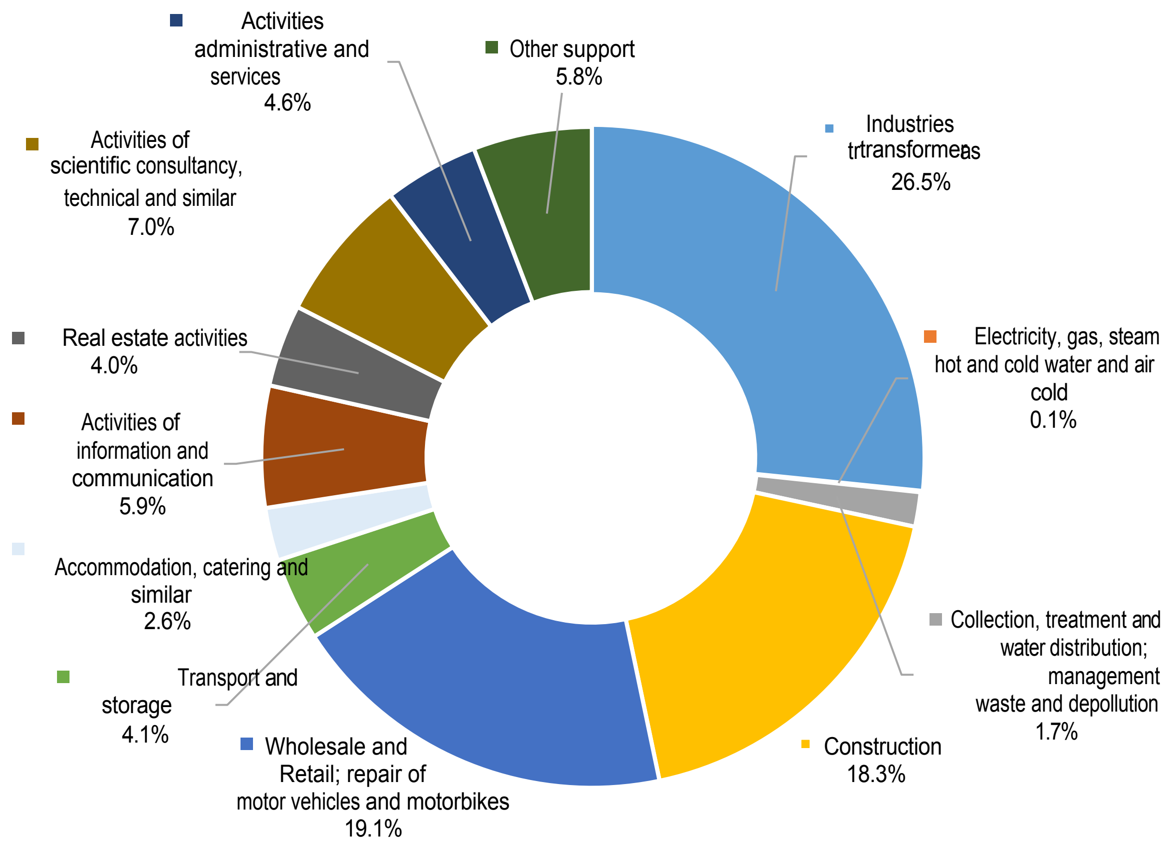


Figure 3.19. Gross value added (%) of companies in the municipality of Braga and economic activity, year 2021

Source: INE, 2022. Integrated company accounts system.

3.6 Environment and Risks

3.6.1 Natural and Landscape Heritage

Although the municipality of Braga does not include classified nature and biodiversity conservation areas, along with the vast historical and monumental heritage that exists in the area of intervention, there is a natural and environmental heritage all over the municipality and its protection and valorisation is essential for the sustainable development of the area of intervention.

Biodiversity is defined as the diversity of life forms and plays an essential role in maintaining the full balance of ecosystems, acting as a filter for atmospheric components and water resources and playing a fundamental role in combating soil erosion and preventing natural hazards.

The analysis of the municipality's fauna and flora was based on the book *Os Bichos de Braga (1st edition, Braga, April 2022)*[4].

According to the aforementioned book, the municipality is made up of different habitats. Each one has unique characteristics. Woodlands, hills, riparian galleries, watercourses, meadows and agricultural areas are the most significant habitats in the municipality.

Hardwood forests

Forests mainly made up of black oak (*Qucrcus pyrcnaica*), oak (*Qucrcus robur*), chestnut (*Castanca sativa*), laurel (*Laurus nobilis)*, ash (*Fraxinus angustifolia)*, holly (*//ex aquifolium*), hawthorn (*Cratacgus monogyna)*, hazel (*Corylus avcllana)* and cork oak (*Qucrcus subcr*). These forests are made up of large mature trees that are characterised by the great biodiversity they harbour. They are shady areas with little or no undergrowth. The ground is covered in leaves that retain moisture. They are highly resilient to fires. They formed a large part of the native forest area in this zone. Good examples of this habitat are the woods of the Monastery of S Martinho de Tibães and some forested areas between Bom Jesus and Sameiro.

[4] https://issuu.com/municipiodebraga/docs/livro_os_bichos_de_braga

Mixed woods

Forests made up of some hardwoods, such as oak, cork oak and black oak, interspersed with exotic species such as maritime pine (*Pinus pinastcr*) and eucalyptus (*Eucalyptus globulus*). These forests are characterised by an abundance of scrub, made up of broom (*Cytisus striatus*), bramble (*Rubus fruticosus)*, gorse (*Ulcx curopacus*) and other shrub species. They are therefore dense forest areas, with some biodiversity and which make up a large part of the municipality's woodland, such as the Picoto hill.

Mountains

No elevation in the municipality exceeds 700 metres. In some of the more wind-beaten areas, tree density is low. Cork oaks and eucalyptus are the most common trees, interspersed with dense areas of scrubland. These are generally areas with little water. Monte das Caldas and Serra dos Picos are good examples.

Riparian galleries

Linear formation of woody tree and shrub species that are associated with the banks of watercourses. They form a kind of tunnel over the watercourses that serves as an ecological corridor. Species such as poplar (*Populus nigra)*, alder (*Alnus glutinosa*), leech (*Frangula alnus*), white willow (*Salix alba)*, black borage (Salix *atrocincra)* and elm (*Ulmus minor)* are the most common. Good examples are some stretches of the River Este - in Priscos and Ferreiros - and the initial stretch of the River Guisando.

Rivers and streams

Most of them are perennial. The Cávado River has little gradient and little current. The same is not true of the streams and small rivers, such as the Este. They are all clear water rivers, i.e. they only have very visible amounts of suspended sediment during heavy rainfall.

Meadows and agricultural areas

Typically open areas, where (normally) there is a mosaic landscape with cultivated agricultural fields, pastures for livestock and uncultivated fields that are home to scrubland and woodland with small hardwood or mixed woodlands in between or on the edges. In the Minho it's normal to have lines of poplar trees or fruit trees separating the properties. There are also ponds and water courses that enrich the habitat.

You can find this landscape all over the municipality, but the agricultural areas of Sequeira, Figueiredo and Lamas are good examples.

As far as fauna is concerned, the book *Os Bichos de Braga (1st edition, Braga, April 2022)* has been organised by the various animal groups, with the species sorted in alphabetical order. The vertebrates are dealt with by groups (Birds, Mammals, Reptiles, Amphibians and Fish) and the invertebrates are dealt with as a single group (Insects and other invertebrates). **Table 3.14** shows the fauna groups mentioned.

Table 3.14. Fauna observed in the municipality of Braga

Groups	Common and Scientific Name
Birds	Round-winged eagle (*Buteo búteo*)
	Grey wolfsbane *(Motacilla cinérea)*
	Horse carrion *(Troglodytes troglodytes)*
	Blue tit (*Cyanistes caeruleus*)
	Red-crowned tit (*Periparus aterl)*
	Great tit (*Aegithalos caudatus*)
	Great tit (*Parus major*)
	Grey whippoorwill (*Oenanthe oenanthe*)
	Barn owl (*Strix aluco*)
	White-faced cormorant (*Phalacrocorax carbo*)
	Black starling (*Sturnus unicolor*)
	Kestrel Falcon (*Falco tinnunculus*)
	Peregrine falcon (*Falco peregrinus*)
	Common phaeton (*Phylloscopus collybita*)
	Common Tern (*Garrulus glandarius*)
	Yellow-legged gull (*Larus michahellis*)
	Heron (*Ardea cinerea*)
	Sparrowhawk *(Accipiter nisus*)
	Blackcap (*Corvus corone*)
	Kingfisher (*Alcedinidae*)
Mammals	Wild rabbit (*Oryctolagus cuniculus*)
	Squirrel (*Sciuridae*)
	Gineta (*Genetta genetta*)
	Wild boar (*Sus scrofa*)
	Otter (*Lutrinae*)
	Lesser horseshoe bat (*Rhinolophus hipposideros*)
	Hedgehog (*Erinaceus europaeus*)
	Red fox (*Vulpes vulpes*)
	Short-tailed field mouse (*Microtus agrestis*)
	Badger (*Meles meles*)

Groups	Common and Scientific Name
	Bullfinch (*Mustela putorius*)
	American mink (*Neovison vison*)
Reptiles	Mediterranean collared water snake (*Natrix astreptophora*)
	Viperine water snake (*Natrix maura*)
	Scaled snake *(Rhinechis scalaris*)
	Otter snake (*Malpolon monspessulanus*)
	Bocage lizard (*Podarcis bocagei*)
	Water lizard (*Lacerta schreiberi*)
	Red grouse (*Anguis fragilis*)
	Moorish gecko (*Tarentola mauritanica*)
	Sardinian (*Timon lepidus*)
Amphibians	Spotted frog (*Discoglossus galganoi*)
	Iberian frog (*Rana ibérica*)
	Green frog (*Pelophylax perezi*)
	Yellow-spotted salamander (*Salamandra salamandra*)
	Lusitanian salamander (*Chioglossa lusitânica*)
	Common toad (*Bufo bufo*)
	Orange-bellied newt (*Lissotriton boscai*)
	Marbled newt (*Triturus marmoratus*)
	Pallid Triton (*Lissotriton helveticus*)
Fish	Boga (*Boops boops*)
	Gobio (*Gobio gobio*)
	Northern bog (*Pseudochondrostoma duriense*)
	Redhead (*Achondrostoma oligolepis*)
	River trout (*Salmo truta*)
	Common wormwood (*Cobitis maludica*)
Insects and other invertebrates	Honeybee (*Apis melifera*)
	Wasp spider (*Argiope bruennichi*)
	Boatman (*Notonecta glauca*)
	Skylark butterfly (*Acherontia atropo*)
	Small emperor butterfly (*Apatura ilia*)
	Blue jay (*Calopteryx virgo*)
	Swift dragonfly (*Libellula depressa*)
	Mantis (*Mantodea*)
	Firefly (*Lampyridae*)
	Blonde cow (*Lucanus cervus*)

Source: Book Os Bichos de Braga (1st edition, Braga, April 2022).

The management of public spaces is often subject to contradictory needs and expectations, and this is a permanent challenge for the management of municipal public trees. However, urban and peri-urban areas are now key locations for defining policies to protect and enhance Biodiversity. Trees and vegetation cover are central elements of this urban Biodiversity and this is one of the important Ecosystem Services they promote. Biodiversity Support Services are joined by Regulatory Ecosystem Services that are widely described in the literature, for example: improving air quality, sequestering carbon, reducing temperature, noise and energy consumption. They also promote Cultural Ecosystem Services, contributing to the identity aspects of communities and improving their quality of life and well-being. In a context where the Climate Crisis and the Loss of Biodiversity will be the determining global challenges over the coming decades, it is essential that urban space management acts to maximise the various Ecosystem Services promoted by trees.

To this end, a series of planting actions were carried out by different organisations as part of "Oxigenar Braga" and "Florestar Braga", which have been taking place since 2014; actions to control invasive plant species; the reforestation of Monte do Picoto with native species; the phytosanitary assessment of trees in urban areas carried out in partnership with a specialist team from the University of Trás-os-Montes and Alto Douro (UTAD); the planting of riparian species along the bank of the River Este; the creation of green spaces or the planting of trees in various parishes in the municipality.

Based on the report of the *Inventory of Trees Planted in the Municipality of Braga 2014-2021*, which systematised and quantified the actions carried out since 2014, **Figure 3.20** shows a summary divided into five distinct parts: Picoto Park, the East River Ecovia, planting carried out by municipal services in various parts of the municipality, the post-fire emergency rehabilitation and stabilisation project and finally an analysis of the volunteer actions supported by the municipality and carried out by different entities.

Figure 3.20. Summary of planting actions in Braga between 2014 and 2021

Source: Inventory of Trees Planted in the Municipality of Braga 2014-2021

It should also be noted that in the municipality, as shown in **Figure 3.21**, there are six trees of public interest.

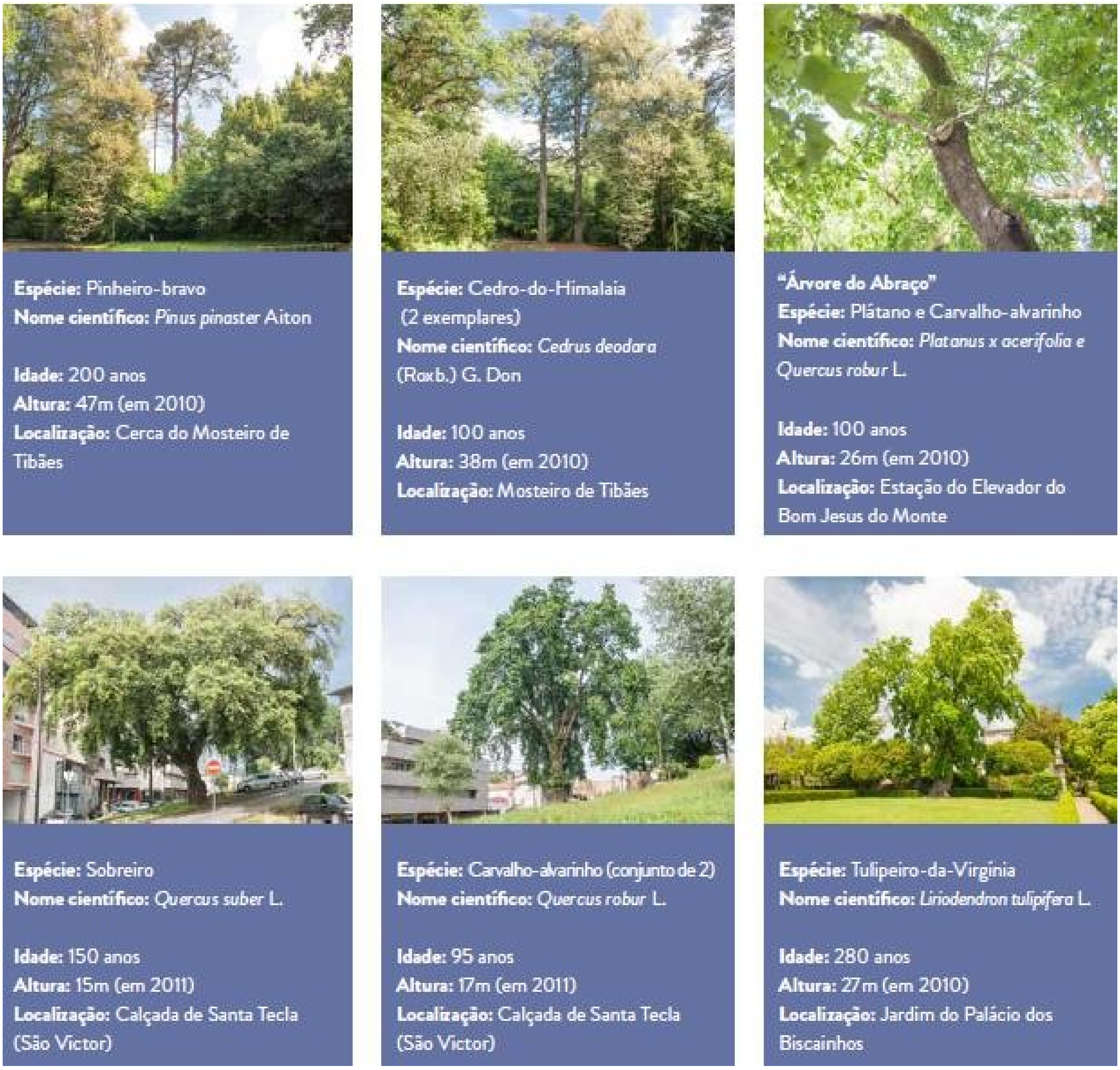


Figure 3.21. Trees of public interest in the municipality of Braga.

Source: Guia Verde de Braga

The municipality of Braga has a huge range of unique and truly distinctive tangible and intangible heritage. In environmental terms, more than half of the municipality of Braga is covered by some form of protection. Therefore, Braga, centrally located in the Minho region, between the coast and the mountainous interior of the Peneda-Gerês National Park, contains a vast array of spaces and elements of admirable environmental interest. Along traditional and ancient paths, between rivers and streams, mountains, hills, valleys, fields and leisure parks, elements of the fauna, flora, geology and landscape are surprisingly evident, in constant harmony with the heritage elements of a rural and even urban culture.

The Braga Walking Route Network is an important means of publicising the different periods of history and the urban and rural culture that come together in Braga, while at the same time emphasising other distinctive natural and landscape factors, in a context of visitor interaction with the territory, giving them the chance to live appealing and enriching experiences in their own time.

Totalling around 280 km (825 walking routes), the routes are grouped into four main themes: Paths with History (six routes); Rivers (six routes); the City and Nature (five routes); Hills and Valleys (eight routes). The routes vary greatly in terms of the physical challenge they represent and the motifs that inspire them, emphasising local potential and aspects of local identity.

In this way, the network of routes offers exciting discovery experiences, with options suitable for everyone, whether they are local walkers, tourists or sports walkers.

Some routes are marked on the ground in accordance with the routing marks of the Portuguese Camping and Mountaineering Federation (FCMP), guaranteeing safety and a level of information that is captivating and enhances the complete enjoyment of the hiking experience. The rest will be progressively implemented and signposted; until then, they can be explored with caution, using the GPS tracks for each route and the Braga Walking Route Network Mobile App to support interpretation.

In landscape terms, there are some areas with specific characteristics that make them unique.

On the basis of a synthesised analysis of the configuration of the terrain, the characteristics of urban occupation and rural land use, areas were identified that have relatively uniform landscape characteristics and are in some way deeply related to the catchment areas of the main rivers that run through the municipality.

The units identified can be organised into three main groups:

- The Traditional Agricultural Landscape covers the Cávado East Valley, Cávado West Valley, Este East Valley, Labriosque Valley, Guisande Valley, Veiga River Valley and Provências Valley.

  These are areas of traditional agricultural landscape, comprising a mosaic of cultivated fields bordered by living hedges - in the case of Braga, trellises and hanging vines are very common - loose stone walls, paths and water lines, occasionally punctuated by small patches of forest, usually pine or oak groves.

  It also includes the production forest areas on the steeper slopes, which were traditionally made up of pine forests from which various by-products were extracted, such as firewood, resin, broom and scrub for cattle bedding. With the progressive abandonment of more traditional agricultural practices, the option of eucalyptus has become more widespread, and is currently dominant in the municipality.

  It also includes areas of urban occupation that are concentrated in smaller settlements, but also isolated single-family homes scattered along the roads due to their proximity to farmland, with a recent slight increase, in some areas significant, for purely residential purposes.

- The Peri-Urban Landscape encompasses the Central Cávado Valley and the East-West Valley.
  It is a landscape of transition from rural to urban areas. There is a noticeable dispersion of urban occupation along the communication routes, along with clusters of considerable size and urbanisation operations of significant dimensions, often based on a rural cadastral matrix. The type of construction varies greatly, from single-family detached houses to multi-family buildings, including semi-detached houses, which in recent years have been one of the most sought-after options for developers.

  There are industrial and storage units that have been relocated because they are incompatible with the functions installed in the city. These facilities, isolated or organised in industrial parks, mostly use the pre-existing road access network, which is therefore insufficient, as it was not calculated for the type of traffic it now has to cope with.

  Rural areas, used for agriculture or forestry, are often interspersed with urban areas, and there are often pockets of rural areas completely surrounded by buildings, as well as the opposite, i.e. pockets of urbanised land surrounded by rural areas. This

It is, therefore, an area of great contrasts that raises its own problems, namely the inadequacy of the road network, the architectural language of the new constructions that break with the surrounding area and issues of frequent incompatibility of the new functions with pre-existing agricultural or forestry facilities.

- The Urban Landscape corresponds to the platform of the consolidated city, with a predominance of residential, commerce and services. The organisation of space reflects greater planning and design urban in the definition of the road network and the type of construction, as well as a substantially higher level of density and complexity. It has a more abrupt transition to the countryside.

  As a result of the densification of built-up areas and large-scale soil sealing, it is a landscape where the need for green spaces is felt more urgently, all the more so the more internalised the location in the urban fabric.

  There has been a growing concern with environmental quality, as well as with the creation and preservation of landscape units and leisure spaces. The design of new urban parks, such as Parque Norte, Parque do Monte Picoto and the redevelopment of Parque da Ponte/S. João, is a visible sign of the attempt to provide the city with better environmental quality and new leisure spaces. In addition to these projects, the municipality of Braga has crucial green areas adjacent to the city, such as Monte do Bom Jesus, Sameiro and Santa Marta, which function as cultural and leisure spaces and also have an important natural and landscape function.

3.6.2 Water Resources

Surface Water Resources

The municipality of Braga is crossed by the Cávado and Ave river basins, as shown in **Figure 3.22**. These basins are in Hydrographic Region 2 (RH2) and are under the management of the Portuguese Environment Agency - Northern Hydrographic Region Administration (APA-ARHN).

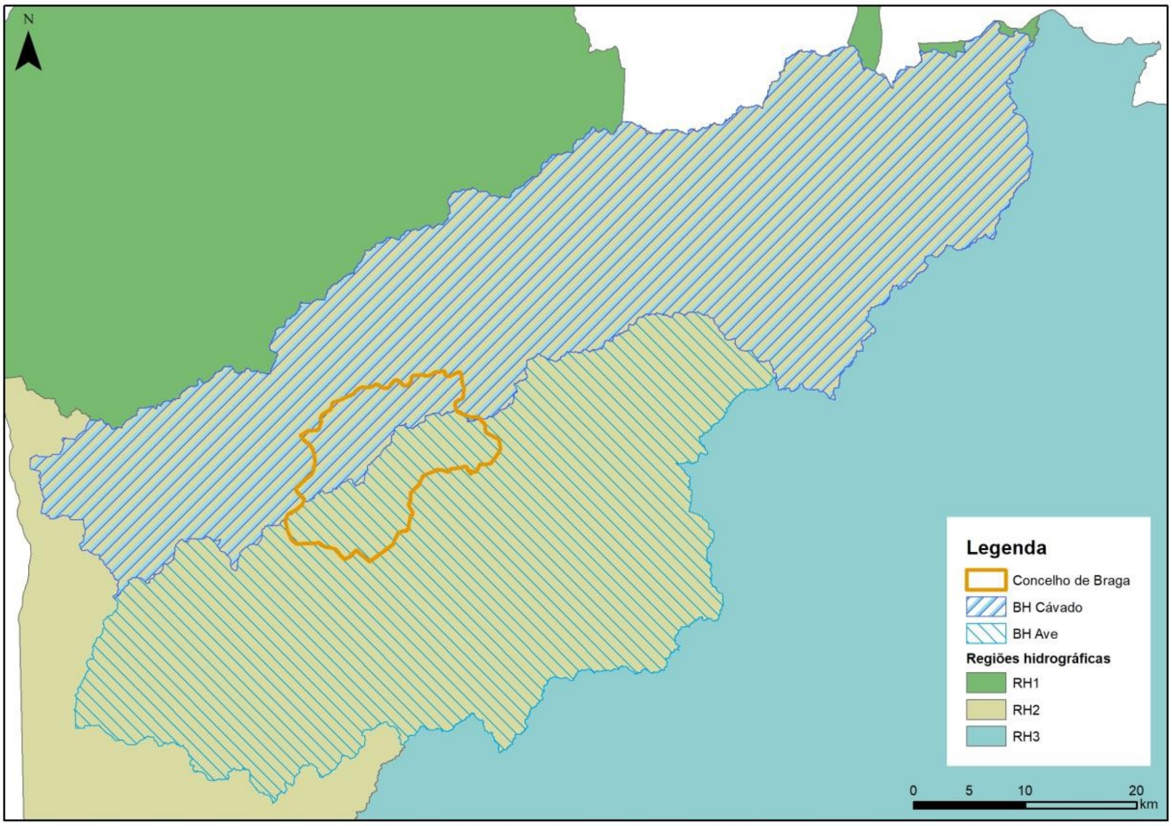


Figure 3.22. Hydrographic basins in the municipality of Braga

Source: SINIAMB, PGRH-RH2 (2022)

With regard to the bodies of water in the municipality of Braga, these mainly concern the Ribeira de Panóias and its tributaries in the Cávado basin and the Rio Este and its tributaries in the Ave basin (**Figure 3.23**).

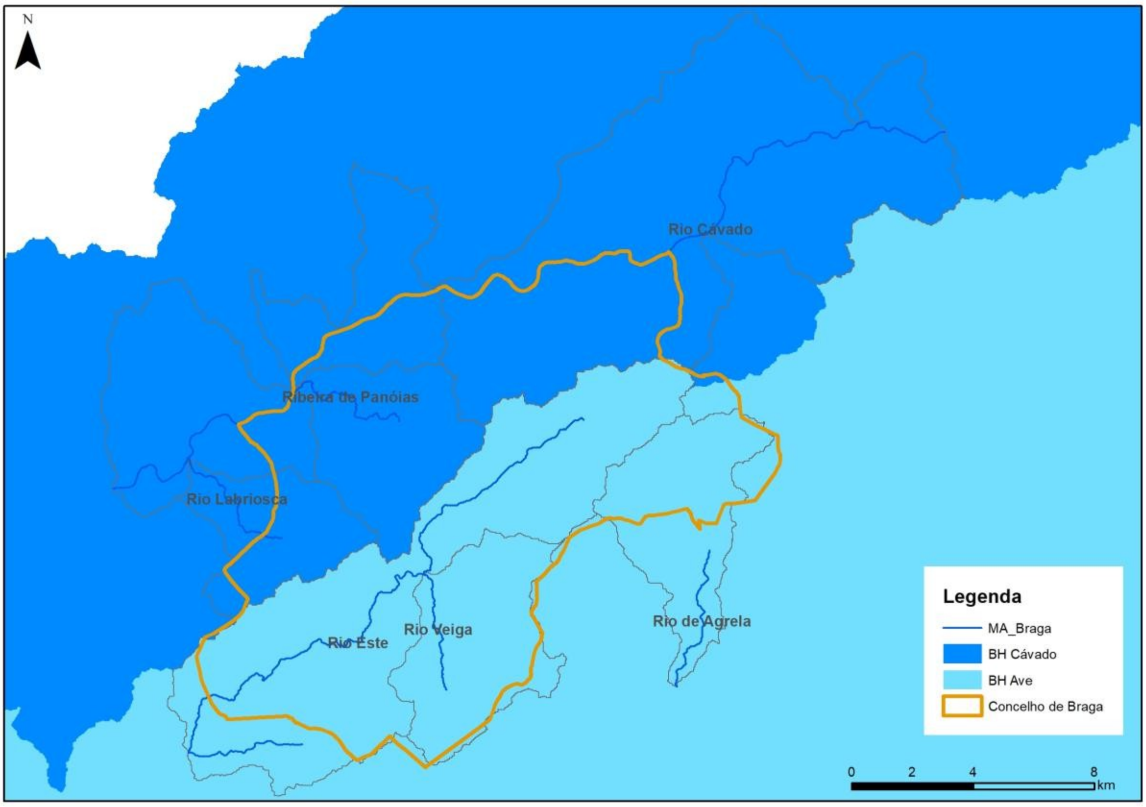


Figure 3.23. Surface water bodies in the municipality of Braga
Source: SINIAMB, PGRH-RH2 (2022)

The list of water bodies in the municipality is shown in **Table 3.15**.

Table 3.15. Water bodies in the municipality of Braga

River Basin	Water body (code)
Rio Ave	River Veiga (PT02AVE0113)
	River Agrela (PT02AVE0114)
	River Este (PT02AVE0117)
Cávado River	Cávado River (PT02CAV0090)
	Panóias stream (PT02CAV0093)
	Labriosca River (PT02CAV0094)
	Cávado River (PT02CAV0095)

Source: APA, PGRH-RH2, 2022

According to the Cávado, Ave and Leça Hydrographic Region Management Plan (PGRH-RH2), the main pressures identified for these bodies of water concern diffuse agricultural and livestock sources, as well as undue inflows to urban drainage networks and the hydrographic network.

As a result of the pressures affecting the bodies of water, the status of some of them is below Good, as shown in **Figure 3.24**.

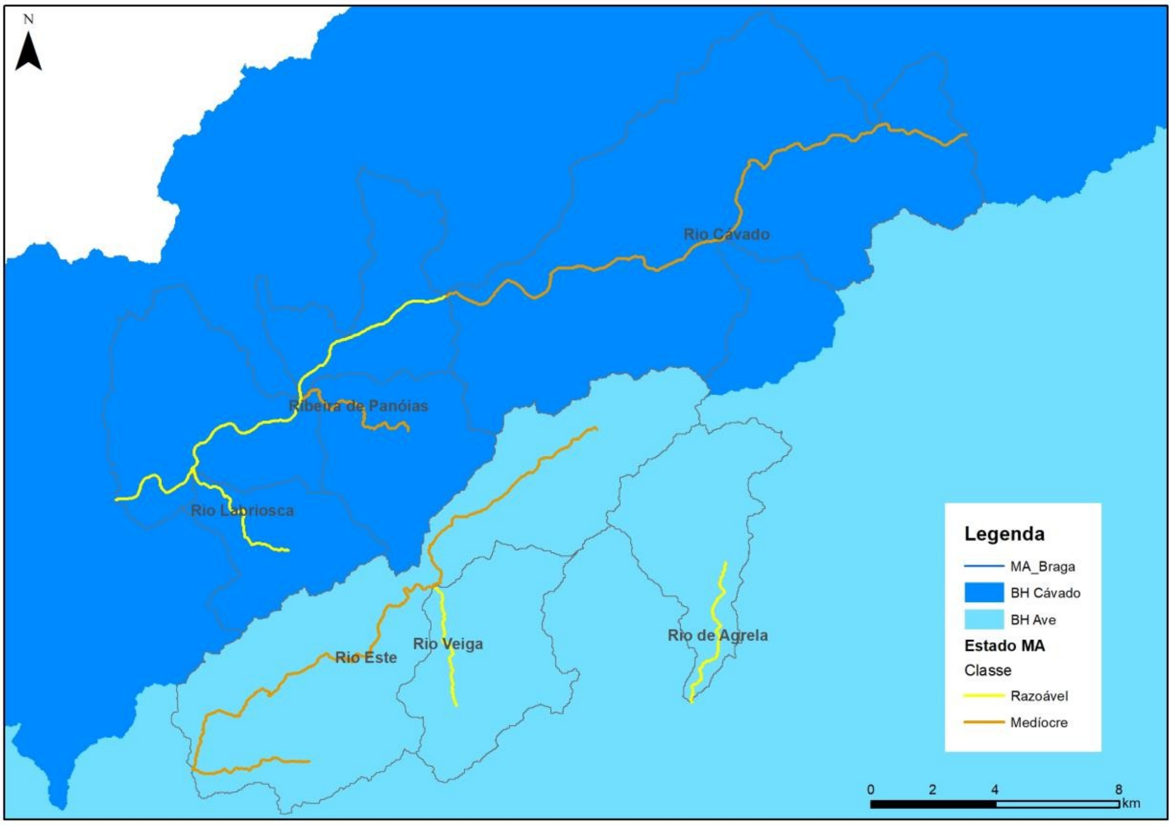


Figure 3.24. Status of surface water bodies in the municipality of Braga

Source: SINIAMB, PGRH-RH2 (2022)[5]

Groundwater Resources

The municipality of Braga is crossed by two bodies of groundwater: the Undifferentiated Ancient Massif of the Cávado Basin and the Undifferentiated Ancient Massif of the Ave Basin.

The Undifferentiated Massifs of the Cávado and Ave Basins are characterised by geological formations of

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[5] Geographical information on the status of water bodies from the 3rd planning cycle of the PGRH-RH2 is not available.

granites and metasediments. They have low hydraulic conductivity and, as a general rule, very low productivity, which usually does not exceed 3 l/s per unit tube catchment.

Given the nature of the geological formations in the Undifferentiated Massif of the Cávado Basin, the annual recharge values are between 5 and 10% of the average annual rainfall (2 102 mm/year). The most conservative value gives a global average annual water availability of around 133 $^{hm3/year}$, which corresponds to approximately 90% of the average groundwater recharge.

The Undifferentiated Massif of the Ave Basin also has annual recharge values in the order of 5 to 10 per cent of annual precipitation (1 683 mm/year), resulting in annual water availability in the order of 112 $^{hm3/year}$, with a recharge value identical to that of the Cávado water body.

Figure 3.25 shows the groundwater bodies in the municipality of Braga.

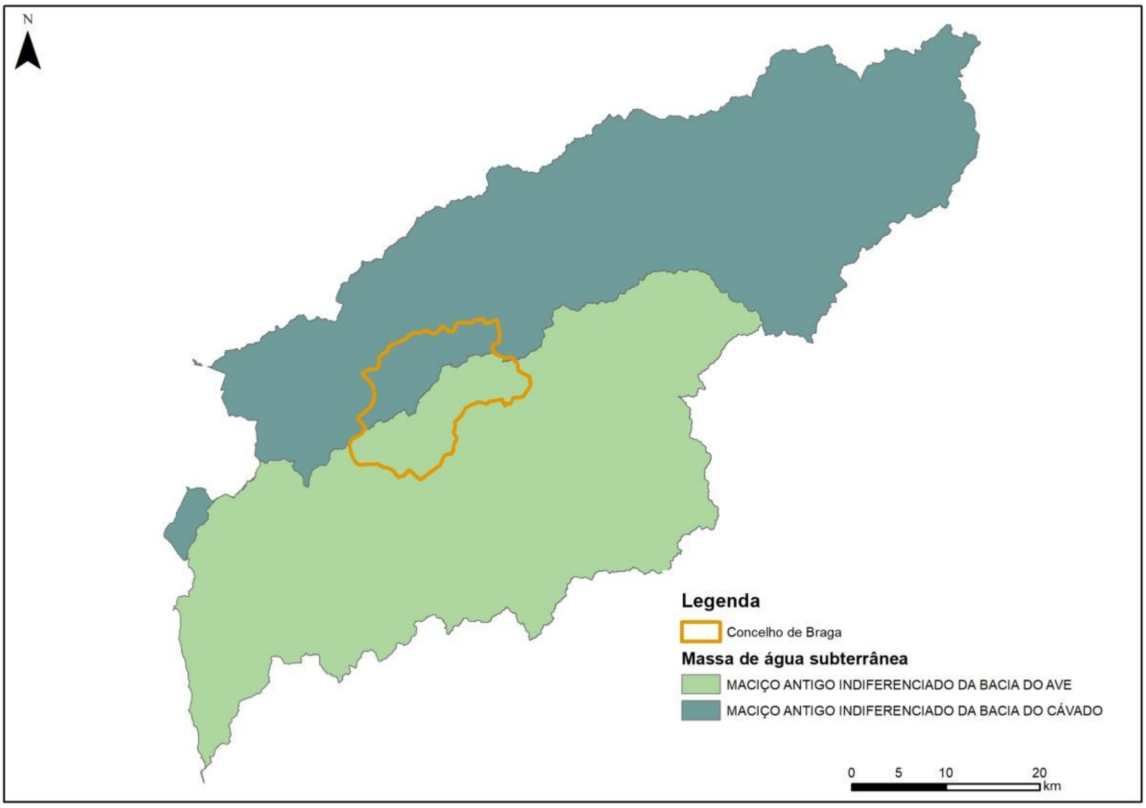


Figure 3.25. Groundwater bodies in the municipality of Braga

Source: SINIAMB, PGRH-RH2 (2022)

According to the PGRH-RH2, from its 1st planning cycle (2012) to the current 3rd cycle (2022), it can be seen that the overall status of groundwater bodies has changed, with significant degradation over time.

The bodies of water Undifferentiated Ancient Massif of the Cávado Basin and the Undifferentiated Ancient Massif of the Ave Basin are in Mediocre quantitative status. The pressure responsible for this status is water abstraction for agricultural activities, namely irrigation.

As far as chemical status is concerned, both bodies of groundwater are in Good status. Thus, the overall status of these bodies of water is classified as "poor".

3.6.3 Energy

Electricity

According to official statistics, between 2011 and 2020 the municipality of Braga saw a relative stagnation in electricity consumption, with only a 1% increase in total electricity consumption (**Figure 3.26**). The domestic sector is the most representative and has undergone the least change over the decade (2%). The trade and services sector was the one that inflated its electricity consumption the most (19 per cent), followed by industry (12 per cent). On the other hand, the lighting sector for state buildings (-79%) and public lighting (-29%) were the sectors that showed the most significant reductions in electricity consumption. Agriculture also showed a 25 per cent reduction in its electricity consumption. Even so, the municipality still hasn't reached efficiency levels capable of achieving the minimum energy consumption figures recorded at the time of the 2015 economic crisis.

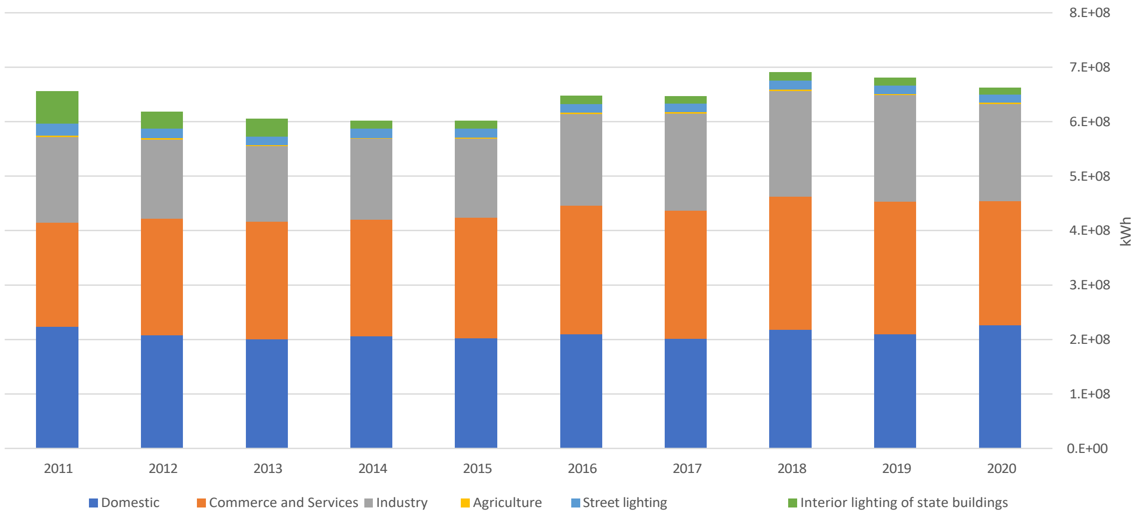


Figure 3.26. Evolution of electricity consumption by type of consumption between 2011 and 2020 in the municipality of Braga

Source: INE, 2022.

Analysing the total energy intensity per consumer recorded at national, regional and municipal level, in general terms there will be a reduction of between 5 and 7 per cent in electricity consumption per consumer between 2011 and 2020, with particular emphasis on the decrease observed from 2018 onwards (**Figure** 3.27).

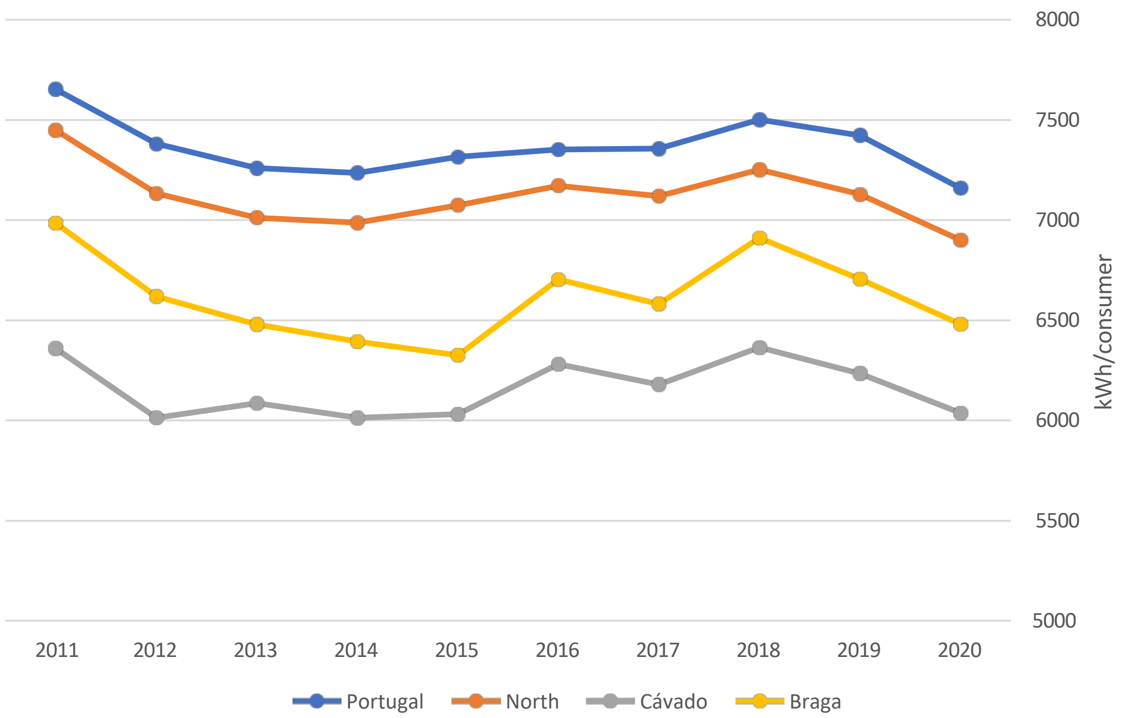


Figure 3.27. Evolution of total electricity consumption per consumer between 2011 and 2020

Source: INE, 2022.

In 2021, the municipality of Braga consumed around 666.5 GWh, which translates into a 2 per cent increase compared to 2011. **Figure 3.28** shows the sectors of activity with the greatest representation in municipal electricity consumption. The most important sectors of activity are domestic (35%), retail trade (7%), computer equipment manufacturing (6%), basic metallurgy (4%) and textiles (4%).

The transport sector consumed around 381,547 kWh during 2021, relating to vehicle electricity consumption.

Self-consumption is still insignificant in the municipality, with almost all energy coming from the public grid.

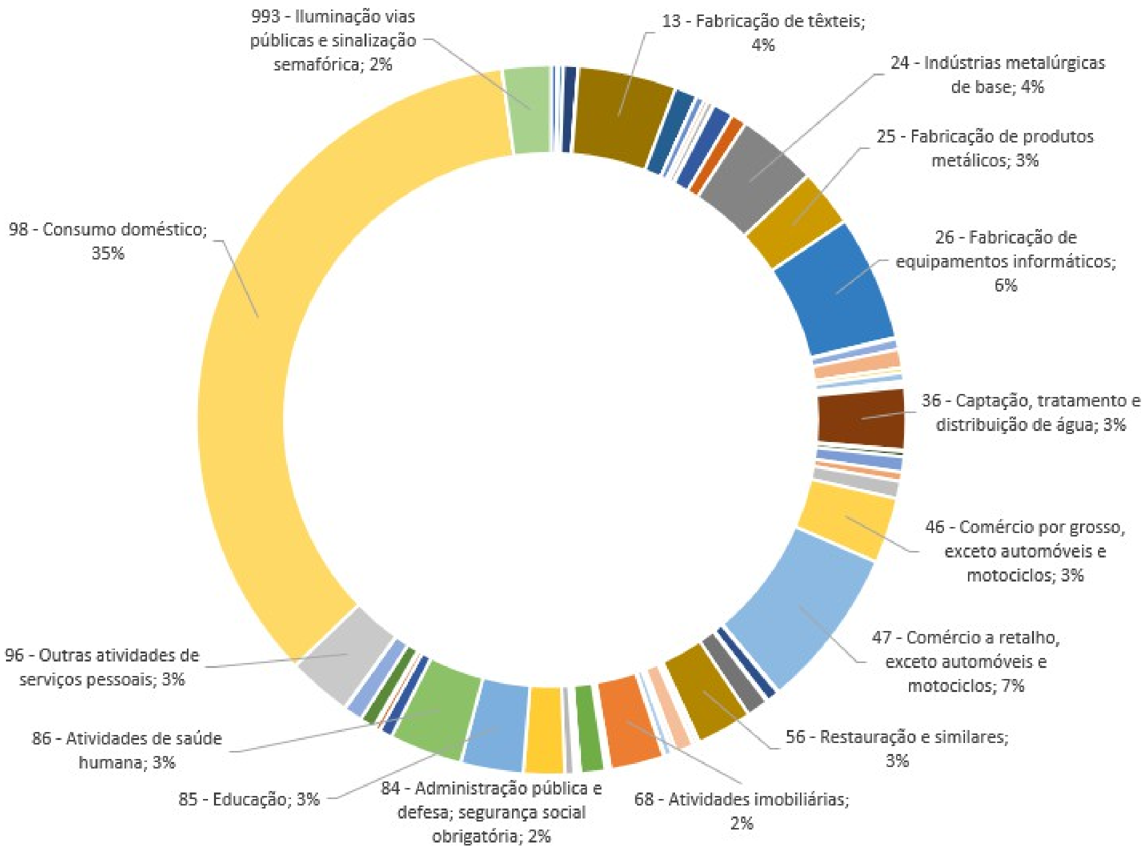


Figure 3.28. Representativeness of activity sectors in electricity consumption in 2021 in the municipality of Braga

Source: DGEG, 2022.

Renewable Energy

According to the PAESC, in 2019 around 21 MWh/year of renewable energy was produced in the municipality of Braga. Of particular note is the production of electricity from water (42%), biogas (33%) and photovoltaics (24%). In terms of endogenous renewable energy production, the municipality of Braga is home to the Palmeira (Ponte do Bico) Mini-Hydroelectric Power Station, a run-of-river power station supplied by the Cávado River and owned by the company Sociedade Elétrica do Douro Litoral Lda, with 2.46 MW of installed capacity, and the Ruães (Mire de Tibães) Mini-Hydroelectric Power Station, a run-of-river power station supplied by the Cávado River and owned by the company Hidrocentrais Reunidas Lda, with 2.53 MW of installed capacity.

In the municipality of Braga there is only one registered photovoltaic plant in the parish of Ruilhe, owned by ALFACOOP C.R.L., which started operating in 2019 and has an installed capacity of 0.12 MW.

There is also a Biogas Valorisation Plant managed by BRAVAL, which began operating in 2010, and an Organic Valorisation Plant using controlled anaerobic digestion, which began operating in 2016. These BRAVAL facilities have three generation engines, one of which is a resource engine, totalling an installed power of 2.13 kW. The electricity produced by burning the biogas from these facilities is raised to 15 kV and injected into the public electricity distribution network. In 2021, 6,142 MWh of electricity was produced at these waste-to-energy facilities (BRAVAL, 2022). However, in 2022 electricity production was significantly lower (3,672 MWh).

Fuels

According to the statistical data on sales of petroleum products on the domestic market by sector of economic activity published by DGEG for 2021, it can be seen that approximately 144,281 tonnes of petroleum products were consumed (**Figure 3.29**), with road diesel being the most representative (70%), followed by petrol 95 (13%) and asphalts (7%).

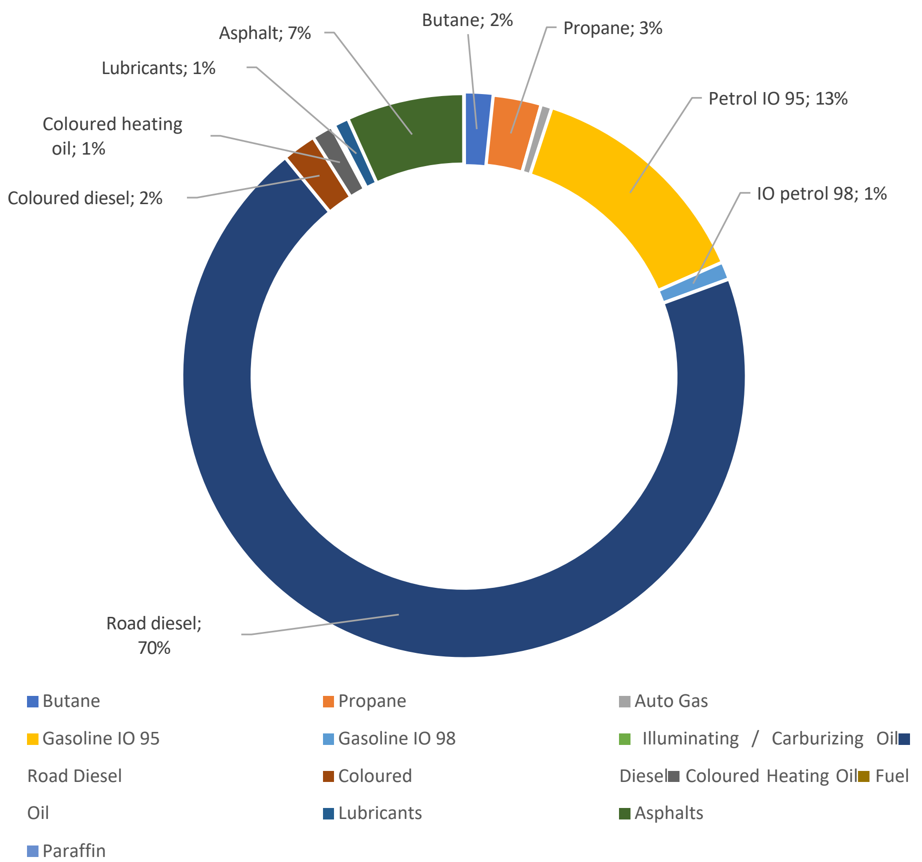


Figure 3.29. Representativeness of sales of oil products in 2021 by type of product in the municipality of Braga
Source: DGEG, 2022

The economic activity that consumes the most oil-based products is by far land transport, which accounts for a very significant share of consumption (83%). The other sectors have negligible consumption, but the civil engineering and construction, agriculture and domestic consumption sectors have some noteworthy consumption (**Figure 3.30**).

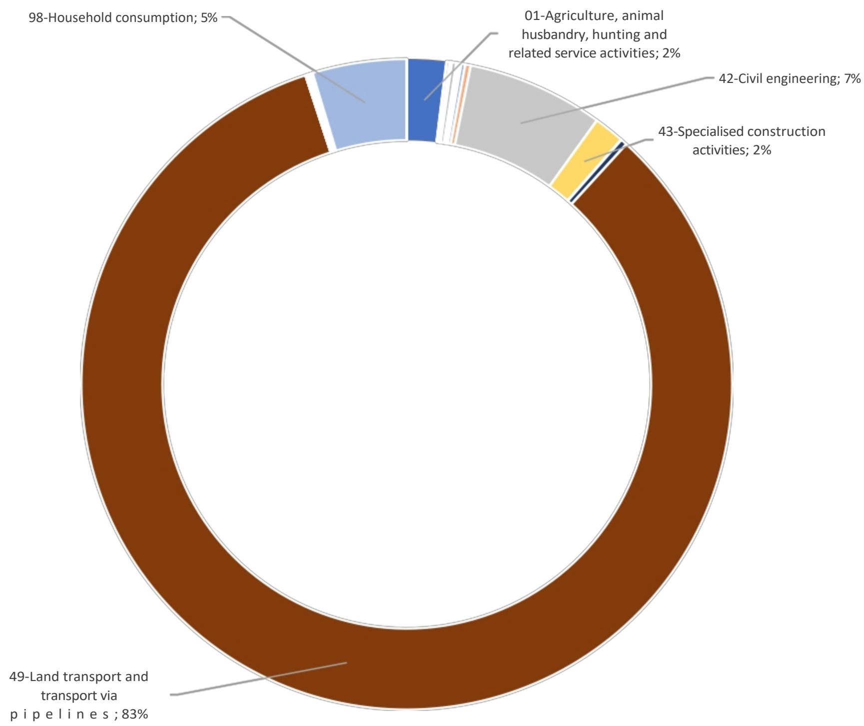


Figure 3.30. Representativeness of activity sectors in sales of oil products in 2021 in the municipality of Braga

Source: DGEG, 2022

Taking into account the available history of the sale of liquid and gaseous fuels (t) by companies between 2011 and 2020 (**Figure 3.31**), there was a relative stagnation in consumption over this period, with around 132,500 tonnes of fuel consumed by the municipality's companies in 2020. The most consumed fuels were road diesel (96,766 tonnes) and unleaded petrol 95 (19,033 tonnes).

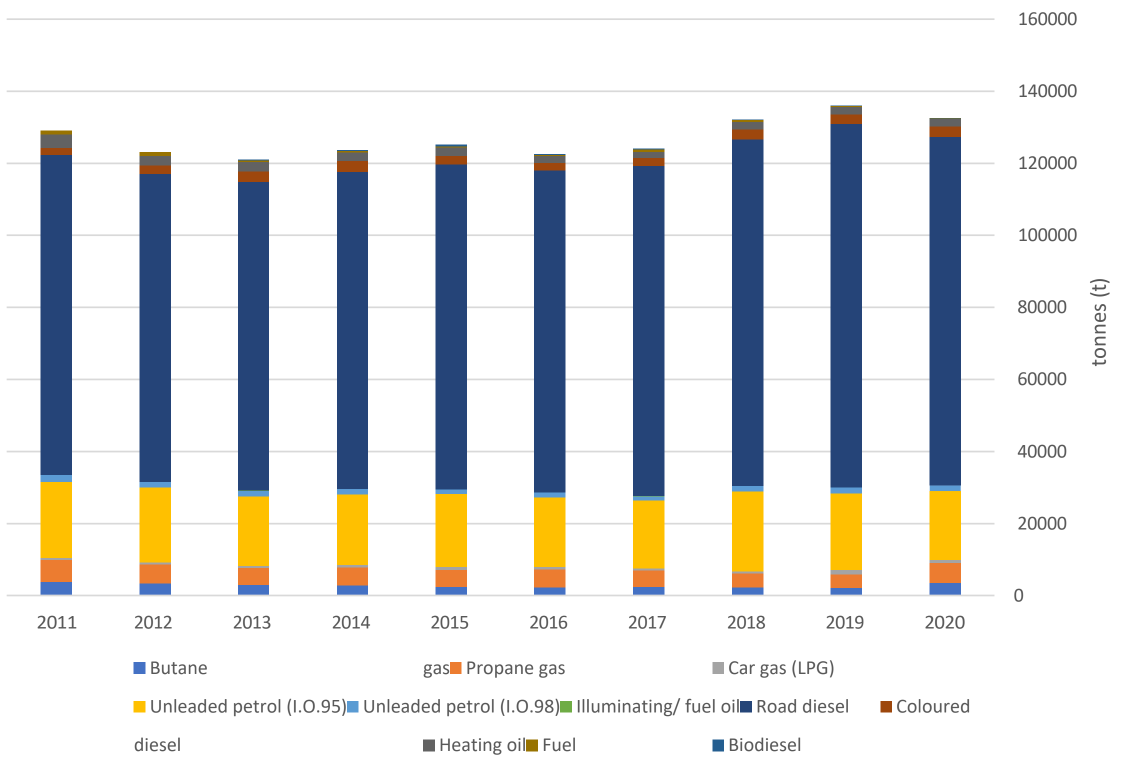


Figure 3.31. Sales of liquid and gaseous fuels (tonnes) between 2011 and 2020 by companies in the municipality of Braga

Source: INE, 2022.

According to the most recent DGEG statistics for 2021, the fuels most used for road transport in the municipality of Braga are diesel (82%) and petrol (16%) (**Figure 3.32**). Between 2011 and 2020 there was a reduction in the use of petrol and an increase in the use of diesel and LPG, essentially used in the transport sector.

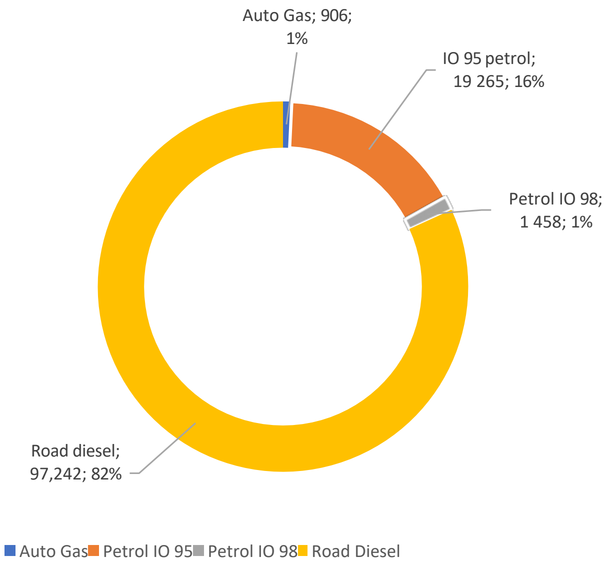


Figure 3.32. Fuel consumption in tonnes in the land transport sector in 2021 and percentage by energy vector in the municipality of Brag

Source: DGEG, 2022.

With regard to motor fuel consumption, the Braga municipality has a higher capitation than the region in which it is located and above the national average, and has even seen a successive increase since 2011 and until 2020, when the pandemic effect resulted in a decrease in motor fuel consumption (**Figure 3.33**). In the year before the pandemic, in 2019, the municipality of Braga consumed around 128,000 toe of motor fuels, an increase of 11% compared to consumption in 2011, contrary to the national trend of a decrease in the use of fossil fuels at national level (-3% compared to 2011).

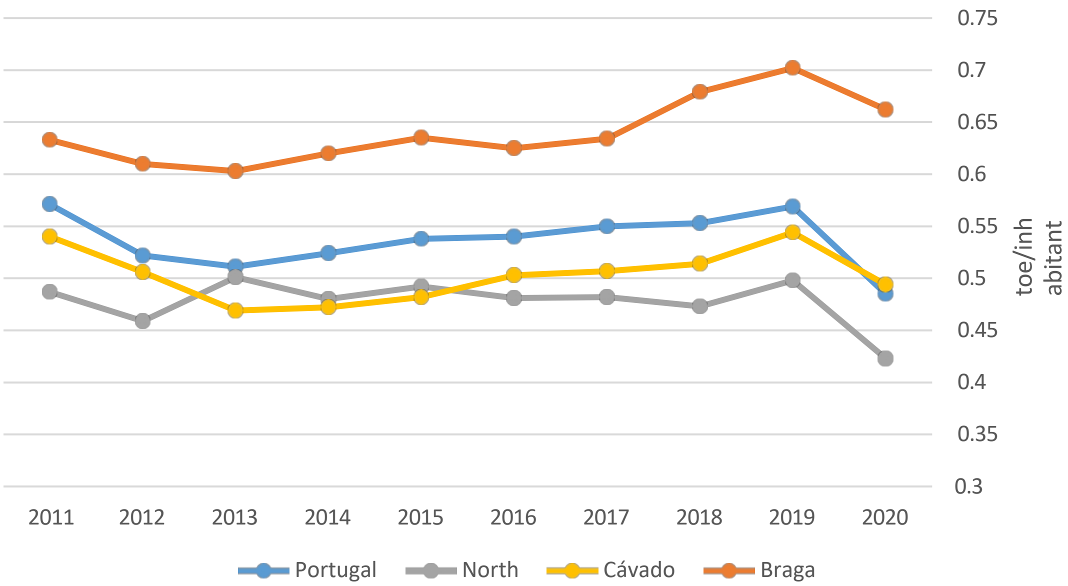


Figure 3.33. Changes in car fuel consumption per inhabitant (toe/inhabitant) between 2011 and 2020 in the municipality of Braga

Source: INE, 2022.

In 2021, the municipality of Braga consumed around 37.9 million m^3 of natural gas, which translates into an increase of 27% compared to 2011. It should be noted that this consumption does not take into account the consumption of natural gas for electricity production by thermoelectric power stations outside the municipality. Despite the growth in the municipality's natural gas consumption, it is below the regional and national average (**Figure 3.34**).

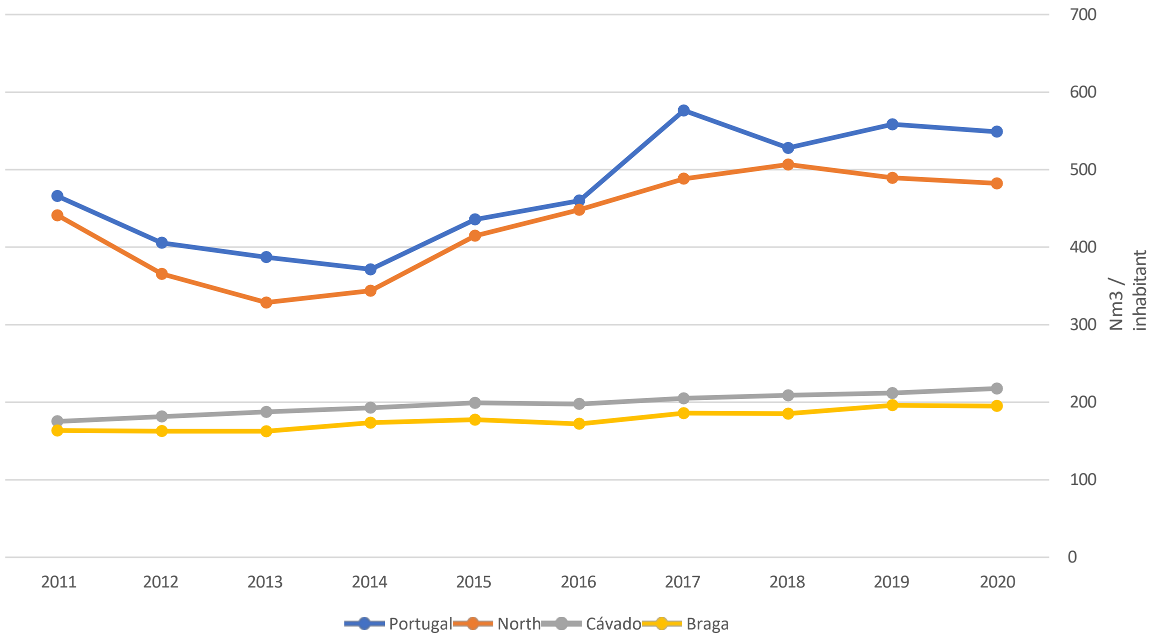


Figure 3.34. Total natural gas consumption per inhabitant between 2011 and 2020

Source: INE, 2022.

Figure 3.35 shows the sectors of activity with the greatest representation in municipal natural gas consumption. The most important sectors of activity are the domestic sector (31 per cent), the textile industry (30 per cent), the production of electricity, gas, steam, hot and cold water and cold air (8 per cent), and the basic metallurgical industry (7 per cent).

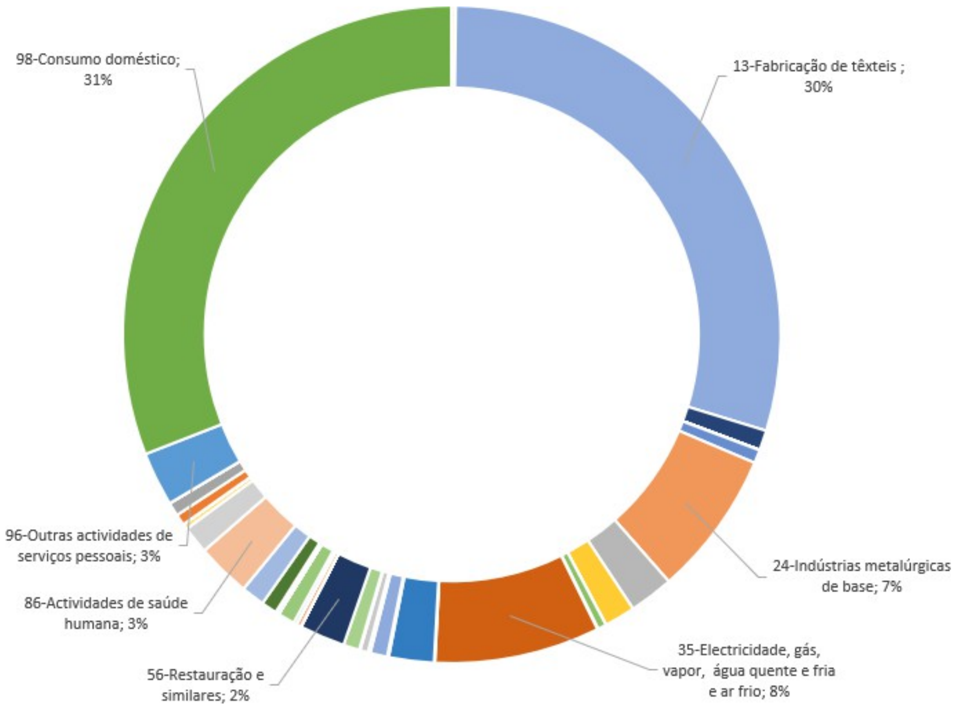


Figure 3.35. Representativeness of activity sectors in natural gas consumption in 2021 in the municipality of Braga

Source: DGEG, 2022

3.6.4 Natural Risks

Braga's Municipal Civil Protection Emergency Plan (PMEPCB) identifies the risks and vulnerabilities in the municipality, in order to establish a greater interconnection between civil protection emergency planning mechanisms and territorial management instruments (IGT).

Figure 3.36 identifies the risks that are most likely to occur in the municipality of Braga, according to the PMEPCB (2018).

RISCOS NATURAIS (os que resultam do funcionamento dos sistemas naturais)

- Movimentos de Massa em Vertentes;
- Cheias e Inundações;
- Sismos;
- Ondas de calor;
- Vagas de Frio;
- Geadas;
- Nevões;
- Nevoeiros;
- Secas.

RISCOS MISTOS (decorrem da combinação de ações continuadas de atividade humana com o funcionamento dos sistemas naturais)

- Incêndios Florestais;
- Degradação e Contaminação de Aquíferos.

RISCOS TECNOLÓGICOS (advêm de acidentes, frequentemente súbitos e não planeados, decorrentes da atividade humana)

- Acidentes Rodoviários;
- Acidentes Ferroviários;
- Acidentes no Transporte Terrestre de Mercadorias Perigosas;
- Acidentes Graves que Envolvem Substâncias Perigosas;
- Colapso de Estruturas (barragens, pontes, viadutos, diques);
- Ruína de Edifícios;
- Incêndios Urbanos.

Figure 3.36. Risks most likely to occur in the municipality of Braga

Source: CMB, 2018. PMEPCB.

Of the risks mentioned, it is important to highlight the natural risks that are fuelled by phenomena resulting from climate change, such as heat waves, droughts, floods and inundation.

3.6.4.1 Heat waves

According to the definition of the *Heat Wave Duration Index* (*HWDI*) by the World Meteorological Organisation (WCDMP-No.47, WMO-TD No. 1071), a heat wave occurs when, over an interval of at least 6 consecutive days, the maximum daily temperature is 5ºC higher than the average daily value for the reference period.

This definition is more related to the study and analysis of climate variability (in terms of trends) than to the impacts on public health of extreme temperatures that may be observed over a shorter period of time.

As the IPMA states, heatwaves, which can occur at any time of the year, are most noticeable and felt when they occur in the summer months (June, July and August). Since the 1940s, when daily meteorological data was available from a greater number of stations, heatwaves of varying lengths have occurred; however, it is since the 1990s that this phenomenon has been most frequent.

Figure 3.37 shows that a significant area of the municipality is in the High susceptibility class, according to the PMEPCB information - approximately 28.5 per cent.

In this context, it is worth mentioning the existing *Adverse Extreme Temperatures Programme: Specific Contingency Plan - Aces Cávado I Braga Heat Module*, the aim of which is to minimise the dangers of this phenomenon to the health of the general population.

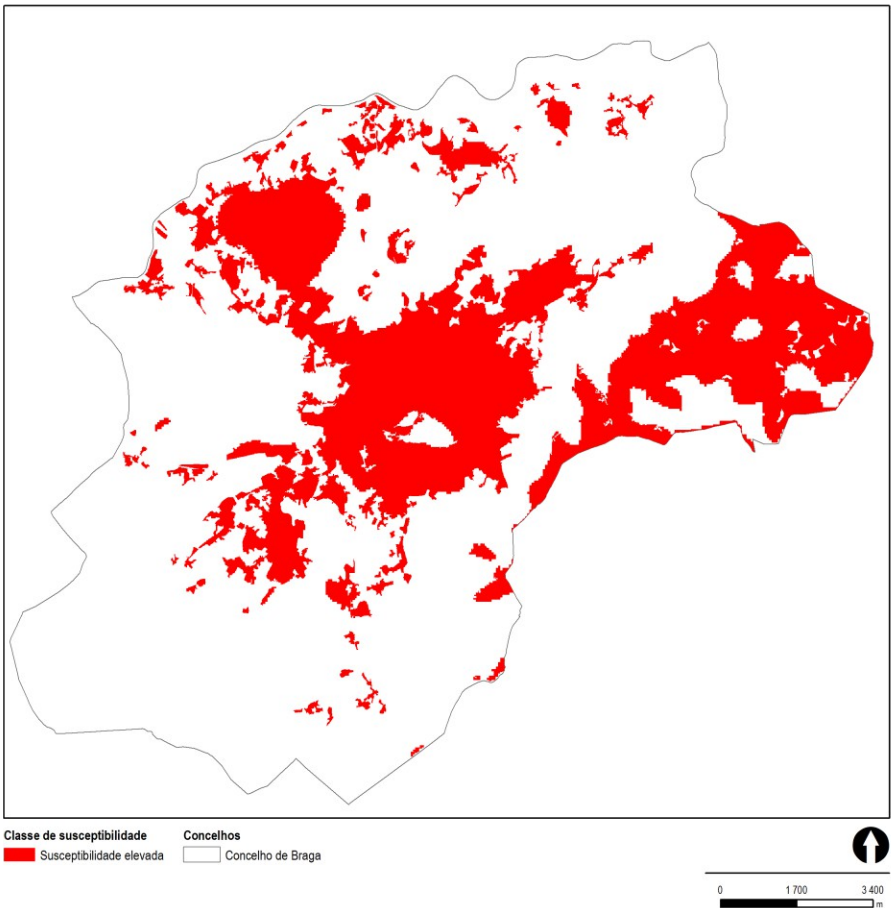


Figure 3.37. Heatwave susceptibility map - representation of the High susceptibility area

Source: adapted from PMEPCB, CMB, 2018.

According to the Risk Analysis (PMEPCB, Part IV - Complementary Information), the main area with high susceptibility to the occurrence of heat waves corresponds to the urban perimeter of the city of Braga, where more than 50 per cent of the resident population is over 65, namely in the current parishes of São José de São Lázaro and São João do Souto and Maximinos, Sé and Cividade. It should also be noted that in the other areas with high susceptibility, the weight of the elderly population is less of a concern, although it is important to bear in mind that the thermal conditions in cities (a situation known as "heat islands") reflect a risk that is not only related to the age group of the population.

Table 3.16 shows the critical elements located in areas at high risk of heat waves identified in the PMEPCB.

Table 3.16. Critical elements located in an area at high risk of heat waves

Typology	Name
Health Equipment in Braga	Cávado I Health Centre Grouping - Braga
	Maximimos Health Unit
	São Vicente/Infias Health Unit
	Carandá Health Units
	Esporões Health Unit
	Cabreiros Health Extension
	Celeirós Health Extension
	Ruães Health Extension
	Pedralva Health Centre
	Braga Hospital
	Carandá Family Health Unit
	Gualtar Family Health Unit
	Bracara Augusta Family Health Unit
	Manuel Rocha Peixoto Family Health Unit
	St John's Family Health Unit in Braga
Fire stations	Braga Volunteer Fire Brigade Humanitarian Association
	Braga Fire Brigade
PSP	PSP - District Command
	PSP - 2nd Police Station - Souto Maior
GNR	GNR - Braga Territorial Post
	GNR - Sameiro Territorial Post
	GNR - Braga Tax Office
Teaching equipment	Caloutre Gulbenkian Conservatory of Music Art School
	André Soares Primary School, Braga
	Braga Oeste Primary School
	Celeirós Primary School
	Gualtar Primary School
	Marações Primary School
	Mosteiro and Cávado Primary School
	Nogueira Primary School
	Palmeira Primary School
	Real Primary School
	Dr Francisco Sanches Elementary School
	Friar Caetano Brandão Primary School
	Trigal de Santa Maria Primary School
	Alberto Sampaio Secondary School
	Carlos Amarante Secondary School, Braga

Typology	Name
	D. Maria II Secondary School, Braga
	Maximinos Secondary School, Braga
	Sá de Miranda Secondary School, Braga
CMPC	Municipal Civil Protection Commission

Source: PMEPCB, CMB, 2018.

3.6.4.2 Cold Vacancies

A cold wave is produced by a mass of cold, generally dry air that develops over a continental area. According to the ANEPC, a cold wave is considered to occur whenever, on at least six consecutive days, the minimum air temperature is 5°C or more below the average daily minimum temperature for the reference period. During these phenomena there are significant, sometimes sudden, drops in daily temperatures, with minimum values falling below 0.ºC in winter.

Figure 3.38 shows that the eastern sector of the municipality has a significant area in the High susceptibility class, according to the PMEPCB information, which despite representing approximately 18.5 per cent of the municipality, still represents a significant area.

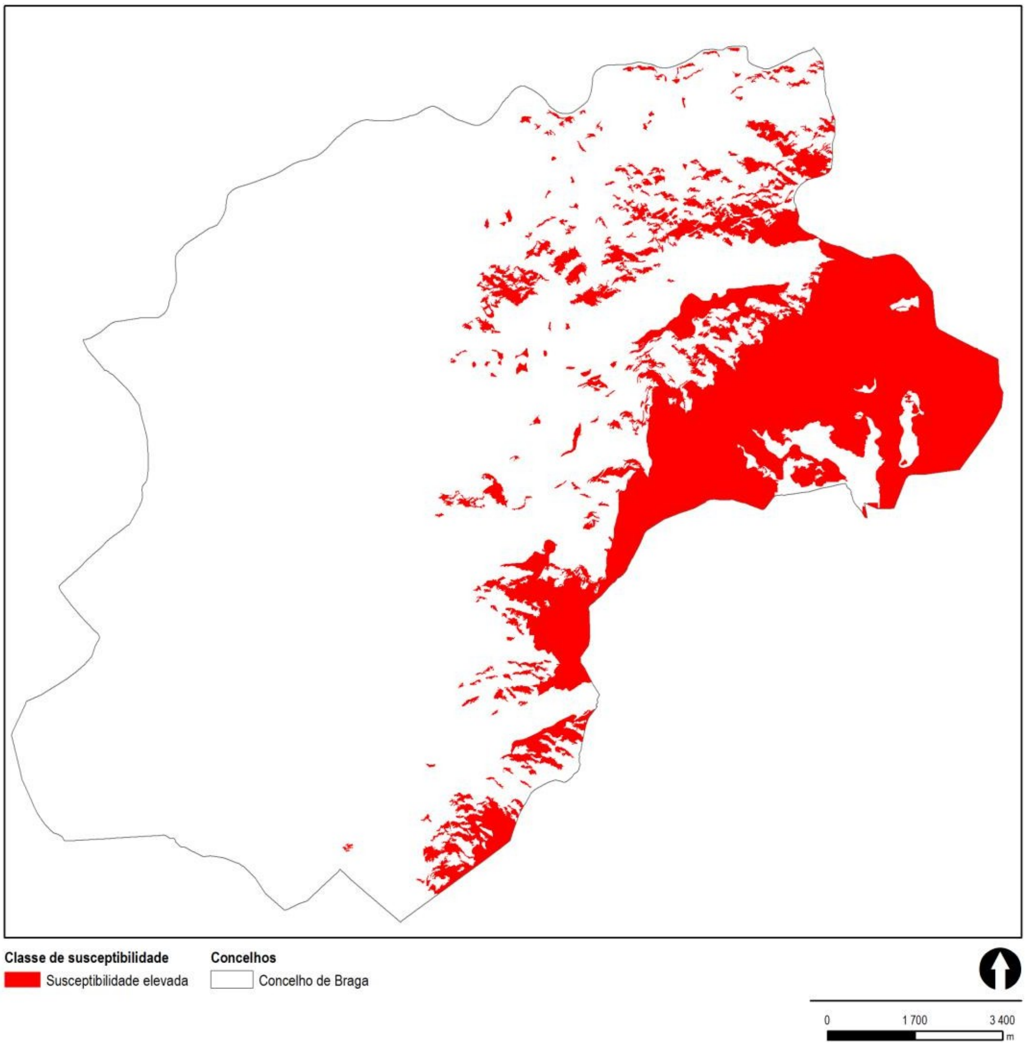


Figure 3.38. Cold wave susceptibility map - - representation of the High susceptibility area

Source: adapted from PMEPCB, CMB, 2018.

According to the Risk Analysis (PMEPCB, Part IV - Complementary Information) and **Figure 3.38**, the eastern part of the municipality, the parishes of Sobreposta, Espinho and Pedralva, are highly susceptible to the occurrence and permanence of cold spells. It is also noted that the risk extends to areas where the thermal comfort of homes is low or non-existent.

Table 3.17 shows the critical elements located in areas at high risk of cold waves identified in the PMEPCB.

Table 3.17. Critical elements located in an area at high risk of cold waves

Typology	Name
Health Equipment	Pedralva Health Centre
GNR	GNR - Braga Territorial Post
	GNR - Sameiro Territorial Post
Teaching equipment	Crespos Primary School
	Pedralva Primary School
	Sobreposta Kindergarten
	Esprominho - Professional School of Minho
	Espinho Primary School

Source: PMEPCB, CMB, 2018.

3.6.4.3 Droughts

According to the PMEPCB's agricultural drought susceptibility chart - drought associated with a lack of water caused by an imbalance between the water available in the soil, the crops' needs and plant transpiration - 26.50 per cent of the municipality's area is highly susceptible to agricultural drought (**Figure 3.39**).

It should be emphasised that this type of drought is related to the characteristics of crops and natural vegetation, i.e. agricultural systems in general.

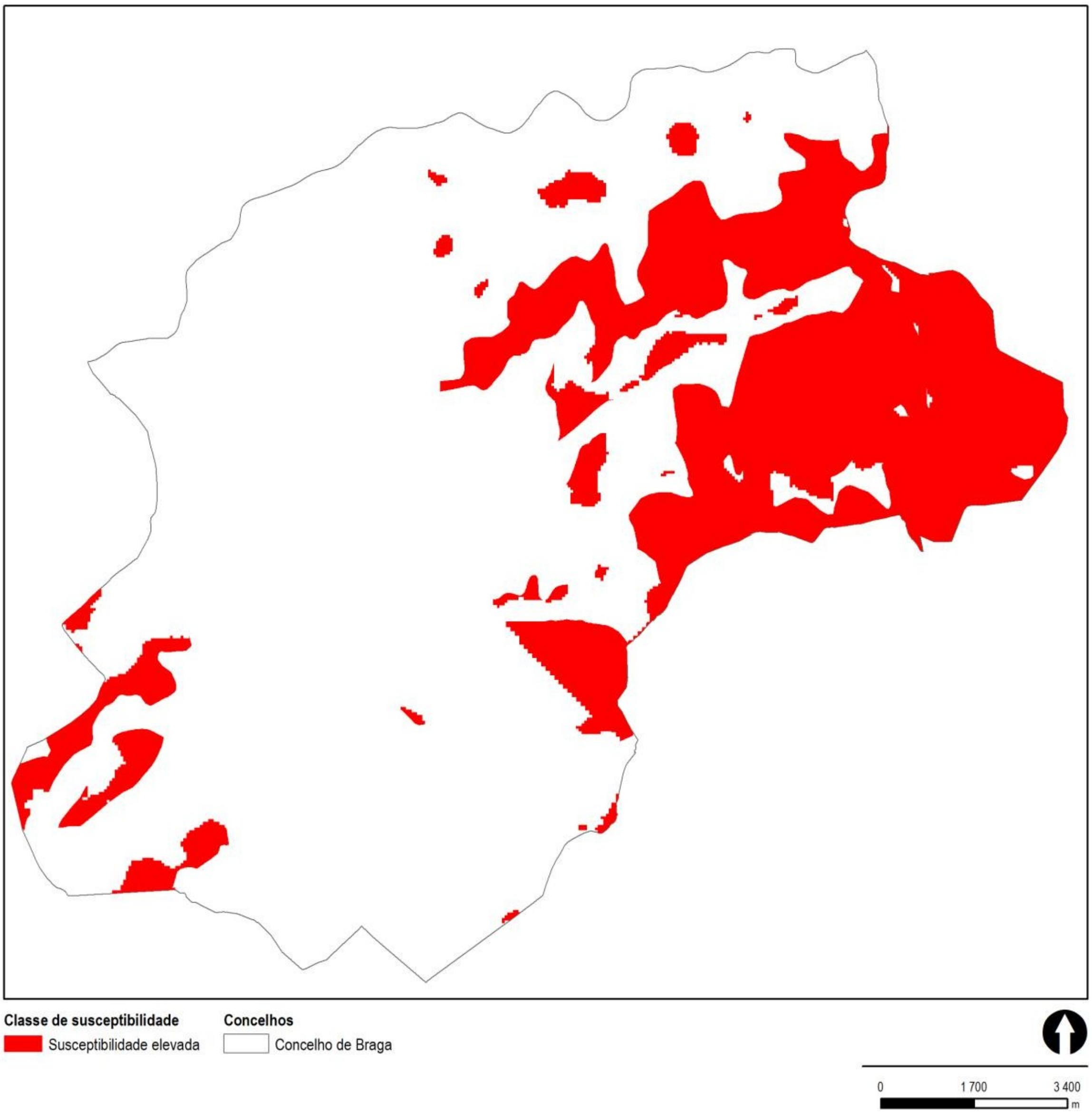


Figure 3.39. Agricultural drought susceptibility map - representation of the High susceptibility area

Source: adapted from PMEPCB, CMB, 2018.

The areas most at risk correspond to the main agricultural areas located in the parishes of Pedralva and Sobreposta, in the eastern part of the municipality, and Ruílhe to the north-west.

According to the Risk Analysis (PMEB, Part IV - Complementary Information) in a situation of hydrological drought, the municipality of Braga has one surface water catchment, located in the parish of Palmeira, which is managed by AGERE - Empresa de Águas, Efluentes e Resíduos de Braga.

3.6.4.4 Floods

As mentioned above, the average annual rainfall in the Cávado, Ave and Leça basins is very high, making it one of the regions in the country with the highest rainfall, ranging from 1540 mm to 2370 mm. The distribution of rainfall throughout the hydrological year is concentrated in the second quarter, with December and January being the wettest months.

The average annual distribution of runoff, which essentially stems from the distribution of average annual rainfall, is characterised by great variability in monthly runoff. In fact, especially in the case of some tributaries, such as the Ribeira de Panóias in the Cávado basin, the Rio Veiga or even the Rio Este in the Ave basin, the flow values recorded in the summer are tiny, especially when compared to the wetter months, when this flow often exceeds the flow capacity of these watercourses, generating frequent floods.

As the main instrument for managing flood risks, the Flood Risk Assessment and Management Directive (FRAMD), Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007, defines the preparation of Flood Risk Management Plans (FRAMP) for six-year cycles, focused on the prevention, protection, preparation and forecasting of these phenomena, in close coordination with the management plans of the river basin districts.

The delimitation of flood areas in these plans uses hydrological and hydraulic modelling methodology, allowing the results to assess the consequences of flooding for the population, the environment, economic activities and heritage. These plans are drawn up by Hydrographic Region, specifically for the Cávado, Ave and Leça Hydrographic Region - RH2, which includes the municipality of Braga.

According to the PGRI-RH2, specifically in the municipality of Braga, two Areas of Significant Potential Flood Risk (ARPSI) are identified. One of these ARPSI is in the Ave - Este river basin, and the other is in the Cávado - Padim da Graça river basin. These ARPSI are shown in **Figure 3.40** and **Figure 3.41**. The municipality of Braga reported the highest number of events with significant impacts, clearly affecting public services, the road network and the population.

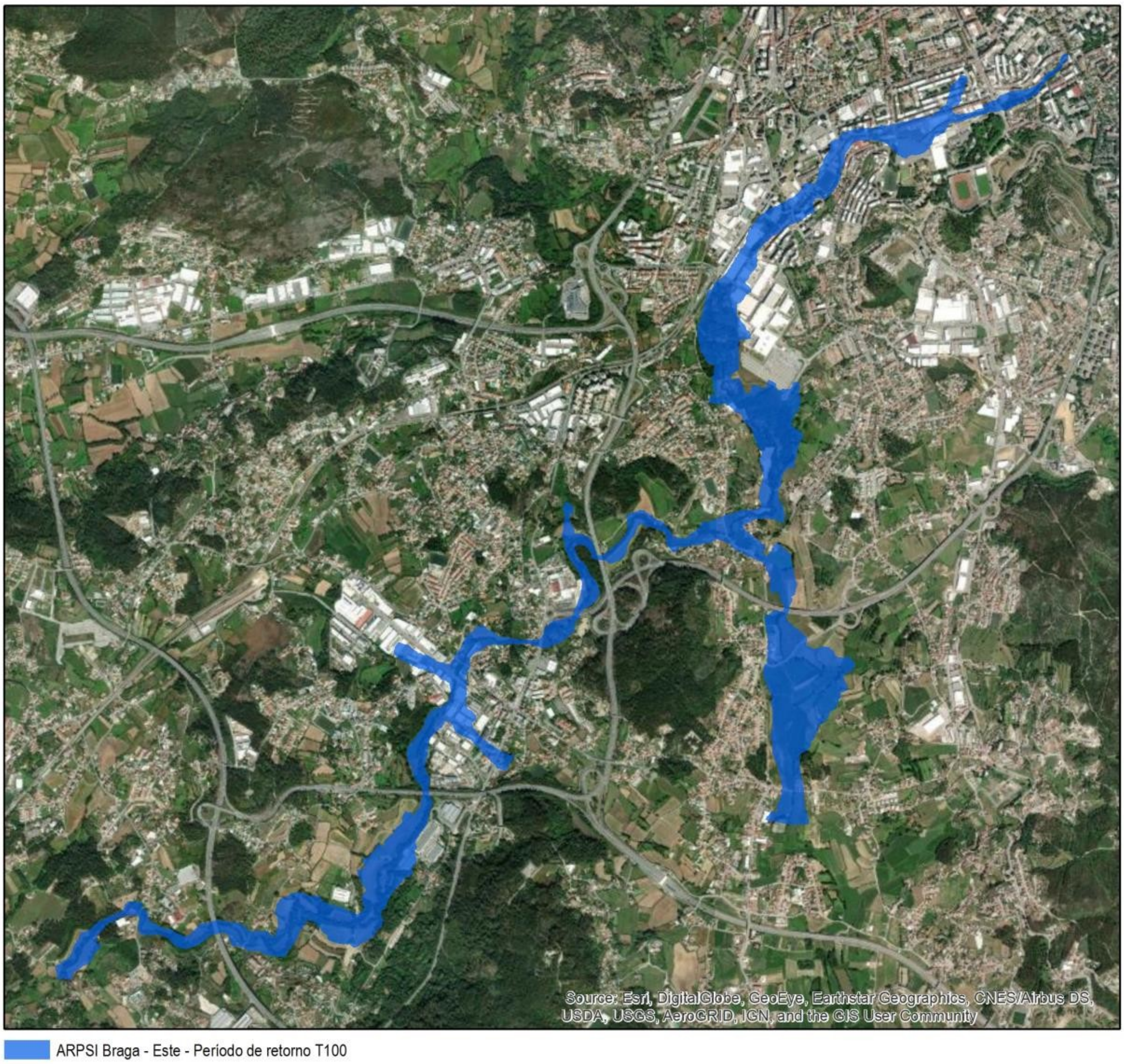


Figure 3.40. ARPSI - East

Source: PGRI-RH2, 2nd cycle (2020)

Figure 3.41. ARPSI - Padim da Graça

Source: PGRI-RH2, 2nd cycle (2020)

According to the PGRI-RH2, the East River ARPSI establishes the event with the greatest impact - 08/10/2014 - as potentially affecting more than 100 people, with a high impact on economic activities, as well as high but unaccounted for damage. No impacts on the environment were accounted for.

The set of sensitive buildings potentially affected by this ARPSI are shown in **Table 3.18**.

Table 3.18. Sensitive buildings potentially affected by the East ARPSI in the municipality of Braga

Name	Category
Cepsa (Rua Padre Cruz)	Petrol station
Dierum - Early Childhood Education	Education
EB1/JI de Ponte Pedrinha	
Celeirós Social Centre kindergarten	
Celeirós Parish Council	State administration

Source: APA, PGRI-RH2 2022

The Padim da Graça ARPSI establishes the event with the greatest impact - 06/04/2012 - as potentially affecting between 50 and 100 people, with a low impact on economic activities, reduced damage and impacts on the environment, specifically on existing polluting industries, as well as on protected areas. It should be noted that this ARPSI includes the Areias de Vilar catchment and its respective protection area.

The group of sensitive buildings potentially affected by this ARPSI is located in the municipality of Vila Verde.

The Braga Municipal Master Plan corroborates the assessment of the flood zones defined in the PGRI. In fact, this plan's conditioning chart, dated 2017, shows an identical flood area, with only slight differences, especially in the upstream sections.

3.6.4.5 Slope movements

Risk Analysis (PMEPCB, Part IV - Complementary Information) most of the areas of high susceptibility are located where the steepest slopes prevail, particularly the slopes of Serra dos Carvalhos, Serra dos Picos and Monte de Vasconcelos in the eastern part of the municipality, Monte das Caldas to the west and the relief bordering Vila Nova de Famalicão (Penedo das Letras).

In addition to the slope, the proliferation of artificialised land leads to less waterproofing which, according to the PMEPCB Risk Analysis, strongly influences soil loss and consequently increases susceptibility to movement along the slopes.

Figure 3.42 shows the PMEPCB's map of susceptibility to slope movements.

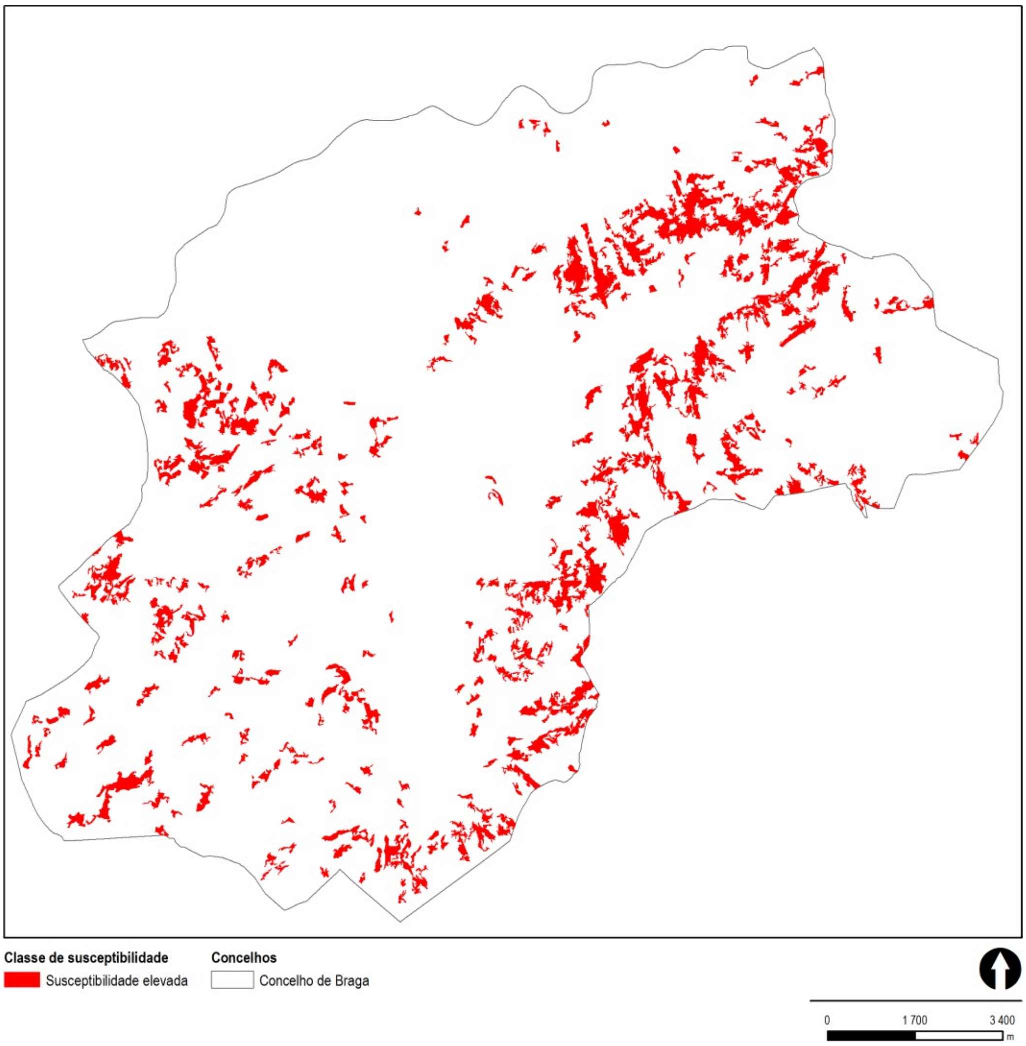


Figure 3.42. Map of susceptibility to the occurrence of slope movements - representation of the High susceptibility area

Source: adapted from PMEPCB, CMB, 2018.

When analysing the susceptible elements in the municipality, the PMEPCB identifies the following situations:

- To the west of the municipality, some stretches along the EM 563 and the villages located on the slopes of Monte S. Filipe (Vieiros, Monte, Cachada and D. Pedro); the villages at the foot of the relief near S. Filipe.

  Filipe (Monte de Caldas), since some sectors of Monte de Caldas are highly susceptible (Esperança, parish of Semelhe, and Caldas, parish of Sequeira);
- Also to the west of the municipality, in the parish of Passos S. Julião, some stretches of the EM 561 also intersect with areas of high susceptibility;
- In the southern part of the territory there are some sections of the EM 562 (parish of Ruilhe and Arentim) in highly susceptible casses;
- In the parish of S. Pedro de Oliveira, the element most at risk is the A3 motorway, a situation that is repeated in some areas located in Fradelos and Vilaça;
- In the parish of Escudeiros there are two communication routes, the one that connects to the municipality of Vila Nova de Famalicão (EM 309) and the EM 568 that crosses the areas of aggregate extraction.

  existing in that area;
- Another important road at risk is the EN 101, in the parishes of Esporões, Trandeiras and Moreira. This communication route is associated with settlements

  which are installed at the foot of Monte de Santa Marta;
- On the most important elevation in the municipality of Braga (Monte Sameiro) there are vital and sensitive elements that are exposed to the risk of slope movement, namely the

  villages located on the foothills and slopes of Fraião, Nogueiró, Tenões and Espinho. In addition to these settlements, some sections of the EM 309 and EN 103-3 (Sameiro/Bom Jesus link) are identified as sensitive areas;
- To the north is the CM 1288, which connects the parishes of S. Lucrécia de Algeriz, some sections of the EM 591 and EN 103 stand out, as well as the places of Monte, Aldeia and Igreja, as they are close to each other.

  downstream of 1st order watercourses, consequently with greater erosive power when short but intense periods of precipitation occur.

With regard to the elements considered critical to this risk, the PMEPCB identifies the basic school of Semelhe, located in the parish of Semelhe in the village of Igreja.

3.6.4.6 Adverse Meteorological Phenomena

The Risk Analysis (PMEPCB, Part IV - Complementary Information) also considers what they call adverse meteorological phenomena, associated with heavy rainfall and strong wind. As an example, they mention the case study that took place in October 2011, in which between 20 and 27 October the total amount of rainfall recorded in the municipality of Braga was 229.9 millimetres, spread over eight days and the maximum amount of rainfall in ten minutes reached 5 to 7 millimetres in the afternoon of the 23rd, 6 to 8 millimetres in the early hours of the 24th and 12 to 14 millimetres in the afternoon of 26 October. On 26 October, the total rainfall was 117 millimetres, with approximately 98 millimetres falling between 1pm and 11pm that day and 74.6 millimetres falling between 5pm and 7pm. As a result, several floods were recorded, mainly in road tunnels and roads, but also in homes and agricultural areas.

According to the IPMA, in 2022, the month of December was characterised by several episodes of precipitation (days 4 and 5, days 7 to 9, days 11 to 15, days 19 and 20, days 24 to 26 and days 29 to 31) which were sometimes associated with strong winds, with impacts such as flooding in some places in the Greater Lisbon and Tagus Valley region, the Algarve, Alto Alentejo and Minho and Douro Litoral - some of these episodes were characterised by intense precipitation.

For example, according to ANEPC, between 4pm and 9.30pm on 29 December, 137 incidents were recorded in mainland Portugal, with a total of 51 in the municipality of Braga.

3.6.4.7 Forest Fire

Rural fires are one of the most serious natural disasters in Portugal, not only because of the high frequency with which they occur and the extent they reach, but also because of the destructive effects they cause. In addition to the economic and environmental damage, they can be a source of danger to people and property. Their recognition as a natural disaster is more related to the fact that they develop in nature and that their possibility of occurrence and propagation characteristics depend heavily on natural factors, than because they are caused by natural phenomena.

However, human intervention can play a decisive role in their origin and in limiting their development, which is why the importance of human action in these phenomena distinguishes rural fires from other natural disasters.

The spread of a fire of this type depends on meteorological conditions (wind direction and intensity, relative humidity, temperature), the degree of dryness and type of vegetation cover, terrain orography, accessibility to the fire site, intervention time (time between the alert and the first intervention to attack the fire, commonly referred to as initial attack), etc. It can spread across the surface of the ground, through the tops of trees and through the mulch.

Within the scope of the PMEPCB, forest areas associated with uncultivated and agricultural land were considered for fire hazard.

According to the forest fire danger map (**Figure 3.43**), 13.5 per cent of the territory is in the "High" and "Very High" danger class, located in the most continuous forest patches (Perimeter of Sameiro and Bom Jesus, Monte das Caldas, Serra dos Picos and Serra dos Carvalhos).

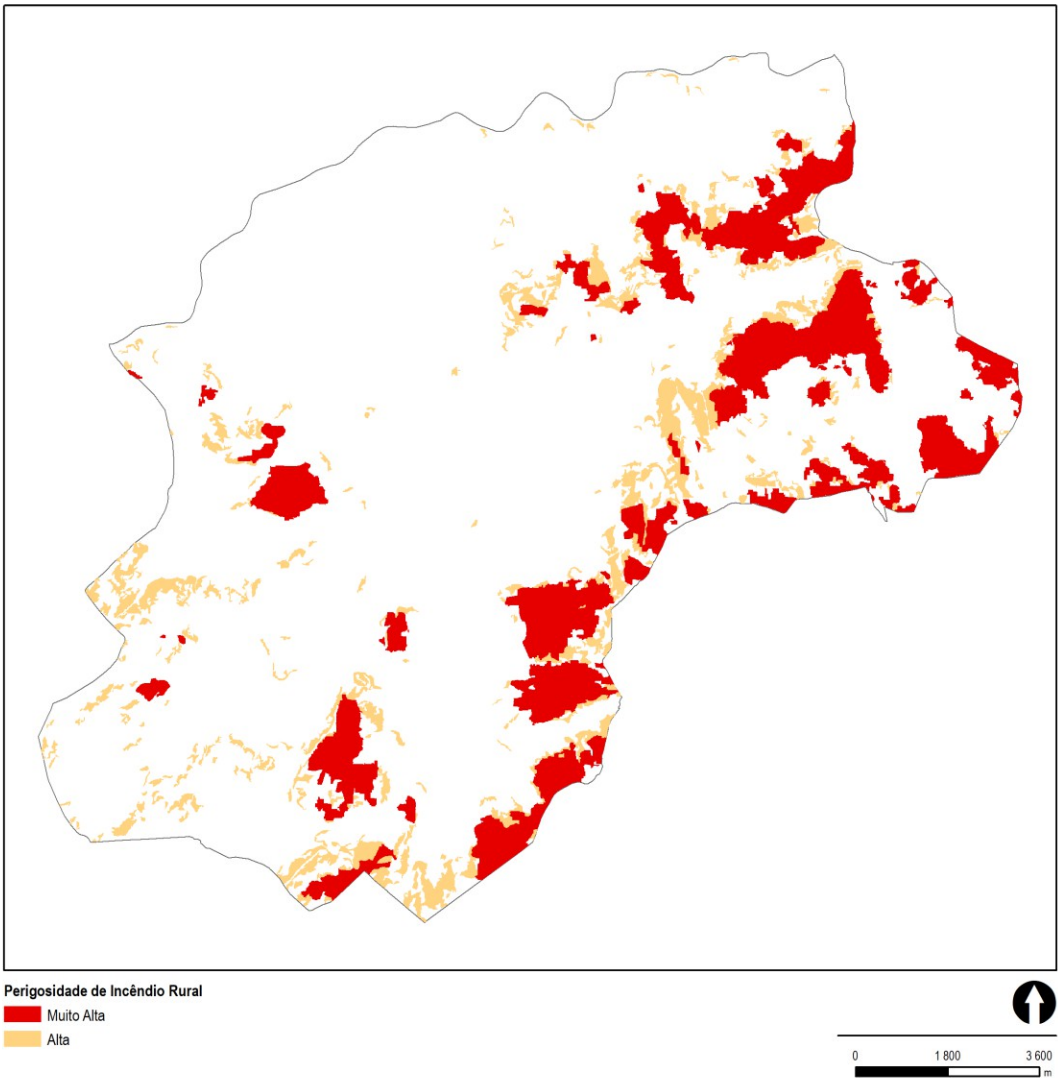


Figure 3.43. Hazard map for the occurrence of rural/forest fires - representation of the High susceptibility area

Source: adapted from PMEPCB, CMB, 2018.

From the cross-referencing with the elements exposed to this risk, the following should be highlighted as critical elements, as they are in the "High" and "Very High" risk class: the Ruilhe GNR Territorial Post, the Santo Estêvão Basic School and the Este Industrial Park.

3.7 Cultural Heritage

The architectural heritage considered in Braga's Municipal Masterplan is made up of two large groups that correspond to different "levels of heritage and cultural valuation". The first group includes properties classified at national level (MN - National Monuments or IP - Public Interest) and at municipal level (IM - Municipal Interest) and properties in the process of being classified. The Municipality of Braga also has a vast unclassified architectural and archaeological heritage, which is listed (**Figure 3.44)** and catalogued in Braga's PDM.

In terms of the first group, classified properties include those classified as a National Monument (a total of 14) and those classified as a Property of Public Interest (a total of 43).

The municipality of Braga has a vast archaeological and architectural heritage, particularly due to the existence of a Roman city under the current city platform, and there are several ruins of archaeological and historical interest.

Table 3.19 identifies the archaeological heritage classified and inventoried in Braga's Municipal Master Plan.

Table 3.19. Archaeological heritage classified and inventoried in Braga's Municipal Master Plan

Name	Classification	Category	Legislation
Roman Ruins of Alto da Cividade or Maximinos Hill	National Monument	Site	Decree no. 1/86, D.R., 1st series, no. 2 of 3rd January 1986 Z.E.P., D.R., 1ª Série B, nº 192, Portaria 865/91 de 22/08/1991
Archaeological Ruins of São Martinho de Dume	National Monument	Site	Decree Law no. 45/93, D.R., 1st series - B, no. 280 of 30 November 1993 Z.E.P., Ministerial Order 227/97, D.R., 2nd Series B, no. 110 of 13 May 1997
Santa Marta das Corticas Archaeological Site	Property of Public Interest	Set	Decree no. 40 361, D.G., 1st series, no. 228 of 20 October 1955 Z.E.P. Decree No. 251/70 of 3rd June

Name	Classification	Category	Legislation
Monte Redondo Hillfort	National Monument	Set	Decree of 16/06/1910, D.G. no. 136 of 23 June. 1910
Monte da Consolação Hillfort	Property of Public Interest	Set	Decree no. 26-A/92, D.G., 1st series - B, no. 126 of 1st December, 1992 June 1992
Idol Backyard Tank or Idol Fountain	National Monument	Site	Decree of 16/06/910 Z.E.P. Ordinance no. 105, D.G., 2nd series, of 5th May, 2009 1970
Change from the Quinta do Fujacal	Property of Public Interest	Site	Approval order of 18 April 1985
Castro Máximo or Monte Castro	Property of Public Interest	Set	Decree no. 29/84, D.R. 1st series, no. 145 of 25th June 1984 Z.E.P. Ordinance no. 281/85, D.R. 1st series, no. 108 of 11 May 1985
Roman ruins of Carvalheiras	Property of Public Interest	Set	Decree no. 29/90, D.R. 1st series, no. 163 of 17th July 1990

On the other hand, **Table 3.19** identifies the architectural heritage classified and inventoried in Braga's Municipal Master Plan.

Table 3.20. Architectural heritage classified and inventoried in Braga's Municipal Masterplan

Name	Classification	Category	Legislation
Sé de Braga, comprising the tombs of Count Henry the Navigator, of D. Teresa, Infante D. Afonso and Archbishops D. Gonçalo Pereira and D. Diogo de Sousa	National Monument	Monument	Decree of 16/06/910, D.G. no. 136 of 23 June 1910 Z.E.P., Portaria, D.G., 2ª série, n.º 202 de 30 de agosto 1967

Chapel of Our Lady of the Conception (dos Coimbras)	National Monument	Monument	Decree of 16/06/1910, D.G. no. 136 of 23 June 1910 Z.E.P., Ordinance, D.G., 2ª series, no. 69 of 23 March 1955

Name	Classification	Category	Legislation
Cruzeiros (2) Sé, Campo das Carvalheiras (a) and Largo Senhora-a-White (b)	National Monument	Monument	Decree of 16/06/1910, D.G. no. 136 of 23 June. 1910
Tibães Cruise	National Monument	Monument	Decree of 16/06/1910, D.G. no. 136 of 23 June 1910 Z.E.P., Portaria, D.G., 2ª Série, nº 242 de 18 de October 1949 Zona non aedificandi, D.R., 1ª série B, n.º 187 of 13 August 1994
Braga Castle (remains), namely the Tower of Menage	National Monument	Monument	Z.E.P., Portaria, D.G., 2ª série, n.º 58 de 09/03/62
Porto Bridge (over the Cávado River)	National Monument	Monument	Decree of 16/06/1910, D.G. no. 136 of 23 June. 1910
PRADO BRIDGE, over the Cávado (see Vila Verde)	National Monument	Monument	Decree of 16/06/1910, D.G. no. 136 of 23 June 1910
New Gate Arch	National Monument	Monument	Decree of 16/06/1910, D.G. no. 136 of 23 June. 1910
Chapel of São Frutuoso	National Monument	Monument	Decree no. 33 587, D.G., 1st series, no. 63 of 27 March 1944 Z.E.P., Ministerial Order no. 624/2014, D.R., 2nd series, no. 143 of 28 November 2014 July 2014
Water supply system for the city of Braga in the 18th century, known as Sete Fontes (Seven Fountains)	National Monument	Monument	Decree Law no. 16/2011, D.R., 1st series, no. 101 of 25th May 2011 Z.E.P., Portaria 576/2011, D.R., 2ª Série B, nº 110, de 04 June 2011
Braga pillory (fragment)	Property of Public Interest	Monument	Decree no. 23 122, D.G., 1st series of 11 October 1933

Name	Classification	Category	Legislation
			Covered by Z.E.P., D.G., 2nd Series, No. 202 of 30/08/1967 (Braga Cathedral)
Tibães Church and Monastery, fountains, architectural constructions of the estate, fence, fountains and cross	Property of Public Interest	Monument	Decree no. 33587, D.G. 1st series, no. 63 of 27 March 1944 Z.E.P., Ordinance No. 736/94, D.R. 1ª Série B, of 13 August 1994 Non-aedificandi zone, Ordinance 736/94, D.R. 1st series - B, no. 187 of 13th August 1994
Casa dos Biscainhos, yard, gardens, orchard and wall	Property of Public Interest	Monument	Decree no. 37366, D.G 1st series, no. 70 of 05 April 1949
St Mark's Hospital (main façade and church)	Property of Public Interest	Monument	Decree no. 40684, D.G., 1st series, no. 146 of 13 July 1956 Z.E.P., Ordinance no. 105, D.G., 2nd series, of 05 May 1970
Palacio do Raio or Casa do Mexicano (rocaille façade and staircase)	Property of Public Interest	Monument	Decree no. 40684, D.G., 1st series, no. 146 of 13 July 1956 Z.E.P., Ministerial Order no. 105, D.G., 2nd series, of 5th May, 2006. 1970
Chapel of the Old Convent of the Saviour	Property of Public Interest	Monument	Decree no. 42692, D.G., 1st series, no. 276 of 30 December. November 1959
Former Episcopal Palace (home to the Public Library and District Archive)	Property of Public Interest	Monument	Decree no. 47508, D.G., 1st series, no. 20 of 24 January 1967 Z.E.P., Ordinance no. 191, D.G., 2nd series of 18 August 1949
19th century house or Casa Pimentel	Property of Public Interest	Monument	Decree no. 47984, D.G. 1st series, no. 233 of 06th December. October 1967

Name	Classification	Category	Legislation
Parish Church of Santa Eulália de Tenões	Property of Public Interest	Monument	Decree no. 47984, D.G. 1st series, no. 233 of 06th December. October 1967
Sanctuary of Bom Jesus do Monte (consisting of the sanctuary, staircase, chapels and portico)	Property of Public Interest	Monument	Decree no. 251/1970, D.G., 1st series, no. 129 of 3 June 1970
Casa das Gelosias or Casa dos Crivos	Property of Public Interest	Monument	Decree no. 516/1971, D.G., 1st series, no. 274 of 22 December. November 1971
Casa dos Macieis Aranhas	Property of Public Interest	Monument	Decree no. 516/1971, D.G., 1st series, no. 274 of 22 December. November 1971
Casa da Avenida Central no. 118 to 124 or Casa Rolão	Property of Public Interest	Monument	Decree no. 129/1977, D.R., 1st series, no. 226 of 29 September 1977
Casa Grande or Casa Cunha Reis	Property of Public Interest	Monument	Decree no. 129/1977, D.R., 1st series, no. 226 of 29th December. September 1977
Casa da Naia	Property of Public Interest	Monument	Decree no. 129/1977, D.R., 1st series, no. 226 of 29 September 1977
Church and Convent of Pópulo	Property of Public Interest	Monument	Decree no. 129/1977, D.R., 1st series, no. 226 of 29th December. September 1977
Misericórdia Church of Braga	Property of Public Interest	Monument	Decree no. 129/1977, D.R., 1st series, no. 226 of 29 September 1977 Included in the Z.E.P. of Braga Cathedral and Old Palace Archbishop of Braga
Parish Church of St Victor	Property of Public Interest	Monument	Decree no. 129/1977, D.R., 1st series, no. 226 of 29 September 1977
House 51-55 Rua dos Plames	Property of Public Interest	Monument	Decree no. 95/78, D.R., 1st series, no. 210 of 12th December. September 1978
Parish Church of São Salvador	Property of Public Interest	Monument	Decree no. 95/78, D.R., 1st series, no. 210 of 12th December.

			September 1978
Residences (2) attached to the Casa dos Macieis Aranha	Property of Public Interest	Monument	Decree no. 95/78, D.R., 1st series, no. 210 of 12th December. September 1978

Name	Classification	Category	Legislation
Church of St Vincent	Property of Public Interest	Monument	Decree no. 1/86, D.R., 1st series, no. 2, 3 January 2016 1986
Pereira House	Property of Public Interest	Monument	Decree no. 1/86, D.R., 1st series, no. 2, 3 January 2016 1986
Casa dos Paivas or Casa da Roda	Property of Public Interest	Monument	Decree no. 1/86, D.R., 1st series, no. 2 of 3 January 1986
Convent, College and Church of the Congregants, also known as the Congregation of St Philip of Nery	Property of Public Interest	Monument	Decree No. 45/93, D.R. 1ª Série- B, no. 280 of 30 November 1993
Buildings (two), Nos. 34 to 40 (former District Hostel)	Property of Public Interest	Monument	Decree no. 45/93, D.R. 1ª Série - B, no. 280, of 30 April 1993 November 1993
Mouzinho de Albuquerque Square or Campo Novo complex	Property of Public Interest	Monument	Ministerial Order no. 443/2006, D.R., 2ª Série, no. 49, of 9 December 2006 March 2006
Braga Town Hall Building or *Domus Municipalis*	Property of Public Interest	Monument	Decree no. 5/2002, DR, 1ª Série-B, no. 42, of 19 December. February 2002
Bom Jesus do Monte lift	Property of Public Interest	Monument	Ministerial Order no. 305/2013, D.R., 2nd series, no. 99, of 23 May 2013
Chapel of Our Lady of Guadalupe (and surrounding area)	Property of Public Interest	Monument	Order no. 740-AX/2012, D.R., 2nd series, no. 248 (supplement), of 24 December 2012 Z.E.P. Portaria n.º 740 - AX/2012, D.R. 2ª série, n.º 248 de 24 de dezembro de 2012
Carmo Church and Old Carmelite Convent Building	Property of Public Interest	Monument	Ordinance no. 740-EX/2012, D.R., 2nd series, no. 252 (supplement), of 31 December 2012 Z.E.P., Ordinance no. 240 - EX/2012, D.R. 2nd series, no. 252 of 31 December

			2012 2012

Name	Classification	Category	Legislation
Church of the Third	Property of Public Interest	Monument	Order no. 740-I/2012, D.R., 2.ª série, no. 248 (supplement), of 24th December, 2007 December 2012 Covered by the Z.E.P. of Keep
Recollection of St Mary Magdalene or of the Converts	Property of Public Interest	Monument	Order no. 665/2012, D.R., 2nd series, no. 215, of 7th November 2012 Z.E.P. Ordinance no. 665/2012, D.R. 2nd series, no. 215 of 7th November 2012
Casa e Quinta da Igreja	Property of Public Interest	Monument	Order no. 740-X/2012, D.R., 2.ª série, no. 248 (supplement), of 24th December, 2007 December 2012 Z.E.P. Order no. 740 - X/2012, D.R. 2nd series, no. 248 of 24 December 2012
Casa de São Brás da Torre (Including chapel, garden and woodland)	Property of Public Interest	Monument	Order no. 740-CC/2012, D.R., 2nd series, no. 248 (supplement), of 24 December 2012 Z.E.P. Ministerial Order no. 740 - CC/ 2012, 2nd series, no. 248 of 24 April 2012 December 2012
Quintã House	Property of Public Interest	Monument	Order no. 884/2013, D.R., 2nd series, no. 240, of 11 December 2013 Z.E.P. Ordinance no. 884/2013, D.R. 2nd series, no. 240 of 11 December 2013

1st of May Stadium	Property of Public Interest	Monument	Order no. 740-FO/2012, D.R., 2nd series, no. 252 (supplement), of 31 December 2012

Name	Classification	Category	Legislation
			Z.E.P. Ministerial Order no. 740 - FO/2012, D.R. 2nd series, no. 252 of 31 December 2012 2012
Dona Chica Castle or Palmeira Castle	Property of Public Interest	Monument	Ministerial Order no. 120/2013, D.R., 2nd series, no. 48, of 8 March 2013 Z.E.P. Ordinance no. 120/2013, D.R. 2nd series, no. 48 of 8 March 2013
Chapel of Recollection of Charity	Property of Municipal Interest	Monument	Decree no. 1/86, D.R. 1st series, no. 2 of 3rd January 1986
Casa da Maínha and its portal and adjoining walls	Property of Municipal Interest	Monument	Announcement no. 13501/2012, D.G. 2nd series, no. 190, 1st October 2012
Teodósio Barbosa de Almeida House	Property of Interest Municipal	Monument	N.D.
Tower House	Property of Interest Municipal	Monument	N.D.
Casa e Quinta das Lages	Property in the process of being listed	Monument	Announcement no. 345/2013, D.R., 2nd series, no. 214, of 5 November 2013

Figure 3.44 gives a general picture of the current state of cultural heritage in the municipality of Braga.

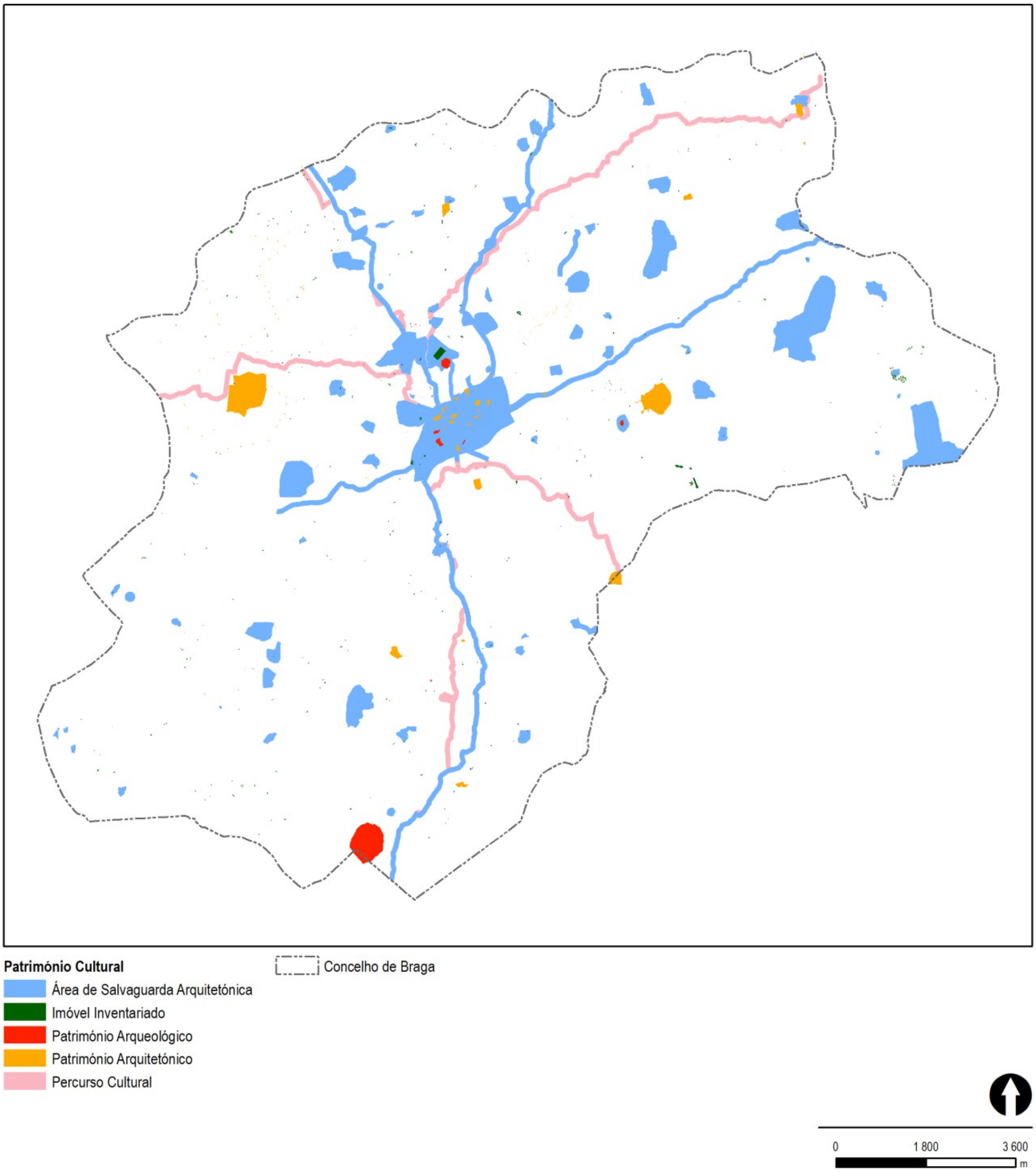


Figure 3.44. Cultural heritage in the municipality of Braga
Source: CMB, 2015. PDM Braga

4. Climate Characterisation and Cenarisation

4.1. Regional Climate Characterisation

The Cávado Region, due to its location (between the Atlantic Ocean and the climatic environments of the interior) and the configuration of the relief, condition the climatic characteristics of this sub-region and determine the type of climate that exists.

The geographical position close to the Atlantic, as well as the shape and layout of the main mountain ranges in north-west Portugal, mean that the Cávado sub-region is the wettest in Portugal, with moderate summers and cool winters.

Upstream of the Cávado sub-region, namely the Larouco mountain range, there is a continental climate, accentuated by its topographical position. There are cold and very cold winters.

According to simple classification criteria, the climate of the Cávado sub-region varies between cool, humid and very rainy in the upstream sectors covered by the Gerês, Larouco, Amarela and Barroso mountains and temperate, humid and rainy in the coastal strip.

According to Thornthwaite's climate classification6, the climate of most of the region is super-humid, mesothermal, with a moderate lack of water in summer and little thermal efficiency in summer.

On the coast, the climate is sub-humid to humid, as rainfall is lower than in other parts of the region. (PBH Rio Cávado (2000) and Brito, A.; Costa, S., Pinho, J. (2008); Estudo de Valorização e Desenvolvimento Estratégico dos Rios Cávado e Homem).

[6] Thornthwaite, 1953 in Casimiro Mendes & Bettencourt, 1980

4.2 Climate characterisation of the municipality

Climate is one of the most important factors contributing to the formation of landscapes, with precipitation, temperature, relative humidity, atmospheric pressure and wind being the most decisive elements of climate.

Climatic and meteorological factors are one of the main conditioning factors for the spread of rural fires, and knowledge of them allows for better management of the material and human resources needed to prevent and mitigate rural fires.

It is important to know the meteorological conditions in real time and in the forecast, so as to be able to assess the greater or lesser risk of rural fires. It should also be borne in mind that these conditions are also a determining factor in terms of the flammability of the vegetation cover, related to the degree of humidity of its tissues, and in its development during its life cycle.

To characterise the climate of the Braga municipality, the following parameters were analysed:

- Air temperature;
- Relative humidity;
- Precipitation;
- Wind.

The climatic characterisation was based on information provided by the Portuguese Institute of the Sea and Atmosphere (IPMA), relating to the climatological data obtained from the Braga Meteorological Station for the period 1971 to 2000. This weather station is located at Latitude: 41° 33'N; Longitude: 08° 24'W; Altitude: 190 m.

- **Air temperature**

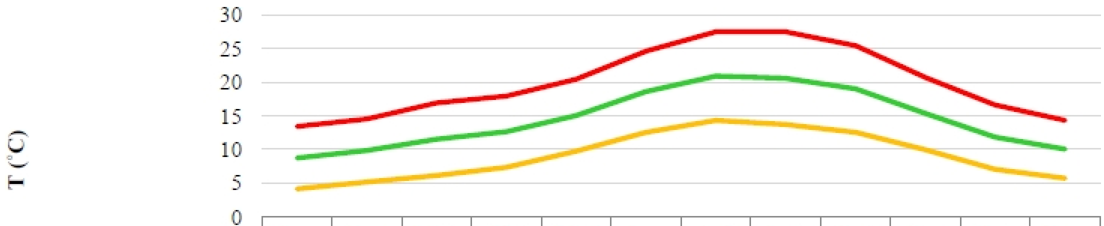
Air temperature has an influence on whether rural fires are more or less likely to occur, since if temperatures are higher, fuels become drier and consequently the likelihood of them combusting increases. On the other hand, if temperatures are lower, the likelihood of rural fires is also lower.

The average annual temperature in the municipality of Braga (line shown in green) is 14.5˚C, of which the months of July (20.9˚C), August (20.6˚C), September (19.0˚C) and June (18.6˚C) have the highest values. On the other hand, January (8.7˚C), February (9.8˚C) and December (10.0˚C) are the months with the lowest temperatures.

With regard to the maximum daily temperature in the municipality of Braga, as can be seen in Error! Reference source not found. (red line), the annual average is 20.0˚C, with the highest values in July and August (27.5˚C) and the lowest in January (13.4˚C). With regard to the minimum daily temperature in the municipality of Braga, as can be seen in **Figure 4 (**orange line), the average annual value is 9.0˚C, with the highest value in July (14.3˚C) and the lowest in January (4.1˚C).

In short, temperatures are highest during the summer months, namely July, August and September. On the other hand, the coldest months are January, February and December, i.e. the winter months. The annual temperature range, considering the average monthly temperature of the hottest month and the coldest month, was 23.4ºC.

The data shows that in the municipality of Braga the temperature is generally high during the critical period for forest fires (June to September), which contributes to easier ignition and faster progression of the flame front. It is important to pay attention to the occurrence of extreme temperature values, as these greatly influence the moisture content of plant fuels, as well as their temperature and, consequently, the energy required for ignition to occur, increasing the risk of fire. Observing these values is very important, as they impose the most constraints on human activity.

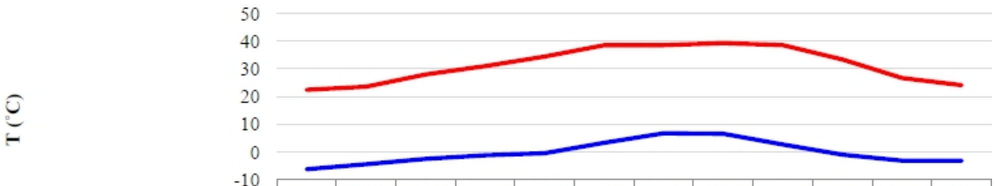


	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
T (˚C) Média	8.7	9.8	11.5	12.6	15	18.6	20.9	20.6	19	15.3	11.8	10
T (˚C) Máxima	13.4	14.5	16.9	17.9	20.4	24.6	27.5	27.5	25.4	20.7	16.6	14.3
T (˚C) Mínima	4.1	5.1	6.1	7.3	9.7	12.5	14.3	13.7	12.5	9.9	7	5.7

Figure 4.1. Average monthly air temperature values

Source: Climatological Normals for Braga Station/Agrarian Post (1971 - 2000), Portuguese Institute of the Sea and Atmosphere, 2020

In Error! Reference source not found. you can see the values for extreme temperatures (˚C), namely the highest maximum and lowest minimum, in the municipality of Braga. It can be seen that the extreme maximum temperature (line in red) shows values that oscillate between 39.3˚C (recorded i n August) and 22.4˚C (recorded in January), while the extreme minimum temperature (line in blue) shows values that oscillate between -6.3˚C (recorded in January) and 6.7˚C (recorded in July).



	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
T (˚C) Maior Máxima	22.4	23.5	28	31	34.4	38.5	38.5	39.3	38.5	33.3	26.7	24.1
T (˚C) Menor Mínima	-6.3	-4.5	-2.6	-1.3	-0.5	3.3	6.7	6.5	2.6	-1	-3.2	-3.2

Figure 4.2. Extreme temperatures (maximum and minimum)

Source: Climatological Normals for Braga Station/Agrarian Post (1971 - 2000), Portuguese Institute of the Sea and Atmosphere, 2020

- **Relative humidity**

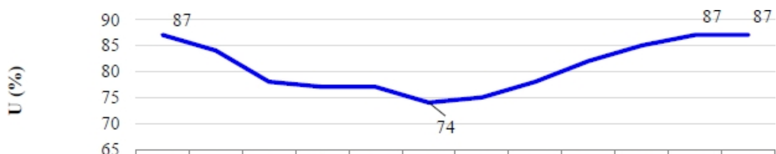
The ratio between the amount of water vapour in the atmosphere at a given temperature and that for which the air would be saturated at that same temperature corresponds to relative humidity, and these values are expressed as a percentage (%) (0% corresponds to dry air and 100% corresponds to air saturated with water vapour).

Relative humidity is a very important phenomenon, as it affects the frequency and intensity of rural fires, just as air temperature does. Thus, when there are high air temperatures combined with low rainfall (a common situation during the summer months), there is a stress on the vegetation, causing a significant decrease in the humidity of the vegetation cover and, consequently, an increase in the flammability of the cover.

The higher the humidity of the vegetation cover, the less likely it is to combust, thus reducing the risk of rural fires.

Figure 4 shows the average relative humidity at 9am over the twelve months of the year.

In all months, the average relative humidity is equal to or greater than 74%. The highest values for average relative humidity are in January (87%), November (87%), December (87%), October (85%) and February (84%), while the lowest values are in June (74%), July (75%), April (77%) and May (77%).



	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
U (%)	87	84	78	77	77	74	75	78	82	85	87	87

Figure 4.3. Relative humidity values in (%)

Source: Climatological Normals for Braga Station/Agrarian Post (1971 - 2000), Portuguese Institute of the Sea and Atmosphere, 2020

Humidity, along with temperature and directly related to it, is another determining factor in the outbreak and spread of forest fires, since by determining the humidity of fuels, it influences how easy it is for plant material to combust. The lower the humidity, the greater the likelihood of a forest fire spreading.

It should be noted that in terms of forest defence against rural fires, the decrease in the relative humidity of the vegetation cover observed in the summer months (June, July and August) and in April and May, favours an increase in the degree of flammability of the vegetation cover in the municipality of Braga, making it essential to pay greater attention and vigilance during these months.

- **Precipitation**

As far as rainfall is concerned, it is not continuous either in time or space, showing clear seasonal variability. Around 63% of the rain falls between October and February, with a dry season lasting two months in July and August, a characteristic that reveals the Mediterranean influence.

In July and August, the hottest months, rainfall did not exceed 30 mm. The sum of the average monthly rainfall was 1465.7 mm, with December being the wettest month with 231.4 mm, followed by January and November with average monthly rainfall of 192.7 mm.

and 175.4mm, respectively.

The maximum daily rainfall was 162.5 mm in October, followed by 123.7 mm in September. Although there was precipitation in every month of the year, in July and August the average daily rainfall did not exceed 29.8mm. **Figure 4** shows the variation in average monthly rainfall and the maximum daily values reached in each month during the period covered by the data.

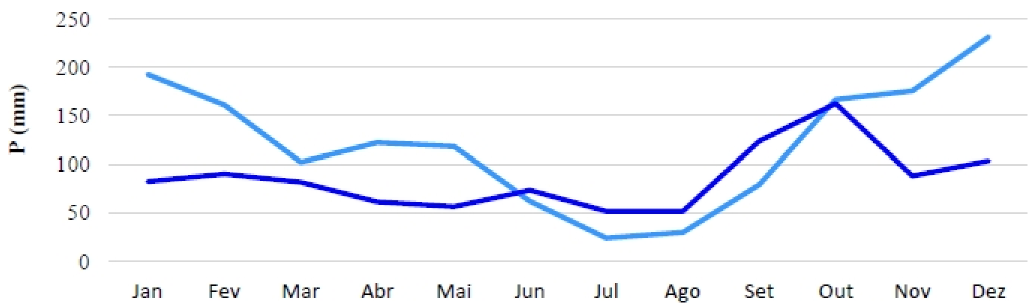


Figure 4.4. Variation in total and maximum daily rainfall (mm)

Source: Climatological Normals for Braga Station/Agrarian Post (1971 - 2000), Portuguese Institute of the Sea and Atmosphere, 2020

Rainfall is relatively low in the summer, a factor that, combined with high temperatures and low relative humidity, makes fire prevention and firefighting very difficult. In general, low rainfall and relative humidity, combined with high temperatures, create ideal conditions for the dissection of plants, which consequently leads to greater flammability and a greater risk of fire for the municipality.

- **Wind**

The direction and intensity of the wind has a notorious effect on the spread of fires, as it favours the inclination of the flame, promoting greater efficiency in the energy transmission processes and increasing the speed of the fire's progression. In addition, the wind promotes the desiccation of fuels by accelerating the process of transpiration of the vegetation cover (influencing the higher or lower relative humidity of the fuels), promotes greater oxygenation of the air and increases the projection distance of incandescent materials, such as sparks and hot ashes (which can cause other ignition points).

It is therefore essential to take into account the intensity and direction of the wind when it comes to preventing and fighting rural fires, in order to determine its behaviour. In addition, the wind can provide favourable conditions for the ignition, inclination and spread of flames.

Table 4.1 shows the average wind speed (km/h) in the municipality of Braga, where it **can be seen** that the values remain relatively stable throughout all the months of the year. The highest values are in February (5.6 km/h), March (4.9 km/h), December (4.9 km/h) and January (4.7 km/h), while the lowest values are in September (2.3 km/h), July (2.5 km/h), August (2.5 km/h), June (3.0 km/h) and October (3.0 km/h). With regard to the highest instantaneous maximum wind speed, on average, the highest gust values were in February (60.0 km/h), October (52.6 km/h), January (50.0 km/h) and July (50.0 km/h), while the lowest gust values were in May (17.0 km/h), June (21.0 km/h) and April (21.7 km/h).

Table 4.1. Wind speed (average and highest maximum instantaneous speed) per km/h

Mês	Velocidade média do vento (Km/H)	Maior valor de velocidade máxima instantânea do vento (rajada) (KM/H)
Janeiro	4,7	50,0
Fevereiro	5,6	60,0
Março	4,9	26,0
Abril	4,6	21,7
Maio	3,9	17,0
Junho	3,0	21,0
Julho	2,5	50,0
Agosto	2,5	40,0
Setembro	2,3	35,2
Outubro	3,0	52,6
Novembro	3,2	23,2
Dezembro	4,9	42,0
Anual	3,8	60,0

Source: Climatological Normals for Braga Station/Agrarian Post (1971 - 2000), Portuguese Institute of the Sea and Atmosphere, 2020

With regard to wind frequency by direction (**Table 4.2**), it can be seen that the most frequent winds in the municipality of Braga are from the north-east, throughout all the months of the year, varying between the 42.8 per cent observed in August (the month in which the most significant figure was recorded) and the 27.1 per cent observed in December (the month in which the least significant figure was recorded).

On the other hand, the least frequent winds in the municipality of Braga are from the west (with the exception of the months of

June and August, whose winds are less frequent from the south, and November, whose winds are less frequent from the north-west quadrant), ranging from 2.4 per cent in April to 0.5 per cent in October.

With regard to the monthly distribution of average wind speed by direction (**Table 4.2**), it can be seen that the south quadrant has a higher speed during ten months of the year, namely in January (11.4 km/h), February (10.2 km/h), March (9.7 km/h), December (9.7 km/h), November (8.9 km/h), October (7.4 km/h), September (6.9 km/h) and June (5.6 km/h). It should be noted that in June, the south-westerly winds had an average speed equal to that of the southerly winds (5.6 km/h).

As for the winds with the lowest average speed, those in the north-east quadrant stand out (they have a lower average speed in eleven months of the year, with the exception of July, whose wind has the lowest values is in the north-east quadrant), recorded in September (3.6 km/h), October (3.7 km/h), November (3.7 km/h), February (2.9 km/h), August (2.9 km/h), July (4.0 km/h), December (4.0 km/h),
January (4.2 km/h), March (4.2 km/h), June (4.2 km/h), May (4.4 km/h) and April (4.6 km/h).

Finally, calms are most frequent in November (51.7%), December (43.0%) and October (42.9%), while they are less frequent in May (25.1%), June (26.9%) and April (28.6%). It is also important to note that calms are more frequent than winds in November (51.7%), December (43.0%), October (42.9%), January (42.2%), September (41.4%), February (33.8%), March (32.7%) and April (28.6%).

The wind is a factor responsible for oxygenating combustion and, since calms are less frequent in the warmer months, it is during these months that the spread of fires is favoured. As well as intensifying the flame, it favours the transport of sparks, which can lead to new secondary outbreaks, sometimes over long distances.

Table 4.2. Average monthly wind speed and frequency values for the different directions

	jan	fev	mar	abr	mai	jun	jul	ago	set	out	nov	dez	Anual
	NORTE (N)												
%	2	4,1	6,5	9	8,9	4,5	4,3	5,9	3,6	3,7	3,2	1,3	4,8
km/h	9,2	6,3	6,4	6,4	5,4	4,8	4,3	4,7	5,7	6,1	4,4	6,9	5,9
	NORDESTE (NE)												
%	29	28,2	29,8	28,3	31,9	39	41,3	42,8	36,9	33,6	27,4	27,1	32,9
km/h	4,2	3,9	4,2	4,6	4,4	4,2	4	3,9	3,6	3,7	3,7	4	4
	ESTE (E)												
%	3,2	5,7	5,4	3,4	2	1,8	1,2	1,1	2	3,4	4,2	4,3	3,1
km/h	5,3	6,3	5,8	5,9	5,4	5	3,9	5,9	6	4,8	6,3	4,8	5,5
	SUDESTE (SE)												
%	6,8	8,8	4,8	4,6	2,8	2,3	1,9	1,1	3,1	3,8	5,3	7,3	4,4
km/h	7,2	6,9	5,8	6,7	5,7	5,1	4,2	5,4	5	5,1	6,1	7	5,9
	SUL (S)												
%	7,6	7,7	6,6	4,1	5,3	1,9	0,8	0,6	2,8	3,1	3,5	8,4	4,4
km/h	11,4	10,2	9,7	8,7	9,3	5,6	5,5	5	6,9	7,4	8,9	9,7	8,2
	SUDOESTE (SW)												
%	7,6	8,3	10,5	12,8	15,9	15	10,3	6,8	7,7	7	3,8	6,7	9,4
km/h	8	6,7	6,3	6,1	6,5	5,6	5,1	4,9	5,9	5,5	8,2	8,4	6,4
	OESTE (W)												
%	0,7	1,2	1,1	2,4	1,7	1,6	1,2	0,6	0,6	0,5	0,6	0,7	1,1
km/h	7,3	8,9	7,1	6,4	5	5,5	6,2	4,9	6	5,3	6,7	8,9	6,5
	NOROESTE (NW)												
%	1	2,2	2,5	6,8	6,3	7,1	7,3	5	1,9	2	0,4	1	3,6
km/h	5,5	4,7	4,8	5	5,4	4,6	4,6	4,4	4,4	4,9	5,8	6,9	5,1
	Calma												
%	42,2	33,8	32,7	28,6	25,1	26,9	31,8	36,2	41,4	42,9	51,7	43	36,4

Source: Climatological Normals for Braga Station/Agrarian Post (1971 - 2000), Portuguese Institute of the Sea and Atmosphere, 2020

As can be seen throughout the regions characterised by the Mediterranean climate, the municipality of Braga has higher temperatures during the summer months (June, July, August and September) which combine with lower relative humidity values and relatively low amounts of rainfall.

Given this combination, the likelihood of rural fires increases significantly, as the conditions favourable to the ignition and spread of fires are in place. In addition, it should be recognised that after the dry season, heavy rainfall can cause a great deal of damage, in particular the damage that can be caused to the forest road network through water erosion of the soil.

It should therefore be emphasised that vigilance must be intensified throughout the summer months, as well as firefighting readiness levels, with the aim of ensuring a rapid and efficient response from the teams.

As far as the climate classification of the intervention area is concerned, according to Köppen, it has a temperate climate, Type C, with the sub-type Cs (temperate climate with dry summers) and the variety Csb (temperate climate with dry and temperate summers) (**Table 4.3**).

Table 4.3. Climatic classification of the region under study, according to Köppen

c	A humid mesothermal (temperate) climate, the average temperature of the coldest month is between -3°C and 18°C, while the hottest month is over 10°C.
s	Dry season in summer, the amount of rainfall in the driest month of the hot half-year is less than 1/3 of that in the wettest month of the cold half-year and less than 40 mm.
b	Hot summer, the average temperature of the hottest month is less than or equal to 22°C, with at least 4 months with averages above 10°C.

As far as microclimatic characterisation is concerned, it is determined by its topography, the type of land use and the way these factors interfere with the processes of radiation and air circulation in the layer of air next to the ground.

The municipality of Braga has a temperate climate with Mediterranean characteristics and an Atlantic influence from the westerly winds that are channelled along the main valleys. This transport of large masses of humid air keeps the relative humidity at 80 per cent. The climate is characterised by the presence of four well-defined seasons, with cool to cold winters, influenced by the coast and the Cávado Valley, and hot to comfortable summers, from the coast to the interior. In terms of rainfall, the average annual totals are over 1400 mm, with greater intensity in the autumn, winter and spring seasons. The average annual temperature is between 12.5°C and 17.5°C.

The integration of the climate characteristics of the Braga municipality makes it possible to carry out a climate zoning, identifying homogeneous climate response units (**Figure 4**), which will be a spatially explicit basis for the subsequent design of specific climate actions geared towards the climate characteristics of each area of Braga's territory, giving them a more consistent degree of operability and effectiveness for taking advantage of opportunities and responding to constraints associated with climate change in the local context.

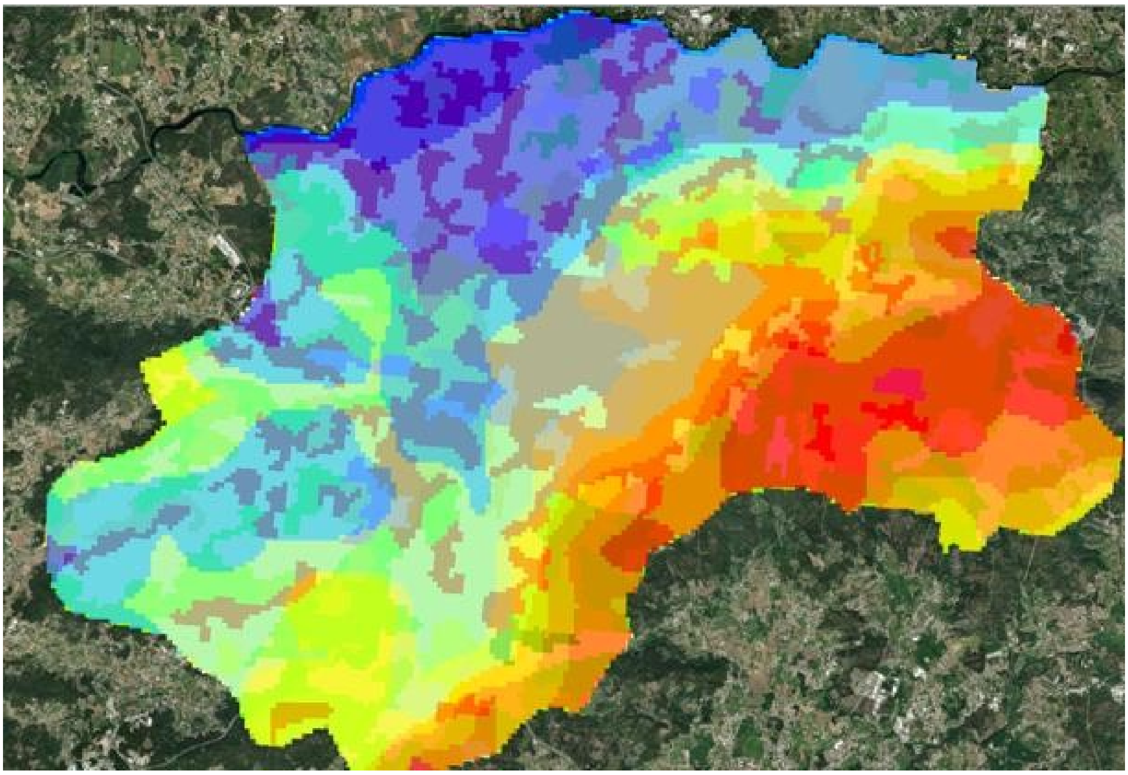
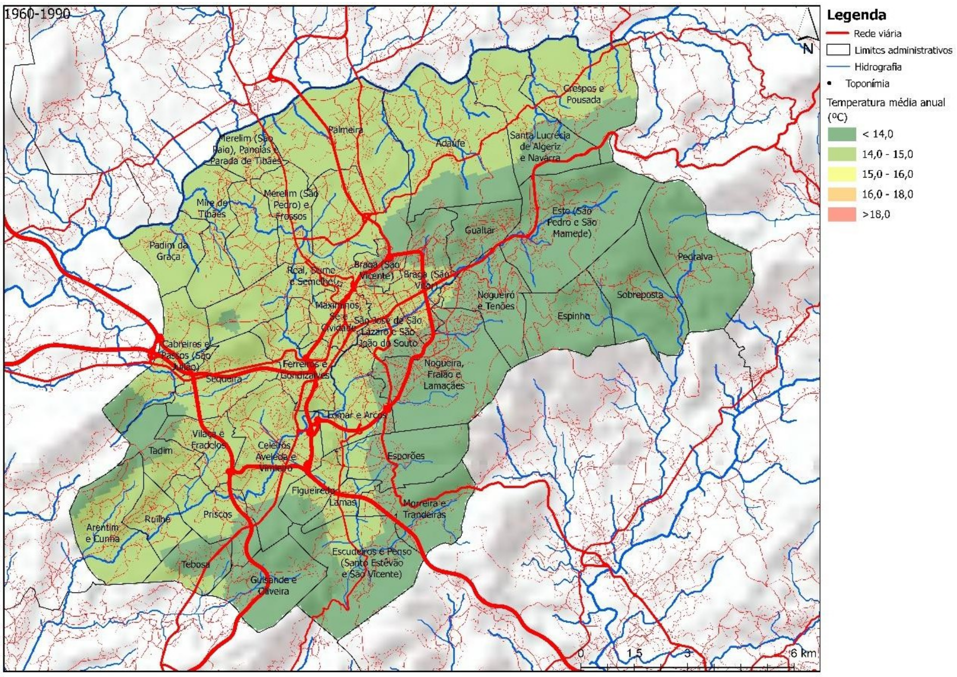


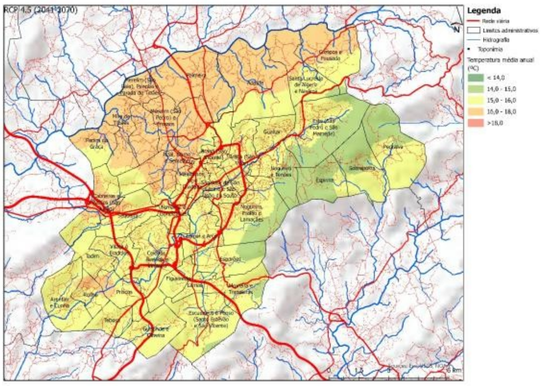
Figure 4.5. Homogeneous Climate Response Units

4.3 Future Climate Scenarios

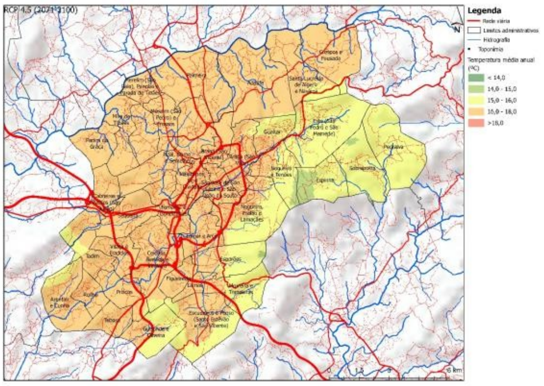
According to the scenario of climate variables, climate projections for the territory point to a potential decrease in total annual precipitation and a potential increase in temperatures, particularly maximum temperatures, intensifying the occurrence of hotter and drier summers, an increase in the frequency of heat waves and the occurrence of extreme phenomena with events of intense and/or very intense precipitation (Error! Reference source not found. a Error! Reference source not found.).



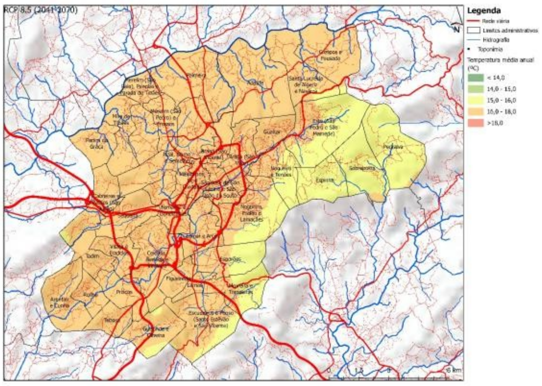
Climatological Normal 1960-1990



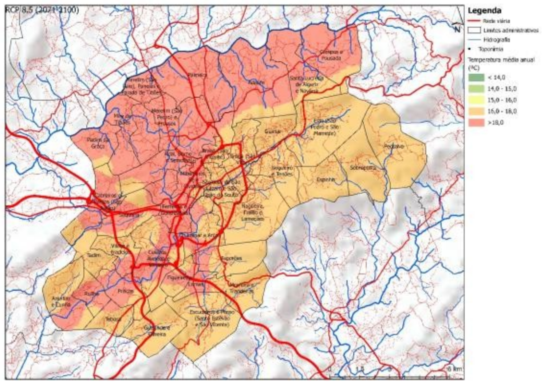
RPC 4.5 (2041-2070)



RPC 4.5 (2071 - 2100)



RPC 8.5 (2041-2070)

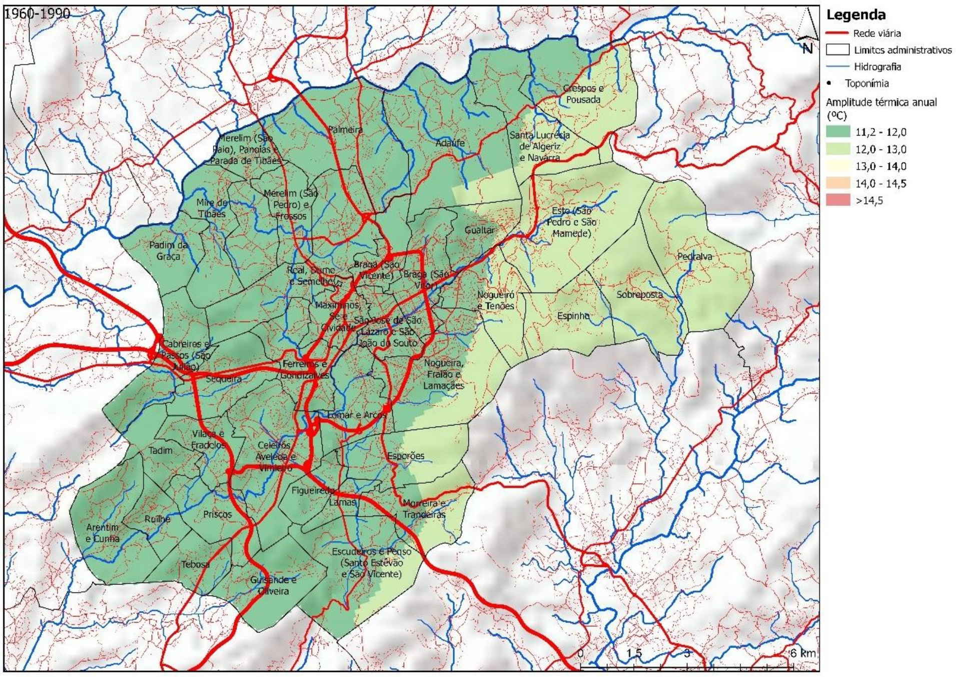


RPC 8.5 (2071 - 2100)

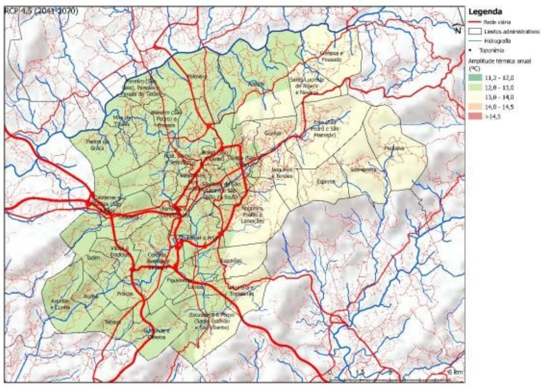
Figure 4.6. Average annual temperature

Table 4.4. Average annual temperature anomalies

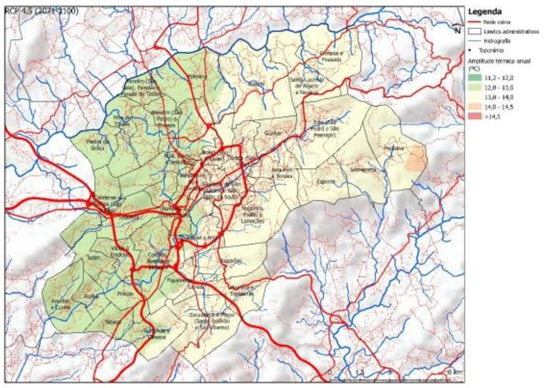
Station	Modelled history		Anomalies							
			RCP 4.5				RCP 8.5			
	Present		2041-2070		2071-2100		2041-2070		2071-2100	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Winter	9,8	7,1	1,3	1,3	1,5	1,6	1,7	1,8	2,8	2,9
Spring	13,7	11,1	1,7	1,6	2,0	2,0	2,1	2,1	3,5	3,5
Summer	20,3	18,3	2,4	2,5	2,9	3,0	3,2	3,2	5,0	5,1
Autumn	15,9	13,7	1,9	1,9	2,4	2,4	2,7	2,6	4,3	4,3



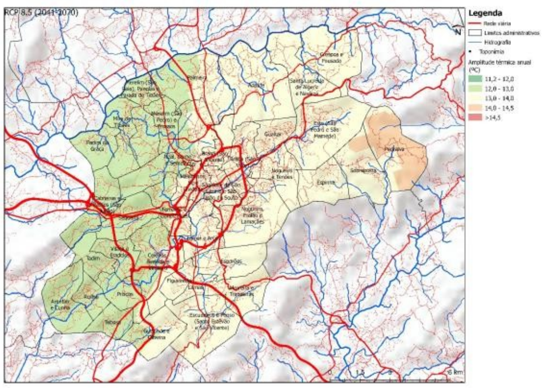
Climatological Normal 1960-1990



RPC 4.5 (2041-2070)



RPC 4.5 (2071 - 2100)



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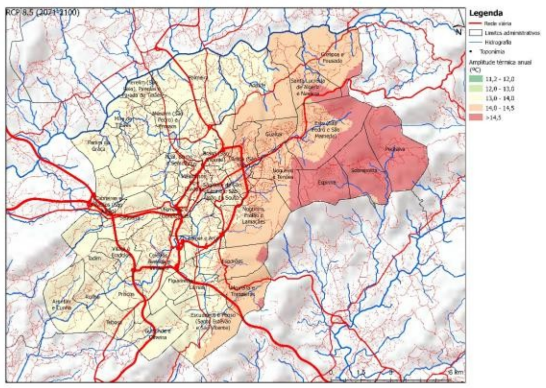
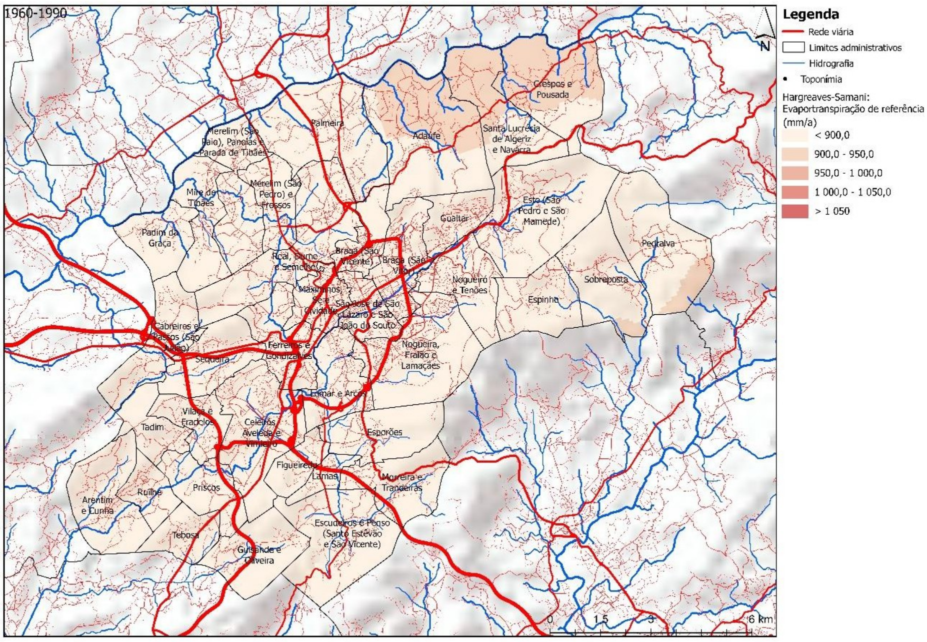


RPC 8.5 (2071 - 2100)

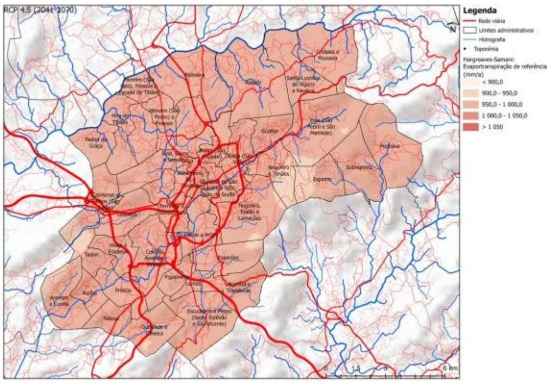
Figure 4.7. Annual temperature range

Table 4.5. Annual temperature range anomalies

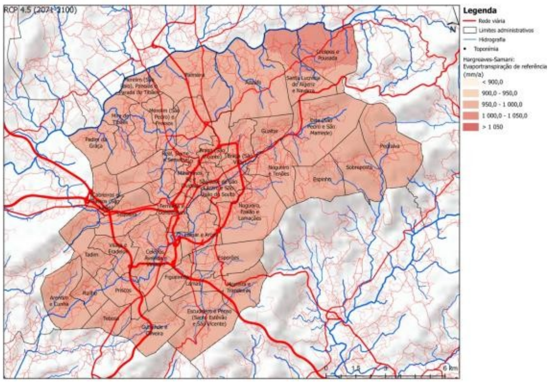
Station	Modelled history		Anomalies							
			RCP 4.5				RCP 8.5			
	Present		2041-2070		2071-2100		2041-2070		2071-2100	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Annual	12,8	10,8	1,2	1,0	1,5	1,3	1,5	1,4	2,3	2,1



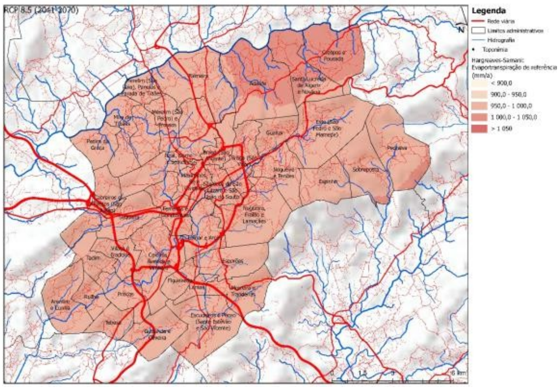
Climatological Normal 1960-1990



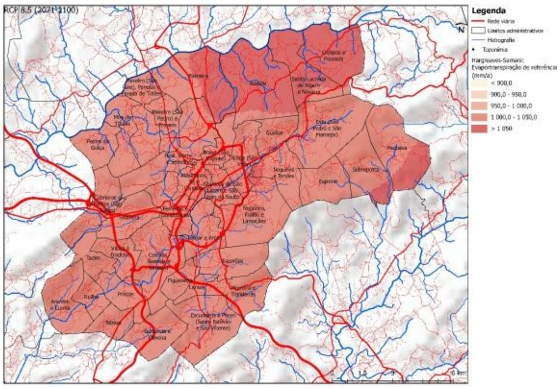
RPC 4.5 (2041-2070)



RPC 4.5 (2071 - 2100)



RPC 8.5 (2041-2070)

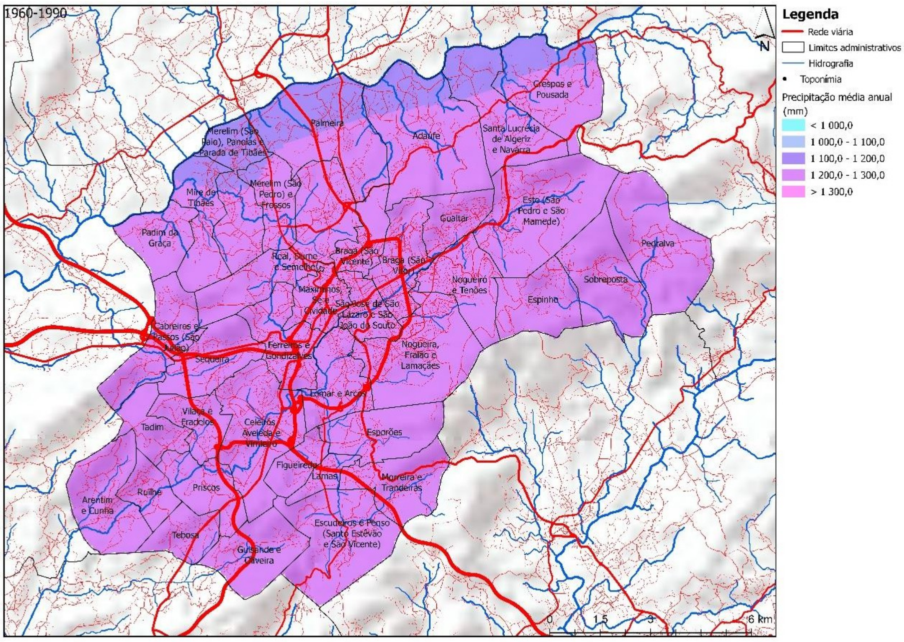


RPC 8.5 (2071 - 2100)

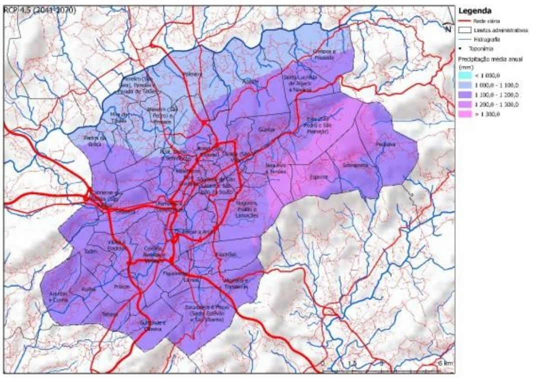
Figure 4.8. Reference evapotranspiration

Table 4.6. Reference evapotranspiration anomalies

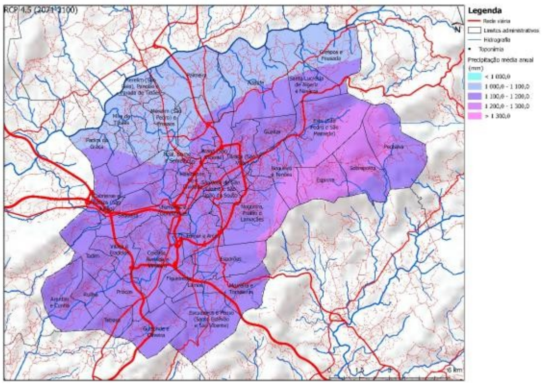
Period		Modelled history		Anomalies							
				RCP 4.5				RCP 8.5			
		Present		2041-2070		2071-2100		2041-2070		2071-2100	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Annual	(mm)	926	858	80,8	74,3	97,8	86,8	104,8	93,5	162,8	144,8
	(%)			8,7	8,7	10,6	10,1	11,3	10,9	17,6	16,9



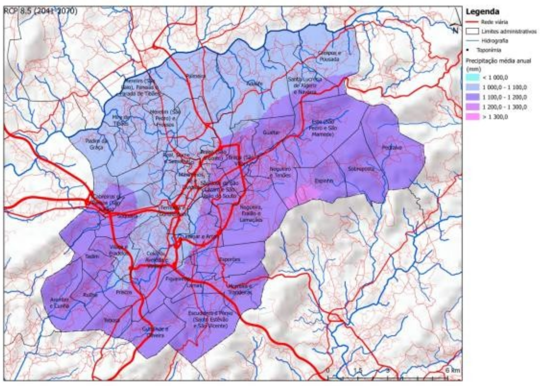
Climatological Normal 1960-1990



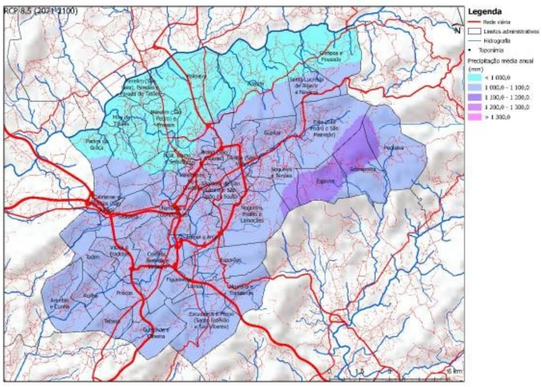
RPC 4.5 (2041-2070)



RPC 4.5 (2071 - 2100)



RPC 8.5 (2041-2070)

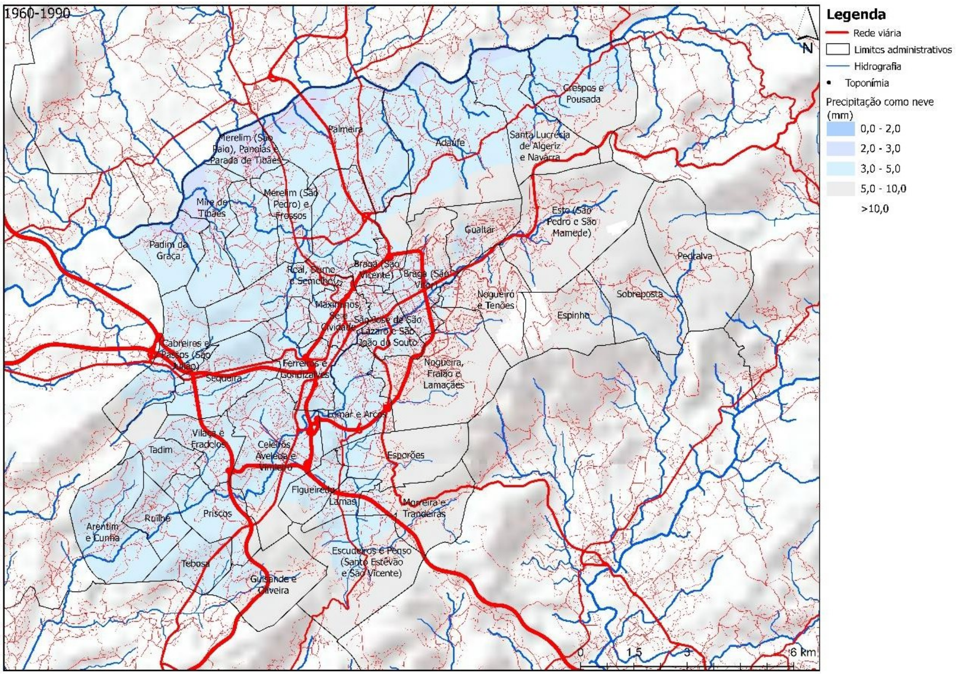


RPC 8.5 (2071 - 2100)

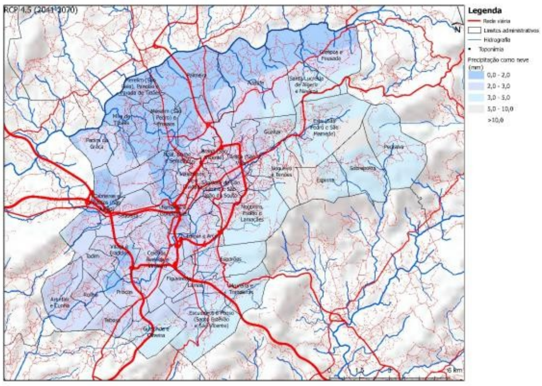
Figure 4.9. Average annual rainfall

Table 4.7. Average annual rainfall anomalies

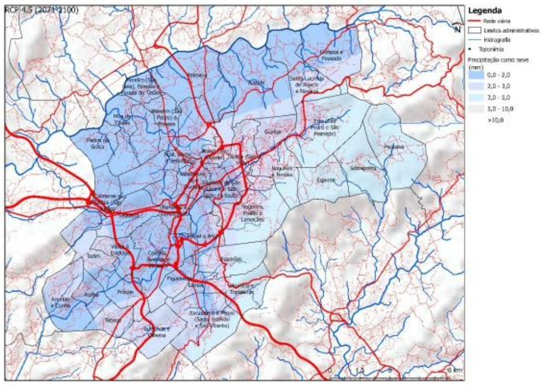
Period		Modelled history		Anomalies							
				RCP 4.5				RCP 8.5			
		Present		2041-2070		2071-2100		2041-2070		2071-2100	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Annual	(mm)	1372	1165	-133,5	-114,6	-128,6	-109,6	-159,4	-134,9	-245,4	-208,9
	(%)			-9,7	-9,8	-9,4	-9,4	-11,6	-11,6	-17,9	-17,9



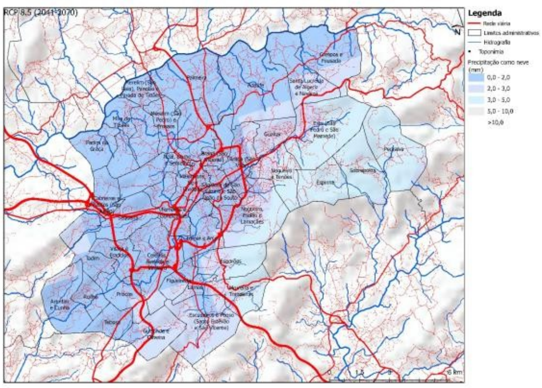
Climatological Normal 1960-1990



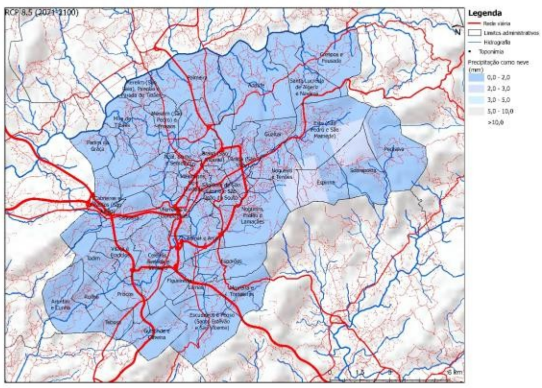
RPC 4.5 (2041-2070)



RPC 4.5 (2071 - 2100)



RPC 8.5 (2041-2070)



RPC 8.5 (2071 - 2100)

Figure 4.10 Precipitation as snow

Table 4.8. Precipitation anomalies as snow

Period		Modelled history		Anomalies							
				RCP 4.5				RCP 8.5			
		Present		2041-2070		2071-2100		2041-2070		2071-2100	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Annual	(mm)	12	3	-6,1	-1,0	-7,0	-1,0	-7,1	-2,0	-9,0	-2,0
	(%)			-50,4	-33,3	-58,4	-33,3	-58,8	-66,7	-75,4	-66,7

Based on the cenarisation carried out, it is possible to identify the trend of expected future climate risks (**Table** 4.9).

Table 4.9. Trends in risks associated with climate variables

Climate variables	Trends	RCP 4.5		RCP 8.5	
		2041-2070	2071-2100	2041-2070	2071-2100
Risk of decreasing average annual rainfall	Decrease in the number of days with precipitation.	↑	↑	↑	↑
Risk of decreased seasonal rainfall	Decrease in rainfall in the spring and autumn months, with variations ranging from can reach 27 per cent	↑	↑	↑	↑
Risk associated with periods of drought	More frequent and intense droughts resulting from a significant reduction in the number of days with precipitation, increasing the frequency and intensity of droughts. dry.	↑	↑	↑	↑
Risk associated with storms	An increase in extreme phenomena, in particular heavy and very heavy rainfall in short periods of time, with the occurrence of very intense winter storms expected. strong winds.	↑	↑	↑	↑
Risk associated with an increase in average annual temperature	An increase in the average annual temperature of between 1.3°C and 5.1°C, with a significant increase in maximum temperatures.	↑	↑	↑	↑
Risk of rising maximum temperatures	Very significant increase in maximum temperatures especiall y in summer, with a variation between 2.8°C and 5.3°C and in autumn between 2.0°C and 4.6°C.	↑	↑	↑	↑
Heatwave risk associated with an increase in very hot days	Increase in the number of days with very high temperatures (>35°C) and tropical nights with temperatures >20°C More frequent and more intense heatwaves	↑	↑	↑	↑
Risk of rising minimum temperatures	Increase in minimum temperature more significant in summer (with anomalies between 2.1°C and 4.5°C) and in autumn (1.7°C and 3.9°C).	↑	↑	↑	↑

Risk of increased evapotranspiration	Increasing trend in evapotranspiration based on minimum and maximum temperatures, using the equation of Hargreaves-Samani.	↑	↑	↑	↑

Climate variables	Trends	RCP 4.5		RCP 8.5	
		2041-2070	2071-2100	2041-2070	2071-2100
Number of days with temperature below 0º C	Reducing the number of days with a temperature below 0ºC	↓	↓	↓	↓
Risks associated with the occurrence of low temperatures	Increased temperatures minimum temperatures	↓	↓	↓	↓

Legend: ↑ Increased risk; → Maintained risk; ↓ Decreased risk

In this sense, the most worrying climate risks in Braga are those related to an increase in high temperatures/heatwaves, droughts and an increase in extreme phenomena in terms of excessive precipitation/intensity (increase in floods and flash floods). As such, the priority climate risks for analysing impacts and vulnerabilities are those identified in **Table** 4.10.

Table 4.10. Trends in priority climate risks

Climate Risks	RCP 4.5		RCP 8.5	
	2041-2070	2071-2100	2041-2070	2071-2100
Risk of flooding	↑	↑	↑	↑
Slope movements	↑	↑	↑	↑
Strong winds / storms	↑	↑	↑	↑
Droughts	↑	↑	↑	↑
Forest fires	↑	↑	↑	↑

In terms of the risks associated with the occurrence of low temperatures and the number of days with a temperature below 0º C, the level of risk is projected to decrease. However, due to the uncertainties associated with the evolution of climatic phenomena, these projections should be taken into account with some reservations.

5. Strategic Intervention Sectors

The mitigation and adaptation measures and actions that make up the PMAC-Braga action plan will be organised according to various strategic sectors.

Below is a preliminary identification of the sectors that the PMAC-Braga is specifically targeting or will have the most impact on, covering the areas of climate change mitigation and adaptation.

5.1 Mitigation

In terms of mitigating greenhouse gas emissions, it is important to emphasise the importance of aligning municipalities with the following national targets of the PNEC 2030 for the year 2030, which are also consistent with a path towards carbon neutrality by 2050:

- Reduce greenhouse gas emissions by between 45 % and 55 % compared to 2005;
- Incorporate 47 per cent of energy from renewable sources into gross final energy consumption;
- Reduce primary energy consumption by 35 per cent with a view to improving energy efficiency;
- Achieve 15 per cent electricity interconnections.

The climate change mitigation action plan will be structured for each of the sectors of activity, in accordance with the list of sectors of activity considered by the bodies of the United Nations Economic Commission for Europe (UNECE or ECE), namely the one described in **Table 5.1**.

Table 5.1. Activity sectors involved in GHG mitigation

Sector of activity	Sub-sector	Activities
Energy	Stationary energy	▪ Energy industry; ▪ Manufacturing and construction industry; ▪ Domestic, commercial and institutional buildings; ▪ Agriculture, forestry and fisheries; ▪ Fugitive emissions (from the use of fuels).
	Transport	▪ Road (including off-road); ▪ Railway; ▪ Navigation (sea and river); ▪ Aviation;
Processes Industrial and Product Use	Industrial processes	▪ Industrial processes
	Use of products	▪ Use of products;
Agriculture, Forestry and Fisheries	Livestock	▪ Enteric fermentation
	Land Use	▪ Agricultural soil; ▪ Forest soil; ▪ Other types of soil.
	Other agriculture	▪ Rice cultivation; ▪ Use of fertilisers; ▪ Application of lime and urea.
Waste	Solid waste	▪ Landfill; ▪ Organic valorisation; ▪ Incineration;
	Waste water	▪ Wastewater treatment;

Source: UNECE, INERPA/APA

Below is a brief overview of the sectors of activity for the municipality of Braga, taking into account the information available in the Inventory of Greenhouse Gas Emissions for the Municipality of Braga drawn up in 2023, and relating to the year 2021 (**Annex AII**).

5.1.1. Energy

Energy is an essential asset for economic development and people's well-being, but it is also at the centre of humanity's greatest current concern and challenge - climate change.

According to the latest data from Braga municipality's GHG Emissions Inventory for 2021, the energy sector is responsible for the emission of 745,000 tonnes of $_{CO2,}$ corresponding to 87.8% of all municipal GHG emissions. Transport accounts for 51 per cent of this sector's emissions, and stationary energy uses for the remaining 49 per cent.

This sector has a strong potential for mitigating the GHG emissions produced. Electricity production is the energy vector with the greatest potential, through the integration of renewable energies and increased energy efficiency, allowing for the decarbonisation of the electricity and transport sectors. These possibilities emerge as critical factors in the transition to a circular economy model, promoting, on the one hand, the reduction of GHG emissions and, on the other, the reduction of dependence on non-renewable and external resources, which is a weak point in the security of energy supply.

The replacement of fossil fuel-based energy sources with renewable or indigenous energy sources will have to be greatly increased and complemented with the use of energy storage technologies, including the promotion of self-consumption and micro-generation solutions.

5.1.1.1. Domestic, commercial and institutional buildings

Considering the GHG Emissions Inventory, the activity of the residential or domestic buildings sector in 2021 accounted for 35% of the municipality's total electricity consumption (232,969 MWh/year) and 19.6%[7] of CO2e emissions (167,$_{042tCO2/year}$). It is the sector with the greatest weight in electricity consumption and the second most representative in terms of $_{CO2e}$ emissions in the municipality. Between 2011 and 2020, electricity consumption increased by 2 per cent in the domestic sector, and there is no satisfactory result from the policies and actions promoted in terms of energy efficiency in this sector. It should be noted that domestic consumption in 2020 was boosted by the COVID-19 pandemic, which forced prophylactic isolation for much of 2020 and increased the time spent in homes,

[7] The percentages referred to in this chapter always refer to total emissions (without LULUCF).

increasing energy consumption and GHG emissions associated with this sector. Electricity is predominantly consumed in this sector, followed by natural gas, while renewable energy sources such as biomass and solar are also used.

Considering the GHG Emissions Inventory, the activity of the tertiary buildings sector (commercial, service or institutional) in 2021 accounted for 34% of electricity consumption in the territory (229,441 MWh/year) and 10% of GHG emissions (85,717 $_{tCO2e/year}$). Between 2011 and 2020, electricity consumption in the sector increased by 19 per cent, which shows low attractiveness or adherence to the policies and actions promoted in terms of energy efficiency in this sector. However, the increase would have been even higher if 2020 had not been affected by the pandemic, which forced the closure of most commercial and service establishments for much of 2020. It should also be noted that there was a break in the series in the 2013 - 2014 period, associated with the revision and updating of the EAC of the energy-consuming sectors. This revision may have been associated with the transfer of consumption from the municipal buildings sector to the tertiary buildings sector and, as such, a possible inflation in the sharp decrease in consumption in municipal buildings and the increase in consumption in tertiary buildings. The tertiary buildings sector consumes mainly electricity and natural gas.

Situations of energy poverty in the building stock, particularly in the domestic sector or in commerce and services, must be identified and remedied through measures aimed above all at urban regeneration, promoting energy efficiency in buildings, focussed above all on insulation measures, and reducing dependence on fossil fuels. In this field, investing in decentralised electricity production based on renewable energy communities and making the most of collective systems that mitigate maintenance costs could be solutions, as they make it possible to reduce energy costs and relieve families, and this is the path that is already being pursued.

By 2030, the residential sector and the commerce and services sector aim to reduce GHG emissions by 35 per cent and 70 per cent compared to 2005, respectively. In order to ensure the fulfilment of the targets and objectives in the area of energy efficiency, interventions should include the renovation of buildings and the implementation of NZEB (*Nearly Zero Energy Buildings*). Refurbishing buildings to make them more energy efficient can achieve multiple objectives (e.g. reducing energy bills, improving thermal comfort), which is why the energy renovation of buildings is particularly important and a priority. Particularly important in this context are the transposition of the amendment to the EPBD (*Energy Performance* of *Buildings Directive*), the new energy certificate, the revision of the Certification System

Energy of Buildings (SCE) and the redesign of funding/support mechanisms for building renovation. On the other hand, NZEB buildings are gaining importance, since their energy needs for air conditioning are almost zero or very small. The introduction of sustainable construction techniques will also be important, as will the incorporation of secondary raw materials in building components, bioclimatic architecture, passive houses and modular, multifunctional and dynamic architecture. Favouring the reuse of building components and the use of recycled materials in both new construction and refurbishment operations.

5.1.1.2. Transport and Mobility

Transport plays a fundamental role in the development of any community, guaranteeing the mobility of people and goods.

Today, as always, accessibility and mobility capacity are absolutely crucial to boosting economic activity, increasing competitiveness and improving people's quality of life.

Currently, a large part of the energy consumed in the transport sector comes from fossil fuels, with a high level of GHG emissions.

Considering the GHG Emissions Inventory, the transport sector stands out as the main final energy consumer and the main source of $_{CO2e}$ emissions in the municipality. In 2021, GHG emissions from the transport sector in Braga totalled 382,682 $_{tCO2e}$, corresponding to 44.8% of the municipality's total emissions.

Road transport (99.9%) was the dominant source of GHG emissions from the transport sector, with rail transport contributing just 0.1% of emissions. It should be noted that it was not possible to obtain data to calculate emissions from air transport generated from Braga Municipal Aerodrome.

Without the implementation of effective mitigation policies, transport emissions could increase at a faster rate than emissions from any other energy end-use sector, which is why there is a need to adapt transport and mobility models so that they offer efficient and sustainable responses (e.g. reducing the use of own vehicles, promoting soft mobility solutions, decarbonising fleets, optimising routes and modernising public transport services).

Sustainable mobility plays an important role as a factor in energy and environmental efficiency, contributing decisively to the reduction of gas emissions in urban areas and the progressive replacement of fossil fuels with alternative energy sources, constituting one of the main contributions to achieving the goal set by the 2019 European Green Deal: reaching carbon neutrality by 2050. In order to meet this global challenge, the European Commission has come up with a series of strategic packages, namely the Climate 2030 Energy Package, the Clean Mobility Package and the Clean Energy for All Europeans Package. At national level, the Integrated National Energy and Climate Plan (PNEC) was approved, which is the main energy and climate policy instrument for the 2021-2030 decade. Among the various objectives and targets defined by the PNEC for the various sectors of activity, it is worth highlighting the objective of reducing greenhouse gas emissions by 40 % in the transport sector by 2030 compared to 2005.

At municipal level, the SUMP defines a set of operational objectives and targets (**Table 5.2**) that aim to realise the strategic vision of intervention defined, consisting of five strategic objectives, three cross-cutting objectives and one systemic objective, and their respective specific objectives (**Figure 5.1**).

Figure 5.1. SUMP Braga intervention objectives

Source: SUMP Braga, 2023.

In order to achieve this vision, tangible actions are included, such as those directed at transport systems and their infrastructure and services, and intangible ones, such as strengthening a mobility culture based on raising awareness and training to change behaviour, and a set of strategic, transversal, systemic and specific objectives has been defined.

Table 5.2. SUMP Braga operational objectives and targets for 2032

Objectives	Indicator	Reference year	Reference situation	Target 2032
Encouraging sustainable modes of travel	Predominantly pedestrianised areas (m^2)	2018	245 000	360 000
	Cycle network length (km)		18	90
	Number of bike-sharing stations (no.)		0	150
Changing the modal split of commuting by the resident population	Journeys made by bicycle (%)	2011	0,2	10
	Journeys made on foot (%)		17	25
	Journeys made by public transport (%)		16	26
	Travel by individual motorised transport (%)		67	39
Improving the quality of the urban environment	CO_2 emissions associated with the transport sector (t/year)	2015	200 529	170 450
Reducing the impact of individual transport	Motorisation rate in the municipality (no. of cars) /1000 inhabitants)	2017	580	435
	Number of occupants per vehicle (no.)	2012	1,5	2
Reducing road accidents	Reduction in the number of accidents per year (%)	2016	55%	50%
	Reduction in the number of fatalities (%)		3%	100%

Source: SUMP Braga (2023)

The decarbonisation of mobility and transport will take on a special focus in 2030, as this is one of the most important sectors in terms of national GHG emissions. The next decade will see a paradigm shift in this sector. Profound changes are expected towards decarbonising the sector, with traditional fossil fuels being progressively replaced by electricity, advanced biofuels and hydrogen, resulting in significant environmental and efficiency gains.

In addition, there must be a simultaneous and continued commitment to public transport, which changes mobility patterns and reverses the trends of recent years. The increase in demand for passenger mobility should be ensured either by more public transport, using low-emission vehicles, or by generalising shared transport, while also focusing on increasing the expression of active modes in short-distance mobility.

In the period up to 2030, the focus on electric mobility and advanced biofuels should be the

the most cost-effective decarbonisation option in transport, although other low-carbon mobility alternatives may emerge, such as hydrogen-powered vehicles.

The decarbonisation of mobility is also intrinsically linked to the territorial organisation models of cities, economic and leisure activities and their implications in terms of mobility needs, as well as the implications in terms of collective versus individual mobility.

In freight transport, the focus will be on optimising logistics and fleet management, with a major commitment to electric light goods vehicles, biofuels and hydrogen. The railways will play an important role in the decarbonisation of freight transport over medium and long distances, which is why investment in this infrastructure, its decarbonisation through electrification and other energy carriers such as hydrogen, and its modernisation and expansion will be intensified.

5.1.1.3. Agriculture

Considering the GHG Emissions Inventory, the agriculture and fisheries sector accounted for 1.1% of GHG emissions in 2021 (9,439 $_{tCO2e/year}$). This sector predominantly consumes petroleum products, namely diesel. Between 2011 and 2020, consumption of coloured diesel increased by around 53%. Electricity consumption fell by around 25 per cent over the same period.

The transition to a circular economy model in the agricultural sector, through the development of more efficient production systems and the incorporation of innovative technologies and more sustainable production and commercial practices, will make it possible to achieve greater productivity with less environmental impact.

5.1.1.4. Industry

Considering the GHG Emissions Inventory, the activity of the industry sector in 2021 accounted for 10.5 per cent of total GHG emissions (9,892 $_{tCO2e/year}$). This is the third largest sector in the municipality's consumption of $_{CO2e}$ emissions, with the manufacturing and construction industries accounting for 99% of this sector's emissions, and the energy industries only accounting for 1% of emissions. In this sector there is a predominant consumption of electricity, natural gas and diesel. Between 2011 and 2020, electricity consumption in the sector increased by 14%.

5.1.2. Industrial Processes and Product Use

In the GHG Emissions Inventory, emissions resulting from industrial processing and product use were responsible for the emission of 722 tonnes of $_{CO2e}$, corresponding to 0.1% of total municipal emissions. These emissions relate to the use of lubricating products for non-energy purposes. According to the inventory, no industrial activities have been identified in the municipality of Braga that trigger emissions from the non-energy use of fuels in the chemical or physical transformation of materials.

5.1.3. Agriculture, Forestry and Other Land Use

Climate neutrality means a neutral balance between GHG emissions and the sequestration of these gases by the various sinks. Responsible land use policies that value ecosystem services, promote the protection of soils and forest heritage, encourage afforestation and a sustainable and resilient forest, and promote the recovery of degraded forests and soils, add to people's quality of life and contribute to mitigating climate change.

GHG emissions from the agriculture, forestry and other land use (AFOLU) sector originate from livestock production, land use and land use change, as well as other aggregate emissions, namely from forest fires and the application of fertilisers and soil improvers. This sector also includes important carbon sinks, such as forests.

According to the results of the GHG Emissions Inventory, in 2021, emissions from the sector, without accounting for land use, land use change and forestry (LULUCF), totalled around 29,940 t $_{CO2e}$, corresponding to 3.5% of total emissions in the municipality of Braga. Livestock farming, through enteric fermentation and manure management systems, contributed 61.5% (18,418 t $_{CO2e}$) of the sector's emissions and the remaining 38.5% (11,522 t $_{CO2e}$) corresponded to other emissions from aggregate sources, namely forest fires, burning of agricultural waste, application of organic and inorganic fertilisers, incorporation of crop residues into the soil, and indirect emissions from manure management.

In contrast, the land use, land use change and forestry (LULUCF) subsector contributed to an effective removal of 137,796 t $_{CO2e}$ in the municipality of Braga. Consequently, in that year, the AFOLU sector (including LULUCF) contributed in terms of net emissions to the removal of 107,856 t $_{CO2e}$ from the atmosphere.

The agricultural sector is set to make an essential contribution towards decarbonisation. Although at a slower pace than the other sectors, it is expected that over the next decade, changes will already be taking place that will make it possible to reduce emissions by 11% by 2030 compared to emissions in 2005, with a commitment to more sustainable agriculture, through greater dissemination of integrated production practices, along with the expansion of organic farming, conservation and precision agriculture, reducing emissions associated with animal effluents and the use of synthetic fertilisers and boosting carbon sequestration resulting from increases in the content of organic matter in soils, namely through the promotion of biodiverse pastures. This type of agriculture will also have consequences in terms of improving the efficiency of water use, enabling productivity gains and water savings, given that water is a scarce and essential commodity to preserve.

In the case of forests and other land uses, proper agroforestry management will be essential in order to progressively reduce the area burnt, increasing productivity and reinforcing the commitment to ecosystem services that enable and contribute to combating desertification and enhancing the value of the territory, constituting another of the foundations of territorial cohesion.

The sink potential, particularly in the forestry area, will have to be strengthened by taking on its management in conjunction with land-use planning, investing in management practices and models that enhance the sink role of forests and increase their resilience in the face of climate change, which has the potential to worsen the conditions for forest fires and soil degradation.

5.1.4. Waste

Promoting circular economy practices and sustainable consumption, which embody the principles of waste prevention and reduction and ensure proper and sustainable waste management, can contribute to decarbonisation in general by reducing the consumption of raw materials and energy, as well as promoting the efficient and sustainable use of natural resources and protecting biodiversity.

In order to complete the municipal decarbonisation strategy, we must also focus on the waste and wastewater sector, which, although it has little significance in the overall calculation of emissions, is a sector where substantial changes are expected by 2050 due to the implementation of various strategies such as the Roadmap to Carbon Neutrality 2050 (RNC 2050), the PNEC 2030 and sectoral strategies for waste and wastewater management such as the PNGR 2030, PERSU 2030, or the Strategic Plan for Water Supply and Wastewater and Stormwater Sanitation 2030 (PENSAARP 2030), all of which are in the public consultation and approval phase.

In 2020, the General Waste Management Regime (RGGR)[8] and the Landfill Diploma[9] were revised, in accordance with the 2018 Directives, and these were subsequently subject to amendments proposed in Parliament in 2021 and published through Law 52/2021 of 10 August. In this context, the diplomas bring important changes to the panorama of public policy instruments in this area, namely with regard to the increase in fees associated with material waste by landfill (Waste Management Fee - TGR), the ban on landfilling recyclable materials, including bio-waste, or the bonuses associated with the diversion of bio-waste from the undifferentiated stream. The RGGR therefore set the following targets:

- By 2025, reduce the amount of waste produced per inhabitant by 5 per cent compared to 2019 figures;
- By 2030, reduce the amount of waste produced per inhabitant by 15 per cent compared to 2019 figures;
- Overall minimum increase to 50 per cent by weight for preparing for the reuse and recycling of waste;
- By 2025, a minimum increase to 55% by weight of preparing for re-use and recycling of waste, with at least 5% resulting from preparing for re-use textiles, equipment electrical and electronic, furniture and other waste suitable for preparing for re-use;
- By 2030, a minimum increase to 60 per cent by weight of the preparation for re-use and recycling of waste, with at least 10 per cent resulting from the preparation for re-use of textiles, electrical and electronic equipment, furniture and other waste suitable for preparing for re-use;
- By 2035, a minimum increase to 65 per cent by weight in the preparation for re-use and recycling of waste, with at least 15 per cent resulting from the preparation for re-use of textiles, electrical and electronic equipment, furniture and other waste suitable for preparing for re-use.

There are also a number of other objectives that contribute to achieving the targets defined in the RGGR, namely those for packaging and packaging waste (ERE), defined under Article 29, and also the selective collection targets for single-use plastic drinks bottles, in Decree-Law no. 78/2021, of 24 September.

The legal regime for the landfill of waste, the Landfill Diploma, stipulates in its article 8 that up to

[8] Decree-Law no. 152-D/2017, of 11 December.

[9] Annex II of Decree-Law no. 102-D/2020, of 10 December, amended by Law no. 52/2021, of 10 August.

2035 the amount of waste deposited in landfill must be reduced to a maximum of 10 per cent of the total amount of waste produced, by weight.

There will also be a paradigm shift in the need for greater reuse and recycling of waste, betting on a more circular economy with less waste.

The priority will therefore be first and foremost to reduce waste production, followed by strengthening selective waste collection, prioritising the biological treatment of bio-waste and intensively exploring solutions for the reuse and recycling of materials.

The municipality is currently showing an upward trend in the amount of municipal waste produced, particularly in terms of undifferentiated collection, and stagnation in terms of selectively collected municipal waste (**Figure 5.2**). Selective collection accounts for only 21 per cent of the municipal waste collected, down from 25 per cent in 2015.

In per capita terms, the evolution is similar and close to the capitations registered at national level (**Figure 5.3**).

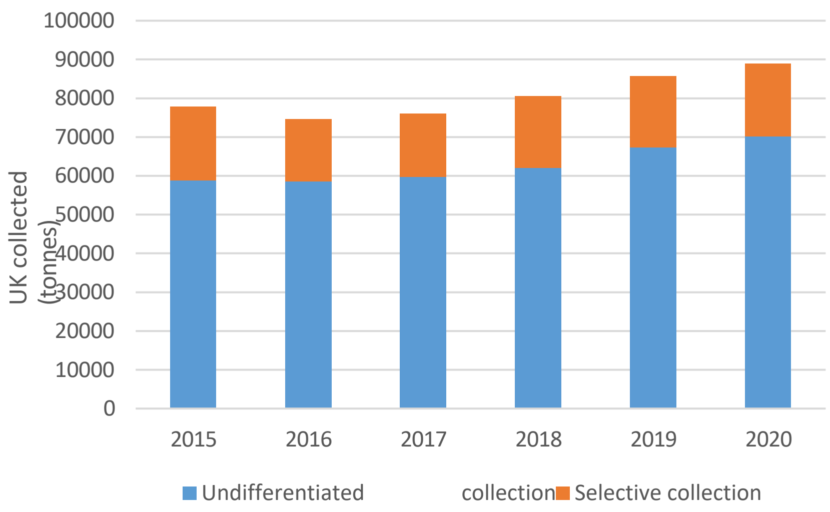


Figure 5.2. Evolution of municipal waste (MW) collected, by year

Source: INE, 2022.

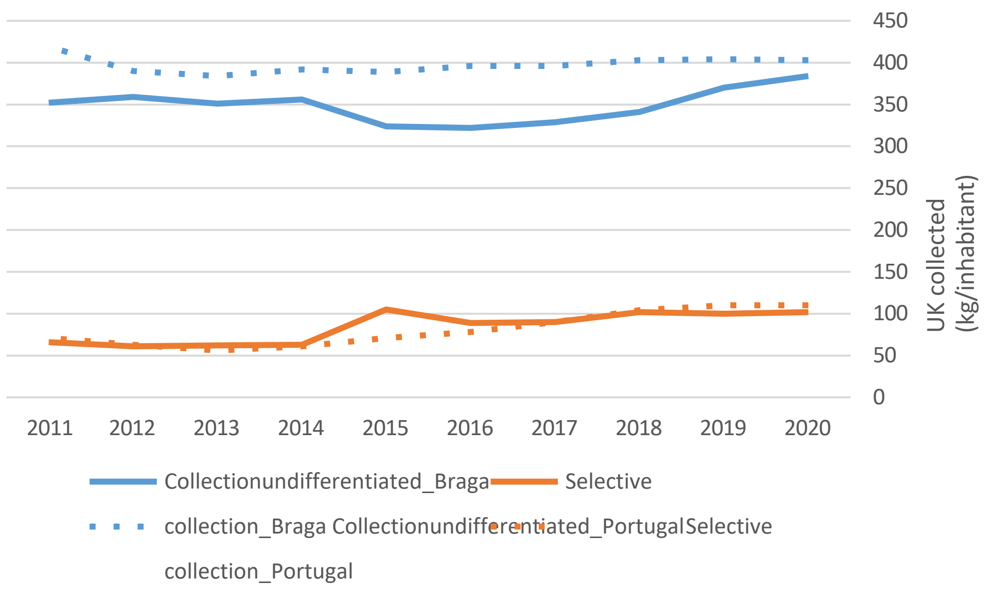


Figure 5.3. Evolution of municipal waste (MW) collected by type of collection in the municipality and at national level

Source: INE, 2022.

In 2020, around 54% of the municipal waste collected was landfilled, with only 24% of the biodegradable fraction, essentially due to the existing organic recovery plant that degrades and energetically valorises part of the biodegradable fraction of municipal waste. The proportion of municipal waste prepared for reuse and recycling was 67.3 per cent in 2020. This data shows that there is an urgent need to reduce waste production in the municipality of Braga and to boost selective collection, recycling and waste recovery solutions in order to reduce landfill to 10%.

The rational use of existing water resources and meeting the needs of all consumers, including environmental ones, must be guaranteed. On the other hand, since energy costs are one of the most significant components of the operating and running costs of water supply and wastewater sanitation services, with direct implications for tariffs, energy management is one of the main challenges facing the organisations that manage these services today. It is from this perspective of an integrated and multidisciplinary view of system management (hydraulic aspects, water quality, reliability, energy management and operation and maintenance) that service management entities must promote actions to reduce the energy consumed in water services, by improving energy and water efficiency and increasing the level of energy self-sufficiency of wastewater treatment plants and other facilities.

According to the GHG Emissions Inventory, in 2021, emissions attributed to the waste and wastewater sector in the municipality of Braga totalled 73,872 t $_{CO2e}$, corresponding to 8.7% of the total emissions recorded in the municipality.

The wastewater subsector was responsible for 79.4 per cent (58,650 t $_{CO2e}$) of emissions from this sector, followed by the biological waste treatment (14.5 per cent) and solid waste disposal (6.1 per cent) subsectors.

5.2 Adaptation

The action plan for adapting to climate change will be organised into strategic intervention sectors adapted to the scope, scale and specific characteristics of the Braga municipality.

The following is a systematised identification of the sectors that the PMAC-Braga is specifically targeting, or will have the most impact on, in the context of adapting to climate change:

5.2.1 Ecosystems and Biodiversity

Climate change poses increasingly serious risks to ecosystems, human health and the economy. Due to climate change, the municipality of Braga is already facing more extreme weather conditions, such as more frequent and more intense heatwaves, floods, droughts and storms.

Forest fires, heat waves and other extreme meteorological phenomena devastate entire ecosystems and soils. Recovery from these one-off events, which are increasing in intensity and frequency, is also becoming increasingly difficult. The pressures induced by climate change, both acute and chronic, only further aggravate other risks that result, for example, from the felling of forests, air, water and soil pollution, excessive hunting and fishing, and the proliferation of invasive species, among others.

Furthermore, nature has always played a crucial role in alleviating the impacts caused by humans on the global climate. More than half of all CO2 emissions derived from human activity are captured by plants through photosynthesis and temporarily stored in living and dead biomass. Living organisms also affect the physical parameters of the climate system, such as the reflectivity of the earth's surface and the formation of clouds and dust in the atmosphere.

Healthy and diverse ecosystems can therefore help humans survive climate impacts such as extreme weather events - for example, intact forests retain rainwater and reduce the damage caused by floods. Ecosystems can also help us adapt to a changing climate by sustaining livelihoods and creating sustainable food and energy solutions for local communities.

As important as it is, protecting biodiversity from climate change is not just about preserving beautiful living things for their own sake. Forests, rivers and ecosystems have economic and cultural value for countless local communities. What's more, as constant warming and environmental degradation erode the carbon storage capacity of forests, rivers and ecosystems, we need to protect them from climate change.

natural ecosystems, there is a significant and growing risk of feedback, aggravating an already serious situation.

To this end, PMAC aims to support and develop different projects to implement nature-based solutions with the aim of promoting biodiversity, respecting the natural water cycle, increasing carbon storage capacity, enhancing biodiversity, forests, soils, reducing energy consumption, making ecosystems more resilient to climate change and enhancing their potential to provide services to the community.

5.2.2 Water Resources

Water is an essential resource, both as the basis of biological activity, essential for life and fundamental for the development and balance of ecosystems, and as a critical element for socio-economic development and people's quality of life.

Climate change can have an impact on the hydrological regime, significantly affecting its quantity and regularity, but also the quality of water resources.

Extreme rainfall events, increased climate variability and rising temperatures tend to have an impact on water resources, affecting the quality and quantity of groundwater and surface water bodies.

Water resources, as a natural asset of strategic importance, require sustainable management and climate change adaptation policies to ensure their qualitative and quantitative preservation.

5.2.3 Agriculture

Adapting to climate change is essential for the future of sectors such as agriculture that depend on land use, natural resources and meteorological factors. It is therefore imperative to increase the resilience of agriculture and forestry against climate change and to support actions that contribute to national and EU climate objectives.

Agriculture and forestry are strongly exposed to the impact of rising temperatures: increased seasonal fluctuations disrupt agricultural cycles, coupled with the substantial challenges posed by changing rainfall patterns and extreme weather events such as heatwaves, droughts, storms and floods, influencing crop yields and livestock productivity, which can lead to economic losses and the abandonment of activity, with social and territorial impacts, as well as the impact on the environment.

as affecting food production and safety, as well as the price and quality of products.

In this sense, the Action Plan aims to ensure that farmers can adapt to climate uncertainty, reduce emissions and mitigate climate change.

5.2.4 Tourism

Climate is an important component in affirming and defining the attractiveness of a tourist destination, with meteorological and climatic aspects often determining the choice of place or time to carry out a tourist activity.

The potential impacts of climate change on infrastructure and transport operations can also affect tourism.

In this context, climate change can have an impact on tourism demand, either positively (e.g., rising air temperatures) or negatively (e.g., extreme weather events, loss of biodiversity, transport cancellations, vector-borne diseases).

The tourism sector is dependent on the adoption of adaptation measures in various sectors, as well as specific adaptive responses, including in terms of destination promotion.

It is essential to assess the climate sensitivity of the dimensions related to buildings (tourist accommodation), historical and cultural heritage. Climate change could have direct physical impacts on built heritage, cultural facilities and cultural landscapes. These negative impacts could be the result of both extreme and sudden events, such as excessive rainfall, storms or strong winds, as well as situations resulting from gradual, less obvious climate change, causing changes in the amplitude of humidity or temperature cycles, for example, with repercussions on historical and cultural heritage, particularly buildings.

5.2.5 Spatial planning

Spatial planning establishes the spatial organisation model, based on territorial systems, namely the natural system, the urban system, the social system, the economic system and the connectivity system.

The territory is facing increasingly significant impacts from climate change, requiring land use and occupation to ensure resilience in the face of climate impacts and vulnerabilities. The response to climate change adaptation requires adequate planning and

This is because the possible impacts of these changes tend to occur at different scales, according to the specific characteristics of each part of the territory, and it is necessary to know and map vulnerabilities in order to identify and implement effective adaptation measures. By identifying the reference situation in the territory and the adaptation actions already adopted and to be adopted in the municipality, it is possible to promote the adaptation component in territorial policy and management instruments.

Spatial planning can be characterised by six attributes that facilitate the pursuit of adaptation to climate change (Hurlimann et March, 2012):

- Planning action on issues of collective interest;
- Managing conflicting interests;
- Articulate various scales at territorial, temporal and governance level;
- Adopt uncertainty management mechanisms;
- Acting on the basis of the knowledge repository;
- Defining guidelines for the future, integrating the activities of a wide range of players.

This is effectively a cross-cutting sector that will result in inputs and outputs to and from other sectors. It is also important to increase the territory's resilience capacity, preparing it for current and future climate impacts and vulnerabilities, and limiting their magnitude and severity, especially in sensitive or higher risk areas. In this way, the activities recommended in the municipality's strategy will be developed with the aim of achieving the following aspects:

- **Strategic: to** define preferential guidelines for the location of buildings and infrastructures, as well as for the use, morphology and preferred forms of territorial organisation; to establish new land use and occupation guidelines; formulate medium and long-term sustainable development strategies.
- **Regulate:** indicate technical guidelines to ensure that adaptation to climate change is integrated into the main territorial management instruments; establish legal and **regulatory** standards. regulations covering the use, occupation and alteration of land, as well as urban planning practices; encouraging the implementation of energy efficiency solutions and other measures to minimise environmental impact.
- **Operational:** establishing guidelines for prioritising interventions in the territory; implementing public policies and economic and financial regimes with a territorial impact; monitoring and communicating the results obtained.

- **Governance:** promoting the active participation of local authorities, economic agents and civil society, through the integration of knowledge and experience, as well as coordination.
of territorial policies[10].

The PMAC is therefore a territorial management instrument that provides a reference framework for its implementation through the various IGTs, taking into account the characterisation of the response that has already been made. It seeks to provide guidelines for integrating adaptation options into the material and documentary content of each plan, in order to promote the regular consideration of adaptation to climate change in the processes of drawing up, amending and revising territorial plans at municipal and regional level.

The effective integration of adaptation options into spatial planning will require in-depth assessments of territorial vulnerabilities (climate and non-climate), particularly with regard to their spatial impact, to be carried out when plans are amended or revised.

Alternative solutions for realising each adaptation option at a spatial level should also be considered, in conjunction with other planning and development options.

5.2.6 Industry

In addition to its importance in terms of mitigation (mainly associated with energy consumption), the industrial expression of the municipality also justifies taking into account the resilience of facilities, activities and industrial zones to climate change, safeguarding their accessibility, exposure and vulnerability to climate risks.

Within the framework of Braga's industrial activity, we have identified the main reference activities that mark the municipality:

- Information, Communication and Electronic Technologies
  - High supply of qualified resources in the area of Engineering, trained by the University of Minho;
  - Low labour costs compared to other regions and countries, particularly in the European Union;
  - Existing business fabric strongly focussed on the technology sector;

[10] In this context, it is important to mention the role of the Municipal Council for the Environment and Climate Action of the Municipality of Braga, which contributed to the drafting of the PMAC-Braga (its contributions and respective weighting can be found in **Annex AIV**).

- Partnership between the University of Minho and Bosch Car Multimedia Portugal S. A., for the creation of an Innovation and Technological Development Centre (I&DT).

- Construction and Environmental Engineering
  - Braga is recognised as a leader in engineering and has leading companies;
  - History of activity in this sector;
  - Low labour costs compared to other countries, particularly in the European Union;
  - Business fabric with a strong predominance in the engineering area: DST, Casais, ABBorges, Rodrigues & Névoa, among others;
  - Development of environmental engineering.
- Regional Clusters
  - It has a strong industrial component, characterised by companies linked to the textile, metallurgical and metalworking industries;
  - Existence of industrial parks and business centres on the outskirts of the city;
  - Research centres, such as those at UMinho and the International Nanotechnology Laboratory (INL), as well as infrastructures such as the racetrack and aerodrome.
  - An important centre for the production of religious articles (saints, paramentaria and bells), strongly associated with the Diocese of Braga.
- Health
  - Braga has a number of landmark health infrastructures, recently created and which have provided the city with a new public hospital and a leading health sciences school at UMinho. In the private sphere, Braga also has excellent health centres of excellent quality and size.
  - These infrastructures, together with the medical technology industries, form a critical resource, since with the existing infrastructures and the skills trained for the market, the conditions are created for the development of new activities and the creation of new companies around the areas of health, leisure and well-being.

In this sense, PMAC - Braga will support these communities in their transformation towards climate resilience, helping them to understand, prepare for and manage the risks induced by climate change.

5.2.7 Infrastructure

Climate change has brought challenges to all sectors, and the impact on infrastructure is one of the aspects to be taken into account.

In addition to the contribution of sustainable construction to reducing GHG emissions related to mitigation, it is important to ensure that infrastructures are resilient to climate change, safeguarding accessibility, exposure and vulnerability to climate risks.

On the other hand, there may be a need to promote adaptation measures associated with strengthening or relocating critical infrastructure.

Critical infrastructures have become increasingly important in today's societies, as they fulfil fundamental functions for the economy and security of communities. Their prolonged inoperability causes tremendous damage to the economy due to the paralysis of strategic activities, and can jeopardise the regions' ability to respond.

It is therefore important to safeguard the capacity of these infrastructures to remain in operation during and after a disaster or other disruptive event. This is not only to guarantee the availability of vital goods and services, but also because these infrastructures, operating in an environment of great interdependence, mean that very localised dysfunctions tend to exacerbate their consequences by spreading their effects across strongly connected and therefore interdependent systems. There are therefore compelling reasons for societies to join forces to protect their critical infrastructures.

It is in this context that the protection of critical infrastructures takes on a leading role in helping to raise their resilience to desired but economically sustainable levels. The aim is to prioritise the reduction of vulnerabilities and, at the same time, to identify and disseminate efficient measures and good practices that reduce the risk to which these infrastructures may be exposed.

Within the scope of this Plan, the following are considered critical: road and airport infrastructures, energy distribution and telecommunications, water supply, sanitation and waste management, and collective infrastructures or facilities for health, education, social support, civil protection and public safety.

5.2.8 Human Health and Safety of People and Goods

The foreseeable increase in the frequency and intensity of extreme weather events will increase the risk of serious accidents or disasters, with an impact on the safety of people and property. In the field of health itself, there could be an increase in the risk of vector-borne diseases and a deterioration in air quality.

Taking precautions against climate-related natural hazards, mitigating their impacts and adapting protection and rescue systems when these situations occur, as well as health responses, are priority challenges in adapting to climate change.

Municipalities, through their municipal civil protection services, are responsible for pursuing objectives such as:

- The prevention of collective risks and the occurrence of a serious accident or disaster resulting from them;
- Mitigating collective risks and limiting their effects in the event of a serious accident or disaster;
- Rescue and assistance to people and other living beings in danger and protection of cultural and environmental assets and values of high public interest;
- Support in restoring normality to the lives of people affected by a serious accident or disaster.

The potential evolution of the climate framework may require that the precautionary principle of natural risks of climate origin be reinforced in municipal policies, particularly at territorial level, but also in terms of the planning, management and operation of municipal civil protection itself.

In this way, the Human Health and Safety of Persons and Goods sector is a field of adaptation whose object is people and goods, and it is therefore important to emphasise its character as a sector of governance.

6. Greenhouse Gas (GHG) Inventory

6.1 GHG Inventory

6.1.1. Area of Intervention

The area of intervention of the GHG emissions inventory corresponds to the territory of the municipality of Braga, located in the district with the same name (Figure 6.1).

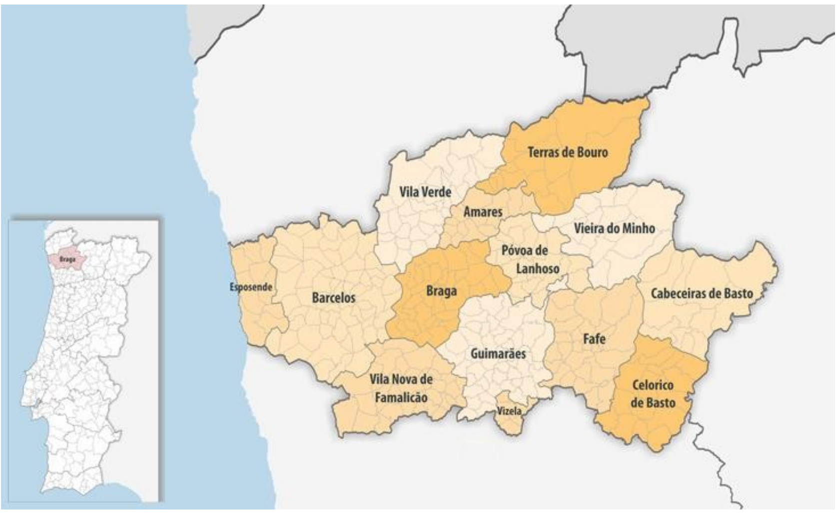


Figure 6.1. The municipality of Braga in the context of the district and the country
Source: https://pt.wikipedia.org

With a total area of 183.4 km^2, the municipality of Braga is divided into 37 parishes in terms of administrative organisation, as shown in Figure 6.2.

Figure 6.2. Administrative division of the Braga municipality

Source: https://www.cm-braga.pt

6.1.2. Methodological Reference

The GHG emissions inventory was developed with the aim of finding out about total emissions and emissions by sector in the municipality of Braga, as well as identifying the main sources of emissions and removals by carbon sinks.

The GHG emissions inventory for the municipality of Braga was drawn up based on the guidelines of the Intergovernmental *Panel on Climate Change* (IPCC), following the Global Protocol for *Community-Scale Gre*enhouse Gas Emission Inventories (GPC), a consistent and globally recognised standard for carrying out emissions inventories for the sub-national level.

Table 6.1 shows the identification and definition of the relevant sectors considered for the inventory of GHG emissions in the municipality of Braga.

Table 6.1. Relevant sectors for the GHG emissions inventory

Sector	Definition
Stationary energy uses	Stationary uses of energy are one of the largest contributors to GHG emissions, covering emissions from combustion activities and energy consumption in residential buildings, commercial buildings and facilities and public buildings, public lighting, industrial facilities and construction activities, including combustion activities for the generation of electricity and heat for self-consumption in agriculture and forestry, as well as in industries producing energy for grid supply.
Transport	The transport sector is currently one of the main sources of GHG emissions, covering all road, rail, sea and air journeys, including intercity and national routes. Emissions from international transport (shipping and aviation) are not accounted for, as is the case with INERPA. GHG emissions result directly from combustion or indirectly from the use of electricity supplied by the grid.
Waste	The treatment and disposal of waste and the treatment and discharge of wastewater produce GHG emissions through aerobic or anaerobic decomposition processes or incineration. GHG emissions from solid waste are calculated for landfill disposal, biological treatment and incineration and open burning, while emissions from wastewater treatment and discharge are determined according to the effluent load of organic matter. GHG emissions resulting from methane recovery and incineration activities with energy utilisation are reported under stationary energy uses (energy industries).
Industrial processes and product use	Industrial processes for the chemical or physical transformation of materials produce GHG emissions that are not related to energy use. On the other hand, GHG emissions can be identified as a result of the use of certain products by industry and end consumers (e.g. use of lubricants for non-energy purposes, use of solvents).
Agriculture, forestry and other land uses	The agriculture, forestry and other land use sector encompasses various sources of GHG emissions and removals. Sources of GHG emissions include enteric fermentation, manure management, the application of inorganic fertilisers and some land use changes. On the other hand, forests, wetlands and scrubland are important carbon sinks.

Source: Adapted from GPC

The inventory groups GHG emissions in the municipality of Braga into three areas, so as to cover emissions whose sources are located within the municipality's boundaries, as well as those that occur outside the municipality and are attributable to activities carried out within its boundaries.

Table 6.2 Scoping GHG emissions

Scope 1	GHG emissions from sources located within the municipality's boundaries.
Scope 2	GHG emissions that occur as a result of using energy supplied by an integrated network within the municipality's boundaries.
Scope 3	All other GHG emissions that occur outside the municipality attributable to activities that take place within the municipality's boundaries.

Source: Adapted from GPC

The GHG emissions inventory for the municipality of Braga was drawn up using the CIRIS[11] system, a tool designed in accordance with the GPC standard and with the aim of supporting the drawing up of GHG emissions inventories at sub-national level12.

GHG emissions are estimated by multiplying the activity data by an emission factor associated with the activity being measured. As a rule, predefined emission factors from the IPCC 2006 were used, in line with INERPA.

The results of the inventory are reported in quantities of CO_2 equivalent, a unit obtained on the basis of the global warming potentials[13] of the different GHGs. In this inventory, the global warming factors defined in the IPCC's Fifth Assessment Report (AR5) were used, in order to allow comparability with INERPA[14].

[11] The CIRIS (City Inventory Reporting and Information System) system is a spreadsheet developed in Excel.

[12] CIRIS is aligned with the Common Reporting Framework (CRF) of the Global Convenant of Mayors for Climate & Energy (GCoM), serving as the basis for drawing up GHG emissions inventories for various cities and regions around the world.

[13] The Global Warming Potential (GWP) is a metric defined by the IPCC, based on CO_2, to determine the contribution of each GHG to global warming.

[14] In 2023, INERPA started using the global warming potentials (GWP) defined in AR5.

Table 6.3 GHGs and global warming potentials

GEE	Global warming potential (GWP)
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous oxide (N_2O)	265

Source: IPPC (AR5)

The necessary basic data was collected from a variety of sources and whenever it did not correspond to the geographical limits of the Braga municipality, it was disaggregated to the municipal level using scale factors.

The methodologies described in **Annex AI** were applied to calculate GHG emissions in the municipality of Braga of this report.

6.1.3. General GHG Balance Profile

Based on the inventory carried out, it is estimated that in 2021, GHG emissions in the municipality of Braga totalled **821,535** tCO_{2e}, without accounting for the carbon sequestration capacity of land use, land use change and forests (LULUCF), and **683,739** tCO_{2e} considering it, thus representing the net balance of emissions in the municipal territory (**Table 6.4**).

Table 6.4. Summary of Braga's GHG inventory (2021)

Sectors	Scope 1	Scope 2	Scope 3	TOTAL
Stationary energy uses	221 282	100 576	13 038	334 895
Transport	382 629	60	-	382 688
Waste and wastewater	73 289	-	-	73 289
Industrial processes and product use (IPPU[15])	722	-	-	722
Agriculture, forestry and other land uses (AFOLU[16])	- 107 856	-	-	- 107 856
Total emissions (without LULUCF)	**707 862**	**100 635**	**13 038**	**821 535**
Land use, land use change and forestry (LULUCF)	- 137 796	-	-	- 137 796
Total net emissions (with LULUCF)	**570 066**	**100 635**	**13 038**	**683 739**

Unit: t CO2e

Table 6.5 shows GHG emissions in the municipality of Braga in 2021, broken down by sector and subsector.

Table 6.5. GHG balance by sector and subsector in Braga (2021)

Sectors and Sub-sectors	Scope 1	Scope 2	Scope 3	TOTAL
Stationary energy uses	221 282	100 576	13 038	334 895
Domestic	119 847	35 178	-	155 026
Commercial and institutional	25 739	40 632	-	66 371
Manufacturing and construction	64 315	24 455	-	88 769
Energy industries	1 081	1	-	1 082
Agriculture, forestry and fisheries	9 129	309	-	9 439
Unspecified uses	2	-	13 038	13 040
Fugitive emissions	1 168	-	-	1 168
Transport	382 629	60	-	382 688
Road transport	382 392	58	-	382 449
Rail transport	237	2	-	239

[15] Industrial Processes and Product Uses.

[16] Agriculture, forestry and

Sectors and Sub-sectors	Scope 1	Scope 2	Scope 3	TOTAL
Aviation	-	-	-	-
Waste and wastewater	73 289	-	-	73 289
Solid waste disposal	4 514	-	-	4 514
Biological waste treatment	10 707	-	-	10 707
Incineration and open burning	-	-	-	-
Wastewater treatment and discharge	58 068	-	-	58 068
Industrial processes and product use (IPPU)	722	-	-	722
Industrial processes	-	-	-	-
Use of products	722	-	-	722
Agriculture, forestry and other land uses (AFOLU)	- 107 856	-	-	- 107 856
Livestock	18 418	-	-	18 418
Land use, land use change and forestry (LULUCF)	- 137 796	-	-	- 137 796
Other emissions	11 522	-	-	11 522
Total emissions (with LULUCF)	**570 066**	**100 635**	**13 038**	**683 739**

Unit: t CO2e

Analysing GHG emissions by sector, without accounting for LULUCF, it can be seen that transport (46.6%) and stationary energy uses (40.8%) shared responsibility for almost 90% of the emissions recorded in the municipality of Braga in 2021.

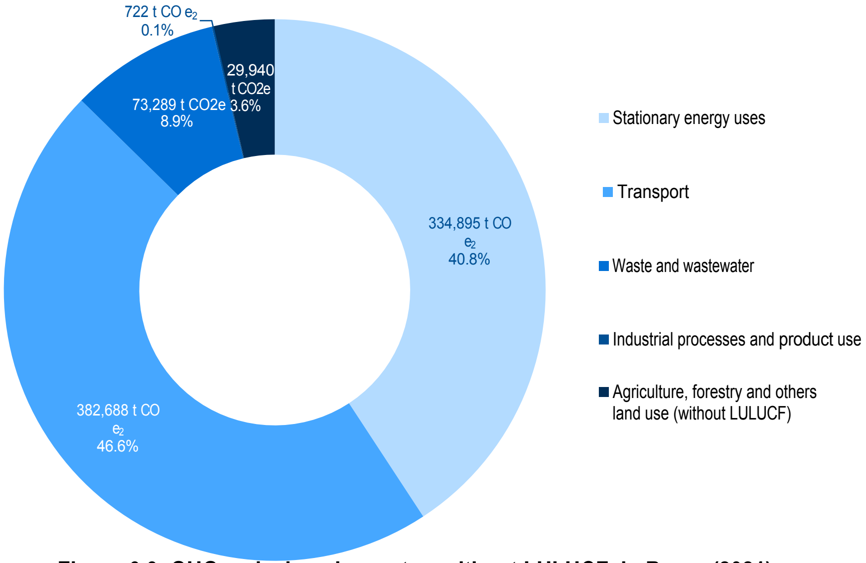


Figure 6.3. GHG emissions by sector, without LULUCF, in Braga (2021)

Figure 6.4 shows the result of GHG emissions by scope and sector in 2021, without accounting for the LULUCF, highlighting the fact that 86.2% of emissions are Scope 1, originating mainly from activities related to transport and stationary uses of energy, developed within the boundaries of the municipality of Braga. Scope 2 emissions from stationary uses of electricity from the integrated network accounted for 12.2 per cent of total GHG emissions, while Scope 3 emissions were the least significant in the Braga municipality (1.6 per cent).

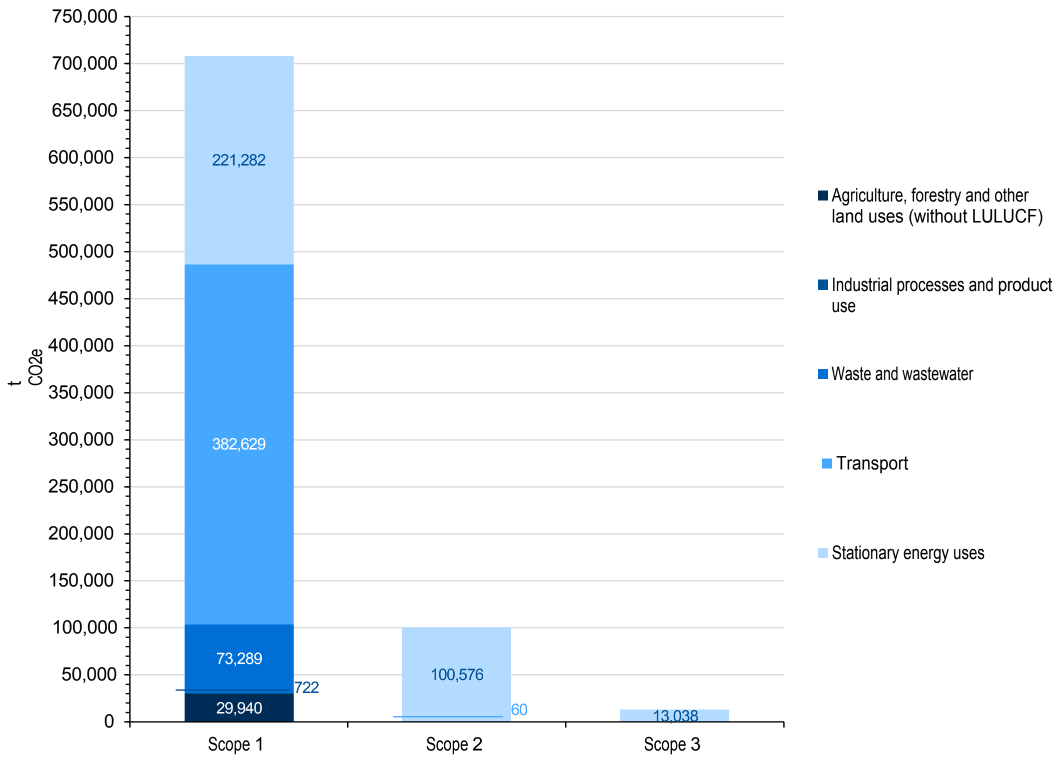


Figure 6.4. GHG emissions by scope and sector, without LULUCF, in Braga (2021)

Carbon dioxide (CO_2) was the main GHG emitted in the municipality of Braga in 2021, accounting for 85.5 per cent of total emissions, followed to a lesser extent by methane (CH_4) and nitrous oxide (N_2O), as can be seen in **Figure 6.5**.

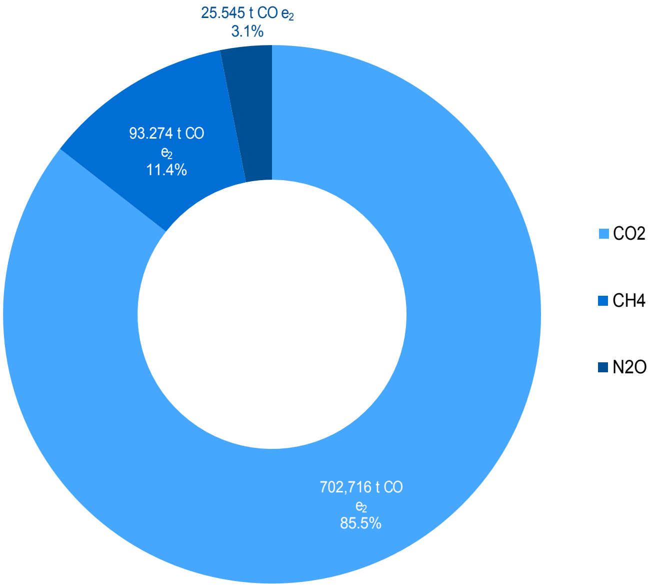


Figure 6.5. Emissions by type of GHG in Braga (2021)

6.1.4. GHG Balance Sector Profile

As already mentioned, the transport sector and stationary energy uses were the main contributors to GHG emissions in the municipality of Braga in 2021. Below is an analysis of emissions in the municipality, broken down by sector.

6.1.4.1. Stationary energy uses

Stationary uses of energy cover emissions from combustion activities and energy consumption in residential buildings, commercial buildings and installations and public buildings, public lighting, industrial installations and construction activities, including combustion activities for the generation of electricity and heat for self-consumption, in agriculture, forestry and fishing activities, as well as in industries producing energy for grid supply.

In 2021, GHG emissions attributed to stationary energy uses in the municipality of Braga totalled 334,895 tCO_{2e}, corresponding to 40.8% of total emissions.

Domestic consumption (46.3 per cent) stood out as the sector's main source of emissions, followed by combustion activities in the manufacturing and construction industries (26.5 per cent) and commercial and institutional uses of energy (19.8 per cent).

Emissions from stationary uses of energy are essentially split between Scope 1 (66.1 per cent) and Scope 2 (30.0 per cent), with Scope 3 emissions being almost residual (3.9 per cent).

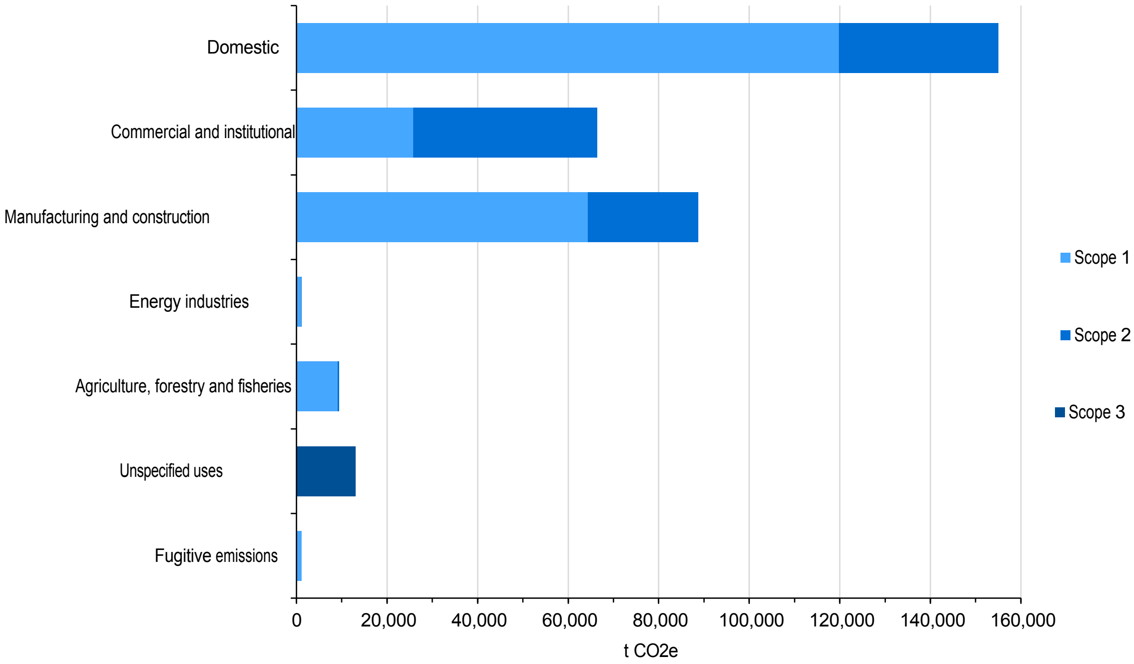


Figure 6.6. GHG emissions from stationary energy uses (2021)

Looking at the profile of emissions from stationary uses of energy by type of gas17, there is an almost absolute dominance of CO_2 (96.9 per cent), with small emissions of CH_4 (2.4 per cent) and N2O (0.7 per cent).

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[17] Emissions from electricity supplied by the grid were attributed to each type of gas according to information provided by the Portuguese Environment Agency (APA), namely: 98.3 per cent CO_2, 0.2 per cent CH_4 and 1.5 per cent N_2O.

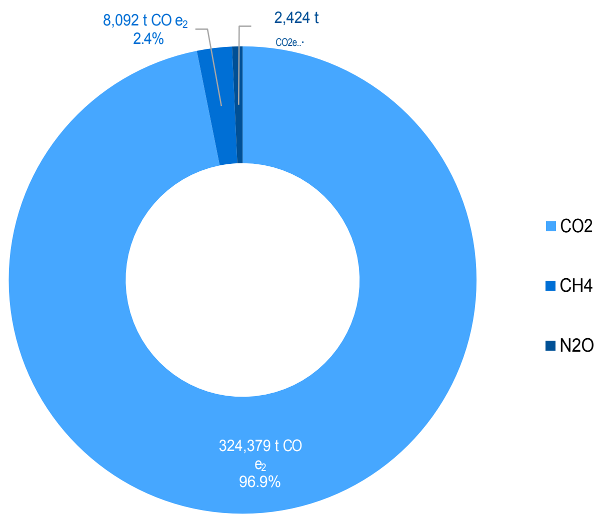


Figure 6.7. Emissions from stationary energy uses by type of GHG (2021)

Analysing GHG emissions from stationary energy uses according to energy vector, it can be seen that natural gas, grid-supplied electricity and biomass together accounted for more than 85% of the sector's emissions in the municipality of Braga in 2021. The other energy carriers that contributed to the sector's emissions were diesel (7.5%), butane and propane gases (5.7%) and, residually, landfill gas (0.3%), fuel oil (0.2%), kerosene (0.02%) and petrol (0.002%).

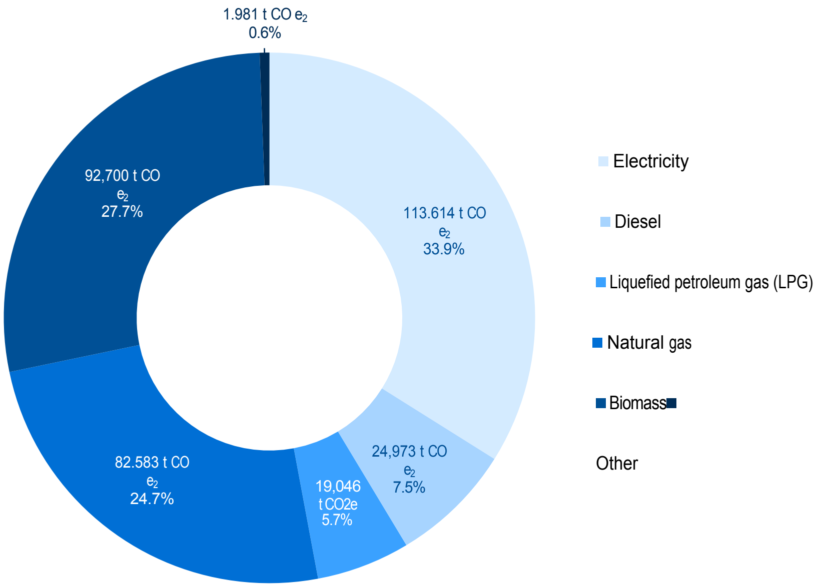


Figure 6.8. Emissions from stationary energy use by energy vector (2021)

It should be noted that, in 2021, GHG emissions attributed to the energy vector of electricity generation supplied by the grid resulted from the combustion of coal, fuel oil, diesel, natural gas and biomass, as well as energy recovery (waste incineration and biogas)[18].

6.1.4.2. Transport

The transport sector includes GHG emissions from road and rail journeys. It was not possible to obtain data to calculate emissions from air transport generated from Braga Municipal Aerodrome.

In 2021, GHG emissions from the transport sector in the municipality of Braga totalled 382,688 tCO_2e, corresponding to 46.6% of the municipality's total emissions.

Road transport was the dominant source of GHG emissions from the transport sector, with rail transport contributing just 0.001 per cent of emissions.

Emissions from the transport sector, both road and rail, are almost all Scope 1 and, residually, Scope 2.

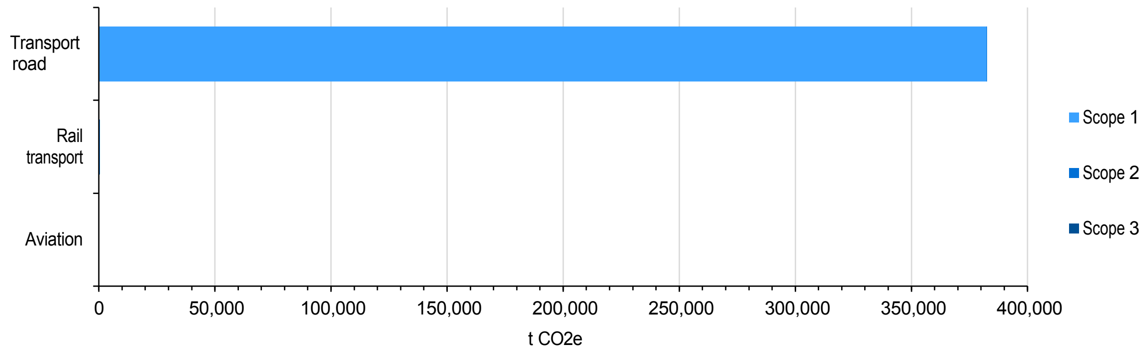


Figure 6.9. GHG emissions from the transport sector (2021)

In 2021, GHG emissions from the transport sector in the municipality of Braga were almost entirely CO_2 (98.3 per cent), with small emissions of N_2O (1.3 per cent) and CH_4 (0.4 per cent).

[18] APA - Portuguese Environment Agency (2023). Greenhouse gas emission factor for electricity produced in Portugal 2005-2021. Amadora, Portugal.

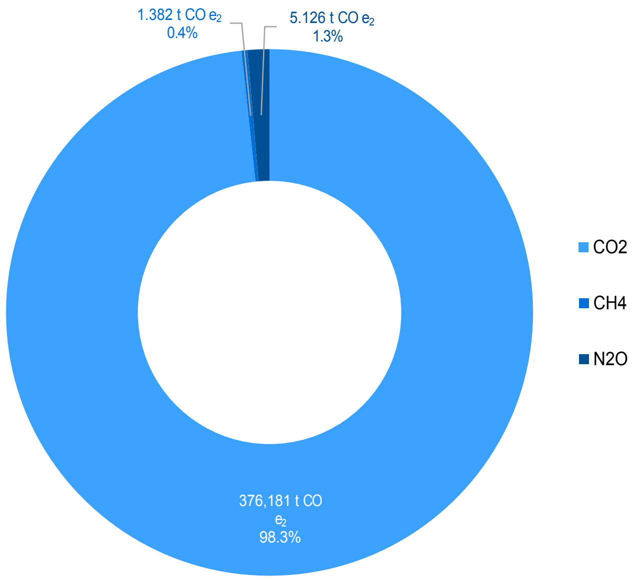


Figure 6.10. Transport sector emissions by type of GHG (2021)

Looking at the energy vector, it can be seen that, in 2021, GHG emissions from the transport sector in the Braga municipality came essentially from the combustion of diesel (82.3 per cent) and 95 and 98 octane petrol (17.0 per cent), with the remaining energy vectors (LPG, natural gas and electricity[19]) having a residual expression.

[19] The GHG emissions resulting from the consumption of electricity supplied by the grid in the transport sector do not take into account domestic charging of electric vehicles, the corresponding emissions being accounted for in stationary uses of energy.

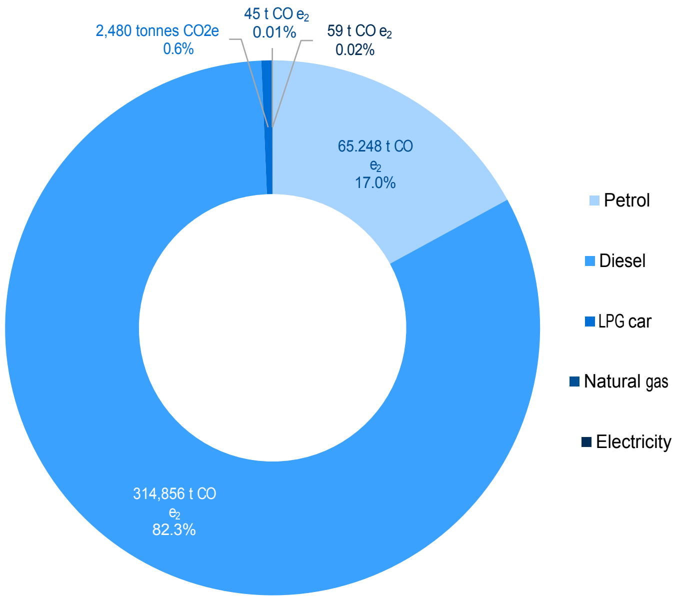


Figure 6.11: Transport sector emissions by type of GHG (2021)

6.1.4.3. Waste and wastewater

This sector's GHG emissions come from waste treatment and disposal and wastewater treatment and discharge operations.

GHG emissions attributed to the waste and wastewater sector in the municipality of Braga totalled 73,289 tCO_{2e} in 2021, corresponding to 8.9% of total recorded emissions, all of which are Scope 1.

The wastewater subsector was responsible for 79.2 per cent (58 068 t $_{CO2e}$) of emissions from this sector, followed by the biological waste treatment (14.6 per cent) and solid waste disposal (6.2 per cent) subsectors.

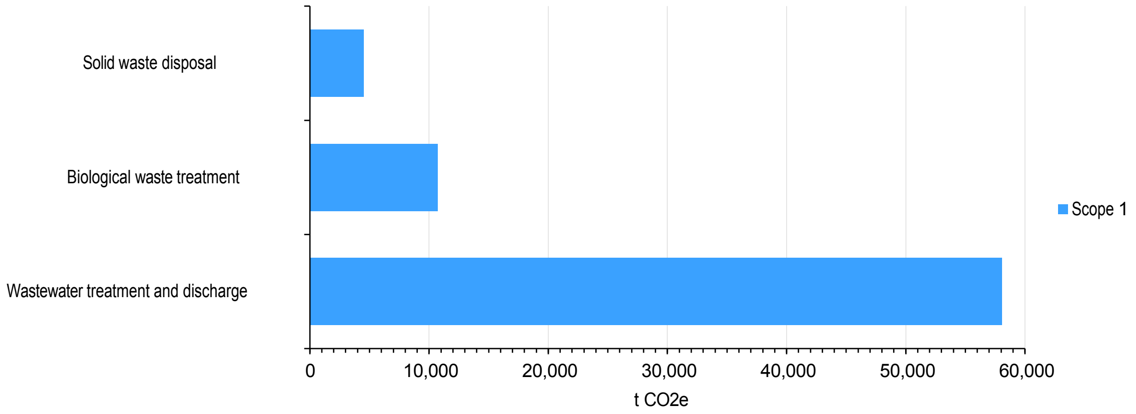


Figure 6.12. GHG emissions from the waste and wastewater sector (2021)

The emissions profile by type of gas in the waste and wastewater sector in the municipality of Braga in 2021 was clearly dominated by CH_4 (89.6 per cent), with a further share of N_2O (10.4 per cent).

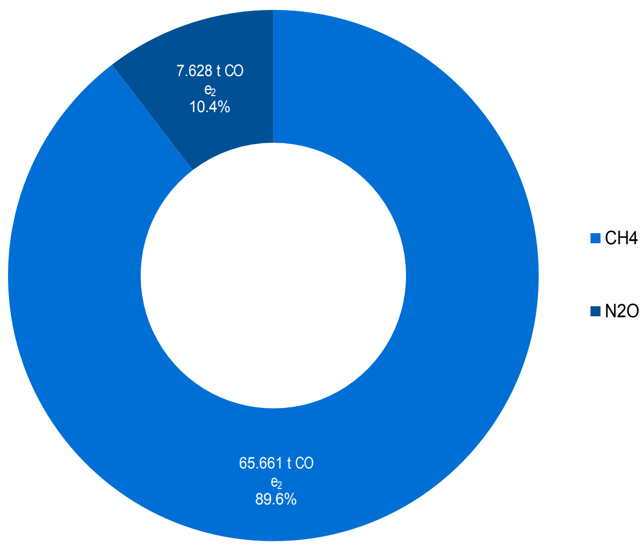


Figure 6.13. GHG emissions from the waste and wastewater sector (2021)

6.1.4.4. Industrial processes and product use

GHG emissions from the industrial processes and product use sector in the municipality of Braga were only 722 tonnes $_{CO2e}$ in 2021, corresponding to 0.001% of total recorded emissions.

These emissions were entirely Scope 1 and related to the use of lubricating products for non-energy purposes, since no industrial activities were identified in the municipality of Braga that trigger emissions from the non-energy use of fuels in the chemical or physical transformation of materials.

6.1.4.5. Agriculture, forestry and other land uses

GHG emissions from the agriculture, forestry and other land use (AFOLU) sector originate from livestock production, land use and land use change, as well as other aggregate emissions, namely from forest fires and the application of fertilisers and soil improvers. This sector also includes important carbon sinks, such as forests.

In 2021, emissions from the AFOLU sector, without accounting for land use, land use change and forestry (LULUCF), totalled around 29,940 t $_{CO2e}$, corresponding to 3.6% of total emissions in the municipality of Braga. Livestock farming, through enteric fermentation and manure management systems, contributed 61.5% (18,418 t $_{CO2e}$) of the sector's emissions and the remaining 38.5% (11,522 t $_{CO2e}$) corresponded to other emissions from aggregate sources, namely forest fires, burning of agricultural waste, application of organic and inorganic fertilisers, incorporation of crop residues into the soil, and indirect emissions from manure management.

Emissions from the AFOLU sector only formed part of Scope 1.

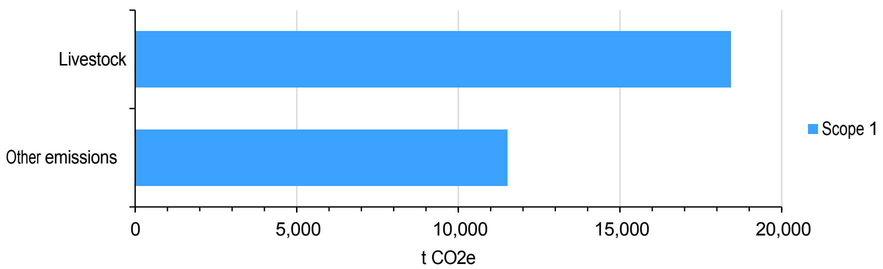


Figure 6.14. GHG emissions from the AFOLU sector, without LULUCF (2021)

In 2021, GHG emissions from the AFOLU sector, without LULUCF, in the municipality of Braga were 60.6 per cent CH_4, 34.6 per cent N2O and 4.8 per cent CO_2, as shown in Figure 6.15.

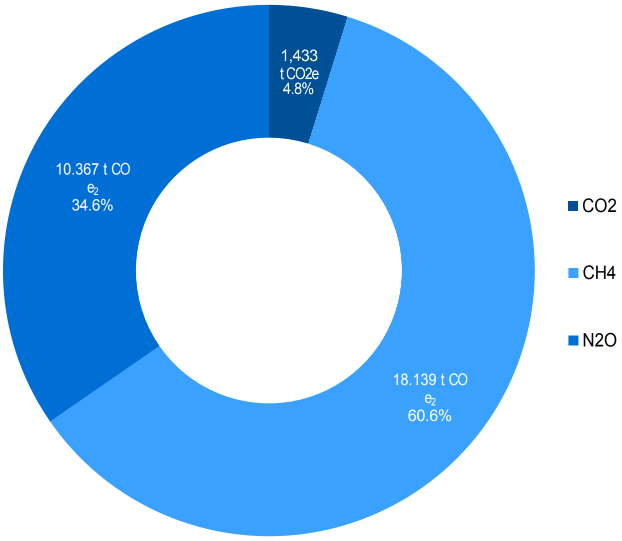


Figure 6.15. Emissions from the AFOLU sector, without LULUCF, by type of GHG (2021)

In 2021, the balance between emissions and removals of carbon from the atmosphere in the land use, land use change and forestry (LULUCF) subsector contributed to an effective removal of 137,796 tonnes of CO_{2e} in the municipality of Braga.

Consequently, in that year, the AFOLU sector (including LULUCF) contributed in terms of net emissions to the removal of 107 856 t CO2e[20] .

[20] The forest's carbon sink capacity is conditioned by the loss of living biomass, specifically through logging. In this inventory, given the lack of information on logging in the municipality of Braga, only the biomass losses attributable to the clear-cutting of the forest area burnt in the previous year (2020) were considered.

6.2 GHG balance projections

Knowledge of greenhouse gas (GHG) emissions is an important tool for analysing and supporting decision-making and, when complemented with emissions projections, provides a comprehensive, forward-looking view of possible development paths and their impacts.

Emissions estimates help formulate policies and measures to mitigate climate change, making it possible to identify opportunities and challenges, consider strategic and operational alternatives, and develop more effective and sustainable policies and investments. Emissions projections also help to increase civic awareness of the impacts of human activities on the global climate, alerting people to the importance of individual and collective action to reduce GHG emissions.

Based on the GHG emissions inventory carried out for the reference year (2021), emissions projections were drawn up for the municipality of Braga for 2050.

The GHG emissions trajectory projection exercise covers all activity in the municipality of Braga, as well as sectoral estimates.

Given the low weight of the industrial processes and product use (IPPU) sector in overall emissions and considering that these result essentially from the use of lubricating products for non-energy purposes, it was decided to draw up projections of GHG emissions for the municipality of Braga with reference to the following sectors:

- Energy and industrial processes;
- Transport;
- Waste and wastewater;
- Agriculture, forestry and other land uses.

6.2.1. Prospective Socioeconomic Scenarios

Prior to the exercise of drawing up projections of GHG emissions in the municipality of Braga, alternative socio-economic evolution scenarios were developed, based on the quantification and analysis of biophysical and socio-economic indicators and sectoral strategic goals and objectives that could influence emissions trajectories.

The process of constructing the socio-economic scenarios included:

- Identification of the dynamics or activities that contribute to the main sources of GHG emissions or sequestration;
- Synthetic analysis of the current situation, in particular the driving forces (e.g. planning instruments, sectoral policies, structuring investments) of the sectors that generate the greatest growth.
  GHG emissions or removals;
- Identification, quantification and synthetic analysis of exogenous variables whose evolution may affect GHG emissions and sink capacity, namely indicators
  demographic and socio-economic trends, public policy options, investments, technological advances and consumer preferences that are expected for the municipality and the sectors covered.

As a result, three prospective socio-economic scenarios were conceived, representing different socio-economic development processes in the municipality of Braga in the 2050 timeframe, namely a scenario of maintaining economic and social routines (*business-as-usual*) and two extreme scenarios, one assuming economic and social stagnation, and the other characterised by significant structural change in the context of sustainable development.

Table 6.6. Description of the prospective socio-economic scenarios

C1 Stagnation	It considers that the essentials of production structures, mobility patterns and consumption habits have been maintained, without innovation or an increase in decarbonisation policies, which translates into an economy that is losing competitiveness, stagnating or going into recession, along with a slight demographic decline, the result of a tendentially negative natural balance and a lack of capacity to retain an active population and attract migration.
C2 Moderate growth	It foresees the maintenance of economic and social routines, without significant changes in production structures, mobility patterns and consumption habits, with a modest incorporation of circular economy and decarbonisation models in the context of the policies already adopted or in force, and a measured commitment to innovation and technology, resulting in an economy with competitiveness problems and moderate economic growth, accompanied by the stabilisation of the population, as a result of a tendency towards zero natural balance and an unstable migration balance.
C3 Smart development	It is characterised by a structural and transversal change in production processes, the generalisation of sustainable mobility patterns and a change in lifestyle, embodied in an increasingly innovative, circular, decarbonised and technological economy, which is highly competitive, generates economic growth and promotes the attractiveness of the territory, in terms that enable demographic growth, through a tendentially positive natural balance and the strengthening of the migratory balance.
C4 Carbon neutrality	It assumes the same socio-economic evolution assumptions as scenario C3 - Intelligent Development, but intensifies the mitigation capacity (reduction of GHG emissions) through technological evolution and a significant increase in sink capacity in the territory.

The scenario period was divided into six sub-periods (2021-2025, 2026-2030, 2031-2035, 2036-2040, 2041-2045 and 2046-2050), for which the following indicators were considered for each of the different scenarios:

- Resident population;
- Gross Domestic Product (GDP);
- Structure of Gross Value Added (GVA);
- Stationary energy consumption;
- Transport;
- Waste production and treatment;
- Animal production;
- Land use structure.

The projections of the variables considered in drawing up the GHG emissions trajectories, accounted for in each of the indicators, scenarios and sub-periods established, are set out in **Annex AII** of this report.

Since it is not possible to achieve carbon neutrality through the C3 scenario, a supplementary scenario (C4 - carbon neutrality) was developed, which assumes an increase in the reduction of GHG emissions by 0.5 percentage points per year for all sectors, starting in 2025, as well as a significant reinforcement of the carbon sink capacity, through the doubling of the forest area in the municipality of Braga, by the year 2050. The demands of this C4 scenario show the difficulty of the municipal path to achieving a zero net emissions balance

6.2.2. GHG Balance Projections

Table 6.4 shows the projections of GHG emissions in the municipality of Braga, by sector and by scenario, up to 2050.

Table 6.7. Projections of GHG emissions for the municipality of Braga up to 2050

Sectors	Inventory 2021	Scenario	2025	2030	2035	2040	2045	2050
Energy and industrial processes	335 618	C1	333 536	328 897	322 549	315 986	308 929	305 117
		C2	340 883	339 062	339 736	336 112	335 422	335 376
		C3	317 070	293 380	263 373	234 031	205 286	178 587
		C4	315 485	284 031	247 874	214 064	182 425	154 131
Transport	382 688	C1	380 417	348 030	315 949	285 995	265 657	237 399
		C2	385 440	359 373	298 343	248 862	208 563	175 555
		C3	365 903	285 453	193 291	113 298	70 429	44 246
		C4	364 073	274 912	179 270	100 606	60 022	36 205
Waste and wastewater	73 289	C1	74 901	74 664	74 332	73 732	73 083	71 826
		C2	75 499	76 400	76 187	75 893	74 939	74 497
		C3	74 865	74 028	73 720	73 279	71 492	69 768
		C4	74 491	71 794	69 698	67 537	64 201	61 049
Agriculture, forestry and other land uses	- 107 856	C1	- 93 945	- 83 871	- 82 783	- 74 449	- 65 338	- 65 166
		C2	- 91 146	- 74 558	- 82 791	- 60 361	- 51 960	- 47 596
		C3	- 101 332	- 107 050	- 119 577	- 122 067	- 124 599	- 133 665
		C4	- 101 505	- 122 250	- 152 332	- 179 520	- 210 882	- 251 410

Sectors	Inventory 2021	Scenario	2025	2030	2035	2040	2045	2050
Total net emissions (with LULUCF)	683 739	C1	694 908	667 720	630 048	601 263	582 331	549 176
		C2	710 676	700 277	631 475	600 506	566 964	537 832
		C3	656 506	545 811	410 807	298 541	222 608	158 936
		C4	652 544	508 487	344 509	202 688	95 766	- 25
Land use, land use change and forestry (LULUCF)	- 137 796	C1	- 130 914	- 122 860	- 118 497	- 111 525	- 104 440	- 100 999
		C2	- 128 111	- 113 540	- 109 644	- 97 422	- 91 043	- 83 405
		C3	- 135 956	- 142 125	- 151 159	- 154 184	- 157 305	- 163 039
		C4	- 135 956	- 156 288	- 1 82 091	- 209 077	- 240 242	- 277 046
Total emissions (without LULUCF)	821 535	C1	825 821	790 580	748 545	712 788	686 771	644 235
		C2	838 787	813 817	749 969	697 928	658 007	621 237
		C3	792 462	687 936	561 966	452 725	379 913	321 975
		C4	788 500	664 775	526 600	411 765	336 008	277 021

Figure 6.16 shows the modelled trajectories of total GHG emissions, with and without LULUCF, in the municipality of Braga for the scenario period.

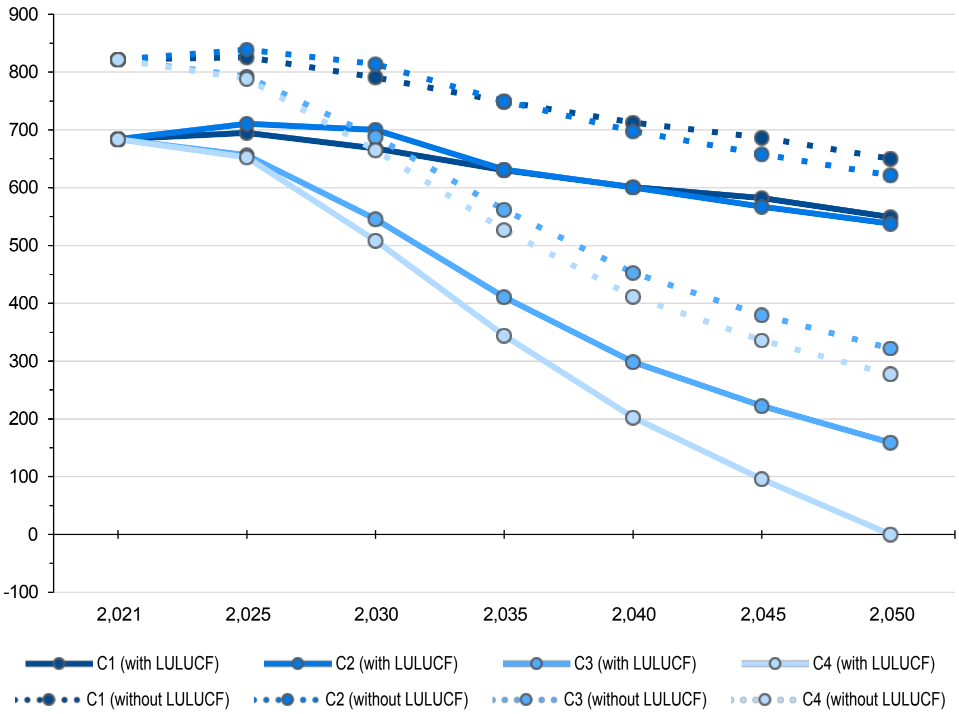


Figure 6.16. GHG emission trajectories for the municipality of Braga

In turn, **Figure 6.17** illustrates the contributions of the various sectors to the GHG emissions trajectories in the municipality of Braga.

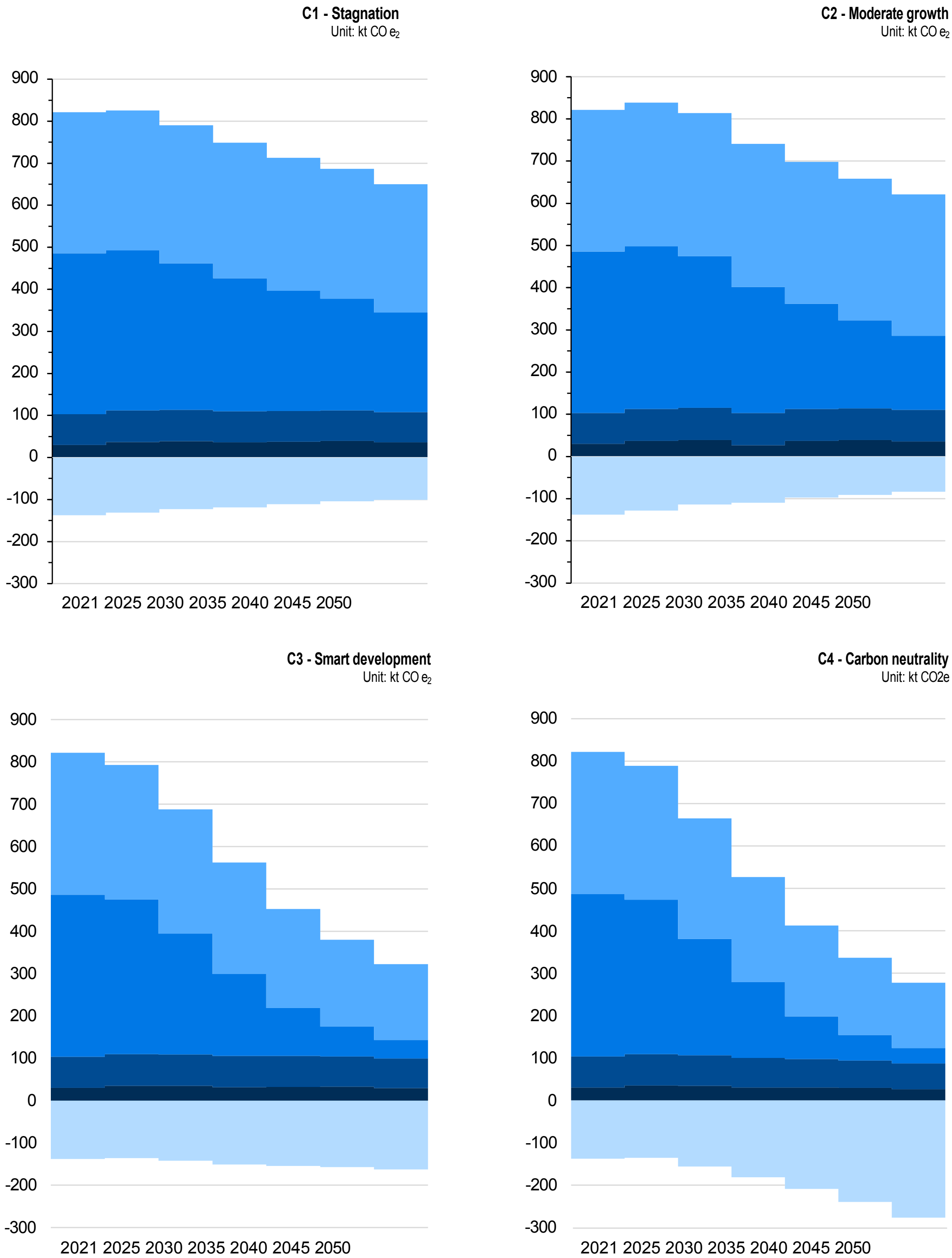


Figure 6.17. Contribution by sector to GHG emission trajectories in the municipality of Braga

In all scenarios, GHG emission reduction trajectories are identified in the municipality of Braga, which are much more pronounced in C3 than in C1 and C2. The additional scenario C4 corresponds to a path towards carbon neutrality. It is clear from the exercise that the processes of decarbonising road transport and reducing the carbon intensity of electricity production, with the consequent reduction in the use of fossil fuels, have a significant impact on the modelled trajectories in all scenarios, giving special relevance to the Transport and Energy sectors.

The contribution of the waste and wastewater sector does not show significant changes in the modelled trajectories for most scenarios, representing a slight increase in emissions in scenario C2, due to the projected increase in the resident population.

The AFOLU sector is the least significant in terms of gross GHG emissions in the municipality of Braga, with negative net emissions due to the contribution of the LULUCF subsector, a situation that is maintained throughout the scenario period, although with different trajectories in the various scenarios, i.e. with a tendency for removal capacity to decrease in scenarios C1 and C2 (more marked in C2) and to increase in scenarios C3 and C4 (in the latter with greater intensity).

The trajectories of GHG emissions are very similar in scenarios C1 and C2, although shaped by substantially different factors. The evolution of emissions in the C1 scenario is essentially conditioned by the reduction in the resident population, the slight recession in economic activity and, above all, the decarbonisation of road transport, taking into account, in particular, the provisions of the Basic Climate Law regarding the end of the sale in Portugal of new light vehicles powered exclusively by fossil fuels. The emissions trajectory in the C2 scenario is shaped by the sustainability strategies and policies in force, with a focus on decarbonising road transport, which makes it possible to reduce net GHG emissions, albeit modestly, even in the context of a slight increase in the resident population and positive macroeconomic indicators.

The scenarios carried out allow us to conclude, with ample certainty and as shown in scenarios C3 and C4, that an effective decarbonisation process cannot fail to be associated with the intensification and generalisation of sustainability policies and a technological reconfiguration that ensures future competitiveness and sustainability in critical sectors such as energy, mobility, water resources, land use, forests and biodiversity. The fight against climate change is therefore an opportunity to energise territories of environmental, scientific and technological quality, with the capacity to settle people and attract migratory movements, generating effective development and wealth.

7. Climate Impacts and Vulnerabilities

In order to determine and assess climate risks, the conceptual risk model was applied, highlighting some fundamental elements: Hazard, understood as the probability of occurrence (assessed qualitatively or quantitatively) of a phenomenon with a given magnitude (to which a potential for destruction is associated), in a given period of time and in a given area; Elements at risk (or Vulnerable Elements), represented by the population, equipment, property and vulnerable economic activities in a territory; and Vulnerability, corresponding to the degree of loss of an element or set of vulnerable elements, resulting from the occurrence of a phenomenon (natural or human-induced) with a given magnitude or intensity. In this context, risk is understood as the probability of occurrence of a specific effect causing serious damage to humanity and/or the environment, in a given period and under given circumstances. In other words, risk expresses the possibility of occurrence, and the corresponding quantification in terms of costs, of serious consequences, economic or even for the safety of people, as a result of the triggering of a natural phenomenon or one induced by human activity.

The quantitative risk assessment is obtained by multiplying the hazard by the vulnerability and the value of the elements at risk - R = P * V * E (**Figure 7.1**).

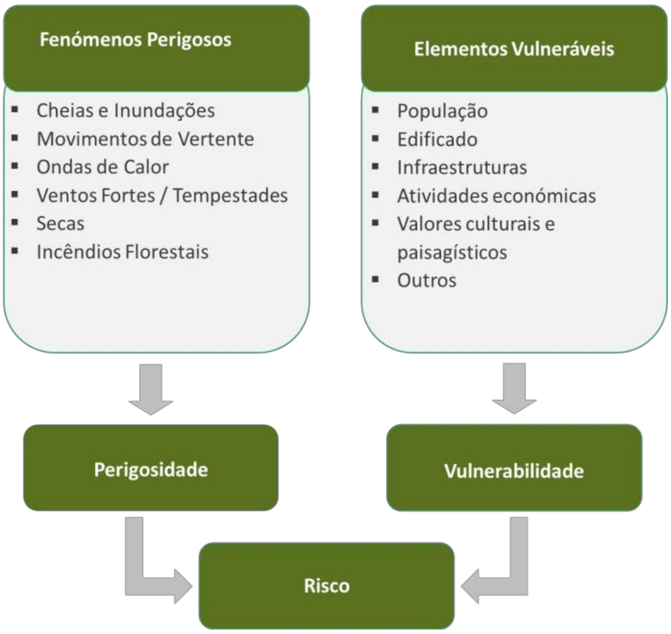


Figure 7.1 Conceptual risk model

Source: adapted from Panizza, 1990

It is considered like this:

- **Hazard (P)** - Probability of occurrence (assessed qualitatively or quantitatively) of a phenomenon of a certain magnitude (with associated potential for destruction),
  in a given period of time and in a given area (Zêzere, 2007; Julião et al., 2009);
- **Vulnerability (V)** - The degree of loss of a vulnerable element or set of elements, resulting from the occurrence of a phenomenon (natural or human-induced) with a specific
  magnitude or intensity. Vulnerability, V, therefore represents the degree of potential damage or loss to an element or set of elements as a result of the occurrence of a phenomenon of a certain intensity. It depends on the characteristics of the element in question (not its economic value) and the intensity of the phenomenon. Its value varies between 0 (no damage) and 1 (total loss or destruction of the element) (Zêzere, 2007; Julião et al., 2009).
- **Risk (R)** - Probability of occurrence of a dangerous process or phenomenon and respective estimation of its consequences on people, goods or the environment, expressed in damage.
  bodily injury and/or direct or indirect material and functional damage (Julião *et al*., 2009).

7.1 Current Climate Impacts and Vulnerabilities

Developing this component involves integrating information from the characterisation and diagnosis and climate characterisation and scenario phases, interpreting it from the perspective of identifying and assessing climate risks, with the identification of current impacts and vulnerabilities for the territory and socio-economic activities (**Figure 7.2**).

Research was also carried out into the impacts and respective consequences recorded by the media and in municipal databases.

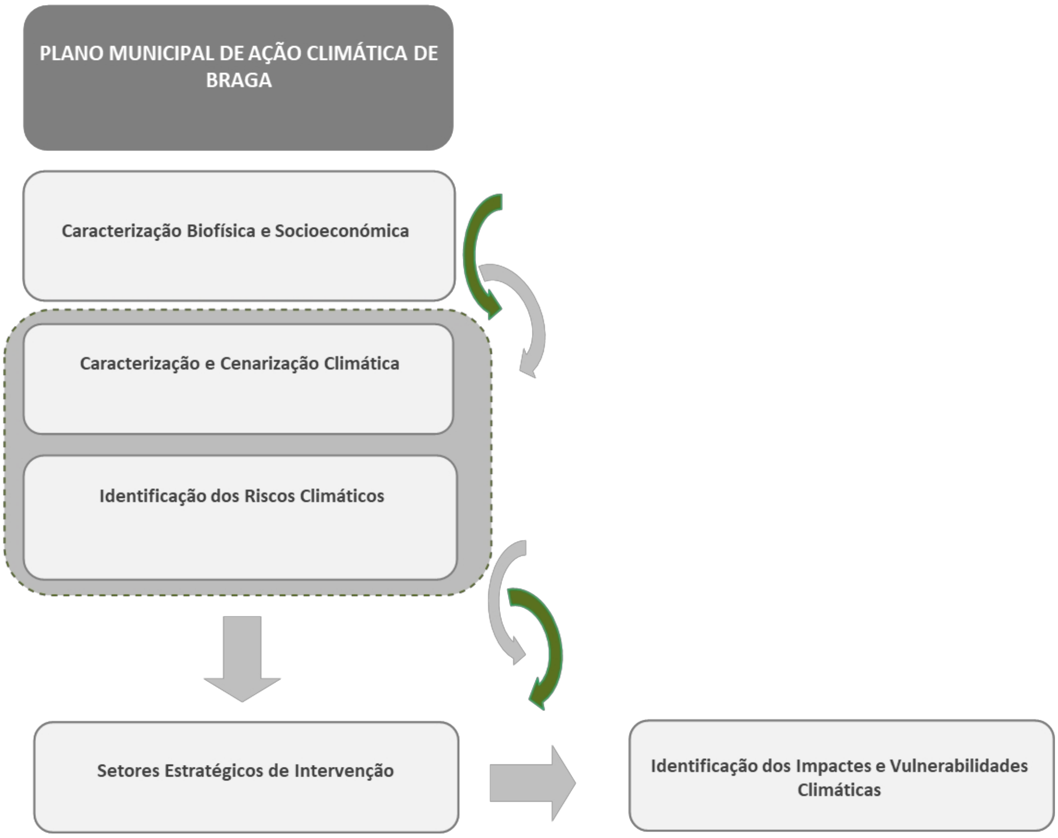


Figure 7.2. Conceptual model for identifying impacts and vulnerabilities

Currently, the most relevant climate risks identified in the municipality of Braga are:

- Heat waves
- Droughts
- Floods
- Slope movements
- Extreme Meteorological Phenomena
- Forest fires

7.1.1 Current Impacts and Vulnerabilities by Adaptation Sector

7.1.1.1 Ecosystems and Biodiversity

Climate change has consequences for biodiversity and ecosystems, which are often fuelled by other pressures exerted on those same ecosystems, such as an increase in the density of invasive species, degradation, fragmentation or even the disappearance of native *habitats*, pollution, among others.

In this context, the disappearance or degradation of ecosystems reduces their capacity to capture and store carbon. If the climate system reaches irreversibility thresholds and climate change is unpredictable, this could lead to potential situations in which ecosystems are unable to respond due to a loss of resilience, which will have particular consequences in terms of transforming these reservoirs/transformers into carbon sources.

It is also important to emphasise the importance of maintaining biodiversity as well as the genetic and specific diversity of ecosystems which, by ensuring the existence of a variety of species sufficient to sustain ecological processes in the event of unforeseen disturbances, increases their resilience. This is particularly pertinent when it comes to maintaining the various services that ecosystems provide, particularly with regard to the ecosystems that interconnect the terrestrial and aquatic environments and how these ecosystems maintain their diversity and interconnection and their intrinsic response to the phenomena associated with climate change.

In line with the climate risks analysed above, the main current impacts on Braga's ecosystems and biodiversity are identified (**Table 7.1**).

Table 7.1. Main current impacts in the Ecosystems and Biodiversity sector

Climate Risks	Current direct and indirect impacts
Floods	▪ Damage to vegetation and changes in biodiversity; ▪ Soil loss and degradation; ▪ Degradation, fragmentation or even the disappearance of native habitats
Slope movements	▪ Damage to vegetation; ▪ Soil loss and degradation; ▪ Degradation, fragmentation or even the disappearance of native habitats
Heat waves	▪ Increased pressure on ecosystems and natural resources; ▪ Degradation, fragmentation or even the disappearance of native habitats ▪ Changes in the distribution, abundance or survival of certain species that are more sensitive to the effect of diminishing water reserves; ▪ Reduced productivity of certain agricultural crops due to water shortages, with consequent impacts on the local and regional economy on the one hand and on the other nature tourism by de-characterising the associated landscape; ▪ Increased occurrence and severity of forest fires.
Extreme Phenomena (Strong Winds / Storms)	▪ Damage to vegetation ▪ It could contribute to an increase in the number of trees falling, with possible consequences for the population, property and road traffic restrictions. public;
Droughts	▪ Soil loss and degradation; ▪ Degradation, fragmentation or even the disappearance of native and endemic habitats.
Forest Fire	▪ Damage to the environment, with loss of flora and fauna, ▪ Damage to ecosystem services and changes in biodiversity.

Table 7.2 summarises the current vulnerabilities to the risks identified for the Ecosystems and Biodiversity sector.

Table 7.2. Vulnerabilities to climate risks identified in the Ecosystems and Biodiversity sector

Climate Risks	Vulnerabilities
Floods	▪ Natural values and ecosystems
Slope movements	▪ Natural values and ecosystems
Heat waves	▪ Natural values and ecosystems
Extreme Phenomena (Strong Winds / Storms)	▪ Natural values and ecosystems
Droughts	▪ Increased pressure on ecosystems and natural resources; ▪ Soil ▪ Agricultural areas
Forest Fire	▪ Services provided by ecosystems; ▪ Natural values and ecosystems

7.1.1.2 Water Resources

In line with the climate risks identified above, the main current impacts on Braga's water resources are identified (**Table 7.3**).

Table 7.3. Main current impacts on the Water Resources sector

Climate Risks	Current direct and indirect impacts
Floods	▪ Damage to infrastructure; ▪ Damage to economic activities with unquantified losses; ▪ Potential human impact.
Slope movements	▪ Deterioration of water quality.
Heat waves	▪ Droughts and deteriorating water quality.
Extreme Phenomena (Strong Winds / Storms)	▪ Increased occurrences of flooding; ▪ Damage to infrastructure.
Droughts	▪ Deterioration of water quality; ▪ Reduced water availability.
Forest Fire	▪ Deterioration of water quality.

Table 7.4 summarises the current vulnerabilities to the risks identified for Water Resources.

Table 7.4. Current climate vulnerabilities in water resources

Climate Risks	Vulnerabilities
Floods	▪ Population: around 26,000 people potentially affected in the parishes of Priscos; União das Freguesias de Celeirós, Aveleda e Vimeiro; Esporões; União das Freguesias de Celeirós, Aveleda e Vimeiro. Parishes of Lomar and Arcos; Union of Parishes of Braga (São José de São Lázaro and São João do Souto); Union of Parishes of Ferreiros and Gondizalves; Union of Parishes of Real, Dume and Semelhe; Union of Parishes of Merelim (São Pedro) and Frossos; Union of Parishes of Merelim (São Paio), Panóias and Parada de Tibães; Mire de Tibães; Padim da Graça; ▪ Petrol station: - Cepsa (Rua Padre Cruz). ▪ Educational establishments: - Dierum - Early Childhood Education; - EB1/JI de Ponte Pedrinha; - Kindergarten at the Celeirós Social Centre. ▪ State administration - Celeirós Parish Council.
Movements of strand	▪ Population; ▪ Economic activities.
Heat waves	▪ Population; ▪ Economic activities.
Extreme Phenomena (Strong Winds / Storms)	▪ Population; ▪ Economic activities.
Droughts	▪ Population; ▪ Economic activities.
Fire Forestry	▪ Population; ▪ Economic activities

7.1.1.3 Agriculture

In line with the climate risks identified above, **Table 7.5** identifies the main current impacts on agriculture in the municipality of Braga.

Table 7.5. Main impacts on Agriculture

Risks Climate	Current direct and indirect impacts
Floods	▪ Loss of crops and reduced yields; ▪ The occurrence of floods on agricultural land directly affects agricultural production, leading to the destruction of crops and the waterlogging of land during critical seasons, conditioning agricultural activities such as sowing and other cultivation operations.
Movements of strand	▪ No current impacts have been identified as a result of the recording of occurrences;
Heat waves	▪ Anticipation of the start of the vegetative cycle, negatively affecting the quantity and quality of production, including its preservation capacity; ▪ Combined with a reduction in rainfall in spring, this could make it impossible to exploit many of the orchards and even to adopt less demanding crops, whose economic return may be different from the existing one. ▪ Increased water consumption for irrigation, and increased production costs; degradation of water quality due to overexploitation.
Extreme Phenomena (Strong Winds / Storms)	▪ Production breaks and reduced yields.
Droughts	▪ Anticipation of the start of the vegetative cycle, negatively affecting the quantity and quality of production, including its preservation capacity; ▪ Combined with a reduction in rainfall in spring, this could make it impossible to exploit many of the orchards and even to adopt less demanding crops, whose economic return may be different from the existing one. ▪ Increased water consumption for irrigation, and increased production costs; degradation of water quality due to overexploitation.
Forest Fire	▪ Damage to pastures and agricultural land ▪ Loss of ecosystem services

Table 7.6 shows the current vulnerabilities identified for the Agriculture sector.

Table 7.6. Current vulnerabilities for the Agriculture sector

Climate Risk	Vulnerabilities
Floods	▪ Predominant agricultural crops.
Slope movements	▪ Predominant agricultural crops.
Heat waves	▪ Fruit-growing, olive-growing and arable crops, leading to partial or total loss of production
Extreme Phenomena (Strong Winds) / Storms)	▪ Fruit-growing, olive-growing and arable crops, leading to partial or total loss of production
Droughts	▪ Fruit-growing, olive-growing and arable crops, leading to the partial or total loss of crops, production, installations and equipment.
Forest Fire	▪ Predominant agricultural crops. ▪ Fruit-growing, olive-growing and arable crops, leading to the partial or total loss of crops, production, installations and equipment.

7.1.1.4 Tourism

In line with the climate risks identified above, **Table 7.7** identifies the main current impacts on the municipality of Braga in terms of tourism.

Table 7.7. Main current impacts on tourism

Climate Risks	Current direct and indirect impacts
Floods	▪ Affecting tourist facilities and infrastructures: destruction and/or blocking of access routes; interruption of means of communication; ▪ Affecting environmental services.
Movements of strand	▪ Unidentified
Heat waves	▪ Consequences on visitors' sense of thermal comfort; ▪ Rising energy and water bills ▪ Increased occurrence and severity of rural and forest fires.
Extreme Phenomena (Strong Winds / Storms)	▪ It could contribute to an increase in damage to infrastructure and equipment, falling trees, with possible consequences for the population, property and the restriction of traffic on public roads; ▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings and/or contents; ▪ Damage/conditioning to infrastructure (destruction of buildings to support activities/use of cultural heritage);

Climate Risks	Current direct and indirect impacts
	▪ Changes in the use of equipment/services
Droughts	▪ Affecting the profitability of the activity due to increased operating costs; ▪ Increased occurrence and severity of rural and forest fires.
Forest Fire	▪ Changes to the practice of any leisure activity in rural or forest areas, namely trails

Table 7.8 shows the current vulnerabilities identified for the tourism sector.

Table 7.8. Current climate vulnerabilities in tourism

Climate Risks	Vulnerabilities
Floods	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Accommodation units and tourist or transport infrastructures;
Slope movements	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Equipment and infrastructure in higher risk areas; ▪ Tourist resources in a risk area.
Heat waves	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Tourist accommodation establishments.
Extreme Phenomena (Strong Winds / Storms)	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Equipment and infrastructure in higher risk areas; ▪ Tourist resources in a risk area.
Droughts	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Tourist accommodation establishments.
Forest Fire	▪ Natural and cultural heritage; ▪ General public, tourists and visitors; ▪ Loss of services provided by ecosystems.

7.1.1.5 Spatial planning

Climate change is causing changes in the intensity and territorial incidence of risks associated with floods, landslides, high temperatures and heat waves, strong winds and droughts with a strong impact on the territory, generally worsening their frequency and intensity.

In addition, the soil itself is an important element of the climate system, being the second largest "store or sink" of carbon, after the oceans, and its contribution to recharging aquifers should also be emphasised. With changes in land use and occupation due to the type of occupation, but also the reduction in productivity and agricultural and livestock yields, associated with higher temperatures can also increase the decomposition of the soil's organic matter, which not only has an effect on some of its characteristics, such as productivity, but also a faster decomposition of organic matter results in the production of more carbon dioxide, as well as contributing to a reduction in permeability and preventing its role as a filter and conductor of water in the soil.

To this end, **Table 7.9** shows the main current impacts of the climate risks identified above on the land-use planning sector, with a special focus on land classification and use.

Table 7.9. Main current impacts on land use planning

Climate Risks	Current direct and indirect impacts
Floods	▪ Loss of riparian zones; ▪ Damage to the road network with traffic interruptions or restrictions.
Slope movements	▪ Damage to vegetation
Heat waves	▪ Loss of biodiversity in riparian zones and consequent physical alteration of these areas.
Extreme Phenomena (Strong Winds / Storms)	▪ Damage to the road network with traffic interruptions or restrictions; ▪ Damage/conditioning to infrastructure; ▪ Damage to buildings.
Droughts	▪ Loss of biodiversity in riparian zones and consequent physical alteration of these areas; ▪ Decreased water availability.
Forest fires	▪ Degradation or destruction of forest space; ▪ Disturbance of ecosystem dynamics.

Table 7.10 shows the current vulnerabilities identified for the land-use planning sector.

Table 7.10. Current climate vulnerabilities in land use planning

Climate Risks	Vulnerabilities
Floods	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Slope movements	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Heat waves	▪ Population; ▪ Built;
Extreme Phenomena (Strong Winds / Storms)	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Droughts	▪ Population; ▪ Agricultural land.
Forest fires	▪ Built; ▪ Population; ▪ Forest areas;

7.1.1.6 Industry

In line with the climate risks identified above, **Table 7.11** identifies the main current impacts in the municipality of Braga, in terms of Industry.

Table 7.11. Main current impacts on Industry

Climate Risks	Current direct and indirect impacts
Floods	▪ They can jeopardise the physical and operational integrity of critical infrastructures, such as the electricity grid, telecommunications, and supply and distribution infrastructures. sanitation, waste, civil protection, among other infrastructures, urban equipment and buildings.
Slope movements	▪ No current impacts were observed
Heat waves	▪ Affects workers' health due to high temperatures and lack o f cooling or heating in the buildings where work is carried out. business activities.
Extreme Phenomena (Strong Winds / Storms)	▪ Temporary discontinuation of essential public services (water and electricity)
Droughts	▪ Affectation of some business activities.
Forest Fire	▪ They can jeopardise the physical and operational integrity of critical infrastructures, such as the electricity grid, telecommunications, and supply and distribution infrastructures. sanitation, waste, civil protection, among other infrastructures, urban equipment and buildings.

Table 7.12 shows the current vulnerabilities identified for the Industry sector.

Table 7.12. Current climate vulnerabilities in Industry

Climate Risks	Vulnerabilities
Floods	▪ Industrial buildings; ▪ Communications.
Slope movements	▪ Unidentified
Heat waves	▪ Workers.
Extreme Phenomena (Strong Winds / Storms)	▪ Industrial buildings; ▪ Communications; ▪ Workers.
Droughts	▪ Food industry
Forest Fire	▪ Industrial buildings; ▪ Communications; ▪ Workers.

7.1.1.7 Infrastructure

In line with the climate risks identified above, **Table 7.13** identifies the main current impacts in the municipality of Braga, in terms of infrastructure.

Table 7.13. Main impacts on infrastructure

Climate Risks	Current direct and indirect impacts
Floods	▪ Traffic restrictions; ▪ Power supply failures; ▪ Possible damage to the integrity of wastewater sanitation infrastructures located in areas of high susceptibility to flooding or inundation, with consequent an increase in the risk of accidental contamination or pollution of the natural environment and the risk of a breakdown in service and a reduction in levels of habitability and social conditions; ▪ Possible damage to the integrity of water supply networks and infrastructures located in areas of high susceptibility to flooding or inundation, with consequent increased risk of service breakdown and reduced levels of habitability and social conditions; ▪ Possible threat to the integrity of and damage to social, security and civil protection equipment located in the flooded area, with a consequent increase in the risk of breakage of the service or reduced levels of safety, service provision and social conditions;
Slope movements	▪ Damage to the integrity and operability or reduction in safety levels of road communication routes due to landslides (**Figure 7.3**); ▪ Damage to the integrity and operation of water supply, energy distribution and telecommunications networks and infrastructures (**Figure 7.3**), with consequent

Climate Risks	Current direct and indirect impacts
	the existence of a risk of service breakdown and a reduction in levels of safety, habitability and social conditions; ▪ Possible damage to the integrity and operation of social facilities, with the consequent risk of service breakdown and reduced levels of safety and security. social conditions. For example, a day and night centre was detected in the parish of Fraião, Nogueira and Lamaçães, coinciding with an area at risk of slope movement (**Figure 7.3**); ▪ Possible damage to the integrity of wastewater infrastructure (**Figure 7.3**), with the consequent risk of contamination or accidental pollution of the natural environment;
Heat waves	▪ Damage to the integrity and operability or reduction in safety levels of road communication routes, due to the indirect risk of rural fires (**Figure** **7.4**); ▪ Possible damage to water and energy distribution, gas or telecommunications infrastructures due to high temperatures or indirect risk of rural fire (**Figure** **7.4** and **Figure 7.5**); ▪ Increased indirect risk of fire or degradation of thermal comfort conditions in social, civil protection or public safety facilities (**Figure 7.4** and **Figure 7**.5). **Figure 7.5**), with a consequent increase in the risk of reduced living conditions and service provision. Possible increase in energy consumption to mitigate thermal discomfort.
Extreme Phenomena (Strong Winds / Storms)	It was not possible to georeference the risk of strong winds and storms, but in the event of this type of extreme weather event, it is possible to list a number of expected impacts: ▪ Damage to airport infrastructure (aerodrome) and reduced operating conditions; ▪ Damage to energy distribution or telecommunications infrastructures due to strong wind or storms; ▪ Damage to the integrity of health, social support and education infrastructures or equipment, civil protection and public safety, with a consequent increase in the risk of breakdown of service and reduced levels of safety, service provision and social conditions; ▪ Worsening public safety conditions in areas with a higher risk of strong wind or storms. ▪
Droughts	▪ Increased risk of deterioration of operating and living conditions in social, civil protection or public safety facilities as a result of the possible need to implement restrictions on the use of water in extreme drought situations, with a consequent increase in the risk of reducing the conditions for providing these services.
Forest Fire	▪ Health facilities, social support and education, civil protection and public safety;

Climate Risks	Current direct and indirect impacts
	▪ Road infrastructure; ▪ Supply, sanitation and waste management infrastructures; ▪ Electricity production and distribution infrastructures; ▪ Telecommunications infrastructures.

Currently, there are extreme weather events that can cause damage to the infrastructure or equipment identified for each climate risk. It is important to highlight the foreseeable damage to the road network due to the occurrence of possible floods or slope movements that could affect public safety on the road network and accessibility to the population, especially in emergency situations.

There are other infrastructures, networks and equipment that normally coincide with the road network, such as telecommunications, electrical, water supply or sanitation infrastructures, which could be affected in the same way, in terms of their integrity and operability, which could affect the provision of the respective service. Furthermore, these infrastructures could also be particularly vulnerable to storms and high temperatures (heatwaves), which could cause significant damage. It was not possible to assess the risks associated with the waste management infrastructure (Ecoparque da Braval) as it is partially outside the intervention and administrative area of the municipality of Braga and the climate risk areas, as can be seen in **Figure 7.6**, **Figure 7.7** and Figure 7.**8**.

In terms of collective facilities for healthcare, social support and education, as well as civil protection and public safety, some facilities coincide with the risks of slope movements, high temperatures or heat waves, and fire, which could have a significant impact on their integrity and operation. Nonetheless, and taking into account any gaps in geographical information, the expected occurrence of risks to the integrity and operation of this equipment in storms, floods and droughts should not be ruled out. The occurrence of extreme drought events could induce risks of inoperability in social, civil protection and public safety facilities, due to the possible occurrence o f situations of thermal discomfort or restrictions on the use of water, which could affect the practice of these activities or services.

Airport infrastructures (aerodromes) could be affected in their operation essentially by storms.

Table 7.14 shows the current climate vulnerabilities identified for the Infrastructure sector, which refers to the exposed (vulnerable) elements in each type of climate hazard that presents a high (or higher) risk.

Figure 7.3, **Figure 7.4** and **Figure 7.5** show geographical information on the location of the exposed elements available in relation to the risk maps for landslides, high temperatures (heat waves) and rural fires, respectively. The content presented is limited to the geographical information available.

Table 7.14. Current climate vulnerabilities in infrastructures

Climate Risks	Vulnerabilities
Floods	▪ Health facilities, social support and education, civil protection and public safety; ▪ Road infrastructure; ▪ Supply and sanitation infrastructures; ▪ Electrical distribution infrastructures; ▪ Telecommunications infrastructures.
Slope movements	▪ Road infrastructure; ▪ Social facilities; ▪ Supply and sanitation infrastructures; ▪ Electrical distribution infrastructures; ▪ Telecommunications infrastructures.
Heat waves	▪ Road infrastructure; ▪ Health facilities, social support and education, civil protection and public safety; ▪ Water and energy distribution, gas or telecommunications infrastructures.
Extreme Phenomena (Strong Winds / Storms)	▪ Health facilities, social support and education, civil protection and public safety; ▪ Airport infrastructures (aerodrome); ▪ Electrical distribution infrastructures; ▪ Telecommunications infrastructures.
Droughts	▪ Health facilities, social support and education, civil protection and public safety.

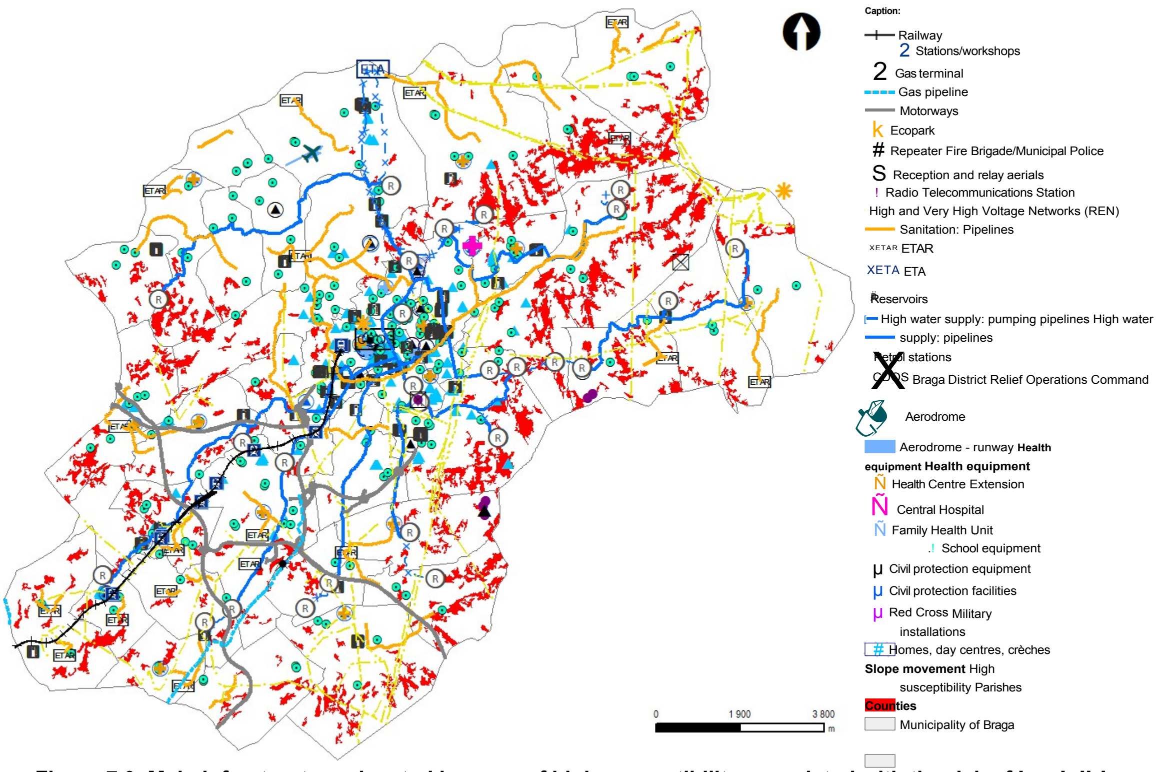


Figure 7.3. Main infrastructures located in areas of high susceptibility associated with the risk of landslides

Source: CM Braga, 2023.

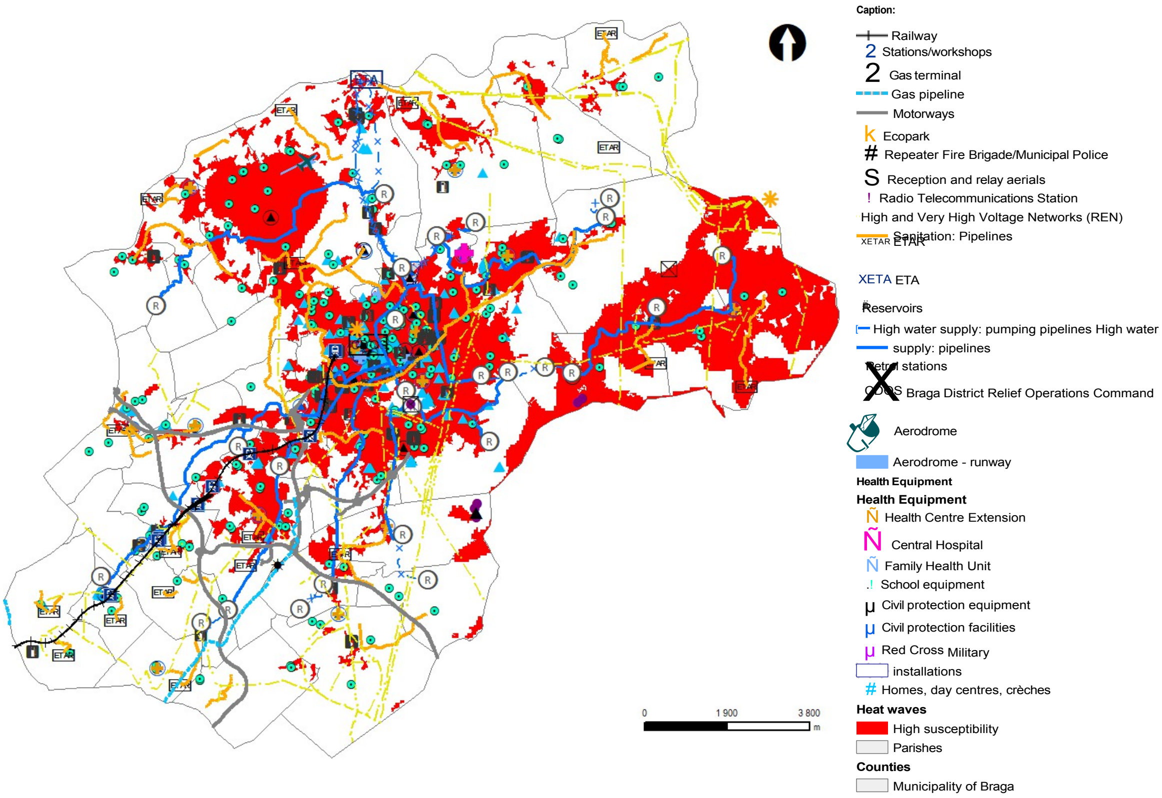


Figure 7.4. Main infrastructures located in areas of high susceptibility associated with the risk of high temperatures and heat waves

Source: CM Braga, 2023.

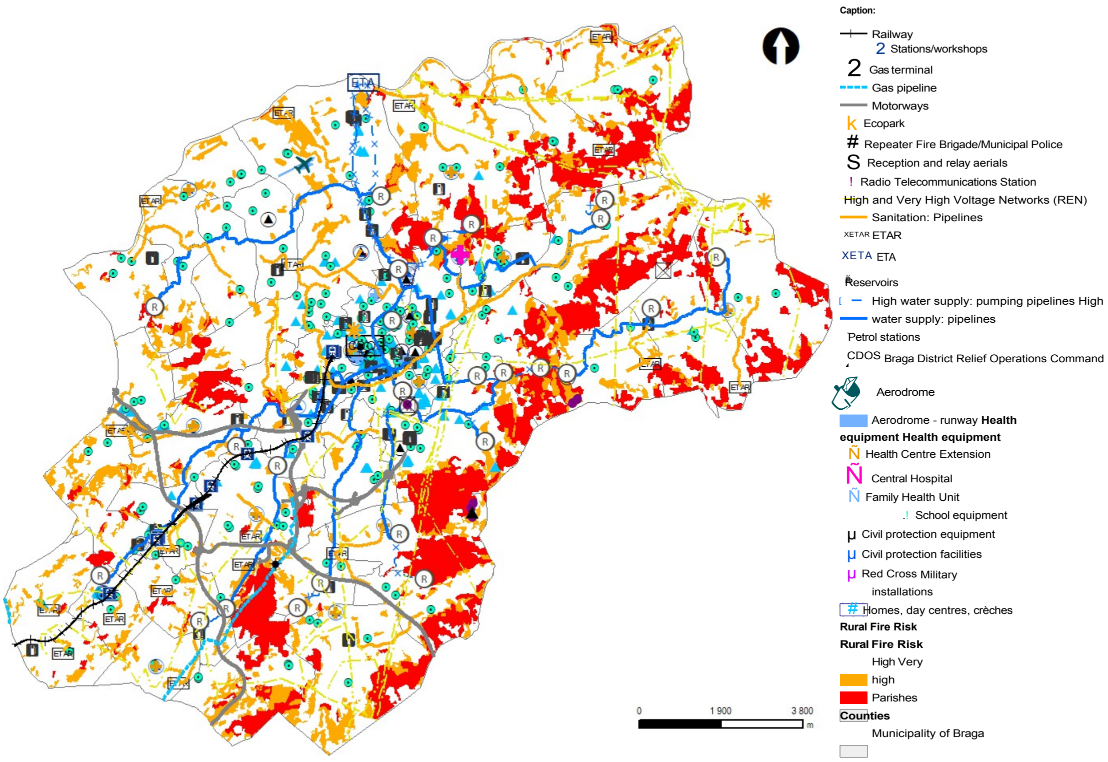


Figure 7.5. Main infrastructures located in areas of high and very high rural fire risk

Source: CM Braga, 2023.

7.1.1.8 Human Health and Safety of People and Goods

Climate change is expected to have a significant impact on the population's quality of life and health, both in terms of extreme weather events and gradual changes in living conditions and territorial characteristics. Population characteristics such as age, health, physiology, living conditions, among others, are factors that condition the population's vulnerability to climate change and, consequently, its ability to adapt.

The rise in temperature, which in some situations is translated into heat waves, has a direct impact on human health, namely because it requires an extra thermoregulatory effort on the part of individuals in order to achieve thermal comfort.

With the increase in the magnitude and intensity of extreme heat peaks or heat waves, it is expected that there will be greater morbidity and/or mortality from heat-related illnesses (dehydration, fatigue and heat strokes), which will be more severe in the population with less protective capacity, such as the elderly, children or non-acclimatised tourists.

As far as aerobiological agents are concerned, phenomena resulting from climate change may have an impact on key factors for their season of occurrence, as well as their concentration levels - for example, there may be changes in the season of occurrence and in the quantity of pollens, an important factor for respiratory diseases.

As far as fungal spores are concerned, warmer and drier weather increases the risk of these agents and their harmful effects on health.

Habitat disturbance can cause predictable changes in biodiversity and the taxonomic composition of potential pathogen hosts that affect human health.

Mammal species that harbour more pathogens in general (shared by humans or not) are more likely to occur in ecosystems under anthropogenic action.

The destruction of natural ecosystems thus favours species that are more likely to cause disease. Although it hasn't been proven in relation to COVID-19, climate change may drive the emergence of pandemics due to the increase in global greenhouse gas emissions over the last century, which are driving a large-scale change in vegetation types.

The loss of biodiversity has an impact on outbreaks of infectious diseases and as a result of changes in temperature and levels of sunlight and carbon dioxide, these natural habitats can evolve into more tropical habitats, these environments being more suitable for host species of pathogens and giving rise to the more frequent occurrence of pandemics.

According to some studies, as climate change modifies habitats, species migrate, taking viruses with them. This not only alters the regions where the viruses are now present, but will most likely enable new interactions between animals and viruses.

In line with the climate risks identified above, **Table 7.15** shows the main current impacts in the municipality of Braga in terms of Human Health and the Safety of People and Goods.

Table 7.15. Main impacts on Human Health and the Safety of People and Goods

Climate Risks	Current direct and indirect impacts
Floods	▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings; ▪ Damage/conditioning to infrastructure; ▪ Changes in the use of equipment/services.
Slope movements	▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings; ▪ Damage/conditioning to infrastructure; ▪ Changes in the use of equipment/services.
Heat waves	▪ Increased thermal discomfort, particularly with extra thermoregulatory effort; ▪ Degradation of air quality;
Extreme Phenomena (Strong Winds / Storms)	▪ Increased instances of falling trees, ▪ Landslides and slopes; ▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings; ▪ Damage/conditioning to infrastructure; ▪ Changes in the use of equipment/services.
Droughts	▪ Degradation of air quality.
Forest Fire	▪ Burnt buildings / infrastructure; ▪ Damage to communication and other routes; ▪ Damage/conditioning to infrastructure; ▪ Degradation of air quality.

Table 7.16 shows the current vulnerabilities identified for the Human Health and Safety of Persons and Goods sector.

Table 7.16. Current Vulnerabilities in Human Health and the Safety of People and Goods

Climate Risks	Vulnerabilities
Floods	▪ General population ▪ Equipment ▪ Road infrastructure, communications ▪ Infrastructure and energy supply
Slope movements	▪ General population ▪ Equipment ▪ Road infrastructure, communications ▪ Infrastructure and energy supply
Heat waves	▪ General population ▪ Equipment
Extreme Phenomena (Strong Winds / Storms)	▪ General population ▪ Equipment ▪ Road infrastructure, communications ▪ Infrastructure and energy supply
Droughts	▪ General population
Forest Fire	▪ General population

7.1.2. Identification of Vulnerable and Priority Intervention Zones

This chapter identifies the main climate vulnerabilities to which the municipality is already exposed, with particular attention to the location of the areas particularly affected and potentially prioritised in terms of intervention.

7.1.2.1 Floods

According to the impacts and vulnerabilities identified above, the areas where flooding occurs generally correspond to the parishes of Priscos; União das Freguesias de Celeirós, Aveleda e Vimeiro; Esporões; União das Freguesias de Lomar e Arcos; Union of the Parishes of Braga (São José de São Lázaro and São João do Souto); Union of the Parishes of Ferreiros and Gondizalves; Union of the Parishes of Real, Dume and Semelhe; Union of the Parishes of Merelim (São Pedro) and Frossos; Union of the Parishes of Merelim (São Paio), Panóias and Parada de Tibães; Mire de Tibães and Padim da Graça.

In **Figures 7.1.6**. and **7.1.7**. you can see details of the most vulnerable zones in terms of

Exposure to the risk of flooding in terms of population, housing, educational establishments, state administration buildings and some sections of municipal and regional roads.

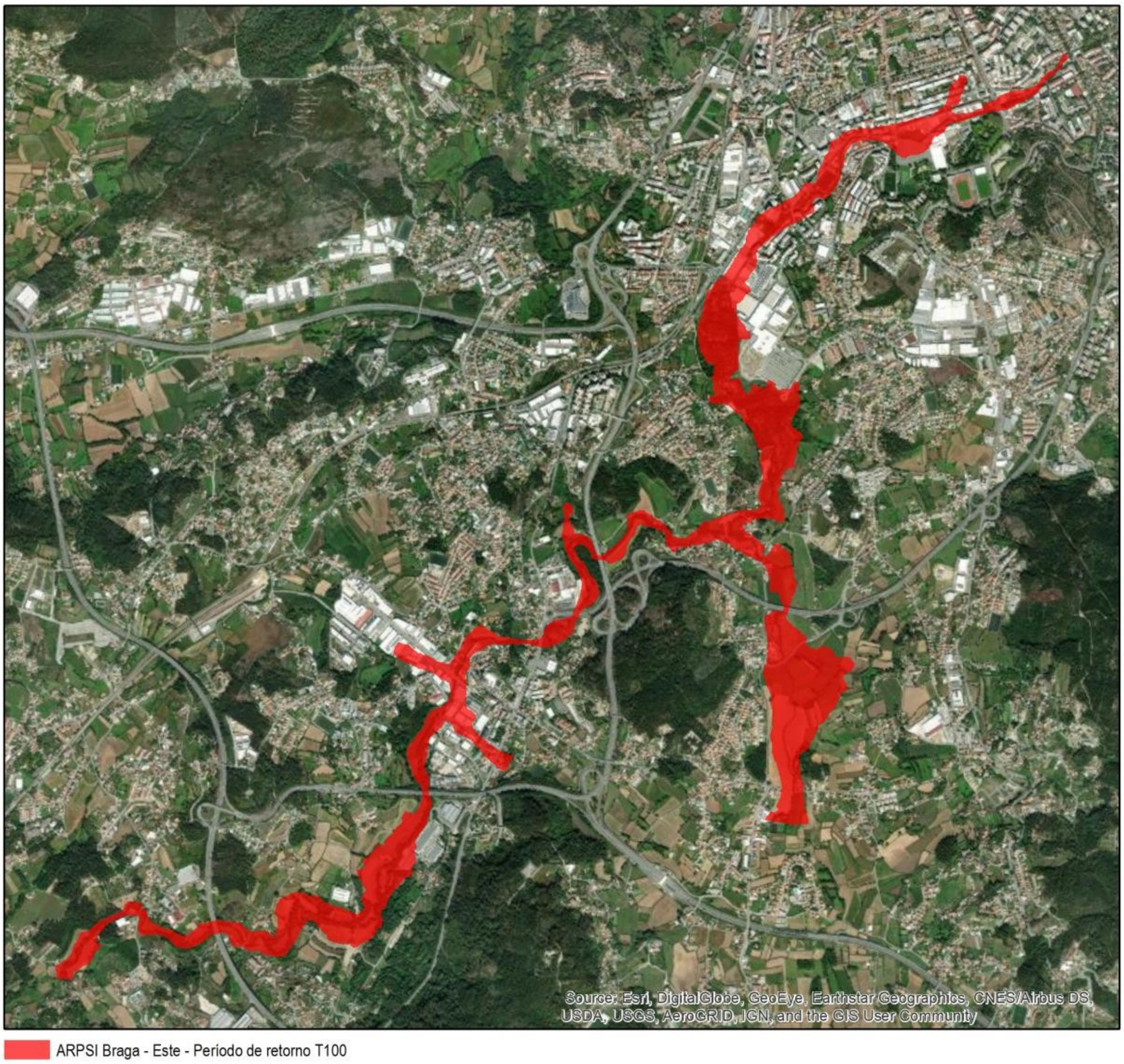
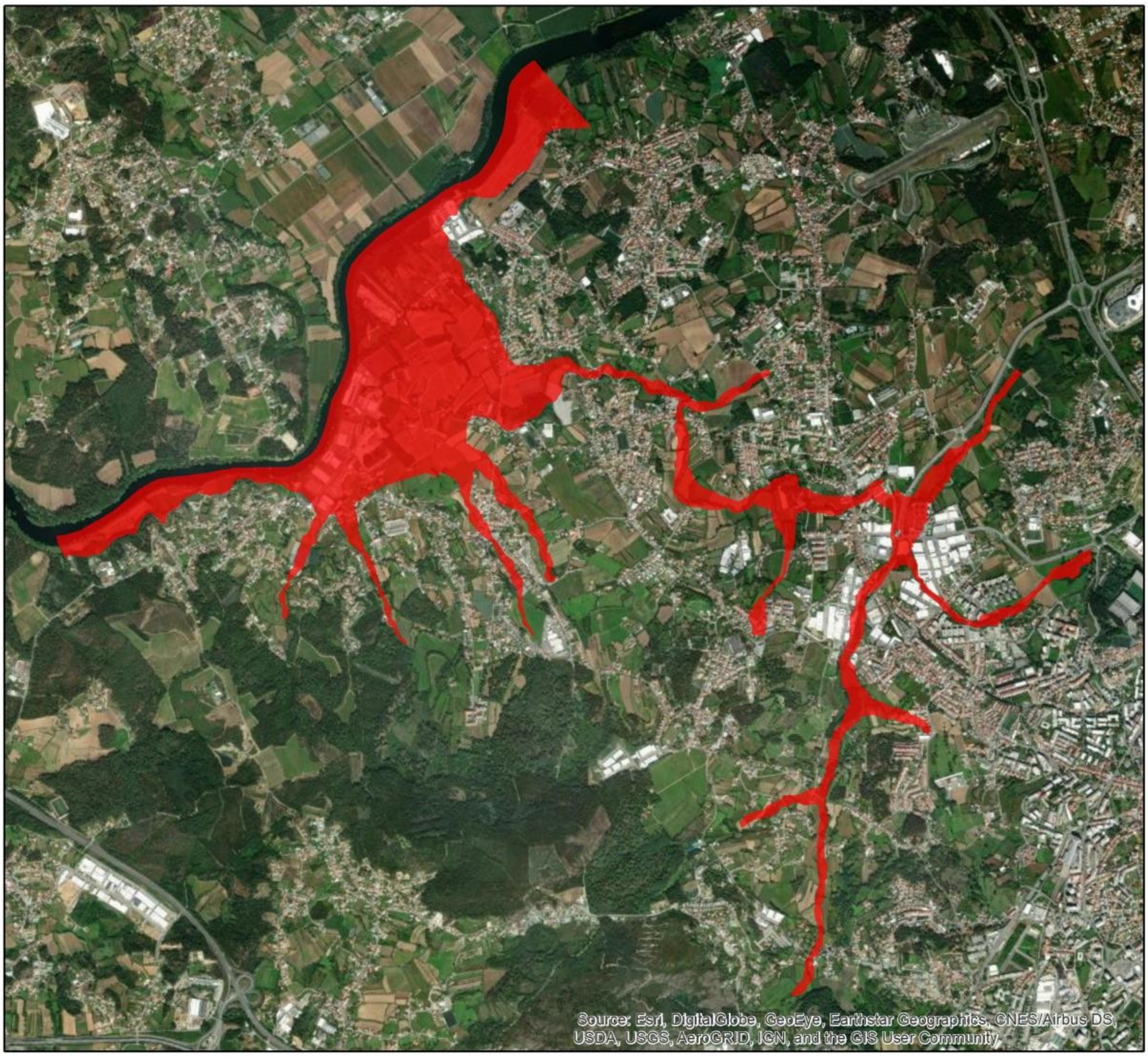


Figure 7.6. Detail of the areas most vulnerable to flooding and priority intervention - East
Source: PGRI-RH2, 2nd cycle (2020)



ARPSI Braga - Padim da Graça - Período de retorno T100

Figure 7.7. Detail of the areas most vulnerable to flooding and priority intervention - Padim da Graça
Source: PGRI-RH2, 2nd cycle (2020)

7.1.2.2 Slope movements

Priority intervention areas are those identified in the PMEPCB as being particularly susceptible to the occurrence of slope movements, such as:

- To the west of the municipality, some stretches along the EM 563 and the villages located on the slopes of Monte S. Filipe (Vieiros, Monte, Cachada and D. Pedro); the villages at the foot of the relief near S. Filipe.
  Filipe (Monte de Caldas), since some sectors of Monte de Caldas are highly susceptible (Esperança, parish of Semelhe, and Caldas, parish of Sequeira);
- Also to the west of the municipality, in the parish of Passos S. Julião, some stretches of the EM 561 also intersect with areas of high susceptibility;
- In the southern part of the territory there are some sections of the EM 562 (parish of Ruilhe and Arentim) in high susceptibility classes;
- In the parish of S. Pedro de Oliveira, the element most at risk is the A3 motorway, a situation that is repeated in some areas located in Fradelos and Vilaça;
- In the parish of Escudeiros there are two communication routes, the one that connects to the municipality of Vila Nova de Famalicão (EM 309) and the EM 568 that crosses the areas of aggregate extraction.
  existing in that area;
- Another important road at risk is the EN 101, in the parishes of Esporões, Trandeiras and Moreira. This communication route is associated with settlements
  which are installed at the foot of Monte de Santa Marta;
- On the most important elevation in the municipality of Braga (Monte Sameiro) there are vital and sensitive elements that are exposed to the risk of slope movement, namely the
  villages located on the foothills and slopes of Fraião, Nogueiró, Tenões and Espinho. In addition to these settlements, some sections of the EM 309 and EN 103-3 (Sameiro/Bom Jesus link) are identified as sensitive areas;
- To the north is the CM 1288, which connects the parishes of S. Lucrécia de Algeriz, some sections of the EM 591 and EN 103 stand out, as well as the places of Monte, Aldeia and Igreja, as they are close to each other.
  downstream of 1st order watercourses, consequently with greater erosive power when short but intense periods of precipitation occur.

With regard to the elements considered critical to this risk, the PMEPCB identifies the Semelhe Basic School, located in the parish of Semelhe in the place of the Church.

In addition to the particularities mentioned in the PMEPCB as being more susceptible to slope movements, it was decided to cross-reference the susceptibility map with the municipality's buildings, highlighting the following buildings in areas of high susceptibility that should be considered as priority intervention areas (**Table 7.17**) and the industrial zones also in a high susceptibility class (**Figure 7.10** and Error! Reference source not found.).

Table 7.17. Vulnerable buildings Slope movements

Building type	Number
Restoration	3
Water tanks	2
Sports grounds	2
Religious	10
Educational	1
Homes / Day Care Centres / Creche	2

These buildings are identified below to make it easier to consider possible interventions:

- **Restaurants:** Hotel do Templo; Casa da Torre; Restaurante Águeda;
- **Water reservoirs:** RDE10_NOGUEIRO; RD08_SMAMEDEALTO;
- **Sports grounds:** Tennis court - Escudeiros multi-sports ground; 10 October football pitch (Esporões);
- **Religious:** S. Salvador Church - Figueiredo; Mortuary Chapel; Escudeiros Parish Centre; Esporões Parish Church; Chapel of Santa Ana or Casa da Torre; Chapel of S. Bento; Cross da Igreja; Capela de S. Bento (Monte da Quinta); Capela da N.ª Srª. da Saúde or do Barrio; Capela da Quinta do Justo;
- **Educational:** EB1 Semelhe;
- **Social:** Centro Social Paroquial de Esporões; Centro de Solidariedade de Braga/Projeto Homem (CeSB/Projeto Homem) (Falperra).

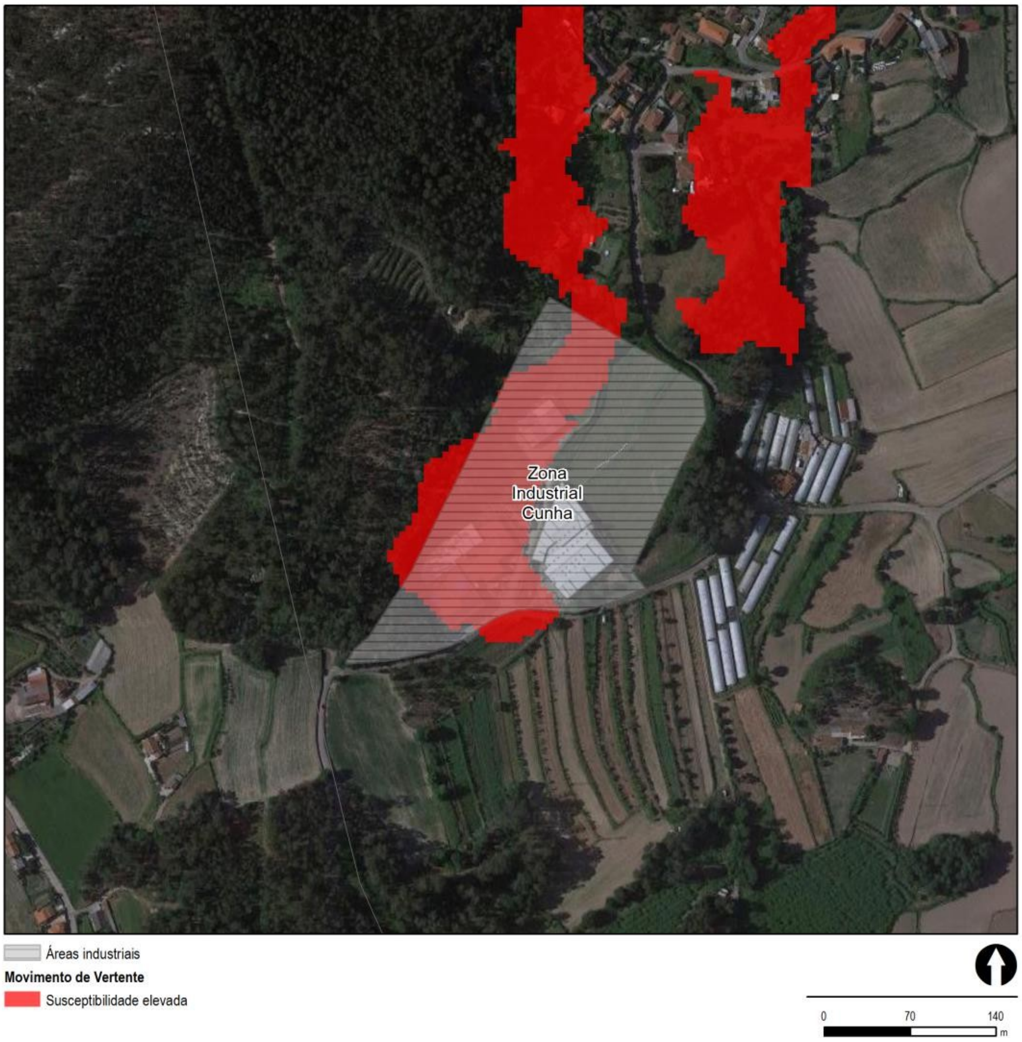


Figure 7.8. Detail of the industrial zones most susceptible to slope movements - Cunha Industrial Zone

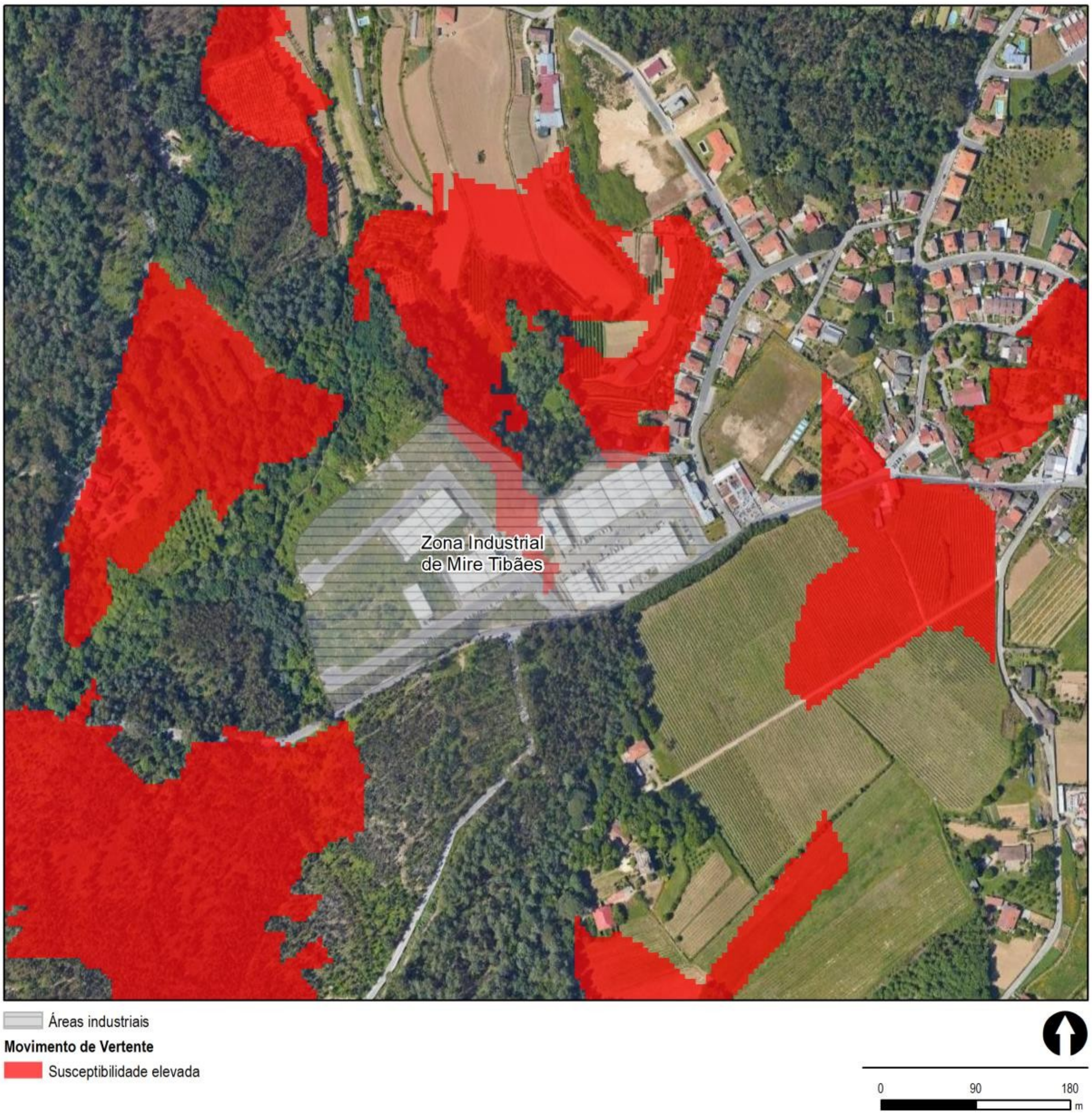


Figure 7.9. Detail of the industrial zones most susceptible to slope movements - Mire Tibães Industrial Zone

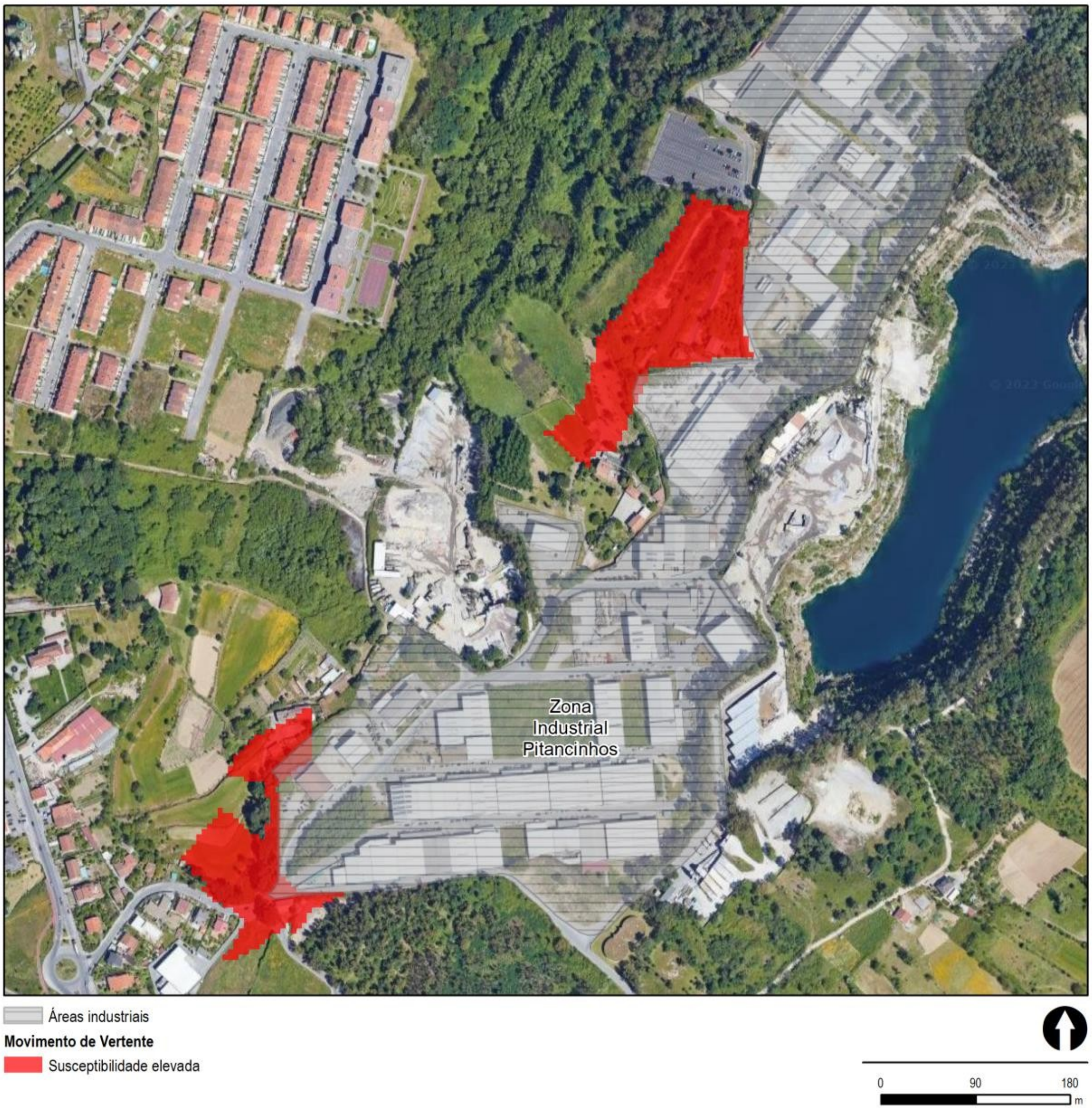


Figure 7.10. Detail of the industrial zones most susceptible to slope movements - Pintancinhos Industrial Zone

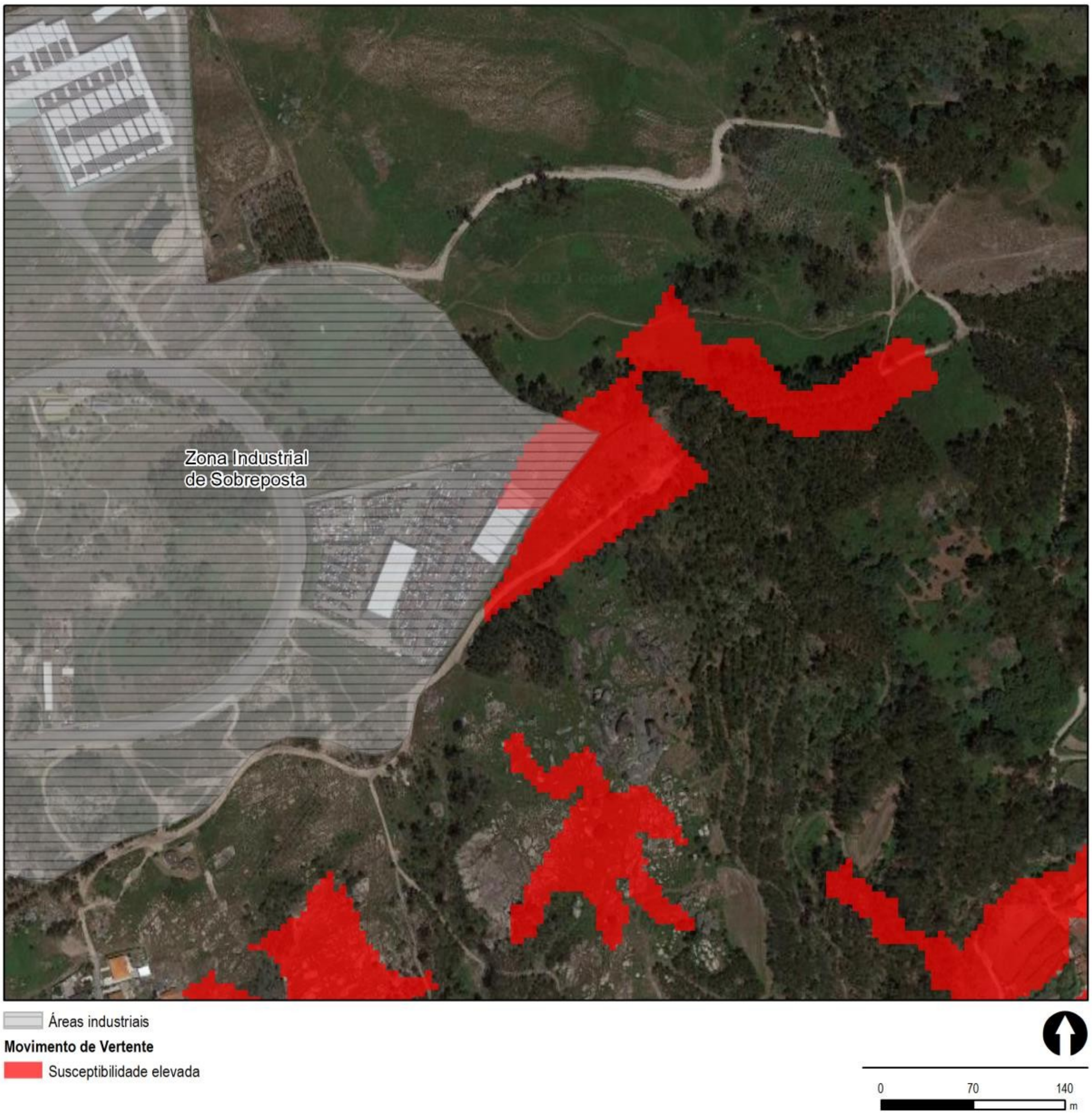


Figure 7.11. Detail of the industrial zones most susceptible to slope movements - Sobreposta Industrial Zone

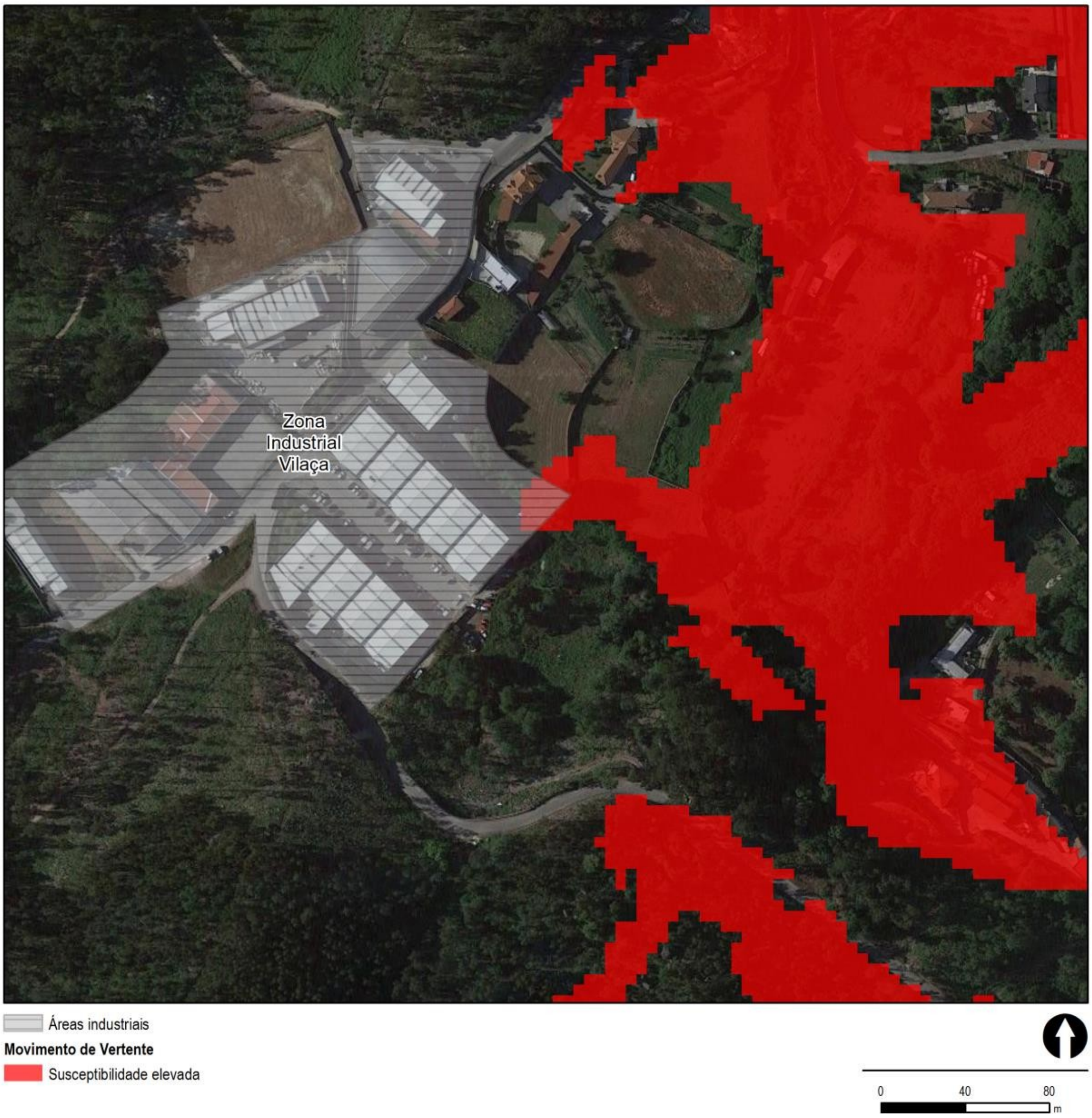


Figure 7.12. Detail of the industrial zones most susceptible to slope movements - Vilaça Industrial Zone

7.1.2.3 Heat waves

In order to determine areas of high vulnerability and priority intervention, the population aged over 65 was identified, as were living conditions, taking into account households without air conditioning, the age of the building, the state of conservation of the building and the need for major repairs. These and other factors determine the population's vulnerability to heatwaves and, consequently, their ability to adapt.

Figure 7.13 shows that a significant area of the municipality is in the High susceptibility class, according to the PMEPCB information - approximately 28.5 per cent.

According to the Risk Analysis (PMEPCB, Part IV - Complementary Information), the main area with high susceptibility to the occurrence of heat waves corresponds to the urban perimeter of the city of Braga, where more than 50 per cent of the resident population is over 65, namely in the parishes of São José de São Lázaro and São João do Souto and Maximinos, Sé and Cividade. They also point out that in the other areas that are highly susceptible, the weight of the elderly population is less of a concern, a fact that is aggravated by the thermal conditions in the cities (a situation known as "heat islands") and in which the risk is not only related to the age of the population.

The parish union of Santa Lucrécia de Algeriz and Navarra is highly vulnerable due to the age and need for repair of its buildings. The parish of Padim da Graça is also highly vulnerable due to the number of households without air conditioning and the age of its buildings.

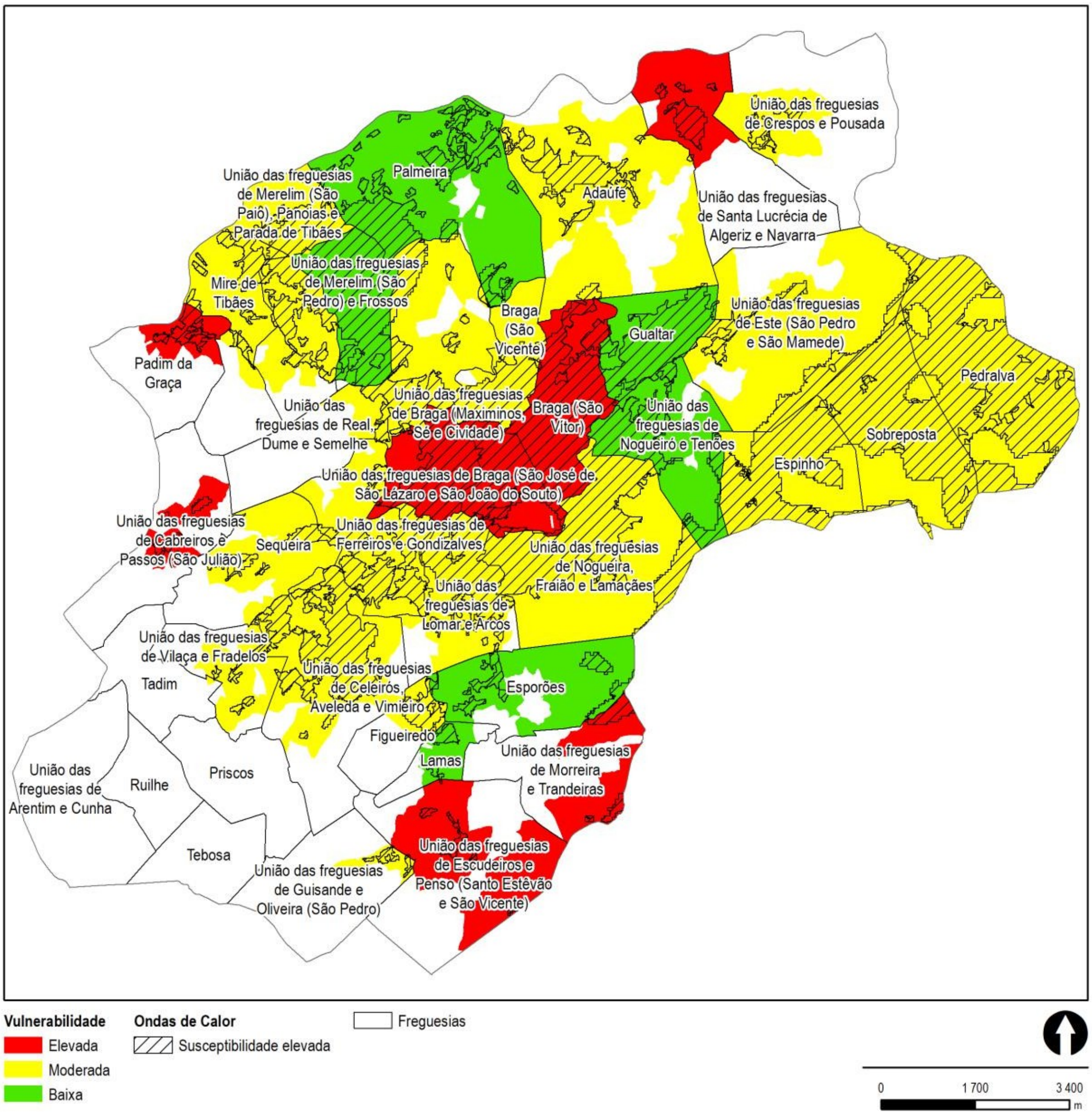


Figure 7.13. Heat Wave Vulnerability Chart showing the area of High susceptibility

Source: adapted from PMEPCB, CMB, 2018.

Error! Reference source not found. presents the critical elements located in the areas of high risk to heat waves identified in the PMEPCB.

Table 7.18. Critical elements located in an area at high risk of heat waves

Typology	Name
Health Equipment in Braga	Cávado I Health Centre Grouping - Braga
	Maximimos Health Unit
	São Vicente/Infias Health Unit
	Carandá Health Units
	Esporões Health Unit
	Cabreiros Health Extension
	Celeirós Health Extension
	Ruães Health Extension
	Pedralva Health Centre
	Braga Hospital
	Carandá Family Health Unit
	Gualtar Family Health Unit
	Bracara Augusta Family Health Unit
	Manuel Rocha Peixoto Family Health Unit
	St John's Family Health Unit in Braga
Fire stations	Braga Volunteer Fire Brigade Humanitarian Association
	Braga Fire Brigade
PSP	PSP - District Command
	PSP - 2nd Police Station - Souto Maior
GNR	GNR - Braga Territorial Post
	GNR - Sameiro Territorial Post
	GNR - Braga Tax Office
Teaching equipment	Caloutre Gulbenkian Conservatory of Music Art School
	André Soares Primary School, Braga
	Braga Oeste Primary School
	Celeirós Primary School
	Gualtar Primary School
	Maraçães Primary School
	Mosteiro and Cávado Primary School
	Nogueira Primary School
	Palmeira Primary School
	Real Primary School
	Dr Francisco Sanches Elementary School
	Friar Caetano Brandão Primary School
	Trigal de Santa Maria Primary School
	Alberto Sampaio Secondary School
	Carlos Amarante Secondary School, Braga

Typology	Name
	D. Maria II Secondary School, Braga
	Maximinos Secondary School, Braga
	Sá de Miranda Secondary School, Braga
CMPC	Municipal Civil Protection Commission

Source: PMEPCB, CMB, 2018.

The increase in temperature, which in some situations is translated into heat waves, has a direct impact on human health, namely because it requires an extra thermoregulatory effort on the part of individuals to achieve thermal comfort. With the increase in the magnitude and intensity of extreme heat peaks or heatwaves, it is expected that there will be greater morbidity and/or mortality from heat-related illnesses (dehydration, fatigue and heat strokes), and that these will act more severely on the population with less protective capacity, such as the elderly, children or non-acclimatised tourists.

7.1.2.4 Extreme Meteorological Phenomena (Strong Winds / Storms)

For the municipality of Braga, there has so far been no georeferenced identification of the location of occurrences and consequences of extreme weather phenomena - it is not possible to territorialise this risk cartographically.

However, as it is considered that the risk of flooding and the risk of slope movements are associated with extreme weather events, it is suggested that within the scope of the risk of extreme weather events, the areas defined within the scope of these risks (flooding and slope movements) should be considered as priority intervention areas.

7.1.2.5 Droughts

According to the PMEPCB, the areas most at risk from a lack of water due to an imbalance between the water available in the soil, the crops' needs and plant transpiration, correspond to the agricultural areas located in the parishes of Pedralva and Sobreposta, in the eastern part of the municipality, and Ruílhe in the north-west.

Figure 7.14 shows details of the most vulnerable zones in terms of exposure to the risk of Drought.

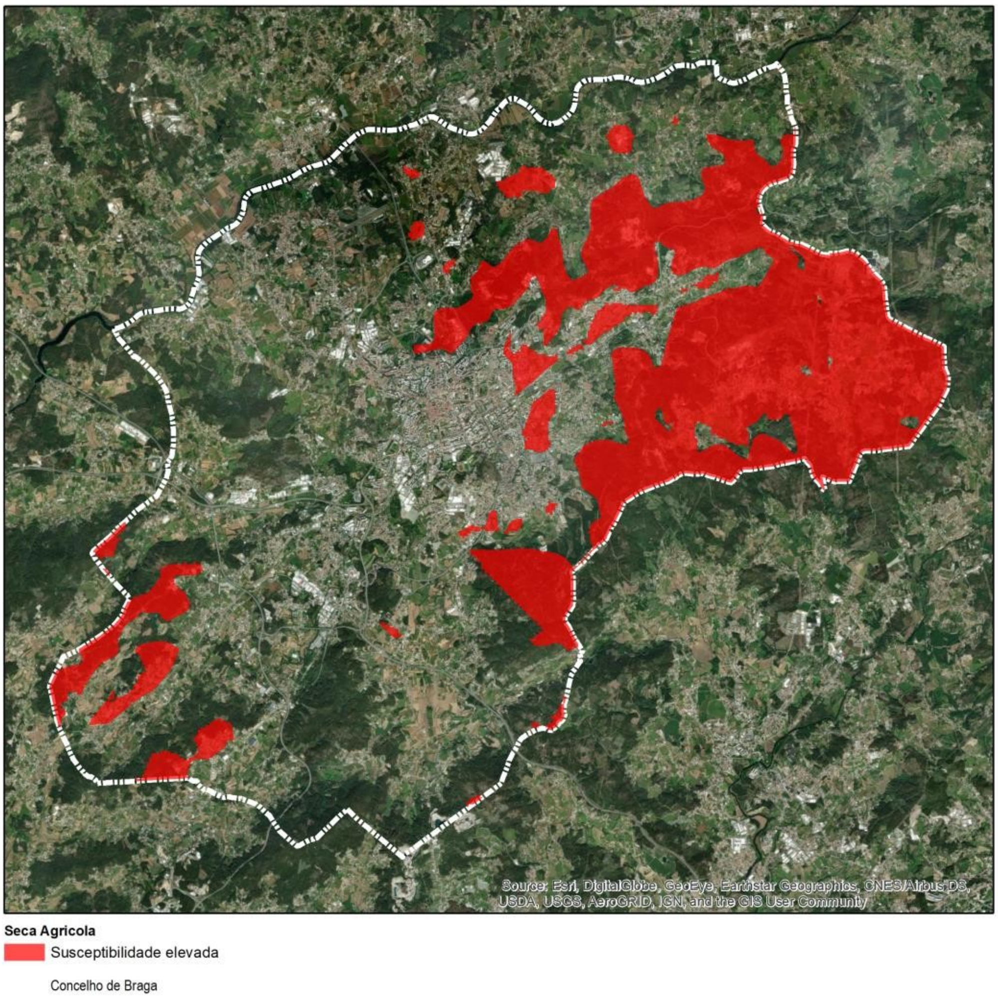


Figure 7.14. Details of the areas most vulnerable to agricultural drought and priority intervention areas
Source: PMEPCB, CMB, 2018.

This type of drought - agrometeorological - is strongly correlated with the type of crop grown, especially maize.

7.1.2.6 Forest fires

The PMDFCI Braga identifies the elements that should be protected because they are most susceptible to forest fires - Defence priorities chart (forest fire) (**Figure 7.15**).

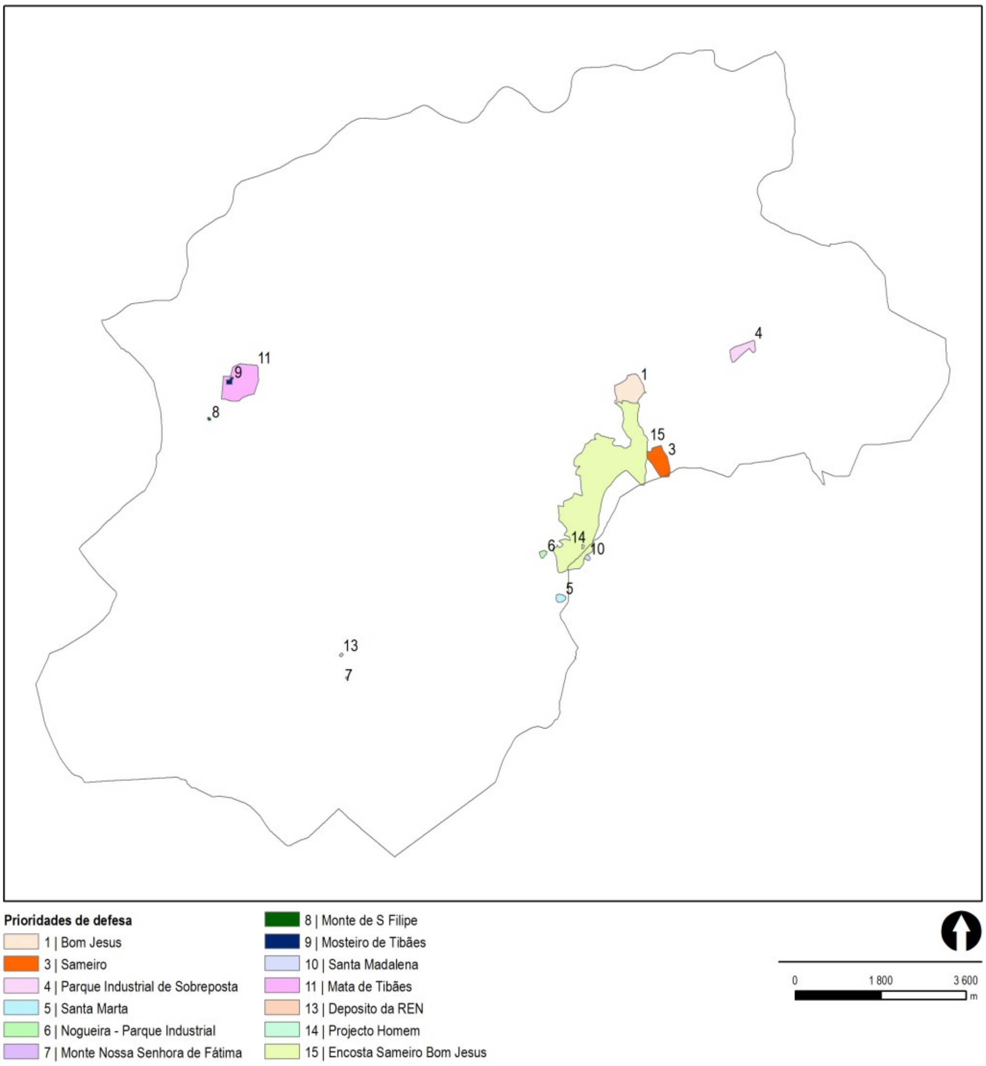


Figure 7.15. Defence priority chart (forest fire)
Source: adapted from PMEPCB

From this exercise, a group of eleven (11) "ecological, social and historical-cultural values" were identified: Bom Jesus, Mata de Tibães, Mosteiro de Tibães, Encosta do Sameiro, Santa Marta e Sameiro, Sameiro, Santa Maria Madalena, Parque Industrial de Nogueira, Santa Marta, Parque Industrial de Sobreposta, Capela Nossa Senhora de Fátima. Chapel of St Philip.

7.1.3 Current Response Capacity

The municipality's current response is the result of integrated action and is the result of the joint effort and action of multiple and varied organisations, of which the following stand out:

- CMB;
- Fire Brigade and Volunteer Fire Brigade;
- Cávado Sub-Regional Command (CSR Cávado);
- Parish Councils;
- Municipal companies;
- Portuguese Environment Agency;
- Northern Regional Coordination and Development Commission (CCDR-N)
- Public Security Police (PSP);
- National Republican Guard (GNR);
- Braga Hospital;
- National Institute for Medical Emergencies (INEM);
- Northern Regional Health Administration (ARS-Norte);
- Agrupamento de Centros de Saúde do Cávado I (Braga).

As for those responsible for the response at municipal level, the Fire Brigade and Civil Protection are identified as the main interlocutors and activators of resources and services in cases of extreme events. In this sense, Civil Protection plays a key role in warning of extreme events, publicising the alert itself and self-protection measures through various means of communication. However, there are other municipal services that have played a leading role in the response, in particular the Municipal Directorate of Works.

Part IV Complementary Information of the PMEPCB establishes the structure of civil protection and, with regard to the existing civil protection bodies in the municipality of Braga and their respective competences **Table 7.18**.

Table 7.18. Existing civil protection bodies in the municipality of Braga

Organisation	Responsible	Competences
Management	Mayor	The mayor of the municipality is competent to declare a municipal alert situation and is heard by the District Operational Commander for Relief Operations for the purpose of declaring a district alert situation, when the area of the respective municipality is concerned (Article 6(2) of Law 65/2007 of 12 November).
Coordination	CMPC	a) Trigger the preparation of the municipal emergency plan, submit it for approval by the National Civil Protection Commission and monitor its implementation; b) Monitor policies directly linked to the civil protection system that are developed by public agents; c) Determining the activation of plans, when justified; d) Ensuring that the organisations and institutions that make up the CMPC provide the necessary resources to carry out civil protection actions at municipal level, within the scope of their organisational structure and duties; e) Disseminate communiqués and warnings to the population and to entities and institutions, including the media (Article 3(3) of Law 65/2007 of 12 November).
Execution	SMPC	a) Monitoring the preparation and updating of the municipal emergency plan and special plans, where these exist; b) Ensuring the functionality and effectiveness of the SMPC structure; c) Inventory and permanently update the records of existing resources in the municipality that are of interest to the SMPC; d) Carrying out technical studies with a view to identifying, analysing and dealing with the consequences of natural, technological and social risks that may affect the municipality, depending on their estimated magnitude and the foreseeable location of their occurrence, promoting their mapping in order to prevent, where possible, their manifestation and to assess and minimise the effects of their foreseeable consequences; e) Keeping up-to-date information on serious accidents and disasters that have occurred in the municipality, as well as information on the conditions in which they occurred, the measures taken to deal with their consequences and the conclusions on the success or failure of the actions taken in each case; f) Plan logistical support and provide it to victims and rescue forces in the event of a serious accident or disaster; g) Set up, organise and manage accommodation centres and activate them in the event of a serious accident or disaster; h) Drawing up prior intervention plans and preparing and proposing the execution of exercises and drills that contribute to the effective performance of all the organisations involved in civil protection actions; i) Study the issues it is entrusted with, proposing the solutions it deems most appropriate (Article 10(2) of Law 65/1007 of 12 November).

The declaration of an alert situation is the only one that can be declared at municipal level and by the Mayor when, in view of the occurrence or imminence of a serious accident or disaster, the need to adopt preventive measures and/or special reaction measures is recognised (Article 9(1) of Law 27/2006 of 3 July) and implies:

- Convene the CMPC;
- Establish appropriate procedures for the technical and operational coordination of civil protection services and agents;
- Establish guidelines for procedures to coordinate the intervention of security forces and services;
- Adopt preventive measures appropriate to the occurrence;
- Special obligation for the media to collaborate (Article 15 of Law 27/2006 of 3 July).

It is also important to schematically represent the warning system in operation in the municipality of Braga (**Figure 7.16**).

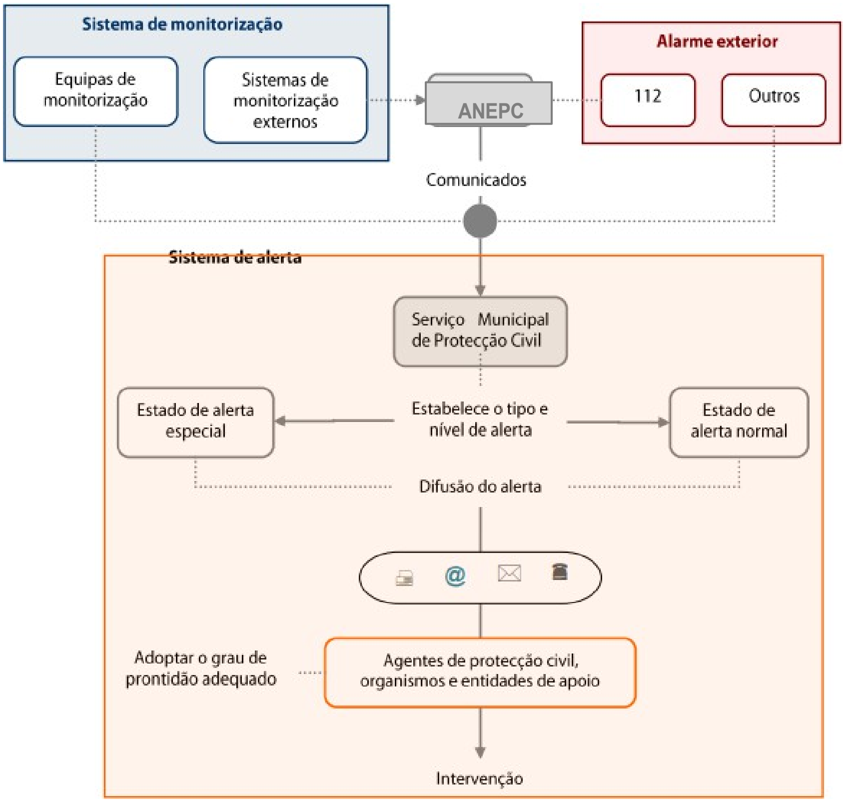


Figure 7.16. Organisation of the alert system
Source: PMEPCB, CMB, 2018

In order to ensure that the warning system works properly, the PMEPC includes an Emergency Preparedness phase which aims to make citizens aware of self-protection measures and ways of collaborating with the authorities, with the MSPC being responsible for raising awareness through, for example, information leaflets, manuals, posters, publications, information sessions and awareness campaigns (**Figure 7.17**).

Figure 7.17. Organisation of the warning system in an emergency preparedness phase
Source: PMEPCB, CMB, 2018.

In the emergency phase, it is essential to warn the population quickly and effectively about the places that will potentially be affected, what the evacuation routes will be, where they should go to shelter, what they should take with them and what their self-protection measures should be

The diagram in **Figure 7.18** explains the type of warning, the method of dissemination, the information to be transmitted and the responsibility of the organisations for the emergency phase.

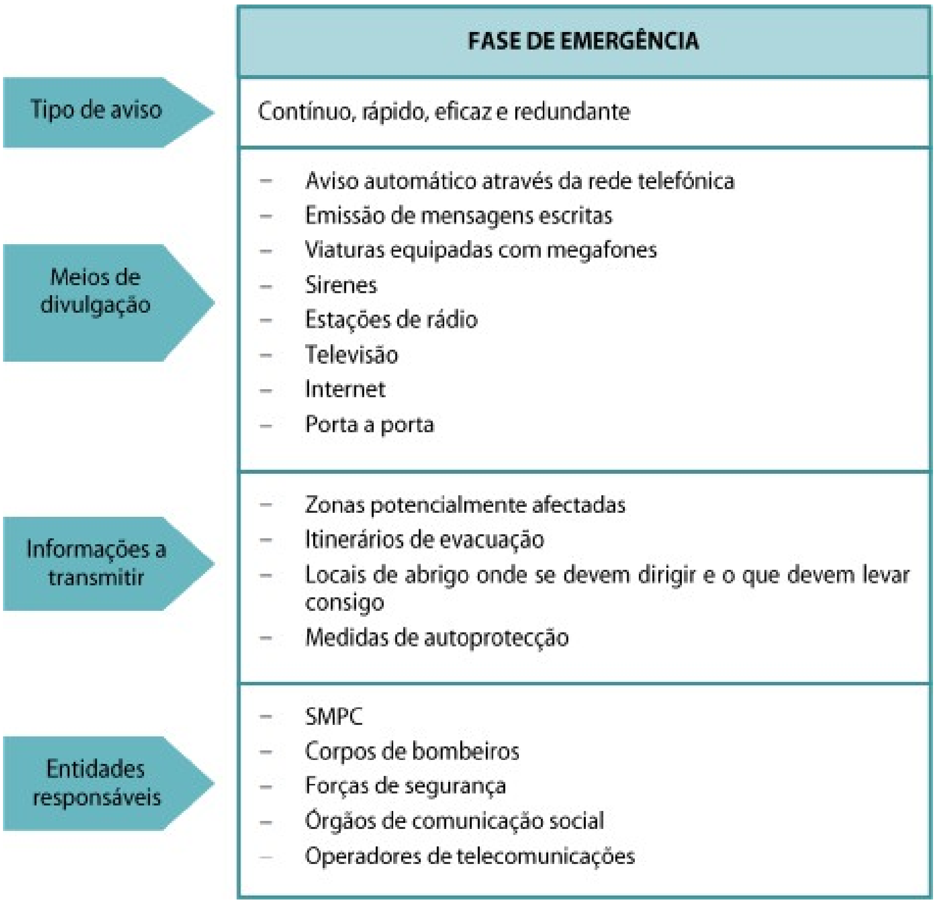


Figure 7.18. Publicising the warning in the emergency phase
Source: PMEPCB, CMB, 2018.

Exercises are an important tool for testing the operability of the PMEPCB: according to the exercise log, the operability of the Plan was tested on 18 November 1999 (CAVADEX 99 Scenario) and then on 7 December 2004 (CAVADEX 04).

However, Braga's EMAAC concludes that, in the period of data analysed (between 2010 and 2015), the response capacity has been less than effective. With regard to the long term and learning from past events, one example was flooding, where the municipality and the municipal company AGERE have acted accordingly by cleaning gutters, unblocking water lines, monitoring the pumping system in tunnels and setting up an alert system for the water level in tunnels. It was not possible to finalise the municipality's response capacity after 2015 due to a lack of information.

Also contributing to the current response capacity, the project **Cuidar Braga - Proteger a Natureza, Pessoas e Bens** (**Caring for Braga - Protecting Nature, People and Goods)** (which was promoted by the City Council and had the following partner organisations: the residents, the Parish Councils / Unions, the Agricultural Cooperatives and BRAVAL - Centro de Valorização e Tratamento de Resíduos) was intended to give continuity to Braga's EMAAC by encouraging the recovery of agricultural and forestry waste (biomass) instead of burning it, which resulted in a 40% reduction in burning, in nine (9) rural parishes. This project was continued by **Cuidar Braga II (**EEA Grants funding totalling €199,658.20)**,** which boosted this impact by reapplying and extending the action to the municipality's 32 rural parishes.

According to **Cuidar Braga II**, "In Braga, Nature and People live in harmony and security *with an active policy to combat climate change and protect nature, people and property, the Municipality supports organisations and the population:*

- Cleaning and management of agricultural and forestry waste;
- Constant monitoring of the health of the tree park;
- Promoting forest management;
- Using forest biomass as a natural fertiliser;
- Production of ecological fuel from leftovers;
- Drastic reduction in fires caused by burning;
- Preserving and improving air quality and the health of residents."

Figure 7.19 illustrates the expected results of the project.

Figure 7.19. Caring Braga II Project, Expected Results
Source: Cuidar Braga II, EEAGrants.

7.2 Future Climate Impacts and Vulnerabilities

7.2.1 Future Impacts and Vulnerabilities by Adaptation Sector

7.2.1.1 Ecosystems and Biodiversity

As the number and severity of occurrences worsen, the following impacts/vulnerabilities can be expected in the future at Braga municipality level, in addition to the worsening of those already occurring today, particularly with regard to the main impacts of heatwaves, which drive an increase in morbidity and mortality, especially among the most vulnerable segments of the population.

Table 7.20 summarises the future impacts of the Biodiversity and Landscape sector.

Table 7.20. Summary of future impacts in the Biodiversity and Landscape sector

Climate Risks	Future direct and indirect impacts
Floods	▪ Changes in the landscape. ▪ Changes in soil quality and loss of associated functions. ▪ Increased erosion phenomena.
Slope movements	▪ Changes in the landscape. ▪ Increased erosion phenomena. ▪ Changes in soil quality and loss of associated functions.
Heat waves	▪ Decrease in agricultural production (of species of relevant ecosystem value) with greater water requirements. ▪ Decrease in the productivity of forest stands (of species with relevant ecosystem value) (with species such as *Eucalyptus spp. and Pinus pinaster)*. ▪ Increase in the number of forest fire incidents. ▪ Decrease or even extinction of vegetation. ▪ Changes in soil quality and loss of associated functions. ▪ An increase in the number of birds that migrate in autumn and winter and become residents.
Extreme Phenomena (Strong Winds / Storms)	▪ Decrease or even extinction of vegetation ▪ Increased erosion phenomena.
Droughts	▪ Decrease or even extinction of vegetation ▪ Changes in soil quality and loss of associated functions.
Forest Fire	▪ Damage to the environment, with loss of flora and fauna, ▪ Damage to ecosystem services and changes in biodiversity;

Climate Risks	Future direct and indirect impacts
	▪ Degradation, fragmentation or even the disappearance of habitats indigenous and endemic.

There is a trend towards increasing climate risks and a consequent worsening of the associated impacts on Ecosystems and Biodiversity.

Given the prospect of a reduction in rainfall, an increase in the number of days/periods of drought and an increase in high temperatures and heatwaves, this means an increase in the flora's need for water, an increase in water stress due to the unavailability of water in relation to the need, and a consequent increase in the risk of fires.

Table 7.19 shows future climate vulnerability in the Biodiversity and Landscape sector.

Table 7.19. Future vulnerabilities identified for the Biodiversity and Landscape sector

Climate Risks	Vulnerabilities
Floods	▪ Natural values and ecosystems
Slope movements	▪ Natural values and ecosystems ▪ Soil loss and degradation
Heat waves	▪ Soil loss and degradation ▪ Increased pressure on ecosystems and natural resources
Extreme Phenomena (Strong Winds / Storms)	▪ Environmental services ▪ Loss of biodiversity ▪ Increased pressure on ecosystems and natural resources
Droughts	▪ Increased pressure on ecosystems and natural resources ▪ Soil loss and degradation

Table 7.20 systematises the evolution of the level of risks to the Biodiversity and Landscape sector for each climate risk.

Table 7.20. Evolution of risk in the Biodiversity and Landscape sector, for each climate risk

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Extreme Phenomena (Strong Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

Low Moderate High

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.1.2 Water Resources

In line with the climate risks identified above, the main future impacts/vulnerabilities in the municipality of Braga with regard to Water Resources are identified (**Table** 7.21).

Table 7.21. Main future impacts/vulnerabilities on Water Resources

Climate Risks	Future direct and indirect impacts
Floods	▪ Damage to infrastructure; ▪ Damage to economic activities with unquantified losses; ▪ Potential human impact.
Slope movements	▪ Deterioration of water quality.
Heat waves	▪ Droughts and deteriorating water quality
Extreme Phenomena (Strong Winds / Storms)	▪ Increased occurrences of flooding. ▪ Infrastructure damage
Droughts	▪ Deterioration of water quality; ▪ Reduced water availability.
Forest Fire	▪ Deterioration of water quality.

In the future, the main threats and vulnerabilities are associated with damage to property and people, as well as to economic activities, due to the worsening of extreme phenomena, especially heavy rainfall that can lead to floods and flash floods that will make it difficult for private property owners, businesses, industries and services to safeguard their property and evacuate people, particularly those considered vulnerable.

There could also be an increase in the volume of eutrophied waters due to the "washing away" that soils can undergo after being fertilised with synthetic fertilisers, as these products are washed into the waterways and contribute to the contamination of groundwater with agrochemicals.

Combined with the municipality's steep topography, the occurrence of forest fires and then heavy rainfall will aggravate the risk of slope movements, especially in steep areas, thus increasing the risk of debris being swept into watercourses, which can aggravate flooding by creating barriers to the flow of water, and even lead to the destruction of infrastructure and endanger people and animals.

Table 7.22. shows the future vulnerabilities of each risk for the Water Resources sector.

Table 7.22. Future climate vulnerabilities in water resources

Climate Risks	Vulnerabilities
Floods	▪ Population; ▪ Services ▪ Economic activities.
Slope movements	▪ Population; ▪ Economic activities
Heat waves	▪ Population; ▪ Economic activities
Extreme Phenomena (Strong Winds / Storms)	▪ Population; ▪ Economic activities
Droughts	▪ Population; ▪ Economic activities
Forest Fire	▪ Population; ▪ Economic activities

Table 7.23 systematises the evolution of the level of risks to the Water Resources sector for each climate risk.

Table 7.23. Evolution of risk in the Water Resources sector, for each climate risk

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Extreme Phenomena (Strong Winds / Storms)				→
Droughts				→
Forest Fire				↑

Caption:

Low — Moderate — High

↑ **Increased risk**
→ **Risk maintenance**
↓ **Decrease in risk**

7.2.1.3 Agriculture

In line with the climate risks identified above, the main future impacts on the municipality of Braga with regard to agriculture are identified (**Table 7.24**).

Table 7.24. Main future impacts on agriculture

Climate Risks	Future direct and indirect impacts
Floods	▪ Loss of crops and reduced yields; ▪ The occurrence of floods on agricultural land directly affects agricultural production, leading to the destruction of crops and the waterlogging of land during critical seasons, conditioning agricultural activities such as sowing and other cultivation operations.
Slope movements	▪ Loss of crops and reduced yields.
Heat waves	▪ Anticipation of the start of the vegetative cycle, negatively affecting the quantity and quality of production, including its preservation capacity; ▪ Rising temperatures coupled with reduced rainfall in spring could make it impossible to grow current crops and force the adoption of new crops. less demanding, whose economic return may be different from the existing one.

Climate Risks	Future direct and indirect impacts
	▪ Increased water consumption for irrigation and higher production costs; degradation of water quality due to overexploitation.
Extreme Phenomena (Winds / Storms)	▪ Production losses and yield reductions of more than 50%
Droughts	▪ The combination of rising temperatures and reduced rainfall in the spring months leads to a reduction in the production of grass and fodder maize for the animals; ▪ Changes in cultural practices; ▪ Downsizing of farms; ▪ Reduction in the area sown in drought situations.
Forest Fire	▪ Damage to pastures and agricultural land ▪ Loss of ecosystem services

Table 7.25 shows the projected future climate vulnerabilities for the Agriculture sector.

Table 7.25. Future climate vulnerabilities in Agriculture

Climate Risks	Vulnerabilities
Floods	▪ Agricultural crops; ▪ Soils; ▪ Agricultural equipment and infrastructure.
Slope movements	▪ Agricultural crops; ▪ Soils; ▪ Agricultural equipment and infrastructure,
Heat waves	▪ Partial or total loss of crops, production, installations and equipment.
Extreme Phenomena (Winds / Storms)	▪ Partial or total loss of crops, production, installations and equipment.
Droughts	▪ Soils; ▪ Agricultural crops; ▪ Forest stands; ▪ Livestock numbers.
Forest Fire	▪ Agricultural crops; ▪ Forest stands; ▪ Soils.

Table 7.26 systematises the evolution of the level of risks for the Agriculture sector, for each climate risk.

Table 7.26. Evolution of risk in the Agriculture sector, for each climate risk

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Extreme Phenomena (Strong Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.1.4 Tourism

In line with the climate risks identified above, the main future climate impacts in the municipality of Braga for the tourism sector are identified (**Table 7.27**).

Table 7.27. Main future climate impacts on the tourism sector

Climate Risks	Future direct and indirect impacts
Floods	▪ Destruction of tourist facilities and infrastructures: destruction and blocking of access roads; interruption of means of communication; ▪ Affecting environmental services;
Slope movements	▪ Destruction of tourist infrastructure; ▪ Blocking access routes; ▪ Interruption in the media.
Heat waves	▪ Consequences on visitors' sense of thermal comfort; ▪ Competition for water between tourism and other sectors; ▪ Loss of performance and problems in the operation of cooling and HVAC systems; ▪ Affecting the profitability of the activity due to increased operating costs;
Extreme Phenomena (Winds / Storms)	▪ Damage to infrastructures and equipment, falling trees, with possible consequences for the population, property and road traffic restrictions public; ▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings and/or contents; ▪ Damage/conditioning to infrastructure (destruction of buildings to support activities/use of cultural heritage); ▪ Changes in the use of equipment/services.
Droughts	▪ As temperatures rise, there could be an increase in the distribution area of these species, contributing to the degradation of biodiversity and resources resulting in overall negative impacts on the tourism sector, in particular on the "Nature tourism" and "Cultural and landscape touring" products.
Forest Fire	▪ As temperatures rise, there could be an increase in the distribution area of these species, contributing to the degradation of biodiversity and resources resulting in overall negative impacts on the tourism sector, in particular on the "Nature tourism" and "Cultural and landscape touring" products.

In the future, these extreme weather events are expected to worsen, associated with increased damage to infrastructure and environmental services, as well as to the bioclimatic comfort of buildings.

Table 7.30 shows the future vulnerabilities identified for the tourism sector.

Table 7.30. Future climate vulnerabilities in the tourism sector

Climate Risks	Vulnerabilities
Floods	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Accommodation units and tourist or transport infrastructures.
Slope movements	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Equipment and infrastructure in higher risk areas; ▪ Tourist resources in a risk area.
Heat waves	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Tourist accommodation establishments.
Extreme Phenomena (Winds / Storms)	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Equipment and infrastructure in higher risk areas; ▪ Tourist resources in a risk area.
Droughts	▪ Ecosystems and natural resources.
Forest Fire	▪ Tourists and visitors with a special focus on the elderly and children; ▪ Equipment and infrastructure in higher risk areas; ▪ Tourist resources in a risk area.

Table 7.28 systematises the evolution of the level of risks to the tourism sector for each climate risk.

Table 7.28. Evolution of the risk to the tourism sector, for each climate risk

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Extreme Phenomena (Strong Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.1.5 Spatial planning

In line with the climate risks identified above, the main future climate impacts in the municipality of Braga are identified in terms of land classification and use (**Table 7.29**).

Table 7.29. Main impacts on spatial planning

Climate Risks	Future direct and indirect impacts
Floods	▪ Increased occurrence of extreme phenomena. ▪ The type of impact considered is the same as the current impacts, but the magnitude and frequency are expected to be higher.
Slope movements	▪ Increased occurrence of extreme phenomena. ▪ The type of impact considered is the same as the current impacts, but the magnitude and frequency are expected to be higher.
Heat waves	▪ Increased occurrence of extreme phenomena; ▪ Increase in average and maximum temperatures in all seasons; ▪ Population in general, increasing inequalities and social vulnerabilities due to the climate; ▪ Thermal comfort of the housing stock; ▪ Loss of biodiversity; ▪ Increased pressure on ecosystems and natural resources; ▪ The type of impact considered is the same as the current impacts, but the magnitude and frequency are expected to be higher.
Extreme Phenomena (Winds / Storms)	▪ Increased occurrence of extreme phenomena. ▪ The type of impact considered is the same as the current impacts, but the magnitude and frequency are expected to be higher.
Droughts	▪ An increase in the frequency and severity of droughts associated with a decrease in precipitation combined with an increase in average temperatures and maximums at all stations; ▪ Decrease in water availability due to a reduction in total rainfall in spring, summer and autumn and in the number of days with rain. precipitation; ▪ An increase in the frequency and severity of droughts associated with a decrease in precipitation combined with an increase in average temperatures and maximums at all stations; ▪ Population in general, increasing inequalities and social vulnerabilities due to the climate; ▪ Reduction in agricultural, forestry and agroforestry production; ▪ Soil loss and degradation; ▪ Loss of biodiversity; ▪ Increased pressure on ecosystems and natural resources.

In the future, these extreme weather events are expected to worsen, associated with increased damage to environmental service infrastructures, as well as to the bioclimatic comfort of buildings. In addition, climate-related hazards directly affect the lives of people with fewer financial resources through impacts on livelihoods, such as reduced crop yields.

Table 7.30 shows the future vulnerabilities identified for the land-use planning sector.

Table 7.30. Future vulnerabilities in spatial planning

Climate Risks	Vulnerabilities
Floods	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Slope movements	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Heat waves	▪ Population; ▪ Built; ▪ Agricultural land.
Extreme Phenomena (Winds / Storms)	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Droughts	▪ Built; ▪ Population; ▪ Road network; ▪ Leisure and cultural facilities; ▪ Agricultural land.
Forest Fire	▪ Degradation or destruction of forest space; ▪ Disturbance of ecosystem dynamics.

Table 7.31. systematises the evolution of these climate risks in the spatial planning sector.

Table 7.31. Evolution of risk in the Spatial Planning sector, for each climate risk

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Phenomena Extreme (Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.1.6 Industry

In line with the climate risks identified above, the main future climate impacts in the municipality of Braga are identified with regard to Industry (**Table 7.32**).

Table 7.32. Main future climate impacts on Industry

Climate Risks	Future direct and indirect impacts
Floods	▪ Damage to the physical and operational integrity of critical infrastructures, such as the electricity and telecommunications networks, supply and sanitation infrastructures, waste, civil protection, among other infrastructures, urban equipment and buildings. ▪ Assignment of staff
Slope movements	▪ Damage to the physical and operational integrity of critical infrastructures, such as the electricity and telecommunications networks, supply and sanitation infrastructures, waste, civil protection, among other infrastructures, urban equipment and buildings. ▪ Assignment of staff
Heat waves	▪ Affects workers' health due to high temperatures and lack of cooling or heating in buildings where work is carried out. industrial activities; ▪ Increased costs for cooling buildings; ▪ Reduced production and lower yields; ▪ Assignment of staff
Extreme Phenomena (Winds / Storms)	▪ Damage to the physical and operational integrity of critical infrastructures, such as the electricity and telecommunications networks, supply and sanitation infrastructures, waste, civil protection, among other infrastructures, urban equipment and buildings. ▪ Assignment of staff
Droughts	▪ Affectation of some business activities.
Forest Fire	▪ They can jeopardise the physical and operational integrity of critical infrastructures such as the electricity grid, telecommunications, civil protection and other infrastructures.

Table 7.33. shows the current vulnerabilities identified for the Industry sector.

Table 7.33. Future climate vulnerabilities in Industry

Climate Risks	Vulnerabilities - exposed elements
Floods	▪ Industrial buildings; ▪ Communications
Landslides	▪ Industrial buildings; ▪ Communications
Heat waves	▪ Workers
Extreme Phenomena (Winds / Storms)	▪ Industrial buildings; ▪ Communications; ▪ Workers
Droughts	▪ Food industry
Forest Fire	▪ Industrial buildings; ▪ Communications; ▪ Workers.

Table 7.34 systematises the evolution of these climate risks in the industry sector.

Table 7.34. Evolution of risk for the Industry sector, for each climate risk

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Phenomena Extreme (Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.1.7 Infrastructure

In line with the climate risks identified above, the main future climate impacts in the municipality of Braga are identified in terms of critical infrastructure (**Table 7.35**).

Table 7.35. Main impacts on infrastructure

Climate Risks	Future direct and indirect impacts
Floods	▪ Damage to roads, and the growing need to provide road infrastructures with wear and tear surfacing with more frequency; ▪ Possible damage to energy distribution or telecommunications infrastructures in areas of high susceptibility to flooding or inundation; ▪ Possible damage to the integrity of wastewater sanitation infrastructures located in areas of high susceptibility to flooding or inundation, with a consequent increase in the risk of contamination or accidental pollution of the natural environment and the risk of service breakdown and reduction in levels of habitability and social conditions; ▪ Possible damage to the integrity of water supply networks and infrastructure located in areas of high susceptibility to flooding or inundation, with consequently increasing the risk of service breakdown and reducing levels of habitability and social conditions; ▪ Possible threat to the integrity of and damage to social, security and civil protection equipment located in the flooded area, with a consequent increase in risk of service breakdown or reduction in safety levels, service provision and social conditions; ▪ Worsening public safety conditions in flooded areas.
Landslides	▪ Damage to the integrity and operability or reduction in safety levels of road communication routes due to landslides (**Figure 7.3**); ▪ Damage to the integrity and operation of water supply, energy distribution and telecommunications networks and infrastructures (**Figure 7.3**), with the consequent risk of a breakdown in service and a reduction in levels of safety, habitability and social conditions; ▪ Potential damage to the integrity and operation of social facilities, with the consequent risk of a breakdown in service and a reduction in the level of services provided. safety and social conditions. For example, a day and night centre was detected in the parish of Fraião, Nogueira and Lamaçães, coinciding with an area at risk of slope movement (**Figure 7.3**); ▪ Possible damage to the integrity of wastewater drainage infrastructure (**Figure 7.3**), with the consequent risk of contamination or accidental pollution of the natural environment.

Climate Risks	Future direct and indirect impacts
Heat waves	▪ Damage to the integrity and operability or reduction in safety levels of road communication routes, due to the indirect risk of fires occurring rural areas (**Figure 7.5**); ▪ Possible damage to water and energy distribution, gas or telecommunications infrastructures due to high temperatures or indirect risk of fire rural areas (**Figure 7.4** and **Figure 7.5**); ▪ Increase in the indirect risk of fire or through the deterioration of thermal comfort conditions in social, civil protection or security facilities (**Figure 7.4** and **Figure 7.5**), with a consequent increase in the risk of reduced living conditions and service provision. Possible increase in energy consumption to mitigate thermal discomfort.
Extreme Phenomena (Winds / Storms)	▪ It was not possible to obtain georeferencing for the risk of strong winds and storms, however, in the event of this type of weather event occurring extreme, it is possible to list a series of expected impacts: ▪ Damage to airport infrastructure (aerodrome) and reduced operating conditions; ▪ Damage to energy distribution or telecommunications infrastructures due to strong wind or storms; ▪ Damage to the integrity of health, social support and education infrastructures or equipment, civil protection and public safety, with a consequent increase the risk of service breakdown and reduced levels of safety, service provision and social conditions; ▪ Worsening public safety conditions in areas with a higher risk of strong wind or storms.
Droughts	▪ Increased risk of deteriorating operating and living conditions in social, civil protection or public safety facilities, in as a result of the possible need to implement restrictions on water use in extreme drought situations, and with a consequent increase in the risk of reducing the conditions for providing these services. Even so, the occurrence of this type of extreme weather event resulting in drought seems unlikely to happen within the period being analysed.
Forest Fire	▪ Risk of damage to the integrity of road communication routes, or reduced accessibility. ▪ Possible damage to water supply, energy distribution and telecommunications networks and infrastructures, with a consequent increase in the risk of failure of the service and reduced levels of safety, habitability and social conditions, due to the occurrence of forest fires; ▪ Any damage to the integrity of health, social support or education infrastructures or facilities, as well as equipment or infrastructures of civil protection and public safety, with a consequent increase in t h e risk of service breakdown and a reduction in security levels;

Climate Risks	Future direct and indirect impacts
	▪ Possible damage to the integrity of wastewater infrastructure and waste management, and any risk of accidental contamination or pollution of the natural environment.

In the future, some of the climate risks are expected to worsen, resulting in an increase in their intensity, specifically through an increase in the frequency and/or severity of the damage or conditions of operation and provision of essential services of the infrastructure or equipment identified. **Table 7.36** shows the future vulnerabilities identified for the Infrastructure sector, which refers to the exposed (vulnerable) elements in each type of climate risk that has a high (or higher) degree.

Table 7.36. Future climate vulnerabilities in infrastructures

Climate Risks	Vulnerabilities
Floods	▪ Health facilities, social support and education, civil protection and public safety; ▪ Road infrastructure; ▪ Supply and sanitation infrastructures; ▪ Electrical distribution infrastructures; ▪ Telecommunications infrastructures.
Landslides	▪ Road infrastructure; ▪ Social facilities; ▪ Supply and sanitation infrastructures; ▪ Electrical distribution infrastructures; ▪ Telecommunications infrastructures.
Heat waves	▪ Road infrastructure; ▪ Health facilities, social support and education, civil protection and public safety; ▪ Water and energy distribution, gas or telecommunications infrastructures.
Extreme Phenomena (Winds / Storms)	▪ Health facilities, social support and education, civil protection and public safety; ▪ Airport infrastructures (aerodrome); ▪ Electrical distribution infrastructures; ▪ Telecommunications infrastructures.
Droughts	▪ Health facilities, social support and education, civil protection and public safety;
Forest Fire	▪ Health facilities, social support and education, civil protection and public safety; ▪ Road infrastructure; ▪ Supply, sanitation and waste management infrastructures; ▪ Electricity production and distribution infrastructures; ▪ Telecommunications infrastructures.

Table 7.40 systematises the evolution of the level of climate risks in the infrastructure sector.

Table 7.40. Evolution of climate risks for the Infrastructure sector

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Phenomena Extreme (Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

Bass Moderate High

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.1.8 Human Health and Safety of People and Goods

As the number and severity of events worsens, it is expected that the following vulnerabilities will occur in the future on a Braga municipality scale, in addition to the worsening of those already occurring today, namely with regard to the main impacts of droughts/heatwaves, which drive an increase in morbidity and mortality, especially in the most vulnerable segments of the population, and extreme precipitation and strong winds, which can cause a greater number of victims and more serious consequences for them.

Table 7.37 identifies the main future impacts on the municipality of Braga in terms of Human Health and the Safety of People and Goods.

Table 7.37. Main future impacts on Human Health and the Safety of People and Goods

Climate Risks	Current direct and indirect impacts
Floods	▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings; ▪ Damage/conditioning to infrastructure; ▪ Changes in the use of equipment/services.
Slope movements	▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings; ▪ Damage/conditioning to infrastructure; ▪ Changes in the use of equipment/services.
Heat waves	▪ Increasing discomfort discomfort discomfort, in particular with extra thermoregulatory effort; ▪ Burnt buildings / infrastructure; ▪ Degradation of air quality;
Extreme Phenomena (Strong Winds / Storms)	▪ Increased instances of falling trees, ▪ Landslides and slopes; ▪ Damage to the road and railway network with traffic interruptions or restrictions; ▪ Damage to buildings; ▪ Damage/conditioning to infrastructure; ▪ Changes in the use of equipment/services.
Droughts	▪ Degradation of air quality.
Forest Fire	▪ Burnt buildings / infrastructure; ▪ Damage to communication and other routes; ▪ Damage/conditioning to infrastructure; ▪ Degradation of air quality.

Table 7.38 shows the current vulnerabilities identified for the Human Health and Safety of Persons and Goods sector.

Table 7.38. Future climate vulnerabilities for the Human Health and Safety of Persons and Goods sector

Climate Risks	Vulnerabilities
Floods	▪ General population; ▪ Equipment; ▪ Road infrastructure, communications; ▪ Infrastructures and energy supply;
slope movements	▪ General population; ▪ Equipment; ▪ Road infrastructure, communications; ▪ Infrastructures and energy supply.
Heat waves	▪ General population; ▪ All sectors of economic activity and services; ▪ Equipment.
Phenomena Extreme (Winds / Storms)	▪ General population; ▪ Equipment; ▪ Road infrastructure, communications; ▪ Infrastructures and energy supply.
Droughts	▪ General population.
Forest fire	▪ General population; ▪ Equipment; ▪ Road infrastructure, communications; ▪ Infrastructures and energy supply.

Table 7.39 systematises the evolution of these climate risks in the Human Health and Safety of Persons and Goods sector.

Table 7.39. Evolution of climate risks for the Human Health and Safety of Persons and Goods sector

Climate Risks	Risk Level			Risk Trend
	Present (until 2040)	Medium Term (2041-2070)	Long Term (2071-2100)	
Floods				↑
Slope movements				↑
Heat waves				↑
Extreme Phenomena (Winds / Storms)				↑
Droughts				↑
Forest Fire				↑

Caption:

Low Moderate High

↑ **Increased risk**

→ **Risk maintenance**

↓ **Decrease in risk**

7.2.2 Summary of Future Impacts and Vulnerabilities

It is expected that the climate changes projected and described for the municipality of Braga will increase the development of vulnerabilities and risks, in the areas and sectors already affected today or in new areas and sectors. The evolution and interaction between climatic and non-climatic factors (social, demographic, land use, planning, among others) are of particular importance since they can alter the conditions of exposure and sensitivity to future climatic events.

Table 7.40 presents a more detailed analysis of the main future climate impacts for the municipality of Braga.

Table 7.40. Main negative impacts

Main negative impacts
The loss of goods and services: floods and flash floods are unlikely to give private property owners, traders, industries and services time to safeguard their goods, as well as to remove people, particularly the elderly, children or those with reduced mobility.
Traffic jams happen so quickly, especially in areas with tunnels and one-way streets, particularly in the late afternoon (rush hour), and take on such proportions that there is no time to warn the population (by radio or other form of generalised warning) so that they take other routes.
Damage to infrastructure, buildings, equipment and vehicles - floods and flash floods can occur at times when people are asleep or out of the building and therefore unable to create obstacles to the entry of water, and strong winds and falling trees and/or branches can destroy roofs which, combined with rain, can greatly increase the damage and therefore the associated costs when rebuilding, as well as increasing insurance premiums.
Associated with slope movements, there is damage to the integrity and operability or reduction in safety levels of road communication routes, due to landslides (Figure 7.5); damage to the integrity and operability of water supply, energy distribution and telecommunications networks and infrastructures (Figure 7.5), with the consequent risk of service disruption and reduction in safety levels, habitability and social conditions; possible damage to the integrity and operability of social facilities, with the consequent risk of service disruption and reduction in safety levels and social conditions. For example, a day and night centre was detected in the parish of Fraião, Nogueira and Lamaçães coinciding with an area at risk of slope movement (Figure 7.5); possible damage to the integrity of wastewater sanitation infrastructures (Figure 7.5), with a consequent risk of contamination or accidental pollution of the natural environment;
Heatwaves can damage the integrity and operability or reduce the safety levels of road communication routes, due to the indirect risk of rural fires (Figure 7.6); possible damage to water and energy distribution, gas or telecommunications infrastructures due to high temperatures or indirect risk of rural fires (Figure 7.6 and Figure 7.7); increased thermal comfort in social, civil protection or public safety facilities (Figure 7.6 and Figure 7.7).6 and Figure 7.7); an increase in the indirect risk of fire or through the degradation of thermal comfort conditions in social, civil protection or public safety facilities (Figure 7.6 and Figure 7.7), and with a consequent increase in the risk of reduced living conditions and the provision of services. Possible increase in energy consumption to mitigate thermal discomfort.
If we add to the impact of climate change on health and the consequent increase in the mortality of tree species the greater likelihood of more intense individual storms as the average temperature rises, there is a very high risk of damage to buildings and infrastructures, as well as damage to people's health and lives.
Extreme rainfall events could cause excessive amounts of effluent to be sent to the wastewater treatment plants, making it impossible to treat it and consequently contaminating the natural environment. It could also cause flooding and physical damage to waste and wastewater management equipment or infrastructure. With regard to high temperatures / heatwaves, the increase in temperature could lead to an acceleration in the anaerobic digestion processes of waste and wastewater, and the consequent production of biogas which, if released into the atmosphere, would increase global warming.

Main negative impacts
Agriculture will be one of the sectors most affected. Agricultural diseases and pests may increase and/or change, creating major difficulties for farmers and increasing investments, the need for training, etc. The most affected crops, because they take longer to produce, will be fruit trees, particularly vines, which are one of the most widespread in the municipality. There could be an increasing loss of fertile soil, causing a reduction in agricultural and forestry productivity and the consequent abandonment of agriculture/forestry, leaving land unused and increasing the risk of erosion, fires, etc. Waterlogged soils can also destroy crops and delay planting beyond what is recommended, leading to major economic losses and increased insurance, as well as job losses. What's more, if the farmer, in desperation, insists on cultivating, he may compact and erode the soil, which will be aggravated if there have been fires in the area, associated with high temperatures, dry weather and wind.
Changes in biodiversity, associated with climate change itself, but also with fires, land abandonment, etc. In addition, as the areas invaded by certain species are growing rapidly (several of the Acacia genus, Ailanthus altissima, Cortaderia selloana, etc.) climate change could be to their advantage, particularly fires in the case of Acacias. Some plants, such as sedge (an agricultural weed that is currently controlled by frost) and possibly other weeds, could become particularly difficult to control, increasing the need for interventions and/or the use of agrochemicals that contaminate soil, air, food and water.
The increase in average temperature and the increase in the occurrence of strong winds and storms, in addition to causing changes in phenology, with consequences for the vegetative cycle, can cause damage to structures, leaving trees weakened and under stress, reducing their resilience, causing a greater incidence of pests and diseases, as well as the emergence of new pests and diseases as a result of changes in habitats.
Heatwaves can contribute to a change in the distribution, abundance or survival of certain species that are more sensitive to the effect of diminishing water reserves.
In general, climate change will contribute to an increase in pressure on ecosystems and natural resources and will consequently contribute to the degradation, fragmentation or even disappearance of native and endemic habitats.
The increase in average temperature and consequently the occurrence of periods of severe and recurrent drought also disturb the development of plant species, since these phenomena slow down tree growth and can lead to poor health and the possible death of trees.
Associated with the municipality's steep topography, if there are forest fires and then heavy rainfall, there is a great risk of landslides, but the same can happen if large tracts of soil in sloping areas are without any cover to stabilise them, or with short or fragile root cover. Particular care needs to be taken with such land, as well as trying to reduce the risk of debris being carried into water lines, which can aggravate flooding by creating barriers to the flow of water, and even lead to the destruction of infrastructure and endanger people and animals.
There could be an increase in the volume of eutrophied waters due to the "washing" that soils can undergo after being fertilised with synthetic fertilisers, which are then washed into the water lines; as well as contamination of groundwater with agrochemicals.

Main negative impacts
Illegal sewage connections to rainwater (and the other way round) could jeopardise public health if the network exceeds its capacity and sewage begins to appear on the roads and thus comes into contact with the population. This, along with rising temperatures and the maintenance of puddles in the ground, could lead to the reappearance of diseases that seemed to have been eliminated (cholera, malaria, etc.), particularly among the most fragile groups (the elderly, children and the chronically ill).
High temperatures, combined with more concentrated rainfall over short periods of time, will increase water consumption for irrigation and bathing and water scarcity, which will imply the need to invest in the resizing of water treatment and storage infrastructures and new consumption habits, opting for green areas with less (or no) irrigation, creating green roofs, "infiltration gardens", fewer waterproofed areas, shading public spaces and less use of water mirrors (unless with closed-circuit water but with the risk of Legionella), biological swimming pools rather than conventional ones, etc.
Increased water scarcity, coupled with greater evapotranspiration, will result in a necessary change in the municipality's agricultural practices. Irrigated crops that are currently very popular in the municipality will have to give way to others.
The increase in temperature and the reduction in summer rainfall will result in a foreseeable reduction in water quality, making eutrophication more frequent, with the consequent risk to the use of these waters.
As far as groundwater is concerned, it is generally accepted that its response time is much slower overall, so no changes to aquifer recharge values have yet been noted. It is therefore understood that their availability is not currently affected. However, climate change, by causing a reduction in surface water availability and thus an increase in water demand, will necessarily increase the pressure on groundwater abstraction. What's more, a greater constraint on the quality of surface water will necessarily have implications for the quality of water that recharges aquifers.
The increase in energy consumption for cooling, with the environmental and economic consequences this could have.
Wind on unprotected (possibly ash-covered) and dry ground will increase the rate of particles in the air, in addition to the gases from the combustion itself (fires), which will increase air pollution and therefore respiratory health problems.
With the increase in the occurrence of fires (high temperatures, associated with low humidity in the air and soil, and possibly wind), also due to the common species (coniferous and eucalyptus) and lack of clearing of the undergrowth, the level of CO_2 released will increase, contributing to the intensification of climate change.
The extreme conditions (in summer) could lead to the desertification of urban centres, with a consequent reduction in traditional commerce and an increase in insecurity.
Climate change will also have an impact on tourism at various levels, particularly with the increase in forest fires, which will lead to changes in the practice of any leisure activity in rural or forest areas, particularly hiking trails; floods and inundations will also lead to the destruction of tourist facilities and infrastructures: destruction and blocking of access routes; interruption of means of communication.

Despite these negative impacts, it is possible to identify some opportunities arising from climate change that should be considered with a view to the future development of the municipality (**Table 7.41**).

These opportunities stem from excessive rainfall and rising temperatures, which could boost the utilisation of rainwater and create new dynamics in the tourism sector.

Table 7.41. Main positive impacts and opportunities

Positive Impacts and Opportunities
The reduction in frosts and cold snaps will bring advantages to most crops (although some may delay or prevent germination and/or fruiting, as is the case with fruit trees, which lose quantity and quality, and brassicas - turnips, cabbages, etc.), increase the comfort of the population and reduce heating costs and the consequent environmental impact.
Possibility of opting for other crops in the agricultural sector and more adapted species in public green areas, as well as native forest.
Land redevelopment, minimising soil sealing, improving drainage and creating more and better green areas as infiltration zones.
Possibility of raising public awareness and monitoring private spaces, the water network, drainage systems, etc.
Increased scientific knowledge, creation of new energy generation technologies, studies in the field of geology in order to study the risks of landslides, better construction techniques, soil consolidation, etc.
Greater use of rainwater and grey water.
Improvements in the quality/methods of construction materials, for greater durability and better behaviour, given the new characteristics of the climate.
Increased response capacity from Civil Protection services, for example through campaigns and interventions.
New possibilities for the tourism sector, given the increase in sunny days.

7.2.3 Climate Risk Assessment

Table 7.42 and **Figure 7.20** assess Braga's climate risk according to meteorological events and associated impacts, identifying current and future vulnerabilities in the medium term (2041).
- 2070) and in the long term (2071-2100).

Currently, the climate risks with the greatest incidence in the municipality of Braga are floods and inundations, slope movements, heat waves, extreme phenomena (winds and storms), droughts and forest fires.

The occurrence of intense precipitation, the change in the precipitation regime with a concentration of periods of precipitation, but of greater magnitude, will increase the occurrence of floods, with the potential to cause loss of human life, damage to buildings, equipment, infrastructures and public space. Daily life will be profoundly disrupted, with roads being restricted/closed and the operation of public facilities and services being interrupted. In terms of agriculture, there could be heavy damage due to loss of sowings and affected crops. It is well known that the storms, cyclones and strong winds that have been frequent in recent years have affected the functioning of the local community. The damage tends to be extensive, both to municipal and regional property and to private property, with damage to public spaces, buildings, falling structures and trees, and to vehicles. In the medium and long term, these impacts are expected to worsen.

The occurrence of heatwaves has effects on natural and human systems. Loss of biodiversity and impacts on human health, as well as increased mortality, are the fastest-growing impacts over the century.

Droughts will become more frequent, with very significant impacts on agriculture, crop losses and farming systems.

The fires will be based on the expected occurrence of higher temperatures with losses of forest, crops and agricultural land and the possibility of damage to the population, property and the environment.

Table 7.42. Evolution of climate risks

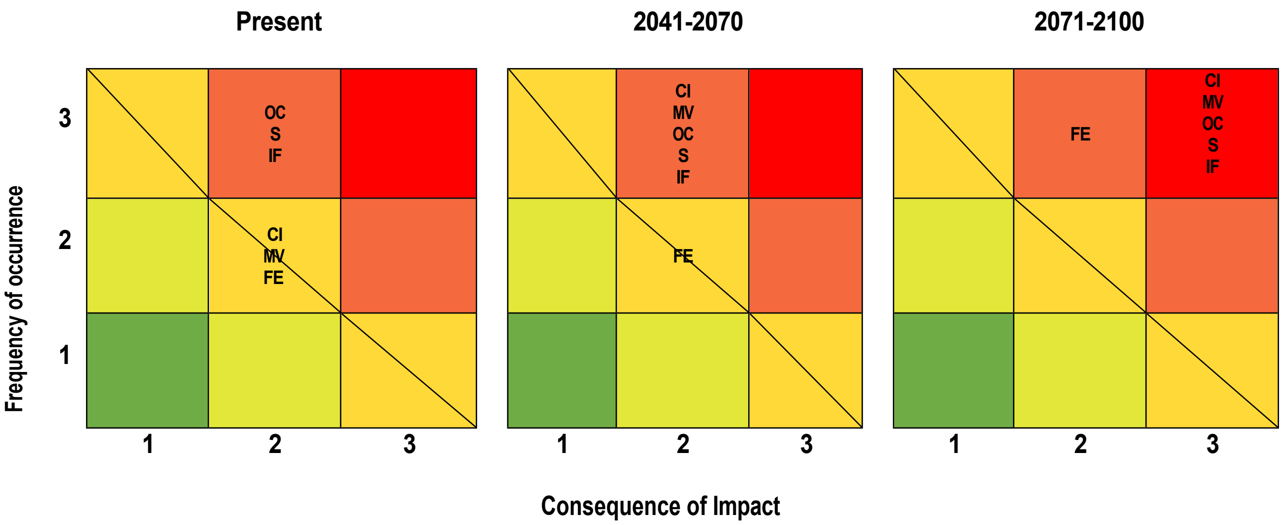
Climate-related natural risks	Risk Level		
	Present	Medium Term (2041/2070)	Long Term (2071/2100)
Floods			
Slope movements			
Heat waves			
Extreme Phenomena (Winds / Storms)			
Droughts			
Forest fire			

Caption:

Low Moderate High

↑ **Increased risk**
→ **Risk maintenance**
↓ **Decrease in risk**

Figure 7.20 schematically shows the evolution of risk for the main impacts associated with climatic events in the municipality, indicating the assessment made in terms of priority.



Legend Climate Risks: Floods (CI); Slope Movements (MV); Heat Waves (OC); Extreme Phenomena (Winds / Storms) (FE); Droughts (S); Forest Fires (IF).

Figure 7.20. Evolution of climate risks for the municipality of Braga

7.3 Climate Sensitivity Analysis

The sensitivity matrix below systematises the sensitivity analysis of the various sectors to the different climate risks (Error! Reference source not found.) in the long-term scenario (2071/2100). It should be noted that various climate risks can act cumulatively in different sectors, which in many cases exonerates the sensitivity of these climate risks.

It is important to note that the potential for resilience and adaptive capacity that the municipality is aiming for (for example through the implementation of the actions in this PMAC) is aimed at reducing the sensitivity of the various sectors.

Table 7.43. Sensitivity matrix by sector

Climate Risks	Sensitivity			
	Low	Average	High	Very high
Floods			▪ Tourism ▪ Infrastructure ▪ Industry ▪ Human Health and Safety and Goods	▪ Ecosystems and Biodiversity ▪ Water Resources ▪ Agriculture ▪ Organisation of Territory
Slope movement		▪ Tourism	▪ Ecosystems and Biodiversity ▪ Agriculture ▪ Infrastructure ▪ Human Health and Safety and Goods	▪ Water Resources ▪ Spatial planning ▪ Industry
Heat waves		▪ Tourism	▪ Industry ▪ Spatial planning ▪ Infrastructure	▪ Ecosystems and Biodiversity ▪ Water Resources ▪ Agriculture ▪ Human Health and Safety and Goods
Extreme phenomena (strong winds / storms)		▪ Spatial planning	▪ Ecosystems and Biodiversity ▪ Water Resources ▪ Tourism ▪ Industry ▪ Infrastructure ▪ Human Health and Safety and Goods	▪ Agriculture
Droughts	Infrastructure		▪ Water Resources ▪ Tourism	▪ Ecosystems and Biodiversity ▪ Agriculture ▪ Spatial planning ▪ Industry ▪ Human Health and Safety and Goods
Forest fires			▪ Water Resources ▪ Industry ▪ Infrastructure ▪ Agriculture ▪ Tourism	▪ Ecosystems and Biodiversity ▪ Spatial planning ▪ Human Health and Safety and Goods

7.4 Resilience Potential and Adaptive Capacity

With regard to the resilience potential and adaptive capacity of the municipality of Braga, it is important to highlight Braga's EMAAC - a reference that determined a set of adaptation measures, based on the identification and characterisation of measures, initiatives or projects that could respond to the main needs, objectives, vulnerabilities and climate risks (current and future) to which the municipality i s already, or may be, exposed.

Table 7.44 shows the status and evidence of implementation of the measures proposed in the Braga EMAAC (**Annex AIII**).

72 per cent of the measures have been fully implemented and 28 per cent are in the final stages of implementation or execution.

Table 7.44. Implementation status of Braga's EMAAC adaptation measures

Adaptation options	State
Measure 1 - Creation of a Municipal Civil Protection Centre.	
Measure 2 - Creation of a monitoring system for river flows and flood zones (tunnels).	
Measure 3 - Monitoring air quality parameters (O3) and meteorology.	
Measure 4 - Monitoring the health of the tree park.	
Measure 5 - Production of a Municipal Manual of Good Practices.	
Measure 6 - Promoting the study and definition of a set of tree and shrub species to be preferentially used in both local authority and private projects, as part of the preparation of the Good Practices Manual.	
Measure 7 - GIS preparation of a 'Climate Change Susceptibility Map' for the municipality.	
Measure 8 - Implementation of an annual training and awareness-raising plan.	
Measure 9 - Construction of retention basins upstream of the city (Sete Fontes Park; Este river valley), Torto river (Real Dume and Frossos).	

Adaptation options	State
Measure 10 - De-silting water lines and optimising preventative processes at the beginning of autumn in relation to rainwater drainage: collecting foliage, cleaning ditches and gutters, etc.	✓
Measure 11 - Rehabilitation of riparian galleries.	✓
Measure 12 - Integration between sustainable drainage systems (bio-swales or others) and the existing or planned rainwater network.	⚙
Measure 13 - Promoting the development of urban design options: creation of infiltration gardens/retention basins/conversion of impermeable pavements.	✓
Measure 14 - Creating buffer strips with shrub vegetation on the slopes most susceptible to water erosion.	✓
Measure 15 - Introduce shading elements, based on vegetation, in the most open and busy streets.	✓
Measure 16 - Promoting the increase and diversification of green spaces, including vertical gardens and landscaped roofs.	✓
Measure 17 - Promoting shaded areas in artificial structures built in critical areas.	✓
Measure 18 - Introduction of evaporative cooling solutions (such as water mirrors, sprinklers and sprays) in green spaces and public open spaces.	✓
Measure 19 - Maintenance of natural ventilation corridors (wooded banks of water courses, especially along the slopes of the main local reliefs) and urban corridors (tree-lined streets, orientated to the prevailing winds, north-south and north-west-south-east).	⚙
Measure 20 - Promoting bioclimatic and energy-efficient construction.	⚙
Measure 21 - Promoting a programme to improve the use of treated and free water (boreholes, wells, mines, etc.).	⚙
Measure 22 - Recovery, conservation and extension of water storage infrastructures.	✓
Measure 23 - Reuse of treated water from the WWTP for irrigation.	✓
Measure 24 - Promoting the utilisation of forest biomass (water heating, pellets, etc.).	✓
Measure 25 - Promoting forest planning and management - giving preference to native species, making mosaics and opening firebreaks, installing water points, etc.	✓

Adaptation options	State
Measure 26 - Promoting the control of invasive species, pests and diseases.	✓
Measure 27 - Implementing an integrated mobility plan to effectively reduce the use of individual motorised transport, promoting travel by public transport and soft modes (cycling and walking).	✓
Measure 28 - Promoting the cultivation of alternative agricultural species adapted to climate change.	✓
Measure 29 - Promoting an increase in the area of worked agricultural land.	✓

Source: CMB, 2023

Caption:
✓ Measure implemented ⚙ Measure being implemented or partially implemented

The IGTs can also play a decisive role in the capacity to adapt to climate change since they define the spatial distribution of uses, activities, equipment and infrastructures, as well as the forms and intensities of their utilisation, with reference to the territory's development potential and the protection of its resources.

The spatial and urban planning approach makes it possible to highlight the specific conditions of each territory and take them into due consideration when analysing the effects of climate change.

It also allows adaptation responses to be optimised, avoiding forms of land use, occupation and transformation that increase exposure to the most significant impacts, taking advantage of the conditions of each location to provide more sustainable solutions.

Spatial planning also makes it possible to combine strategies for mitigating and adapting to climate change, through the Strategic Environmental Assessment (SEA) procedure to which municipal territorial plans are generally subject.

Notwithstanding the specific legislation applicable, with the aim of preserving and protecting infrastructure and the built environment, the Braga PDM defines a set of regulatory provisions that stipulate constraints in flood zones and corridors of the Municipal Ecological Structure, and fire defence constraints in forest or rural areas. It also defines a protection regime and constraints in road network easement areas and the public railway domain, as well as constraints in a number of other areas.

basic infrastructure, namely:

a) Public Water Supply;

b) Basic sanitation (wastewater drainage);

c) Electrical Network;

d) Gas network (gas and oil pipelines);

e) Collection and Valorisation of Solid Waste (Braval).

In this sense, the revision of Braga's Municipal Master Plan is an opportunity to translate the principles and guidelines listed above and those that will be defined in the next phase of this plan into land-use planning and management.

The Municipality of Braga is also one of the 301 signatories of the **Climate Change Adaptation Mission**, a project that supports the European Green Deal and the EU Strategy for Climate Change Adaptation and aims to accelerate the climate resilience of regions and communities in order to prepare for and manage climate risks. It mobilises around 370 million euros for research and innovation under the *Horizon Europe* programme and has the support of more than 17 private companies, service centres, research networks and local action groups in a follow-up process until 2030.

The Cávado Intermunicipal Community (CIM Cávado) is also part of a European project, "***Nature Based Solutions for Atlantic Regional Climate Resilience***", which has 30 European partners, with CIM Cávado as a partner and the participation of the municipalities of Braga and Esposende. This project has been funded to the tune of 18 million euros, and CIM Cávado has been allocated a budget of 346,000 euros to replicate actions in the territory, taking into account the solutions developed in the project's "demonstrator" regions - "*Nature Based Solutions*" (natural, sustainable and innovative approaches) related to water management, coastal and marine systems and biodiversity will be applied over four years; It also involves improving sustainable urbanisation to reduce the impact of heatwaves, and restoring degraded ecosystems, providing solutions to both floods and droughts and combating the proliferation of invasive aquatic species.

In March 2023, the Braga Business Association (AEB) joined the Braga Business Mobility Pact, leading the transition to more sustainable mobility and committing to implementing a set of actions that promote **decarbonised**, multimodal and inclusive **mobility** in Braga.

This initiative, promoted by BCSD Portugal and Braga City Council, aims to **reduce the municipality's GHG emissions,** ensure that everyone has access to the same mobility solutions, ensure greater well-being when travelling from home to work and promote better air quality and healthier habits. To materialise these goals, it relies on the direct contribution of companies and institutions.

This potential for resilience and adaptive capacity will be analysed in detail and taken into account in the product of the next phase of this project, which will comprise the preparation of the Municipal Climate Action Plan (PMAC), where a vision will be developed and the objectives of the municipal climate action policy for the municipality of Braga will be outlined, with the identification of measures and actions in terms of mitigation, adaptation and governance - which will consist of the Climate Action Plan.

8. Climate Action

8.1 Vision and objectives of the municipal climate action policy

8.1.1. Vision

In a context of climate change, and despite the existence of a high degree of uncertainty, the likelihood of adverse meteorological events is very significant, namely floods, extreme phenomena, droughts and heatwaves.

These events result in heavy material damage, as well as the costs inherent in the operational resources of civil protection and the municipal services mobilised. This situation will tend to worsen over the course of the century, according to climate projections.

It is therefore considered necessary to make Braga's municipal territory and society more resilient to climate risks, to adapt municipal policies to this new reality and to prepare municipal services for an articulated and effective response, in order to minimise the negative impacts on human, environmental, economic and urban systems.

The PMAC-Braga embodies the municipal approach to responding to the challenges posed by climate change, an approach that is intended to guide municipal action to mitigate GHG emissions and adapt to the current and future climate, as well as mobilise behavioural changes in the community, in particular, towards its progressive decarbonisation and adaptation.

Braga's Municipal Climate Change Adaptation Strategy had as its strategic vision: "To *enable the municipality to deal with climate change, with a view to reducing its vulnerability in its territorial space*" and the proposed measures were defined in order to meet the objectives:

- Improving the level of knowledge about climate change
- Designing and implementing adaptations to climate change with a view to reducing vulnerability;
- Raising awareness of the need to change behaviour and implement adaptation measures.

The Municipality of Braga has signed the Covenant of Mayors for Climate and Energy, making a commitment to support the implementation of the goal of reducing its $_{CO2}$ emissions $_{by}$ at least 55 per cent by 2030, the reduction of energy poverty and the creation of a long-term vision to achieve climate neutrality by 2050. In order to fulfil this commitment, the Municipality undertakes to define a number of measures for

The Sustainable Energy and Climate Action Plan identifies situations with potential for improvement, based on the continuous assessment of indicators defined in accordance with the recommendations of the Covenant of Mayors. The SECAP covers areas where the municipality can influence energy consumption in the medium to long term (such as land use planning), encourage markets for energy-efficient products and services (public procurement), as well as changes in consumption patterns (working with citizens).

Thus, the PMAC-Braga is a municipal climate policy instrument for developing and monitoring the implementation of environmental policies, particularly in the fight against climate change.

The Climate Change Programme must reflect the municipality's contribution to national climate policy objectives. In this sense, it is essential to ensure that they are aligned with the objectives and targets established at national level, such as the Basic Climate Law, the Roadmap for Carbon Neutrality (RNC 2050) and the National Climate Energy Plan (PNEC 2030), in the mitigation dimension, and the National Strategy for Adaptation to Climate Change (ENAAC) and the Action Programme for Adaptation to Climate Change (P3-AC), in the adaptation dimension, adopting a vision of **Braga - a municipality that is more resilient to climate change**.

8.1.2. Strategic Objectives

The PMAC should include the objectives and targets set at municipal level, both in terms of reducing greenhouse gas emissions and in terms of preparing for and responding to the effects of climate change, as well as the actions to be developed and the associated investment. Therefore, the following are established as the strategic objectives of the PMAC-Braga:

- **SO1:** Reduce GHG emissions in the municipality, promoting carbon neutrality;
- **SO2:** Promote territorial adaptation to extreme climate events;
- **SO3:** Build the capacity of municipal structures and other stakeholders for climate action on a local scale;
- **SO4:** Increase knowledge of climate risks and their impacts and responses on a local scale.

To this end, a series of climate actions are set out below in order to realise these objectives and implement strategies to increase resilience to a changing climate.

8.2 Action plan

The actions of PMAC-Braga are organised according to the four areas summarised in **Figure 8.1**.

Figure 8.1. Sectoral framework for climate action

The PMAC-Braga actions have an impact on different sectors (**Figure 8.2**): buildings (population, commerce, services, industry, agriculture, forests, biodiversity, WCD and buildings), transport/mobility, local renewable energy production, waste, green infrastructure, water, land use planning (urban planning) and the safety of people and goods (civil protection and emergency). Although a key sector has been identified for each action, in reality most of them also contribute to other sectors, intersecting in different areas of action.

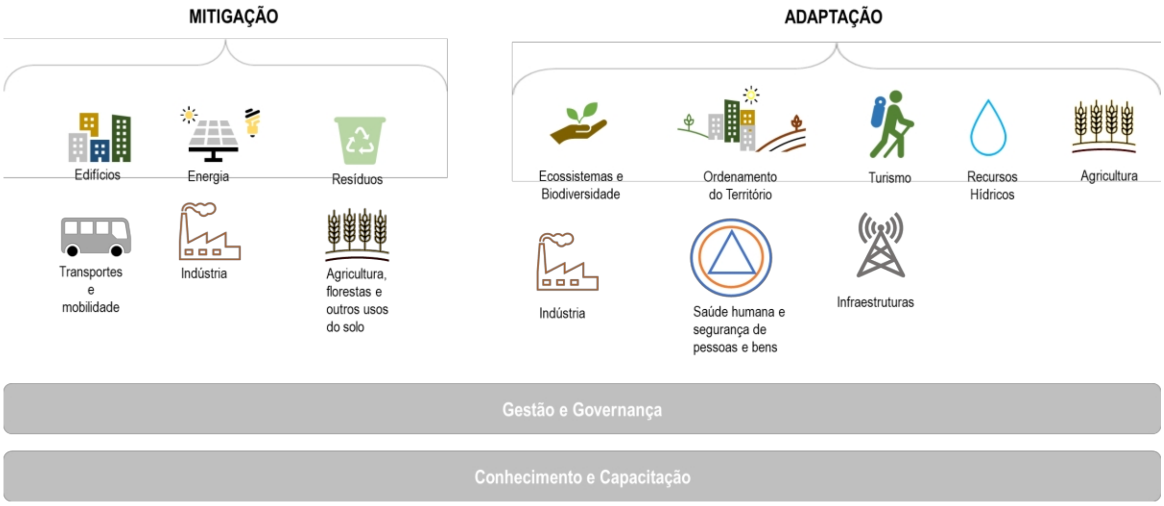


Figure 8.2. Sectoral framework for cross-cutting measures and actions

In addition to the sectoral impact, there are other actions of a transversal nature which, although they don't have a direct impact on climate action, act as support and leverage instruments and are common to all sectors. The cross-cutting actions act in the field of knowledge, technical training, new technologies and information systems, as well as governance, awareness-raising, communication, citizenship and civic participation. These actions are described and detailed in action sheets in **Volume II.**

In this context, **Table 8.1** shows the set of actions included in the scope of the PMAC-Braga, for the climate action areas considered (Mitigation, Adaptation, Management and Governance, Knowledge and Capacity Building).

Table 8.1. PMAC-Braga actions

Scope	Code	Action	Cost estimate
Mitigation	M#01	Ensure the safety and continuity of pedestrian circulation through the requalification of public space and articulation with other modes of transport	€€€
	M#02	Decarbonising the public transport fleet	€€€
	M#03	Introduce information and communication technology and integrate tariffs to encourage the use of public transport and soft modes	€€
	M#04	Expanding the municipal cycling network	€€€
	M#05	Promoting the energy rehabilitation of commercial and service buildings	€€€
	M#06	Drawing up the Programme for Optimising Energy Performance and Decarbonisation in Industry	€€
	M#07	Remodelling and upgrading public lighting networks (2nd phase)	€€€
	M#08	Draw up and implement the Municipal Bio-waste Strategy	€€
	M#09	Improving the self-sufficiency and energy efficiency of wastewater and waste treatment infrastructures	€€€
	M#10	Increasing electric charging stations	€€
	M#11	Implementing the Braga Business Mobility Pact	€€
	M#12	Draw up a Plan to Minimise Energy Poverty in Buildings	€€
	M#13	Promoting the energy rehabilitation of buildings and public spaces, social housing and public facilities	€€€
Adaptation	A#01	Review the Braga Municipal Health Plan to include specific actions to combat the effects of climate change	€
	A#02	Maintaining and promoting natural ventilation corridors in the city's urban fabric	€€
	A#03	Strengthen entomological surveillance and control of vector-borne diseases	€
	A#04	Reusing treated wastewater or rainwater for irrigation and cleaning public spaces	€€
	A#05	Encouraging the consumption of locally produced agricultural products	€
	A#06	Create a roadmap for the circular economy in the municipality's agroforestry sector, linked to existing initiatives and programmes.	€
	A#07	Continuing to implement the Municipal Afforestation Plan	€€

Scope	Code	Action	Cost estimate
	A#08	Draw up the Municipal Drought and Water Scarcity Management Plan	€
	A#09	Preserving, promoting and benefiting municipal green spaces	€€€
	A#10	Draw up a plan to control and eradicate exotic and invasive flora species	€
	A#11	Incorporate climate risk analysis into the Municipal Civil Protection Emergency Plan (PMEPC)	€
	A#12	Regularising drainage and renaturalising water bodies	€€€
	A#13	Expanding the area of urban gardens and implementing a "my school garden" programme	€
	A#14	Promoting afforestation and improving the environmental value of forests in municipal territory	€€
Management and Governance	G#01	Developing a Municipal Civil Protection Platform	€€
	G#02	Promoting sustainable public procurement by defining and incorporating criteria into public procurement specifications	€
	G#03	Implement an air quality monitoring network with an atmospheric pollution forecasting model	€€
	G#04	Develop a Materials Management and Circularity Platform (including a materials bank and a circular market)	€€
	G#05	Create tax and/or financial incentives for adopting climate actions	€€
Knowledge and Training	C#01	Implement the PMAC-Braga Communication Plan	€
	C#02	Draw up good practice manuals and studies on the subject of climate change	€€
	C#03	Disseminating information on active mobility and walking and cycling routes	€
	C#04	Create a communication and awareness-raising centre for good energy sustainability practices	€€
	C#05	Draw up and implement the Municipal Environmental Education and Awareness Plan	€

Caption:

€	Reduced cost	(up to €75,000)
€€	Average cost	(75 000 € a 750 000 €)
€€€	High cost	(over €750,000)

8.3 Integration into municipal land-use plans

The climate action strategy recommended for the municipality of Braga comprises a set of structural adaptation options (grey and green infrastructure) and non-structural adaptation options, which correspond to the design and implementation of policies, strategies and processes that contribute to climate change adaptation and mitigation. One of the ways in which non-structural options are realised is through the integration of climate action measures into municipal land management instruments. This chapter presents a reference framework for integrating priority actions that can be implemented through land use planning into municipal land management instruments. Within the more specific framework of urban planning, a framework of climate guidelines for urban planning is also presented, which sets out a number of planning options that can help mitigate adverse climate events on human health and comfort and which should be taken into account when drawing up, reviewing or amending land use and urban planning instruments in Braga.

Spatial planning and urban planning policy defines and integrates the actions promoted by the Public Administration in order to ensure the proper organisation and use of the territory, with a view to its enhancement and with the ultimate aim of ensuring the integrated, harmonious and sustainable economic, social and cultural development of the country, the regions and the various areas that make up the municipal territories.

This public policy is implemented through the territorial management system determined by Law no. 31/2014, of 30 May - which establishes the general bases of public policies and the legal regime for land, spatial planning and urbanism - and Decree-Law no. 80/2015, of 14 May - which approves the revision of the Legal Regime for Territorial Management Instruments (RJIGT) approved by Decree-Law no. 380/99, of 22 September.º 80/2015, of May 14 - which approves the revision of the Legal Framework for Territorial Management Instruments (RJIGT), approved by Decree-Law no. 380/99, of September 22, the national scope is implemented through the national spatial planning policy programme (PNPOT), sectoral programmes and special programmes, while the regional scope is implemented through regional programmes. The inter-municipal sphere takes the form of inter-municipal programmes, inter-municipal master plans, inter-municipal urbanisation plans and inter-municipal detailed plans. Finally, the municipal level is implemented through the municipal master plan, urbanisation plans and detailed plans. Within the scope of the Municipal Territorial Management System, municipal plans correspond to regulatory instruments and establish the land use regime, defining territorial occupation models and the organisation of urban networks and systems and, on the appropriate scale, land use parameters, as well as guaranteeing sustainability.

socio-economic and financial as well as environmental quality.

The drawing up of municipal plans is determined by resolution of the city council, which establishes the deadlines for drawing them up and the period for participation. In the case of the municipal masterplan, the decision to draw it up must be based on the local development strategy, which defines the strategic guidelines for the implementation and structured management of the municipality's development and competitiveness processes.

The land use and urban planning approach makes it possible to highlight the specific conditions of each territory and take them into due consideration when analysing the effects of climate change. It also allows adaptation responses to be optimised, avoiding forms of land use, occupation and transformation that accentuate exposure to the most significant impacts, taking advantage of the conditions of each location to provide more sustainable solutions.

Finally, spatial planning makes it possible to combine strategies for mitigating and adapting to climate change. This value of spatial planning also stems from the result of the Strategic Environmental Assessment (SEA) procedure to which municipal territorial plans are usually subject. In effect, this procedure sets out, based on the weaknesses and/or opportunities identified, the areas and focuses of interest that the plan can and should assess/think about and that its implementation can resolve or enhance, respectively.

Overall, and considering the material and documentary content of territorial plans at municipal level, there are four main ways of promoting local adaptation to climate change through land use planning and urban planning:

- **Strategic** - producing and comparing territorial development scenarios; conceiving medium and long-term sustainable development visions; establishing new principles of land use and occupation; defining guidelines for the location of buildings and infrastructures and for uses, morphologies and preferred forms of territorial organisation;
- **Regulatory** - establishing provisions of a legal and regulatory nature relating to the use, occupation and transformation of land and forms of urbanisation and building; encouraging the adoption of energy efficiency and other solutions to reduce spatial impact;
- **Operational** - determining provisions on priority interventions; identifying the most appropriate projects in view of territorial exposure and sensitivity; monitoring and publicising results; defining the investment framework for territorial qualification, enhancement and protection; concretising the various public policies and economic and financial regimes with territorial expression;

- **Territorial governance** - mobilising and stimulating awareness, capacity building and the participation of local, regional and central government, economic actors and society articulating knowledge and experience and promoting the coordination of different policies with a territorial expression.

As a strategic instrument and taking into account the assessments made in the previous chapters, the PMAC presents a reference framework for the contribution of the IGTs to the implementation of the municipality's adaptation strategy. In this context, the most suitable/opportune territorial plans at municipal level (under review/being drawn up) are signalled for the implementation of the adaptation options identified as potentially achievable.

Based on guidelines on how to integrate adaptation options into the material and documentary content of each plan, the aim is also to help ensure that adaptation to climate change is regularly considered in the processes of drawing up, amending and revising territorial plans at municipal level. The effective integration of adaptation options into municipal spatial planning will require in-depth assessments of territorial vulnerabilities (both climatic and non-climatic), particularly with regard to their spatial impact, to be carried out when plans are amended or revised. Alternative solutions for implementing each adaptation option should also be considered, in conjunction with other planning and development options for the municipality.

Spatial planning and urban planning policy is based on a territorial management system which, in a context of coordinated interaction, is organised at national, regional, inter-municipal and municipal level. Within the scope of this system, municipal plans, along with inter-municipal plans, are regulatory instruments and establish the land use regime, defining territorial occupation models and the organisation of urban networks and systems and, on the appropriate scale, land use parameters, as well as guaranteeing socio-economic and financial sustainability and environmental quality. Territorial plans at municipal level can be of three types:

- Municipal Master Plan (PDM);
- Urbanisation Plan (PU);
- Detailed Plan (PP), which can adopt the following specific modalities:
    - Rural Area Intervention Plan (PIER);
    - Urban Rehabilitation Detail Plan;
    - Safeguarding Detail Plan.

Inserted in a region with great social, economic and constructive dynamism, the Municipality of Braga has endeavoured, through the territorial management instruments at its disposal, to promote a more sustainable territorial development model, through the planning and zoning of rural and urban land, of which the tourist and business plans stand out, as well as those that focus on urban agglomerations.

The municipality of Braga is covered by 4 territorial plans of municipal scope, which include: Municipal Master Plan (under review); 1 Urbanisation Plan; 2 Detailed Plans:

- Municipal Master Plan (Notice no. 11741/2015, of 14 October);
- Tibães Detailed Plan (Notice no. 22323/2008, of 22 August);
- Monte Picoto Park Detailed Plan (Notice no. 13888/2021, of 13 July);
- Sete Fontes Urbanisation Plan (Notice no. 18100/2021, of 24 September, Declaration of Rectification no. 982/2022, of 22 November).

In addition to the territorial plans at municipal level, the municipality is also covered by the following territorial management instruments at national and regional level:

- National Spatial Planning Policy Programme (PNPOT);
- National Programme for the Efficient Use of Water (PNUEA);
- National Road Plan (PNR);
- Baixo Minho Regional Forest Management Plan (PROFBM);
- Entre Douro e Minho Regional Forest Management Programme;
- River Basin Management Plan for River Basin District 2 (RH2) 3rd Cycle - PGRH do Cávado, Ave e Leça 2022-2027.

Table 8.2. General guidelines for integrating sectoral and transversal actions into territorial plans at municipal level

Phase/Process	Guidelines
General guidelines for all Municipal Spatial Plans (PMOT)	
Drafting / Amendment / Revision	- Create and articulate networks to strengthen and promote sustainable mobility in the municipality; - Define measures, both structural and non-structural, to reduce the likelihood of flooding and/or its impact in certain locations. - Rehabilitate streams and associated riparian galleries; - Preparing public spaces for rising temperatures and other extreme phenomena; - Create green corridors/connect green spaces; - Avoid excessive soil sealing; - Give preference to the use of native plant species that are suited to the ecological systems present; - Promoting the use of 100% sustainable energy in public spaces - Promote urban regeneration; - Contribute to the diversification/valorisation of the tourist offer; - Promote the enhancement of public spaces and create conditions for their enjoyment; - Comply with the measures stipulated in the Municipal Forest Fire Defence Plan; - Strengthening adaptation in urban planning and territorial management. Considering the climate scenarios, produce the municipal risk map, namely the following maps: - Susceptibility/hazard maps for each of the hazards identified in the municipality; - Municipal charter of exposed elements; - Risk localisation maps for each of the hazards identified in the territory. When drawing up susceptibility/hazard maps, consider the following risks (in addition to others not directly related to climate change): - Forest fire - Areas of high and very high fire risk considered in the PMDFCI; - Floods - Areas of Significant Potential Flood Risk (ARPSI) published in the PGRI. - Slope movements Promoting community involvement in raising awareness of territorial/environmental issues and their participation through the plans.
Manageme nt / Monitoring and Evaluation	- Comply with the defined measures/guidelines; - A detailed assessment of the impacts associated with extreme events; - Liaising with the organisations involved to implement the measures; - Keeping the guidelines of the various regional and national sectoral policies up to date.
Specific guidelines for revising the PDM	
Review	Defining the Municipal Ecological Structure, taking into account the diagnosis of the different elements of the urban and peri-urban green structure, namely:

Phase/Process	Guidelines
	- Survey and identification of existing public and private green spaces in the urban area, and peri-urban area, with a survey of tree cover. - Identifying and prioritising ecosystems and the services they provide in the context of urban dynamics and climate action; - Identification and analysis of vacant areas, municipal or of potential interest for integration into this domain, which offer favourable conditions for the creation of new green spaces, urban woodlands, productive areas and other plant formations, both in the urban area and on the outskirts, including a survey of the ownership situation, vegetation conditions and potential modalities for their use for recreational purposes; - Analysis of the main streams and watercourses that could still be the target of requalification and renaturalisation, recovering their ecological functions and dimensions, both horizontal and vertical, identifying the problems with the beds and banks and proposals for correcting the flow conditions. Generally speaking, there are several stretches of the river Este/Veiga in the Ave basin and the Panóias/Torto stream in the Cávado basin in the municipality that would benefit from this type of intervention; -Identification of the areas of maximum infiltration, to be considered non aedificandi, to safeguard the regeneration capacity of the water resource, not only from the perspective of human consumption, but also of its ecological function in the soil; - Identification of the most productive agricultural soils, to be allocated to production and/or conservation functions, safeguarding the fertility fund and the carbon cycle; - Identification of other areas and/or elements that, due to their intrinsic value or landscape and/or cultural context, justify their inclusion in the Urban and Peri-urban Green Structure; - Define and incorporate rules that condition the use and occupation of land in the areas most at risk of flooding, according to current and future climate parameters, taking the Areas of Significant Potential Flood Risk (ARPSI) as a starting point. In areas at higher risk of flooding, favour non-permanent occupations whose recovery or resettlement after the occurrence of an extreme event is not particularly costly. In flood risk areas, opt for incorporating occupation conditioning measures into municipal land management instruments. The development plan should be accompanied by a risk map, which identifies risk zones corresponding to areas with certain physical or human characteristics, which should be subject to additional regulations that condition the dominant uses and occupations established for each category of space.

9. Implementation, Monitoring and Evaluation

9.1 Management and monitoring structure

The PMAC-Braga management and monitoring model should be based on the three pillars of Leadership, Operationalisation and Monitoring (**Figure 9.1**).

Figure 9.1. PMAC-Braga management and monitoring model

(**Figure 9.2**):

- **Leadership of the** climate action policy is the responsibility of the Mayor and Councillors of Braga City Council;
- The Environment, Climate Change and Animal Policy Division (DAACPA) is responsible for **coordination and operationalisation;**
- The participation and dissemination dimension is centred on an "**alliance for climate action**" responsible for co-governance, systemic innovation, networking and national and international partnerships, in particular the Braga Municipal Council for the Environment and Climate Action (CMAACB).

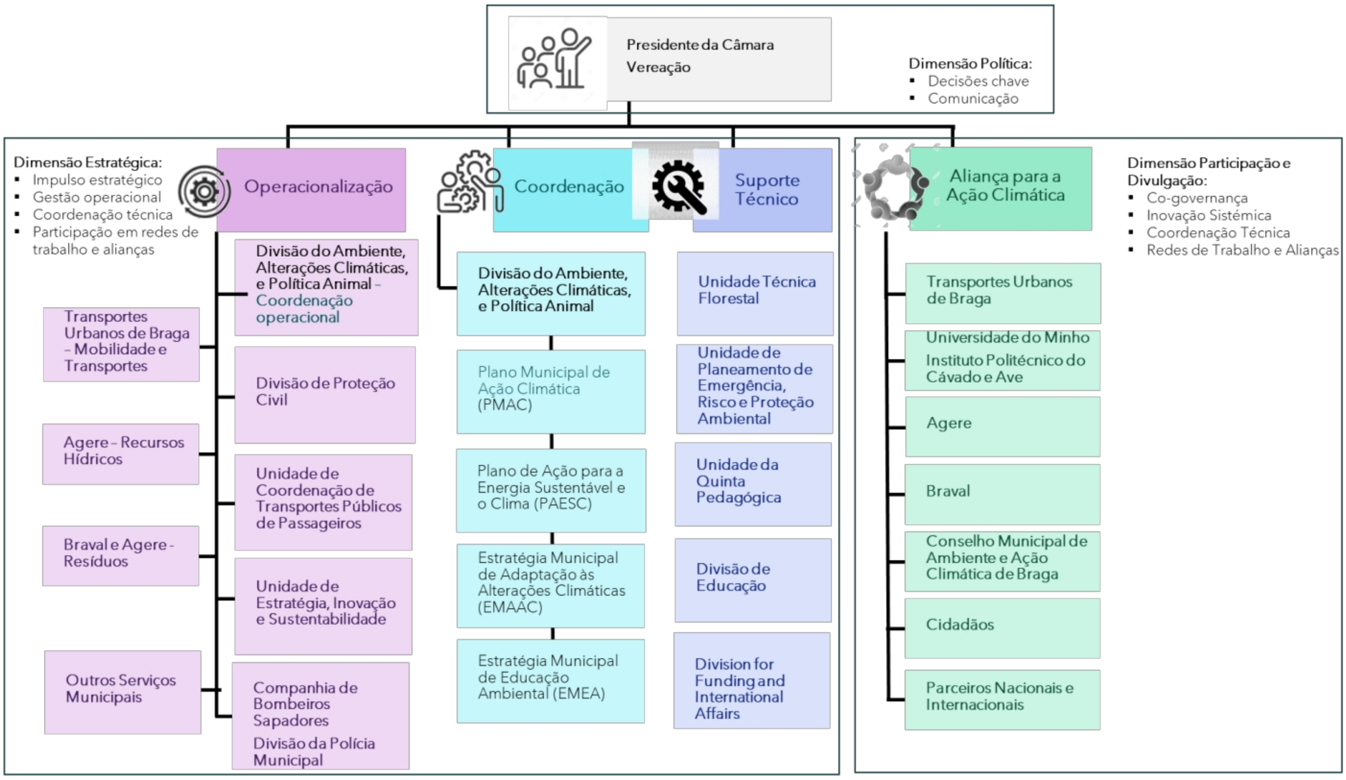


Figure 9.2 Climate action governance model

9.1.1 Operationalisation Component

The Environment, Climate Change and Animal Policy Division (DAACPA) is the body responsible for drawing up and implementing the PMAC-Braga and for liaising with other public administration bodies (central, regional and local) and other groups, people or organisations with an interest in or responsibility for implementing the PMAC's actions. In this respect, DAACPA is responsible for:

1. **Coordinate the implementation of actions** - Lead the execution of the actions recommended in the PMAC-Braga that fall within their responsibilities and attributions;
2. **Monitor** - Manage the PMAC monitoring and evaluation process;
3. **Establishing Partnerships / Protocols** - Ensuring that actions for which other organisations are responsible are carried out;
4. **Communicate** - Regularly publicise the implementation status of the PMAC-.

It should be noted that the PMAC-Braga, in addition to being a guiding document for Braga City Council's climate action policy, is a dynamic, evolving instrument, capable of representing the current reality, but also anticipating future scenarios, according to the most recent territorial and scientific data available.

9.1.2 Follow-up component

The implementation of PMAC-Braga should be monitored by various entities, including citizens, national and international partners, research and innovation centres and the Braga Municipal Council for the Environment and Climate Action (CMAACB)[21]. This co-governance dimension aims to establish a permanent structure for debate and participation in all relevant municipal matters in the field of the environment and climate action, with a view to protecting the natural heritage and sustainable municipal and regional development.

The CMAACB has the following competences (Article 2 of Chapter I of the Regulations):

a) Debate relevant municipal matters that may have environmental impacts and issue opinions, recommendations or suggestions regarding such matters;

b) To analyse and issue recommendations on intervention and rehabilitation projects for the urban environment, as well as those relating to the rural environment, which may have an impact on the environment and/or hinder adaptation to climate change, in accordance with the guidelines of the Municipal Strategy for Adaptation to Climate Change (EMAAC);

c) Suggest actions to implement intervention and rehabilitation projects for the urban environment, in accordance with the EMAAC guidelines;

d) Collaborate in drawing up guidelines that encourage the integration of good practices in private intervention projects, in accordance with the EMAAC guidelines and with a view to ensuring the fulfilment of the SDGs and the 2030 Agenda;

e) Helping to draw up policies and measures for climate action in the municipality;

f) Debate, support and evaluate the current Municipal Strategy for Adaptation to Climate Change;

g) Promoting scientific knowledge about the phenomenon of climate change and communicating it to different target audiences;

h) Facilitating and sharing information with public bodies on climate change mitigation measures;

i) Propose and encourage environmental education and awareness-raising activities aimed at all of society's target audiences, adapting the content to the diversity it reflects;

j) Facilitate collaboration, teamwork and information sharing between CMAACB members, and between them and the municipality.

[21] Regulation approved and published by Notice 13920/2023 of 21 July.

It is important to highlight the composition of the CMAACMB, which is intended to be representative of the population and various organisations (**Table 9.1**) (Article 5 of Chapter II of the Regulation).

Table 9.1. Composition of the CMAACB

Composition of the CMAACB
Mayor or Councillor with responsibility for the Environment and Climate Change, who presides
Councillor, or his representative, responsible for town planning
Councillor, or his representative, responsible for Mobility
Councillor, or his representative, responsible for Education
A representative from AGERE
A representative of the BRAVAL company
One representative from each group of the Braga Municipal Assembly
The Municipal Civil Protection Coordinator or his/her representative
The animal's Provider
A representative of the mayors, elected by the Braga Municipal Assembly
A representative of the Braga Sapper Fire Brigade
A representative of the Braga Volunteer Fire Brigade;
A representative from Eco-Schools/ABAE
A representative of the Northern Regional Coordination and Development Commission
A representative of CIM Cávado
A representative of the Cávado Forestry Association
A representative of Braga Urban Transport
A representative from InvestBraga
An ICNF representative
A SEPNA representative
A PSP representative
A representative of the Municipal Police
A representative of the Institute of Science and Innovation for Bio-sustainability of the University of Minho
A representative of the Plant Germplasm Bank
A representative of the Eco-Veiga Eco-Club
A representative of AREA - Friends of the River East
A representative of Katavus - Associação Ambiental e Cultural da Zona do Vale do Cavado a Norte do Concelho de Braga (Environmental and Cultural Association of the Cavado Valley North of the Municipality of Braga)
A representative of Minhorigem - Agro-ecological Association of Minho
A representative of ASPA - Association for the Defence, Study and Dissemination of Cultural and Natural Heritage

Composition of the CMAACB
A representative of JOVEMCOOP - Associação Jovem Cooperante Natureza/Cultura (Young Cooperating Nature/Culture Association)
A representative from ASPEA - Portuguese Association for Environmental Education - Braga Centre
A representative of ADOC - Associação de Ocupação Constante (Constant Occupation Association)
A representative of Braga Ciclável - Association for Urban Mobility by Bicycle
Other organisations and personalities at the invitation of the president of CMAAC, on the recommendation of the majority of councillors.

In addition to its members, other natural or legal persons who specialise in matters of great environmental importance or have a special interest in the matters on the agenda may be invited to take part in the CMAACMB, such as:

- Specialised experts in the field of the environment or climate action, with academic recognition;
- Representatives of other Environmental Non-Governmental Organisations (ENGOs) or similar organisations with relevant environmental or action activities in the municipality of Braga
  climate, formally expressing an interest in participating in the CMAACB;
- Representatives of private companies or public bodies, at the invitation of the chairman of the Council, particularly in the areas of the environment, construction, energy, waste and
  information technologies.

Still on the subject of the structure and monitoring of the PMAC-Braga, it is considered that it should follow the provisions of *Chapter III Organisation and Functioning of* the CMAACMB, particularly with regard to **meetings and convening notices**. The CMAACMB meets in ordinary session every four months, and extraordinarily whenever the Bureau or the Chairman so determines, or a third of the members so request (Article 17, Section II of Chapter **III** of the Regulations).

Article 21 of Section II of Chapter III of the Regulation provides for the publicising of decisions.

All decisions, opinions or recommendations of relevance to the Municipality are sent by the Bureau to the Mayor, the President of the Municipal Assembly and other entities with an interest in the matters being decided.
All CMAACMB decisions sent to the **municipality are published on its official website**.

9.2 Financing

The realisation of the actions planned in this PMAC-Braga depends on the availability of financial resources, as many of the actions involve high volumes of investment, due to the acquisition of expensive equipment or the large territorial dimension of the intervention. The overall investment associated with implementing the actions is estimated at around **59 million euros by 2030** (**Table 9.2**).

Table 9.2. Summary of investment estimates

Types of Actions	Number of Shares	Estimated Investment	
		Total (€)	Total (%)
Mitigation	13	42 390 000 €	72%
Adaptation	14	15 360 000 €	26%
Management and Governance	5	735 000 €	1%
Knowledge and Training	5	515 000 €	1%
Total	**37**	**59 000 000 €**	**100%**

Access to support instruments and sources of funding for implementing the actions recommended in the PMAC-Braga is crucial. In this regard, there are funding opportunities in various European Union instruments, national funds, international institutions and other private organisations, which are identified in the action sheets (**Volume II**).

9.3 Monitoring and evaluation

The PMAC-Braga management monitoring model makes it possible to gauge the fulfilment of the Plan's objectives, as well as to assess the performance of its implementation and the impacts of the proposed actions, but also to follow the evolution of local climate parameters and impacts.

Monitoring the PMAC-Braga is a continuous, flexible and adaptive process (**Figure 9.3**). The PMAC-Braga will be reviewed every 5 years or, extraordinarily, if there are significant deviations from the main indicators and targets planned or if there is a need to make structural changes to the plan. The need for reformulation may arise for reasons of force majeure, such as fundamental changes in the municipality's political and governmental guidelines or substantial legal or regulatory changes in the national or European context. Each time the PMAC-Braga is revised, a follow-up and monitoring report is drawn up on the targets and measures defined in the plan, and annual interim progress reports are also planned. These evaluations are also important for highlighting possible constraints or new opportunities in the field of climate action, as well as revising the timing of actions if necessary.

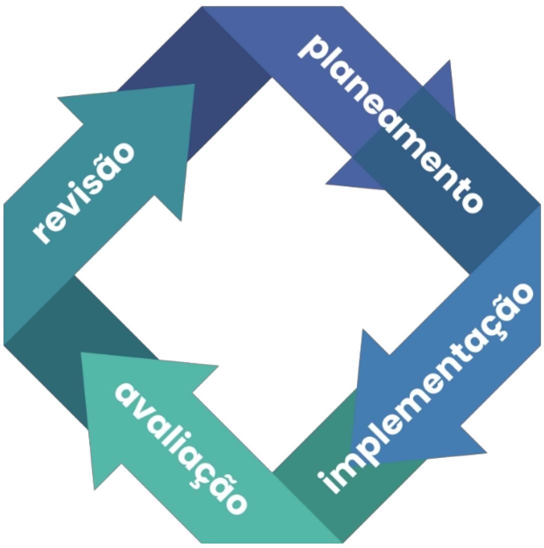


Figure 9.3. Evaluation and monitoring component of PMAC-Braga

Thus, three areas of evaluation are proposed for monitoring Braga's PMAAC:

- PMAC performance monitoring (adaptation actions);
- Climate monitoring (climate parameters);
- Impact monitoring (Climate Impact Profile).

The impact of the actions should also be assessed, measured in terms of their contribution to reducing emissions and climate risk and achieving social, environmental and economic benefits. In terms of adaptation, the monitoring of climate variables, specifically extreme weather events with an impact on the municipality, should be systematised and automated, as well as integration with warnings/alerts and impact indicators. There is also a need to deepen knowledge and monitor the effects of climate change on health, with external collaboration from public organisations in the sector.

9.3.1 Performance monitoring of PMAC-Braga

Based on the identification and characterisation of the actions to be carried out within the scope of this PMAC-Braga and in response to the current and expected vulnerabilities, it is important to guarantee the quality of their implementation in an effective and efficient manner. To this end, it is crucial to establish a monitoring process that will accompany the various actions and tasks planned.

A set of indicators for monitoring the actions up to 2030 was therefore determined, taking into account that: it should be a set of indicators that are simple in form, clear in terms of their evaluation objective and non-exhaustive in number; it should be possible to re-evaluate them periodically, allowing for the integration of new data, particularly scientific data and possible changes (whether of a climatic, economic, social or environmental nature), in conjunction with other municipal instruments.

This monitoring should be carried out periodically and its results used, in particular, to adjust and rethink the planned actions and tasks in order to achieve the objectives set by PMAC-Braga.

In this context, **Table 9.3.** presents the set of indicators that should be used to monitor and evaluate the implementation of the PMAC-Braga, for which the Braga City Council is responsible, in technical liaison with the entities that are relevant stakeholders in the field of climate change.

Table 9.3. PMAC-Braga performance indicator system

Action		Indicator(s) Realisation	Source	Indicator(s) Result	Source
ID	Name				
M#01	Ensure the safety and continuity of pedestrian circulation through the requalification of public space and articulation with other modes of transport	Investment in the implementation or upgrading of footpaths (€/year; % of planned)	CMB	Footpaths built or upgraded (no. of footpaths and metres built or upgraded; % compared to planned).	CMB
M#02	Decarbonising the public transport fleet	Investment in alternative energy vehicles (€/year; % of forecast)	TUB	Alternative energy vehicles (no.; % total fleet)	TUB
M#03	Introduce information and communication technology and integrate tariffs to encourage the use of public transport and soft modes	Revised tariff policy (Yes/No)	TUB	Modal journeys by public transport (%)	TUB/CMB
		Introduction of ICT in public transport (Yes/No)	TUB	Evolution of public transport demand (no. of passengers/year; no. of passengers/km; no. of monthly or annual passes issued)	TUB/CMB
M#04	Expand the cycling network (Ecovia do Cávado)	Degree of physical execution of the cycle path (metres executed; % compared to plan)	CMB	Daily users on the cycle path (average number of daily users at certain times of the year)	CMB
M#05	Promoting the energy rehabilitation of commercial and service buildings	Support mechanisms implemented (no. of mechanisms, actions or projects; € invested/year; % of planned)	CMB	Gains or energy reduction achieved in supported buildings (kWh/year; €/year)	CMB
		Commercial and service buildings rehabilitated (no. of buildings supported/rehabilitated)	CMB		CMB

Action		Indicator(s) Realisation	Source	Indicator(s) Outcome	Source
ID	Name				
M#06	Drawing up the Programme for Optimising Energy Performance and Decarbonisation in Industry	Support mechanisms implemented (no. of mechanisms, actions or projects; € invested/year; % of planned)	CMB	Energy gains or reductions achieved in supported industries (kWh/year; €/year)	CMB
		Rehabilitated industries (no. of industries supported/rehabilitated)	CMB		
M#07	Remodelling and upgrading public lighting networks (2nd phase)	LED street lighting coverage (%)	CMB	Evolution of public lighting consumption (kWh/year; % reduction)	CMB/DGEG
M#08	Draw up and implement the Municipal Bio-waste Strategy	Degree of implementation of the bio-waste strategy (in preparation / approved / being implemented / completed)	AGERE / BRAVAL	Population served by selective collection of bio-waste (%)	AGERE
M#09	Improving the self-sufficiency and energy efficiency of wastewater and waste treatment infrastructures	Wastewater and waste management infrastructures improved (no; €; % of forecast)	AGERE/ BRAVAL	Reduction of consumption and GHG emissions in the wastewater and waste management infrastructures benefited (kWh/year; kg-CO2e/year)	AGERE/ BRAVAL
M#10	Increasing electric charging stations	Implementation of electric charging stations (no./year)	CMB / BCSD	Energy consumption associated with charging electric vehicles (kWh/year)	CMB / DGEG
M#11	Implementing the Braga Business Mobility Pact	Degree of implementation of the Braga Business Mobility Pact (% implementation)	BCSD / CMB	Companies adhering to the PMEB (no.)	BCSD / CMB

Action ID	Action Name	Indicator(s) Realisation	Source	Indicator(s) Outcome	Source
M#12	Draw up a Plan to Minimise Energy Poverty in Buildings	Degree of implementation Building Energy Poverty Minimisation Plan (in preparation / approved / being implemented / completed)	CMB	Households supported (no./year; €/year; % of existing households identified with energy poverty)	CMB
M#13	Promoting the energy rehabilitation of buildings and public spaces, social housing and public facilities	Buildings and public spaces, social housing and public facilities rehabilitated (no./year; €/year)	CMB	Energy gains or reductions achieved in supported buildings or equipment (kWh/year; €/year)	CMB
A#01	Review the Braga Municipal Health Plan to include specific actions to combat the effects of climate change	Actions included in the Municipal Health Plan (no.)	CMB	Health Newsletter	CMB
		Actions implemented (no.)	CMB	Environmental actions carried out (no.)	CMB
		Actions being implemented (no.)	CMB	Users covered, by type of action (no. per type)	CMB
		Actions not implemented (no.)	CMB		
A#02	Maintaining and promoting natural ventilation corridors in the city's urban fabric	Length (km) and areas of green corridors (ha)	CMB	Area of green space per inhabitant (m2/inhabitant)	CMB
		Photographic record of actions	CMB	Number of connections to other green spaces: <1; 1-2; ≥3	CMB
A#03	Strengthen entomological surveillance and control of vector-borne diseases	Awareness-raising activities on pest control (aimed at agricultural and forestry producers) (no.).	CMB	Identification and quantification of areas affected by disease vectors	CMB
				Identification and quantification of disease-transmitting species	CMB

Action		Indicator(s) Realisation	Source	Indicator(s) Outcome	Source
ID	Name				
A#04	Reusing treated wastewater or rainwater for irrigation and cleaning public spaces	Degree of implementation of rainwater or treated wastewater reuse projects (in preparation / approved / being implemented / completed)	AGERE	Consumption of treated wastewater (m^3/year)	AGERE
		Financial execution realised in projects for the reuse of treated rainwater or wastewater (€/year)	AGERE	Rainwater consumption (m^3/year)	AGERE
A#05	Encouraging the consumption of locally produced agricultural products	Monthly events (no.)	CMB	Local farmers in the programme (no.)	CMB
		Realised investment (€)	CMB	Commercial establishments such as restaurants, schools and supermarkets that have joined the programme (no.)	CMB
				Degree of consumer satisfaction with the quality, price and availability of local agricultural products (consumer/customer questionnaire).	CMB
A#06	Create a roadmap for the circular economy in the municipality's agroforestry sector, linked to existing initiatives and programmes	Publication of the Roadmap for the Circular Economy in the Agroforestry Sector in the Municipality of Braga	CMB	Agricultural waste recycling rate (%)	CMB
				Farms that have adopted renewable energies (no.)	CMB
				New products developed from agricultural and forestry waste (no.)	CMB

Action		Indicator(s) Realisation	Source	Indicator(s) Outcome	Source
ID	Name				
				Rate of change in areas of forests and natural and semi-natural environments (%)	CMB
				Awareness-raising and training activities (no.)	CMB
A#07	Continue the implementation of the Municipal Afforestation Plan	Drawing up the intervention plan	CMB	Georeferenced survey of municipal tree heritage (%)	CMB
		Implementation of interventions (no.; % by level of implementation)	CMB	Recording the quality of afforestation (yes / no)	CMB
				Species inventory (yes / no)	CMB
				Species identified (no.)	CMB
				Launch of the municipal platform (yes / no)	CMB
A#08	Draw up the Municipal Drought and Water Scarcity Management Plan.	Publication of reports under the Plan	CMB	Boreholes/wells since the implementation of the measure (no.)	APA/ARHN
		Measures identified in the Plan (no.)	CMB	Increase in the municipality's water availability due to the implementation of the measure (%)	AGERE/CMB
A#09	Preserving, promoting and benefiting municipal green spaces	Priority areas identified for implementing green roofs (no. and ha)	CMB	Recording the quality of afforestation (yes / no)	CMB

Action		Indicator(s) Realisation	Source	Indicator(s) Outcome	Source
ID	Name				
		Periodic survey of interventions carried out, with quantification of the area intervened upon.	CMB	Elimination of invasive species (nº /ha)	CMB
				Introduction of endemic species (nº/ ha)	CMB
A#10	Draw up a plan to control and eradicate exotic and invasive flora species	Publication of reports under the Plan	CMB	Eradication of exotic and invasive species (nº /ha)	CMB
		Sensitive areas identified (nº /ha)	CMB	Rate of area rehabilitated and recovered after fires (%)	CMB
		Publicity actions promoted on environmental conservation and enhancement (no./year).	CMB		
A#11	Incorporate climate risk analysis into the Municipal Civil Protection Emergency Plan (PMEPC)	Revision/amendment of the PMEPC.	CMB / SMPC	Production of mapping and updating of risks and vulnerabilities (yes/no by typology).	CMB / SMPC
A#12	Regularising drainage and renaturalising water bodies	Degree of implementation of Braga's General Drainage Plan (in preparation / approved / being implemented / completed)	CMB	Drainage infrastructure built or improved (no.)	CMB
				Drainage networks built or improved (km)	CMB
				Retention basins built (no.)	CMB
		Financial execution of the Braga General Drainage Plan (€/year; % of forecast)	CMB	Occurrences of flooding (no.)	CMB/ANEPC
				Water bodies that have improved their status (no.)	APA/ARHN

Action ID	Action Name	Indicator(s) Realisation	Source	Indicator(s) Result	Source
				Intervened water lines (km)	CMB
A#13	Expanding the area of urban gardens and implementing a "my school garden" programme	Good agricultural practice manuals produced (no.).	CMB	Urban gardens created (no.)	CMB
				Area of urban vegetable garden expansion (ha)	CMB
A#14	Promoting afforestation and improving the environmental value of forests in municipal territory	Publication of reports under the Plan (no.)	CMB	Changes in forest area by type (ha)	CMB
				Actions taken to conserve biodiversity and forest ecosystems (no./year)	CMB
				Specific actions to prevent forest fires (no./year)	CMB
G#01	Developing a Municipal Civil Protection Platform	Platform Creation (Yes/No)	CMB / SMPC	Website created (yes / no)	CMB / SMPC
				Content produced (no.)	CMB / SMPC
				Accesses and interactions (no.)	CMB / SMPC
G#02	Promoting sustainable public procurement by defining and incorporating criteria into public procurement specifications	Publication of the good practice manual	CMB	Gains from sustainable public procurement (€)	CMB
				Expenditure resulting from sustainable public procurement (€)	CMB
G#03	Implement an air quality monitoring network with an atmospheric pollution forecasting model	Network implemented (yes/no)	CMB	Air Quality Index (yes / no)	CMB
				Exceedances of limit values set for pollutants in ambient air (no. / year)	CMB

Action		Indicator(s) Realisation	Source	Indicator(s) Result	Source
ID	Name				
G#04	Develop a Materials Management and Circularity Platform (including a materials bank and a circular market)	Degree of implementation of the materials management and circularity platform (in preparation / approved / being implemented / completed)	CMB	Flows or value chains created between entities (no.)	CMB
				Materials reused or recovered (t/year)	CMB
G#05	Create tax and/or financial incentives for adopting climate actions	Tax and financial incentives granted (€)	CMB	Reduction of GHG emissions in supported actions (kg-CO2e/year)	CMB
		Beneficiaries supported (no.)	CMB		CMB
C#01	Implement the PMAC-Braga Communication Plan.	Publication of Plan follow-up reports	CMB	Awareness-raising actions organised and participants in each of the planned actions (no. of actions)	CMB
				Training activities organised (no.) and technicians covered (no.)	CMB
				Dissemination mechanisms produced (no.)	CMB
				Website created (yes / no) Content produced (no.) Accesses and interactions (no.)	CMB
C#02	Draw up good practice manuals and studies on the subject of climate change	Manuals and studies published (no.)	CMB	Individuals who benefited from awareness-raising activities (no.)	CMB
				Buildings built/rehabilitated according to technical guidelines (no.)	CMB

Action		Indicator(s) Realisation	Source	Indicator(s) Outcome	Source
ID	Name				
C#03	Disseminating information on active mobility and walking and cycling routes	Dissemination actions carried out (no.; % implementation)	CMB	Movements on the active mobility network (average number of daily passages at predefined points on the network and at certain times of the year).	CMB
C#04	Create a communication and awareness-raising centre for good energy sustainability practices	Counter implemented (Yes/No))	CMB	Collective and individual organisations served (no./year)	CMB
C#05	Draw up the Municipal Environmental Education and Awareness Plan	Manuals produced under the Plan	CMB	Environmental awareness actions carried out (no./year)	CMB
		Participation rate in Educational Activities (%).	CMB		

9.3.2 Climate monitoring

Monitoring is based on a set of indicators organised by climate parameters (**Table 9.4**), which must be regularly updated, processed and systematised, and taken as reference and starting values for comparative analysis and subsequent assessment, particularly of anomalies that have occurred and are potentially representative of climate change.

Table 9.4. Climate monitoring indicator system

ID	Indicators	Units	Frequency	Source
Temperature				
MC#01	Average, maximum and minimum summer temperatures	ºC	Annual	IPMA
MC#02	Average, maximum and minimum winter temperatures	ºC	Annual	IPMA
MC#03	Average maximum summer temperature	ºC	Annual	IPMA
MC#04	Average annual number of very hot days (tx ≥ 35 ºC)	no. of days	Annual	IPMA
MC#05	Average annual number of summer days (tx ≥ 25 ºC)	no. of days	Annual	IPMA
MC#06	Average annual number of tropical nights (tx ≥ 20 ºC)	no. of days	Annual	IPMA
MC#07	Heat waves - WSDI index	no. of days	Annual	IPMA
MC#08	Cold waves - CSDI index	no. of days	Annual	IPMA
MC#09	Average annual number of frost days (T < 0 ºC)	no. of days	Annual	IPMA
Precipitation				
MC#11	Average annual rainfall	mm	Annual	IPMA
MC#12	Average annual number of days with rainfall > 1 mm	no. of days	Annual	IPMA
MC#13	No. of days with precipitation > 10 mm (annual, summer and winter)	no. of days	Annual	IPMA
MC#14	No. of days with rainfall > 20 mm (annual, summer and winter)	no. of days	Annual	IPMA
MC#15	No. of days with rainfall > 50 mm (annual, summer and winter)	no. of days	Annual	IPMA
MC#16	No. of droughts and degree of severity: moderate, severe, extreme (SPI index)	No.	Annual	IPMA
Wind				
MC#17	Management	no. of days	Annual	IPMA

ID	Indicators	Units	Frequency	Source
MC#18	Intensity (trend)	no. of days	Annual	IPMA

9.3.3 Monitoring impacts

As far as impact monitoring indicators are concerned, it is important to update the Climate Impact Profile (PIC-L), since it makes it possible to identify sources and gather information on the main meteorological events to which the municipality is exposed. This monitoring will strengthen the municipality's adaptive capacity. **Table 9.5** outlines the structure of the PIC-L proposed for monitoring.

Table 9.5. Monitoring system for climatic events and impacts

Identification and consequences of the climatic event					Responsiveness				Thresholds
Date of weather event	Type of weather event	Impact(s)	Details of the consequences	Location	Responsible for the response	Those responsible for planning the response	Actions / responses	Effectiveness of actions / responses	Critical thresholds

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Annex AI. Summary of the methodology for estimating GHG emissions

SECTOR 1 - STATIONARY USES OF ENERGY

GHG emissions from the stationary energy use sector were calculated based on annual fuel consumption and the respective emission factor.

The activity data considered and the respective sources, as well as the corresponding emission factors and information on the methodology applied, are presented below by sub-sector.

Domestic

Activity data	Sources	Methodology
Domestic consumption of butane and propane	Directorate-General for Energy and Geology (DGEG) - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of Liquefied Petroleum Gas (LPG, includes butane and propane) in the category residential.
Domestic consumption of light oil / fuel oil	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for kerosene combustion in the category residential.
Domestic consumption of coloured diesel for heating	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the residential category.
Domestic biomass consumption	DGEG - National Energy Balance (2021).	IPPC 2006 - Standard emission factor for biomass combustion in the residential category. The national consumption of biomass has been reduced for the municipality through the factor of scale - resident population.
Domestic natural gas consumption	DGEG - Natural gas consumption in the internal market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the category residential.
Domestic consumption of natural gas for heat pumps	DGEG - National Energy Balance (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the residential category. National consumption has been reduced to through a scale factor - resident population.
Consumption consumption of electricity supplied by the grid	DGEG - Electricity consumption by sector of economic activity and municipality (2021). Portuguese Environment Agency (APA) - GHG emission factor of electricity produced in Portugal (2023).	National emission factor for 2021.

Commercial and institutional

Activity data	Sources	Methodology
Butane consumption in the wholesale trade	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of LPG (includes butane) in the category commercial / institutional.
Consumption of coloured diesel for heating in commerce by thick	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of diesel fuel in the commercial category / institutional.
Consumption consumption propane in restaurants and accommodation	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for LPG combustion (includes propane) at commercial / institutional category.
Consumption of coloured diesel for heating in restaurants and accommodation	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the commercial category / institutional.
Propane consumption in administrative services, education and health activities human and social support	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of LPG (including propane) in the commercial / institutional category.
Diesel consumption for heating in administrative, education, human health and support service activities services, education, human health and support social	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the commercial / institutional category.
Consumption of road diesel for waste collection, treatment and disposal, and material valorisation	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the commercial / institutional category.
Consumption of propane in artistic and literary activities, sports, amusement and recreational activities, and activities of the membership organisations	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of LPG (including propane) in the commercial / institutional category.
Consumption of coloured diesel in artistic and literary activities, sports, amusement and recreational activities, and activities of the membership organisations	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the commercial / institutional category.
Natural gas consumption in commerce, consultancy, scientific, technical and other activities personal services	DGEG - Natural gas consumption in the internal market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the commercial / institutional category.
Natural gas consumption in public services	DGEG - Natural gas consumption in the internal market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the category commercial / institutional.

Biomass consumption in public services	DGEG - National Energy Balance (2021).	IPPC 2006 - Standard emission factor for biomass combustion in the commercial category / institutional. National biomass consumption has been reduced

Activity data	Sources	Methodology
		for the municipality as a factor of scale - resident population.
Natural gas consumption for heat pumps in public services	DGEG - National Energy Balance (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the commercial / institutional category. National consumption was reduced to the municipal level through a scale factor - resident population.
Electricity consumption in the commercial, institutional and public lighting sectors, supplied by the grid	DGEG - Electricity consumption by sector of economic activity and municipality (2021). Portuguese Environment Agency (APA) - GHG emission factor of electricity produced in Portugal (2023).	National emission factor for 2021.

Manufacturing and construction

Activity data	Sources	Methodology
Propane consumption in industry	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of LPG (includes propane) in the category manufacturing industries and construction.
Road diesel consumption in industry	DGEG - Sales of petroleum products in the internal market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the diesel combustion in the manufacturing and construction industries category.
Consumption of coloured diesel for heating in industry	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the industries category transformation and construction.
Fuel oil consumption in industry	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of fuel oil in the industries category transformation and construction.
Paraffin consumption in industry	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for kerosene combustion in the category manufacturing and construction industries.
Own consumption of coloured diesel for heating in the domestic sales market of petroleum products	DGEG - Sales of oil products on the domestic market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the manufacturing and construction industries category.
Natural gas consumption in industry	DGEG - Natural gas consumption on the market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of natural gas in the manufacturing and construction industries category.
Biomass consumption in industry	DGEG - National Energy Balance (2021).	IPPC 2006 - Standard emission factor for biomass combustion in the commercial category / institutional. National biomass consumption was reduced to the municipal level using the scale factor - resident population.
Industrial consumption of grid-supplied electricity	DGEG - Electricity consumption by sector of economic activity and municipality (2021). APA - Electricity GHG emission factor produced in Portugal (2023).	National emission factor for 2021.

Energy industries

Activity data	Sources	Methodology
Combustion of landfill gas with energy utilisation	BRAVAL, Waste Valorisation and Treatment Sólidos, S.A.	Calculated with the "*solid waste*" tool *disposal*" *of* CIRIS with some default values with some default factors (e.g. degradable organic carbon content. Local data regarding the composition of landfilled waste.
Own consumption of grid-supplied electricity	DGEG - Electricity consumption by sector of economic activity and municipality (2021). APA - Electricity GHG emission factor produced in Portugal (2023).	National emission factor for 2021.

Agriculture, forestry and fisheries

Activity data	Sources	Methodology
Consumption of IO 95 petrol in agricultural and forestry activities	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of petrol in the agricultural category and forest.
Consumption of road diesel in agricultural and forestry activities	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the agriculture category and forest.
Consumption of coloured diesel in agricultural and forestry activities	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the agriculture category and forest.
Consumption of coloured diesel for heating in activities agricultural	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the agriculture category and forest.
Consumption of illuminating oil / fuel in the forestry sector and forestry	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for kerosene combustion in the category agriculture and forestry.
Natural gas consumption in agricultural activities	DGEG - Natural gas consumption on the market by sector of economic activity and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of natural gas in the agriculture and forestry category.
Consumption by the agriculture and fisheries sector of grid-supplied electricity	DGEG - Electricity consumption by sector of economic activity and municipality (2021). APA - Electricity GHG emission factor produced in Portugal (2023).	National emission factor for 2021.

Other uses

Activity data	Sources	Methodology
Own consumption of natural gas on the domestic market	DGEG - Natural gas consumption in the internal market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the category commercial / institutional.
Grid electricity transmission and distribution losses	REN - Redes Energéticas Nacionais, S.A. E-REDES - Distribuição de Eletricidade, S.A. DGEG - Electricity consumption by economic activity sector and municipality (2021). APA - GHG emission factor of electricity produced in Portugal (2023).	National emission factor for 2021. Energy transmission losses (REN) = 2%, energy distribution losses (E-REDES) = 9.47%; total losses = 11.47%; calculation of total production in the municipality of Braga by adding total consumption and the 11.47% losses; calculation of losses: "total production" - "total consumption".

Fugitive emissions from oil and gas systems

Activity data	Sources	Methodology
Fugitive emissions resulting from the distribution of natural gas in all sectors	DGEG - Natural gas consumption in the internal market by economic activity sector and municipality (2021).	Calculated using the CIRIS "*fugitive gas"* tool with standard IPCC emission factors 2006 (volume 2, chapter 4).

SECTOR 2 - TRANSPORT

GHG emissions from the transport sector were calculated based on annual fuel consumption and the respective emission factors for road and rail transport. GHG emissions from air and sea transport were not included in this sector.

The activity data considered and the respective sources, as well as the corresponding emission factors and information on the methodology applied, are presented below by sub-sector.

Road transport

Activity data	Sources	Methodology
Consumption of petrol (IO 95 and IO 98), diesel and LPG used in land transport	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for the combustion of each of the fuels in the road transport category.
Consumption of natural gas used in land transport	DGEG - Natural gas consumption in the internal market by economic activity sector and municipality (2021).	IPPC 2006 - Standard emission factor for natural gas combustion in the category road transport.
Consumption of grid-supplied electricity in land transport	DGEG - Electricity consumption by sector of economic activity and municipality (2021). APA - Electricity GHG emission factor produced in Portugal (2023).	National emission factor for 2021.

Rail transport

Activity data	Sources	Methodology
Diesel consumption in rail transport	DGEG - National Energy Balance (2021). National Statistics Institute (INE) - Main means of transport (2021).	IPPC 2006 - Standard emission factor for diesel combustion in the railway transport category. National diesel consumption in rail transport has been reduced to the municipality level using a scale factor - the percentage of all people travelling by train on mainland Portugal who live in the municipality. Braga municipality.
Electricity consumption in rail transport	DGEG - National Energy Balance (2021). INE - Main means of transport (2021). APA - GHG emission factor of electricity produced in Portugal (2023).	National emission factor for 2021. National electricity consumption in rail transport was reduced to the municipality level using a scale factor - the percentage of all people travelling by train on the mainland who live in the municipality of Braga.

SECTOR 3 - WASTE AND WASTEWATER

Calculations of GHG emissions from the waste and wastewater sector were based on the respective annual production and type of treatment.

Solid waste disposal

Activity data	Sources	Methodology
Direct release of landfill gas into the atmosphere	BRAVAL - Valorisation and Treatment of Solid Waste, S.A.	Calculated with the CIRIS "*solid waste disposal*" tool with some default values with some default factors (e.g. degradable organic carbon content). Local data on the composition of landfilled waste.
Combustion of landfill gas without energy utilisation	BRAVAL - Valorisation and Treatment of Solid Waste, S.A.	Calculated with the CIRIS "*solid waste disposal*" tool with some default values with some default factors (e.g. degradable organic carbon content). Local data on the composition of landfilled waste.

Biological waste treatment

Activity data	Sources	Methodology
Treatment of mechanically separated organic waste through anaerobic digestion in tunnels	BRAVAL - Valorisation and Treatment of Solid Waste, S.A.	GHG emissions were accounted for using the CIRIS *"biological treatment"* calculator. The calculation used standard factors for

Activity data	Sources	Methodology
		emissions of CH_4 and N2O from the biological treatment of waste (IPPC 2006, volume 5, chapter 4).
Organic waste valorisation through composting	BRAVAL - Valorisation and Treatment of Solid Waste, S.A.	GHG emissions were accounted for using the CIRIS *"biological treatment"* calculator. Standard factors for CH_4 and N2O emissions from the biological treatment of waste (IPPC 2006) were used in the calculation, volume 5, chapter 4).

Incineration and open burning

There are no waste incineration plants in the municipality of Braga and it was assumed that there was no open burning.

Wastewater treatment and discharge

Activity data	Sources	Methodology
Domestic waste water	AGERE - Empresa de águas Efluentes e Resíduos de Braga, E.M.	GHG emissions were calculated using the CIRIS *wastewater* calculator. CH_4 emissions were calculated based on the distribution of wastewater by type of treatment and N_2O emissions were calculated based on the population and daily protein consumption per inhabitant in Portugal in 2021.
Industrial wastewater	AGERE - Empresa de águas Efluentes e Resíduos de Braga, E.M.	GHG emissions were calculated using the CIRIS *wastewater* calculator. CH_4 emissions were calculated based on the annual production of milk, meat, olive oil and wine and the type of treatment.

SECTOR 4 - INDUSTRIAL PROCESSES AND PRODUCT USE

Industrial processes

No industrial activities were identified in the municipality of Braga that triggered emissions from the non-energy use of fossil fuels in the chemical or physical transformation of materials.

Use of products

Activity data	Sources	Methodology
Use of lubricants for non-energy purposes	DGEG - Sales of oil products on the domestic market by economic activity sector and municipality (2021).	Calculated using equation 5.2, p. 5.7, from IPCC 2006 (volume 3, chapter 5) with some default values.

SECTOR 5 - AGRICULTURE, FORESTRY AND OTHER LAND USES

The calculations of GHG emissions and carbon sequestration in the agriculture, forestry and other land use (AFOLU) sector were carried out considering three sub-sectors, as shown below.

Livestock

Activity data	Sources	Methodology
Bovine enteric fermentation processes	INE - Cattle population (2021); Milk production (2021); Fat content of cow's milk collected (2021).	GHG emissions were calculated using the equations published in IPCC 2006 (volume 4, chapter 10.3, pp. 10.24-10.34). The continental data for milk production was reduced to the municipal level using a scaling factor - number of cows. dairy.
Enteric fermentation processes in other animals	INE - Sheep, goat, pig, horse, poultry and rabbit populations (2021).	IPPC 2006, with the respective 2019 updates (IPCC 2019 Refinement) - Standard emission factors for emissions from each type of animal. There are still no emission factors for birds and rabbits (table 10.10, p. 10.37).
Cattle manure management systems	INE - Cattle population (2021).	GHG emissions were calculated using the equations published in IPCC 2006 (volume 4, chapters 10.4 and 10.5, pp. 10.35-10.67) with the respective updates of 2019 (IPCC 2019 Refinement).
Management systems for manure from other animals	INE - Sheep, goat, pig, horse, poultry and rabbit populations (2021).	IPPC 2006 - Standard emission factors for direct emissions of CH_4 and N2O resulting from the manure management systems used, with the respective 2019 updates (IPCC 2019 Refinement).

NOTE: Indirect emissions of CH_4 and N2O from manure management systems are not accounted for in this subsector, but are considered under other emissions (subsector 5.3).

Land use, land use change and forestry (LULUCF)

Activity data	Sources	Methodology
Organic soil management	INERPA 2023 - National Inventory of Emissions by Sources and Removal by Sinks of Atmospheric Pollutants 1990-2021 *Coordination of Information on the Environment* (CORINE) *Land Cover* (2018, CORINE areas 411 and 412).	Portugal currently classifies organic soils as NO (No Occurrence).
Forests - living biomass gains	Directorate-General for Territory (DGT) - Land Use and Occupation Map for 2018 (COS 2018). INERPA 2023	The estimate of CO_2 sequestration in forests was determined by the gains in living biomass due to forest growth in the municipality of Braga in 2021, using standard values published by INERPA and following the guidelines published in IPCC 2006 (volume 4, chapter 4, p. 4.17).
Forests - losses of living biomass due to cutting and natural mortality	Directorate-General for Territory (DGT) - Land Use and Occupation Map for 2018 (COS 2018). Institute for Nature Conservation and Forests (ICNF) - Geographical information on burnt areas in 2020.	There is no data on the volume of wood per species cut in the municipality of Braga in 2021, so the wood that existed in the burnt area in 2020 was considered as cuts in 2021. Losses of living biomass due to logging and natural mortality in the municipality of Braga in 2021 were calculated using equations 40 and 42, pp. 105-107, from IRERPA.

NOTES:

Since the inventory of GHG emissions relates to a single year (2021), changes in land use and their impact on carbon stocks were not taken into account.

In line with what was defined in IPCC 2006, scrubland and permanent pasture were considered to have a neutral carbon balance, on the assumption that changes in the stock of living biomass over time are marginal.

Other emissions

Activity data	Sources	Methodology
Indirect emissions of N2O in the management of manure produced in cattle farming	INE - Number of calves, dairy cows and other cattle in the municipality (2021).	Indirect N2O emissions were calculated using equations published in IPCC 2006 (volume 4, chapter 10.5, pp. 10.52-10.66)
Indirect N2O emissions from the management of manure produced at raising other animals	INE - Numbers of each type of animal in the municipality (2021).	IPPC 2006 - Standard emission factors for each type of animal by type of animal manure management.
Burning of agricultural waste (orchards and vineyards) without energy utilisation	INE - Area and production of each crop (2021).	Calculations of CH_4 and N_2O emissions were carried out using equations published in IPCC 2006 with standard emission factors (volume 4, chapter 2, pp. 2.42-2.49).
Direct emissions from the application of synthetic and organic fertilisers, direct deposition of manure	INE - Area and production of each crop (2021).	The calculations of direct N_2O emissions were made using equations published in the IPCC 2006 with standard emission factors

Activity data	Sources	Methodology
in the soil by animals		(volume 4, chapter 11, pp. 11.6-11.18).
Forest fires	PORDATA - Area of forest and scrub burnt in the municipality of Braga (2021).	Emissions calculations were carried out using the IPCC 2006 *tier 1* approach (volume 4, chapter 2, equation 2.27, p. 2.42), using default values for the amount of biomass fuel, combustion factor and emission factors.

Annex IIA. Quantification of the variables used in greenhouse gas emission projections

The following indicators were considered for each of the scenarios (C1, C2, C3 and C4) when constructing the greenhouse gas (GHG) emissions trajectories in the municipality of Braga for 2050:

- Resident population;
- Gross Domestic Product (GDP);
- Structure of Gross Value Added (GVA);
- Stationary energy consumption;
- Transport;
- Waste production and treatment;
- Animal production;
- Land use structure.

The variables relating to each of the indicators were calculated for each of the six sub-periods established for the scenario (2021-2025, 2026-2030, 2031-2035, 2036-2040, 2041-2045 and 2046-2050), as shown below.

Annex AII.1 Resident population

The figure presented for the resident population in the municipality of Braga in 2021 corresponds to the final result of the 2021 General Population Census (193,324 individuals)[22].

For the three scenarios (C1, C2, C3 and C4), the resident population projections up to 2025 take into account the provisional estimate drawn up by the National Statistics Institute (INE) for 2022 (197,594 residents). When drawing up the resident population projections for the C1 scenario, a figure similar to the INE estimate for 2022 was considered for 2025, and for the 2026 to 2050 period, the evolution of the Alto scenario from INE's resident population projections for the Northern Region was taken into account[23]. The projections for scenario C2 envisage an average annual population growth of half the average of the previous five years for the periods 2023 to 2025 and 2026 to 2030, followed by a relative stabilisation of the number of residents between 2031 and 2050. In the projections for scenarios C3 and C4, the average annual population growth for the period 2023 to 2025 corresponds to the average of the previous five years, with the growth trend continuing, albeit progressively slowing, between 2026 and 2050.

[22] The provisional population estimate drawn up by the National Statistics Institute (INE) points to a total of 195,274 residents in the municipality of Braga in 2021 (a figure revised in March 2023, depending on the definitive results of the 2021 Census).

[23] INE, Resident population projections 2018-2080.

Table AII.1 shows the projected evolution of the resident population in the municipality of Braga for each of the scenarios and sub-periods established.

Table AII.1: Projections of the resident population in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	193 324	197 594	197 070	196 252	194 739	191 889	188 009
C2 - Moderate growth	193 324	200 037	203 394	203 801	204 004	204 025	204 004
C3 - Smart development	193 324	202 480	209 403	215 104	219 176	221 619	222 433
C4 - Carbon neutrality	193 324	202 480	209 403	215 104	219 176	221 619	222 433

Annex AII.2 Gross Domestic Product (GDP)

The figure presented for GDP in the municipality of Braga in 2021 is sourced from the INE (Regional Accounts), with the GDP figure for the Cávado Region having been reduced to the municipality level due to the relative weight of the municipality of Braga in the GVA of the Cávado Region in the same year (50.65%).

The GDP projections up to 2025 take into account, for the four scenarios (C1, C2, C3 and C4), the national rate of change for 2022 (6.7 per cent) and the Bank of Portugal's economic projections24 for the period 2023 to 2025, with the annual rates of change being halved in the C1 scenario and doubled in the C3 scenario. For the years 2026 to 2050, scenario C1 incorporates alternating periods of stagnation and slight recession, while scenario C2 predicts average annual economic growth of 1.5 per cent and scenarios C3 and C4 predict growth of 3 per cent.

Table AII.2. shows the GDP projections for the municipality of Braga for each of the scenarios and sub-periods established.

Table AII.2 GDP projections for the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	3 844,5	4 255,8	4 245,1	4 238,8	4 230,3	4 223,9	4 215,5
C2 - Moderate growth	3 844,5	4 413,2	4 754,3	5 121,7	5 517,5	5 943,9	6 403,3
C3 - Smart development	3 844,5	4 739,6	5 494,5	6 369,6	7 384,1	8 560,2	9 923,6
C4 - Carbon neutrality	3 844,5	4 739,6	5 494,5	6 369,6	7 384,1	8 560,2	9 923,6

Millions of euros (M€)

[24] According to the Bank of Portugal (Economic Bulletin, June 2023), the Portuguese economy will grow by 2.7 per cent in 2023, 2.4 per cent in 2024 and 2.3 per cent in 2025.

Annex AII.3 Structure of gross value added (GVA)

The breakdown of gross value added (GVA) by sector of economic activity in the municipality of Braga in 2021 is sourced from INE[25].

The projections for the sectoral breakdown of GVA for scenario C1 take into account the historical trend of a slight increase in the relative weight of the primary and secondary sectors in a period of recession. In turn, the projections for scenario C2 essentially maintain the current structure, while scenario C3 points to a trend towards an increase in the weight of the tertiary sector and a slight increase in the weight of the primary sector, due to the incorporation of circular economy principles, including the bioeconomy.

Table AII.3 shows the projections for the structure of GVA by sector of activity in the municipality of Braga for each of the scenarios and sub-periods established.

Table AII.3 Projections for the sectoral structure of GVA in the municipality of Braga

Scenario	Sector activity	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	Primary	0,22%	0,23%	0,24%	0,25%	0,26%	0,27%	0,28%
	Secondary	46,7%	46,8%	46,9%	47,0%	47,0%	47,1%	47,2%
	Tertiary	53,1%	53,0%	52,9%	52,8%	52,7%	52,6%	52,5%
C2 - Moderate growth	Primary	0,22%	0,22%	0,23%	0,23%	0,24%	0,24%	0,25%
	Secondary	46,7%	46,7%	46,7%	46,6%	46,6%	46,6%	46,5%
	Tertiary	53,1%	53,1%	53,1%	53,2%	53,2%	53,2%	53,2%
C3 - Smart development e C4 - Carbon neutrality	Primary	0,22%	0,24%	0,26%	0,28%	0,30%	0,31%	0,32%
	Secondary	46,7%	46,3%	45,3%	44,4%	43,6%	43,1%	42,5%
	Tertiary	53,1%	53,5%	54,4%	55,3%	56,1%	56,6%	57,2%

Annex AII.4 Stationary energy consumption

Electricity consumption in the municipality of Braga in 2021 is based on statistical information provided by DGEG[26].

The electricity consumption projections took into account, for the three scenarios, the projected changes in the resident population and GDP, combined with energy efficiency objectives and the replacement of energy sources dependent on fossil fuel imports with electricity. In scenario C1, the reductions in consumption are essentially the result of the loss of population and the negative evolution of the economy. Scenario C2 shows an increase in consumption due to population growth and economic activity,

[25] INE, System of integrated company accounts.

[26] DGEG, Consumption by municipality and sector of activity.

including increasing electrification of the economy, which are not sufficiently offset by energy efficiency measures. In turn, in scenarios C3 and C4 the impacts of population growth, economic dynamism and the strong electrification of the economy are accompanied by technological changes and efficiency measures that make it possible to stabilise electricity consumption at 2021 levels.

Although the electrification of road transport will cause changes in household and service consumption, this was not taken into account in the projections of stationary electricity consumption in the municipality of Braga, which are presented in Table AII.4.

Table AII.4: Electricity consumption projections for the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	666,45	666,45	659,78	653,12	646,45	639,79	633,12
C2 - Moderate growth	666,45	679,77	693,10	706,43	719,76	733,09	746,42
C3 - Smart development	666,45	666,45	666,45	666,45	666,45	666,45	666,45
C4 - Carbon neutrality	666,45	666,45	666,45	666,45	666,45	666,45	666,45

Unit: GWh

Reducing the carbon intensity of electricity production by increasing renewable energy sources, as advocated in the National Energy and Climate Plan 2030 (PNEC 2030), was the benchmark for the projections of the GHG emission factor for electricity, although with different intensities in the various scenarios, as shown in Table AII.5.

Table AII.5: Electricity emission factor projections for mainland Portugal

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	0,151	0,146	0,141	0,136	0,131	0,126	0,121
C2 - Moderate growth	0,151	0,146	0,136	0,131	0,121	0,115	0,110
C3 - Smart development	0,151	0,141	0,134	0,120	0,106	0,092	0,080
C4 - Carbon neutrality	0,151	0,141	0,134	0,120	0,106	0,092	0,080

Unit: tCO2e/MWh

The consumption of biomass (firewood and vegetable waste) in the municipality of Braga in 2021 is based on national energy balance data provided by the DGEG[27], reduced to the municipality level using a scale factor (resident population).

The biomass consumption projections took into account, for the three scenarios, the projected changes in the resident population and GDP, combined with timid objectives for reducing firewood cuts in the scenario

[27] DGEG, National Energy Balance 2021.

C2 and the evolution towards the exclusive utilisation of residual forest biomass in scenarios C3 and C4.

Table AII.6 shows the projections of biomass consumption in the municipality of Braga for each of the scenarios and sub-periods established.

Table AII.6 Biomass consumption projections for the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	18 751	18 823	18 784	18 722	18 608	18 393	18 100
C2 - Moderate growth	18 751	19 008	19 261	19 292	19 307	19 309	19 307
C3 - Smart development	18 751	17 771	16 385	15 137	14 013	13 003	12 093
C4 - Carbon neutrality	18 751	17 771	16 385	15 137	14 013	13 003	12 093

Unit: toe

In order to determine consumption of LPG28, natural gas and other fossil fuels, projections of population growth and economic activity were taken into account for scenarios C1 and C3, while for scenario C3 a trend of a 1% reduction in annual percapita consumption was considered.

Annex AII.5 Transport

The data on the car fleet in the municipality of Braga in 2021 is sourced from information on the insured car fleet29.

When drawing up the projections for the evolution of the car fleet in the municipality of Braga, the data for the insured car fleet in 2022 was taken into account30. All the scenarios, from 2023 onwards, were based on projections of the resident population and economic activity, with scenarios C3 and C4 considering a gradual increase in the use of public transport and soft mobility solutions.

Table AII.7: Projections of the car fleet in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	138 509	149590	153329	150263	147258	144312	141426
C2 - Moderate growth	138 509	152360	159978	160618	165436	168745	170433
C3 - Smart development	138 509	145434	145434	138163	131255	124692	118457
C4 - Carbon neutrality	138 509	145434	145434	138163	131255	124692	118457

Unit: Number of vehicles (all categories)

[28] Liquefied Petroleum Gas.

[29] Information provided by the Insurance and Pension Funds Supervisory Authority (ASF), corresponding to all registrations with valid insurance on 31 December of the respective year.

[30] 142,730 vehicles, according to the ASF.

Based on projections of the car fleet and the rate of 100% electric vehicles in 2021[31], as well as gradual objectives differentiated by road transport decarbonisation scenarios up to 2050, projections were established for the fleet of vehicles using fossil fuels and 100% electric vehicles, as shown in Tables II.8 and II.9.

Table AII.8 Projections of fossil fuel vehicles in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	137 662	135 906	121 991	109 336	97 644	86 593	76 358
C2 - Moderate growth	137 662	137 586	125 905	100 926	80 821	64 663	51 726
C3 - Smart development	137 662	130 562	97 519	61 645	31 406	15 878	7 968
C4 - Carbon neutrality	137 662	130 562	97 519	61 645	31 406	15 878	7 968

Unit: Number of vehicles (all categories)

Table AII.9. Projections of 100% electric vehicles in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	847	13 684	31 339	40 927	49 614	57 719	65 068
C2 - Moderate growth	847	14 774	34 073	59 692	84 615	104 082	118 707
C3 - Smart development	847	14 872	47 916	76 517	99 848	108 814	110 489
C4 - Carbon neutrality	847	14 872	47 916	76 517	99 848	108 814	110 489

Unit: Number of vehicles (all categories)

Based on car fuel consumption in the municipality of Braga in 2021[32] and projections of the number of fossil fuel vehicles, considering an average consumption of 7 litres of fuel per 100 km, road fuel consumption scenarios were established, as shown in Table AII.10.

[31] The national rate of 0.61% was used, corresponding to the relative weight of 100% electric vehicles in motorised road vehicles as a whole, according to the information provided by INE.

[32] DGEG, Statistics on coal, oil, electricity and natural gas.

Table AII.10. Projections of road fuel consumption in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	124 307	121 971	109 483	98 125	87 632	77 715	68 529
C2 - Moderate growth	124 307	123 479	112 996	90 577	72 534	58 033	46 422
C3 - Smart development	124 307	117 175	87 520	55 325	28 186	14 250	7 151
C4 - Carbon neutrality	124 307	117 175	87 520	55 325	28 186	14 250	7 151

Unit: toe

In turn, the projections for electricity consumption in road transport in the municipality of Braga, shown in the following table, took into account the projections for the number of 100% electric vehicles, as well as an average consumption of 16.9 kWh per 100 km and the average distance travelled per vehicle in the year 2021[33].

Table AII.11. Projections of electricity consumption in road transport in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	382	34 074	78 033	101 909	123 538	143 721	162 020
C2 - Moderate growth	382	36 787	84 841	148 634	210 692	259 163	295 580
C3 - Smart development	382	37 032	119 310	190 528	248 623	270 946	275 118
C4 - Carbon neutrality	382	37 032	119 310	190 528	248 623	270 946	275 118

Unit: MWh

Annex AII.6 Waste generation and treatment

The figures presented for the production and treatment of urban waste in the municipality of Braga in 2021 are based on information provided by Braval.

The projections for the production of municipal waste in the municipality of Braga took into account, for all scenarios, the projected evolution of the resident and floating population and GDP, with scenario C3 contemplating a gradual reduction in the per capita production of municipal waste, assuming an increase in prevention practices, within a framework of transition to a circular economy.

[33] 14,744 kilometres, at 7 l/100 km.

Table AII.12. Projections of municipal waste generation in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	86 197	88 101	87 648	87 153	86 308	84 917	83 034
C2 - Moderate growth	86 197	89 636	91 596	92 238	92 792	93 266	93 722
C3 - Smart development	86 197	88 916	89 658	89 566	88 524	86 601	83 877
C4 - Carbon neutrality	86 197	88 916	89 658	89 566	88 524	86 601	83 877

Unit: Tonne (t)

Table AII.13 shows the projections for municipal waste production broken down by type of treatment, with scenarios C2, C3 and C4 showing, albeit with different expressions, an increase in the relative weight of material and organic recovery operations, to the detriment of landfill disposal.

Table AII.13. Projections of municipal waste generation in the municipality of Braga

Scenario	Type of treatment	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	Valorisation material	13 266	13 559	13 489	13 413	13 283	13 069	12 779
	Valorisation organic	54 077	55 272	54 987	54 677	54 147	53 275	52 093
	Disposal in landfill	18 854	19 270	19 171	19 063	18 878	18 574	18 162
C2 - Moderate growth	Valorisation material	13 266	15 474	17 644	19 613	21 586	23 562	25 552
	Valorisation organic	54 077	56 235	57 465	57 867	58 215	58 512	58 798
	Disposal in landfill	18 854	17 927	16 487	14 758	12 991	11 192	9 372
C3 - Smart development e C4 - Carbon neutrality	Valorisation material	13 266	19 796	25 340	26 210	26 790	27 074	27 061
	Valorisation organic	54 077	55 783	56 248	56 191	55 537	54 331	52 622
	Disposal in landfill	18 854	13 338	8 069	7 165	6 197	5 196	4 194

Unit: Tonne (t)

To determine wastewater production, population growth projections were taken into account for all scenarios.

Annex AII.7 Animal production

The data on the number of animals in the municipality of Braga in 2021 is sourced from INE statistics.

The livestock projections take into account the trends of recent years for scenarios C1 and C2, while scenarios C3 and C4 foresee a decrease in cattle and pig herds, accompanied by an increase in other herds.

Table AII.14. Livestock projections in the municipality of Braga

Scenario	Species / Class	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	Cattle (< 1 year)	2 293	2 293	2 293	2 293	2 293	2 293	2 293
	Dairy cows	1 566	1 566	1 566	1 566	1 566	1 566	1 566
	Cattle (> 1 year)	3 047	3 047	3 047	3 047	3 047	3 047	3 047
	Sheep	2 219	2 330	2 446	2 569	2 697	2 832	2 974
	Goats	721	757	795	835	876	920	966
	Pigs	344	344	344	344	344	344	344
	Horses	179	183	188	193	198	203	208
C2 - Moderate growth	Cattle (< 1 year)	2 293	2 293	2 293	2 293	2 293	2 293	2 293
	Dairy cows	1 566	1 566	1 566	1 566	1 566	1 566	1 566
	Cattle (> 1 year)	3 047	3 047	3 047	3 047	3 047	3 047	3 047
	Sheep	2 219	2 330	2 446	2 569	2 697	2 832	2 974
	Goats	721	757	795	835	876	920	966
	Pigs	344	344	344	344	344	344	344
	Horses	179	183	188	193	198	203	208
C3 - Smart development e C4 - Carbon neutrality	Cattle (< 1 year)	2 293	2 178	2 069	1 966	1 868	1 774	1 686
	Dairy cows	1 566	1 488	1 413	1 343	1 276	1 212	1 151
	Cattle (> 1 year)	3 047	2 895	2 750	2 612	2 482	2 358	2 240
	Sheep	2 219	2 441	2 685	2 953	3 249	3 574	3 931
	Goats	721	829	954	1 097	1 261	1 450	1 668
	Pigs	344	327	310	295	280	266	253
	Horses	179	188	197	207	218	228	240

Unit: Number of heads

Annex AII.8 Land use structure

The figure for forest areas in the municipality of Braga in 2021 is based on the Municipal Forest Fire Defence Plan (PMDFCI).

The projections for the evolution of forest areas in the municipality of Braga took into account, for scenarios C1 and C2, the resident population and GDP projections for those scenarios, reflecting deforestation trends as a result of economic activities and forest fires. Scenarios C3 and C4, on the other hand, consider a gradual recovery of forest areas, namely through the afforestation of agricultural or uncultivated land.

Table AII.15 shows the projections of forest areas in the municipality of Braga for each of the scenarios and sub-periods established.

Table AII.15. Projections of forest areas in the municipality of Braga

Scenario	2021	2025	2030	2035	2040	2045	2050
C1 - Stagnation	6 574	6 377	6 058	5 755	5 467	5 194	4 934
C2 - Moderate growth	6 574	6 245	5 621	5 340	4 806	4 565	4 109
C3 - Smart development	6 574	6 574	6 902	7 248	7 429	7 615	7 805
C4 - Carbon neutrality	6 574	6 574	7 560	8 694	9 998	11 498	13 148

Unit: Hectare (ha)

Annex AIII. Evaluation of the implementation of Braga's EMAAC

Table AIII.1 State of implementation of the adaptation measures in the Braga EMAAC

Adaptation options	State	Evidence
Measure 1 - Creation of a Municipal Civil Protection Centre.		The aim of completing the measure is to create a municipal operations management room and implement a civil protection toll-free number, thus enabling the centralisation and management of all emergency occurrences and the dispatch of resources, with a view to greater efficiency and profitability. of the various agents.
Measure 2 - Creation of a monitoring system for river flows and areas flooding (tunnels).		A system is in operation to monitor river flows and flood zones in the tunnels, next to the Rodovia Municipal Swimming Pool, Hotel Meliã and on the bridge with Bosch.
Measure 3 - Monitoring air quality parameters (O3) and meteorology.		In Braga, there are two CCDRN stations for monitoring air quality, one in an urban context, on Av. Frei Bartolomeu dos Mártires, and the other in a rural context, at the Municipal Garden in Frossos, and, for meteorology, the CIM Cávado station in Lomar. There are also air quality monitoring sensors from the Build Project and Mosaic (Inovation Point). The municipality also has access to the IPMA Meteorological Station in Merelim S. Pedro, via the same CIM Cávado platform. Whenever necessary, the acquisition of provision of meteorological services dedicated to the municipality of Braga.
Measure 4 - Monitoring the health of the tree park.		Whenever a risk of fracture or health intervention is detected, the situation is analysed and reports are drawn up by the Gardens and Green Spaces Division. Regarding the health status of the tree park, UTAD was asked to carry out studies on the phytosanitary status of the tree park. Two assessments were carried out by UTAD for 200 trees in each action, as well as the Inventory of Trees Planted in the Municipality of Braga between 2014-2022. The municipal technical services assessed 67 trees. In total, 267 trees were assessed and slaughtered 57.
Measure 5 - Production of a Municipal Manual of Good Practices.		A Manual of Good Practices was drawn up in partnership with CIM Cávado.
Measure 6 - Promote the study and definition of a set of tree and shrub species to be preferentially used in both local authority and private projects, as part of the preparation of the Good Practices Manual.		The planting of native species in Picoto has been favoured, in particular, more than 2,000 trees have been planted as part of an application to the Environmental Fund, and thousands of trees have been planted in collaboration with companies, institutions and schools. Around 27,000 trees were planted along the water lines after the 2017 fires, with support from the APA and the Environmental Fund. To date, around 42,500 trees have been planted, involving more than 19,000 volunteers. The "Green Space Management Regulations" have yet to be approved due to the delay in approving the ICNF's Guide to Good Practices for Urban Tree Management. The "Municipal Inventory of Urban Trees" is currently at the stage of preparing the specifications for the tender, but we are still waiting for it to be finalised. approval of the ICNF's Guide to good practice in urban tree management.
Measure 7 - GIS preparation of a 'Climate Change Susceptibility Map' for the municipality.		As part of the GIS preparation of the climate change susceptibility map, prior work has been done to register actions, activities, studies and projects in Google Earth Pro, namely: Study of Braga's Solar Potential and Bio-roofs; Registration of the City's Public and Private Green Spaces; Registration of the rainwater network around the River Este (120km); Study of Water and Electricity Consumption Management in Buildings, Equipment and Gardens. Municipal; Camélias Urban Park - Laboratory for the EMAAC; Garden

Adaptation options	State	Evidence
		Brazil; Landscaping of the land surrounding the Castro stream and the Torto river in Real and Frossos; Collection points for bacteriological analyses on the Este river and the Cávado river; Points of most recurrent contamination on the Este river; Location of mills on the Cávado and Este rivers; Monte do Picoto Reforestation Project (Application to the Environmental Fund to Support Adaptation to Climate Change); Afforestation Actions; Micro Forests; East Ecovia route (preliminary study phase); East Ecological Park (preliminary study phase); Ponds with life; Braga Walking Route Network; Cycle Route Network; River basin network areas for intervention to control invasive species, etc.
Measure 8 - Implementation of an annual training and awareness-raising plan.		In this context, various actions and sessions have been developed with schools, as they are considered to be the target audience with the greatest capacity to embrace the concepts and transform theory into more environmentally friendly practices, namely: Environmental Education Campaign on Climate Change - with the Quadrilateral. Teacher training on climate change Sessions in schools - according to requestsrequests. Decarbonisation Laboratory - in operation. Offer of ecopoints and composters and theatre play "The ecopoints revolt" - with CIM Cávado. Invasive species - internships, sessions in schools and CIM Cávado (aquatic) and invasive plant control campaigns in Picoto. Control of the velutin wasp by the Fire Brigade and the chestnut gall wasp in collaboration with the DRAPN. The "Efficient School" project in the municipality's EB1 and JI schools. Braga Forest. Oxygenating Braga. Pedagogical offer of the "Pedagogical Farm", available on the website. Braga Florida. Braga Natural, photography exhibition. Launch of the book "Os Bichos de Braga".
Measure 9 - Construction of retention basins upstream of the city (Sete Fontes Park; Este river valley), Torto river (Real Dume and Frossos).		Aimed at resolving long-standing problems of flooding that put people and property at risk, the aim is to improve drainage, since extreme events are likely to become more frequent, taking advantage of the intervention to create a space for enjoyment, which will include the construction of retention basins, desilting the water lines and renaturalising their banks, as well as controlling invasive plants. As part of the planning and regularisation project for the Torto river, Panoias stream and Castro stream, work is planned on three different sections: Section 1 - 250 metres of the Torto river and 457 metres of the Panoias stream, between the Av. do Estádio roundabout and the EN 201, where work is currently being completed. Section 2 - approximately 1775 metres of the Castro stream, from the intersection with the Torto river to Rua S. Martinho (near the Av. do Estádio roundabout) with a hydraulic crossing under the EN 205-4 (Reta do Feital). Section 3 - a stretch of around 300m, from the River Torto, from the EN 201 to the Av. do Estádio roundabout (Rotunda da ETAR). For the aforementioned phases 2 and 3, the public tender for the works will be issued shortly. Rehabilitation of the East River next to the INL - The rehabilitation of this stretch of the East River consisted of desilting the bed, removing the concrete side walls, slightly re-profiling the river course, reviving the bed, lining the side walls with natural materials, stone and wood, giving continuity and enhancing the connection to the previously re-naturalised stretch, between Pedrinha Bridge and Frei Bartolomeu dos Mártires Avenue. A small

Adaptation options	State	Evidence
		retention basin in its final section, with the aim of dampening floodwaters, regulating downstream flows as far as possible. In order to minimise the effects of erosion, the bed was consolidated with high grain size stone. Requalification of the River Este between INL and Circular Sul - The section of the river Este that is to be regularised and renaturalised, over a length of around 620m, is located between Av. Mestre José Veiga (Instituto de Nanotecnologia) and Av. Frei Bartolomeu dos Mártires and aims to continue the work already carried out by the municipality, in partnership with the Portuguese Environment Agency, on the rehabilitation of the river Este next to INL. Requalification of the Mill in Este S. Pedro - The restoration and revitalisation of the water-powered mill on the river Este, in the parish of Este S. Pedro, consisted of cleaning the bed and banks of this stretch of the river Este, as well as desilting the bed, restoring the levadas and creating better waterways. water circulation conditions and flood amortisation.
Measure 10 - De-silting water lines and optimising preventative processes at the beginning of autumn with regard to rainwater drainage: collecting foliage, cleaning ditches and gutters, etc.	✓	Numerous actions were carried out to clean up water lines, namely on the river Este, along the entire length that crosses the city, in Celeirós, Arentim, Priscos, as well as on the river Torto, Ribeira de Castro and Ribeira de Panoias in Real, the river Labriosque in Passos S. Julião and the river Cávado near the beaches of Adaúfe, Ponte do Bico and Merelim S. Paio. A more extensive cleaning and desilting of the East River was carried out downstream of Bosch, over a 2km stretch, and occasionally upstream, where all types of large waste (mattresses, household appliances, shopping trolleys, etc.) were removed, as well as mud, trunks, bushes and decaying leaves which, as well as affecting water circulation and causing flooding upstream, created bad smells and a poor visual appearance. The East River was desilted at the Parque da Rodovia lake, Rua da Fábrica, Rua dos Barbosas (Zona dos Galos), Ponte de S. João, Altice Forum, Rua Padre Armando Lira (next to FOC and in front of Elefante Azul), Ponte Pedrinha (next to APTIV), etc. Ditches and gutters are regularly cleaned by the municipality's technical and operational services, particularly during the predicted rainfall. However, in the event of adverse weather conditions, particularly heavy rainfall, the operational teams from the Civil Protection Division, Maintenance and Infrastructure Division and AGERE check and clear the rainwater drainage system's manholes. in the most historically vulnerable places.
Measure 11 - Rehabilitation of riparian galleries.	✓	The rehabilitation and renaturalisation of the East River, next to the INL and, in general, along the water lines, was carried out through planting, cleaning and pruning. Firstly with the technical services of the gardens and the Sappers. Water line recovery project - natural engineering and planting of native species with APA and PDR 2020. Project to clean and restore water lines (10m each way) in the aftermath of the 18km fire, planting more than 26,900 trees and shrubs. Creation and provision of "Rivers Laboratories" for schools. Ciência Andante - financed by the Environmental Fund - on the theme of Rivers, among others. Adoption of 500 metre stretches under the Rios Project (by ASPEA), through which the entire East River (18km) has been adopted, with some stretches of other watercourses, in which the municipality has challenged the respective adopters, during Oxigenar Braga, Climate Week and Florestar Braga, to plant riparian galleries, for what riparian plants offer.
Measure 12 - Integration between sustainable drainage systems (bio-swales or others) and the existing or future rainwater network programme.	⚙	Rehabilitation and renaturalisation of the East River next to the INL. Rehabilitation of the Camellia Park - Laboratory for the EMAAC. Significant increase in the number of trees, shrubs and various plantings in the park of Monte do Picoto.

Adaptation options	State	Evidence
		Permeable car park in Monte do Picoto Park.
Measure 13 - Promoting the development of urban design options: creation of infiltration gardens/retention basins/conversion of impermeable pavements.	✓	In 2013, Braga City Council began a vast plan to afforest the city with green areas. During this process, a plan was d r a w n up to create "green lungs" in various locations, such as Rua de S. Martinho - UF de Maximinos, Sé e Cividade, Rua Vitor de Sá - União das freguesias de Nogueira, Fraião e Lamaçães, next to Campo da Rodovia (near the university residence) - parish of S. Victor and next to the Continente and Maxmat hypermarket in Frossos (on the bank of the river Torto) - União de freguesias de Merelim (S. Pedro) e Frossos. With the emergence of the "Miyawaki" method developed by the famous botanist Akira Miyawaki, urban microforests emerged. The municipality joined in and followed up the initial "green lungs" project with this new model, planting urban microforests in November last year. Due to their high density (thirty times denser than the average conventional forest), these microforests grow ten times faster and have a twenty-fold greater capacity to attract biodiversity. They are self-sustaining and authentic urban micropulms, helping to reduce heat islands, improve air quality, reduce noise levels and increase local biodiversity. In this way, and by involving neighbouring schools, it was possible to create links between the students and the surrounding areas, as well as drawing attention to the issue of adapting to and mitigating climate change and preserving biodiversity. So far, 8,825 trees have been planted, involving more than 19,000 volunteers. In addition, 6,772 trees have been donated to associations, institutions, JF/UF and schools, as well as 26,900 trees used in post-fire emergency rehabilitation and stabilisation, for a total of 42,497 trees. Trees are donated annually to schools, IPSS, associations and JF/UF on Autochthonous Forest Day and Forest Day, totalling thousands over the last few years. Rehabilitation of the Camellia Park - Laboratory for the EMAAC. Landscaping at the Hunters' Club. Interior of the Parretas Urbanisation Block. Picoto Park project. Work on the Ribeira de Castro Park in Real. Work on the Hospital junction. Rodovia Sports Park.
Measure 14 - Creating buffer strips with shrub vegetation on the slopes most susceptible to water erosion.	✓	Interventions on the steepest slopes at Monte do Picoto. Water line recovery project - natural engineering and planting of native species with APA and PDR 2020. Project to clean and restore water lines (10m on each side) in the aftermath of the 18km fire, more than 26,900 trees and shrubs were planted. Inventory of Trees Planted in the Municipality of Braga 2014-2022. With the aim of minimising the expected effects of flooding and environmental degradation of the water lines, two projects were implemented: the River Ecosystem Requalification Project (co-financed by the Environmental Fund) and the Post-Fire Emergency Stabilisation Project (co-financed by the PDR 2020). These projects involved the planting of 26,900 plants and the natural recovery of watercourses. The interventions were carried out in the parishes of Esporões, Nogueira, Fraião and Lamaçães; Nogueiró and Tenões; Santa Lucrezia and Navarre and Crespos and Pousada.

Adaptation options	State	Evidence
Measure 15 - Introduce shading elements, based on vegetation, in the most open and busy streets.	✓	Inventory of Trees Planted in the Municipality of Braga 2014-2022. To date, 8,825 trees have been planted, involving more than 19,000 volunteers. In addition, 6,772 trees have been donated to associations, institutions, JF/UF and schools, and 26,900 trees have been used in post-fire emergency rehabilitation and stabilisation, for a total of 42,497 trees. Reforest Monte do Picoto" project. Ecovia do Rio Este. Other plantations carried out by municipal services: - 25th April Street, - Friar Caetano Brandão, - In general, diseased trees are replaced, - Next to the university residence, - Along the cycle path, - Cockerel zone, - Near Altice Forum. Florestar Braga. Oxygenate Braga.
Measure 16 - Promoting the increase and diversification of green spaces, including vertical gardens and landscaped roofs.	✓	Green roof at the camping site (Parque das Camélias). Green roof on the Rodovia swimming pool building. Creation of 9 urban and community gardens, 5 social gardens and 32 school gardens. Launch of a book on urban gardens. Shooting club next to Parque da Ponte. Picoto and Parque da Ponte. Parque da Ribeira de Castro and around Continente and Maxmat.
Measure 17 - Promoting shaded areas in artificial structures built in critical areas.	✓	Rodovia Sports Park. CMB car park (Pópulo building). Braga Sapper Fire Brigade car park. Monte do Picoto car park.
Measure 18 - Introduction of evaporative cooling solutions (such as water mirrors, sprinklers and sprays) in green spaces and public open spaces.	✓	Three water mirrors next to the Altice Forum. Avenue fountain - Luminous Fountain. Source Fountain Dragon - Justino Street Justino Cruz. Fujacal Fountain. Ponds in Bairro das Andorinhas, Quinta Pedagógica and Monte do Picoto. Ponds with Life in schools: Escola EB 2, 3 André Soares, Escola Secundária Carlos Amarante, EB 2,3 de Trigal de Santa Maria - Tadim, EB 2, 3 de Nogueira, EB 2, 3 Dr Francisco Sanches.
Measure 19 - Maintenance of natural ventilation corridors (wooded banks of water courses, especially along the slopes of the main local reliefs) and urban corridors (tree-lined streets, orientated to the prevailing winds, north-south and north-west-south-east).	⚙	The renaturation/beneficiation works of the green/blue corridor along the East River and the maintenance of the green spaces and tree planting along the streets that define the urban fabric, with special emphasis on the Av. da Liberdade and Av. Central axis. Camélias Urban Park - Laboratory for the EMAAC. As part of the project for the development and regularisation of the Torto river, Panoias stream and Castro stream, work is being carried out on Section 1: Section 1 - 250m of the Torto river and 457m of the Panoias stream, between the Av. do Estádio roundabout and the EN 201, with work nearing completion. In the public tender phase. Section 2 - a stretch of around 1775m, from the Castro stream, from the intersection with the Torto river to Rua S. Martinho (next to the Av. Do estádio roundabout) with a hydraulic crossing under the EN205-4 (Reta do Feital). Section 3 - about 300 metres long, from the River Torto, from the EN 201 to the Av. do Estádio roundabout (Rotunda da ETAR). For the aforementioned phases 2 and 3, the public tender for the works will be issued shortly. Over the last seven years, the municipal services have planted more than 6899 trees in various streets and public spaces in the city.

Adaptation options	State	Evidence
Measure 20 - Promoting bioclimatic and energy-efficient construction.		Photovoltaic panels have been installed on the Rodovia swimming pools, the Braga Sapper Fire Brigade, the Town Hall car park (Pópulo building), solar panels on the campsite, dozens of primary schools and kindergartens. schools and kindergartens. The bioclimatic construction component is missing. It is not clear how apply this measure to buildings constructed by the municipality
Measure 21 - Promoting a programme to improve the use of treated and free water (boreholes, wells, mines, etc.).		Making use of surplus water from a mine that enters the municipal area, whenever possible, to water the garden areas. In several gardens, the mains water irrigation system has been replaced by natural water collection systems, such as: - Av. da Liberdade, - Central Avenue, - Civic Hill, - Campo das Hortas, - Campo de S. Tiago Fountain, - Campo Novo, - Rodovia Sports Park. The municipality's initiatives to improve the use of treated water are not noticeable. It can be seen that there has been a decrease in the use of treated water for irrigation.
Measure 22 - Recovery, conservation and extension of water storage infrastructures.		Construction of a tank with a capacity of 20,000 litres to use the groundwater used to irrigate the greenhouses in the Municipal Garden. Water retention tanks were built in suitable locations. Pond in the Andorinhas neighbourhood, Quinta Pedagógica and Picoto. Ponds with Life in Schools. Within the scope of the Integrated Rural Fire Management System, 11 water points have been identified in the municipality, including tanks, pools, ponds and other water storage structures, for access by aerial rural firefighting vehicles, with an average of three being upgraded every year.
Measure 23 - Reuse of treated water from the WWTP for irrigation.		AGERE has been reusing treated water for irrigation and washing.
Measure 24 - Promoting the utilisation of forest biomass (water heating, pellets, etc.).		Recovery of green waste - Cuidar Braga I and II - by obtaining shredders and a Biotrituration Centre, energy production and the production of natural fertiliser are promoted, reducing carbon dioxide emissions. The Cuidar Braga II project consisted of establishing a partnership with local authorities and forest managers and setting up the Biotrituration Centre to take in, process (shred) and forward the green/forest biomass delivered by citizens and partners. This project aims to implement three adaptation options from the municipality's Municipal Strategy for Adaptation to Climate Change (EMAAC), by setting up and boosting the community Biotrituration Centre and making this service available to the public free of charge, thereby promoting changes in risky behaviour, such as burning to dispose of waste. The aim is to reduce the number o f fires that start as a result of uncontrolled burning and to reduce greenhouse gas emissions by biotreating waste rather than burning it. This project is funded by the 'Environment, Climate Change and Low Carbon Economy Programme', which is the EEA Grants financial instrument for funding innovative and structuring projects for the country in the areas of Environment, Climate Change and Low Carbon Economy, contributed to the

Adaptation options	State	Evidence
		the objective of promoting the good environmental status of ecosystems and reducing the effects of adverse effects of pollution and other human activities harmful to the environment.
Measure 25 - Promoting forest planning and management - favouring native species, making mosaics and opening firebreaks, installing water points, etc.	✓	Treatment of the tree park using the endotherapy method and replacement of chemically synthesised pesticides with pesticides and pest control methods using biological means. Choosing species adapted to the climate - this has already been taken into account in the Picoto and Camellia Park projects. EEM (Municipal Ecological Structure - PDM). PMDFCI (Municipal Forest Fire Defence Plan). Within the scope of the PMDFCI (Municipal Forest Fire Defence Plan), an average of around 50 km of forest paths are intervened on every year, 3 water points for access to rural fire-fighting aircraft are improved, and 200 ha of fuel management strips are executed. Private projects have been assessed and approved for the planting of 17 ha of planting native species.
Measure 26 - Promoting the control of invasive species, pests and diseases.	✓	Invasive species - internships, sessions in schools and monitoring with CIM Cávado (aquatic) and control campaigns in Picoto. With regard to the biological control of the chestnut gall wasp, the municipality, through the local technical committee and the farmer's support office, together with Refcast and DRAPN, advises, monitors, makes technical visits, accompanies the release of parasitoid insects and sponsors their acquisition for locations that meet the technical requirements. With regard to Vespa Velutina control, the Companhia de Bombeiros Sapadores changed its intervention method from incinerating nests to eliminating the Vespa Velutina by injecting biocide into the nest. As part of the Strategic Plan for the detection and control of the Vespa Velutina in NUTS III Cávado, and through an application by the Cávado Intermunicipal Community to the Operational Programme for Sustainability and Efficiency in the Use of Resources - POSEUR, the Municipality of Braga has been distributing several selective traps with food bait to capture and monitor the founding wasps. The traps have been distributed to beekeepers in the municipality and placed in strategic locations previously defined by the Civil Protection Division, which coordinates the georeferencing of the traps and monitors the project. This project aims to implement a common strategy to prevent and control this invasive species by distributing as many traps as possible throughout the municipality. Of the 230 traps delivered to the municipality of Braga, 166 traps have so far been placed in the municipality (57 by the DPC, 58 by beekeepers and 51 by Eco Schools). It's not clear what the municipality's initiatives are to combat the plants invasives. Recent actions carried out at Monte Picoto were identified.
Measure 27 - Implementing an integrated mobility plan to effectively reduce the use of individual motorised transport, promoting travel by public transport and soft modes (cycling and walking).	✓	The Sustainable Urban Mobility Plan (SUMP) is currently being implemented in the Municipality of Braga and aims to achieve sustainable mobility solutions to solve problems related to car traffic, parking and public transport, without ignoring the promotion of soft modes such as pedestrian and cycling. This is a strategic and operational document for pursuing the city's mobility objectives, which serves as an instrument for action, knowledge and awareness-raising. The Municipality of Braga, which is carrying out the Revision of the PDM at the same time as drawing up the SUMP, is guaranteeing maximum coordination between land use planning and mobility, as indicated by European Good Practices in this area. TUB's commitment to decarbonisation is being pursued through the renewal of the fleet. They began in 2018 with six 100 per cent electric buses. This was followed by

Adaptation options	State	Evidence
		the acquisition of 25 natural gas vehicles and a further 7 electric vehicles, which will be delivered in 2021 as a result of a second application to POSEUR. In 2021, TUB will have 13 electric vehicles and 25 gas vehicles, totalling 38 clean, more efficient and eco-sustainable buses, which represent around 30% of the total useful fleet in operation. Also in 2021, a new application was submitted for the purchase of 30 more electric vehicles. In 2022, this application was approved, with the Priority Axis - Supporting the transition to a low-carbon economy in all sectors and Specific Objective (OE) - Support for the implementation of energy efficiency measures and the rationalisation of consumption in Public Passenger Transport. Following this application - POSEUR- 01-1407-FC-000090 - procedures were carried out for the purchase of 30 new electric vehicles (18 Standard vehicles and 12 Midi vehicles), 16 chargers and the respective infrastructure, which will be implemented this year. East river cycle path and others. Zones 30. Schoolbus.
Measure 28 - Promoting the cultivation of alternative agricultural species adapted to climate change.		The Farmers' Support Office (GAA), which has been in existence since 2016 and is based at the Quinta Pedagógica, has been advising farmers who come to it to change their farming practices to more sustainable ones, to abandon intensive farming practices and to use organic farming techniques so that they can adapt more easily to the effects of climate change in the long term. The Pedagogical Farm has several plots with trials, such as the orchard with regional varieties of apple trees, vegetable plots that since 2016 have been fully practising organic farming techniques, namely rotations, green manure, the use of compost produced on the farm with animal excrement and some green waste, among other techniques such as biological fighting, the creation of conditions for helpers to settle in, the insect house installed in 2016, the active and growing biodiversity of the agricultural space. The CMB has a test tube at the Pedagogical Farm to provide more and better advice to farmers in the municipality who want to adapt to climate change. Dissemination of DRAPN's technical recommendations through the G.A.A. Joint information sessions with CAVAGRI. Technical information session for farmers as part of AGRO, organised by the GAA, on 28 March 2019 with the theme "The chestnut gall wasp - a real threat". Technical support in the biological fight against the chestnut gall wasp, in conjunction with DRAPN and RefCast. There have already been releases since 2016 and, knowing that it takes several years of biological control to obtain results (an average of 3 / 4 years), there have so far been 20 releases supported by the municipality and carried out in the county. In 2022, the biological control plan in the municipality of Braga, based on the release of parasitoids in places that met the technical requirements, satisfied the main objective of creating conditions for the installation of the parasitoid that fights this pest. In the future, it will be important to monitor and evaluate new sites that may be reported, share information with Refcast and DRAPN on the national evolution of this key chestnut pest and study more varieties that are more resistant to this new pest in the future. may be important in the establishment of new plantations.
Measure 29 - Promoting an increase in the area of worked agricultural land.		The pressure to urbanise and use land for purposes other than agroforestry has been constant over the last few decades and has slowed down, especially since 2008. However, it should be noted the change in agricultural land use in the municipality with an increase in the area

Adaptation options	State	Evidence
		destined for permanent crops (vineyards, orchards, pastures and/or forage) to the detriment of short and very short cycle crops (vegetables). The Pedagogical Farm has an area of 2.5 hectares and belongs to the Municipality. In November 2022, an area of 7000m2 (within the 2.5ha) was added to its agricultural management, resulting from the transfer of land to caretakers who reverted to the Municipality after their death. The techniques used by the municipality are organic farming and this area is also being converted using these techniques. They were plots growing crops in the conventional way, namely vegetables and cereals. In one of the plots, a new project "Social and Therapeutic Gardens" was born in January 2023 in partnership with CERCI - Braga. It is already in the planting phase. In 2013, the Municipality set up the Rural Development Department and defined various measures to promote and enhance the rural world. One of these measures was to support the creation and expansion of urban gardens, combining community, social, inclusive and educational gardens. Until 2012, the Municipality of Braga had a community garden, located in Parada de Tibães, which still stands today, called "Horta Comunitária de Parada de Tibães" (Parada de Tibães Community Garden). From 2013 onwards, several gardens began to emerge, with the support of the Municipality and Parish Councils. Since then, nine new gardens have been created and are fully operational. With regard to school gardens, new ones are being implemented/studied, but there is no official data yet, but there were 31 last school year. Raising environmental awareness in the area of conventional, vertical and inclusive gardens at the most diverse school levels, in public and private education, IPSS and other institutions, day centres and homes for the elderly. CAVAGRI is an excellent partner in disseminating information to farmers. It has collaborated with the municipality in publicising the fight against invasive species, publicising the Biotriturador service with a view to reducing fires and producing a natural fertiliser, publicising training activities for farmers to apply plant protection products, raising farmers' awareness of the Rios programme, collaborating with the Quinta Pedagógica in a session on wines and their characteristics as part of the AGRO Fair (2019). CAVAGRI is a partner of the municipality and the Quinta Pedagógica in carrying out the actions of the National Plan for the Surveillance and Irradiation of diseases in domestic livestock (in sheep and goats), in the programme for the improvement and conservation of animal species (cattle, for example). In terms of the conservation of indigenous breeds, the Pedagogical Farm collaborates with AMIBA in the selection of pure-bred animals to guarantee their conservation. of indigenous breeds on the farm.

Caption:

Measure implemented Measure being implemented or partially implemented

Annex AIV. Weighting of the participation of the members of the Municipal Council for the Environment and Climate Action

Table AIV.1 Weighting of the participation of members of the Municipal Council for the Environment and Climate Action

Organisation	Contribution	Weighting	Integrated (Yes/No)
KATAVUS Association Environmental and Cultural Association of the Cávado Valley Area North of the Municipality of Braga	The importance of moving forward with the construction of the Cávado Cycle Path (inter-municipal), connecting it to the cycle paths in the city and the municipality. Where appropriate, complement the links between the municipality's river beaches and the Cávado, or at least ensure the existence of traditional fishermen's trails.	CMB shares the same concerns and has included M#04 Expand the cycling network (Ecovia do Cávado). As far as funding is concerned, there is a lack of framework for this initiative in low-density territories, while the other municipalities in the CIM have obtained funding to make this viable. project partially.	Yes
	Planting trees on the urban perimeter, which includes Palmeira. This and other parishes need new wooded areas in allotments and other new built-up areas. Urgent in the city. For example, it should not have been allowed to cut down the area of trees in the Quinta de Santigo development in Palmeira, whose origins date back to the second half of the 19th century, with diversified and identified species, in which initiatives to conserve them were, at different stages, unsuccessful. The existing areas of predominantly oak woodland between the Cávado river and the aerodrome, with their pedestrian and cycle paths, should be given timely attention by decision-makers. municipalities.	Planting trees on the urban perimeter is mainly conditioned by the lack of public spaces for this purpose. However, whenever possible, the municipality has been planting trees in existing public spaces and along watercourses, such as the Este river and the Pinheirinho stream in Palmeira. It should also be noted that the revision of the PDM will include guidelines for preserving these woods and oak groves and, if justified, their classification as natural heritage of municipal interest.	Yes
	That the TUB (Braga Urban Transports) include lines that can carry conventional (non-folding) passenger bicycles.	Changes and adaptations to public transport to accommodate non-folding bicycles are expected to be made gradually.	Yes
	Like the economic support announced for the purchase of bicycles, economic support should also be created for the purchase of equipment for eradicating weeds, in order to avoid the application of pesticides such as glyphosate.	Although the municipality does not use herbicides and encourages parish councils, citizens, companies and institutions not to use them, the social need to support private individuals in purchasing equipment is not justified to eradicate weeds.	No
	It is necessary, where necessary, to clear, clear and clean rural paths in order to allow, facilitate and boost pedestrian and cycle traffic.	CMB cleans and maintains rural paths and the network of footpaths. To this end, it relies on the support of the Forest Sappers and encourages the Parish Councils to maintain the paths. clean paths, particularly where	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
		pedestrian or cycling circuits as proposed in the PMAC measures.	
	Take advantage of existing municipal and rural roads by defining certain circuits, with signposting (simple, objective, not expensive) that facilitates pedestrian and cycling journeys throughout the municipality, favouring connections to the city and to local places. of paramount public interest.	In addition to the circuits defined and duly signposted in the Braga Walking Route Network, see the "Braga Explorer" app, it is planned to complete and create more walking and cycling routes.	Yes
	In conjunction with neighbouring municipalities, build external (coupled) crossings on the Bico and Prado bridges, for pedestrians and cyclists, as has been done in other municipalities. (including listed buildings).	This is an infrastructure for which IP is responsible, subject to the opinion of the DRCN. Although this is not a competence of the municipality will report the proposal to the IP.	Yes (conditional on other entities)
ReleVer Monarchist People's Party campaign Pedro Morais Mesquita Borges de Macedo	With regard to the proposals for Braga's Municipal Climate Action Plan (PMAC-Braga), I must point out that the PPM has included some that are also included in the proposals we made for the Broad Economic Policy Options. Plan	Nothing to mention.	-
	We think it would be important to set up a citizens' advice centre with the mission of promoting greater efficiency in homes and with the clear aim of reducing their energy consumption! Many residents don't take advantage of the money available in the Environmental Fund because they don't know about its advantages or because they have difficulty submitting applications! The programme itself is ambiguous as to whether or not condensing boilers can be used to replace conventional boilers, since when it refers to a type of biomass boiler and stove intervention, it can indicate that either the boilers or the stoves are biomass, or it can be understood as Boilers (of all types) and biomass stoves! If this is not the case, and there is a clear environmental advantage in replacing conventional boilers with condensing boilers (which work at a lower temperature, with lower GHG emissions and less consumption), a pool of manufacturers and/or representatives of the brands of these systems could be created in order to obtain studies/proposals for the systems with prices that include installation/application and with well-defined discounts, since the idea would be direct negotiation between partner organisations and residents! We could go further and only allow the participation of boilers that are already capable of receiving a mixture of 70% Natural Gas and 30% Hydrogen! In addition to this exchange, we could think about offering a voucher for €100.00 to buy a condensing boiler in exchange for a gas boiler. proof of	CMB is already in the final stages of setting up a customer service desk to support issues related to energy efficiency and poverty. In the short term, this counter will take on more functions.	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
	be a first home and be free of state debts! It would be an optional part of the Environmental Fund programme! Obviously, if this programme is approved, there could be a limit of 500 municipalities applying in the first year of implementation! Cost maximum of €50,000!		
	We recommend creating a flyer, a video or a newsletter aimed at the general public, explaining that it is a mistake to switch off the heat source when no one is at home when using heat pumps or condensing boilers! The solution is to have a chrono-thermostat that regulates the temperature of the house during a period of comfort and a period of absence! The letter in the Agere invoice could be the vehicle the most important way to send this information!	This is specialised knowledge that needs to be promoted. It will be realised through this service office.	Yes
	We think it would be important to study the air quality on the roads with the most traffic in order to start raising awareness among residents about using controlled mechanical ventilation in their homes instead of opening their windows to ventilate and introducing extremely fine particles from brakes and tyres, which are far more dangerous than combustion car exhausts! We need to increase the number of stations for checking air quality as we only have 2! Qualar https://qualar.apambiente.pt/qualar/estacoes?keywords=braga And the dissemination of data in real time, which I don't think happens in as much detail as in Spain https://meteogalicia.gal/Caire/datos.action?request_locale=gl	Although air quality must be good both inside and outside buildings, this recommendation does not fit the objectives of a PMAC. PMACs can and will define measures that cumulatively and indirectly influence ambient air quality, but defining measures that directly influence ambient air quality seems to us to be outside the scope of a PMAC, since PMACs should only influence GHGs (in the mitigation component) and not ambient air quality parameters (e.g. PM is not a GHG), and the adaptation component should focus on energy efficiency, insulation and thermal comfort of buildings, and not on indoor air quality. Here in adaptation there are some measures to combat CA that also contribute to air quality, but as I said, improving indoor air quality shouldn't be an objective of the PMAC. It should be more of an Environment and Health Plan, or equivalent.	No
	Also linked to the previous topic, publicise and encourage the use of mechanical ventilation systems - VMC in new homes! Basically, these are devices that renovate buildings in cross-flows to utilise the heat or cold from the old air to the new air, reducing the need for heating or cooling, as well as preventing the fine particles entering the house!	Although we recognise the advantages of mechanical ventilation systems, air conditioning and reduced electricity consumption, the issue of particulates must first be addressed at the level of the Environment and Health Plan.	No

Organisation	Contribution	Weighting	Integrated (Yes/No)
	Encourage the use of aerators on taps in order to reduce water consumption, which will indirectly reduce electricity costs by pumping water from the pumping station! We could organise a campaign with Agere to promote this type of tap and even offer aerators to the poorest families in the municipality who benefit from Agere's Social Tariff!	Relevant measure to be included in PMAC In addition to the municipal buildings, the above-mentioned service office should provide this information to citizens.	Yes
	Design all schools and municipal buildings with 2-4 litre toilets instead of the usual and already reasonable 3-6 litres! This measure reduces water consumption and will also influence the consumption of the pumping station! We mustn't forget that for these fittings to work, we have to ensure that the sanitary ware has the same water rating! (See ANQUIP website)	In addition to the relevance of this measure in the preparation of municipal projects and in informing the public through the service office, it is considered important to adapt existing buildings to this system.	Yes
	Design, plan and equip all municipal schools to achieve energy self-sustainability! To this end, make a plan that allows for the implementation of photovoltaic panels, insulation and efficient air conditioning methods!	CMB is considering the technical, financial and environmental feasibility of installing photovoltaic panels in some schools within the scope of measure A#06 Promoting adequate air conditioning conditions in homes and day centres for the elderly, schools and day care centres, health care facilities, among others. others.	Yes
	Encourage the construction of more sustainable buildings, known as green buildings, by increasing the exemption from IMI up to a maximum of 5 years, depending on the impact the building has on the environment!	The CMB plans to support the construction and refurbishment of zero-energy buildings, i.e. NZEB (Nearly Zero Energy Building) buildings. There are already municipal partners in the construction sector applying sustainable techniques and materials, in particular CREE solutions that make it possible to build more sustainable, versatile and efficient buildings with an excellent cost-benefit ratio, durable and reliable	Yes
	Encourage beekeeping in the municipality's tree parks in order to compensate for the worldwide decline in bee populations! It could start with a pilot project at Bom Jesus, the seven fountains, Camellia Park and the pedagogical farm! It should be noted that this project is not innovative and that the Paris City Council already has 300 hives!	CMB plans to promote afforestation and improve the environmental value of forests in the municipality. Although the installation of apiaries is prohibited in urban areas (less than 50 metres from public roads and 100 metres from buildings), a partnership with APICAVE is planned for the installation of hives in suitable locations (e.g. Monte do Picoto).	Yes
	Campaign to make farmers in the municipality aware of the importance of composting, integrated production and the use of bio-fertilisers!	It will be integrated into the PMAC. Draw up, in collaboration with organisations representing the sector, a manual on Climate Change, Agriculture, Forestry and Soil Protection, articulated	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
		with the Good Agricultural Practices Programme, Caring for Braga I and II of PAESC.	
	Braga is known for having restaurants with interesting prices and quantities of food of immense quality and quantity! However, this extra quantity ends up being wasted! For this reason, there should be an awareness-raising campaign, through a partnership with the Braga Business Association and the municipality's catering companies, in order to adjust restaurant portions to the daily recommended calories for a meal! Maintain quality but with balanced portions! Avoiding food waste is also a way of avoiding energy waste at various levels!	The CMB is considering organising an event to raise awareness of the issue among SMEs and business organisations, by sharing information, presenting projects that contribute to reducing food waste and disseminating good business practices in this area. Process of valorising local markets involving the municipalities of CIM Cávado. This project involves the process of characterising producers and the agricultural produce sold in these places, as well as presenting proposals for improvement, both common and specific to each market. This initiative is part of the National Plan for Balanced Food and Sustainable National Rural Network	Yes
	Acquisition of land in agricultural or forestry areas in areas with high urbanisation potential in order to reconcile a large green area near an urbanisable area! This green area should be "cultivated" with native species such as chestnut trees, cork oaks, poplars, oaks, etc. The idea would be to create new air lungs that will serve to mitigate the increase in pollution inherent in the increase in population density! Priority areas Real, Dume, Semelhe, Gualtar, Celeirós! If we were to buy 2 ha in each of these parishes, with only one purchase per year, we would be talking about an investment of €100,000 per year!	Although it is not easy to change the classification of rural to urban land in the PDM and in some way guarantee the existence of these (private) green areas, it is important that the municipality has a pool of urban land, but also agricultural and forest land (within the urban perimeter) to create natural spaces that balance the development and expansion of the city. Examples of this include the Granja UOPG in Este S. Pedro and the Cones UOPG in Maximinos and, closer to the city centre, the Este Ecological Park, Rio Torto, Ribeira de Castro and Ribeira de Panoias, and the Sete Fontes Eco Park.	Yes
	Investing heavily in raising awareness among the younger population, especially about using public transport! Making parents aware of the importance of educating their children and getting them used to using public transport rather than public transport for the future. individual!	The CMB recently drew up the SUMP precisely to provide answers to these questions.	Yes
	Development of vertical gardens in areas where they were not planned due to poor urban planning enough green areas!	In addition to the green façades and walls, the intention is to increase the number of green roofs	Yes
	Restoration of the existing vertical garden in the Generation!	Despite the difficulties of maintaining system is intended to start working.	Yes
	Creation of a website just about the Municipal Plan of Braga Climate Action in which the following are reported	The municipality has an institutional share with the citizen, but in the context of	No

Organisation	Contribution	Weighting	Integrated (Yes/No)
	all the actions carried out for the proper implementation of the plan, as well as publicising the necessary cuts in urban trees, the reasons that led to the decision to cut them down and if, after cutting them down, the decisions were taken, the reasons for the decision to cut them down. were good or bad decisions!	of the Inventory of Urban Trees, which is in the public procurement phase, a platform will be made available containing detailed information on the state of the forest. tree health.	
	Inventory of the municipality's urban trees!	In 2013, the Municipality of Braga began a vast plan to afforest the city with green areas. During this process, a plan was drawn up to create "green lungs" in various locations, such as Rua de S. Martinho, in the UF of Maximinos, Sé and Cividade, Rua Vitor de Sá, in the União das freguesias of Nogueira, Fraião and Lamaçães, next to Parque da Rodovia, in São Victor and in Frossos, on the bank of the river Torto. So far, 8,825 trees have been planted, involving more than 19,000 volunteers. A further 6,772 trees have been donated to associations, institutions, parish councils and schools, as well as 26,900 trees used in post-fire emergency rehabilitation and stabilisation, for a total of 42,497 trees. One of the EMAAC measures being implemented is the "Municipal Inventory of Urban Trees", which is currently being awarded and the Regulation of Trees in the Environment Urban in public discussion phase	Yes

	Finally, a bolder measure, which is the creation of a study with the theme "development of the city's expansion by the end of this century"! It would be a study that should consider how to transform the circular economy! To this end, Braga should think that it is no longer a small city and that it is gradually moving towards being a medium-sized city and that it must prepare itself to eventually become a large city! To this end, it should consider how to "enlarge" its urban centres! To this end, there are places that should be thought of as such: Gualtar (around the University of Minho), Dume near the stadium and with a link to Real, Palmeira near the Nova Arcada shopping centre, or at least with a pedestrian link to the shopping centre, and Celeirós in the industrial park area)! The idea would be to create Super Neighbourhoods along the lines of what Barcelona did, which the population was very reluctant to do at first, but now they want to live in those areas! If the Centre of	Braga tends to become a metropolitan area, involving the municipalities of the quadrilateral, but also those more directly linked to the Cávado CIM. From this point of view, it would be interesting to have studies that reflect an overall vision of the Braga metropolitan area for 2050 and its articulation with the Regional Spatial Planning Plan for the North, which although planned was never carried out by the central administration, CCDRN. In terms of cycle paths and green parks, in the short to medium term the following are planned: Ecovia do Cávado, Ecovia do Este, Ecovia da Quinta dos Lagos (in Real/Dume) linking Ecovia do Este to Av.ª António Palha, Ecovia do Este at Ponte Pedrinha, Eco Parque das Sete Fontes, Jardim Brasil, etc. Regarding the city's expansion areas, Gualtar, Dume Palmeira and	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
	Braga already has a considerable pedestrianised area, but not so in other parts of the city! Gualtar, I think it would be possible to create a super-neighbourhood on the Quinta in front of the Gualtar Campus, where there would be housing, services and a large park with a pedestrian link to the Rio Este ecovia! As for Dume/Real and Palmeira, I think it would be perfectly possible to implement it since it still has a lot of land that could be used to develop such a project. Just like another of Real/Semelhe!	Celeirós, as well as the creation of the Super Neighbourhoods, it is considered that the PDM is the appropriate land management instrument for this purpose.	
	As for Celeirós, the idea would be to relocate the Celeirós Industrial Park to a new area to be defined, with a larger area for possible expansion, and to create a new residential and services super-neighbourhood on the land of the Industrial Zone!	It can be seen that the PDM, namely the Framework Plan, envisages the location of a Logistics Centre or a Business Hosting Area in Celeirós, benefiting from motorway access.	No
Liberal Initiative	After analysing the document sent to us, the Liberal Initiative believes that it is too vague to be able to contribute in a concrete way and with clear proposals, being a good summary as a presentation, but not very detailed. Nonetheless, we would like to point out some ideas and collaborate within the framework of the limitations mentioned:	A full version of the PMAC-Braga will be made available when it is up for public discussion.	Yes
	According to the legislation, the Plan must be ready by February 2024. We're behind schedule with the drafting and public discussion of the document. It's going to be rushed through without much room for sustained input;	Since the start of drafting the PMAC, the technical team has held meetings with municipal technicians, sectoral meetings and field work to assess the most urgent and emerging issues within the scope of this action plan, and analysing various strategic, planning and management documents has also made it possible to incorporate many of the concerns raised by local agents and stakeholders into this document. The technical team and CMB will provide the means and time necessary to analyse and discuss the actions that will prove most efficient and effective for the municipality. The public discussion of the document is a fundamental part of its dissemination and finalisation. The public discussion will be unhurried and as open as possible to all citizens, companies and institutions.	-
	The document presented has no source for the data, no diagnosis by sector of activity, no	The GHG reduction targets and the timetable for the implementation of	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
	has GHG reduction targets by area nor a timetable for implementing the measures;	measures/actions will be presented in due course by measurement sheet	
	We believe that the financial impact of each measure and the potential for reducing the ecological footprint should be defined, introducing an economic return rationale (€/ton $_{CO2}$ reduced), allowing the most impactful investments to be prioritised;	See this question. We also believe that the financial impact of each measure and the potential for reducing the ecological footprint should be estimated, introducing an economic return rationale (€/ton $_{CO2}$ reduced), allowing for prioritisation of the measures. more impactful investments;	Yes
	Identification of a plan for each Municipal Company (TUB, AGERE, Bragahabit; InvestBraga) and different Municipal Services, which allow for investments capable of reducing consumption and/or producing renewable energy;	Generally speaking, the PMAC defines the measures and actions to be developed by the municipality and municipal companies, but it is up to each of the municipal companies to develop specific measures and actions, as is the case with the private companies	No
	Have the parish councils been involved in the plans, with concrete measures to contribute to this goal?	The Braga Municipal Environment and Climate Action Council (CMAACB) has a representative of the Council Presidents, elected by the Braga Municipal Assembly, and several sessions are also being held to discuss the proposed measures involving the councils parish.	Yes
	The current plan must demonstrate the results achieved in the meantime with the Municipal Climate Change Adaptation Plan (2016) and the 2022 Sustainable Energy and Climate Action Plan (PAESC), for an evaluation of the objectives achieved in the meantime;	The PMAC-Braga will present the state of implementation of the measures proposed by the EMAAC and the PAESC	Yes
Couples Group	The structure of Analysis -> Objectives -> Action Plan is of great importance in order to ensure that actions are based on a consistent vision that is coherent with the resilience we want to endow the municipality with. We were unable to extract enough information from the document shared for a specific analysis of the elements, certainly because it is a set of slides that rely on complementarity with explanations in the form of a presentation. Knowledge of the assumptions of the scenarios outlined, as well as the contribution of the actions referred to to the emission reduction trajectories, will be essential for a credible contribution. actionable.	A preliminary and final version of PMAC-Braga will be made available.	Yes
	The Casais Group is already involved in mitigating the carbon footprint, namely through the PMEB, providing relevant knowledge on the subject through the Mestre Casais Foundation and guaranteeing the availability of carbon technologies. construction with a low carbon impact. We do it	Nothing to mention	-

Organisation	Contribution	Weighting	Integrated (Yes/No)
	from the Municipality of Braga to the whole country and export.		
	As a company born and integrated into the municipality's business fabric, we have already expressed our willingness to be part of the co-creation of this plan, taking the opportunity to mention the importance of the resilience and sustainability characteristics of the present and planned buildings, as well as the potential for positive economic externalities for local companies that such a vision would bring. can have.	Nothing to mention	-
DST Group	We have added some complements to the actions presented in Chapter 8 (Contents). For some of them, we have also added measures that can be associated with the actions identified. Mitigation actions ○ Reduction at source/ Promotion of the circular economy/ Prevention of waste generation ▪ Promotion of a municipal materials bank ▪ Reducing food waste/ Specific collection of biodegradable waste	Following on from the Circular Economy diagnosis, the city council is working on Braga's Circular Economy Strategy, where these issues are being addressed. In the meantime, it is public knowledge that the Braga Business Association is implementing a "Embrulhe p.f." collection programme for leftover food. The collection of bio-waste from hotels and restaurants in the Historic Centre (AGERE) has also been in place since mid-2019. Bio-waste collection will soon be implemented in the municipality, for now in two areas (Makro and Parque Norte) and more in the future. later, for the entire municipality.	Yes
	○ Promoting public transport ▪ Increased supply and timetables	TUB has been renewing its fleet (electric and gas) and the frequency of transport, maintaining the price of journeys, etc. However, the increase in users depends to a large extent on transport that meets timetables (like the Metro). This depends on the creation of a network of BUS (or Metro) corridors that appear to be fast, comfortable and safe, and that are a real alternative to individual transport, whose mobility is increasingly under threat.	Yes
	Mitigation actions include energy optimisation programmes for agricultural and industrial activities. Wouldn't it make sense to also have energy optimisation programmes for municipal infrastructures?	The PMAC includes actions with these objectives. In addition, the municipality has been developing energy efficiency programmes at municipal level, such as the Solar Potential and Bio-roofs Project, the Programme to Support the Replacement of Conventional Light Bulbs with LEDs, and the Municipal Programme to Combat Energy Poverty. It has planned to replace all conventional street lighting with LED bulbs. So far it has replaced around 16,000 and aims for next year	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
		replace around 10,000 light bulbs, through direct investment of around 2.5 million euros, and the remaining 10,000 through a partnership with a private company in the area. At the same time, it has been carrying out projects and construction, remodelling, rehabilitation and improvement work on its buildings with energy certification, as well as carrying out studies to create a renewable energy community or collective self-consumption for the installation of photovoltaic panels on sites and municipal buildings with the greatest potential for production and energy efficiency. electricity consumption.	
	Adaptation actions ○ New urban parks/ Reconfiguration of existing ones ▪ Enhancing the area of afforestation. Selection of native species capable of withstand climatic conditions and thus reduce/eliminate irrigation needs. Natural-based solutions for the infiltration of rainwater and regularisation of watercourses.	This type of action is already included in the PMAC-Braga	Yes
	▪ Knowledge and training actions One of the actions set out in the document is the awareness-raising actions and information campaigns. One of the measures associated with this action could be to promote the issue in educational establishments/environmental education.	This type of action is already included in the PMAC-Braga	Yes
ASPA Association for the Defence, Study and Dissemination of Cultural and Natural Heritage	Thank you for sending the pdf of the presentation "Braga Municipal Climate Action Plan". Although it was presented at the meeting of the Braga Municipal Council for the Environment and Climate Action, held on 28 September this year, it was not possible to clarify various aspects in this context, as we had no prior knowledge of the information. Now, in view of the pdf of the presentation we received, and since it is devoid of text and the markers mentioned below, it is not possible to understand some aspects and, above all, to share the information on this subject with associates. We therefore request the following information:	The pdf. of the presentation has fulfilled its purpose of presenting the PMAC. The draft version of the Braga PMAC will be sent to you for your consideration.	-
	Since one of the Plan's objectives is to "Reduce GHG emissions in the municipal territory, promoting carbon neutrality", what is the starting point, given that the projections shown on slide 32 start in 2021 and the national objectives refer to 2005? Which areas of the city/sectors of activity have the highest GHG emissions? GHG production and its causes?	The PAESC had the opportunity to measure emissions between 2005 and 2050, however, the basic data, emission factors and methodologies used are not available, and a specific calculation methodology was considered *(Science for evolution®)*, which cannot be compared	-

Organisation	Contribution	Weighting	Integrated (Yes/No)
		the methodology and emission factors used in the 2021 inventory (internationally accepted). In this sense, due to the lack of methodological information, coherence, measurability and reliability of the data, it was not possible to continue with the inventory carried out in the PAESC, and a new methodology was chosen that meets the most recent methodologies and emission factors used internationally in order to provide the municipality with an instrument that will allow it to continue monitoring emissions in the future. It is therefore not possible or advisable to carry out the suggested analysis. The sectors of activity with the highest GHG production can be found in the inventory, and in a more summarised form in chapters 5.1 and 6.1 of PMAC-Braga.	
	"In 2015, Braga's Sustainable Energy Action Plan was submitted to the Covenant of Mayors, with the aim of reducing CO_2 emissions in the territory by 20 per cent. by 2020", has this objective been met? If not, what was the deviation?	The question will be put to the company and answered at a later date. However, the municipality is working on acquiring a service that will enable it to respond to the request.	-
	What data was included in the mathematical model developed by IrRADIARE, Science for evolution? Did they take into account data on the release of GHGs in the municipality of Braga by fossil fuels resulting from car traffic, as well as emissions related to civil construction? Have measurements of air pollutants that are also GHGs been taken into account? Have you considered factors mitigating the increase in GHG emissions?	The question will be put to the company and answered at a later date. However, the municipality is working on acquiring a service that will enable it to respond to the request.	-
	Data supporting the results presented, the respective sources and bibliographical references, as well as the methodologies and information flows that led to the results presented and proposals decision.	The preliminary version of the Braga PMAC will be sent to you for your consideration, where you can consult all the information mentioned.	-
	The literature describing the analysis models used.	Assuming that they are referring to the ESCP developed by IrRadiare, and having consulted this document, the following can be said: " The scenarios are calculated using a specific mathematical model for the municipality, developed by IrRADIARE, Science for evolution®, which is based on projections available from international organisations and public bodies.	-

Organisation	Contribution	Weighting	Integrated (Yes/No)
		responsible for planning and prospective studies. These projections refer to macroeconomic and demographic variables. In addition, scenarios for the evolution of the national energy system, estimated for the national area, are considered. The set of entities whose references were taken into account include Eurostat, the European Environment Agency, the International Energy Agency, the European Commission's Directorate-General for Mobility and Transport, the European Commission's Directorate-General for Energy, the European Commission's Joint Research Centre (JRC), the Organisation for Economic Cooperation and Development and, of course, the relevant national bodies such as the Directorate-General for Energy and Geology, the Portuguese Environment Agency, the Energy Services Regulatory Authority and the National Statistics Institute. The macroeconomic and energy scenario proposed by the European Commission in 2016 in "EU Energy, transport and GHG emissions trends to 2050" stands out among the elements considered as a reference for the proposed scenarios. These scenarios used the PRIMES model as a resource, supported by some more specialised models and databases, such as those geared towards forecasting the evolution of international energy markets. The POLES model of the world energy system, the GEM-E3 and some macroeconomic models are also considered as references. The methodology adopted for determining CO_2 emissions is based on the methodology used in the reference inventory, following the JRC's recommendations for the execution of the ESAPs. As such, the scenarios presented are determined by applying emission factors to the scenarios resulting from the execution of the energy matrix.	

Organisation	Contribution	Weighting	Integrated (Yes/No)
		by using standard emission factors, in line with IPCC principles." The draft version of the Braga PMAC will be sent for your consideration	
	The Municipal Environment and Climate Action Plan does not include a system for monitoring and evaluating its implementation, which we find strange. It seems essential to us that GHG concentrations be monitored. Will a network of metrological stations be set up?	Point 9 of the draft PMAC provides for implementation, monitoring and evaluation. The monitoring will be based on the information collected in the GHG emissions inventory, which will give us a year-by-year trajectory of the past and the evolution of the situation in terms of meeting the targets set for 2030 and 2050. An environmental monitoring network will also be set up in the city for air quality and for noise.	Yes
	With regard to graphs and maps: • on pages 15 and 35, the titles, sources and territory to which they refer are missing (country? northern region? municipality of Braga?);	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-
	On page 17 you can't read the captions on some maps, the titles and fonts are missing; the bar graph is not legible;	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-
	On page 19 the titles and fonts are missing;	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-
	On page 20, the image is superimposed on the previous graphs; what does it refer to and what is the purpose of the image "Homogeneous climate response units"? How is this URCH poured into PMAC?	The pdf. of the presentation has fulfilled its purpose of presenting the PMAC. The draft version of the Braga PMAC will be sent to you for your consideration. Homogeneous Climate Response Units (HCRUs), commonly known as climatopos, can be described as areas with characteristics and responses from a physical point of view that are homogeneous in terms of topography, exposure, natural ventilation and urban morphology which, depending on the diversity of land use and occupation, interact in a particular way with the climate. atmospheric boundary layer.	-
	Page 24 mentions models of GHG emissions inventories, but we don't have access to the data that supports them (or to the organisations that provide them), so we can carry out studies/reflections on this.	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-

Organisation	Contribution	Weighting	Integrated (Yes/No)
	subject;		
	The graph on page 28 lacks sources, so that it is possible to understand how the figures for each area were arrived at;	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-
	On pages 27 and 29 it is worth reviewing the value indicated in scopes 2 and 3;	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-
	The spatial distribution of the information on pages 27 to 30 in the municipality is missing;	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	-
	The models used to support the information on pages 32 and 33 (graph and text) are not indicated. Also missing are the graphics.	The draft version of the Braga PMAC will be sent for your consideration	-
	What do the climate risk tables on page 36 refer to? Do they concern the scenarios listed on page 31? Does this page refer to risk or hazard? Are the conditioning factors and triggers of risks characterised for the municipality? geomorphological and hydrological?	The draft version of the Braga PMAC will be sent to you for your consideration	-
	The titles of the graphs and maps are missing, as are the captions and descriptive notes on pages 35 and 37;	The presentation pdf has fulfilled its purpose of presenting the PMAC. The draft version of the PMAC- will be sent. Braga for your consideration	Yes
	On pages 39 and 40 several measures are listed without prioritising them; what are the priority measures and how are they going to be implemented in the territory?	A preliminary version of some measures has been presented and is still being discussed and consolidated. Systems will be developed for monitoring actions, prioritising, describing and territorialisation whenever possible.	Yes
	In the mitigation actions on page 39, no specific measures are indicated for urban public trees and trees in peripheral parishes, as well as urban voids (allotment transfer areas), despite the fact that it is well known that vegetation helps to ensure climate harmonisation, given the contribution it makes to reducing climate change. CO_2 emissions, mitigation of the urban heat island effect and carbon sequestration:	A preliminary version of some measures has been presented and is still being discussed and consolidated. Systems for monitoring actions, prioritisation, description and territorialisation will be developed whenever possible.	Yes
	On the same page, 39, it doesn't consider the Braga-Guimarães "Sacromontes" Intermunicipal Programme, it doesn't include forest management in conjunction with forest owners, nor does it consider the environmental benefit provided by private individuals who invest in planting hardwoods; nor does it point to benefits through support for investment in afforestation or tax benefits;	The technical team will reinforce the reference to forest management, as well as considering the "Sacromontes Intermunicipal Programme" which aims to promote the enhancement, rehabilitation, restoration and promotion of the built heritage; the protection of the forest area surrounding the sanctuaries and fortified settlements; the definition of actions for the active management and enhancement of the forest landscape; and the integrated promotion of the whole area and	Yes

Organisation	Contribution	Weighting	Integrated (Yes/No)
		their resources as a set of high heritage and tourist value.	
	On the same page, 39, it doesn't consider the management of agricultural and forestry waste from the perspective of reducing GHG emissions;	An action focusing on this issue will be included, namely in the guides to best agricultural and forestry practices: Reconvert practices in agricultural, livestock and forestry production and encourage the diversification of agricultural crops to improve the resilience of farms and reduce vulnerability to events. extreme weather	Yes
	Page 41 shows a lack of reflection on the subject and reflects an anchoring to old practices that have led us to the current climate risk. It is strange that it does not present strategies for involving citizens in decision-making;	As mentioned above, public participation and stakeholder involvement are taking place. The Municipal Council for the Environment and Climate Action of the Municipality of Braga also took place. Some measures have been identified: Carry out awareness-raising actions and information campaigns, in conjunction with civil protection agents, on the risks associated with floods and the self-protection measures to be adopted by the population. Implement the PMAC-Braga Communication Plan	-
	Page 42 does not reflect the concern and thinking expected in the second decade of the 21st century.	It is suggested that the organisation clarify what it means by "concern and the thinking that is expected in the second decade of the 21st century". XXI"	-
	It is strange that "Signposting identified risk sites" is indicated as a Knowledge and Training Action, since it is expected that these will be provided for in the Municipal Emergency and Civil Protection Plan. It does matter, publicise it to the community.	That's exactly what we're trying to do: signpost high-risk locations in the area.	-
	We have to ask whether major municipal works, or those under the responsibility of the government, which are underway or about to begin, fulfil the objectives set out in this Plan.	The works in progress or about to begin at the time they were designed and approved were not aware of this plan, so it is not appropriate to check whether there is such a plan. correspondence.	No
	We hope that there will be a process of effective public participation in the drafting phase of the Plan and in the practice of monitoring and drawing up conclusions, and not only in the phase of publicising the options that the Plan considers.	The PMAC's public discussion began even before there was a final version of the PMAC, and it will be a privileged moment to publicise it. The aim is to focus on a public discussion that is highly participatory, constructive and adds value to the plan.	Yes

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	Finally, we have to ask how the Municipal Environment and Climate Change Plan will integrate and/or articulate with: • the Braga Municipal Master Plan; • decisions on the municipality's urban management; • municipal works; • waste treatment options.	Everything indicates that the PMAC will be approved before the PDM is revised, so there will be time for the contents and proposals of the PMAC to be incorporated into the PDM during public participation and discussion of the PDM.	Yes

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May 2024