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Mainstreaming climate change responses into urban planning

The case of Lisbon

Academic tutor:
CALDARICE Ombretta

Co-supervisor
BARROSO Sérgio

Candidate:
MARANGON Martina S248977

A mio nonno Ezio,

Alle nostre "partitine a carte" dopo lo studio e tutte le cose belle che mi hai insegnato ad apprezzare

A te che oggi so che avresti voluto essere qui e saresti stato fiero di me.

Il tuo Dunin

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ABSTRACT

The last decades have been characterised by an increase in the average temperature of the earth's surface. Climate change has become increasingly relevant and a worrying phenomenon worldwide, contributing to the rise in the frequency of extreme weather events that affect human life and the safety of people and properties and the balance of ecosystems.

Although mitigation interventions are the critical element to limit the effects of climate change in the long term, immediate interventions are needed to respond now to the impacts of climate change. In this context, the focus on adaptation solutions has increased. This research highlights the integration of adaptation into planning as an effective way to respond to climate change. Thus, the research starts with a purely theoretical introduction. The need for urgent intervention through adaptation measures is highlighted. The local level is highlighted as a critical space for effective intervention since it is the scale where impacts occur, and interdependencies are more easily recognisable.

It also highlights the role of cities, both victims and responsible for the problem, and their potential to promote adaptation through land-use planning. In this framework, an analysis of local climate plans is made, highlighting the need to strengthen the integration process, which in theory is very valid conceptually, but with limited implementation. This was the starting point to investigate how this approach is being implemented in Portugal, more precisely in Lisbon. It is a multi-scale analysis that aims to study adaptation from the national to the city scale. Adaptation is initially analysed at the national level through local plans, strategies and policies. It goes through a vertical coherence and horizontal integration process, highlighting the strengths and weaknesses of the Portuguese adaptation planning system understanding how integration is done in practice.

Subsequently, in the second part of the document, through a downscaling procedure, the measures implemented in Lisbon are analysed, studying the municipality's strategy and actions and their relationship with the recognition achieved as European Green Capital 2020. Finally, the Alcântara Valley Green Corridor is selected as an object of a detailed study to verify how the measures are being implemented.

With the support of CEDRU and the Lisbon Municipality in developing this analysis, we tried to put into practice the theoretical principles, assuming that a project of thematic nature, like the one selected, can contribute to the adaptation to climate change. The final aim of this work is to understand the reasons why Lisbon can truly be described as climate proof. In order to achieve this, it was investigated whether climate policies were already embedded and integrated within the various fields, in particular spatial planning, or whether a specific sector focused only on climate change was created.

RESUMO

As últimas décadas têm sido caracterizadas por um aumento da temperatura média da superfície da terra. As alterações climáticas tornaram-se num fenómeno cada vez mais relevante e preocupante em todo o Mundo, contribuindo para o aumento da frequência de fenómenos meteorológicos extremos que afetam a vida humana e a segurança de pessoas e bens, assim como o equilíbrio dos ecossistemas.

Embora as intervenções de mitigação sejam o elemento-chave para limitar os efeitos das alterações climáticas a longo prazo, são necessárias intervenções imediatas que permitam responder, desde já, aos impactos que as mudanças no clima estão a ter. Neste contexto, o enfoque nas soluções de adaptação tem aumentado nos últimos anos. Esta investigação visa destacar a integração da adaptação no planeamento como uma forma eficaz para responder às alterações climáticas. Assim, a investigação inicia-se com uma introdução puramente teórica, onde se salienta a necessidade de intervir urgentemente através de medidas de adaptação, e se destaca o nível local como espaço chave para uma intervenção eficaz, uma vez que é a escala onde os impactos ocorrem e as interdependências são mais facilmente reconhecíveis.

Realça-se ainda o papel das cidades, vítimas e responsáveis ao mesmo tempo pelo problema, e o potencial que contêm, em especial através do planeamento do uso do solo, para promoverem a adaptação. Neste âmbito, é feita uma análise dos planos climáticos locais, realçando-se a necessidade de reforçar o processo de integração, que em teoria se revela concetualmente muito válido, mas com implementação limitada.Este foi o ponto de partida para investigar como em Portugal, mais precisamente em Lisboa, esta abordagem está a ser concretizada. Trata-se de uma análise de múltiplas escalas que visa estudar a adaptação desde o nível nacional até à escala da cidade. Ou seja, analisa-se inicialmente a adaptação ao nível nacional, através de planos, estratégias e políticas locais, e, percorre-se um processo de coerência vertical e integração horizontal, destacando-se os pontos fortes e fracos do planeamento português, compreendendo-se como é feita a integração na prática.

Posteriormente, na segunda parte do documento, através de um procedimento de downscaling é feita uma análise das medidas implementadas na cidade de Lisboa, analisando-se a estratégia e ações adotadas pelo município e a sua relação com o reconhecimento alcançado como Capital Verde Europeia 2020. Finalmente é feita a

seleção do Corredor Verde de Vale de Alcântara, objeto de estudo de detalhe para verificar a forma como as medidas estão a ser aplicadas.

Com o apoio do CEDRU e da Câmara Municipal de Lisboa no desenvolvimento desta análise, tentámos pôr em prática os princípios teóricas, assumindo-se que um projeto de natureza temática, como aquele que foi selecionado, pode contribuir para a adaptação às alterações climáticas. O objetivo final deste trabalho é compreender as razões pelas quais Lisboa pode verdadeiramente ser descrita como à prova de clima. Para tal, investigou-se se as políticas climáticas já estavam inseridas e integradas nos diversos campos, em particular no ordenamento do território, ou se foi criado um setor específico focado apenas nas alterações climáticas.

1

chapter

INTRODUCTION TO CLIMATE CHANGE

1 Introduction to climate change

1.1 Multilevel climate change adaptation

Climate change is one of the most discussed topics in this period. The increase in temperature is the factor that most highlights this phenomenon and that will continue for decades due to the emissions that have been produced in previous years; even if emissions stopped now, there would still be negative effects due to the past (European Commission, 2013). The Paris Agreement, which sets the objective of limiting global warming to below 2 °C and preferably limiting it to 1.5 °C at pre-industrial levels (UNFCCC, 2021) is considered as a key point for combating this topic. This can be achieved through a commitment at various institutional scales from international to local and with the collaboration of governments to work on three main factors: increasing adaptive capacity to the negative impacts of climate change, promoting resilience and finally on the low amount of greenhouse gas emissions. (Pietrapertosa, Reckien, *et al*., 2021)

Over the years, plans and strategies have been drawn up to deal with this threat, starting with the European Union, which has prepared a strategy that extends to all member states and can be integrated from the national to the local scale, recognizing the need to improve coordination and coherence between the different levels, with particular emphasis on adaptation. Two possible ways to respond to climate change are identified: mitigation and adaptation.

According to the definition of the Intergovernmental Panel on Climate Change (IPCC) mitigation is recognized as "*an anthropogenic intervention to reduce the anthropogenic forcing of the climate system, which includes strategies to reduce sources and emissions of greenhouse gases and improve greenhouse gas sinks*" (IPCC, 2007) and goes to limit long-term impacts, while, always the same organism defines adaptation as "*the adaptation of natural or human systems in response to actual or predicted climate stimuli or their effects, which moderates the damage or exploits beneficial opportunities*" (IPCC, 2007) where the actions have short-term effects.

If mitigation actions can be pursued at any level and the results are mostly seen on a global scale, as far as adaptation actions are concerned, these are interventions that

take place mostly at the local level and the benefits are also manifested at this scale. (Lebel, Li, Krittasudthacheewa, *et al*., 2012)

These two modes of intervention to cope with climate change are considered complementary, in fact, both are necessary to achieve the goal set where "*the results of today's mitigation efforts will determine the degree of adaptation required in the future. At the same time, the achievement of levels of negative impacts that will be impossible to address through adaptation must be prevented through mitigation*" (European Commission, 2013, p.7).

Despite the urgency of moving on these fronts given the consequences that climate change is showing today, it can be noted that mitigation policies are well structured and developed while the adaptation that paradoxically is urgent to implement is still behind in its implementation.

1.1.1 From the European perspective to the local level

The frequency and severity of extreme weather events are constantly growing and its manifestation can be evident through the manifestation of heatwaves and droughts up to storms to storms and floods, to those less visible at the moment such as land use degradation, biodiversity loss and sea-level rise, but which are equally dangerous and destructive in the long run. Moreover, what has just been mentioned not only affects the environmental part but also has devastating effects on health and the world economy and with cascading effects on all sectors transversal to them (European Environment Agency, 2019).

To date, 55% of the total population resides in cities and it is expected that by 2050 this percentage will rise to 82%, and about 80% of these cities are located near coasts and rivers where they are most susceptible to the phenomenon of flooding, sea-level rise and storms. The continuous and rapid phenomenon of flooding will make populations more vulnerable to the effects that this will cause in terms of resource supply and the heat island (Buckley,2009).

Buckley argues that fast-growing cities will be the most susceptible to climate change: if the rapid growth of the city, which brings with it an increase in vulnerability due to growing development, land-use changes and socio-economic disparities, are added to the consequences deriving from climate change, it is foreseeable that the greatest impacts will fall on these types of cities.

To date, mitigation interventions have been more applied than adaptation interventions at all scales of territorial governance, from international to local; this is a consequence also caused by the fact that until recently the response to climate change was seen as if the two solutions to respond to climate change were replaceable with each other instead of both necessary. Adaptation intervenes directly on issues that involve cities to face and control the extreme phenomena that affect urban settlements, mentioned in the previous paragraph. Regardless of the discourse related to climate change, it is paradoxical how this area is poorly developed being able to provide direct and tangible benefits to cities and also quickly, compared to mitigation interventions that at the local level have mostly indirect effects in economic, political and environmental terms. (Buckley, 2009)

It is, therefore, necessary to intervene from different fronts to try to respond effectively and immediately to this problem in a transcalarity and intersectoral way.

Concerning what has just been said, the European Union is working intensively on the problem related to climate change, in fact, after having already adopted a first adaptation strategy of 2013 where the European Commission focused essentially on three objectives:

- Encourage member states to take climate change adaptation measures while also providing funding to incentivize states to work on this and at the same time inviting cities to engage on the model of the Covenant of Mayors which provides for a movement at the local level on climate and energy, to achieve and exceed EU objectives (Covenant of Mayors, 2021)[1].
- Specifically promote adaptation actions on particularly vulnerable sectors such as fisheries and agriculture, with the certainty that Europe can count on a solid infrastructure.
- Closing the adaptation gaps by also creating a support platform called Climate-ADAPT (European Environment Agency, 2019).

[1] The Covenant of Mayors aims to keep the global temperature below 1.5°C, achieving climate neutrality by 2050, thus living in decarbonized and resilient cities and using energy in an economic and sustainable way. In particular, the Covenant of Mayors works on committing to setting medium-long term objectives in line with those of the EU and at the same time aiming at the involvement of citizens, businesses and governments; act through action plans on mitigation and adaptation with clear timelines and deadlines and network with the aim of taking inspiration from the practices that cities implement (Covenant of Mayors, 2021).

Another one followed, in February 2021, which also aims to achieve a resilient society adapted to climate change while maintaining 2050 as a period but setting three objectives to work on:

- smarter adaptation through more intensive data engagement through the enhancement of the Climate-ADAPT platform and spacing on adaptation knowledge;
- a more systemic adaptation that encompasses the development of policies at all scales and sectors, based above all on the integration of macro-financial policies, natural-based solutions and actions at the local level;
- a faster procedure on implementation to adaptation measures (European Environment Agency, 2019).

On a practical level, the EU, which has been recognised globally as a forerunner of the integration of adaptation strategies, has already embarked on a path to strengthen climate resilience virtually all member states have produced a national strategy or plan for adaptation to climate change.

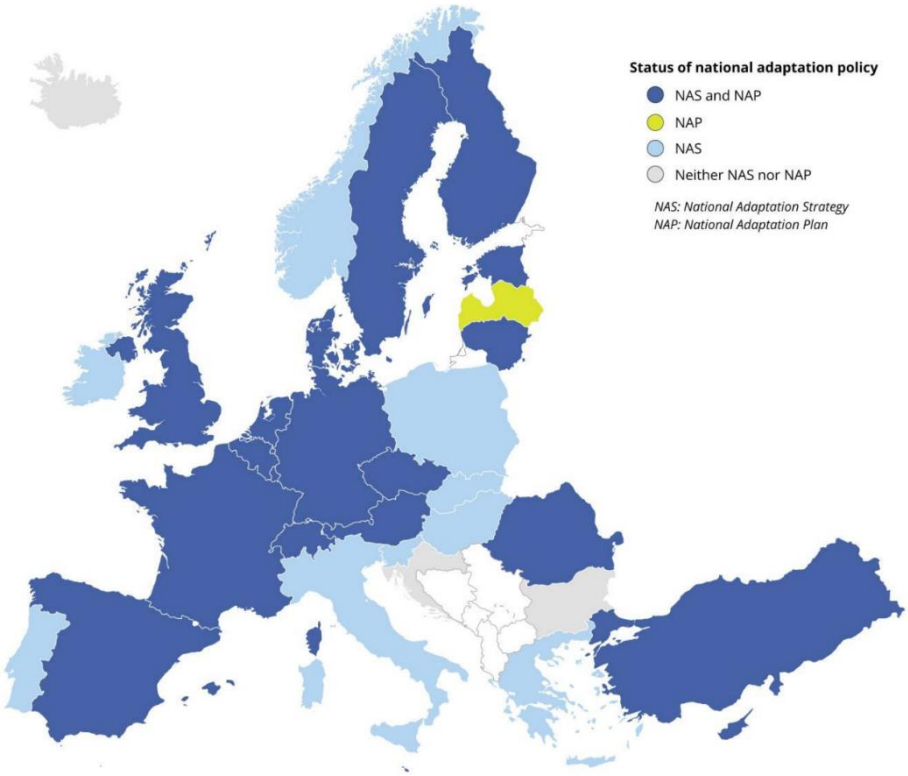


Figure 1 Situation of EU countries (2019 last available data) on national adaptation strategies (NAS) and plans (NAP). Source: Sustainability | Free Full-Text | Adaptation to Climate Change and Regional Planning: A Scrutiny of Sectoral Instruments | HTML (mdpi.com)

The member states are in fact considered the central subjects to achieve the goal set by the European Union. Although part of the adaptation policies is at the local level and therefore specific to a given area, this does not exclude that these can be replicated on a large scale (European Commission, 2021).

This is why Climate-ADAPT plays a fundamental role: the need to know better the risks related to the climate and consequently to all the sectors related to them such as the environment and health, has emerged in order to be ready to face them. The need to expand the available data network to better study the current conditions and therefore understand the risks and vulnerabilities to which a place is subject, serves for a better assessment and adaptation strategy. Through the sharing of good practices and expanding the network of information and data helps to grow and make progress in this area (European Commission, 2021).

- *The main opportunities for boosting local authorities' adaptation efforts lie in improving access to knowledge and funding; making effective use of land use planning regulations and tools; and facilitating both political and community engagement*

- *Improving access to knowledge can be achieved through collaborating with researchers and making greater use of existing data and information sources, including citizen science, insurance claims data, and sharing knowledge with other cities.*

- *Climate change adaptation should be treated as an essential part of sustainable urban development. This can be done by linking it more effectively to other policy areas, especially land use planning, climate change mitigation, and health and social justice agendas.*

Table 1 Towards well-adapted cities and towns. Source: European Environment Agency, https://www.eea.europa.eu/publications/urban-adaptation-in-europe

Finally, to facilitate the implementation of the creation of an adaptation policy, the EU has drawn up and made available to nations the adaptation support tool that supports member states in the implementation, monitoring and evaluation of climate change adaptation strategies and plans to be extended also at the national and sub-national level (Climate ADAPT, 2019).

The guidelines that have been drawn up for the creation of this tool are built on a cyclical process, but since adaptation to climate change cannot be defined as a sequential procedure and that each State is at a different stage of the process, the model was understood as iterative (Climate ADAPT 2019).

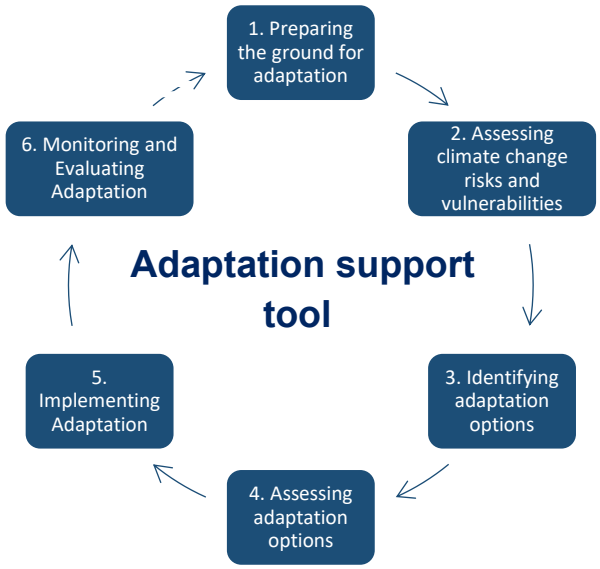


Figure 2 Adaptation support tool process. Source: https://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0

The adaptation support tool "*is particularly relevant for the signatories of the Covenant of Mayors for Climate and Energy; is the main adaptation resource for the Covenant community and helps signatories achieve their commitment to increase resilience to climate change and prepare for the negative impacts of climate change*" (Climate ADAPT, 2019) and will be dealt with in chapters 2.5.2 and 3.1 Lisbon also uses this methodology to build its climate change adaptation strategy.

If on the one hand, we must expand the knowledge of adaptation practices and measures, on the other we must work on integration, on the need and ability to mainstream.

This term was first introduced at the World Summit for Sustainable Development held in Johannesburg in 2002, being defined as *"the integration of policies and measures to address climate change in ongoing sectoral and development planning and decision-making, to ensure the long-term sustainability of investments and reduce the sensitivity of development activities for the climate of today and tomorrow"* (Klein, Schipper, Dessai, 2003).

The following paragraph will discuss the importance of mainstreaming and the potential that it brings with it to face the threats related to climate change.

1.2 The concept of mainstreaming

As Reckien *et al*. affirm, initially European policies have given priority to mitigation, a preference that could be motivated by the fact that it brings benefits related to economic savings, greater energy security and reduction of emissions while the systematic implementation of adaptation is more articulated and connected also with other topics not related to the climate but in any case, inherent as health, therefore, more articulated to be concretized (Dellmuth, Gustafsson, 2021). In recent years, working a lot on climate policies has paid a lot of attention to how concretely they could be transferable in reality so working a lot on the ability to do mainstream to develop transversal objectives and efficiently use the available resources, instead of building separate paths to support adaptation (Lebel, Li, Krittasudthacheewa, *et al*., 2012).

It is now an established concept therefore that mitigation measures, although they have become an international priority in climate matters, are not enough and it is necessary to intervene through adaptation measures with the aim of minimizing the impacts on the population and the environment. (Lebel, Li, Krittasudthacheewa, *et al*., 2012)

The 2013 European Adaptation Strategy stressed the EU's need to provide guidance on the structuring of local climate plans and associated this lack as a consequence of the fact that many cities did not consider adaptation problems in their plans (Olazabal, De Gregorio, *et al.*, 2014). Starting from this gap, guidelines were subsequently formulated to involve cities more relevantly in this commitment recognizing *"that adaptation must be, and for the most part is, undertaken by local authorities, since this is where impacts are experienced and interdependencies are most easily recognizable*"(Heidrich, Reckien. *et al.*, 2016).

The table below shows the relevant adaptation steps.

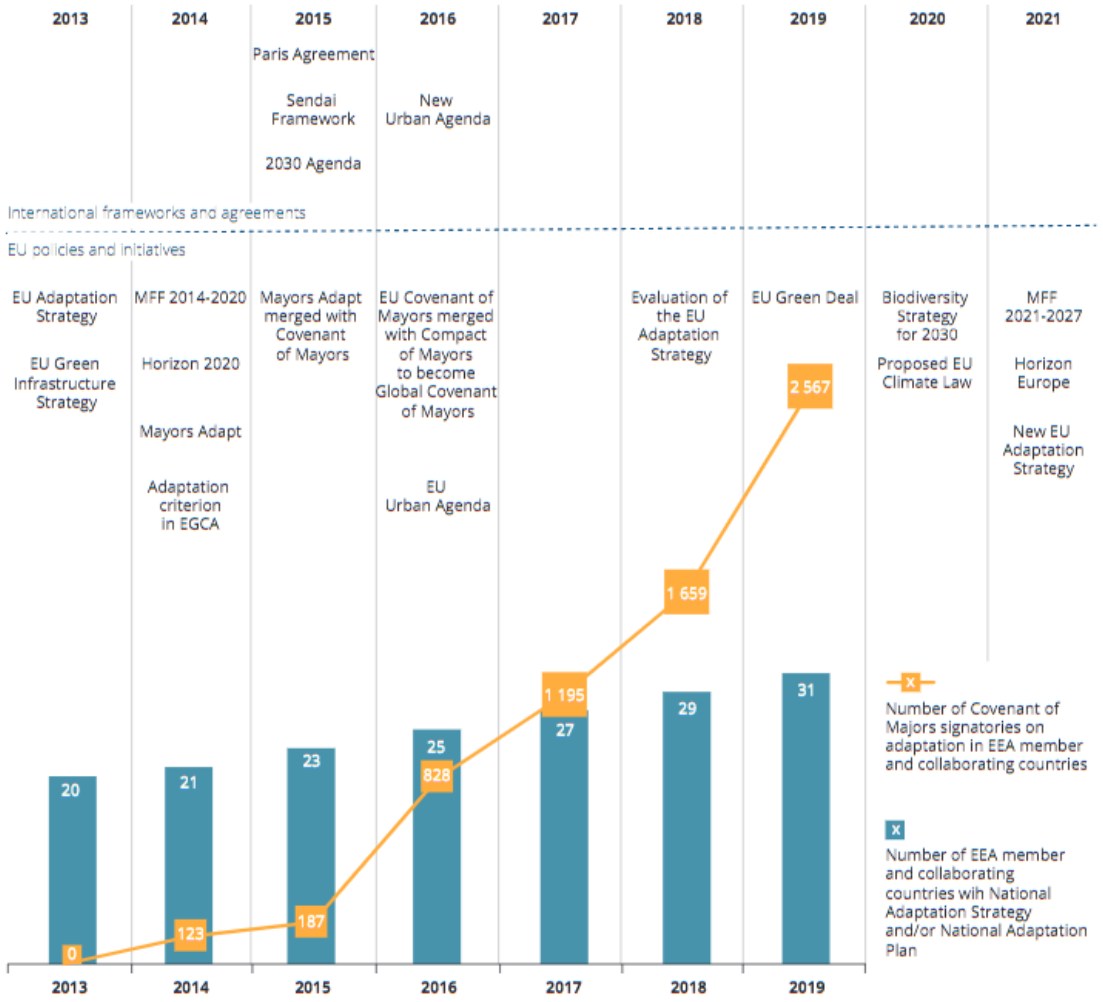


Figure 3Adaptation steps done in the last decde. Source: https://www.eea.europa.eu/publications/urban-adaptation-in-europe

Cities play a key role in this issue and contain in themselves a huge potential to work on (Reckien, Salvia, *et al*., 2018), gaining prominence also among international governments such as the European Union, UN-Habitat (Reckien, Salvia, *et al*., 2019). Local adaptation can be inserted into a broader governance discourse, in which cities can be seen as influenced by higher levels of governance and at the same time can be drive change themselves (European Environment Agency, 2020). In fact, they respond to climate change through local climate plans (LCPs) also encouraged by networks

such as C40 Cities [2] and ICLEI [3] that are directing the participating municipalities in the structuring of local mitigation and adaptation plans. *"LCPs are considered as city-prepared planning documents that contain policies relevant to climate change adaptation and/or mitigation"* (Reckien, Salvia, *et al*., 2018) and are different in terms of detail, structure and scope often influenced by different national climate policies;

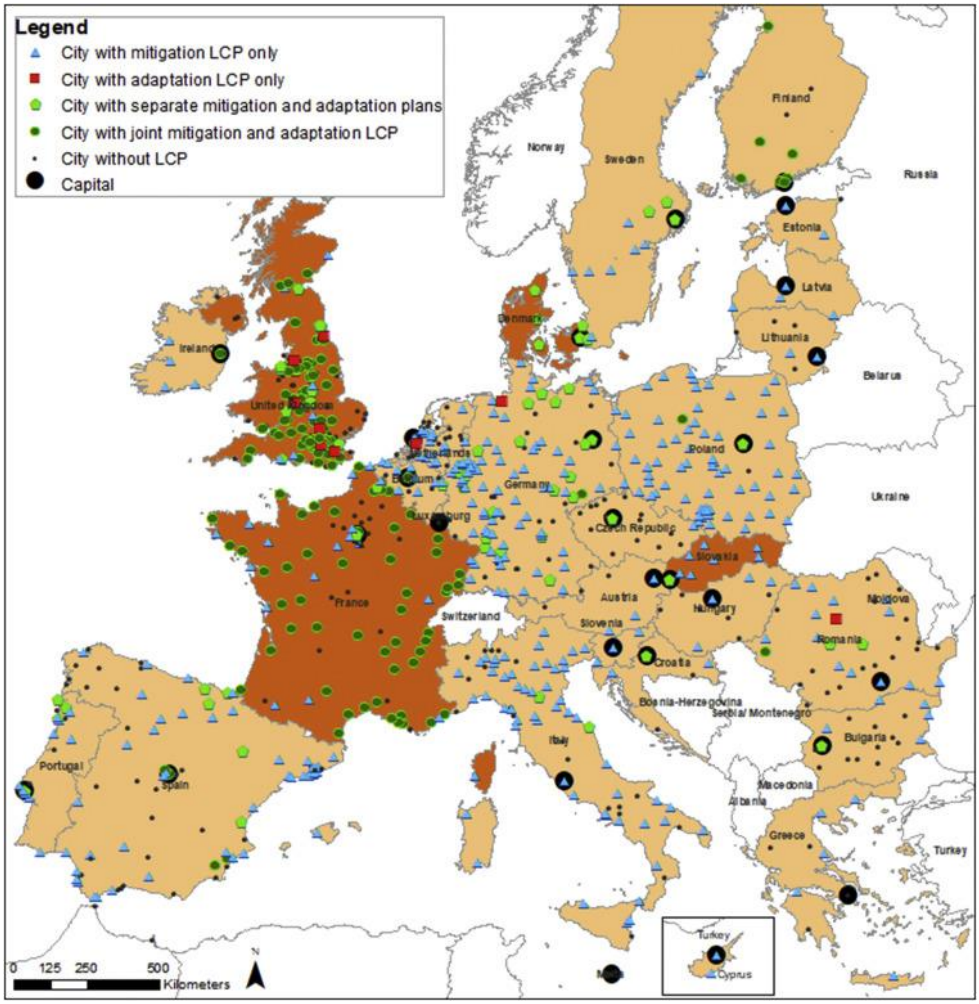


Figure 4 Distinction of local EU climate policies. States that do not require their local governments to develop local climate plans are presented in beige, and states that make it mandatory for larger cities and local governments to develop local climate mitigation or adaptation plans are presented in orange. Source: How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28 - ScienceDirect

[2] C40 cities is a network of 100 leading cities from around the world to contribute to tackling the climate crisis by sharing experiences and practices from which other cities can take their cue by establishing the minimum requirements for all the cities that are part of it. (https://www.c40.org/)

[3] Local Governments for Sustainability is a network of local and regional authorities with the aim of pursuing local development based on emissions, through a resilient and circular fair nature(https://iclei.org/en/Home.html?gclid=Cj0KCQiAzfuNBhCGARIsAD1nu-88ipveaXun2hoVoqWHdskcu-pU5_I62Ob5F2Zu3SIysWZ5MvilTbEaAsajEALw_wcB)

Reckien *et al*. categorizes and subdivides the different countries by distinguishing the role of national governance in local climate plans; this distinction has also been useful to contextualize Portugal in a broader system.

- Autonomous LCPs where national governments do not require their elaboration and therefore it is at the discretion of the city the result of the local climate commitment;
- LCPs that have a national regulation explicitly requested by the nation by releasing guidelines and detailed content to local authorities;
- Internaional climate newwork plans, usually when national climate change policies are lacking (Reckien, Salvia, *et al*., 2018). This will be the case with Lisbon, which will be dealt with in Chapter 3.

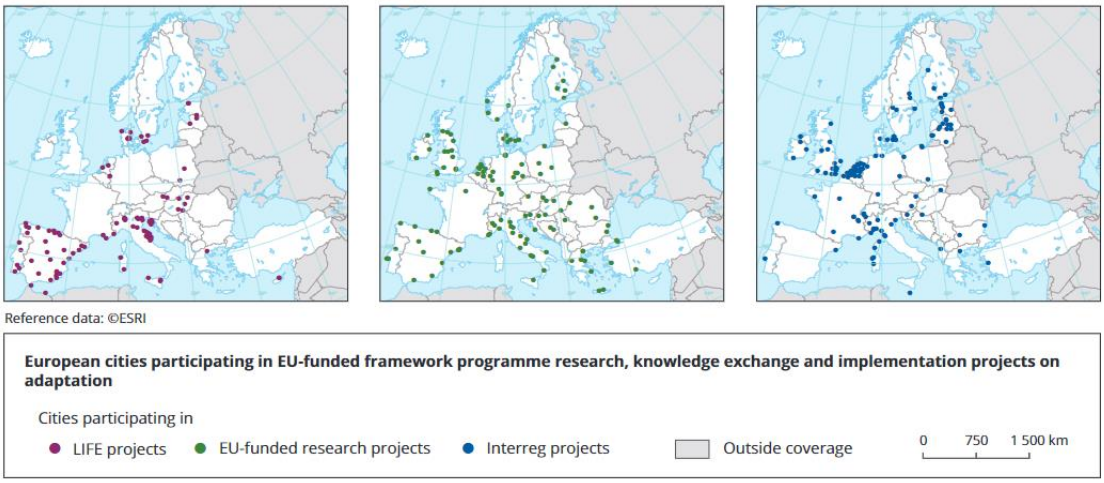


Figure 5 European cities participating in EU-founded framework program research, sharing knowledge and implementation of adaptation project. Source: https://www.eea.europa.eu/publications/urban-adaptation-in-europe

Is possible to find LCP considered as more complete and autonomous judged by Reckien *et al*. such as those that achieve better outcomes in terms of integration, those integrated into other documents such as sustainability and resilience plans that also include mitigation and adaptation of changes less effective than the former due to their breadth of scope, sectoral ones and finally plans of other subjects but still relevant on the topic in question (Reckien, Salvia, *et al*., 2019).

The question of integration is very diversified and labile from the bibliography addressed, the same authors give different definitions and ways of interpretation, some agreeing on the distinction between vertical mainstreaming, connected to the integration of climate policies in sectoral ones, and the horizontal one, understood as

the integration of environmental policies into broader planning frameworks, while others press on the latter stating that that is the true definition of mainstreaming. In practice this distinction is blurred, seeing that in most cases the decision-making process at the local level is composed of both elements of a vertical and horizontal nature, concluding that climate policy will be somehow integrated, at least vertically, when moving from theory to practice (Reckien, Salvia, *et al.*, 2019).

Taking into account the adaptation part, it is possible to note that the Adaptation-LCP are divided into three categories namely:

1. Dedicated: climate documentation;
2. Horizontal mainstreaming: integrating climate aspects into environmental policies;
3. Vertical mainstreaming: vertical integration with particular reference to heat waves and floods.

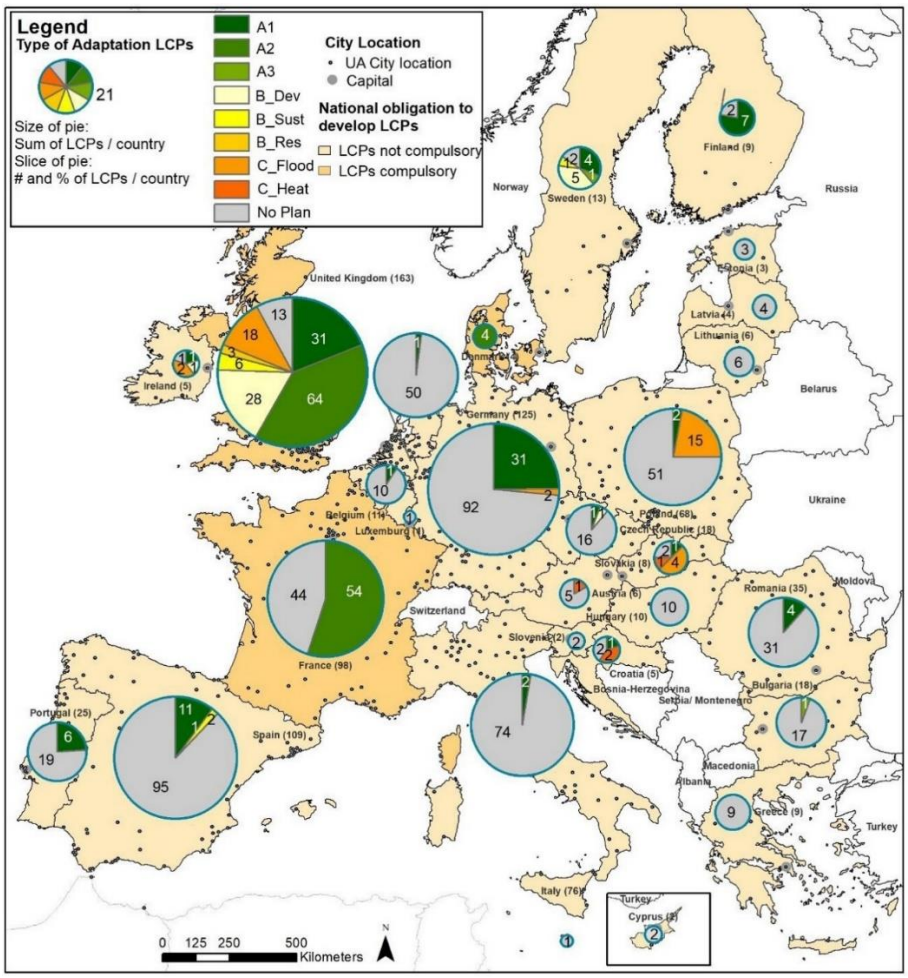


Figure 6 Distinction of adaptation LCP. Source: How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28 - ScienceDirect

Despite the awareness of the effectiveness and advantages of mainstreaming brings in terms of results and relationships linked to synergies and agreements with third parties, there is to date a prevalence of dedicated plans, including precisely Portugal; what has just been said could be justified by the reason that in theory mainstreaming can be considered the preferable but limited choice. Reckien in this regard underlines that the mainstreaming process must be strengthened and improved to ensure that it is exploited according to the previous powers highlighted above all the need for *"the parallel implementation of concrete measures to maintain the visibility and focus of the policy objectives along with the mainstreaming vision"* (Reckien, Salvia, *et al*., 2019).

1.3 Victim and culprit: how cities are responsible for climate change

Cities IPCC 2018 defines cities as *"open, complex, self-organized, adaptive and evolving formations that are incorporated into broader social, ecological, economic, technical, institutional and governance structures"* (IPCC, 2018, p.4) and with the awareness of having a double value, that of threat linked to the effects that urbanization causes and that of opportunities related to innovations and sustainable development of human activities.

To date, more than half of the population lives in cities with a prospect of an increase of 6 out of 10 people by the end of the decade. If on the one hand cities are the place where the most obvious consequences of climate change such as floods, heat islands and extreme events are manifested, thus playing the role of victims, at the same time urban expansion is growing exponentially exerting pressures on water supply systems, on the environment and health, also becoming guilty. Although at present cities occupy only 3% of the earth's surface, they emit energy consumption between 60-80% and 75% of carbon (Organizzazione delle Nazioni Unite, 2015).

The role of the city is currently important to intervene in an effective and timely manner in the face of the global challenges of climate change in the environmental, socio-economic and interrelationships between them, becoming important catalysts about the problems mentioned above. Given this responsibility that local governments are taking with them, they are taking on the challenges that the future holds and the

responsibilities they are facing through urban resilience approaches, even if the system suffers from a clear lack of materials, data and knowledge on which to rely and that is why, as discussed in the previous paragraphs, it is important to focus on sharing experiences, results and data. In particular, in the Cities and Climate Change Science Conference of 2018, a series of elements were highlighted that are the basis for addressing climate issues in cities and improving performance related to cross-cutting issues and insufficient information in the field of "*capacities of local institutions, the interconnectivity of different sectors, the impacts of scale and the availability of data*" (Prieur-Richard, Walsh, *et al*., 2019, p.4) highlighting the lack of data and methodologies useful for the understanding and progress of studies.

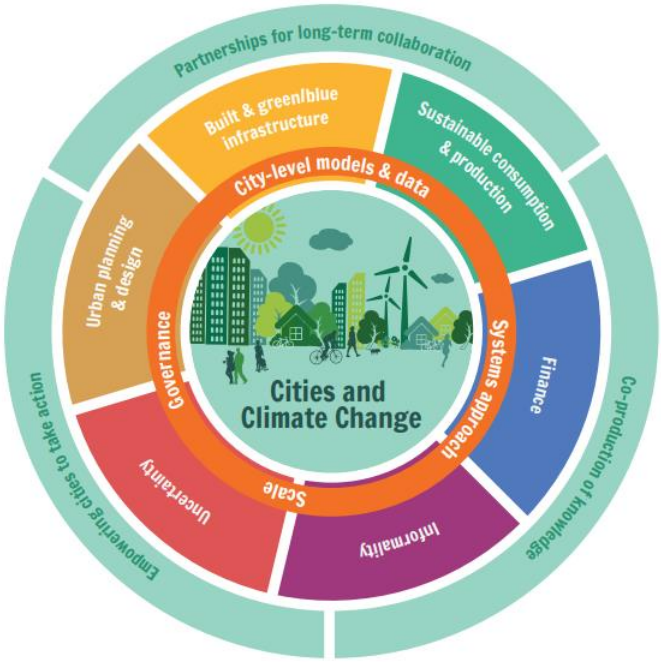


Figure 7 Scheme for climate adaptation and mitigation in cities. Source: https://www. wcrp-climate.org/WCRP-publications/2019/GRAA-Cities-and-Climate-Change-Science-Full.pdf

In fact, given the shortcomings to support research and intervening in a practical way on cities and climate change, the conference itself was an opportunity to gather knowledge and discuss possible solutions (Caldarice, Tollin, N. & Pizzorni, 2021).

The use of a systemic approach, through a broader conception of the term city (mentioned at the beginning of the chapter), would give the possibility of achieving considerable goals in the field of climate change. This can happen, according to the literature consulted, through the recognition of the same as an interdependent system with the regions and states in which the cities themselves are located, it is possible to address several issues, even apparently distant in which more balanced solutions would be found by combining climatic factors with transversal ones. What has just been mentioned goes in parallel with the concept of resilience thought of as a transcalarity and intersectoral notion (Prieur-Richard, Walsh, *et al*., 2019).

The term resilience is not limited to being opposed to that of vulnerability but aims to manage unforeseen events and at the same time improve the quality of the urban environment (Caldarice, Tollin, Pizzorni, 2021).

This concept has thus become a key element in recent decades, also supported by international organizations that through their policies support resilience and the fight against climate change. We can find what has just been stated in the 2030 agenda that dedicates a target aimed exclusively at cities, namely SDG's11 "*Make cities and human settlements inclusive, safe, resilient and sustainable*" (United Nations) which promotes mitigation actions adaptation resilience and rescue plans, in the Paris Agreement which in Article 4 declares that nations will have to prepare, expose and pursue the national objectives they set themselves and achieve them through mitigation measures, and finally in the New Urban Agenda which is committed to pursuing the fight against climate change at all scales through mitigation and adaptation actions and in line with the Paris Agreement. (Caldarice, Tollin, Pizzorni, 2021)

Figure 8 Support resilience in International organization. Source: https://www.wcrp-climate.org/WCRP-publications/2019/GRAA-Cities-and-Climate-Change-Science-Full.pdf

Resilience specifically involves planning, in particular, it requires rethinking the logic of the planning process by intervening in the reduction of the environmental and social needs of the city. In particular, if before spatial planning focused on the regulation of anthropogenic transformations on the environment, now a more complex approach is

required, able to proactively address risks and vulnerabilities and reduce the anthropogenic impact on ecosystems.

In short, urban resilience requires the integration of the adaptation of environmental policies on a local scale in environmental policies, aiming at a transition through the "*rethinking traditional approaches to land use and infrastructure design based on past trends, move towards more forward-looking risk-based design for a range of future climate environmental conditions and reduce administrative costs by strengthening resilience through existing policy channels*" (Caldarice, Tollin, Pizzorni, 2021).

Land use planning, as can be seen from *Figure 9* is the most influencing factor for cities in terms of adapting to climate change and through its implementation by adapting it to the climate is able to significantly reduce the extent of future damage. The relationship between adaptation and land use is particularly remarkable due to the spatial characteristic of climate impacts and the different consequences they have on cities, as well as the future perspective that belongs to the planning itself.

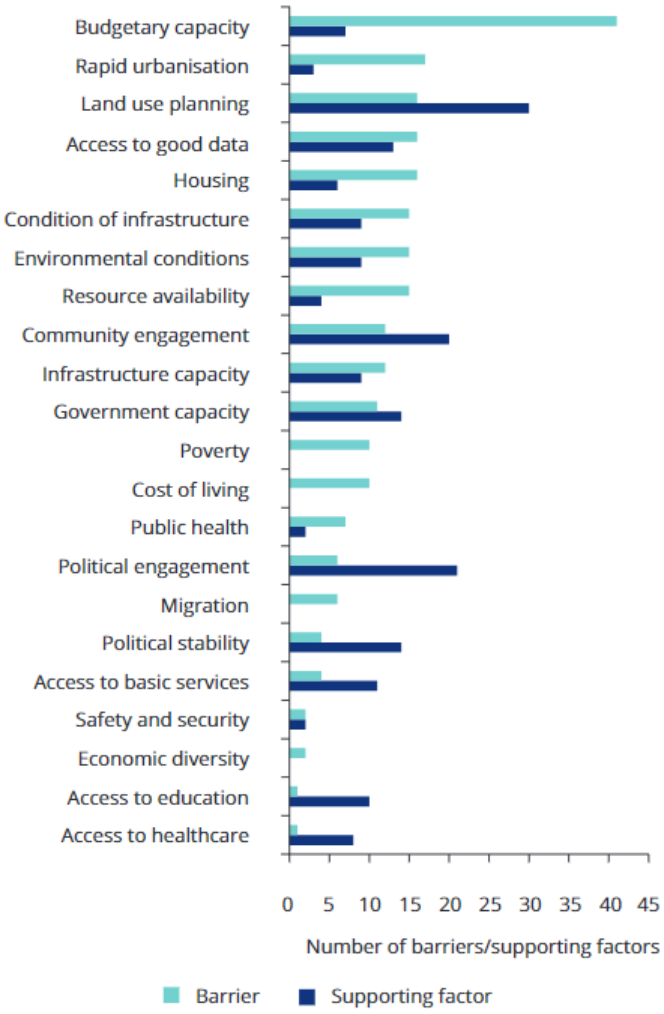


Figure 9 Influencing factor for cities in terms of adapting to climate change. Source: https://www.wcrp-climate.org/WCRP-publications/2019/GRAA-Cities-and-Climate-Change-Science-Full.pdf

Although this area is a very strong support factor for cities, the integration between climate change adaptation plans and territorial planning plans are still being worked on and refined as it turns out to be a very recent topic; Suffice it to say that in 2017 only 15 states were belonging to the European Union that had integrated environmental policies into local planning tools. To date, the process is making

progress by bringing out green infrastructures as indispensable solutions above all able to be interacted even in limited spaces if well coordinated with local planning (European Environment Agency, 2020).

The European Green Capital Award in this regard uses the case of Lisbon as good practice since the city's masterplan attaches the climatic guidelines deriving from a study aimed at proper ventilation and reduction of the urban heat island effect through a mapping of the main ventilation corridors and directives that prevent ventilation areas from being blocked by new constructions (EGCA, 2018).

In conclusion, therefore, the urgency of intervening in practice through tangible adaptation measures and of using cities as the key factors to cope with the climate emergency is highlighted.

2
chapter

HOW PORTUGAL MANAGES ADAPTATION TO CLIMATE CHANGE

2 How portugal manages adaptation to climate change

In this chapter, it will deepen the case of Portugal by analyzing the main phenomena of climate change to which the country is subject, in particular focusing on the continental part. This section will be articulated by a mostly descriptive part that will initially provide a global picture of the situation related to the effects of climate change by analyzing the phenomena and hypothesizing the future scenarios attracting the support provided by the Portal do Clima; subsequently, it will be treated how Portugal behaves in terms of territorial planning mainstreaming and adaptation to climate change through the reading of Portuguese plans and programs.

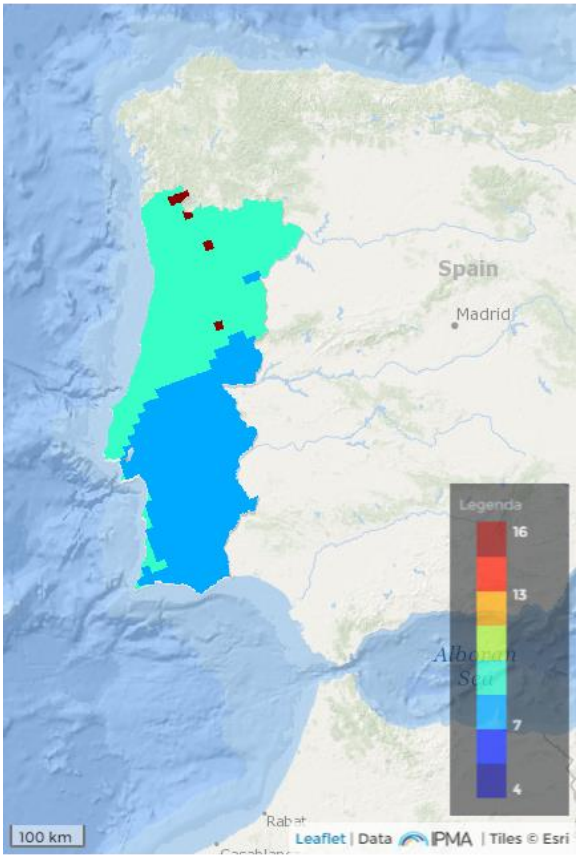


Figure 10 Climate classification- Koppen, period 1971-2000. Source: http://portaldoclima.pt/pt/

Before addressing what has just been mentioned, it is useful to prepare a climate overview of the country under analysis to better understand the dynamics. Geographical and territorial characteristics are the main factors determining climate vulnerability and therefore represent the primary condition for climate adaptation. (APA *et al.*, 2021).

It is possible to divide Portugal into three climatic areas: the continental part (which will later be our focus), the Azores archipelago and that of Madeira.

The continental area is characterized by a Mediterranean climate, based on the Köppen-Geiger climate classification, it is defined as a temperate climate of type C with within it a distinction in subtype:

1. Csa: Seasoned with dry and hot summer prevailing in the southern part,
2. Csb: Seasoned with dry and temperate summer prevalent in the northern part

3. Cfa: Temperate without dry season with temperate summer only in small areas located in the north of the country (Portal do clima 2021).

The average temperature fluctuates between 14-15°C, with a maximum in August and a minimum in January. In the high-altitude areas, rainfall value is higher and decrease as we move inland; in fact, an average annual rainfall of around 900 mm is recorded, with a wide variation between north and south, reaching up to 3000 mm in the north-west mountains and value of less than 500 mm in the south-east (Yohe, 2010).

The situation is different in the Azores archipelago. This is a temperate maritime climate, characterised by a low-temperature range, with an average temperature of 17.5°C (where the highest temperature is recorded in August with 22°C and the lowest in February with 14.5°C), high humidity and a high frequency of rainfall (GRA-DRAAC, 2020).

Madeira, on the other hand, is geographically located in the subtropical area, with a mild climate both in winter and in summer, except for higher areas, where lower temperatures are recorded. The average annual temperature is 19.5°C with a variation of 8ºC, in the highest peaks, and 19ºC in coastal areas. Also in this case we have a great asymmetry concerning precipitation, in fact, in the highest peaks the average accumulated annually is a maximum of 3400 mm, while the minimum recorded is less than 600mm in the Funchal region; this area is the hottest part of the island (CEDRU, 2021).

2.1 Climate impacts in Portugal

"*Portugal is one of the countries most affected by climate change*", said President Von Der Leyen during the European Council meeting in December 2019, in fact in this country we can already observe an intensification of climate change today, with global warming is currently about 1 ° C higher than pre-industrial levels, manifested in a series of effects on humans and ecosystems.

According to the IPCC, due to climate change, southern Europe has experienced an increase in temperature and a decrease in precipitation and it is expected that in the Mediterranean region the drought phenomenon will tend to approach 2 ° C compared to 1.5 ° C thus bringing an increase in sea level that thus aggravate the coastal and

inland areas. In recent decades Portugal has experienced an increase in average temperature and with an ever-growing forecast in the coming years that is expected to bring flooding and coastal erosion, strong heat waves, fires, storms and droughts, increases in extreme rainfall are expected especially in the northeast of Portugal in winter and spring (Schleussner, *et al*., 2020).

What has just been mentioned is also confirmed by the results obtained by the project "*Climate*Change in *Portugal. Scenarios, Impacts and Adaptation Measures"* (SIAM). It has emerged that there will be an increase in average temperature, heat waves with a greater frequency and a decrease in precipitation and the intensification of drought will lead to significant negative effects in the various socio-economic sectors, such as water resources, agriculture, forests, biodiversity, health and tourism. (Schleussner, ***et al***., 2020).

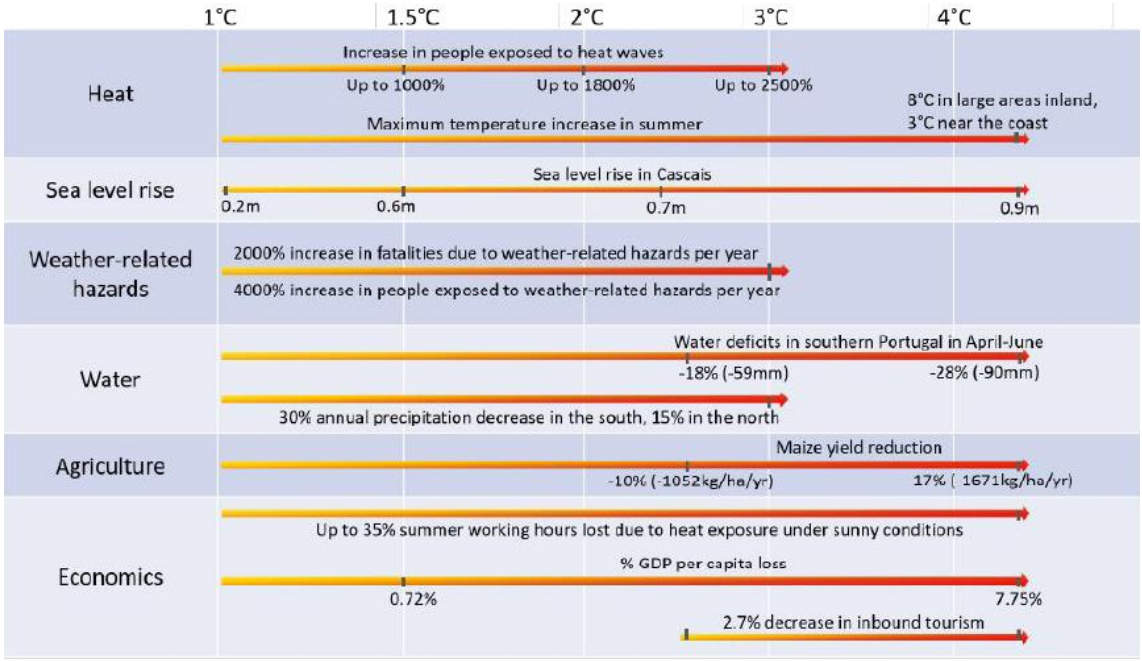


Figure 11 Projected impacts of climate change in key sectors in Portugal. Source: https://climateanalytics.org/

2.2 Socio-economic contextualization related to climate change

From a geographical point of view, it is important to underline that more than 50% of the continental area is subject to desertification, especially this phenomenon manifests

itself in the southern part between the Alentejo and Algarve areas, also due to the climatic conditions aggravated by climate change and years of poor agricultural practices.

The demographic dynamics also influence the priorities of climate adaptation, in fact, the concentration of the population along with the coastal areas is between the metropolitan cities of Lisbon and Porto where about 40% of the Portuguese population is present, and the flow to coastal areas increases in the summer, particularly in the Algarve region, due to both national and international tourism (APA et al, 2021).

These areas, which depend heavily on the climate and the territory itself, will be greatly affected by the effects of climate change; The foreseeable disappearance of the beaches due to the rise of the sea, the loss of biodiversity, the erosion of the coasts and the consequent loss of the landscape would also lead to negative effects not only in the tourism sector but also in the related ones compromising the development and economic growth.

From an economic point of view, Portugal has had a progressive increase in the tertiary sector in recent years, particularly in the Algarve and Lisbon region due also to the growth of tourism activity. As far as the secondary sector is concerned, it is particularly relevant in the centre and north of the country with a concentration of 34% and 29% respectively. Finally, the agricultural sector is mostly concentrated in the Alentejo and Algarve areas and according to the climate evolution scenarios by the end of the century, it will be the sector that will suffer the most. From future projections, a reduction in precipitation is expected, an increase in temperature and frequency of extreme events with a consequent increase in the phenomenon of desertification (APA et al, 2021).

2.3 Uncertainty monitoring

IPMA, the Portuguese Institute of the Sea and Atmosphere, is the entity responsible for meteorological and climatic observations and was the subject that led to the development of the Portal do Clima. This project contributes to raising awareness regarding the issue of climate change by providing data and information such as "*time*

series, climate change at the regional level and climate indicators for specific sectors in Portugal" (CEDRU, 2021, p.10).

Through the climate models offered it is possible to analyze the future scenarios: in this paragraph, the trend of the various phenomena will be analyzed through a comparison of 2 periods: past scenario 1971-2000 and future scenario 2071-2100.

The future scenario is identified as RCP8.5, which "*refers to the concentration of carbon that delivers global warming at an average of 8.5 watts per square meter across the planet. The RCP 8.5 pathway delivers a temperature increase of about 4.3˚C by 2100, relative to pre-industrial temperatures*" (Hausfather, 2019).

L'RCP is the Representative Concentration Pathway i.e. a set of possible trajectories of future emissions and concentrations of greenhouse gases, aerosols and land use (Moss *et al*., 2008).

Through the study of bioclimatic scenarios, the goal is to process information of future climate projections (using in the following case RCP 8.5) serving as basic information for the identification of possible climate changes of this century.

Four phenomena recognized as "priority climate risks" will be analyzed, such as:

- Temperature increase
- Rainfall
- Sea level rise
- Extreme weather events with a focus on **heatwaves, droughts and floods**

which currently have significant impacts on the territory under analysis and where a worsening is expected by the end of the century (Area Metropolitana de Lisboa, 2019).

After that, having a clear framework of the current scenario and future projections, it will be possible to proceed to understand how the Portuguese planning system intervenes on the issue of climate change. This topic will be covered in the following paragraphs.

2.3.1 Temperature increase

As previously mentioned, Portugal is characterized by a Mediterranean climate with hot, dry summers and cool, wet winters (Carvalho et al., 2014). From the data of the last decades, there has been an increase in average temperature and intensification of extremely high temperatures also confirmed by the scenarios that foresee a "*significant increase in maximum and minimum temperatures in all seasons and all scenarios*" (Cardoso et al., 2019).

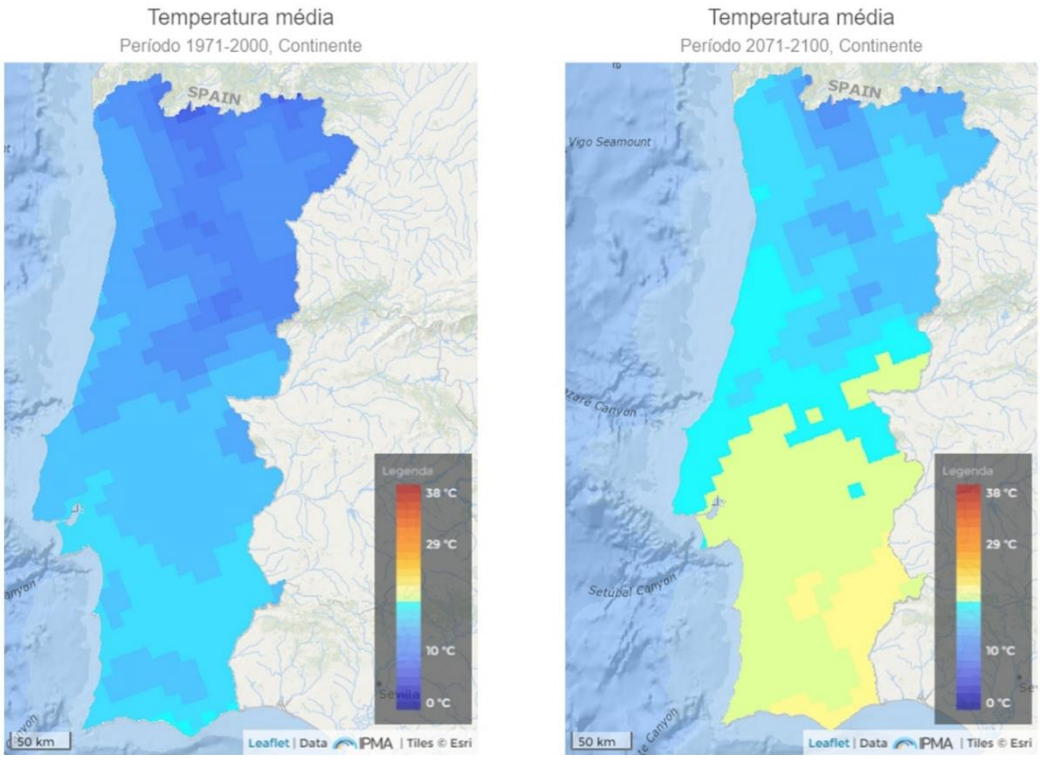


Figure 12 Average temperature period 1971-2000/2071-2100(RCP8.5) Source: http://portaldoclima.pt/en/

As is possible to see from the graphs below, the two different periods have been compared and you can see how the average temperature is constantly growing and will continue to increase until the end of the century with reaching an average temperature above 18 °C.

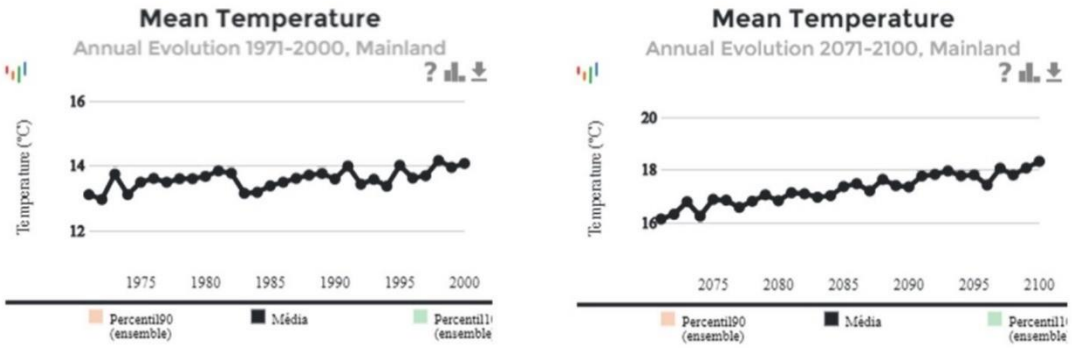


Figure 13 Mean temperature period 1971-2000/2071-2100 (RCP8.5) source: http://portaldoclima.pt/en/

As for the maximum temperature it is expected that temperatures in the summer and autumn season will increase up to 8 °C while for the winter and spring season they will increase between 2 °C and 4 °C. Especially in summer, it is possible that the average maximum daily temperatures increase up to 3 ° C near the coast and up to over 8 ° C inland. *"In general, in a global warming scenario of around 4.3°C by 2100 (RCP8.5), temperatures in Portugal will seldom fall below 2°C, while temperatures above 40°C will be much more common"* (Schleussner et al, 2020, p.8).

If we see the territorial relations with this climatic variable we can deduce that the phenomenon of desertification is therefore linked in part with the rise in temperatures, in particular in the region of the areas of the Alentejo and Algarve which is in progressive depopulation (EMAAC 2020).

2.3.2 Precipitation

"*Portugal is one of the countries with the greatest spatial gradients of precipitation, from the northwestern region, directly affected by the passage of Atlantic storms, to the drier southern regions. Migratory storms are responsible for most of the annual rainfall between November and April*" (Schleussner, C.F.et al, 2020, p.9).

Fussen says that in the last century the Portuguese territory has recorded a decrease in annual precipitation of 90mm per decade (Füssel, et al., 2017).

Through the graph below we can see how the phenomenon of precipitation will tend to decrease: if the average in the period 1971-2000 was 1001.9 mm of annual rainfall, in

the RCP8.5 scenario considered the annual average will be 855.6mm.

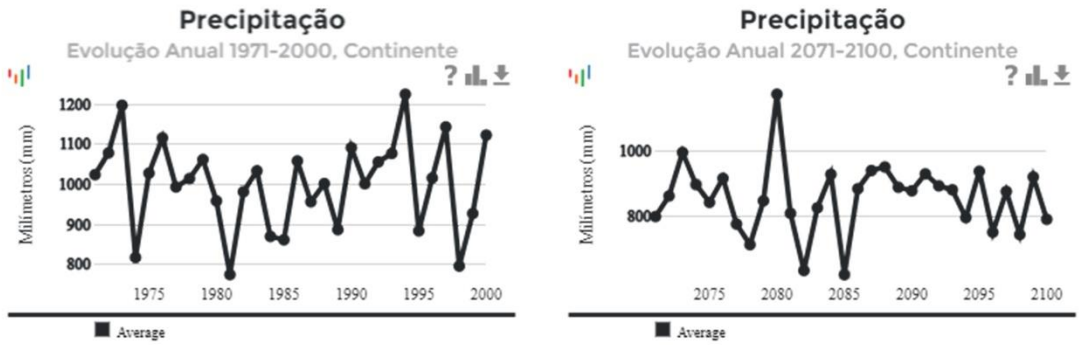


Figure 14 Mean annual precipitation period 1971-2000/2071-2100 (RCP8.5) source: http://portaldoclima.pt/en/

Consequently, days with precipitation of <1mm of rain, i.e. defined as the absence of precipitation, will increase the chances of drought and fire risk where Portugal is particularly susceptible.

Agriculture will be most affected by this phenomenon as the days without precipitation will increase mainly in the central south where the primary sector is concentrated.

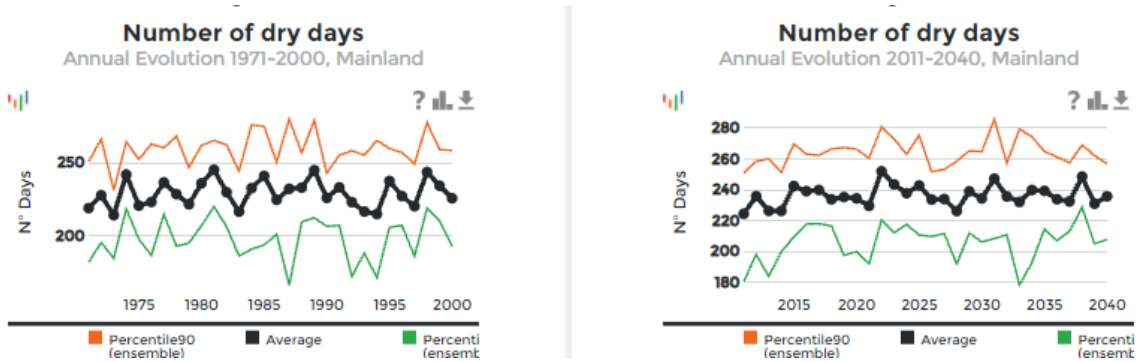


Figure 15 N° of day without precipitation period 1971-2000/2071-2100 (RCP8.5) source: http://portaldoclima.pt/en/

The country reflects what has been expected throughout southern Europe: i.e. an overall decrease in total rainfall with a consequent increase in droughts (Hov *et al.*, 2013).

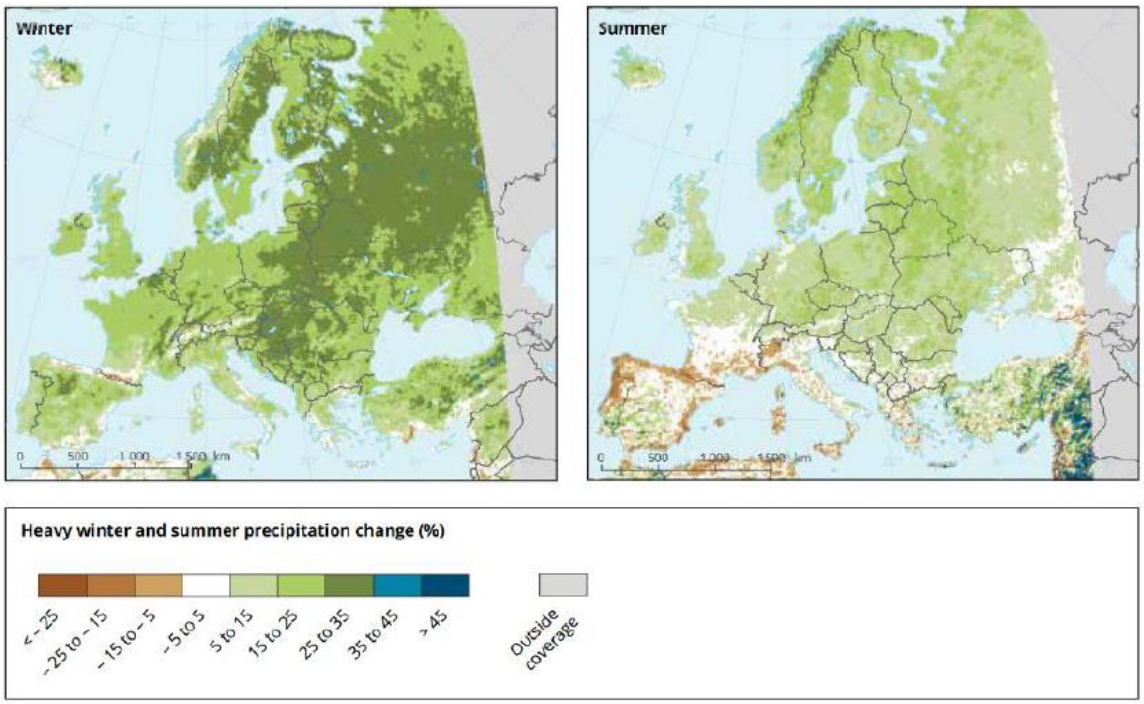


Figure 15 Percentage heavy precipitation change in summer and winter making a comparison of 100 years (between 1971-2000 and 2071-2100). Source:EURO-CORDEX

2.3.3 Sea level rise

Studies by the European Environment Agency have shown that sea levels have risen by 20cm since the last century. In Portugal, sea-level rise is very much affected, particularly in the low-lying, estuary, coastal lagoon and wetland areas classified as highly vulnerable. As the map highlights, there is a high vulnerability concentrated in four zones corresponding to the estuary of the Tagus and Sado river, and the lagoons of Ria de Aveiro and Ria Formosa. In these areas, it is expected that the most sector will be the socio-economic one, in particular about:

- "*direct economic, ecological, cultural and substance value through the loss of coastal land, infrastructure and habitats.*
- *increased risk of flooding of people and infrastructure*
- *other impacts related to changes in water management, salinity and biological activity*." (Ferreira, *et al*., 2008, p.11)

It will not only be the rise of the sea that will affect the conditions of the coast: the effects of extreme weather events will lead to accelerating the damage to the coasts due to climate change. In the west coast, where erosion is particularly significant for more than 2/3 of the length of the coast, there is a higher risk of flooding and consequent loss of the coastline caused by sea-level rise, reaching even 9 meters per year in some areas (Carvalho et al., 2014).

The greatest effects of sea-level rise are expected to occur in the period between 2050-2100 in the northwest.

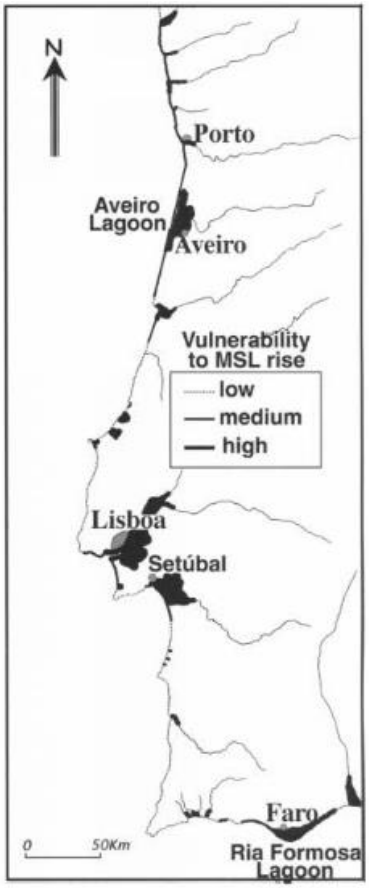


Figure 17 Vulnerability Portugal continental source: Carvalho et al., 2014

2.3.4 Extreme events

Climate change causes acceleration and increases in other risks, particularly where natural and anthropogenic factors intersect, such as coastal erosion or fires.

The reduction of annual rainfall and the change in its distribution will have consequences on watercourses both in terms of flow and quality, and consequent problems related to drought and desertification causing the loss of biodiversity associated with ecosystem alterations. The territory will be more vulnerable to flooding due to concentrations of heavy rainfall. The new temperature and precipitation regimes related to climate change also lead to an increase in heatwaves and consequently an intensification of extreme events.

Carvalho *et al*. stated that the studies showed a trend towards extreme weather events both in terms of time and magnitude, in particular concerning heat waves, droughts and floods that will be analyzed below.

2.3.4.1 Drought

When we talk about the drought we mean: *"A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term; therefore, any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture drought, also termed agricultural drought), and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought. A megadrought is a very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more"* (IPCC, 2014).

Although Portugal annually records an average rainfall of about 900mm, some regions offer water scarcity at certain times of the year, and this is due to weather conditions. In some sectors such as agriculture, water is a key component to ensure vegetation and crops; in periods of continuous drought, a significant part of these activities lose profitability (EMAAC,2021).

As far as mainland Portugal is concerned, there have been serious droughts over the last 30 years. One of the most important events was in the summer of 2005 when it affected the entire continental part of the country going to strongly impact the socio-economic and environmental sectors.

The part that is most affected by drought phenomena is the southern part; studies of climate change models predict a drier climate characterized by an extension of the summer season with less frequent and shorter

Valori SPI	Classe
SPI ≥ 2.0	Umidità estrema
1.5 ≤ SPI < 2.0	Umidità severa
1.0 ≤ SPI < 1.5	Umidità moderata
−1.0 < SPI < 1.0	Nella norma
−1.5 < SPI ≤ −1.0	Siccità moderata
−2.0 < SPI ≤ −1.5	Siccità severa
SPI ≤ −2.0	Siccità estrema

Figure 16 SPI classification Source: https://www.isprambiente.gov.it/pre_meteo/siccitas/

rains, an increase in temperature making drought a common phenomenon.

Looking at the two maps compared, respectively of the historical period 1971-2000 and 2071-2100, it is possible to notice the change that will take place: the most affected area will always be the southern part of the country with moderate drought.

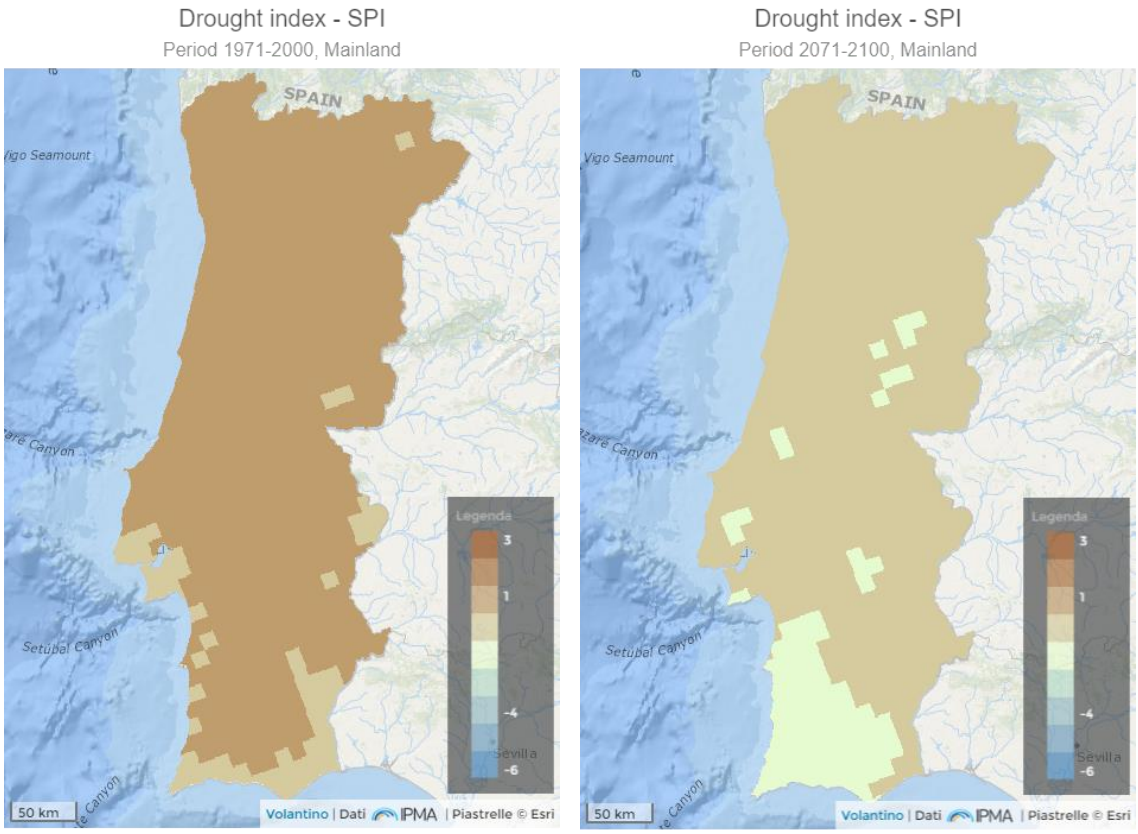


Figure 19 Drought index period 1971-2000/2071-2100(RCP8.5) Source: http://portaldoclima.pt/en/

It is interesting to note the distribution of this phenomenon between the seasons. The graphs show how the distribution of this phenomenon changes: if first, it turns out to be homogeneously distributed during the year, in the RCP 8.5 scenario it is noted that in the winter period there will be no great variations, in the spring and autumn season there are cases of moderate-severe drought, but what will change drastically will be the summer period characterized by extreme drought with an index with a median value of -4.

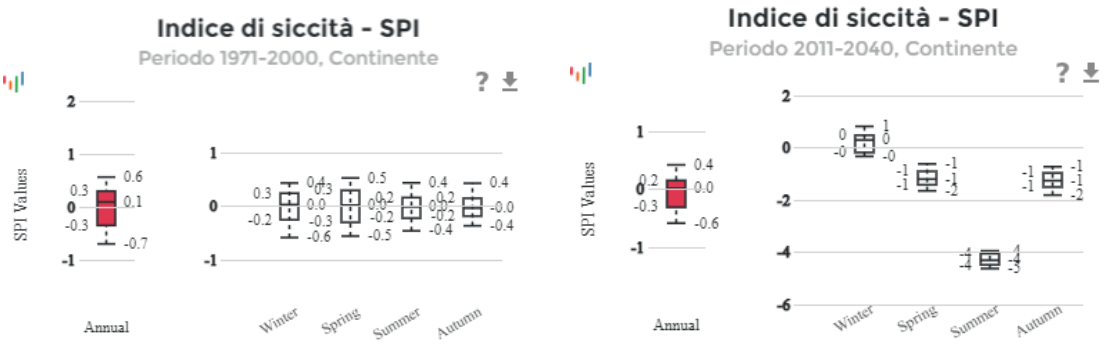


Figure 20 Drought index seasonal distribution period 1971-2000/2071-2100(RCP8.5) Source: http://portaldoclima.pt/en/

2.3.4.2 Heatwaves

Portugal is one of the major areas where there has been an increase in heat waves, particularly in the north-eastern part. Between 1981 and 2010, 130 heatwaves were recorded, mostly concentrated in July and August.

There have been two important years regarding this phenomenon, the summer of 2003 which was for a long time the absolute record of heat ever recorded in the country and then the summer of 2018 which broke all records reaching 45 ° C in the innermost areas.

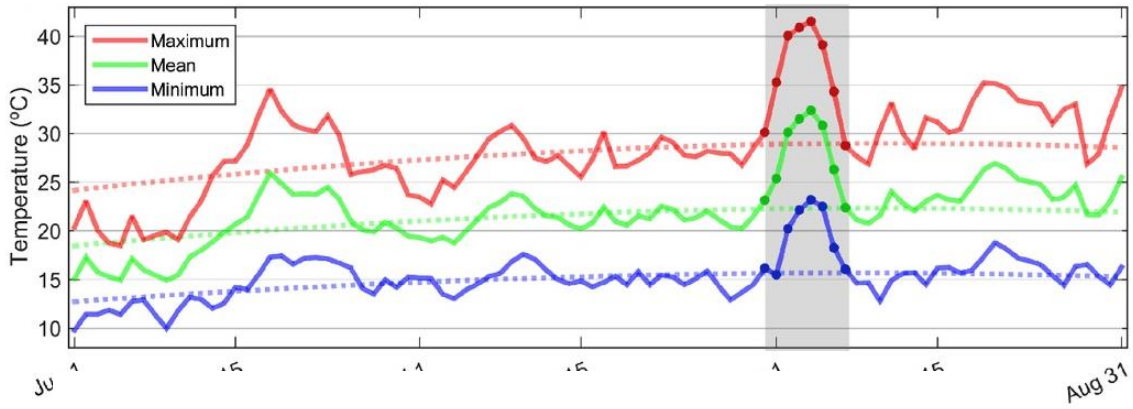


Figure 21 Mean temperature in Portugal during summer 2018 Source: Schleussner et al, 2020)

Looking at the graph, the thick lines show the trend of the average temperature in Portugal during the summer of 2018, compared to the climatological average represented by the dotted lines (Schleussner *et al.*, 2020).

The maps highlight the exceptional scope of this phenomenon in fact if from the map on the left you can read the new records recorded in the 2018 event, the one on the right can be used to understand in a way the difference in the maximum temperatures recorded during the summer of 2018 and the previous records; in some places the temperature recorded was above 2.5 ° C compared to the previous peak.

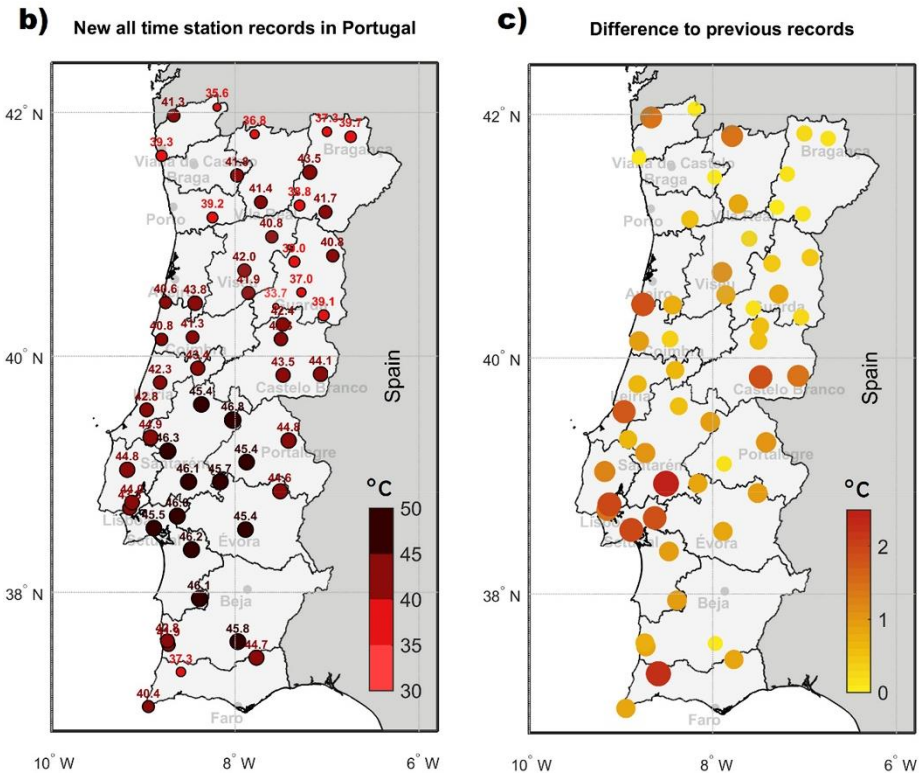


Figure 22 New all-time station record in Portugal and difference to the previous records Source: http://portaldoclima.pt/en/

During the 2003 event that affected the whole part of Southern Europe, only Portugal, more precisely Lisbon, had an alert tool for this type of phenomenon; Since the heatwave of 2003, the Portuguese Emergency Plan for the active heatwave from May to September on the continental part of the country has been established.

The goal is to prevent the negative health effects of heat stress on the population, through daily warnings it is identified which protective measures must be implemented to protect the population during periods of high temperatures (Divisão de Saúde Ambiental e Ocupacional, 2015).

The analysis of RCP8.5 showed that there will be an increase in the frequency and severity of heatwaves: it is expected that the average number of heatwaves will increase from 7 to 9 by 2100 and that the duration of them will increase from 5 to 22

days, with at least 5% of the events lasting more than 30 days. In particular, most of the heat waves that will hit Portugal will be concentrated in the last period, 2071-2100, with a frequency of almost 3 times a year (Cardoso *et al.*, 2019).

2.3.4.3 Flood

As stated in section 2.3.2 concerning precipitation, an average annual decrease in rainfall is expected but with a significant increase in extreme precipitation phenomena, one of the main causes of natural disasters such as flooding, soil erosion and crop destruction. The studies of Santos et al., through the index of extreme susceptibility[4] to the phenomenon of precipitation (EPSI), have identified the most susceptible areas of the country. The maps depicting the scenario of the last century represent how 60% of the municipalities were already classified with an EPSI with a value "high" or "very high", which will increase in the future scenario under analysis, passing to 74% of the municipalities with susceptibility to extreme precipitation "high" or "very high" in the RCP 8.5 scenario (Santos *et al*, 2019).

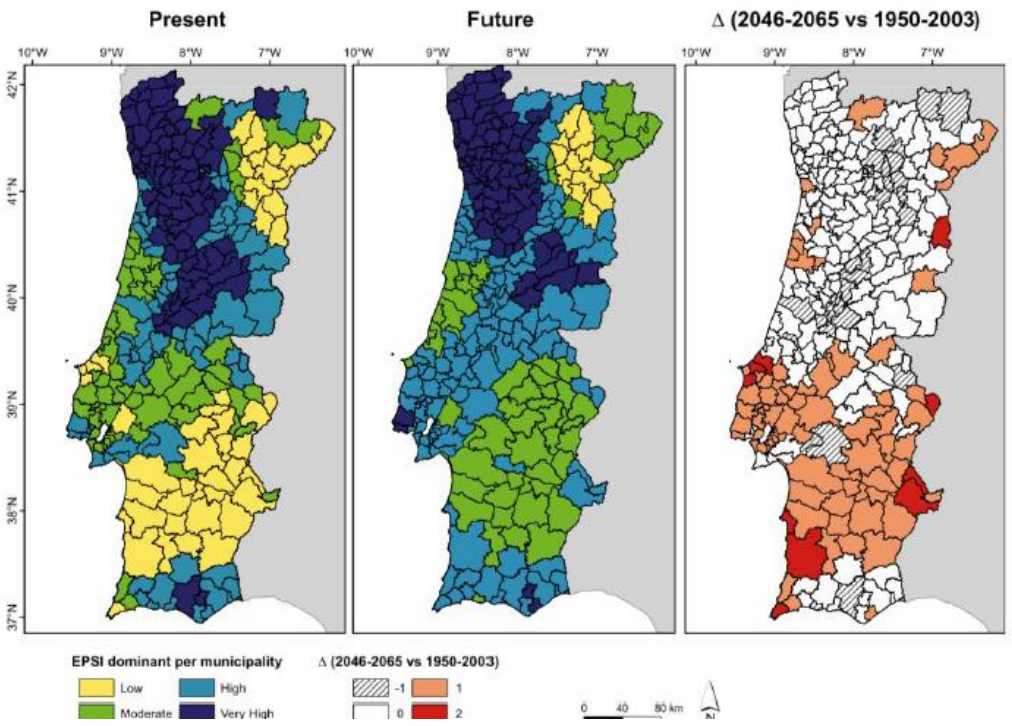


Figure 23 Scenario 1950-2003, future (2046-2065) and time difference indicative of extreme susceptibility dominant (RCP 8.5) Source: Climate Impacts in Portugal 2020

[4] susceptibility refers to the probability that a given region will be affected by a disaster caused by precipitation given a number of conditions" (climateanalytics.org)

Related to extreme rains, it is useful to identify the areas at greatest risk of flooding, an important phenomenon since in the last century, more than 80% of hydro-morphological events were floods, mostly concentrated in the winter period.

In the last 50 years, the country estimates 1012 dead, 478 injured, displacement of 13,372 people and 40,283 homeless people between 1985 and 2010 and a great impact on socio-economic activities.

The map below highlights the areas at risk of flooding, in particular, A) Zezere River; (b) the Colares, Vinhas, Lage and Jamor rivers north of the Lisbon metropolitan area; (c) Ponte de Lima urban area; d) Mondego Estuary (Cunha *et al*.,2017).

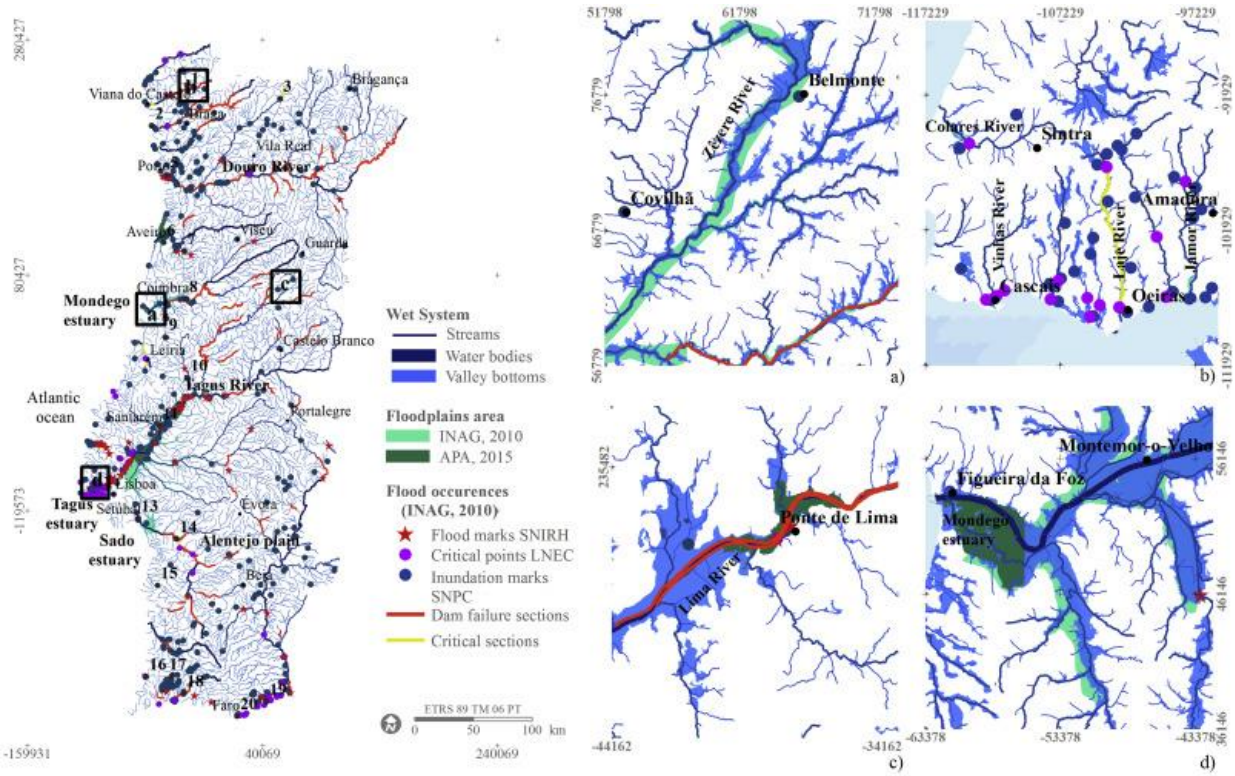


Figure 24 Main flooding risk area. Source:Cunha et al., 2017).

2.4 Adaptation to climate change in Portugal

The commitment to combat climate change has generated a political response at the international level and so Portugal has also implemented policies through the definition of a strategic framework for climate policy (QEPiC, 2015).

Promote the transition to a low-carbon economy, generating more wealth and jobs, contributing to green growth

Quadro Estratégico da Política Climática
Ensure a sustainable path of reducing greenhouse gas emissions.
Strengthening resilience and national adaptability.
Ensure committed participation in international negotiations and cooperation
Stimulating research, innovation, and knowledge production
Engaging society in the challenges of climate change, contributing to increasing individual and collective action
Increase the effectiveness of information systems, reporting and monitoring
Ensuring financing conditions and increasing investment levels
Ensuring effective governance conditions and ensuring the integration of climate objectives in sectoral areas

Figure 25 Strategic framework of climate change.Source: QEPiC,2015

This strategy, composed of 9 objectives to be pursued for the 2030 horizon, was a set of mitigation and adaptation policies to achieve the objectives set out in the Commitment to Green Growth.

Figure 26 Goal of the climate policy Source: QEPiC,2015

While in terms of mitigation Portugal has recognised positive results by reducing its emissions by 13% through the limitation and greenhouse gases in all economic sectors and the contribution of carbon sequestration in land use and forest activities and at the same time has been recognized by the Climate Change Performance Index as the fourth State of 58, (QEPiC, 2015) with the best performance in terms of climate action, on the other hand, the Portuguese government is working a lot on climate change adaptation actions with a particular effort on:

Strengthen resilience and national adaptation capacities, through greater involvement of the different sectors, in a logic of mainstreaming and the implementation of concrete measures;
Stimulate research, innovation and knowledge production on climate change and the development of a knowledge base that supports public policy decisions.
Involve society in the challenges of climate change, helping to increase individual and collective action.
Increase the effectiveness of information, reporting and monitoring systems for the implementation of climate policy, as well as ensuring the active participation of stakeholders.
Ensure financing conditions and increase investment levels, ensuring the self-sustainability of climate policy financing. (QEPiC,2015).

Table 2 Topic of climate change adaptation actions. Source: QEPiC,2015

National Climate Policy is based on two instruments: the National Climate Change Programme 2020/2030 (PNAC 2020/2030) and the National Climate Change Strategy (ENAAC 2020), the latter reference instrument on adaptation.

The first instrument is mainly based on ensuring a sustainable path to reduce the country's greenhouse gas emissions to align Portugal with European objectives through the definition of guidelines such as those concerning the policies and measures of the different sectors, the determination of departmental emission reduction targets in collaboration with relevant policy departments such as transport, energy, agriculture for example (QEPiC, 2015).

In addition, the integration of mitigation objectives in the various sectors is promoted through dynamic planning by conferring greater responsibility in the determination of policies and measures.

The second tool, the one that will be deepened specifically in this dissertation, is the National Climate Change Strategy (ENAAC 2020) extended until 2025 promotes the improvement of knowledge on climate change. This is done through a working group and thematic areas, there is a coherent vertical integration of the different levels necessary for adaptation, from international to local, based on technical-scientific knowledge and good practices (ENAAC,2020).

The maturity reached by the national policy in terms of climate change meant that a more dynamic approach to planning could be developed. This has been possible through the involvement of the various sectors and making them and empowering them, in a logic of integration with concrete measures: To date, Portuguese policies on climate change are an integral part of sectoral policies. Planning plays a key role when we refer to climate change, in fact, it "*reflects the political and institutional response to the challenges of reducing greenhouse gas emissions, strengthening carbon storage capacity and adapting the country to the foreseeable effects of climate change*" (Agência Portuguesa do Ambiente, 2012).

Since adaptation to climate change is a transversal policy, it is the communication between policymakers to support the choices of public institutions by integrating climate change adaptation into land management tools on a local scale.

On this basis, the AdaPT program was promoted. It is a pilot project that initially involves 26 municipalities, aimed at training to develop municipal strategies for adaptation to climate change to be extended throughout the national territory that will be described later (QEPiC,2015).

2.4.1 Mainstreaming adaptation in Portugal

Portugal transposes the European directives on climate change at the national level with a national strategy that transposes the lines of adaptation to the lower levels. It gives further importance and at the same time responsibility, to the different government bodies by putting a lot of effort into mainstreaming: ENAAC has both a support and assistance function in the various sectors, from central administration to local authorities, to transpose theoretical plans into action plans in the different administrative areas (NUT II, NUT III; councils). Not only that, the Associação Nacional de Municípios Portugueses (ANMP), the Autonomous Region of Madeira (RAM) and that of the Azores (RAA) are also managed by ENAAC.

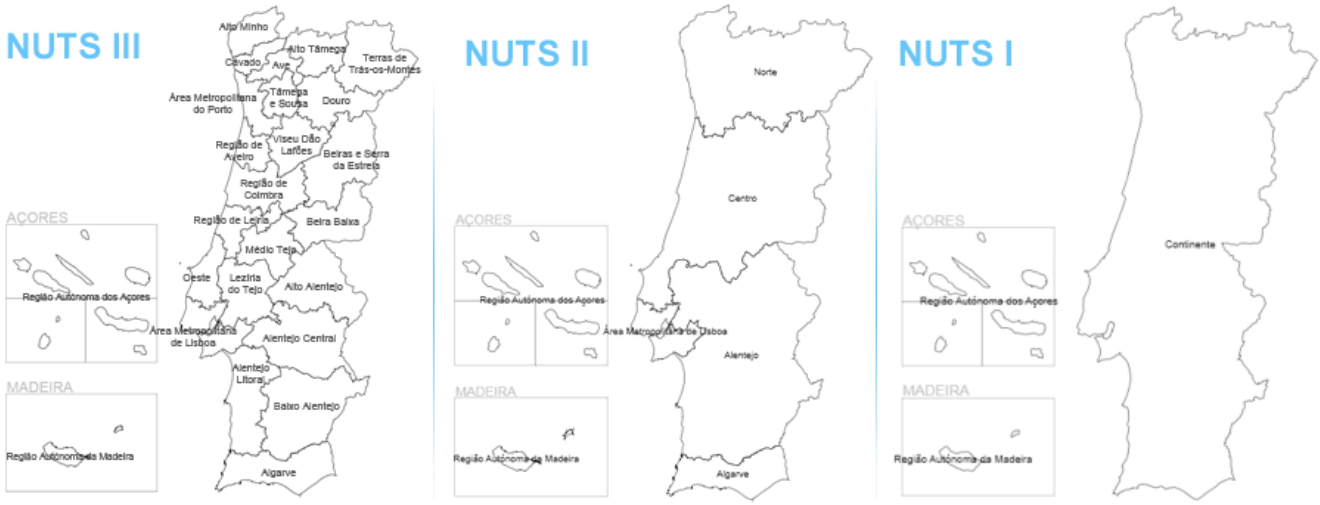


Figure 27 Organization of administrative areas in the continental Portugal Source: ENAAC2020

At the regional level, when we refer to the integration of adaptation in spatial planning to climate change, topics with a strong relevance are dealt with, mainly related to:

- the dissemination of information and tools that can support sectoral bodies in integrating climate change adaptation measures into planning activities at different territorial scales as well as in the PNPOT action program.
- studies, analyses and mapping of climate-related and climate change-related risks;
- drafting of guidelines for the integration of adaptation measures into territorial management tools;
- Integrate adaptation to climate change into sustainable urban development agendas (ENAAC2020).

In addition to this, there are collaborations between the various authorities of the different levels and institutions: through the ClimAdaPT.Local project, Adapt.local - Network of Municipalities for Local Adaptation to Climate Change created in 2016, is a collaboration led by municipalities but which also involves higher education institutions, research centres, non-governmental organizations and companies, to promote local adaptation to climate change in the country. With the awareness that climate change is a very worrying reality that must be addressed instantly, Adapt.local focuses on local solutions and actions, promoting the empowerment of Portuguese municipalities on this issue. Not only that but to date there are also inter-municipal and metropolitan plans (ClimAdaPT.Local, 2016).

The networks that have been created in the development of these instruments have involved multiple local, subregional and even national authorities, thus fostering a closer relationship of work and collaboration between the subjects of different scales of action.

The number of municipalities covered by a municipal, inter-municipal or metropolitan adaptation plan or strategies was 271 at the end of 2020, which corresponds to 88% of Portugal's municipalities (ENAAC, 2020).

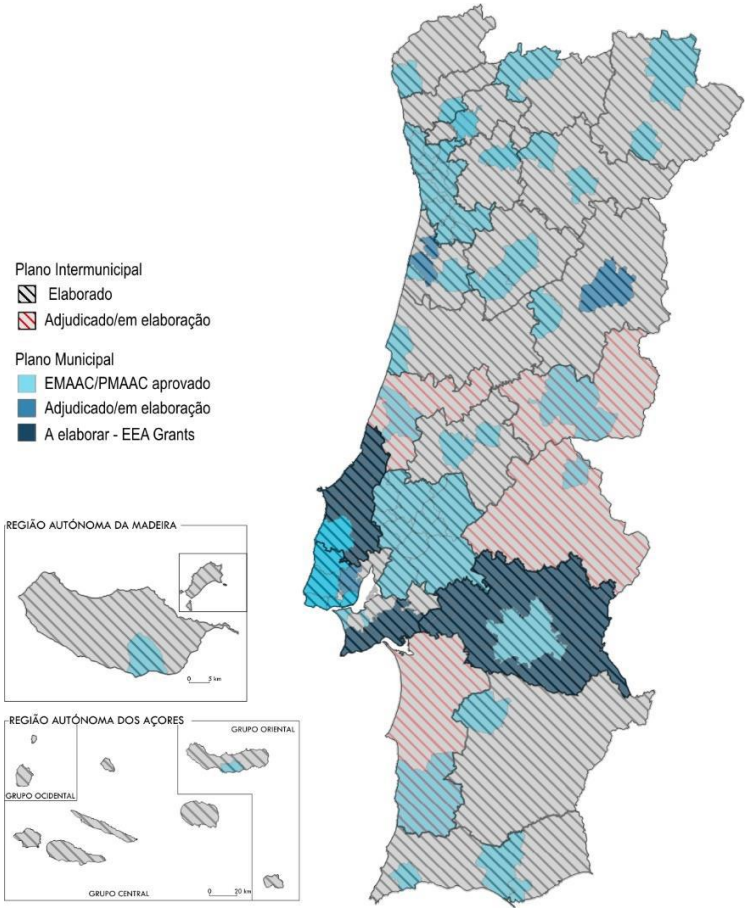


Figure 28 Municipalities covered by a municipal, inter-municipal or metropolitan area adaptation plan inf 2020. Source: ENAAC2020

2.5 Mainstreaming and spatial adaptation to climate change

Spatial planning takes place through management tools that influence the organization and activities in places at different scales. Not only does this instrument play a particular role in adapting to climate change: the decisions that are taken through land management affect the effects of climate change, therefore, it is essential to use this tool in favour of adaptation. The importance between planning and adaptation to climate change is more accentuated due to the differences in exposure to risks and vulnerability to the consequences that climate change can bring and consequently also to the ability to adapt the different territorial strategies to the intrinsic characteristics of the area (AML,2019).

Spatial planning in the field of adaptation to climate change, therefore, makes it possible to detect territorial characteristics and take them into account to analyze the effects of climate change, intervene in actions that do not go to have a greater impact on an already compromised territory and finally be able to study mitigation and adaptation strategies transposed at the local level according to the characteristics of the territory (AML,2019).

2.5.1 Territorial governance in Portugal

Spatial planning is based on a coordinated interaction of the national, regional, inter-municipal and municipal levels.

This was possible thanks to the revision of Lei n.º 31/2014, de 30 de maio – que estabelece as Bases Gerais das Políticas públicas e do Regime Jurídico do Solo, do Ordenamento do Território e do Urbanismo – e do Decreto-Lei n.º 80/2015, de 14 de maio – that approve the revision of Regime Jurídico dos Instrumentos de Gestão Territorial (RJIGT), where the management of the national territory has standardized the planning system, the soil management tool, considered as fundamental tool for the drafting of territorial plans (Cossu, 2019-2020).

The results of this reform were the reorganization of plans and programs: the central administration was entrusted with the programs to strengthen the protection of public interests at the national and regional level; while the master plan has remained the tool for defining local strategies at the sub-regional level. Territorial plans become the only tools that classify and indicate the quality of the soil; provide for their transformation, use and employment and must be integrated with local and inter-municipal masterplans as well as in the territorial development guidelines deriving from national programmes.

As represented by the underlying scheme representing the current organization dictated by the RJIGT reform:

1. at the national level there is the PNPOT, sectoral and special programmes;
2. the regional framework is implemented through regional programmes;
3. the inter-municipal one instead consists of the inter-municipal program, the general plan and that of urbanization and inter-municipal detail. If this plan is

promoted by all the municipalities that are part of the metropolitan area, it is called the metropolitan territorial plan.

4. In the municipal area, there is the municipal master plan, the detailed plan and the urbanization plans (AML,2019).

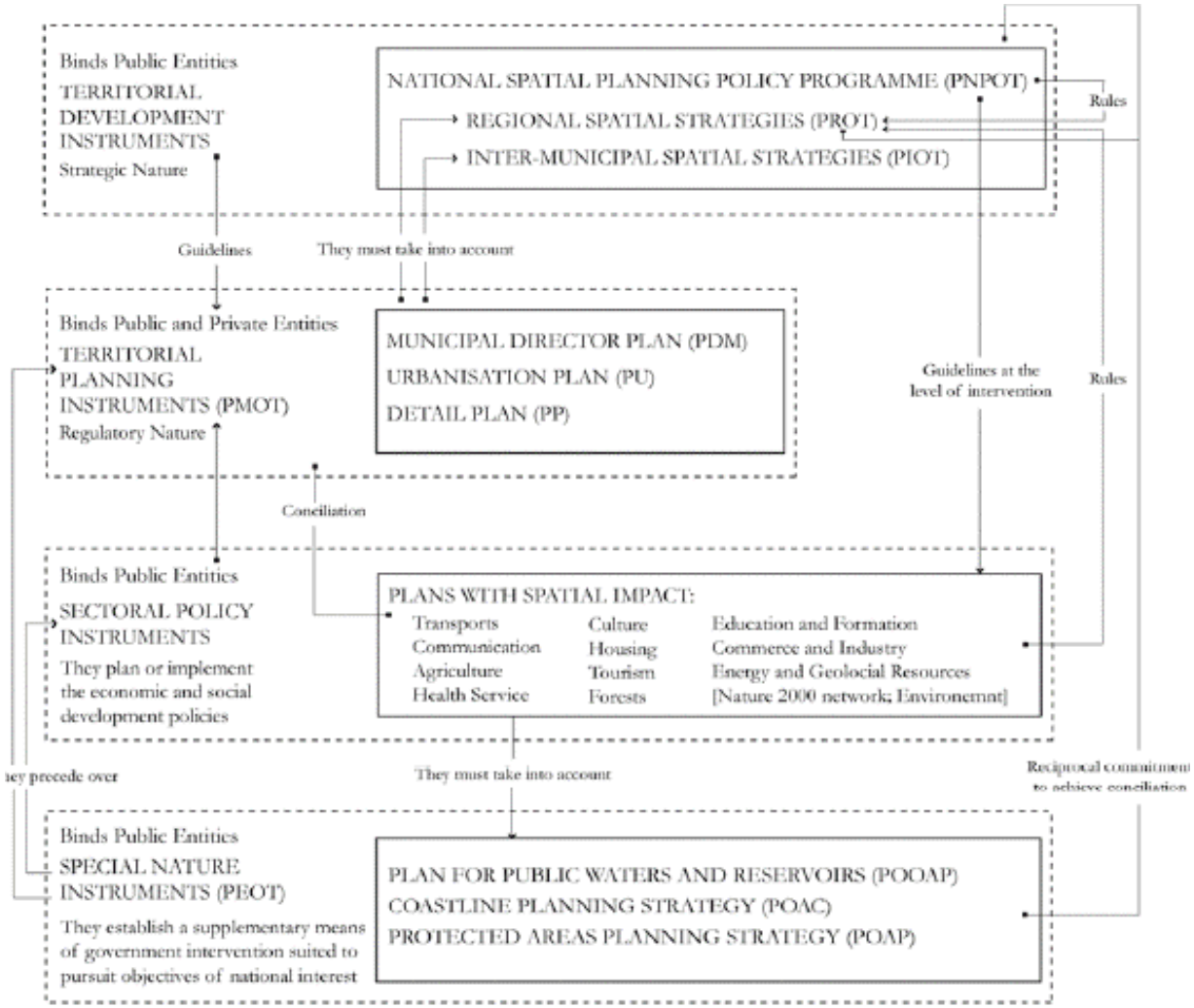


Figure 29 Organization of the Portuguese instruments of territorial governance. Source: Cossu, 2020

The diagram above represents the instruments of territorial governance in Portugal not dealing exhaustively with the issue of climate change. In support of these instruments, the Portuguese government has proceeded to align with the European directives on adaptation to climate change through the creation of a national adaptation strategy ENAAC where it focuses its efforts more. This tool complements the National Spatial

Planning Policy Programme (PNPOT) by integrating climate change adaptation measures and also within sectoral plans on agriculture, biodiversity, economy, energy and energy security, forests, human health, safety of people and goods, transport, communications and coastal areas. Although the increased effort to transpose European directives is concentrated at the national level, Portugal translates adaptation policies into subnational levels mainly through sectoral instruments and also intervenes at the local scale through the creation of local strategies on adaptation to climate change (ENAAC,2020).

2.5.1.1 National

"*Climate change is a national reality and priority, given its future impact on society, economy and ecosystems. The policy response to this problem requires energetic action, translated into measures that prepare society to address the biophysical and socio-economic impacts of climate change. climate change. The political and institutional response translates into Climate Policy which includes, in adaptation to climate change, the main instruments of national policy. In this framework it establishes the vision and objectives of the policy, ensuring the national response to the commitments already made for 2020 and proposed for 2030 within the European Union and, at the national level, the commitment to Green Growth (CCV), establishing an articulated framework of climate policy instruments in the horizon 2020/2030*" (ENAAC,2020, p.39).

At the national level, spatial planning related to adaptation to climate change is treated and managed by two instruments: ENAAC 2020 and PNOPT.

The first represents the National Strategy for Adaptation to Climate Change 2020 and extended until 2025, establishes the objectives, activities and model of organization and functioning of the strategy concerning the effects of climate change in national and sectoral policy (ENAAC,2020).

ENAAC has set 3 macro-objectives for its strategy:

Table 3 The main objectives of ENAAC. Source: ENAAC 2020.

Improving the level of knowledge on climate change	"Update, develop and promote knowledge on climate change and assess its potential risks, impacts and consequences, including those related to extreme weather events.
Implement adaptation measures	Assess current adaptability and prioritise the implementation of adaptation options and measures that mitigate future negative impacts and/or help seize opportunities arising from climate change;
Promoting adaptation integration in public policies and operational instruments	Promote the integration and monitoring of the climate change adaptation component (mainstreaming) in the most relevant public and sectoral policies, including spatial planning and sustainable urban development policies and their territorial planning and management instruments" (Climate-ADAPT,2021).

The last point is the central topic of this thesis, namely the integration of policies aimed at adapting to climate change in the different sectors and planning tools, moving from the theoretical plan to the action plan. ENAAC is also considered a figure of support for the various government bodies, from central administration to local authorities, in fact, it seeks adaptation tools and solutions through technical-scientific knowledge and good practices (Agência Portuguesa do Ambiente, 2016).

Six thematic areas are identified that involve all sectors:

1. research and innovation,
2. financing and implementation,
3. International cooperation
4. communication and dissemination,
5. adaptation in spatial planning
6. adaptation in the management of water resources.

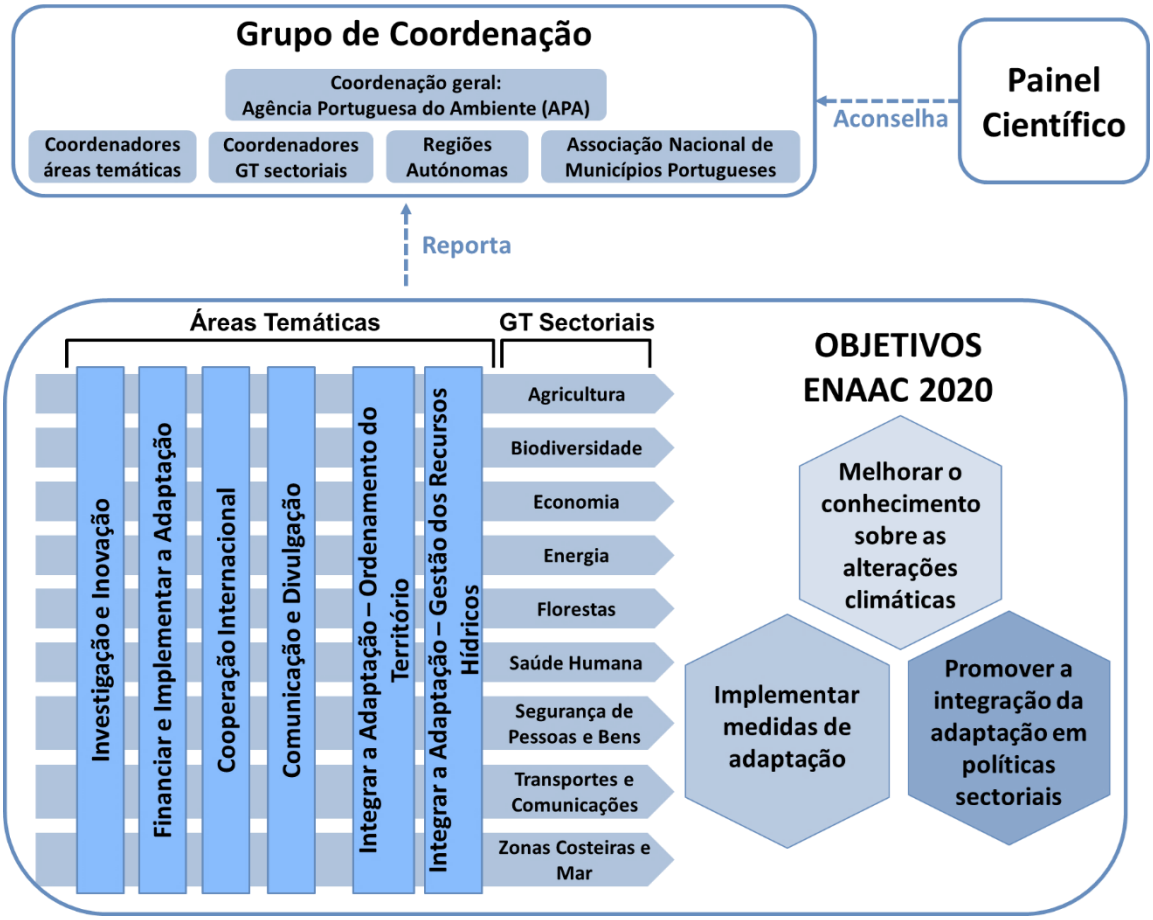


Figure 30 Organization and objectives ENAAC 2020. Source: Agência Portuguesa do Ambiente, 2016

In addition, the Programa de Ação para a Adaptação às Alterações Climáticas was established, focusing on the implementation of the second objective of the ENAAC2020, namely to implement adaptation measures, which will be valid until 2030.

The responsibility for promoting adaptation with new scientific knowledge and international guidelines is the Portuguese Environment Agency, flanked by the Interministerial Commission for Air and Climate Change (CIAAC). The latter in particular focuses on the articulation and integration of climate change policies into sectoral policies (Agência Portuguesa do Ambiente, 2016).

National level		Period
Estratégia Nacional de Adaptação às Alterações Climáticas (ENAAC 2020)		2015-2025
Programa de Ação para a Adaptação às Alterações Climáticas (P-3AC)		2019-2030
Sector		Period
Agricultural	AGRI-ADAPT2020 (action plan)	2018-2020
Forest	Plano de Adaptação das Florestas às Alterações Climáticas	2013-2020
Health	Estratégias Regionais de Adaptação às Alterações Climáticas - Saúde	2019-2020
Civil protection and emergency management	Estratégia Nacional para uma Proteção Civil Preventiva	2017-2020
Transport	Plano de Resiliência das Infraestruturas às Alterações Climáticas (PRIAC), da Infraestruturas de Portugal	2022-2030
Costal area and see	Planos e Programas da Orla Costeira/PAL XXI	More years

Figure 31 Integration of climate change policies in sectorial area. Source: Agência Portuguesa do Ambiente, 2016

As previously stated, this strategy promotes procedures for adaptation to climate change through implementation in different sectoral activities and levels of administration. All this can be considered as a revision of sectoral legislation and as the development of guidelines to be implemented and that will lead to being implemented more autonomously and effectively (AML,2019).

In addition, it is considered essential to monitor the various mainstreaming policies to find indicators of progress and to monitor them. Through the environmental assessment strategy and the environmental impact assessment, it is necessary to ensure that certain investments integrate climate change policies into their projects. (Cossu, 2019-2020)

In the sectoral part concerning adaptation in land management tools, these objectives are mainly highlighted:

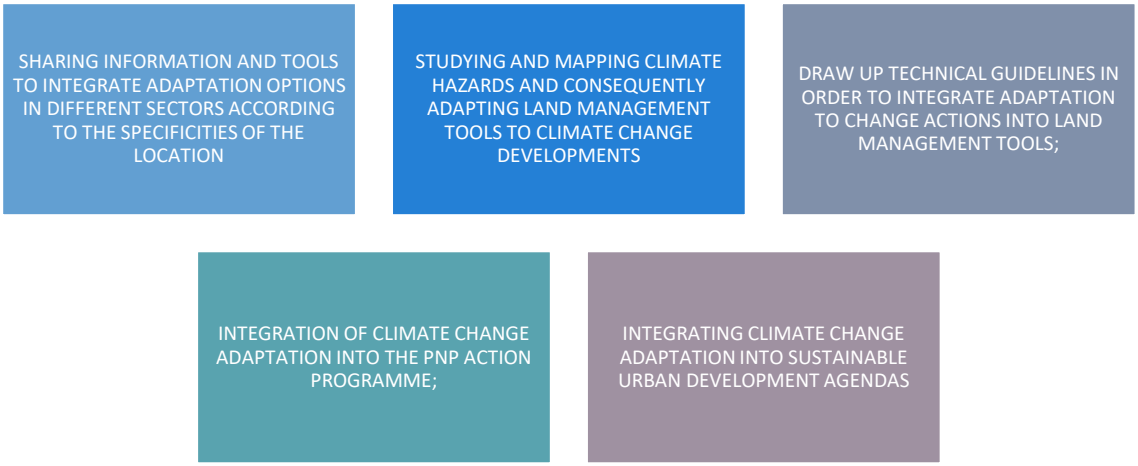


Figure 32 Five main objectives in land management about adaptation. Source: Agência Portuguesa do Ambiente, 2016

The second tool used instead is the PNPOT that is, the National spatial planning policy Programme, which defines the objectives and actions for the territorial development strategy and becomes the reference for the other territorial instruments. Through its review in 2019, it was possible to integrate the climate change adaptation measures of ENAAC 2020 into the PNPOT Programme of Action (Direção-Geral do Território. 2018).

This is a long-term instrument with a perspective up to 2050, but at the same time targets are being set by 2030, especially regarding the action plan (Cossu, 2019-2020). In this program it is expected to achieve in the coming decades a sustainable management of natural resources, the promotion of a polycentric urban system, as well as favouring the inclusion and enhancement of diversity, promoting connectivity and finally promoting territorial governance.

The possibility that the PNPOT sees in spatial planning are summarized in the next scheme:

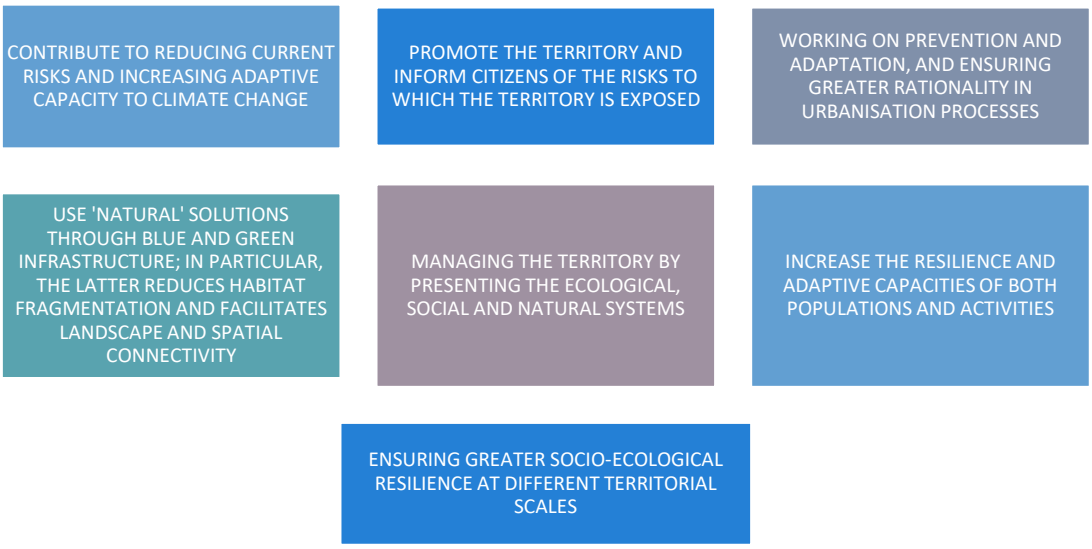


Figure 33 Seven milestone of PNPOT concerning special planning. Source: Direção-Geral do Território. 2018

In particular, it is useful to highlight that among the 82 guidelines (Direção-Geral do Território. 2018) some are particularly related to the integration of climate change adaptation:

GUIDELINE	
n°43	"*Without prejudice to the formal figures of inter-municipal programmes and plans and inter-municipal plans, and in order to foster initiatives and promote capacity building for inter-municipal planning, the NPOT shall encourage the development of specific territorial planning exercises at inter-municipal scale, i.e. exercises for the transposition of sectoral and special programmes (e.g. forest management, agriculture/food proximity nature conservation), study and design of solutions in the framework of sustainability approaches (e.g. sustainable mobility, circular economy adaptation to climate, green structures risks and nature-based solutions) and organisation of the provision of services of general interest*";
n°63	"*Develop integrated sustainability strategies and approaches at the regional level, including in the field of climate change risk and adaptation, ecological structures, landscape and assessment of ecosystem services, circular economy, decarbonisation, sustainable mobility, renewable energy networks, providing frameworks for planning at municipal and inter-municipal level, municipal and inter-municipal planning*".
n°70	"*Outline areas of susceptibility to hazards and risks, taking into account climate change scenarios and define precautionary, prevention, adaptation and risk exposure reduction measures, including the identification of sensitive exposed elements to be managed and relocated, considering the analysis of hazards and risks and at the appropriate scale and the critical territorial macro-vulnerabilities reported by the PNPOT and developed by the PROT*;
n°82	"*Considering the importance of synergies of urban and rural areas in their various functions and activities for sustainability approaches i.e. circular economy, sustainability mobility and climate adaptation and for the quality of life of the population including recreation and leisure, health and access to services of general interest of general interest, the PNPOT points to the interest of planning tools PU and PP planning tools to consider the areas of intervention that promote these synergies, without prejudice to the maintenance of the due classification in urban and rural soil*". (Direção-Geral do Território. 2018)

Figure 34 PNOPT Guidelines concerning climate change adaptation. Source: Direção-Geral do Território. 2018

2.5.1.2 Regional

The instrument used at the regional level Regional Programme for Spatial Planning (Programa Regional de *Ordenamento do Território*, PROT) which defines the organization of the region territory mainly focusing on:

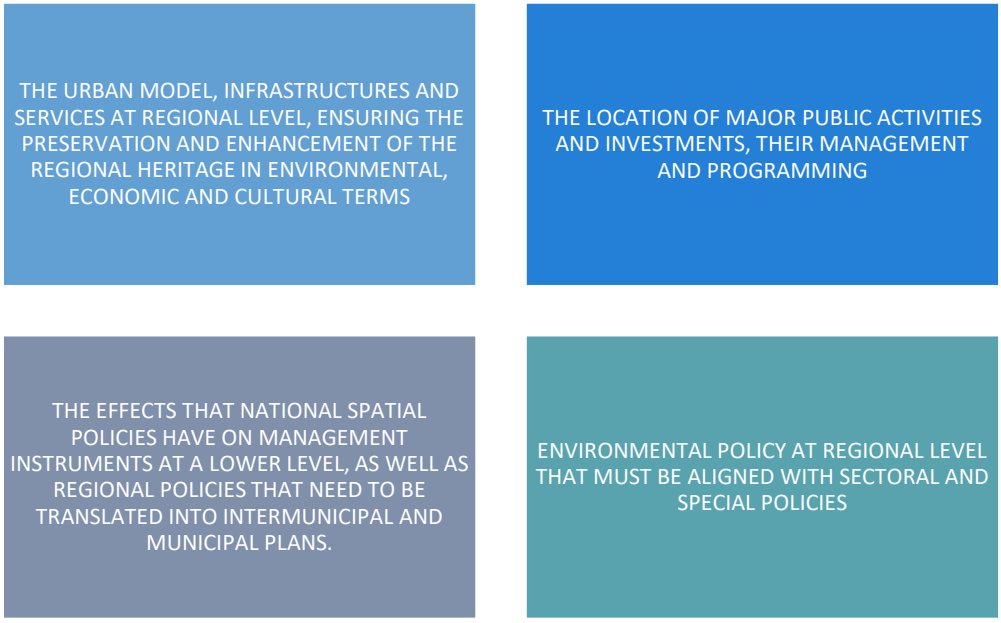


Figure 35 Objectives of Regional Programme for Spatial Planning. Source: ENAAC, 2020

Regional programmes are therefore a model of representation of the territory composed of the main systems, networks and connections on a regional scale. This tool consists of a program report and an environmental report. The first contains the evaluation of territorial dynamics in terms of land use, population and economic-financial; the definition of landscape units; studies on environmental and heritage enhancement; the relevant areas of the rural development strategy; the representation of the mobility networks, the implementation program and finally the identification and estimation of financial resources.

The second, on the other hand, identifies, describes and evaluates the impacts and effects that the programs have on the environment, also considering alternatives taking into account territorial objectives (ENAAC, 2020).

On the issue of adaptation to climate change, ENAAAC assists the figures of lower territorial governance, therefore also the region, in the transposition of the theoretical plan into operation of the measures of adaptation to climate change in the sectoral

plans, and territorial plans and programs. Among the different thematic areas that ENAAC identifies, the one dedicated to the integration of adaptation in territorial planning allows developing and improving the institutional and regional governance tools that encompass related issues such as:

- *"i. The dissemination of information and other resources to guide the various sectoral agents in the active management of climate change adaptation in their activities in a way that adapts to local and regional specificities;*
- *ii. The analysis and mapping of climate hazards, as well as the consequent modification and adaptation of the main instruments of policy and land management;*
- *iii. The development of technical guidelines to ensure the integration of adaptation to climate change into territorial management tools*
- *iv. Mainstreaming climate change adaptation into the NPC Action Programme*
- *v. The integration of climate change adaptation into sustainable urban development agendas"* (ENAAC, 2020, p.44).

2.5.1.3 Intermunicipal

At the inter-municipal level, we have the PIMOT, Plano inter-municipal de Ordenamento do Território, recently introduced among the instruments of the territorial organization as a tool to develop subregional strategies or to administer several contiguous municipalities. For some municipalities, it is possible to choose whether to draw up a municipal plan (PDM) or to be part of the PIMOT.

Within the PIMOT the guidelines for the integrated use of the covered area are defined; the definition of inter-municipal infrastructures, equipment, transport networks and services and the minimum standards and objectives to be achieved in terms of environmental quality. (Rodrigues, 2016)

Since 2014, urbanization plans and detailed plans at the inter-municipal level have also been introduced, which are the same components of the municipal plans treated in the following paragraph (Cossu, 2019-2020).

The integration of the climate change adaptation component within the territorial management tools takes place using the PMAAC metropolitan adaptation plan to climate change.

This instrument concretizes both the European and nation adaptation strategy by creating the conditions of operation at the regional level and at the same time becoming the reference for adaptation at the local level. Among the most successful examples for the realization of this tool, it is right to highlight the PMAAC of the Lisbon Metropolitan Area which represents one of the most successful examples in terms of adaptability to climate change. The concretization of the plan takes place starting from the definition of the basic adaptation scenario outlining the objectives, the methodology and the organization of the plan as well as the strategic framework and making a socio-economic and environmental contextualization; subsequently, it is possible to proceed with the analysis of current and future impacts and vulnerabilities that allow to order and prioritize specific adaptations; finally, the last phase proceeds to define the adaptation options to integrate them into the planning and territorial management tools and monitor them.

The PMAAC transposes the regional strategic plan to the metropolitan level through the management, monitoring and accompaniment of the adaptation plan and regional strategies; in the municipal area through the integration of local policies, in the territorial order and municipal interventions; at the sectoral level through plans, strategies lines of intervention in the sectors identified by the national strategy (Cossu, 2019-2020).

2.5.1.4 Municipal

The Municipal Spatial Plans *(*Planos Municipais de Ordenamento do Território PMOT) *"are territorial planning instruments, which define municipal territorial management policy, with a view to the sustainable use of territorial resources*" (APA, 2016).

The PMOT is composed in turn by three tools: Municipal Director Plan, Urbanization Plan and Detail Plan.

The main tool used at the municipal level is the Municipal Director Plan (Plano Diretor Municipal, PDM. It defines the municipal strategic framework for municipal territorial development, since it is the reference document for the development of other municipal

plans, for sectoral interventions defined by national sectoral strategies on the municipal territory. it also deals with soil policies at the municipal level, options for locating and managing public equipment and also interdependence relations with neighbouring municipalities, integrating and articulating the directives of national, regional and inter-municipal plans (Cossu, 2019-2020).

The PDM is mandatory for all Portuguese municipalities and is elaborated by referring to the PNPOT and especially the PROT.

The PDM is composed of a regulation that constitutes the regulatory part and that establishes the rules for the use of its land and its occupation in both the public and private sectors; a master plan that represents the model of municipal spatial organization and finally the conditional plan that identifies the constraints and easements in force on the municipal territory.

Not only that, the PDM is accompanied by a Report that contains the objectives of the strategy, an environmental report, an implementation program and a financing plan (Câmara Municipal do Porto, 2021).

To date, PDMs are highly heterogeneous in terms of integration of climate change adaptation policies at the local level. This asymmetry is due on the one hand to the levels of development in which the various PDMs are located: some, in fact, are already in force and with subsequent revisions, other municipalities instead are developing their first version. On the other hand, the levels of intensity with which municipalities deal with the issue of climate change also affect: some municipalities, such as Cascais or Sintra, are the great examples of adaptation at the local level in Portugal, others have developed municipal strategies of adaptation to climate change through the ClimAdaPT.Local projects (such as Lisbon and Mafra for example) and still others are concluding or starting their plans.

The development of spatial planning in terms of climate change is more mature in the municipalities that have integrated the strategies during the revision of their PDMs. It is therefore to highlight how the cases of Lisbon and Cascais have particularly distinguished themselves for having further assessed climate vulnerabilities and have better included their municipal adaptation strategies and plans in the revision of the PDM.

To concretize and develop what the PDM proposes there is the Urbanization Plan (Plano de Urbanização, PU), becoming a reference framework for urban policies and defining the location of the main infrastructures and collective equipment.

This tool is used for each area of the municipality included in the urban perimeter also including the rural area of one or more urban perimeters that serve to establish integrated planning and is also used for other parts of the municipal territory that can be used for urban uses and functions, such as the placement of plants or industrial areas, logistics or services, or the location of tourism developments, related equipment and infrastructure.

In conclusion, the third instrument at the local level that develops in detail the proposals for the occupation of municipal areas is the Detail Plan (Plano de Pormenor, PP).

This tool defines the rules on the development of collective infrastructure and equipment through its design and integration on the territory; it also defines the volumes, the building rules and its integration into the landscape; and finally spatial organisation of other activities of general interest. PPs refer to continuous areas of municipal territory that may include an operational planning unit or sub-unit.

2.5.2 Integration of climate adaptation into local level governance

As introduced in chapter 2.4.1, with the aim of integrating the ENAAC process at the local level, the ClimAdaPT.Local project is developed. whose ultimate aim is to improve the capacity of Portuguese municipalities to integrate climate adaptation options into their planning tools and interventions at the local level in line with European and national strategies. This was possible through the creation of the municipal strategies of adaptation to climate change EMAAC (Estratégias Municipais de Adaptação às Alterações Climáticas) and making this, the main tool of local adaptation in Portugal (Cossu, 2019-2020).

The result pursued by ClimAdaPT.Local, was the structuring of the EMAAC model on a unified methodology based on international examples; this was a fundamental requirement for the financing of the project as it would be applicable to all the 26 pilot municipalities and subsequently to all other Portuguese municipalities.

The methodology is the decision support element for the municipal adaptation (Apoio à Decisão em Adaptação Municipal, ADAM), which is, in turn, an adaptation to the Portuguese context of the Adaptation Wizard carried out by UKCIP5, and previously applied in Germany, USA and Australia as well as in the UNITED Kingdom (UKCIP 2014). Although each strategy applied has its own scenarios and characteristics, all EMAACs are united by the fact that they have been developed with the ADAM methodology through the identification of vulnerabilities at the local level and then find the necessary adaptation measures (Cossu, 2019-2020).

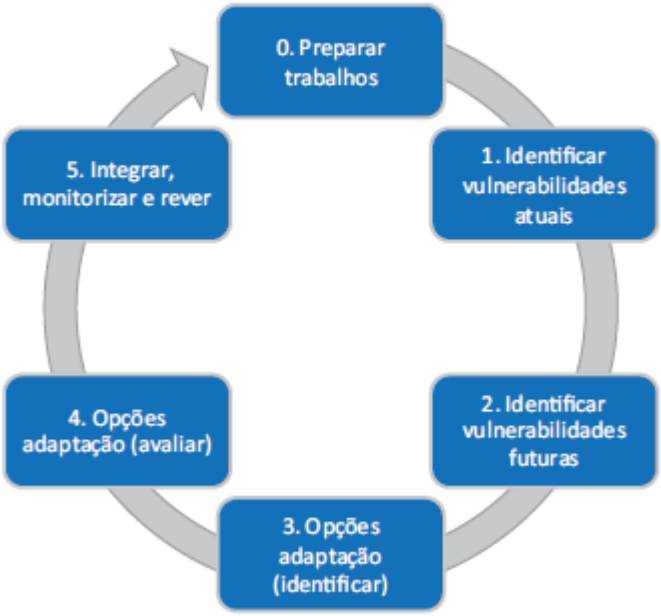


Figure 36 Summary of the 6 steps for integrating adaptation options into land management tools using the UKCIP Adaptation Wizard as a model.

Source: https://www.adapt-local.pt/recursos/documentos

A guidance document was then created that explains synthetically and objectively the methodology used to support the different municipal work teams in the drafting of the strategies. The guide offers a starting point to reflect on the theme of climate change, presents what were the motivations that led to the need to draw up a document that can be applied in the different Portuguese municipalities. The different steps, tasks and resources necessary for its implementation are described. 6 distinct phases have been identified, but at the same time interconnected with each other. This work provides that over time these phases are repeated several times since adaptation is considered a continuous process, and therefore it will be necessary to keep it updated.

The following table summarizes the 6 phases with the expected results at the end of each step.

[5] The UKCIP (UK Climate Impacts Programme) is a leading team in climate adaptation research since its establishment. The UKCIP Adaptation Wizard born in 1997 with the aim of creating a methodology that can be applied in all climate change adaptation processes and involves mainly 5 phases: 1 Getting started, 2 Current climate vulnerability, 3 Future climate vulnerability, 4 Adaptation options, 5 Monitor and review.

Table 4 Phases and expected result of the decision support element for the municipal adaptation (ADAM). Source: EMAAC, 2017.

STEP 0: prepare the work	Expected results at the end of phase 0
Identifies what are the reasons why the municipality wants to adopt climate adaptation measures on the territory; define the objectives of the municipal strategy of adaptation to climate change and identify a working team to implement the strategy; develop internal procedures for the success of the process	compose work team for the work, having guaranteed the support of the decision-makers and the various intermediate levels of municipal management; have clear analysis scales; have an idea with the motivations why you want to make the adaptation, understand what you want to achieve and how the ADAM process can contribute; have identified potential obstacles to adaptation and the solution to overcome them
Step 1: identify the current vulnerability	Expected results at the end of phase 1
serves to identify the vulnerabilities of the municipality, the areas particularly exposed to climate risks useful to understand the position of the interventions; intervene on the awareness factor on the theme of vulnerability and useful information to reflect on the theme of climate change and identify the subjects of the municipality most relevant to the theme of climate change to respond to past climate events and be the starting point for the formulation of a strategy; identify gaps and/or doubts influencing decision-making processes; participate in the compilation of the final report at the end of phase 1	overview of the meteorological events that have affected the municipality in the past understanding what were the consequences and interventions in response to the events; effectiveness of responses from the municipality; which critical thresholds have been exceeded creating unacceptable damage or creating new opportunities
Step 2 Identify vulnerabilities	Expected results at the end of phase 2
increase awareness of climate change by also providing a future scenario and identify future weather events that may affect the municipality; understand how the vulnerability of the municipality can contribute, moving from point 1 to 2, to formulate a strategy; identify the impacts that climate change generates, identify the main climate risks and dangers; participate in the compilation of the final report at the end of phase 2.	have understood the future climate scenarios and how the municipality could be influenced by them having clear the threats and opportunities that the municipality may represent; what risks are associated with these impacts and how they will be in the future; and identifying priority climate risks.
Step 3 identify adaptation options	Expected results at the end of phase 3
analyze the results obtained to decide how to deal with the vulnerabilities and risks to which the municipality is subjected; define a set of adaptation options to respond to the identified future risks and opportunities (from this phase new information on the climate and risks may emerge that can be integrated or included in a second EMAAC review)	Have understood if the municipality has the necessary information to continue; have drawn up a list of possible adaptation actions and have identified the potential sectors responsible to then be able to integrate any adaptation actions and highlight the main gaps to try to address these shortcomings.
Step 4 Selection of Adaptation Options	Expected results at the end of phase 4
reflect on the results obtained in the previous phases to decide how to deal with the vulnerabilities and risks to which the municipality is subjected and analyze and evaluate giving priority to the adaptation options that emerged in the previous phase through a multi-criteria analysis. Also in this section new information on climate and risks may emerge that can be integrated or included in a second EMAAC review	be able to make an evaluation of the different adaptation choices according to the criteria selected and used and to be able to build a ranking of the priority adaptation options.
Phase 5 integration, monitoring and monitoring	Expected results at the end of phase 5
identify the basic aspects of the adaptation options to be included in the municipal territorial management framework and at the same time identify how territorial management plans can respond to adaptation options; define how adaptation options are integrated into territorial management tools at the municipal level	have identified the basic aspects of adaptation options that should be addressed in the field of territorial management; have identified strategies and ways to integrate adaptation options into municipal territorial management tools and draw up a framework of principles, guidelines that allow their integration.

All these phases are summarized in a dossier and represent the main methodological document about local adaptation in Portugal.

What can be deduced from the ClimAdaPT.Local project is that on the one hand it has had great success to spread the methodology for adaptation becoming the key tool for the elaboration of strategy but at the same time has limited some interventions. Each EMAAC identifies the most appropriate adaptation options, which vary from case to case, but therefore does not identify the location of critical points and interventions, a task that falls to the municipality. In addition, some measures have a minimum description that does not allow to be implemented and, in these cases, some municipalities that already had the first strategy have produced a second version by implementing the strategic measures in implementation plans called PMAAC (Planos Municipais de Adaptação ás Alterações Climática) where within them there are detailed maps and define a priority of the actions to be implemented.

2.5.3 Recovery and resilience plan

Portugal was the first country to submit to the EU the recovery and resilience plan, consisting of the initiatives that the state assumes to implement until 2026, according to the criteria that the European Commission has established in terms of measures that the country decides to address according to certain recommendations and that have a lasting impact, the milestones that are needed to monitor progress, the plan must not cause significant damage and must devote 37% of spending to climate and 20% to digital and must provide a good mechanism for controlling and verifying information.

Concerning the green transition, therefore, in addition to the percentages to be respected not to have a significant impact, Portugal, and more generally all the states that adhere, must specifically follow six environmental objectives where the European Commission provides technical guidelines:

- climate change mitigation,
- adaptation to climate change,
- water and marine resources,
- circular economy,
- pollution prevention and control,
- biodiversity and ecosystems.

During the drafting of the PRR, the State followed the specific recommendations that the EU in 2019-2020 about the sustainability of public finances with a particular commitment in the hospital sector and the reduction of public debt, work on the qualification and improve Portuguese skills and make the social protection network more effective, greater investment of companies in innovation and research especially in the field of energy and climate transition and finally, working within the administrative and social courts, with a simplification and speeding up of procedures (PRR, 2021).

Given these provisions, Portugal in the drafting of the Plan intervenes in parallel with the effects generated by the pandemic since the Commission's recommendations were drawn up before this event. Covid has meant that health issues have been urgently developed to the effects that this brought in the economic and social sphere.

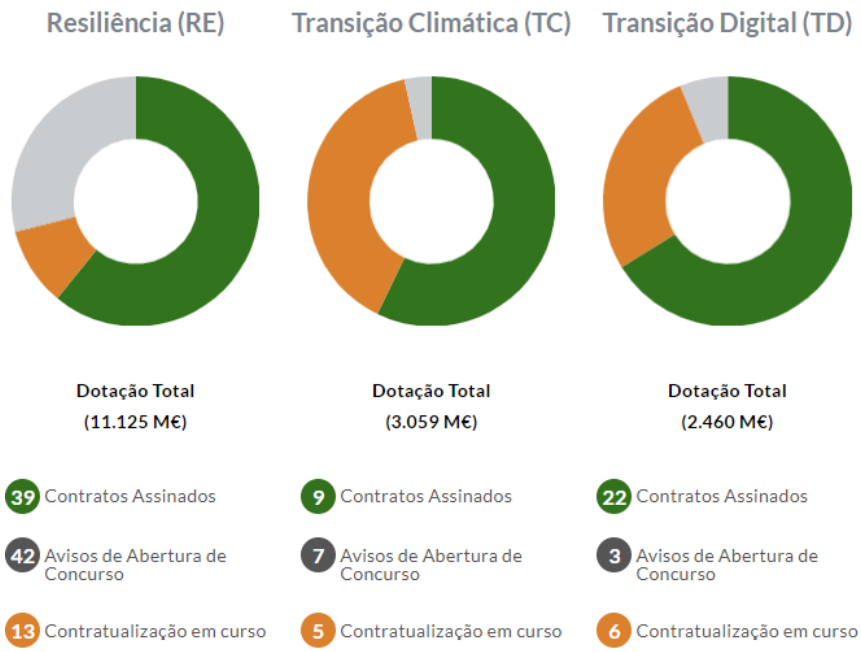


Figure 37 Status of implementation of Plano de Recuoer e Resiliencia Source:https://recuperarportugal.gov.pt/

The issue of climate transition and sustainability is a central element for the government, as we have already seen in the previous paragraphs, given the vulnerability that the territory has on climate change and achieving national commitments of emission neutrality by 2050 (PRR 2021).

Given these premises, the PRR dedicates its part to the climate transition which is based on the following strategic areas: sea, sustainable mobility, industrial decarbonization, bio-economy, the energy efficiency of buildings and renewable energy, to increase sustainable public transport, reduce CO2 emissions by 55% by

2030 following the national energy plan and finally giving incentives for energy efficiency solutions (PRR 2021).

Figure 38 PRR section dedicated to climate transition based on six strategic areas

3
chapter

LISBON

From the municipal strategy of adaptation to the integration of climate change policies in the case of Vale de Alcantara green corridor

3 Lisbon

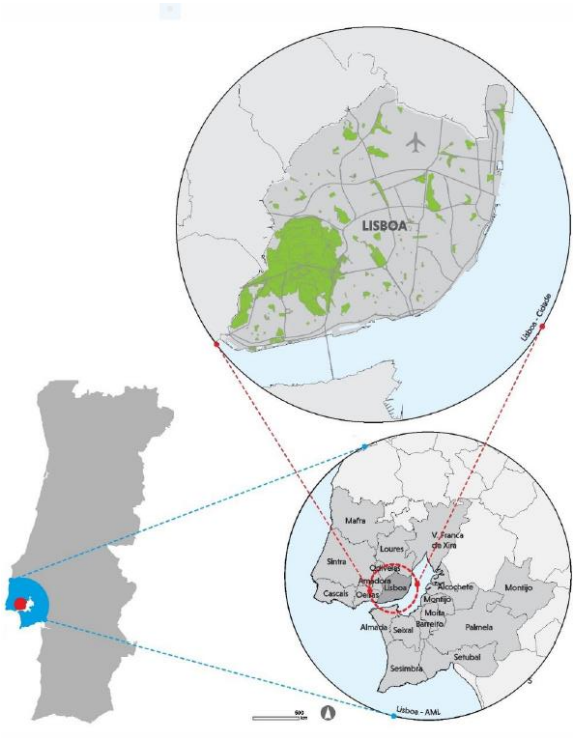


Figure 39 Geographical framework of Lisbon. In blue is rapresented the metropolitean area of Lisbon and in red is rapresented the municipality. Source:PAC Lisboa 2030, 2021

Lisbon is one of the 18 municipalities that make up the metropolitan city of Lisbon and occupies about 3% of the land area. The municipality is located on the right bank of the Tejo River estuary, near the confluence of the Mediterranean Sea and the Atlantic Ocean.

Climate projections for the end of the century mainly foresee 4 scenarios:

- a decrease in average annual rainfall that is accentuated mostly at the end of the century; more frequent drought due to the increase in the number of days without precipitation and which will reflect the climate profile of southern Europe
- An increase in the average annual temperature with a particular increase at the end of the century led to an increase in the number of days with temperatures above 34 ° C and the most frequent heat waves.
- Sea level rise often linked to extreme events such as storms
- The increasing phenomenon of extreme precipitation bringing with it strong wind and rain

From a statement issued by Manuel Salgado, Councillor for Urban Planning, Urban Redevelopment and Public Space of the Municipality of Lisbon, it is clear the great duty that the city has put in place to integrate climate change policy within the PDM of 2012, through mitigation and adaptation measures (EMAAC,2017).

The first one integrates "*technological changes that reduce the resources applied and emissions per unit of production (...) and have found support in the Energy-*

Environment Strategy, which translates into the adoption of incentives for environmental efficiency, bearing in mind, that is, that buildings are responsible for about half of energy consumption and, in this way, also responsible for about half of greenhouse gas emissions into the atmosphere, intended for local energy consumption" (Salgado, 2017 in EMAAC, p.4).

While the latter, which include initiatives for the reduction of vulnerabilities and risks of climate change, is recognized as indispensable to make the city resilient and the development of territories as a basis for social and economic development. Participation in the ClimAda.Pt programme was a great opportunity to manage the different sectoral policies and increase the resilience of the urban territory in the face of future scenarios and which will lead to a valuable result to continue the adaptation objectives and for greater environmental sustainability. So if on the one hand, Lisbon has already achieved excellent results in terms of mitigation with halving of carbon dioxide emissions and reduction in electricity consumption and sustainable mobility, on the other, says José Sá Fernandes, Councilor for the Green and Energy Structure, we have worked hard in the field of adaptation "*through a series of active policies, starting from the PDM of 2012 where the protection of the most ecologically sensitive structure has been mostly carried out for a greater adaptation to the phenomena of climate change which, in urban areas, should be potentially more intense. The guarantee of spaces for the substantial increase of the green structure by more than 20%, is an effective tool to counteract, among other things, the heat island effect or contribute to the regularization of the water cycle and urban flooding. In addition, a set of specific programmes based on increasing urban biodiversity, water efficiency and public participation has increased the rate of implementation of green infrastructure by about 3.5 times compared to the period before 2008, for which the programme horticultural parks, the size of registered tree plantations and the inclusion of grasslands with biodiversity contributed*" (Sá Fernandes in EMAAC, 2017, p.5). Climate change has been part of municipal policies for several years before the creation of EMAAC2020: this was the result of the transposition and integration into national instruments of the directives issued by the European Union and which were transposed on a local scale into territorial management tools (IGT) and other operational management tools. The main climate change projects and instruments launched up to 2014 are listed below.

Figure 40 Climate change projects and instruments launched up to 2014. Source:EMAAC,2017.

ENERGY ENVIRONMENT STRATEGY (2008)	OBJECTIVES FOR AMORE SUSTAINABLE USE OF RESOURCES BY 2013, AS PART OF THE LATEST REVISION OF THE PDM. LISBOA E-NOVA BASED THIS WORK ON TWO TOOLS: MATRIZ DA ÁGUA (2004, REVISED IN 2014) AND ENERGY MATRIX (2005, REVISED IN 2014)
LISBON MUNICIPAL MASTER PLAN (PDM), 2012 IT ALREADY INCLUDED A SET OF STRATEGIC PRINCIPLES FOR CLIMATE CHANGE IN TERMS OF MITIGATION AND ADAPTATION REPORT OF THE PROPOSED PLAN: 5.3 CLIMATE CHANGE STRATEGY LISTING MITIGATION AND ADAPTATION MEASURES	**THE PROPOSAL FOR A MUNICIPAL MASTER PLAN CONTAINS OR IS RELATED TO THE FOLLOWING ADAPTATION MEASURES**: . SAFEGUARDING **PROTECTION MEASURES** IN ECOLOGICALLY SENSITIVE AREAS . STRENGTHENING AND **IMPROVING THE OPERATING CONDITIONS OF THE HYDROLOGICAL SYSTEM**, THROUGH THE CONSTRUCTION OF RETENTION BASINS, PERMEABLE FLOORS, COLLECTION AND STORAGE IN BUILDINGS; . CONSTRUCTION OF A CONTINUOUS **GREEN STRUCTURE** BASED ON MACRO GREEN CORRIDORS, GENERATING SPACES WITH GREATER RESILIENCE TO DROUGHT; . **SOIL REQUALIFICATION** IN ALLUVIAL AREAS, FAVORING THEIR RESPECTIVE REALLOCATION IN THE URBAN ECOLOGICAL STRUCTURE (VALE RIO SECO, ALCÂNTARA, CHELAS E MONTANHA); . INCORPORATION OF **SUBSIDIES FOR URBAN AGRICULTURE AND INCREASED COMPOSTING** "IN SITU" (INCENTIVE PROGRAM FOR URBAN AGRICULTURE AND HORTICULTURE); . GUARANTEE AN ECOLOGICAL STRUCTURE INSIDE THE BUILDING, INCREASE CLIMATE MITIGATION AND COUNTERACT THE PHENOMENON OF THE "HEAT ISLAND"; . **INCREASE IN GREEN SPACES AREAS** WITH REDUCED OR NO IRRIGATION, ASSOCIATED WITH INVESTMENT IN THE USE OF NATIVE OR ADAPTED VEGETATION; . CONSTRUCTION OF A NETWORK OF TREATED WATER FOR WASHING ROADS AND IRRIGATION OF GREEN SPACES; . IMPROVE THE EFFICIENCY OF WATER CONSUMPTION IN IRRIGATED GREEN SPACES THROUGH THE INSTALLATION OF SYSTEMS FOR MONITORING SOIL WATER NEEDS AND REGULATING IRRIGATION ACCORDING TO THEM; . PROMOTION OF **RAINWATER COLLECTION AND STORAGE**; . SETTING TARGETS FOR THE ADOPTION OF RENEWABLE ENERGY TECHNOLOGIES IN THE CITY OF LISBON; . IN NEW URBAN PROJECTS, INCREASE LOCAL ENERGY PRODUCTION; . REALIZATION OF THE CONDITIONS FOR PEDESTRIAN AND CYCLE CIRCULATION OF THE CITY, IN COMBINATION WITH PUBLIC TRANSPORT; . CREATION OF NEW PUBLIC TRANSPORT CORRIDORS; . MODIFICATION OF THE RULES OF PARKING CAPITATION, IN ORDER TO **PROMOTE MOBILITY IN PUBLIC**
EMERGENCY PLANS/ CAMPAIGN 2010 RESILIENT CITIES	IN ORDER TO CONTRIBUTE TO THE PLANNING AND PREVENTION OF PREDICTED METEOROLOGICAL DISASTER RISK SITUATIONS, **EMERGENCY PLANS TOOLS** HAVE BEEN DEVELOPED AT THE MUNICIPAL LEVEL, WHICH DEFINE THE MAIN EXPECTED WEATHER SCENARIOS. FOLLOWING THE APPEAL OF THE UNITED NATIONS, JOINED THE **CAMPAIGN IN 2010 TO MAKE CITIES RESILIENT**: WITH THE AIM OF GIVING VISIBILITY TO THE ROLE OF THE LOCAL LEVEL IN DISASTER RISK REDUCTION, INCLUDING METEOROLOGICAL RISKS.
LISBON STRATEGY 2014	FRAMED BY **THE SUSTAINABLECITIES 2020 STRATEGY**, LISBON PRESENTS PORTUGAL'S SUSTAINABLE URBAN DEVELOPMENT STRATEGY FOR THE PERIOD 2014-2020.OBJECTIVES: -**MORE PEOPLE** (MAINTAINING THE EXISTING POPULATION AND ATTRACTING NEW POPULATION); - **MORE JOBS** (STRENGTHENING THE ECONOMIC FABRIC AND AFFIRMATION OF LISBON IN THE GLOBAL ECONOMY); - **BETTER CITY** (IMPROVEMENT OF QUALITY OF LIFE, ENHANCEMENT OF INTERCULTURALITYAND PROMOTION OF CITIZENSHIP, IMPROVEMENT OF URBAN FUNCTIONING).
INTERNATIONAL NETWORK	THE ENVIRONMENTAL POLICIES OF THE MUNICIPALITY OF LISBON AT THE **INTERNATIONAL LEVEL**: **THE COVENANT OF MAYORS** (2009), AND THE **MAYOR'S ADAPT** (**2014**) THE OBJECTIVES SET BY LISBON WITH THE COVENANT OF MAYORS (2009)14 AIMED AT REDUCING CO EMISSIONS BY 20%TWO AND INCREASING ENERGY EFFICIENCY AND THE INCORPORATION OF RENEWABLE SOURCES IN ENERGY PRODUCTION BY 20%. IN THIS SENSE, LISBON E-NOVA, **THELISBON ENERGYSUSTAINABILITY ACTION PLAN** (**SEAP**) APPROVED IN 2012 AND AIMED AT REDUCING CO2 EMISSIONS BY 20% IN 2020 COMPARED TO 2002 (YEAR OF REFERENCE IN 2015) THE MERGER OF THE COVENANT OF MAYORS WITH THE INITIATIVE MAYORS ADAPT GAVE RISE TO THE NEW AND INTEGRATED COVENANT OF MAYORS FOR CLIMATE AND ENERGY TO REDUCE CO2 EMISSIONS BY AT LEAST 40% BY 2030 AND ADOPT AN INTEGRATED APPROACH TO ADDRESS CLIMATE CHANGE MITIGATION AND ADAPTATION. AN INNOVATION OF THIS NEW VERSION OF THE COVENANT OF MAYORS IS THE PREPARATION OF **THE SUSTAINABLE ENERGY AND CLIMATE ACTION COUNTRIES** THAT FOLLOW THE PREVIOUS SEAPES AND

Lisbon has been recognized among the 10 European cities with a future potential also proclaimed European City of the Year by the Academy of Urbanism (UK) in the field of governance, commercial success-profitability, sustainability and social and environmental functionality, and received in 2014 the recognition of European Entrepreneurial City 2015, for the best regional strategy, promotion in the entrepreneurial sector and innovation among small and medium-sized enterprises.

As can be seen from the image below, one can recognize the commitment that Lisbon has put in the last decade Lisbon to make the city greener and pursue the fight against climate change (PAC Lisboa 2030, 2021).

In recent years, starting from the Covenant of Mayors for Energy and the Environment, it has also developed the Local Action Plan for Biodiversity, the Municipal Strategy and the Energy and Development Action Plan. But not only that, its entry into the C40 network has led to set very ambitious goals for the city by affirming its commitment through the Climate Action Plan 2030 intended as a tool to be used in terms of management and integration of the city's policies and tools and sharing with other members its good practices and at the same time learning from the other cities that are part of the network.

In 2020 it was proclaimed European Green Capital 2020.

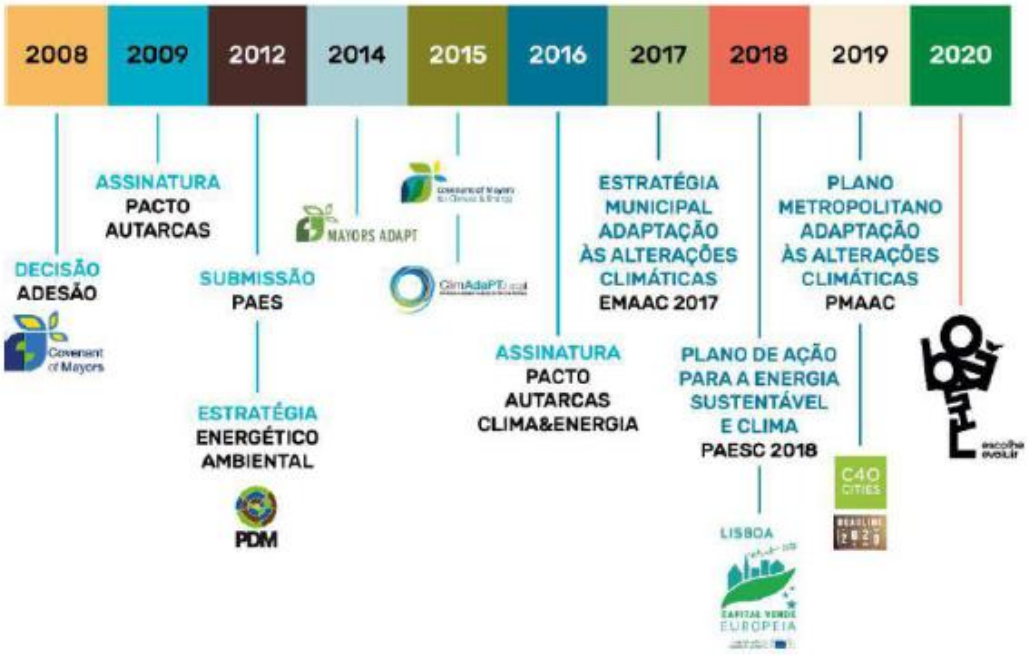
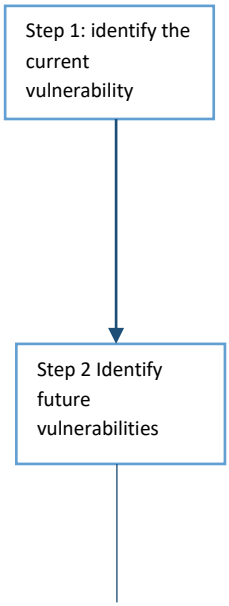


Figure 41 Climate action in Lisban Source: PAC Lisboa 2030, 2021

3.1 Climate change adaptation planning in Lisbon

"*Lisboa - Cidade resiliente às Alterações Climáticas: preparada para o futuro, adaptada no presente*" is the strategic vision for its municipal strategy to climatic alterations. EMAAC Lisbon highlighted the main objectives to create its own adaptation strategy highlighting a great effort in improving the level of knowledge of climate change by paying particular attention to adaptation policies; using the adaptation measures emerged from careful work based on the definition of objectives and strategies that EMAAC develops; integrate adaptation options into different sectoral policies through its application in actions and projects such as territorial and urban planning and territorial management; strengthen the collaboration between public and private figures in the areas mentioned above.

The methodology used to define the climate change adaptation strategy that is part of the climAdapt.Local project was carried out with the ADAM system (Chapter 2.5.1) developed specifically for the Portuguese model along with the heading of the UKCIPI. The aim was to define the main meteorological risks that the city is subject to and what are the adaptation actions necessary to respond to these climate risks. The development of the EMAAC strategy was followed by an external ClimAdaPT.Local team, which provided the necessary training to the local team during the performance of the activities.



The first phase of analysis was the Drafts of the Local Climate Impact Profile (PIC-L), for the period 2010-2014, intending to understand the main meteorological events to which the municipality under analysis is subject and which with the data collected creates a clear profile of the impacts and consequences that the territory is subject to.

After that, the vulnerabilities and the associated future risks were studied, the latter through the risk matrix. From this study that identifies the main risks (negative impacts), through the use of a risk matrix, and the potential opportunities that can be developed (positive impacts) it was possible to give an order of priority that may

require an adaptation response.

Step 3 identify adaptation options

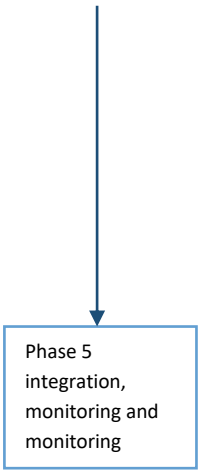
To identify adaptation options relevant to the Lisbon Municipality, several national and international examples have been identified as widely as possible in the context of:

Table 5 Best practices in terms of green and grey infrastructure and non-strucural measure. Source: Mata, 2021.

Grey infrastructure	"They have a direct impact of climate change on infrastructure (such as temperature, flooding, sea-level rise) and usually aim to "control" the threat or prevent its effects.
Green infrastructure	To increase the resilience of ecosystems and achieve objectives of preserving biodiversity, preventing the degradation of ecosystems and promoting the smooth functioning of water cycles by involving blue infrastructure also. (regulation of temperature and humidity, through urban greenery, in densely populated areas and for the improvement of infiltration capacity and water retention;
Non-structural measures	With the design and implementation of policies, strategies and processes (the integration of adaptation in spatial and urban planning, the dissemination of information, economic incentives to reduce vulnerabilities and awareness of adaptation)" (Mata, 2021).

Step 4 Selection of Adaptation Options

Subsequently, adaptation options were evaluated and prioritised taking into account that some actions can be implemented simultaneously and that given the size of the municipality, several options can be recognized as equal importance as adaptation options; it is for this reason that once the strategic axes have been defined, the various adaptation measures have been evaluated, identifying the interdependence and the program lines between the various territorial scales (metropolitan and regional) and the transversal lines to implement the adaptation measures. Finally, once the adaptation measures have been identified, the guidelines for integration into the plans and their monitoring have been laid down. According to the Lisbon Strategy, its implementation will be carried out through the three programmes identified, namely:



Axis A - Adapting the city to climate change: "fruition of the water" and adapt the territory to the heat.

Axis B – Promote intelligent and integrated management for a city more resilient.

Axis C - Involve the community for participatory citizenship and promote collective training.

and monitoring and review of the evolution of the work and the initial assumptions over 10 years (Camera Municipal de Lisboa, 2017).

3.2 Lisbon climate change adaptation mainstreaming

The strategic vision of Lisbon as introduced in the previous paragraph is divided into 3 strategic axes, concretizing the research through the selection of measures where, sometimes, the boundary between mitigation and adaptation often turns out to be very thin.

It is from here that the programmatic lines are defined and subsequently the adaptation options that characterize the municipal strategy.

In the strategic vision of Lisbon correlated with the slogan "Cidade resiliente às alteracoes clima: preparada para o futuro, adaptada ao presente", for each objective the programmatic lines have been identified (Camera Municipal de Lisboa, 2017).

AXIS A: Intending to adapt the city to climate change by working on the use of water and the preparation of Lisbon for heat, the programmatic lines mainly aim to increase the knowledge of the territory and improve its integration within the tools (EMAAC 2017).

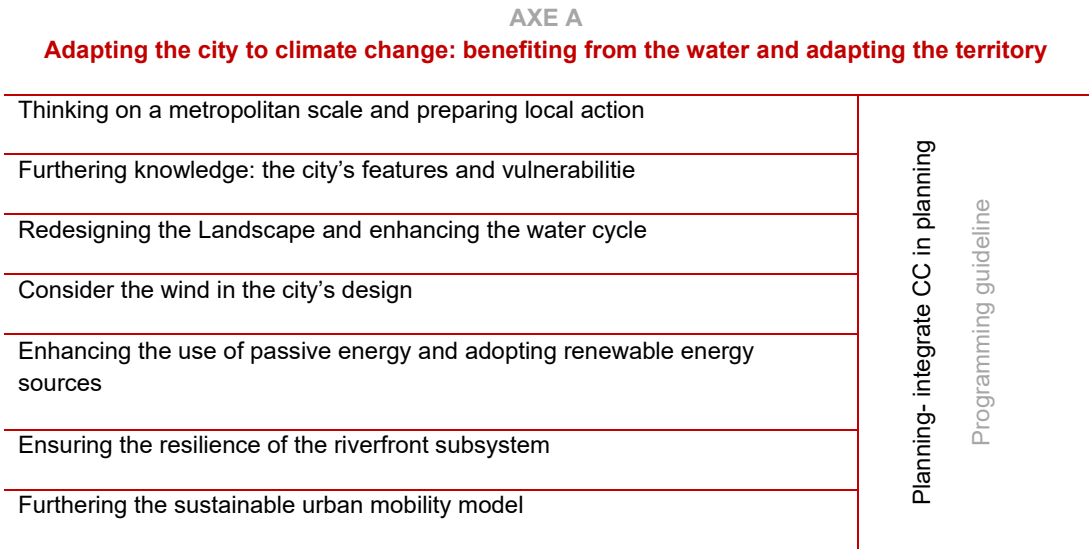


Figure 42 Objective A: integrate CC in planning Source: EMAAC 2017

AXIS B: in promoting smarter management of the resilient city, a lot of work has been carried out on the operational part (EMAAC 2017).

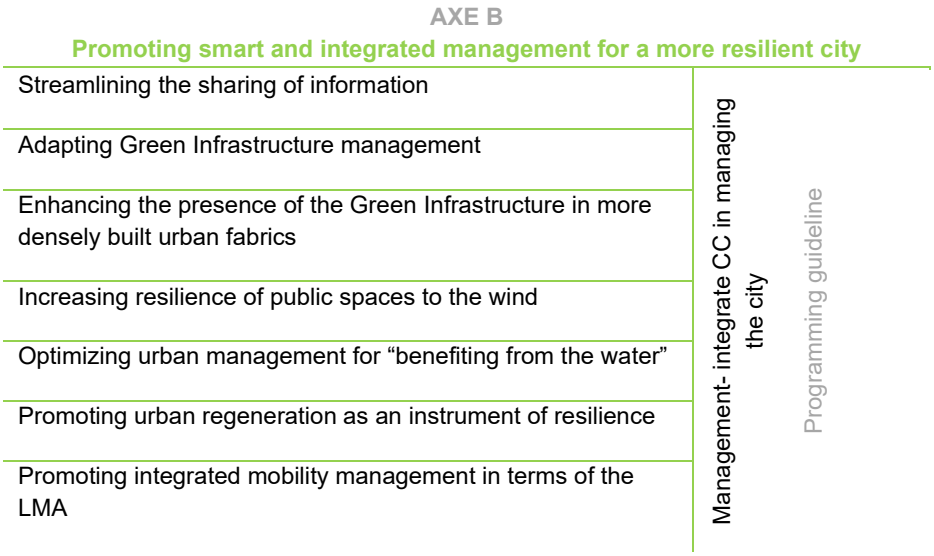


Figure 43 Objective B: integrate CC in managing Source: EMAAC 2017

Axis C: finally, this last strategic axis is very focused on citizen involvement in climate adaptation practices, making the person himself the protagonist and key factor of the adaptation response (EMAAC 2017).

AXE C Involving the community through participatory citizenship while promoting collective empowerment	
Developing citizenship and creating participation networks	Governance/empowerment of CCadaptation Programming guideline
Involving stakeholders	
Liaising with Parish Councils (PCs) and with the LMA	

Figure 44 Objective C Governance/empowerment of CCadaptation. Source: EMAAC 2017

Between the three axes obviously, there is a relationship of interdependence it is useful to underline that the design and management options, enclosed respectively in lines A and B, depending on the transversal actions of C focused on the dissemination of information and involvement of the actors.

The adaptation response suggested by the strategy for each strategic axis is summarized in Annex 1 (Pp.83-85).

The municipality of Lisbon has integrated the issue of climate change into its policies, without neglecting the relationship of continuity between the projects carried out and in progress and the programmatic lines. Some projects have been included in specific sectoral areas (water management, infrastructure and energy, themes that have made the city of Lisbon stand out among others in the European green Capital 2020) to ensure that the work that is being done on climate change must be renewed and deepened and some of these specifically include the area of the case study that will be analyzed in the next paragraph *4.3.2*

WATER MANAGEMENT

The priority given by CML (Lisbon City Council) to water management has given rise to the Matriz da Água (Water Matrix) (Lisboa E-Nova, 2004), which examines consumer patterns and outlines performance targets, in combination with EPAL, whose positive results are shown in the revision of that document in 2014. The PDM (Lisbon Master Plan) (2012) also focuses on water management, highlighting ecology-based solutions in urban planning and management (PDM Regulation). Within this framework, CML's management now reflects a new adaptation culture in a scenario of water shortage, by implementing more efficient irrigation systems, for instance. These lines of action have been concerted in combination with other partners, by developing projects such as:

 Floods CBA (2013) - Knowledge Platform for integrating a cost-benefit analysis (CBA) in the flood prevention measures (EU, CML-Civil Defense Project);

 Remote Manager Project (CML, Lisboa E-Nova) – a project begun in 2015, geared toward increasing the efficient use of water in contracts for supplying CML (Lisbon City Council).

 Reusing treated water for washing streets and irrigating green spaces: preliminary study and delimitation of pilot areas at Parque das Nações***, Vale de Alcântara (Valley***) and Frente Ribeirinha (Riverfront Area);

 RESCCUE - RESilience to cope with Climate Change in Urban arEas – an EU project with a multi-sectoral approach focused on water (H2020) (CML-Civil Defense);

 General Drainage Plan (2016-2030) - Investment of a substantial sum to address floods, whose efficiency will be optimized through the adoption of natural-based solutions locally, as set forth under this EMAAC (stock solutions, such as retention basins integrated into the green infrastructure) which should be appropriately expressed by city management.

GREEN INFRASTRUCTURE

In the pursuit of environmental policies earmarked under the PDM (2012), various initiatives have been undertaken, whose contribution is consistent with adapting to climate change, most notably the following:

 Local Plan of Action for Lisbon's Biodiversity

 Implementing natural-based solutions with demand drainage solutions at the source in 5 parks

 Municipal Plant-Growing Park Program. Best practice recognized by Mayor's Adapt; setup of 13 parks, with another 7 estimated by 2017

 Reinforcement of the Green Infrastructure and its continuity by implementing 9 existing green corridors and/or being implemented, along with a bike path network: . Monsanto - Parque Eduardo VII (Park) . ***Vale de Alcântara (Valley)*** . Alta do Lumiar . Central . Ocidental do Rio Seco . Olivais . Peripheral bike path of Lisbon Ribeirinho (Riverfront) . Oriental

 Land reclassification in alluvial areas, ongoing (Rio Seco, Alcântara and Chelas valleys)

 Implementation of the Forest Management Plan at Monsanto Forest Park. Best practice recognized by FSC certification (2016)

 Reclassification of public space (e.g.: Av. República, Av. Fontes Pereira de Melo, Cais do Sodré, Campo das Cebolas) (2016/2017)

 "Uma Praça em cada Bairro" (A Square in every Neighborhood) Program (2014-2017)

ENERGY EFFICIENCY AND RENEWABLE ENERGY SOURCES

The Lisbon Energy and Environmental Strategy (2008) outlined energy consumption targets for the 2009-2013 timeframe. In 2009, Lisbon signed on to the Covenant of Mayors, having committed to the European Union goals for 2020. As part of the Mayor's Adapt (2014), Lisbon undertook to integrate measures for adapting to climate change. With the new Covenant of Mayors on Climate and Energy (2016), the city commits to new targets (40% reduction of CO2 emissions by 2030). The review of Lisbon's Energy Matrix (2014) shows a drop in CO2 emissions by some 50%, from 2002 to 2014. Within this context for better energy performance, various projects have been developed and/or are ongoing, inter alia:

 Lisbon's Sustainable Energy Action Plan (2012) Lisbon - Solar City: Installation of photovoltaic panels, EE potential and energy certification Eco-Bairro Boavista Ambiente+ (Boavista environment+ Eco-Neighborhood) (2012) Solar Potential Charter for the Municipality of Lisbon (2012) Electric Vehicle Filling Station Network (540) SHARING CITIES (H2020) BESOS - Building Energy decision Support system fOR smart citieS Lisbon Mobility Strategic Vision (MOV) Environmental awareness-raising projects (e.g. School +, Coopetir in the Neighborhood of Boavista, among others). The Municipality has engaged in management focused on greater energy efficiency, via initiatives such as gradually replacing the city's fleet of light passenger vehicles with electric vehicles, introducing low-consumption technology in public lighting and traffic lights, and including renewable energy sources in school equipment, etc.

Figure 45 Example of some listed projects in the areas of water management, green infrastructure and energy related to the commitment that Lisbon puts on the theme of climate change in terms of in-depth analysis and review. Source: PAC Lisboa2030, 2021.

3.3 From the strategy to the actions

The strengthening of the municipal strategy in terms of climate change is accompanied by the Climate Action Plan (PAC 2030).

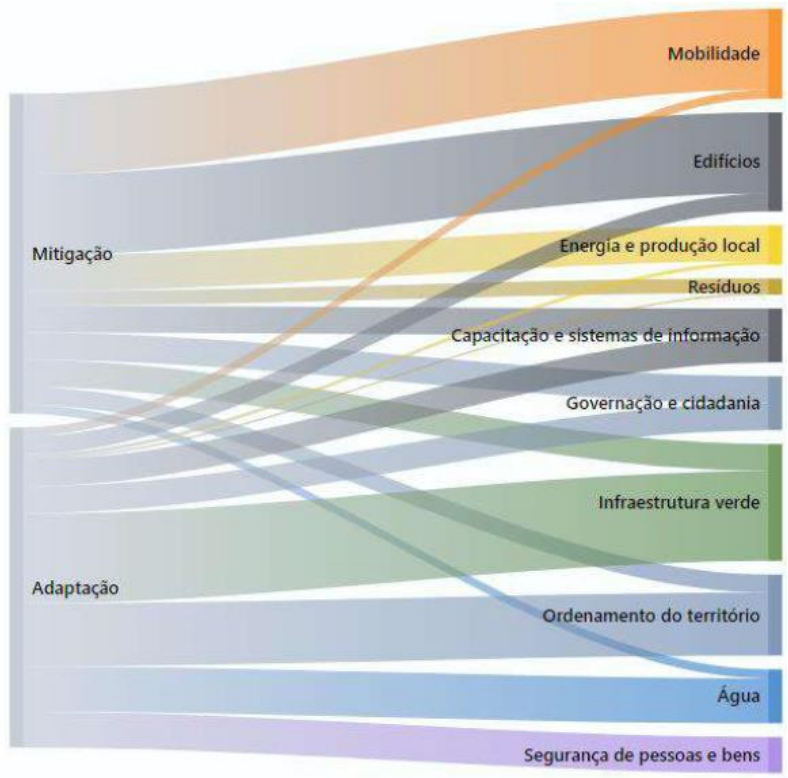


Figure 46 Mitigation and adaptation action. Source: PAC 2030

The city's action plan is based on improving the quality of life and environment in terms of improving public space, accessible mobility, resilience and Lisbon planning, as well as for the issues of security and housing for all.

At the same time, the plan identifies other axes on which to work transversally, i.e. from a social point of view in the field of social inclusion and rights, in economic terms in the field of smart 'city (from the achievement of the title as green capital to affirm the city at a global level), and finally work a lot on decentralized governance with strong involvement of citizens.

It bases its strategy on 10 categories, suggesting in practice what actions to implement to achieve the objectives set in the coming decades.

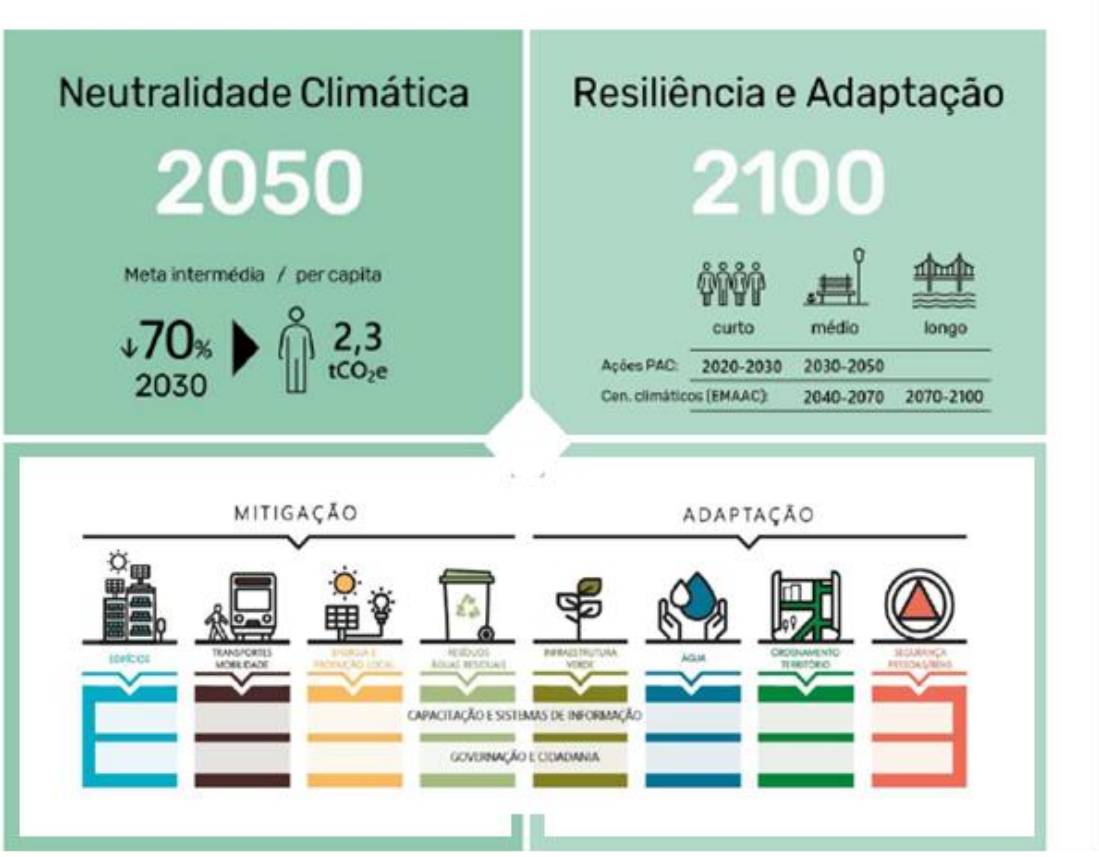


Figure 47 Milestone for 2050-2100. Source: PAC Lisboa2030,2021.

As already seen for the plans drawn previously, Lisbon works in terms of mitigation and adaptation, where very often the boundary between the two is blurred trying to intervene with both in all areas.

In terms of mitigation, the city sets ambitious targets to achieve 70% less emissions by 2030 and to achieve climate neutrality by 2040, bringing forward by 10 years the target that the EU has advocated (EU). Its adaptive response, which requires immediate action, sees Lisbon as needed to find ways to reduce vulnerabilities and strengthen its resilience and integrate it into sectoral areas. The city's preparedness to achieve a degree of resilience by 2050 to respond to future threats in terms of climate change.

The resilience of the city will lead to an increase in soil permeability and the relaxation of the urban climate, thanks to the density of trees and the consolidation of green infrastructure, with a great focus on the following topics:

- Reduce heat exposure by creating shaded public areas;
- Efficient water management and use of non-potable water;

- Improve the adaptation of green infrastructures in terms of temperature increase and water scarcity.
- Flood reduction through drainage with a greater focus on the most vulnerable areas;
- Minimize the effects of sea rise, particularly on the riverfront.

The PAC thus provides a list of targeted actions by attributing to adaptation measures the following:

Table 6 PAC action referred adaptation measures. Source:PAC 2030,2021.

1 Green infrastructure		
	**1.1 Reinforcement of green infrastructure**	increase the area of green spaces and densify afforestation in the City
	1.2 Adaptation of green infrastructure	adapt to green infrastructure to increase in temperature and decrease precipitation
	1.3 Green corridors	strengthening ecological connectivity and promoting ecosystem services and urban biodiversity
2 water		
	**2.1 Water Efficiency Program**	Measures to control water consumption and save money
	2.2 Reuse of non-potable water	alternative water input sources for non-potable uses in the urban water cycle
	2.3 improvement of drainage system	Implementation of the Lisbon General Drainage Plan (PGDL)
	2.4 improvement of drainage system	Natural-based solutions for rainwater infiltration and regularization of watercourses
	2.5 Reinforcement of the watering system	Increase the number of drinking fountains and other sources of drinking water
3 Territorial governance		
	**3.1 Climate adaptation in planning**	Reinforce l'adattamento nella pianificazione urbana e gestione territoriale
	3.2 Adaptation in the riverside area	Adapting the riverfront to the scenario of rising water levels and flooding
	3.3 Adaptation in the riverside area	Preparare lo spazio pubblico all'aumento della temperatura e altri fenomeni estremi
	3.4 Application of heat island study	Know the phenomena of heat waves and urban heat islands
	3.5 Adaptation projects in the metropolitan area	Collaborate in the implementation of the metropolitan projects envisaged in PMAAC
4 Person and object security		
	**4.1 Prevention and emergency plan**	Promote preventive management and response to climate risks through contingency, contingency and operational plans
	4.2 Adaptation to public transport	Plan public transport systems for flooding scenarios and other extreme phenomena

In the same way, the actions of the transversal areas are also defined:

Table 7 PAC actions referred to trasversal areas in term of adaptation. Source: PAC 2030,2021.

5 Training and information systems		
Knowledge and technical training 	**5.1 Studies, strategies and Plans**	Development of studies, specific strategies and plans to support the establishment and development of sectoral measures
	5.2 Collaborative Knowledge	Promotion of knowledge, improvement of technical training of the municipality and promotion of external collaboration and sharing of good practices: Networks and sharing of good practices; Laboratories; Scientific research projects
	5.3 Cost-benefit of non-adaptation	Assess ecosystem services and the cost-benefit of not adapting to climate change
Technology and information system 	**5.4 Intelligent management of information**	Promoting integrated management of information, sensorization and making city data available
	5.5 Monitoring of climate indicators	Systematize the monitoring of meteorological variables and impact indicators
6 Government and citizenship		
Communication and awareness-raising 	**6.1 Campaigns communication and sensitization**	Promote communication and awareness-raising to the population within the framework of climate change
Governance and active participation 	**6.2 Commitments in climate action**	Promote the subscription of declarations, pacts or other commitments for climate action (e.g.: Compromisso Lisboa Mobilidade; Compromisso Lisboa Empresas; Sensibilização de Entidades e Colaboradores Municipais)
	6.3 Green participatory budgeting	Promote initiatives and projects of sustainability and climate action in the Participatory Budgeting
	6.4 Sustainable public procurement	Incorporating criteria in the specifications for public procurement
	6.5 Financing	Creation of instruments for funding for the action climate change and increased capacity investment policy (public and private)

3.3 Lisbon green capital 2020 role to mainstream climate adaptation

Lisbon is proclaimed European Green Capital in 2020, the first capital of southern Europe to win this award thanks to the path it is taking and above all to its future vision.

The profile that a European green capital [6] must have must be in line with the following: commitment in terms of economic, social and environmental sustainability, also confirming the work that local authorities are doing in terms of advancement and innovation but be inspiring for other cities by sharing its good practices and experience.

And in line with the above mentioned it has been established that:

"*The Jury felt that Lisbon, which started its journey towards sustainability during a period of economic crisis, can be an inspiration and a strong role model for many cities across the EU, demonstrating clearly that sustainability and economic growth go hand in hand"* (The European Green Capital Award, Jury, June 2018).

Sà Fernandes José, city councilor for green and energy facilities, states that the reason why the city won is based mostly on its originality; in fact, it is the only city in Europe that has a biodiversity plan for the ecosystem motorization services. The areas for which it stands out are the reuse of water to reduce the consumption of drinking water; a second reason for being named green capital is due to the green, in fact, in recent years more than 300 hectares of green spaces have been created and this thanks to the more shade and trees tries to fight the heatwave. Another very important feature is that it is very exposed to the sun and given the possibility of working in the last 10 years very assiduously on renewable energy and energy efficiency: photovoltaic installations (European Union, 2020).

Continuing, a city needs mobility to ensure that people circulate and that is why in terms of slow mobility with scooters and bicycles, as well as in public transport. It is precisely in the will of evolution that the city has taken a step forward, and precisely in

[6] Applicants for the European Green Capital Award are assessed on their performance in the following key environmental indicator: Air Quality, Noise, Waste, Water, Nature and Biodiversity, Sustainable Land Use and Soil, Green Growth and Eco-innovation, Climate Change in term of Mitigation and Adaptation, Sustainable Urban Mobility, Energy Performance and Governance.

its slogan "*choose to evolve*" are enclosed all projects that the city has in mind, in the perspective of adapting but at the same time of acting for a sustainable future.

The city has set itself several short-, medium- and long-term environmental objectives, also involving other sectors, but distinguishing itself a lot for the effort on green highlighting not only the importance for the planet and the environment but also citizens and biodiversity. He then underlined that the benefits will touch different sectoral areas and the green will therefore promote an improvement in the quality of life in the city and also act as an attractor for the outside, highlighting how infrastructures are very important tools to cool the city, and at the same time emphasizes the importance of promotion and redevelopment of public spaces in the different neighbourhoods also working a lot on public transport and sustainable mobility, in particular on cycle and pedestrian paths.

What greatly influenced the city's winning of this title was abandoning the car-centric vision that many cities still have to work with a different approach to urban and that led to a new master plan that revolutionized urban planning. With the 2012 master plan we had a different approach to planning focusing on land use, high-density building and the relocation of some homes outside of ecologically sensitive areas (European Union, 2020).

All this has led to the development of the strategist of the 9 green runners that Lisbon has, intending to preserve and increase the permeable areas and the rehabilitation of rivers and canals. But not only this, in a broader vision sees the green as a problem-solving infrastructure (Camera Municipal de Lisboa, 2020).

Climate models show how heat waves and are increasing both in terms of frequency and intensity, the same applies to the heat island effect and this would also bring effects on people's health.

Among the measures for him the city is working more in terms of adaptation and at the same time being the answer to this problem is given with the project to implant 100,000 in 4 years along the streets of the city, implement green infrastructure and reduce the temperature with the project of the European Union LIFE +.

The latter in his immediate vision, 2019-2024, has started a project where *"the city is expanding its strategy to replace traditional lawns with rain-fed meadows, where possible. These lawns provide drought-resistant vegetation cover that requires*

absolutely no watering and very little maintenance. In addition, they improve soil organic matter as they are an efficient reservoir of carbon and nitrogen, thus helping to increase the sponge effect that retains water during storms. This successful technology transfer of technology from agriculture to the management of urban green infrastructure increases urban biodiversity" (European Union, 2020).

In a broader vision, adherence to this European initiative has allowed the city to stand out, through LIFE LUNGS, the first LiFE project led by a municipality.

LIFE LUNGS, the acronym for «Towards a more resilient Lisbon UrbaN Green InfraStructure as an Adaptation to climate change» is a five-year project that will end in 2024 that wants to make the urban green infrastructure an essential tool among the adaptation actions that embodies the possibility of promoting and developing related ecosystem services as well as ensuring its sustainable management.

The contribution that this project wants to give to the city is to contribute to the implementation of the local climate adaptation strategy by making the city more resilient to the effects of heatwaves and water decrease outlined by future climate scenarios and at the same time stress an important area that is also the characteristic of the project: active participation; the latter is fundamental for environmental issues to better understand environmental threats and demonstrate how cooperation and active participation lead to better results (Camera Municipal de Lisboa, 2020).

3.4 Corredor verde do Vale de Alcântara

3.4.1 The 9 green corridors of Lisbon: framework

From the definition of the strategy that the CML establishes in terms of adaptation to climate change and from the actions that the PAC suggests for the municipality, a case study of green infrastructure will be presented and analyze how this is integrated into the municipal guidelines.

Before going into the merits of the specific case study of the Corredor Verde do Vale de Alcântara it is necessary to make an overview of how green infrastructure has become one of the structuring axes of Lisbon planning.

At the beginning of the 2000s the city presented itself with a strong urban sprawl occurred starting from the 70s and also a car-centric policy throughout the Metropolitan area, a lack of public spaces and ecological structures, compared with other metropolitan cities presented a loss of competitiveness and an intense decrease of habitats.

Starting in 2008, we started to design a new PDM starting from the one in force at the time and analyzing all the gaps it was bringing with it. In particular, it lacked climate change adaptation policies, a **low rate of new green areas (<10ha/y)**, there was no ecological continuity and consequently, there were no green corridors.

It was a PDM that did not provide for green conditions and with only 7 km of cycle path, also missing the opportunity of social involvement. With the entry into force in 2012 of the new PDM, the idea was to invest in considering different green parks, pedestrian and bicycle connections including dedicated bridges on the green corridors (excluding riverside renovations) with Agreements and partnerships with public and private companies, cohesion Funds financing in some investments and Other EU Funds like LIFE CLIMA.

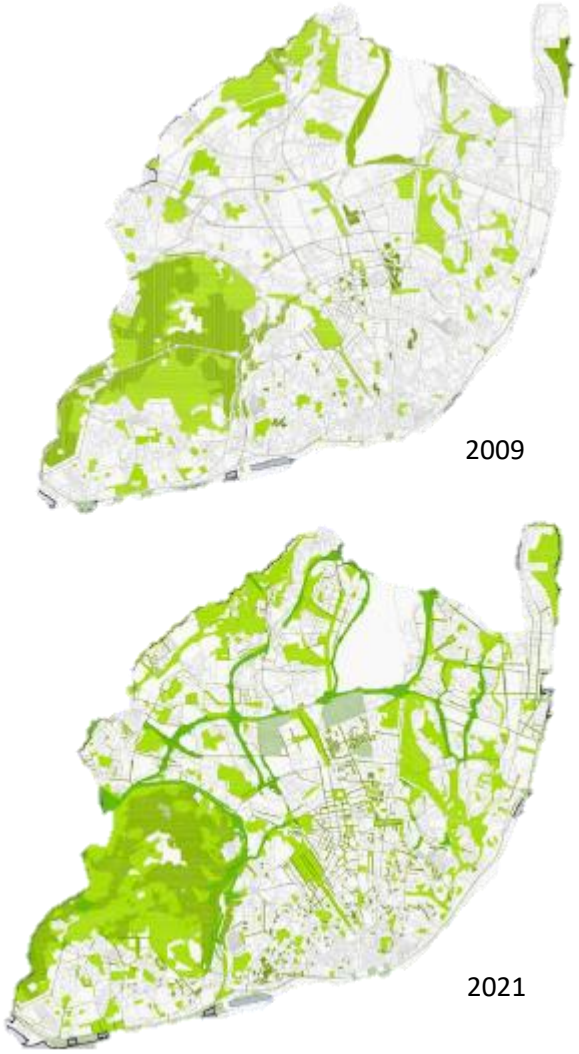


Figure 48 Incrementation of green area between 2010-2021. Source: CML

1. top-down dove the municipality defines master program for each intervention and public debates are realized;
2. Bottom-up where citizens propose ideas that must be voted annually on the Participatory Budget and become mandatory if they win;

3. A mix between top-down and bottom-up in which there is a contribution from both the public and private profile where Companies contribute with budget as social/environmental responsibility or as the counterpart of any initiative;
4. Projects supported by European Union funds based on the themes of green, sustainable mobility and climate;
5. Urban district contributors and local communities cover the profile of partners and managers of the area.

Directing investments makes an intensive form to an extensive one, then arriving at a nature-based solution and green corridor.

In a general view, this type of green infrastructure aims to adapt to the effects of climate change in particular floods, heatwaves and air pollution. The CML has thus decided to set targets to be achieved by increasing green infrastructure: to date, there are more than 400 hectares of new green (20% of green infrastructure since 2008) intended as a network consisting of 9 corridors and not of green areas separate; invest in particular in degraded areas to work on social inclusion; integrate this with other uses such as cycle paths (from 7km in 2008 to 200 km in 2021) and pedestrian and urban allotment gardens to promote ecosystem services; base the strategy on the ecological principles that in addition to the benefits in environmental terms also at an economic level are better both in terms of implementation and management.

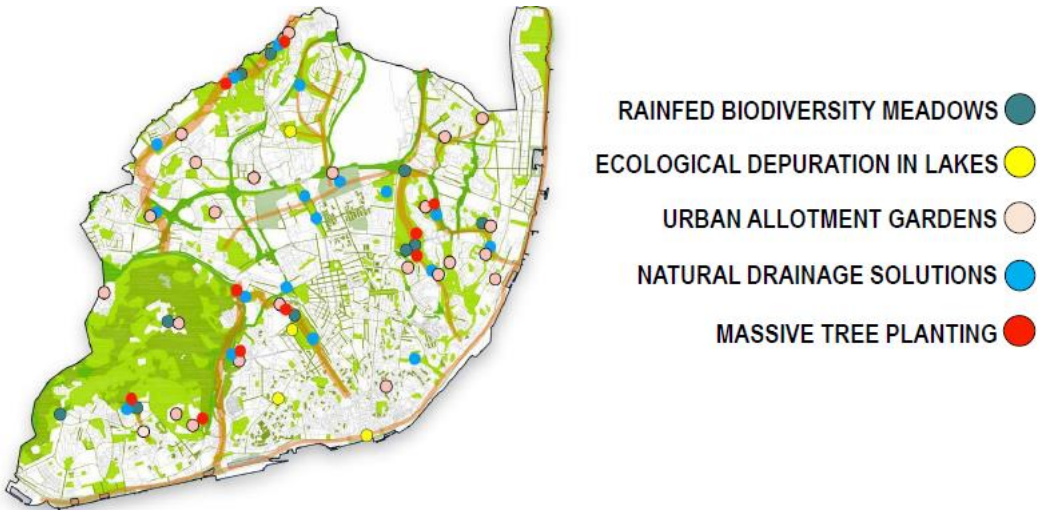


Figure 49 Natural-based solution strategy of the municipality of Lisbon. Source: CML

3.4.2 Description of the project

The development area of the project, analyzed through the websig that through the program Lisboa Interativa the municipality makes available for analysis, can be analyzed as an ecological structure of the green corridor of the Vale de Alcantara. In particular, the presence of green spaces outside the area recognized as a green corridor is dominant. moreover, the large presence of the wet system that the PDM identifies, through the redevelopment of the project will be further expanded through the expansion of the blue line and following the directives of the biodiversity plan.

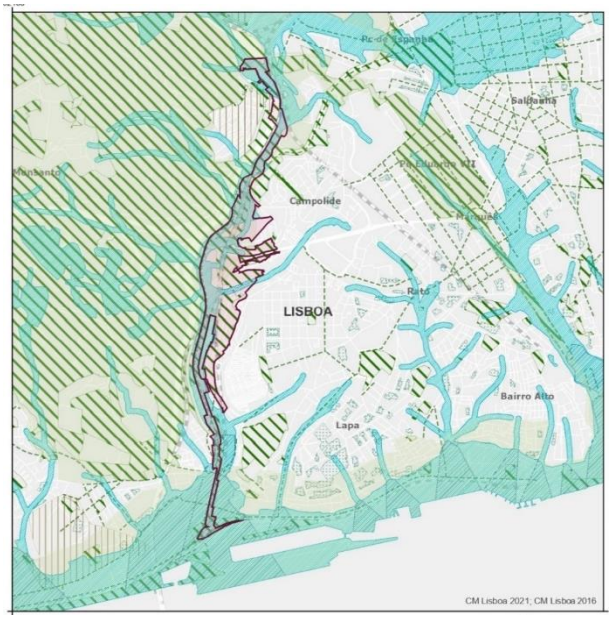


Figure 50 Ecological structure of Lisbon Source data: CML

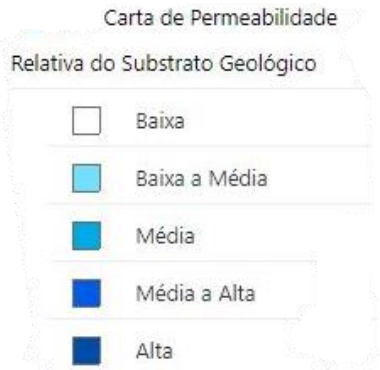
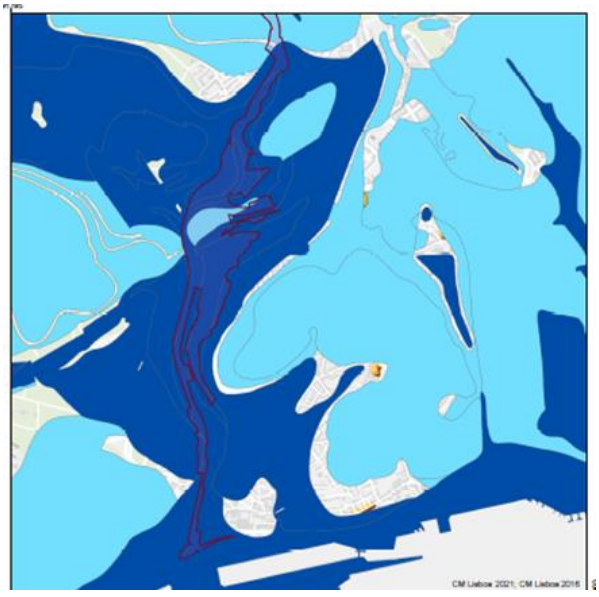


Figure 51 Soil permeability Source data: CML

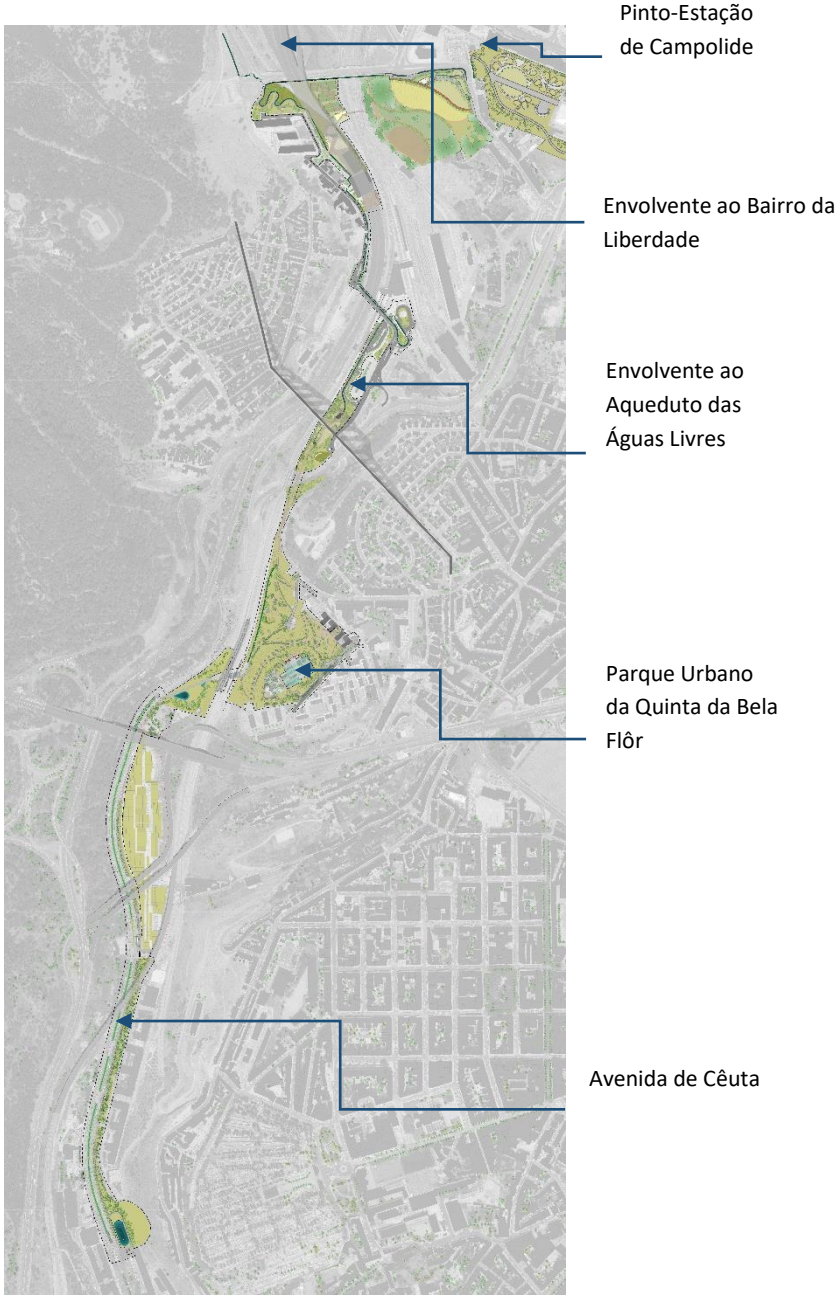


Given these premises the case of the Alcantara corridor is a very important project in the process of adaptation to climatic alterations through mainly the increase of green areas and the optimization of the water circulation.

The intervention, given its extension 4.3 km away and 20 hectares of surface, can be divided into 5 segments:

- Bairro da Liberdade
- Estação de Campolide-Quinta ze Pinto
- Parque Urbano da Quinta da Bela Flôr
- Aqueduto das àguas livres
- Avenida de Ceuta

Figure 52 Project area of Vale de Alcantara intervention



The corridor extends in a continuous path that starts from Quinta José Pinto in Campolide to Av. de Ceuta em Alcântara intending to connect the Monsanto Forest to the Tagus River.

This project aims to create a route that reduces the isolation of some areas that have been limited for many years by the railway infrastructure that prevented the pedestrian and cycle connection to the city.

To bring to mind the concept of "water" since the river has been buried, the project promotes adaptation to climatic alterations through the redevelopment of the functions of the valley through the increase of green areas and the reuse of water for the watering of green areas and also as part of the urban landscape.

The objectives of the project can be summarized in the following points:

1. Climate adaptation through urban and landscape adaptation
2. Establishment of the continuous and functional green corridor in articulation with social activation of surrounding areas, currently disqualified and disintegrated
3. Promoting mobility (soft mobility - pedestrians and bicycles)
4. Reuse of treated wastewater
5. Correction, reinforcement and installation of a vegetable cover
6. Enhancement of water-related heritage

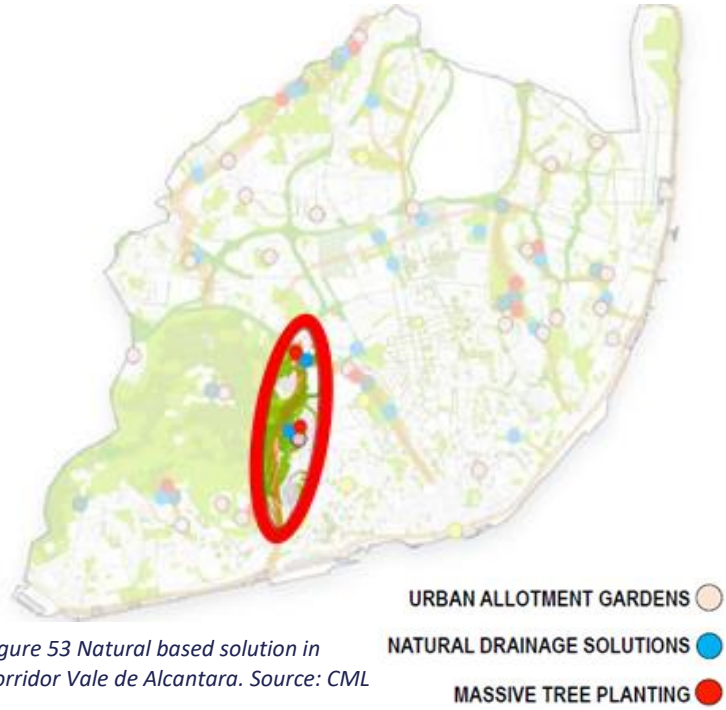


Figure 53 Natural based solution in Corridor Vale de Alcantara. Source: CML

NBS used in this intervention consider the "*interlinkages between urban regeneration, aesthetic appeal, urban development, urban structure, design and aesthetics, urban ecology and its relation to energy and water use.*

For example, landscapes that look well-cared to discourage crime, and social capital may be nurtured by physical evidence of care. Urban regeneration brings new opportunities for cities to reconsider their planning strategies in the context of limited available space, deprived areas, social inequities, or global environmental changes" (Raymond, Berry *et al.*, 2017) and the selected case study contains all these characteristics and at the same time potential.

The Corridor is therefore characterized by combining objectives of ecological importance, linked to the regularization of the water system, the recovery and increase of vegetation cover, ecological continuity with the Monsanto Forest Park and the use of recycled water to reduce the consumption of drinking water, with aspects of response to the lack of slow and active mobility.

Thus, in addition to the stretches in which the aspect of ecological continuity and connection between the spaces is strongly linear, it offers larger spaces that can provide recreation and recreation, with emphasis on the area in the vicinity of the Águas Livres aqueduct and the Urban Park of Quinta da Bela-Flor, as well as the areas of the Bairro da Liberdade.

The proposal is essentially based on an uninterrupted cycle and pedestrian path, flanked by the public transport line.

The concept of water is much emphasized in this intervention, in fact, it is present in some sections on the surface such as in the part of Av. de Ceuta (the only part not yet realized) is the main element, creating along the avenue a new ecosystem that "*connected to the humid environment with all the associated species, we have tried to enhance the ecological heritage of the city, in close relationship with the large adjacent green space, the Monsanto Forest Park"* (CML 2015).

The water line is alternated in underground sections and in surface sections where the latter will be naturalized with the planting of plants on the banks that also have the function of purifying. The plants will also be flanked by trees that will give dynamism to the avenue.

3.4.3 Integration of the project with local plans and strategies

In this paragraph, we will analyze how the project integrates with the municipal strategy and the action plan and in parallel how it is in line with the requirements proposed by the EU.

Table 8 Analysis of project actions consistent with EMAAC and PAC2030 measures. Source:personal elaboration

Goal	EMAAC (annex p.74))	PAC2030 (p.48)	Description
1- Climate adaptation through urban and landscape requalification	A.12; B1.8; B1.9	1.2; 2.5; 3.1; 3.4; 4.1; 5.1; 6.2	Insertion of trees along the roads to combat the heat island effect and make the soil more permeable, also the installation of trees to intervene on the water runoff. In the section of the Envolvente ao Aqueduto das Águas Livres conversion of some roadways into green spaces also increases the permeability of the soil.
2- Establishment of a continuous and functional green corridor in conjunction with social activation of surrounding areas, currently disqualified and disintegrated	C1.1; C1.2; C1.1; C1.4; C1.10	3.5	Creation of parks and green areas, places of leisure with seating and recreation places. Urban gardens have also been designed in the part of the Bela Flor Park, focusing on the redevelopment of the degraded area. The pedestrian street has also been made more attractive with an inclusive design and pergolas to entice the population to use it. Involvement of the population in the creation of the area through days dedicated to the planting of trees
3- Promoting mobility (soft modes - pedestrians and bicycles)	A.11 B1.7	5.1; 6.2	Creation of the cycle and pedestrian path that connects the Monsanto Forest with the Tejo river. 1,9 km of cycle path, 9,92km of the pedestrian path work was also taken to solve the problem of the railway as an artificial barrier that did not allow connections by creating overpasses and tunnels that allow the pedestrian path to be uninterrupted. In the segment of Avenida de Ceuta, we intervened in terms of Road deletion, widening of the promenade and creation of squares/areas of stay and Mostly mixed route. The urban design also serves to encourage soft mobility through pergolas and benches along the way.
4- Reuse of treated wastewater	A1.8; B1.2	2.1; 2.2; 2.3; 2.4	Reuse of ETAR treated water for irrigation, use of water retention basins.
5- Correction, reinforcement and installation of the vegetable cover	B1.1	1,1; 1.3; 3.4; 5.2	Increase in vegetation cover with the integration of the biodiversity plan, social projects with the planting of 600 trees in the Bela flor park to cope with the heat island effect, sensitize citizens to this risk by involving them in actions to cope with this event, creation of urban gardens always in the BelaFlor park.
6- Enhancement of water-related heritage	C1.10	6.2	Reopening on the surface of the river to reconnect the image of the past

Starting from the climate change adaptation strategy, the project integrates with a wider system of green corridors establishing territorial continuity and being part of a municipal climate change adaptation complex.

The landscape is then redesigned. In the 40s it was decided to bury the river that crossed the Alcantara valley and today the project, following the adaptation guidelines, enhances both the historical memory and the bringing to the surface of it going to create wetlands, coping with ecological fragmentation.

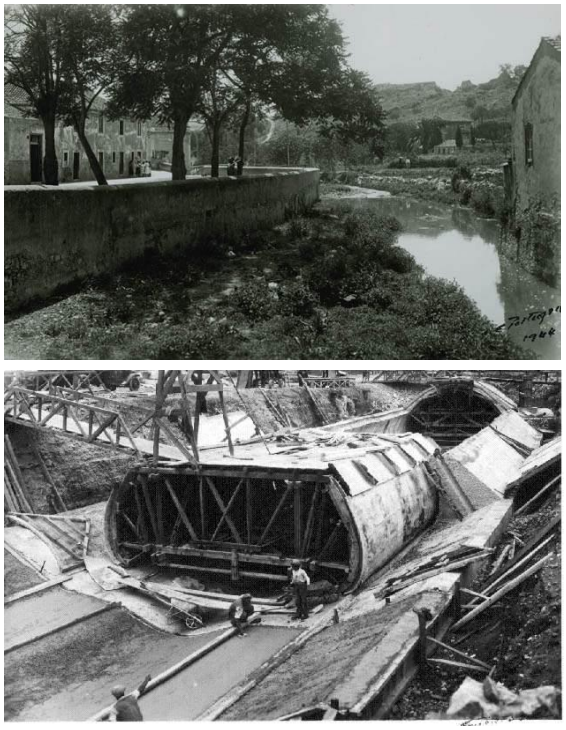


Figure 54 Historical photos of the channel in Vale de Alcantara. Source: CML 2015

Not only that, in public spaces, the strengthening of the water cycle is enhanced through irrigation of treated water (ETAR de Alcantara) and collection in retention basins. For the Avenida di Ceuta, a segment in the running phase that will have to be finished in the coming years, it is planned to make the blue line as the central element of the segment, and that, with its treatment there is the permanent flow of water with quality parameters that allow its use on the surface. In the same stretch to re-naturalize at best we opted for the planting of the banks with species that purify it.

Through the intensive planting of trees in the green infrastructure, it was possible to combine solutions to cope with the heat island and at the same time water management. Since the area had numerous road axes, part of them were converted to green areas thus increasing the green areas (natural-based solution) and consequent also the permeable area as this area is potentially at a high level of permeability.

Figure 55 Transformation in permeable area in Aqueduto das Águas Livres. Source CML2015

Given that the city's strategy integrates actions that can hardly be only mitigation or adaptation, as regards the verse areas it has been possible to distinguish in what terms the green areas go to intervene on climate change.

Objectives /Theme	Enhancing sustainable urbanization	Restoring ecosystems and their functions	Developing climate change mitigation	Developing climate change adaptation; improving risk management and resilience
Green Corridors	Enhancing city attractiveness; Regulating air quality; Increasing property value; Offering recreation and a healthy lifestyle	Creating and improving ecosystems and connections	CO2 sequestration; Bicycle and Pedestrian mobility; Enhancing soil protection with CO2 and NO2 sinking	Maintaining humidity, lowering temperatures; Reducing stormwater runoff and ground drainage
Street Trees	Enhancing city attractiveness; Regulating air quality; Increasing property value	Creating and improving ecosystems and connections	CO2 sequestration; Energy saving	Reducing stormwater runoff; Lowering temperatures
Urban Agriculture	Offering recreation and a healthy lifestyle; Re-use of abandoned areas	Promoting ecological balance of the territory	CO2 sequestration; Local Food Production	Maintaining humidity, lowering temperatures; Reducing stormwater runoff and ground drainage

Figure 56 Benefit achieve enhancing sustainable urbanisation Source: oppla.eu/casestudy/17624

At the level of citizen involvement in which the municipal strategy dedicates one of its axes, it includes citizens in the realization of the area to be redeveloped making them an integral part of the project. In particular, they were involved in the planting of 600 in the area of the Bela Flor Park with the aim of raising awareness of climate change in particular on the consequences that these interventions will imply such as the decrease in the heat island effect, shading but also impacts from the point of view of biodiversity.

It can be said that the project reflects the adaptation measures proposed by the PAC2030.

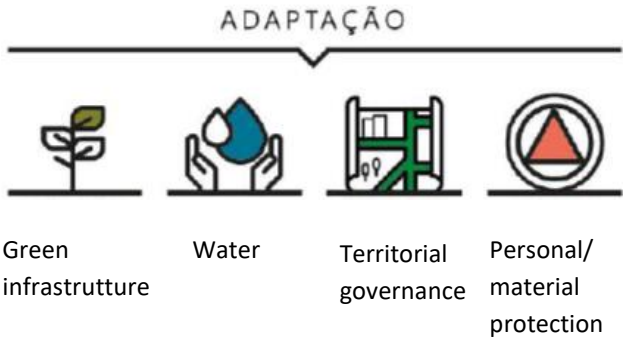


Figure 57 Adaptation sector of PAC 2030 analized in the case study of Corridor Vale de Alcantara. Souce:PAC2030

In terms of green infrastructure, the project intervened by increasing the amount of green spaces and densification of trees both along the streets and in the green and recreational areas, taking into account climate risks such as intense rains, heat island effect in particular. Also concerning ecological connectivity, the project has worked a lot both through the conversion of some areas into green areas therefore at ground level and the return to the surface of the stream, and with the increase in the number of trees at the level of the crown.

As for the issue of water already widely discussed, the project implements the Plano Geral de Drenagem de Lisboa and uses natural-based solutions for water infiltration and reuse of non-potable water treated for irrigation.

As part of the organization of the territory, the public space has been adapted to extreme events and increase in temperature through the tree cover that allows the area to be cooled and in terms of shade to allow the use of the population.

Fundamental for this intervention was to cross the project with the biodiversity strategy integrated into the PDM which was useful for selecting the indicators.

Figure 58 Sectors in which the project contributes to achieving the objectives that Lisbon has set itself for 2030. Source:PAC2030,2021.

3.4.4 Indicators selected for the project

To see how the project contributes to pursuing the climate change strategy despite being an intervention that comes from the master plan and not specifically from the EMAAC, indicators were selected on the subject of green and fragmentation, mobility, water and air. The period before 2015, the period before 2015, the period where the project had not yet been started, and 2021, i.e. the state to date where the project was completed except for the last segment, along with the Avenida de Ceuta, in which it would have been very interesting to calculate indicators related to the water management of the area due to the renaturalization of the urban waterbody and the restoration of wetlands in river-basins.

For the selection of indicators, the:

- EKLIPSE which intends to support the climate resilience of urban areas through the use of NBS provides a series of indicators for the evaluation of measures.
  In particular, the issues that have been consulted that are part of some of the challenges that the EKLIPSE report intends to address concern the areas of:
  - climate mitigation and adaptation,

- water management,
- management of green spaces with a specific focus on the biodiversity of which Lisbon has drawn up a real plan
- air quality

This document was also useful to understand the applicability of some indicators, distinguishing microscale ones in the urban, metropolitan area, street/neighbourhood and construction (Raymond, Berry, *et al*., 2017).

- Lisbon Biodiversity Plan 2020 approved by the CML in 2015, is intended as a tool for implementing policies related to the theme of biodiversity and at the same time enhancing it at the urban level. This plan has as its central element the green infrastructure understood as the key element for the spread of biodiversity recognizing its direct and indirect benefits, environmental, social and economic.

This tool thus identifies indicators that helped to monitor the PDM of 2012 which introduced for the first time the concept of ecosystem quality and at the same time the formulation of the indicators developed was the starting point for the candidacy for several international projects and also for the achievement of the Green Capital of Europe 2020 title.

It is therefore clear the importance of this work and the results it has led to achieving.

Finally, these results were also integrated into the strategies at different scales: "*The recognition of the co-benefits generated by green infrastructure has also grounded the formulation of climate adaptation and mitigation measures, reflected in the Municipal Climate Change Adaptation Strategy (2017), and made operational in the Sustainable Energy and Climate Action Plan (2018), as well as, more recently, in the Climate Action Plan for Lisbon 2030, according to the commitment made at international level within the C40 network of cities*." (Câmara Municipal de Lisboa, 2020, p.5)

It is essential to read these indicators not as mere individual results, but by reading them as part of a complex system that generates benefits to the environment.

"*The use of NBS to improve climate resilience in urban areas in the face of impacts of climate change such as temperature extremes, wind, drought and floods, also*

producing benefits of climate change and pollution mitigation. However, it is recognized that because of their multi-functionality (their ability to perform several functions and present several advantages at once and over time) any NBS is likely to have co-benefits (and costs) in other challenge areas and benefit from them biodiversity " (Raymond, Berry *et al*., 2017, p.37)

3.4.4.1 Green

Green areas provide a range of ecosystem services necessary for the resilience of urban areas providing benefits for society.

This turns out to be a very effective tool in achieving a sustainable urban structure and at the same time a relevant cultural and social dimension through the aesthetic value of the area, the recreational areas and the social interactions that are generated (Raymond, Berry *et al*., 2017).

Being part of a green corridor, the first indicator that was taken into account was the increase in green areas of the intervention area.

Figure 59 Example of permeable area in the project- Aqueduto das àguas livres. Source: CML 2015

It is useful to point out that the area before the implementation of the project had numerous permeable areas but without greenery and therefore not considered vegetated.

Table 9 Green indicators. Source:Personal elaboration

INDICATOR					% incrementation
Vegetated area (m2)	2015	82617	2021	175628	53%
Of which Allotment Gardens (m2)		0		3636	100%
Tree (items)		1113		2487	55%

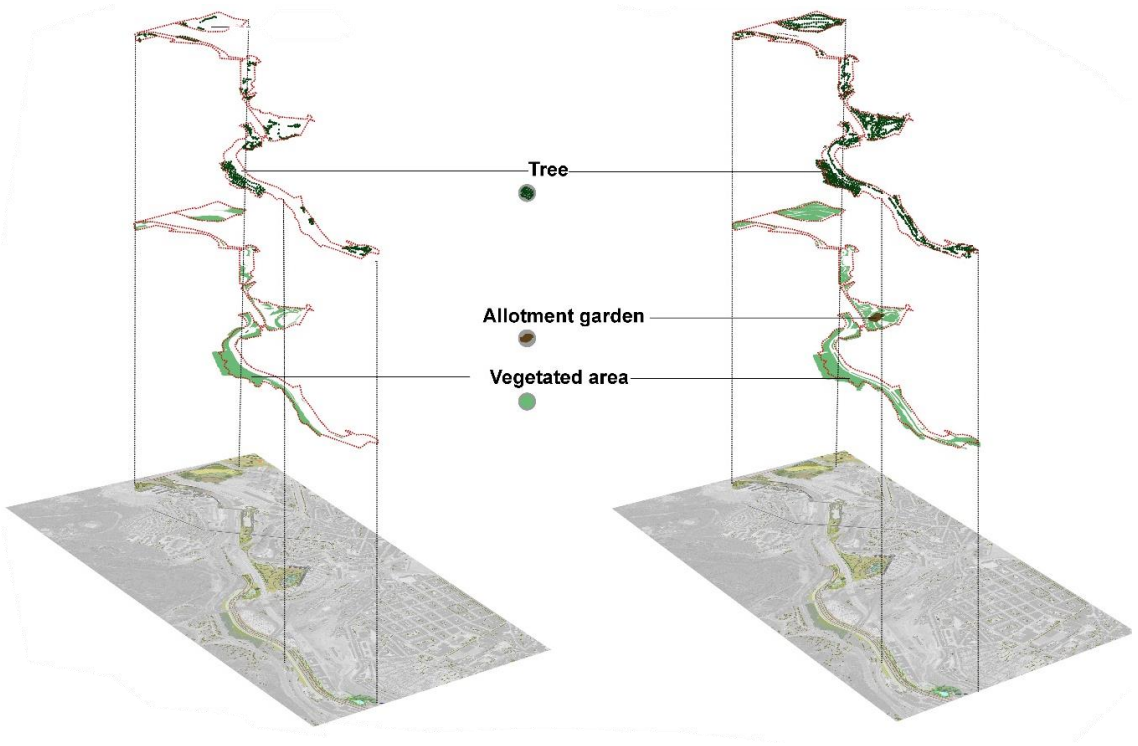


Figure 60 Comparison of the greenery between 2015 and 2021. Source: personal elaboration.

The area today records an increase of 53% considered as vegetated in the analysis, counting more than 17 hectares. Of these areas you see have been dedicated some parts to the urban vegetable garden that until before the project was not present. Following The Urban Allotment Garden (UAG) Program, 3636 m2 of the urban field were included in the Bela Flor park area: it was action both in response to degradation contributing to social inclusion and self-consumption by the owners in the perspective of social participatory and biodiverse green infrastructure.

Finally, between the two reference periods, there was an increase of 55% of plants, the natural-based solution par excellence of the area, going to create benefits both in terms of temperatures and heat island effect thanks, moreover, to a greater shaded area,

both in terms of quality of the area, water and biodiversity as we will see in the next paragraphs.

3.4.4.2 Fragmentation

Although the area is characterized by a good amount of green areas, what affects biodiversity is the continuity of this; in fact, isolated green areas affect fragmentation.

The Lisbon Biodiversity Plan expresses itself clearly on the procedure for calculating connectivity, distinguishing that at ground level and that at the level of tree-lined foliage.

For the calculation of continuity at ground level, a buffer of 10 meters of green areas (identified by the indicator discussed in the previous paragraph) was made, considering therefore that the connection takes place at a maximum of 20m away from the vegetated areas; for connectivity at the level of the canopy was applied instead of a buffer of 20 meters thus considering up to 40m the maximum distance understood as connectivity between two trees.

Table 10 Fragmentation indicators. Source: personal elaboration

INDICATOR					% incrementation
Connectivity at terrain level (buffer 10 m)	2015	174753	2021	381078	54%
Connectivity at tree level (buffer20m)		126534		355055	64%

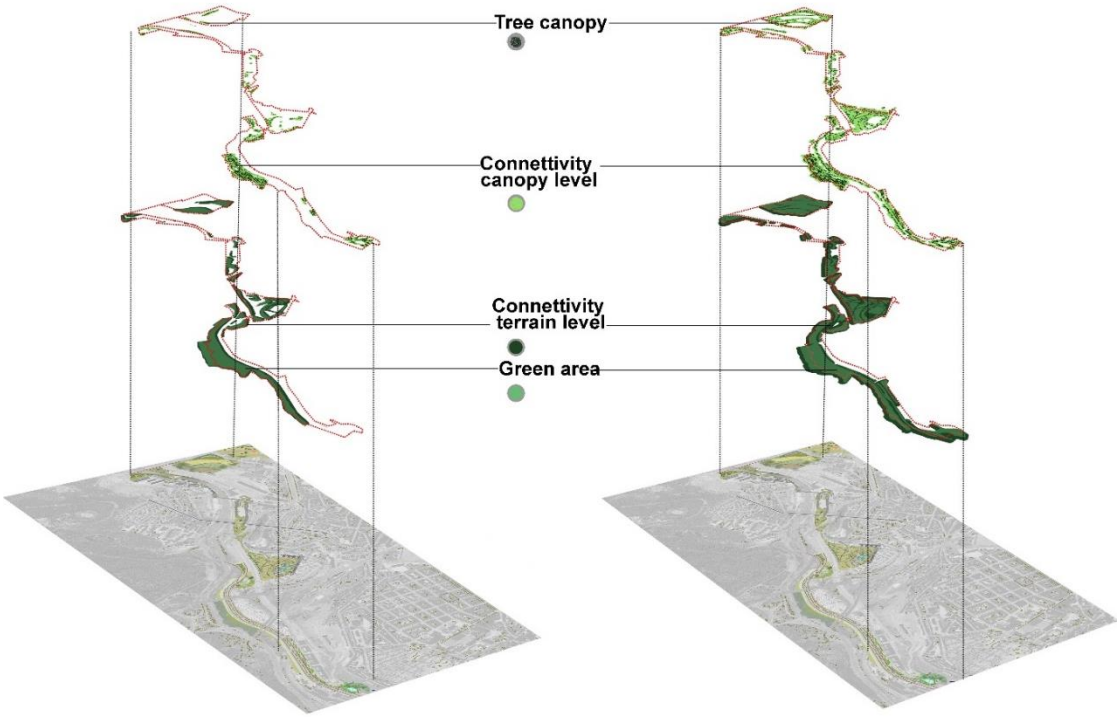


Figure 61 Comparison of the fragmentationy between 2015 and 2021. Source: personal elaboration

In this case, the intervention has generated doubled the values, in particular with a substantial increase in the connectivity of the foliage also due to the intensive planting of trees that took place also with the participation of citizens through awareness campaigns.

Figure 62 Plantng tree campain involving citizen in Vale de Alcantara. Source: CML 2015

In particular, this project was part of a wider campaign across the city of Lisbon that saw an extra boost from the recognition of Green Capital 2020, intending to arrive by 2021 at the planting of 100,000 trees throughout the city. It is important to underline how the awards that the city is achieving are very much felt on a social level, making citizens a fundamental part of this process.

Figure 63 Inclusion of citizens and raising awareness of tree planting campaigns to combat climate change. Source: CML 2015

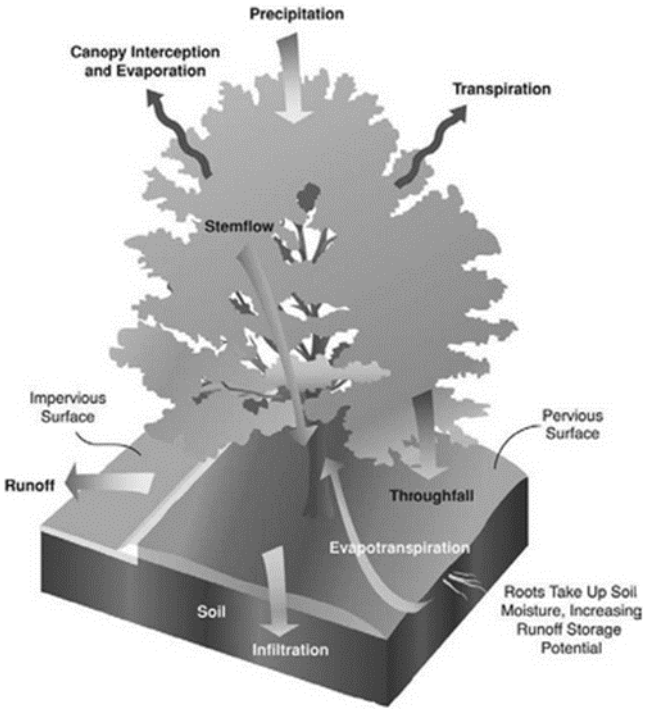


Figure 64 Schematization of the water and air cycle. Source: https://www.itreetools.org/

3.4.4.3 Water and air

Moreover regarding the trees identified and classified according to species through the geoportal of the Municipal Chamber of Lisbon, it was possible to develop some indicators on the benefits that the areas have both in terms of quality of the area and terms of water.

As for the first sector, what is defined in the table was calculated the amount of rain intercepted by

the canopy, by the branches and the amount of water runoff was avoided (stormwater runoff) by the trees. Also, in this case, both parameters show how the area has improved in water management having an increase of 55%.

Water management is a key factor for mitigation and adaptation actions to climate change, especially having analyzed future scenarios that foresee a general decrease in rainy days and a consequent drought in the hottest months but an increase in extreme rainfall and therefore would compromise the outflow of water. In response to these problems, the natural base solutions applied can help to solve or decrease some phenomena: the interventions on part of the road infrastructure in natural areas has increased the permeable surface as well as improved the infiltration for the increase of green areas and produced benefits in terms of on-site water reuse for green areas.

In addition to this, once the last segment is finished, it will be possible to make assessments in terms of load reduction and delay of the flood peak that goes to put pressure on the existing one thanks to the creation of the artificial basins provided as well as the water channel on the traffic divider to which is added the theme of phytodepuration and that of the indirect economic benefits that create an attractive environment of the area (Raymond, Berry, *et al*., 2017).

With regard to the quality of the area, the benefits that plants bring in terms of "removal", i.e. the amount of pollutants that the tree intercepts or absorbs and finally the amount of CO2 sequestered by the trees have been calculated. This last parameter is the one that had a greater incidence among all those that have been calculated from an environmental point of view, increasing by 8 times the amount of tons per year of CO2 sequestered.

Air quality is a very important issue nowadays as its consequences also affect human health. Working precisely on the improvement of the air, we intervene consequently on the reduction of GHG emissions through the removal of pollutants and the regulation of CO2.

The contribution that each tree makes in this mitigation work is limited compared to the amount of emissions produced in the cities, but if the vegetation we are talking about turns out to be included in a more extensive network, this brings with it a series of benefits that encourages the inclusion of green infrastructure in the urban system (Raymond, Berry, *et al*., 2017).

Table 11 Water and air indicators. Source: personal elaboration

INDICATOR					% incrementation
water					
intercepted runoff (m3)	2015	43356	2021	96872	**55%**
stormwater runoff (m3)	2015	7749	2021	17316	**55%**
air					
Air quality benefit (t/y)	2015	1,3	2021	2,9	**55%**
carbon sequestration (t/y)	2015	104,2	2021	832,0	**87%**

3.4.4.4 Mobility

Always related to air quality, it is possible to analyze how the project has intervened on the theme of mobility by reorganizing the area both in terms of public transport and as regards slow mobility.

Starting from the assumption that the initial situation presented a fragmented and mainly driveway mobility organization with pedestrian areas not formally recognized the project envisaged among the different objectives of creating a cycle-pedestrian continuum of about 10 km that connects the Monsanto Forest with the Tejo River.

Part of these routes was the result of a conversion of the driveway into areas for slow mobility. As far as motor roads are concerned, the number of carriageways has been reduced, one of which is used exclusively for public transport and citizens to use them, improving the service and connections with the rest of the city.

Mobility is the sector where it presents the most changes.

Table 12 Mobility indicators. Source: personal elaboration

INDICATOR					% incrementation
mobility					
cyclopedestrian path (km)	2015	3,67	2021	9,92	**63%**
of which dedicated cyclable path (km)		0		1,936	**100%**
public transport dedicated line (km)		0		3,522	**100%**

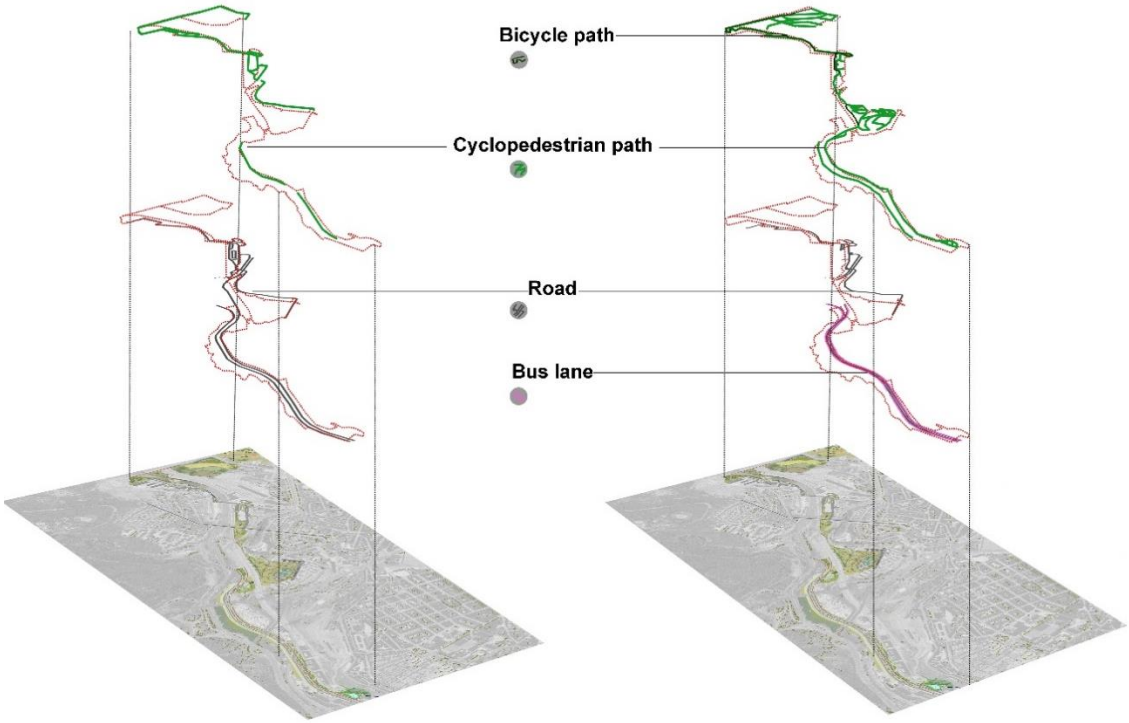


Figure 65 Comparison of the mobility organization between 2015 and 2021. Source: personal elaboration

3.4.3.5 Summing up the results

From the previous paragraph, it can be seen how significant the change of the area that part of the Alcantara Valley Corridor is has been. In all aspects, the intervention has contributed to improving all impacts by doubling all the values considered for the indicators.

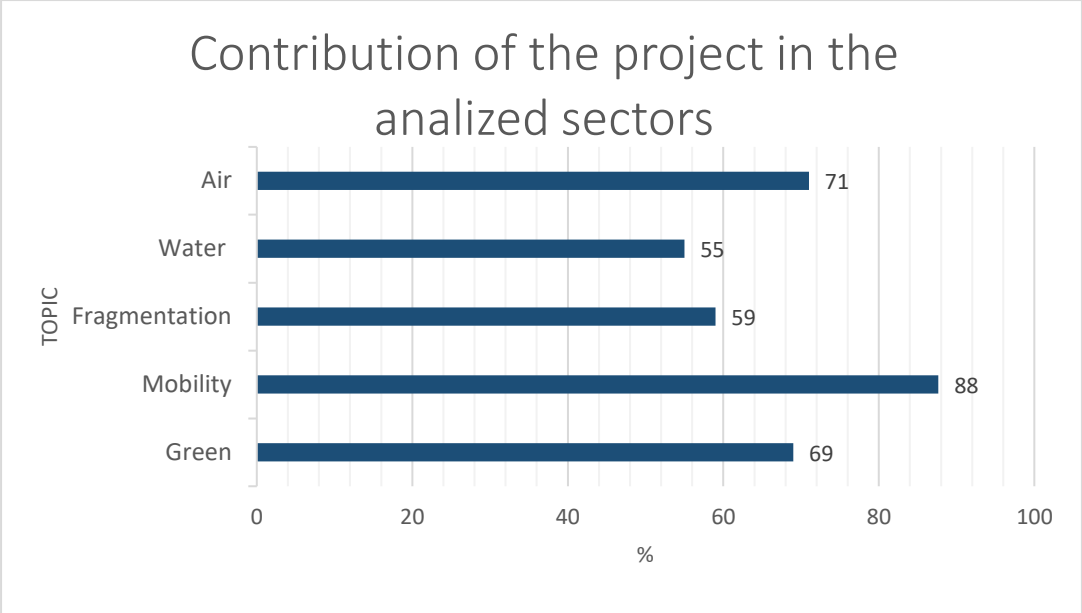


Figure 66 Summary of project accounts (expressed as percentages) in the different sectors analysed, reporting period 2015-2021. Source: Personal elaboration.

Of the 5 topics that have been identified, we note that the one that presents the most incrementation is mobility as there has been a reorganization of the road system in favour of slow mobility and the enhancement of the place through cycle and pedestrian paths that connect two characteristic points of the city.

At the level of environmental indicators, what has shown a greater impact is the quality of the air which, thanks to the increase in greenery and the planting of trees, shows a great contribution to improving the quality of the environment. This result, however, is a temporary result as a part of the project, the last segment that is not yet completed, which is focused on the use and management of water brings with it numerous indicators that could be estimated but that to date has not been possible, in particular in relation to water sensitive urban design and low impact design.

The assessment of impacts must be done through an aggregate reading of the indicators; in fact, many actions of the NBS can have direct effects on a specific challenge, but at the same time have indirect effects on other actions, in fact, the

increase in green areas or even better the planting of trees has influenced both the aspects of connectivity, air quality and also in social terms.

Although these indicators have been used to analyze the benefits they have brought to the area by making a comparison between the situation before the start of the redevelopment of the site, they bring with them relevant aspects in terms of planning and social involvement and well-being that could be considered at the end of the project, creating potential success factors. The involvement of citizens as an active part can lead to a sense of belonging and awareness of the issue and at the same time be involved in the implementation of NBS.

Not only that, the creation of green spaces contributes to the health and well-being of residents, in fact, many of the climate regulation ecosystems affect the regulation of the climate as heatwaves aggravated by the heat island effect; in the same way also the presence of trees goes to reduce the UHI effect through shading and evapotranspiration as well as environmental and noise pollution.

4 chapter CONCLUSION

4 Conclusions

4.1 Observations raised about mainstream climate change adaptation

International institutions, therefore, highlight the importance of the local level in the field of climate change interventions, stressing that adaptation actions, fundamental and at the same time urgent, must be taken at this scale as it is here that impacts are most clearly recognized and interdependencies are most recognizable. Although the adaptation strategy at the European level is working hard to emphasize the importance of intervention in this area since the mere mitigation interventions have not been detected enough for decades now, a real structured procedure and data are still missing and it is for this reason that the importance of sharing the good practices of the cities from the different countries involved is emphasized, gap and at the same time need also highlighted by the Cities and Climate Change Science Conference of 2018.

Therefore, if cities are considered one of the cornerstones of the fight against climate change enclosing in itself a great potential, we can insert local adaptation in a context of broader governance seeing a double direction between the national and local levels understood as the first can give the directives to be integrated into the lower levels and how the second can be the drive changes themselves.

And this is why international governments are developing numerous international networks for cities and are pressing a lot on the development of local climate plans, where they try to prefer LCPs that choose mainstreaming given the results that could be achieved but still weak at a practical level since today dedicated plans are still preferred, easier to put into practice in practice. At the same time, in this dissertation, the notion of resilience is emphasized, showing how this travels in parallel and with a common vision of transcalarity and intersectorality to adaptation. In particular, the push by international organizations that place on resilience, the central theme of the policies of this period, seeks to review the logic of the peace process that goes beyond the mere environmental issue but also involving related sectors, trying to rethink land use approaches more holistically.

It is therefore clear from what has just been said that Portugal is a relevant case to be discussed in terms of climate change management.

Starting from an analysis of vulnerabilities and future projections related to risks to understand what the country is facing and the awareness that the country has about the methods of intervention and management of the problem that will have repercussions with significant consequences in the coming decades, the Nation follows a planning that is based on a vertical and horizontal approach where the authorities, according to the Portuguese constitution, are required in addition to ensuring proper planning throughout the territory (Cossu, 2019-2020).

From the analysis of the structure of the organization of Portuguese territorial governance, it emerged that at the national level the theme of adaptation is well structured through the PNPOT and the National Strategy for Adaptation to Climate Change (ENAAC), the latter fundamental for the analysis and development of the topic at the levels below.

The integration at lower scales, however, is still lacking and with the need for improvement due to the lack of a complete mainstreaming process at local scales that are being finalized, but which to date is the purpose of the ClimAdaPT.Local project which aims to integrate climate adaptation options into planning tools through the creation of Local Strategy for Adaptation to Changes Climate change.

It emerged during the analysis of the work therefore that this project aimed at implementing the methodology for adaptation within the strategies has brought numerous benefits, finding itself a fundamental tool for the transposition of policies at the local level but which brings with it some gaps and limitations on some interventions for example that EMAAC identifies the most appropriate adaptation options which, however, vary from case to case but lack the localization of critical points and interventions that are up to the municipality to implement. It, therefore, emerges as fundamental the collaboration and alignment between the different bodies both vertically and horizontally since already at the base there is an uneven situation between the different municipalities.

The case of Lisbon turns out to be a more than relevant case to be analyzed in this logical thread that goes from the study on an international scale to the local one, since the città in addition to having achieved numerous results in the field of change, is part of an international network and therefore takes up well what was said in the

introduction, helping to be a figure of important support in the network of cities, to the correction of the lack of data previously discussed and sharing good practices especially in the field of green. The city in fact, as we have seen, establishes a medium-term strategic vision by setting an action plan that prepares the city to achieve climate resilience by 2050.

Lisbon working a lot on the green, and here on justifies the reason why it has actually gone to analyze a Green Corridor as a case study, has increased by about 20% the green infrastructures present in the territory in the last 15 years, bringing with it important consequences also on transversal factors going to improve the quality of life of people and acting at the same time a powerful attractor towards the City: All this has contributed to the recognition of Lisbon as the Green Capital 2020.

After an analysis of the operating system of the Lisbon structure in the field of adaptation to climate change, the focus of the second part of the thesis focused on an attempt to put into practice what was discussed, building a sort of feedback for projects not directly related to climate change but that nevertheless relate to the strategies, with the awareness that it was not an explicit link but an attempt to build a circularity between strategies and projects through the selection of some indicators.

The effort to put into practice the theoretical strategies assuming that a project with thematic proximity can be a project that contributes to climate change has led to understanding that there is a double-speed between what are the strategies and actions lacking an effective monitoring and verification system, in fact starting from the availability of some data on which to build indicators has led to limitations during the analyzes. This case was therefore a reconfirmation of what was said in the first chapter having a clear experience of how a limitation of data can compromise or at least limit some types of analysis, unlike the more theoretical part where the comparison of the policies of strategies and actions was well connected consequently showing a desalinizing of strategies and actions very common in many other countries.

In conclusion, it is possible to say that Lisbon is a climate-proof city, a statement that can be supported by the fact that starting from 2012 with the entry into force of the current PDM, revised starting from 2008, the city began to have a different approach to planning, more holistically, focusing on land use, high density of buildings and relocation of some buildings outside the so-called sensitive areas, under the necessity to face problems of strong urban sprawl occurred starting from the 70s and also a car-

centric policy throughout the Metropolitan area, a lack of public spaces and ecological structures (PAC 2030, 2021). The revision of this plan, which since its entry into force begins to introduce climate change measures across the board in the resolution of its planning problems, have been the basis for the creation of an adaptation strategy. In fact, the city found itself in 2017 to have a solid base on which to lean for the development of its adaptation strategy, a very substantial “heritage” supported by a local plan that starting from five years before has anticipated the part of the measures on climate and that aimed to include within it a sustainable vision trying to solve problems related to the extreme phenomena that the city was subject to.

Lisbon, therefore, started from the resolution of specific problems such as the safeguarding of the most sensitive ecological structures and biodiversity, land consumption, the regularization of the urban cycle of water and floods (Camera Municipal de Lisboa, 2020) through specific programs that already within them were indirectly measures that were already part of the branch of climate change and that intertwined with each other contribute to combating climate change, bringing obvious adaptation benefits. All the programs and actions that you can see from the image below have led to the need to be organized and integrated under a strategic line equal to the whole city and allowing to create the right mechanisms to favour transversality.

Figure 67 Timeline of the main plans and programs before 2017 Adaptation strategy. Source: CML 2020

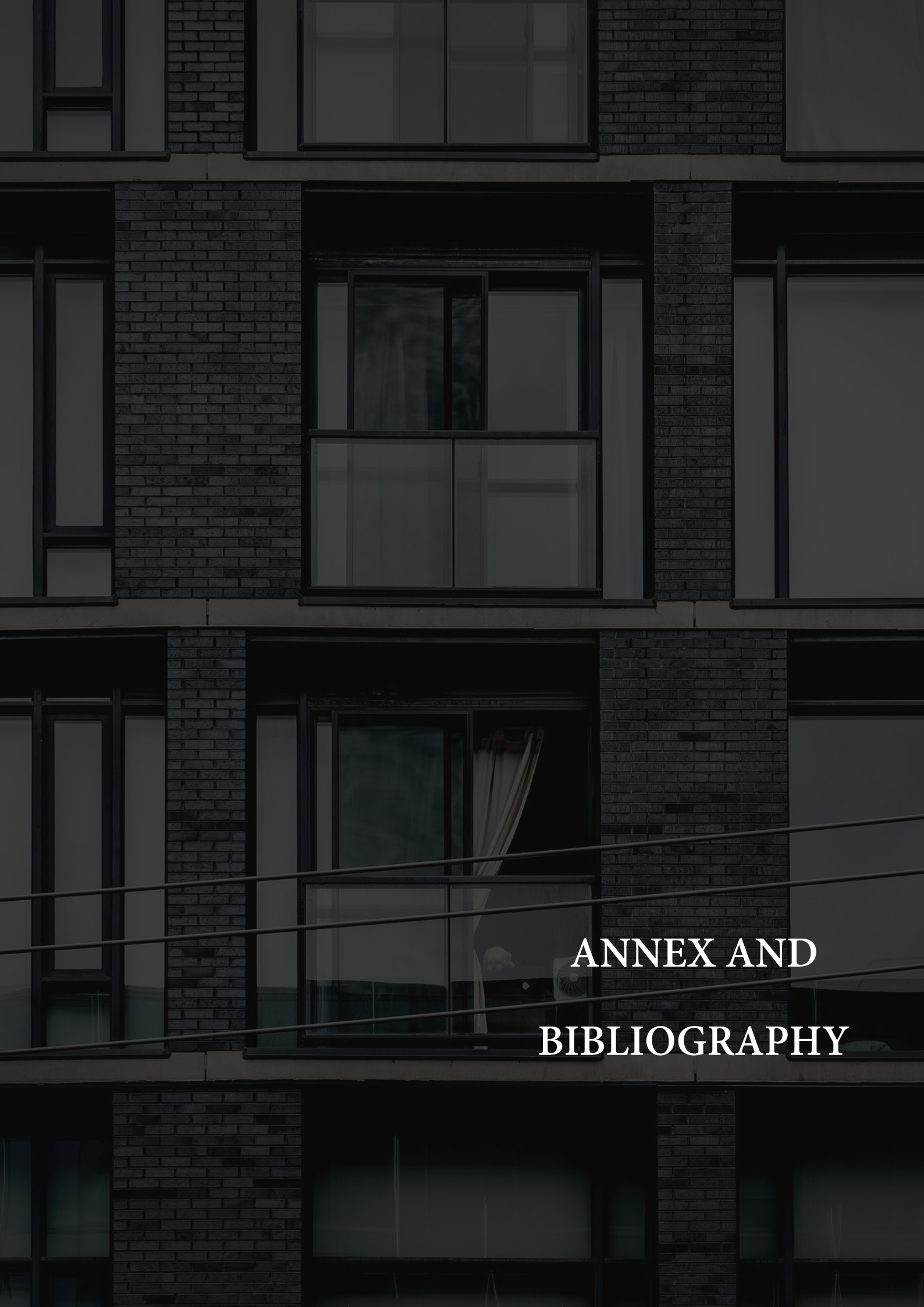
As a natural continuation of this marked attention to environmental issues already included in the planning, the city has turned, in line with the European strategy of 2013, to respond to climate adaptation policies through its previous experience, not making it become a real sector policy but integrating it into the various areas.

Figure 68 Sectoral measures and objectives of Lisbon. Source:PAC 2030

What has just been said has been supported by the need to integrate more into ordinary planning through a support methodology to which the city has been working for some time trying to finalize it as best as possible and making it as concrete as possible.

It is a city that is moving towards a need for mainstreaming in which the theme introduced by the European strategy of 2013 is becoming a reality.

In line with the studies done in the field and with the results that have emerged, it is therefore essential to work at the local level given the potential impact that these interventions have in such an uncertain and constantly changing period, as if it were a race against time to try to offer generations to come a future with totally compromise but still able to change. Despite the great progress in this field, it is still essential to focus a lot of energy on this work process, on process but still to improve, because if the part of policies is well structured, mainstream adaptation is fundamental to achieve concrete improvements.



ANNEX AND BIBLIOGRAPHY

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AXE		INTERVENTION	EVENT TO RESPOND VIA EACH OPTION				TYPE			SCOPE			TERM			
							Gray Infrast.	Green Infrast.	Non-Structural Options	Improve Adaptive Capacity	Decrease Vulnerability	Take Opportunities	Ongoing	Short	Medium	Long
A: Adapting the city to climate change: benefiting from the water and adapting the territory	A,1,1	Articulate with AML to integrate adaptation into Planning and Management Instruments	●	●		●			●	●	●	●				O
	A,1,2	Develop a Hydrogeological Resource Charter, including registration of underground structures	●						●		●	●				O
	A,1,3	Take a thermographic photography of the city		●					●	●						S
	A,1,4	Study the effects of cold and hot weather climate events on the most vulnerable population groups		●					●	●	●	●				S
	A,1,5	Evaluate non-adaptation costs: cost-benefit analysis	●	●	●	●			●		●	●				S-M
	A,1,6	Study stormsurge / tide rise event and adapt riverside front			●	●			●	●	●	●				S
	A,1,7	Reassess Risk Exposure Chart taking into account cascading events	●	●	●	●			●		●	●				S
	A,1,8	Provide public space with stormwater control solutions	●				●	●		●	●	●				O
	A,1,9	Introduce measures to increase the passive resilience of the building through bioclimatic design, new construction or rehabilitation		●			●	●		●						O
	A,1,10	Increase knowledge of the renewable energy application adapted to the urban morphology in climate change scenario		●					●	●						S-M
	A,1,11	Integrate the sustainable urban mobility model into the various IGT scales	●	●	●	●	●	●	●		●	●				S-M
	A,1,12	Adopt land-use policies that favor ecological potential	●	●			●	●		●	●	●				O

AXE		INTERVENTION	EVENT TO RESPOND VIA EACH OPTION				TYPE			SCOPE			TERM	
							Gray Infrast.	Green Infrast.	Non-Structural Options	Improve Adaptive Capacity	Decrease Vulnerability	Take Opportunities	Ongoing	Short Medium Long
B: Promoting smart and integrated management for a more resilient city	B,1,1	Adopting a management Green Infrastructure adapted to the new climate scenarios	●	●				●		●				O
	B,1,2	Adapting public space and green space management to the water cycle, including source control solutions and articulation with PGDL at local level.	●				●	●		●	●	●		O
	B,1,3	Revise normative and regulation of the occupation of public roads due to the intensification of storms of heavy rain and strong wind / gusts.	●		●				●		●	●		S
	B,1,4	Adapt precarious structures, street furniture and signs against the strong wind			●			●		●	●	●		S-M
	B,1,5	Promote the resilience of the municipal building in new construction and rehabilitation	●	●			●			●	●	●		M
	B,1,6	Ensure the transversality of access to information in the municipality, through the articulation of databases and the dematerialization of communication.	●	●	●	●			●	●	●	●		O
	B,1,7	Articular a recolha e o registo de dados com entidades externas	●	●	●	●			●		●	●		O
	B,1,8	Manage land occupation in order to increase occupation by naturalized spaces	●	●			●	●		●	●	●		O
	B,1,9	Supplement municipal budget with external funding	●	●	●	●			●	●	●	●		O

AXE		INTERVENTION	EVENT TO RESPOND VIA EACH OPTION				TYPE			SCOPE			TERM	
							Gray Infrast.	Green Infrast.	Non-Structural Options	Improve Adaptive Capacity	Decrease Vulnerability	Take Opportunities	Ongoing Short	Medium Long
C: Involving the community through participatory citizenship while promoting collective empowerment	C,1,1	Promote dissemination and awareness actions to: "enjoy" water, prepare for heat and shelter from the wind	●	●	●	●			●	●	●	●		S-M-L
	C,1,2	Organize programs for the involvement of KEY ACTORS, with emphasis on Parish Councils, in the implementation of an integrated management model.	●	●	●	●			●	●	●	●		S
	C,1,3	Empower the community to prevent and respond to extreme weather events	●	●	●	●			●	●	●	●		S-M-L
	C,1,4	Organize awareness campaigns for concrete adaptation actions	●						●	●	●	●		S-M-L
	C,1,5	Foster interaction and technical exchanges between the municipalities of AML.	●	●	●	●			●	●	●	●		S-M-L
	C,1,6	Foster interaction and technical exchange across the city	●	●	●	●			●	●	●	●		S-M-L
	C,1,7	Operationalize programs and actions to encourage adaptation	●	●	●	●			●	●	●	●		S-M-L
	C,1,8	Promote and provide technical support for building resilience (new construction and rehabilitation)	●	●					●	●	●	●		S-M-L
	C,1,9	Implement technical training for action through SMART technology tools	●	●	●	●			●	●	●	●		S-M-L

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7 List of Abbreviations and Acronyms

- ADAM Decision Support in Municipal Adaptation (Apoio à Decisão em Adaptação Municipal)
- AML Lisbon Metropolitan Area (Área Metropolitana de Lisboa)
- ANMP National Association of Portuguese Municipalities (Associação Nacional de Municípios Portugueses)
- APA Portuguese Environment Agency (*Agência Portuguesa do Ambiente*)
- CEDRU Centre for Studies and Urban and Regional Development (Centro De Estudos E Desenvolvimento Regional E Urbano)
- *CIAAC* Commission for Air and Climate Change
- CML Lisbon City Council (Câmara Municipal de Lisboa)
- EEA European Environment Agency
- EMAAC Municipal Strategy of Adaptation to Climate Change (*Estratégia Municipal de Adaptação às Alterações)*
- ENAAC National Strategy on Adaptation to Climate Change (*Estratégia Nacional de Adaptação às Alterações)*
- ETAR Wastewater Treatment Plant (*Estação de Tratamento de Águas Residuais*)
- EU European Union
- ICLEI Local Governments for Sustainability
- IGT Territorial management tools (*Instrumentos De Gestão Territorial*)
- IPCC Intergovernmental Panel on Climate Change
- IPMA Portuguese Institute of the Sea and Atmosphere (*Instituto Português do Mar e da Atmosfera)*
- LCPs local climate plans
- NAP National Adaptation Plan
- NAS National Adaptation Strategy
- NBS nature based solutions
- NUTS Nomenclature of Territorial Units for Statistics
- PDM Municipal Director Plan (*Plano Diretor Municipal*)
- PIC-L Local Climate Impact Profile
- PIMOT Intermunicipal Spatial Plan (*Plano intermunicipal de Ordenamento do Território*)

- PMAAC Metropolitan Plan of Adaptation to Climate Change (*Plano Metropolitano de Adaptação às Alterações)*
- PMAAC Municipal Plan of Adaptation to Climate Change (*Plano Municipal de Adaptação às Alterações Climáticas)*
- PMOT Municipal Spatial Plans (*Planos Municipais de Ordenamento do Território*)
- PNAC National Climate Change Programme
- PNPOT National Spatial Planning Policy Programme (*Programa Nacional da Política de Ordenamento do Território*)
- PP Detail Plan (*Plano de Pormenor*)
- PROT Regional Spatial Programme (*Programa Regional de Ordenamento do Território*)
- PRR Recovery and resilience plan (Plano de Recuoer e Resiliencia)
- PU Urbanisation Plan (*Plano de Urbanização*)
- RAA Autonomous Region Azores (*Região Autónoma dos Açores*)
- RAM Autonomous Region of Madeira (*Região Autónoma da Madeira)*
- RCP Representative Concentration Pathway
- RJIGT Legal Regime of Spatial Planning Tools (*Regime Jurídico dos Instrumentos de Gestão Territorial*)
- SDG Sustainable Development Goal
- SIAM Climate Change in Portugal. Scenarios, Impacts and Adaptation Measures - SIAM Project
- UAG Urban Allotment Garden
- UKCIP UK Climate Impacts Programme
- UNFCCC United Nations Framework Convention on Climate Change

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