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D1.2 – Report on existing long-term resilience visions and adaptation solutions in the pilot areas

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Executive summary

The deliverable *D1.2 – Report on existing long-term resilience visions and adaptation solutions in the pilot areas* examines the regulatory frameworks related to urban resilience in Portugal, Slovakia, and Estonia at both regional, municipal, and local levels. It also examines the key drivers and barriers to improve the resilience of buildings and infrastructure across the three RETIME pilot sites (Lisbon, Žilina, and Tartu). Using data on urban multi-risk resilience assessment and first-hand stakeholder data, D1.2 addresses the analyses of how three pilot areas are benefitting from current adaptation solutions either proposed to citizens or implemented by public authorities, at each pilot site, in programmes or initiatives.

For each site-specific hazard scenario in the three pilot areas (Lisbon, Žilina, and Tartu), this report identifies vulnerabilities, resilience, robustness, and recovery capacities. Preliminary recommendations and policy briefs for the three RETIME pilot sites are also included, offering potential pathways for integrating existing long-term resilience visions at both regional and local levels.

This report is intended for policy-and-decision-makers, building users, owners, managers in the three pilot sites, environmental practitioners, industrial stakeholders, SMEs, the research community, and members of other RETIME EU sister projects.

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List of acronyms and abbreviations

ANEPC	Autoridade Nacional de Emergência e Proteção Civil [in Portugal] I National Authority for Emergency and Civil Protection
APA	Agência Portuguesa do Ambiente I Portuguese Environment Agency
BIM	Building Information Modelling
CML	Câmara Municipal de Lisboa I Lisbon Town Council
CPSA	Conselho Português para a Saúde e Ambiente I Portuguese Council for Health and Environment
DSS	Decision Support System
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EC	European Commission
EU	European Union
GHG	Greenhouse Gas
GIS	Geographic Information System
HBIM	Heritage Building Information Modelling
HIRV	Hazard Impact Risk Vulnerability
LMA	Lisbon Metropolitan Area
MCR2030	Making Cities Resilient 2030
NECP	National Energy and Climate Plan
NGO	Non-governmental organisation
NZEB	Nearly Zero-Energy Building
NUTS	Nomenclature of territorial units for statistics
OSH	Occupational safety and health
KURS	Koncepcia územného rozvoja Slovenska I Slovak Spatial Development Perspective
UHIE	Urban Heat Island Effect
UCPM	Union Civil Protection Mechanism
UNDRR	United Nations Office for Disaster Risk Reduction
PAC	Plano de Ação Climática I Lisbon Climate Action Plan
PNPOT	Programa Nacional da Política de Ordenamento do Território I National Spatial Policy Programme
SECAP	Sustainable Energy and Climate Action Plan
SFDRR	Sendai Framework for Disaster Risk Reduction
STAK	Sisekaitse arengukava I Internal Security Development Plan
SDG	Sustainable Development Goal
ZER	Reduced Emission Zone
ŽC	City of Žilina
ŽSK	Žilina Self-Governing Region

1. Introduction

This deliverable, *D1.2 – Report on existing long-term resilience visions and adaptation solutions in the pilot areas*, outlines the regulatory frameworks governing urban resilience in Portugal, Slovakia, and Estonia at various scales. It outlines the public institutions responsible for decision-making in Disaster Risk Management (DRM) and Disaster Risk Reduction (DRR), with a focus on resilience visions and adaptation solutions to enhance the resilience of buildings and infrastructures at the local and regional levels. Key drivers and barriers to enhancing the resilience of buildings and infrastructure are examined in the three RETIME pilot sites (Lisbon, Žilina, and Tartu) to provide a basis for analysing current policy briefs and integrating existing long-term resilience visions at both regional and local levels.

This document is structured into six sections. *Section 2* identifies the urban governance structure and the civil protection system in the RETIME pilot sites.

Section 3 provides an overview of current plans and priorities for civil protection emergencies, as well as climate change adaptation and mitigation plans. It also highlights the key public long-term initiatives and relevant EU-funded projects, both ongoing and planned, along with the corresponding adaptation solutions for each site-specific hazard scenario across the three pilot sites. This is not an exhaustive list of initiatives but highlights key directions and core visions to support the design, monitoring, and management of adaptation strategies in the built environment at both district and individual levels.

Section 4 outlines key opportunities identified through two main activities carried out in 2024 and 2025 by the RETIME consortium members: i) the urban multi-risk assessment and ii) the analysis of stakeholder input from co-design and engagement activities.[1]

Section 5 provides a comprehensive analysis of the key drivers and enablers to urban resilience across RETIME pilot sites at regional and local level to enhance the resilience of buildings and infrastructures. Finally, a preliminary overview of recommendations and policy briefs is outlined in *Section 6*, based on the key dimensions of urban resilience outlined in the City Resilience Framework by The Rockefeller Foundation (2015).

[1] The urban multi-risk assessment was previously developed within the RETIME project under task *T1.1 - Urban multi-risk resilience assessment approaches and methodologies*, while the stakeholder and co-design engagement activities were conducted during the first year of the project under tasks *T2.1 - Analysis of socio-economic contexts, identification of vulnerable groups, and stakeholder mapping at pilot sites* and *T2.2 - Design of the stakeholder engagement and co-design strategy*.

1.1. Interrelated RETIME deliverables

The deliverable *D1.2 – Report on existing long-term resilience visions and adaptation solutions in the pilot areas* explores three core aspects critical to urban resilience in the RETIME pilot areas: i) the regulatory frameworks; ii) enablers, and barriers influencing adaptation site-specific hazard scenarios; and iii) building vulnerability. These key topics and their interconnections with other RETIME deliverables are shown in Figure 1. As a basis for assessing the effectiveness of the project RETIME solutions, the insight gathered in this report will be further utilised in the design and implementation of the RETIME solutions. The analysis of existing long-term resilience visions and adaptation solutions in the pilot areas forms the basis for a strategic and tactical, site-specific demonstration plan tailored to meet the needs of vulnerable groups. This plan will be developed using structured methods and steps, scenarios, and implementation pathways, outlined through a roadmap of adaptation strategies for the three pilot areas.[2] Comprehensive guidelines and policy instruments will be developed within the project RETIME to effectively implement the adaptation roadmaps on the pilots based on innovative business models, ensuring the resilience of the project extends beyond its timeframe. This also may facilitate the upscaling and adaptation of the proposed solutions at other sites across Europe.

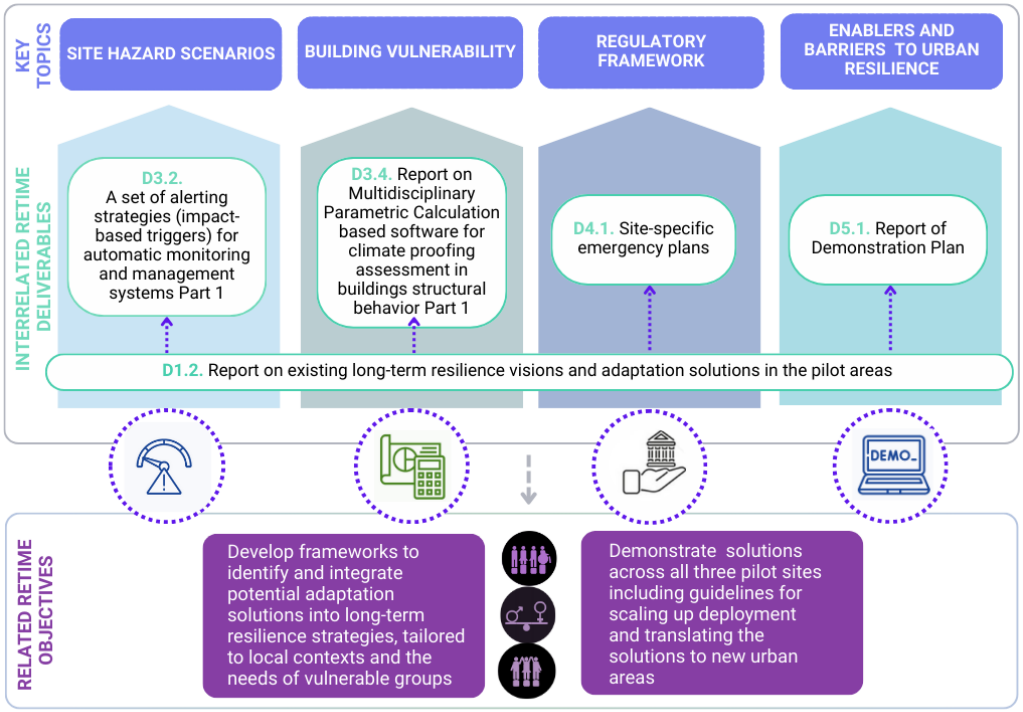


Figure 1. Contents of this report (D1.2) and interrelated RETIME deliverables.

[2] Specifically, the demonstration plan, the demonstration of solutions in three pilot areas, and the impact assessment and cost/benefit analysis of the demonstrations will be carried out within the project RETIME under Work Package 5 (from Month 13 of the project to Month 48, May 2025 to April 2028).

2. Urban governance structure and the civil protection system in RETIME pilot sites

2.1. A brief introduction to urban resilience in Disaster Risk Reduction

"Resilience focuses on enhancing the performance of a system in the face of multiple hazards, rather than preventing or mitigating the loss of assets due to specific events" (The Rockefeller Foundation, 2015, pg. 3). To assess urban resilience, several multi-dimensional frameworks using interdependent indicators have been developed (UNISDR, 2012; Desouza & Flanery, 2013; Manca et al., 2017; Saja et al., 2019). One of the most comprehensive frameworks developed by the Rockefeller Foundation & Arup (2016) evaluates resilience across four key dimensions:

i) health and wellbeing
ii) economy and society
iii) infrastructure and environment
iv) leadership and strategy

These are assessed through 52 indicators and 156 qualitative and quantitative questions. The framework emphasises context-specific priorities and defines resilience through characteristics like robustness, flexibility, inclusivity, and integration.

Section 2.2 outlines how emergency management structures and plans are organised in Portugal, Slovakia, and Estonia across various administrative and operational levels. As the first line of defence in emergencies, these systems play a vital role in urban resilience by coordinating human and infrastructural resources. Their effectiveness underscores the importance of strong leadership, cohesive management, and integrated development planning to reduce the impacts of natural, human-made, and hybrid emergencies, while also supporting the implementation of effective climate adaptation solutions. A brief overview of the opportunity analysis related to these systems is then provided in *Section 4.1*.

2.2. Key bodies involved in crisis management in Portugal

The National Civil Protection System in Portugal is structured across four territorial levels (national, regional, district, and local) and is based on three key dimensions: management, coordination, and operation (Figure 2). Mainland Portugal is administratively divided into districts.[3] The civil protection system, coordinated nationally by the Autoridade Nacional de Emergência e Proteção Civil (ANEPC), is divided into 26 sub-regions (NUTS III level, 24 in

[3] Madeira and the Azores are Autonomous Regions, which have their specific administrative statutes, making them the only official regions with administrative autonomy in Portugal. The regional legislative framework, particularly in civil protection, applies exclusively to these islands, not to mainland Portugal.

mainland Portugal and 2 in the Autonomous Archipelagos Regions), 308 municipalities (278 in mainland Portugal and 30 in the Autonomous Archipelagos Regions).

At the top of the management structure sits the political authority, which, at the municipal level is delegated to the mayor. Civil protection commissions serve as support and advisory bodies for political coordination, offering a framework for political leaders. Additionally, operational coordination centres manage tactical-level coordination within an institutional and operational framework. At the municipal level, these centres are overseen by a municipal civil protection coordinator, supported by the respective municipal civil protection service. The operational level is ensured by the actions of operational commands, distributed across the mentioned four territorial levels of the state's administrative structure. This includes civil protection agents such as firefighters, security forces, the armed forces, maritime and airport authorities, and forestry sappers, with support from the Portuguese Red Cross.

In Lisbon, the municipal civil protection system consists of the Municipal Civil Protection Service, the Fire Brigade Regiment, and the Municipal Police. Under the authority of the mayor, these entities form what is known as the security department. At municipal level, the integrated collaborative governance model illustrated led by the Lisbon City Council (Câmara Municipal de Lisboa, CML, hereafter), the Parish Council, and various local associations, promote an integrated approach to improving neighbourhood living conditions while also strengthening social ties and civic engagement.

CML plays a vital role in urban governance and management, overseeing initiatives aimed at enhancing quality of life, accessibility, and development across all neighbourhoods within its jurisdiction. Through the Municipal Maintenance and Conservation Directorate (Direcção Municipal de Manutenção e Conservação, DMMC), CML manages urban infrastructure, a key element in ensuring residents' well-being. In terms of urban data management, CML works in close collaboration with key entities such as the Lisbon Urban Information Centre (Centro de Informação Urbana de Lisboa, CIUL) and municipal companies, among which Gebalis is particularly relevant for the pilot site. These organisations provide essential data to plan and execute public space development, fostering social integration and neighbourhood sustainability.

Lisbon has defined 86 emergency meeting points,[4] which are safe locations for the population during major disasters (e.g., earthquakes, tsunamis, fires, and floods). These sites serve as temporary shelters where people await assistance from civil protection authorities and collaborating entities before relocation to a Population Support Zone (ZCAP- Zona de Concentração e Apoio à População). These points were selected based on safety and accessibility criteria and can accommodate more than 600,000 people (CML, 2024). Another

[4] https://www.lisboa.pt/temas/seguranca-e-prevencao/protecao-civil/planeamento-de-emergencia/pontos-de-encontro

important public awareness initiative was the evacuation drill, including the activation of the alarm signal, which took place in Lisbon's historic city centre – a major tourist area – between *Cais das Colunas* and *Praça D. Pedro IV*, the designated assembly point. The exercise was held on 1 March 2024 as part of the International Civil Protection Day activities.[5] This warning system, which includes sirens and digital displays (mupis), informs the public about safe locations to go to in the event of an alert, such as in case of a tsunami.

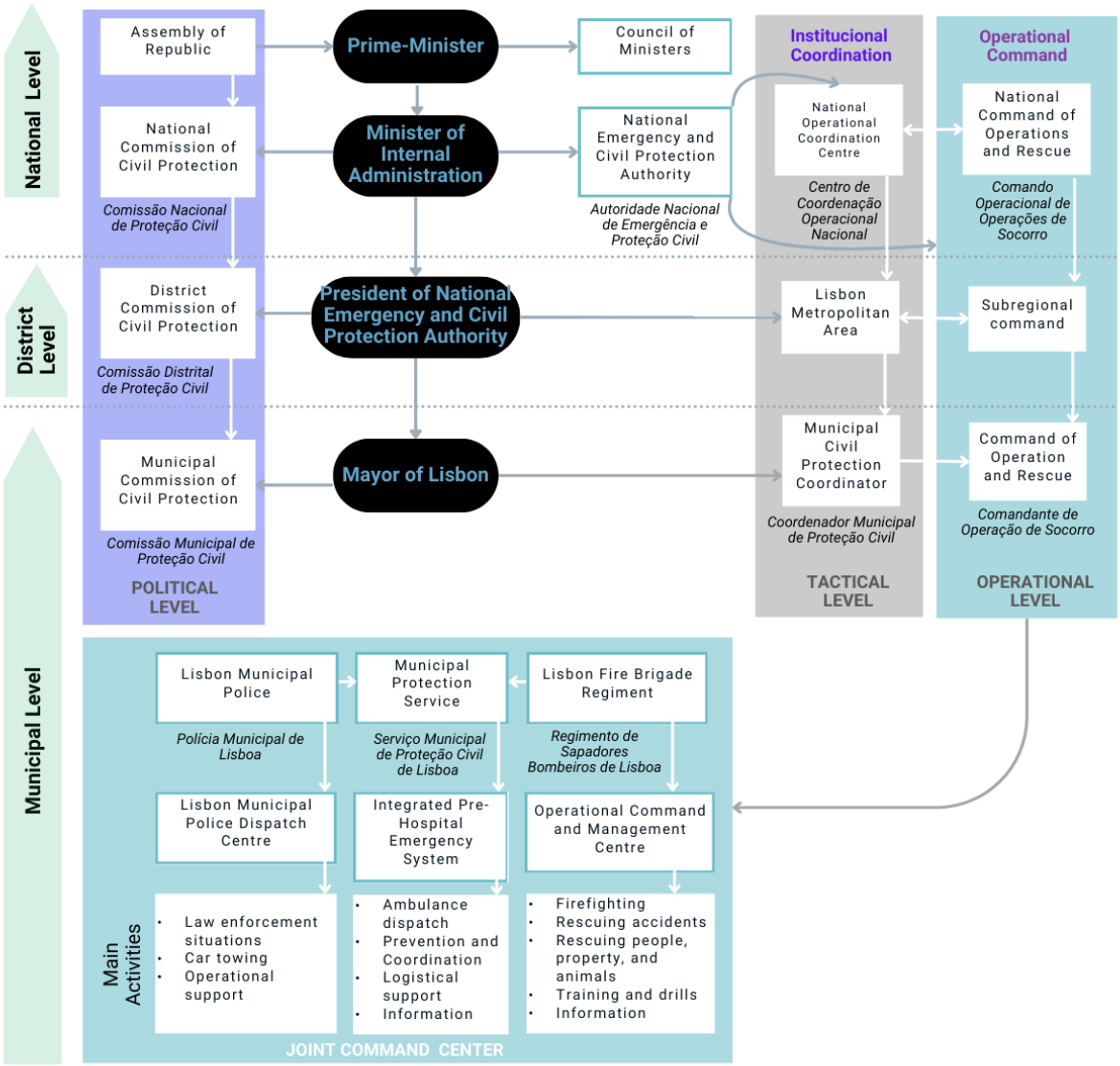


Figure 2. Governance structure related to crisis emergency management in Portugal.

[5] https://informacao.lisboa.pt/noticias/detalhe/baixa-de-lisboa-tem-novo-sistema-de-alerta-de-tsunami

2.3. Overview of legislative planning in Portugal and in *Bairro da Boavista*

In Portugal, the spatial planning policy is structured across national, regional, and municipal levels, following a hierarchical sequence, as shown in Figure 3, beginning with directives set by central government, and cascading down through all levels of public administration, including district, municipal, and local authorities. There is a strong connection between climate change adaptation and mitigation strategies and spatial planning policies, integrating both strategic planning and the more tactical and operational aspects of implementation. These processes extend through all levels of government, with the corresponding plans outlined in *Section 3.1.1*, with impacts at the local level, including *Bairro da Boavista* (in bold, Figure 3).

Three of the most significant instruments governing territorial management at national and municipal levels are the *National Spatial Policy Programme* (*PNPOT- Programa Nacional da Política de Ordenamento do Território*),[6] the *Regional Spatial Plan for the Lisbon Metropolitan Area (LMA)*, and the *Lisbon Municipal Master Plan*. While the first sets national priorities and constraints, the second ensures regional coordination, and the third defines strategic actions and priorities at the municipal level. Together, these plans provide a comprehensive planning framework that balances infrastructure and service improvement, sectoral growth, environmental sustainability, and social well-being across different scales.

The PNPOT is the highest-level instrument related to the territorial development in Portugal, providing strategic guidelines for land use, urban growth, and environmental sustainability. It serves as a reference for regional and municipal planning, ensuring that local strategies align with national priorities. It establishes overarching principles and objectives to ensure consistency and coordination across the country and across different levels of land planning. Key priorities in PNPOT include enhancing economic competitiveness, promoting social cohesion, fostering environmental sustainability, and improving spatial justice (Assembleia da República, 2019).

At the regional level, the *Regional Spatial Plan for the LMA*[7] (Presidência do Conselho de Ministros, 2002) is a strategic document guiding land use and development (in Portugal known as PROT-AML). Revised in 2008, PROT-AML seeks to harmonise urban expansion, transport networks, environmental conservation, and economic activity across the region's municipalities. The PROT-AML plays a critical role in balancing urban density and green spaces, ensuring infrastructure development meets the needs of a growing population while maintaining sustainability.

[6] In 2016-2018, the PNPOT, originally approved in 2007, was revised (Assembleia da República, 2019) to be aligned with the new action programme for Horizon 2030 (Assembleia da República, 2019).
[7] *Plano Regional de Ordenamento do Território da Área Metropolitana de Lisboa*

At the municipal level, the *Lisbon Municipal Master Plan* (CML, 2012) defines land use regulations, zoning policies, and urban development guidelines for Lisbon municipality. This master plan establishes different land classifications (urban, rural, and protected areas) and sets the framework for future infrastructure, housing, and commercial developments. It also incorporates measures for environmental protection, resilience to climate change, and heritage conservation, ensuring that Lisbon's growth is both dynamic and sustainable.

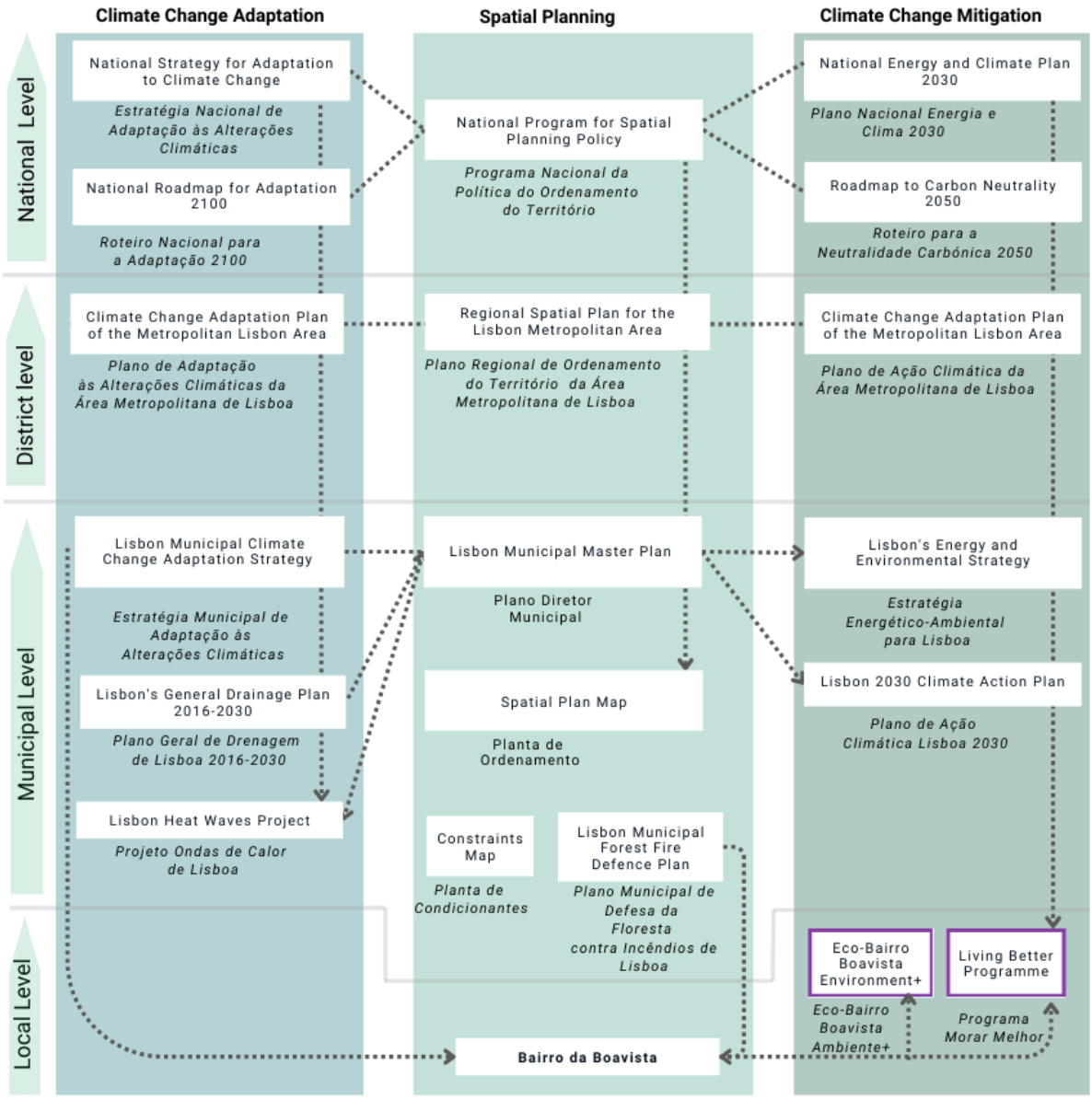


Figure 3. Multi-level legislative framework for climate mitigation and adaptation in Portugal.

The two key strategic plans, the *Estratégia Nacional de Adaptação às Alterações Climáticas* (ENAAC) and the *Plano Metropolitano de Adaptação às Alterações Climáticas* (PMAAC), aim to define climate adaptation actions in Portugal. ENAAC defines the national framework, while PMAAC focuses on implementing adaptation strategies at metropolitan scale, including LMA.
Besides key governing bodies (Figure 2), other stakeholders play a relevant operational role in achieving the objectives indicated in Figure 3. *Eco-Districts* association are developing innovative projects to enhance sustainability and energy efficiency, fostering resilient neighborhoods equipped for future environmental and social challenges. Local associations, such as the *Associação Recreativa de Moradores e Amigos do Bairro da Boavista*, the *Associação de Reformados e Idosos*, the *Centro de Acolhimento Infantil*, and the *Clube Social e Desportivo do Bairro*, foster social cohesion and enhance residents' well-being, with an emphasis on inclusion and community development. Meanwhile, the Monsanto Health Unit, ensures access to basic healthcare for the *Boavista* neighbourhood community.

2.4. Key bodies involved in crisis management in Slovakia

At the national level, the Assembly of the Republic, and the Minister of the Interior play key roles, the latter heading to the National Commission for Civil Protection in case of emergency events exceeding the multiple territories. The Minister of the Interior convenes the National Commission for Civil Protection, which includes other ministers, representatives of rescue services, and various state administrative bodies. Figure 4 shows emergency and land-use planning responsibilities in the Slovak Republic.
At the district level, the Žilina Crisis Management Department coordinates activities and reports to both national and municipal levels. Its primary function is to process risk analyses for the district and coordinate municipalities and city districts in their preparation.
Municipal-level cooperation involves the mayor, the head or of self-governing region, and the Integrated Rescue System (police, firefighters, emergency medical services),[8] all reporting to and cooperating with the Žilina District department; the region's departments also report and coordinate with this department. Zástranie is a part of the Žilina city, therefore it is not an independent municipality. Effective coordination and communication rely on top-down instructions and bottom-up reporting, all overseen by a central crisis command centre. This centre gathers information from all levels and ensures a coordinated response through the institutional integration of various ministries and agencies. The Police units have a special role within the Integrated Rescue System, providing immediate assistance help for citizens in crisis situations. Legal entities, civic associations, and organisations involved in aiding, rescue activities, or humanitarian work also operate within the Integrated Rescue System as other

[8] The Integrated Rescue System includes the Fire and Rescue Service, emergency medical service providers, civil protection chemical control laboratories, the Mountain Rescue Service, and the Mining Rescue Service.

rescue components. The core of the Integrated Rescue System's organisational infrastructure consists of coordination centres located in the regions of Slovakia (eight in total).
The Office of the Chief Architect's Division coordinates spatial planning and urban-architectural activities, prepares documents for the planning and city development,[9] and gathers key territorial information.

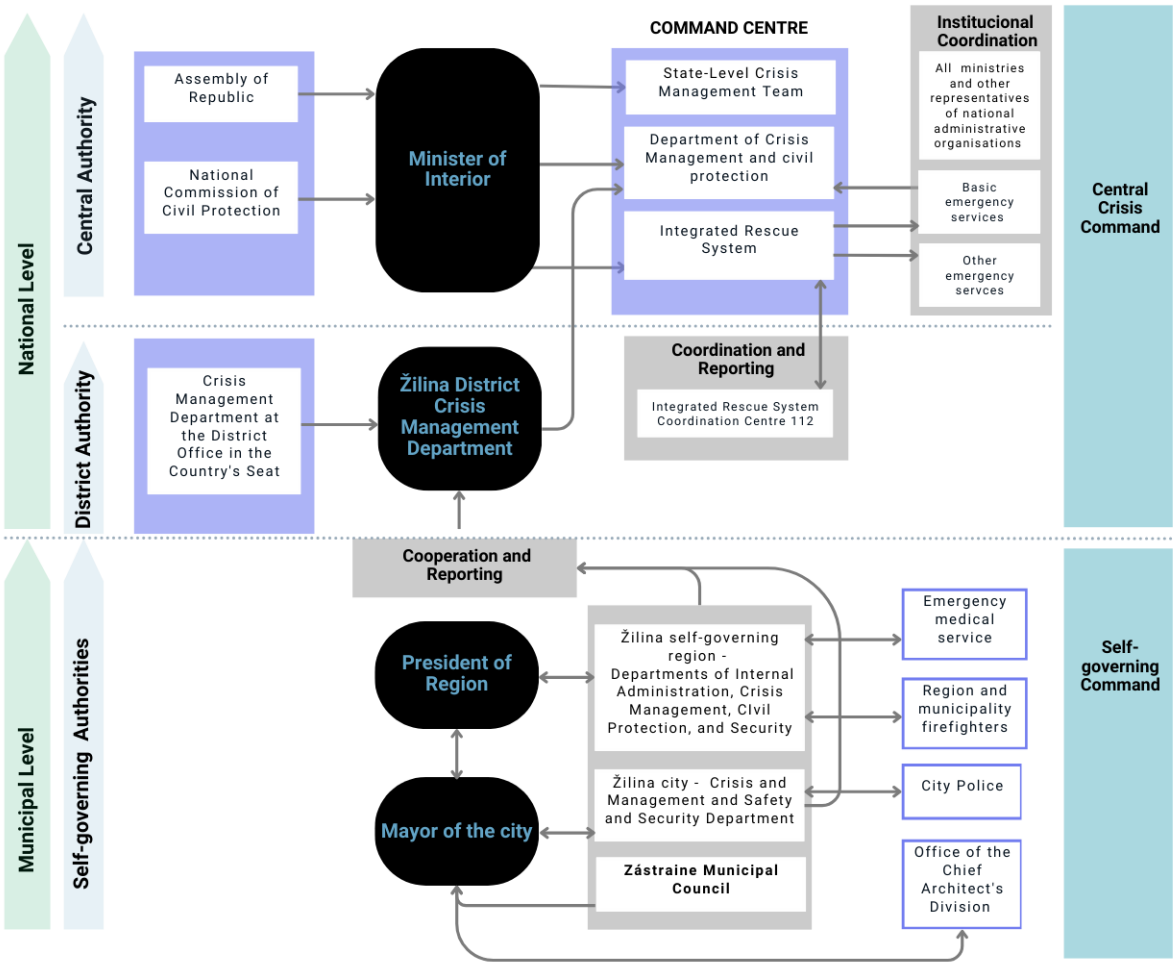


Figure 4. Organisational structure for crisis management governance in the Slovak Republic.

[9] The chief architect of Žilina, along with colleagues, works on the preparation of the spatial plan and its amendments and supplements, spatial planning documents, announces architectural and urban planning competitions, and contributes to design high-quality public space.

2.5. Overview of legislative planning in Slovakia and Žilina

At the national level, two key documents guide climate change adaptation efforts in Slovakia: the *National Strategy for Adaptation to Climate Change* (NSACC) and the *Action Plan for the Implementation of the Slovak Climate Change Adaptation Strategy* (Figure 5).

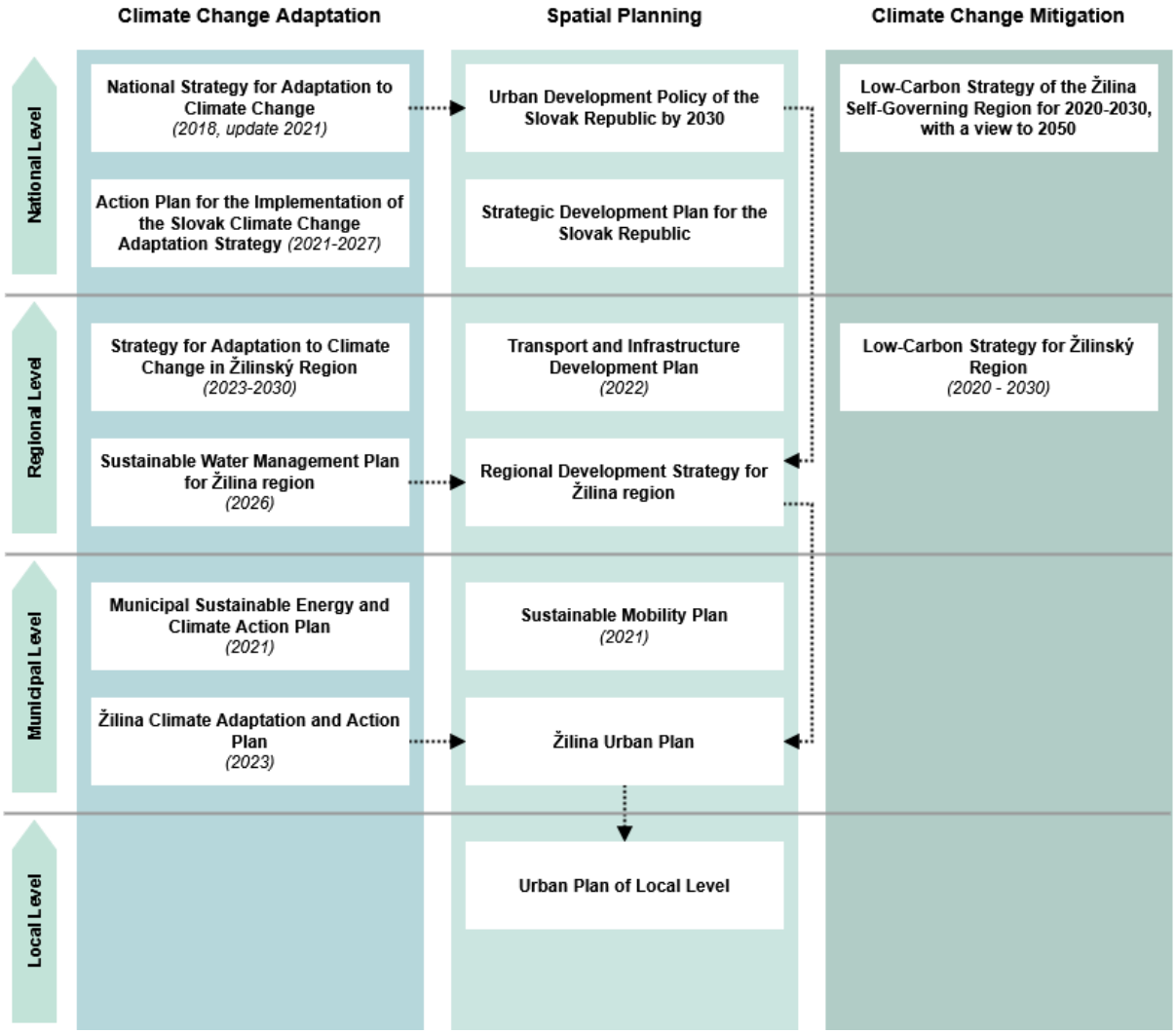


Figure 5. Multi-level legislative framework for climate mitigation and adaptation in Slovakia.

The first document, NSACC, provides a framework to address climate change impacts on different sectors such as agriculture and health to enhance resilience through specific measures and stakeholder actions. It emphasises the need for collaboration among governmental bodies, local communities, and the private sector for sustainable development. For the effort-sharing

sectors, Slovakia largely over-achieved its targets for 2020.[10] Slovakia's land use, land-use change, and forestry sector plays a key role as a carbon sink, absorbing almost a fifth of the country's emissions. In April 2023, Slovakia proposed a revision to its recovery and resilience plan, which included a new REPowerEU chapter. A draft of the updated *National Energy and Climate Plan* (NECP) was submitted in August 2023, which the European Commission reviewed and provided recommendations on, although the final NECP remains overdue as of June 2024.

The *Action Plan* (2021-2027) sets out concrete measures to achieve these objectives, prioritising actions in infrastructure, environment, and public health, while detailing timelines, responsible parties, and resource requirements. It also includes mechanisms for monitoring and evaluating progress to ensure effective implementation.

At regional level, the *Strategy for Adaptation to Climate change in Žilina region* (2023-2030) aims to reach climate neutrality by 2050. It focuses on adapting to climate change at the regional level and includes measures and strategies for specific challenges faced by the region. *Žilina climate change adaptation action plan* is the city's basic plan for adaptation to climate change. It enables to effectively implement measures to prepare for climate change in a safe and timely manner, ensuring the future sustainability of the city. Following the mapping and assessment of the city's vulnerability and risk analysis, adaptation measures will be specified for individual threats that reduce the likelihood of a given threat manifesting itself or mitigate its negative impact. To recommend appropriate adaptation measures, the provider will draw upon examples of good practice, existing catalogues of adaptation measures,[11] i.e., *Municipal Sustainable Energy and Climate Action Plan* (2021).

Žilina Regional Development Plan translates national principles of the *Slovak Spatial Development Perspective* (KURS- Koncepcia územného rozvoja Slovenska) into specific land-use policies and infrastructure development guidelines adapted to the region's needs. Adopted in 2008 and updated in 2018, with five amendments, the *Regional Development Strategy for Žilina Region* (RDSZR) is a link between national and municipal planning, providing direction for the spatial development of towns and municipalities. Currently, a new regional spatial plan is being prepared based on the same methodological approach. It is in the conceptual phase and awaits final approval through the *Strategic Environmental Assessment* (SEA). This new plan introduces new tools focused on mitigating climate change-related risks in the region.

Spatial planning in Slovakia follows a structured system across several levels, with the KURS serving as the guiding document at the national level. This document was adopted in 2001 and amended in 2011. It provides a high-level framework that informs regional and local planning

[10] The country accounted for 1.1% of the EU's total greenhouse gas (GHG) emissions in 2023 and achieved an emissions reduction of 27.3% from 2005 to 2023, slightly below the EU average reduction of 30.2% over the same period. Emissions from sectors under the EU emission trading system (ETS) fell by 41.7%.

[11] https://www.zilinaklima.sk/en/adaptation-strategy-and-measures/

efforts and serves as a reference document for lower levels of planning, ensuring consistency in land use management and sustainable urban development throughout the country of Slovakia. Methodological guidance from the Ministry of Transport, Construction and Regional Development of the Slovak Republic requires municipalities to incorporate *Adaptation Measures in the Settlement Environment* into the binding parts of their spatial plans. Climate resilience principles are directly integrated into local planning processes through the Strategy for Adaptation of the Slovak Republic to Climate Change.

In addition to the regional efforts, the *Sustainable Water Management Plan* for the Žilina Region is currently being prepared, with completion expected in 2026. This plan will further specify regional strategies for water resource management, directly influencing the regional spatial and zoning plans and related initiatives.

At the local level, *Municipal Development Plans* (ÚPN-O) and *Zoning Plans* (ÚPN-Z) regulate land use at the local level, aligning with national and regional guidelines. These plans are required to include adaptation measures based on the 2018 updated National Adaptation Strategy to Climate Change, addressing flood risks, green infrastructure development, and sustainable water management. The *Strategy* and *Action Plan for Adaptation to the Adverse Consequences of Climate Change in the City of Žilina* directly aligns with these requirements, ensuring that municipalities integrate climate resilience measures into their development plans. This collaboration between the municipal development plans and the action plan supports the sustainable and climate-resilient growth of local communities.

Low – carbon development strategy until 2030 with a view to by 2050 aims to identify measures, and include additional measures, to achieve climate neutrality in Slovakia by 2050. It outlines options for a comprehensive long-term (30-year) strategic roadmap for moving to a low-carbon economy. The document sets sectoral targets of Greenhouse gas (GHG) emissions, reductions to 2030 to meet its EU commitment. This document is linked to low-carbon strategy for Žilina region.

2.6. Key bodies involved in crisis management in Estonia

Siseministeeriumi infotehnoloogia - ja arenduskeskus (SMIT) provides the development and management of information systems related to internal security for the Police and Border Guard Board, Rescue Board, Emergency Response Centre, the Estonian Academy of Security Sciences, and the Ministry of the Interior.[12] The Rescue Board ensures public safety by anticipating threats and providing emergency assistance – specifically, the Rescue Board oversees five central threats: fire, water, dangerous substances, explosives, and crisis assistance.[13] It works closely with the Emergency Response Centre, which handles 112 calls, assesses threats, and

[12] https://www.smit.ee/
[13] https://www.rescue.ee/en/about-us

dispatches help.[14] The Police and Border Guard Board maintains general law and order, investigates crimes, secures borders, and conducts maritime rescues[15]. It collaborates with the Internal Security Service on national security matters. The National Foundation for Civil Society supports non-governmental organisations (NGOs) by funding initiatives that enhance crisis response and civic engagement, as well as promoting international cooperation. These organisations form an interconnected system collaborating to ensure public safety, emergency response, and national security.

Estonia adheres to the *Emergency Act*, which establishes the framework, structure, and organisation of crisis management in the country (Riigi Teataja, 2021). The *Emergency Act* clarifies the definitions of emergency and the state of emergency, as well as the roles and responsibilities of different political levels during a state of emergency. The Estonian crisis management has four pillars:

i) decentralisation;
ii) interagency cooperation;
iii) the permanence of tasks;
iv) the principle of subsidiarity.

Under (i), ministries oversee the crisis management within their area of governance. Interagency cooperation (ii) ensures effective joint action, specifically the emergency management authority and the authorities involved agree on the emergency response arrangements. The permanence of tasks means that during crises, people and different institutions will maintain their competencies in different areas of expertise and thus continue to fulfil their obligations. The principle of subsidiarity coordinates crisis management in a way that the lowest possible level is where activities are carried out (Ministry of the Interior, 2023b). The Government of the Estonian Republic creates and oversees the execution of national policies of crisis management. Before July 2021, this role was held by the Ministry of the Interior (Ministry of the Interior, 2021; Riigi Teataja, 2021). At the same time, the Ministry of the Interior still retains a central role in the organisation of national internal security policy and risk management as well as ensuring the safety of the people. This is done through creating legislation and forming policies, maintaining critical infrastructures, and overseeing the Estonian Internal Security Service, the Rescue Board and the Police and Border Guard of Estonia (Ministry of the Interior, 2023a). The *Internal Security Strategy* sets out the framework of internal security until the year 2030. One of the key areas to be developed is crisis prevention and preparedness for emergencies in the private, public as well as the third sector. To attain this goal, producing training materials, disseminating crisis response guidelines, improving the availability and use of data and information in the event of

[14] https://www.riigiteataja.ee/akt/123082017002?leiaKehtiv
[15] https://www.politsei.ee/en/

emergencies has been defined. Additionally, it has been defined that climate change can bring about extreme weather conditions, making crisis readiness more important for the people as well as the State (Ministry of the Interior, 2025).

Estonia has developed a civil defence framework, providing a brief overview of its mechanisms, status, and setting out goals for 2034. This framework serves as a foundation for policymakers in determining which areas of civil protection should be prioritised for development (Kommunikatsioonibüroo, 2024).

At regional level, as stipulated in the national *Emergency Act*, there are four permanent regional crisis management committees in Estonia, as indicated in Figure 6:

- *East Estonia Regional Crisis Committee* in the area of operation of the Eastern Rescue Centre (Ida-Viru and Lääne-Viru counties)
- *South-Estonian Regional Crisis Committee* in the area of operation of the Southern Rescue Centre (Tartu, Võru, Valga, Viljandi, Põlva, and Jõgeva counties)
- *West-Estonia Regional Crisis Committee* in the area of operation of the West Rescue Centre (Hiiu, Järva, Lääne, Pärnu, Rapla, and Saare counties)
- *North-Estonian Regional Crisis Committee* in the area of operation of the Northern Emergency Response Centre (Harju county) (Ministry of the Interior, 2021).

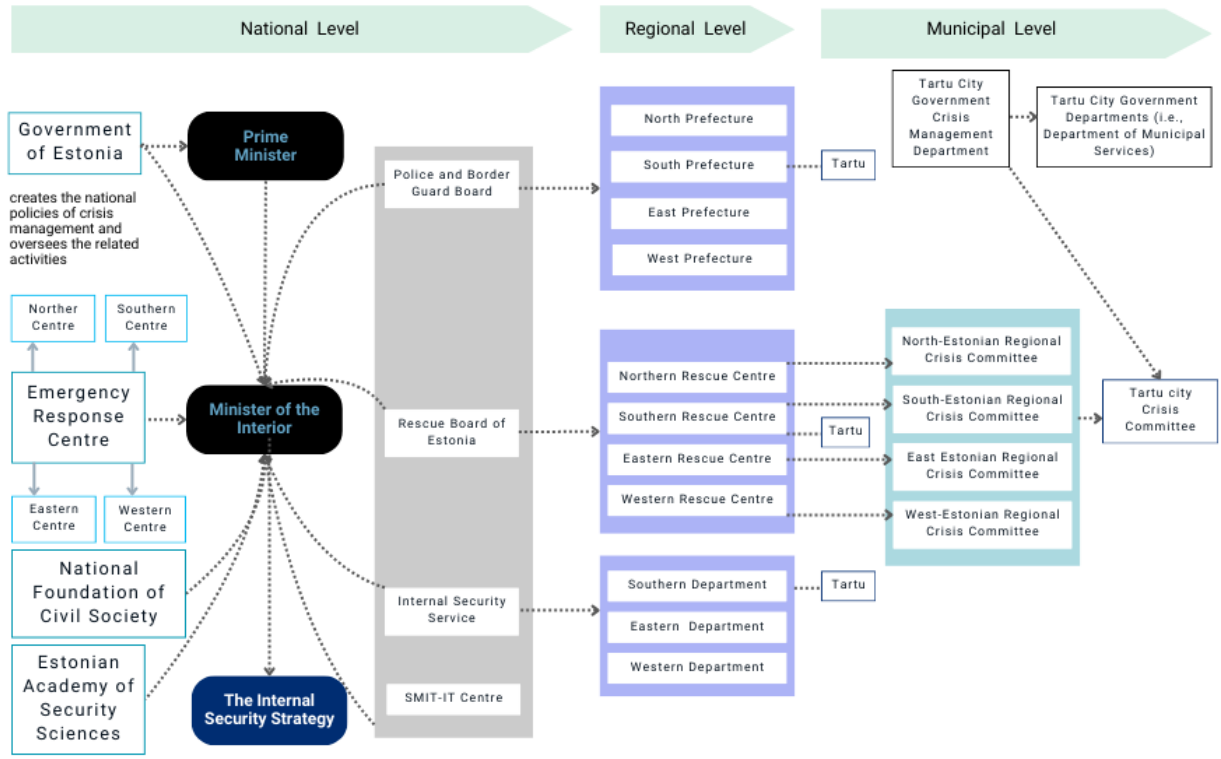


Figure 6. Governance structure related to emergency management in Estonia.

A permanent regional crisis committee is led by the head of the Rescue centre of the region and the committee consists of representatives from local municipalities as well as representatives from State institutions of that region. The composition of the Committee is based on the principle that all regional authorities relevant to crisis management, i.e., emergency prevention, preparedness, response, and continuity of essential services in the region, as well as units of local authorities are represented (Ministry of the Interior, 2021). A permanent regional committee coordinates the organisation of crisis management with regional authorities of executive power and local authorities. The Rescue Board of Estonia is tasked with consulting local authorities and ensuring cooperation between regional and local authorities (Riigi Teataja, 2021). Normally, regional crisis committees convene four times a year. Given that the Rescue Board of Estonia is managed under the Ministry of the Interior of Estonia, the ministry has a supporting role in coordinating crisis management on the regional and local levels.

At municipal level, during a crisis, municipalities need to be able to guarantee the safety of the people as well as ensure the continuity of vital services. Local government units are responsible for the management of critical services if they have a population of more than 10,000 inhabitants and whose services are managed by a provider of a critical service.

As stipulated in the *Emergency Act* (Riigi Teataja, 2021), during a crisis, Tartu City government will convene a crisis management team, which is tasked with solving the crisis as well as organising any necessary aid on the territory of Tartu City. This team will mainly include employees of the Tartu City government, and the leader of the team is the mayor of the city of Tartu. Additionally, an interinstitutional Crisis Committee exists in Tartu, which convenes twice a year to assess aspects crucial to crisis management, such as the availability of vital services and the organisation of a large-scale evacuation and emergency plans. The Committee is also led by the mayor (Ministry of the Interior, 2025; Tartu City Government, 2025).

The local Crisis Committee has more of a support and advisory role, for example to assist the authority leading the crisis in a major emergency. The Crisis Committee can also be involved in crisis management or crisis leadership in the case of an event for which the local authority is responsible. For example, municipalities may decide that the crisis committee is the lead structure for dealing with an emergency caused by the interruption of a vital service (e.g., district heating, water and sewerage services, or the breakdown of a local road). However, a municipality can only take on a leading role when solving a crisis if the number of people living in a municipality surpasses 10,000 people (currently 33 out of 79 municipalities).

Within the Internal Security Strategy created by the Ministry of the Interior, one of the goals defined is to raise local municipalities' situational awareness of risks and events on their territory to ensure the earliest possible preparedness and to anticipate and respond to possible crisis situations (Ministry of the Interior, 2025).

2.7. Overview of legislative planning in Estonia and in Tartu

The formulation and implementation of climate and energy policy is primarily done by the Ministry of Climate of Estonia, which prepares comprehensive guidelines and informs residents about actions taken for climate and energy goal achievement. The current national plans are titled *National Energy and Climate Plan (NECP) 2030* (Ministry of Climate, 2023), *Fundamentals of Estonian Climate Policy* until 2050 *(FECP 2050)*, and *Climate Change Adaptation Development Plan* until 2030. Other contributing bodies and governmental agencies in the domain include the Environmental Board (Keskkonnaamet, under the Ministry of Climate, implementing policies around the environment and its protection) and the Environmental Investment Centre (KIK – Keskkonnainvesteeringute Keskus, funding environmental projects in Estonia) (EIC, 2020; Environmental Board, 2024). Regional plans focusing on climate, energy and the environment are also created with local governments – on the county level, Tartu County has the *Tartu County Climate and Energy Plan* as well as the *Tartu County Development Strategy* 2040. On the municipal level, Tartu has its own Energy plan titled *Tartu Energy 2030* (Tartu City Energy and Climate Action Plan). In Estonia, regional spatial plans for both climate mitigation and adaptation solutions are developed by the Ministry of Economic Affairs and Communications (Figure 7), as follows:

- *National Spatial Plan*: strategic document guiding the spatial development of Estonia. The currently national plan is *Estonia 2030+* with *Estonia 2050* being in the works.
- *Regional plan*: it is drawn up primarily to balance national and local spatial development needs and interests. Tartu County's regional plan is titled *Tartu County Spatial Plan 2030+*, aligning with the broader national plan. On the municipal level, Tartu City is guided by Tartu *City General Plan 2040+*.
- *National designated spatial plan*: it is drawn up for the construction of a building with a major spatial impact, the siting or operation of which is of major national or international interest (Riigi Planeeringud, 2024).

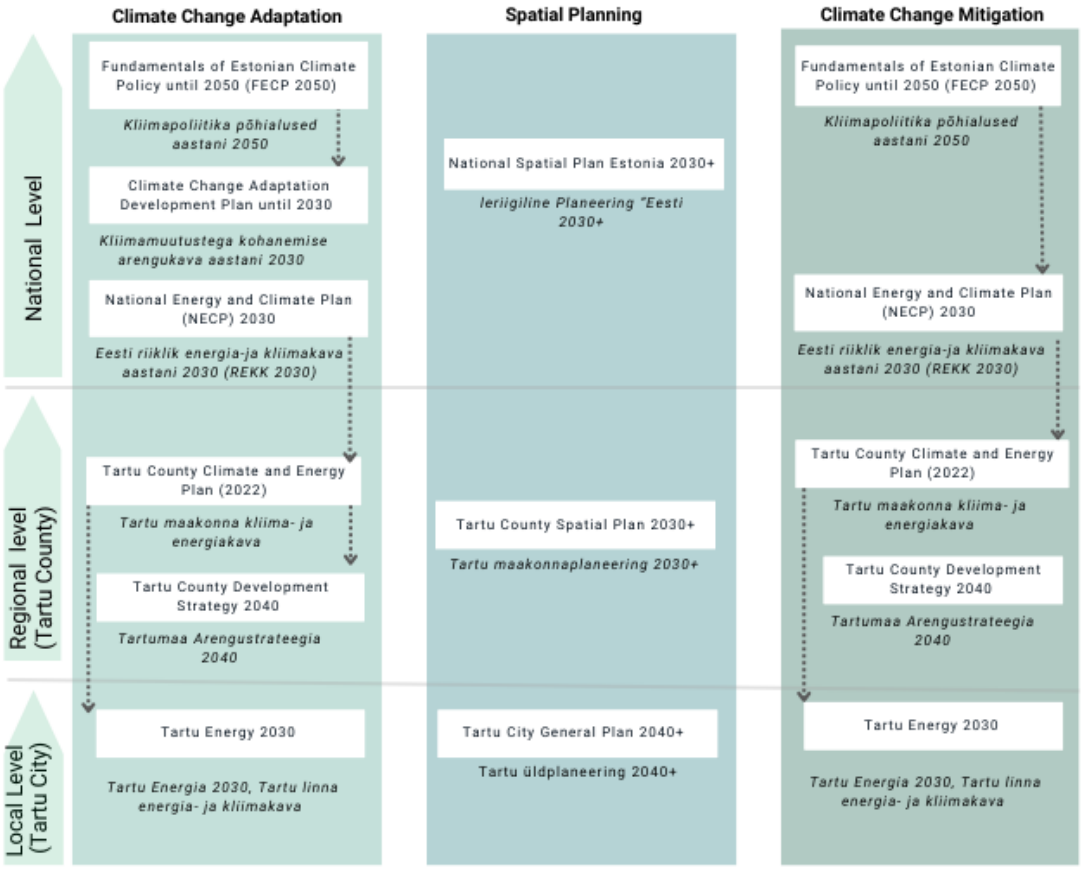


Figure 7. Multi-level framework planning for climate mitigation and adaptation in Estonia.

3. Regulatory frameworks in RETIME pilot sites

3.1. Strategic planning for emergency and climate response

3.1.1. Strategic plans in Portugal

Portugal has implemented several plans across national, metropolitan, municipal, and local levels, as shown in Figure 3. Table 1 highlights key civil protection emergency plans by territorial scale, while Table 2 presents climate change-related plans focused on 2020–2030 adaptation and mitigation, with some extending toward 2050 goals.

Table 1. Emergency preparedness and management plans under civil protection in Portugal.

National level
***National Civil Protection Emergency Plan* (2023)** establishes the structure and procedures for managing large-scale emergencies in Portugal, defining the responsibilities of the various organisations and entities involved in civil protection at national level (ANEPC, 2023).
Regional level
***Lisbon District Civil Protection Emergency Plan* (2024)** aims to coordinate the response to emergencies in the Lisbon district, ensuring coordination between the municipalities and the various civil protection agents. Following the public consultation ending on 31 January 2025, the plan is now being revised based on feedback (ANEPC, 2024).
***Sub-regional Programme for Integrated Rural Fire Management Action of the Lisbon Metropolitan Area* (2024)** defines fire risk mitigation activities focused on areas with high and very high hazard levels (Comissão Sub-Regional do Sistema de Gestão Integrada de Fogos Rurais, 2024).
***The Special Emergency Plan for Seismic Risk in LMA and Surrounding Municipalities* (2009)** is a support tool for the civil protection system for operational management in the event of a seismic occurrence in the region (Área Metropolitana de Lisboa, 2009).
Municipal level
***Lisbon Municipal Civil Protection Emergency Plan* (2018)** defines the specific strategies and procedures for the city of Lisbon in the event of an emergency, including the identification of risks, available resources and response measures (Assembleia Municipal de Lisboa, 2018)
***Lisbon Municipal Risk and Vulnerability Identification Plan* (2019)** this is part of the Lisbon Metropolitan Area Climate Change Adaptation Plan. This plan identifies current and future climate risks in the municipality of Lisbon, analyses the sensitivity of key sectors and assesses the city's adaptive capacity. The plan addresses areas such as health, biodiversity, water resources and infrastructure, highlighting mitigation and adaptation measures. Its aim is to integrate climate adaptation into local policies, promoting resilience and reducing vulnerabilities (CML, 2019).
***Municipal Forest Fire Defence Plan* (2020)** aims to prevent and combat forest fires, protecting biodiversity and the green areas surrounding the city. This plan includes sustainable management of forest spaces, underbrush clearance, the implementation of firebreaks, and enhancing surveillance and firefighting resources. It also raises awareness and promotes good practices on fire risk reduction practices focusing on the local community (Plano Municipal de Defesa da Floresta Contra Incêndios de Lisboa, 2020).

Table 2. Climate Change adaptation and mitigation plans in Portugal.

National level
Adaptation ***National Strategy for Adaptation to Climate Change (2020)*** establishes objectives and models for implementing adaptation solutions in sectors such as agriculture, biodiversity, energy, health, and transport (APA, 2020a).[16] ***National Roadmap for Adaptation 2100 (2020)*** In development since 2020, it aims to assess the vulnerability of the Portuguese territory to long-term climate change and define guidelines for territorial and sectoral planning (APA, 2020c)
Mitigation ***National Energy and Climate Plan 2030 (2020)*** The main energy and climate policy instrument for the decade 2021-2030, it sets national targets for 2030, including a 45% to 55% reduction in GHG emissions compared to 2005, 47% incorporation of renewable energies and 35% energy efficiency (APA, 2020b). ***Roadmap to Carbon Neutrality 2050 (RNC2050) (2019)*** defines the vision and trajectories for Portugal to achieve carbon neutrality by 2050, balancing GHG emissions with their removal through carbon sinks (DGEG, 2019).
Lisbon Metropolitan Area (LMA)
Adaptation ***Metropolitan Climate Change Adaptation Plan (2020):*** It identifies climate vulnerabilities and proposes adaptation measures in the 18 municipalities within the LMA (Área Metropolitana de Lisboa, 2020). **Critical vulnerabilities:** i) heat waves and extreme temperatures; ii) sea level rise and saline intrusion; iii) floods and inundation; and iv) water scarcity and droughts. **Measures:** i) adoption of green infrastructures; ii) efficient water management; and iii) urban upgrading with a focus on thermal comfort and resilience.
Mitigation ***Lisbon European Green Capital 2020 Programme:*** Although focused on Lisbon, this programme had a wider metropolitan impact by promoting sustainability initiatives, such as reducing the carbon footprint, reforestation and afforestation, and implementing nature-based solutions.
Lisbon Municipality
Adaptation

[16] *Estratégia Nacional de Adaptação às Alterações Climáticas* (ENAAC, 2020), built upon the first strategy launched in 2010, was extended until 31 December 2025, in accordance with Council of Ministers Resolution 53/2020 (APA, 2020a).

Smart and Climate Neutral Cities Mission 2030: Lisbon was selected in 2022 to be one of the 100 cities in the EU included in the 'Smart and Climate Neutral Cities Mission 2030' initiative. Lisbon's commitment to achieving climate neutrality by 2030, whose vision focuses on the following goals targeting both mitigation and adaptation (APA, 2021): i) reduce GHG emissions by 80 per cent compared to 2002, achieving climate neutrality by 2030; ii) prepare the city for extreme weather events by strengthening its resilience and response capacity; iii) ensure a just and inclusive transition, reducing inequalities and combating energy poverty; and iv) value participation in the '100 Climate Neutral Cities by 2030 Mission' for attracting new investment and talent (European Commission, 2022).
***Lisbon Municipal Climate Change Adaptation Strategy* (2017)** aims to prepare the city for current and future climate challenges, such as heat waves, extreme cold, heavy rainfall, and flooding (CML, 2017), specifically: i) improve knowledge about climate change, through continuous monitoring and scientific deepening; ii) adopt specific adaptation measures to increase urban resilience; iii) integrate adaptation into sectoral policies, ensuring that urban planning and urban management take climate risks into account; iv) strengthen partnerships between public and private entities, promoting a collaborative approach to managing climate challenges (CML, 2017).
This strategy is aligned with key international commitments, such as the New Covenant of Mayors for Climate and Energy and the C40 Climate Leadership Network, reinforcing Lisbon's role in local climate action. In addition, Lisbon participates in the Network of Municipalities for Local Adaptation to Climate Change, an initiative that aims to increase the capacity of municipalities in Portugal to incorporate climate adaptation into their policies. The adapt.local Network, established in December 2016 through the ***ClimAdaPT.Local project***, brings together municipalities and other institutions to promote local adaptation to climate change in Portugal (adapt.local, 2016).
***Lisbon's General Drainage Plan* (2016-2030)** is a strategic initiative by Lisbon City Council aimed at mitigating flooding in the city, especially in critical areas such as *Baixa* and *Alcântara*. The €250 million (2016–2030) plan aims to prepare Lisbon for future challenges from extreme rainfall and climate change (PGDL, 2015). The main actions include i) *source control:* construction of retention and infiltration basins, in *Ameixoeira* (2018), *Alto da Ajuda* (2019), and *Parque Eduardo VII* (2021), to store and slow down rainwater runoff; ii) *basin transfer:* Construction of two drainage tunnels. The *Monsanto-Santa Apolónia* Tunnel (5 kilometres long), and the *Chelas-Beato* Tunnel (1 kilometre long) are designed to divert excessive flows from the upper areas into the River Tagus, reducing the risk of flooding in the lower areas of the city; iii) *reinforcement and rehabilitation of the drainage network*: interventions in the existing drainage network to increase its capacity and efficiency, including the construction of micro-tunnels and spillways, e.g., in *Parque das Nações* and *Avenida Infante D. Henrique*; iv) *improvement of knowledge of the drainage network*: updating the register and monitoring the drainage network to optimise infrastructure management and maintenance (PGDL, 2015).[17]

[17] https://planodrenagem.lisboa.pt/sobre-o-plano

Lisbon Heat Waves Project (2015) improves the knowledge about the effects of climate change in the municipality, especially the increase in average annual temperature and maximum temperatures. Thematic maps on heat waves and urban heat islands are produced,[18] along with tools to support municipal adaptation and mitigation strategies.
Mitigation ***Lisbon's Energy and Environmental Strategy*** aims to promote the city's energy and environmental sustainability. Drafted by Lisboa E-Nova (https://lisboaenova.org/) and approved in 2008, it anticipates the European *triple 20 targets*, i.e., 20% reduction in GHG emissions, 20% increase in energy efficiency and 20% of energy from renewable sources by 2020 (CML, 2023a). The pillars of the strategy include: i) reduction of energy consumption and CO_2 emissions, with priority given to the transport and buildings sectors; ii) optimisation of the use of water and materials, promoting recycling and waste reduction; iii) implementation of green infrastructure and soft mobility, such as cycle networks and electric vehicle chargers; iv) monitor of results and actions to guarantee targets. This strategy seeks not only to mitigate environmental impacts, but also to improve the quality of urban life. ***Lisbon 2030 Climate Action Plan*** (PAC - Plano de Ação Climática, 2030) aims to transform Lisbon into a carbon-neutral, resilient, and inclusive metropolis by 2050. PAC aims to: i) *emissions reduction*: to reduce GHG emissions by 70% by 2030, taking 2002 as a reference year, and to achieve climate neutrality by 2050; ii) *climate adaptation*: preparing the city for extreme weather events, increasing its resilience to climate risks and capacity to respond to crises and shocks; iii) *sustainable energy*: installing 100 MW of power in solar photovoltaic systems by 2030, promoting the transition to renewable energy sources; iv) *green mobility*: implementing 5.000 charging stations for electric vehicles by 2030, encouraging the adoption of sustainable transport; v) *green spaces*: ensure that 25 per cent of the city's area is made up of green spaces, contributing to improving the quality of life and the urban environment (CPSA, 2021). It also includes measures such as the creation of Reduced Emission Zones (ZERs),[19] the Solar Action Plan, the Lisbon's General Drainage Plan (PGDL) 2016-2030 (2016-2030), and the Affordable Rent Programme, aiming to tackling climate challenges and promoting sustainability in the city through a holistic approach.

[18] Lisbon City Council successfully applied for co-financing from the ERDF/CF under the POSEUR Operational Programme – Axis 'Promoting Adaptation to Climate Change and Risk Prevention' – for the 'Heat Waves in Lisbon' project. Info available at: https://www.lisboa.pt/temas/ambiente/qualidade-ambiental/alteracoes-climaticas/ondas-de-calor#c1008. Climate projections indicate that in LMA, the average number of days with heatwaves could increase from 11 days/year today to 38 days/year in 2050 and 64 days/year by the end of the 21st century, with average temperatures of 40 C° (CML, 2018).

[19] https://urbanaccessregulations.eu/countries-mainmenu-147/portugal/lisbon

3.1.2. Strategic plans in Slovakia

Table 3 presents key plans and strategic documents for the Žilina pilot site across different administrative levels. Table 4 focuses on water management and environmental strategies summarises climate change plans, while Table 5 outlines spatial development plans that incorporate climate change mitigation and adaptation actions.

Table 3. Emergency preparedness and management plans under civil protection in Slovakia.

National level
National Civil Protection Plan (2022) establishes emergency response procedures for disasters, extreme weather events, and industrial accidents. It defines roles of state institutions and local authorities (Ministry of Interior, 2022). ***Crisis Management and Disaster Response Strategy (2021)*** defines a framework for coordinated disaster response, including civil protection, emergency preparedness, and risk assessment (Ministry of Interior, 2021).
Regional level
Regional Civil Protection Plan (2014–2020) focuses on risk management, coordination of emergency services, and disaster response at the regional level (Žilinský samosprávny kraj). ***Regional Fire and Rescue Plan (2021)*** defines emergency procedures for wildfires, industrial accidents, and natural disasters specific to the region (Žilinský samosprávny kraj, 2021).
Municipal level
Municipal Emergency Plan defines local civil protection measures, emergency response coordination, and crisis preparedness, including early warning systems (City of Žilina, 2022). ***Local Fire and Flood Protection Plan (2022)*** provides emergency response measures to minimise fire and flood risks within the municipality (City of Žilina, 2022).

Table 4. Water management plans in Slovakia at national, regional, and municipal level.

National level
Water Plan of Slovakia for the years 2022 - 2027 (2022) implements the EU Water Framework Directive and outlines measures for water resource management and flood prevention in major river basins (Ministry of Environment, 2022). ***Water Policy Concept for 2030 with an outlook to 2050 (2022)*** establishes long-term strategies for water conservation, stormwater management, and adaptation measures in response to climate change (Ministry of Environment, 2022).
Regional level
Sustainable Water Management Plan for Žilina region (2026) develops measures for regional water conservation, flood prevention, and drought mitigation (Žilina Water Authority, 2026). ***Action Plan to Address the Impacts of Drought and Water Scarcity (2018-2025)*** implements measures to prevent water shortages and enhance the resilience of landscapes to climate variability (Ministry of Environment, 2018).
Municipal level

Flood Risk Management Plan for Žilina (2025) defines local flood prevention strategies, including drainage system improvements and early warning mechanisms (City of Žilina, 2025). ***Rainwater Management Plan (2023)*** promotes sustainable stormwater management and green infrastructure to reduce urban flooding risks (City of Žilina, 2023).

Table 5. Climate Change adaptation and mitigation plans in Slovakia.

National level
National Strategy for Adaptation to Climate Change (2018, updated 2021) sets long-term adaptation strategies for different sectors, including disaster risk management, water resource management, and urban planning (Ministry of Environment, 2021). ***Action Plan for the Implementation of the Slovak Climate Change Adaptation Strategy (2021-2027)*** provides specific measures to enhance climate resilience in water management, agriculture, forestry, biodiversity protection, public health, and infrastructure (Ministry of Environment, 2021).
Regional level
Strategy for Adaptation to Climate Change in Žilinský Region (2023-2030) includes regional adaptation strategies focus on flood prevention, green infrastructure, and climate resilience in urban and rural areas. Includes biodiversity protection and disaster risk reduction measures (Žilinský samosprávny kraj, 2023). ***Low-Carbon Strategy for Žilinský Region*** establishes goals for reducing GHG and integrating renewable energy sources (Žilinský samosprávny kraj, 2022).
Municipal level
Žilina Climate Adaptation and Action Plan (2023) focuses on urban greening, water management, and heat mitigation measures to improve local climate resilience (City of Žilina, 2023). ***Municipal Sustainable Energy and Climate Action Plan (2021)*** defines strategies for energy efficiency, emission reduction, and resilience-building measures at local level (City of Žilina, 2021).

Table 6. Spatial development plans in Slovakia at national, regional, and municipal level.

National level
Urban Development Policy of the Slovak Republic by 2030 provides guidelines for sustainable urban planning, integrating climate adaptation measures into land use regulations (Ministry of Transport, 2018). ***Strategic Development Plan for the Slovak Republic*** defines long-term economic and environmental development priorities, including climate resilience (Ministry of Economy, 2022).
Regional level
Regional Development Strategy for Žilina region outlines economic and spatial development priorities, including climate resilience and infrastructure planning (Žilinský samosprávny kraj, 2022). ***Transport and Infrastructure Development Plan (2022)*** identifies key transportation projects with environmental and climate adaptation considerations (Žilinský samosprávny kraj, 2022).
Municipal level
Žilina Master Plan (Územný plán mesta Žilina) defines urban planning policies, zoning, and development regulations with consideration for climate adaptation. ***Sustainable Mobility Plan (2021)*** encourages environmentally friendly transport solutions, including cycling infrastructure and public transport expansion (City of Žilina, 2021).

To enhance climate resilience in spatial planning, Slovakia has introduced key strategic frameworks, such as the *Low Carbon Development Strategy* (2020-2050), which defines decarbonisation goals influencing planning through the promotion of sustainable mobility and energy-efficient building standards, such as nearly zero-energy buildings (NZEBs). In addition, the Low-Carbon Strategy of the Žilina Self-Governing Region for 2020-2030, with a view to 2050, outlines specific regional decarbonisation measures. This strategy focuses on reducing GHG emissions, promoting energy efficiency, and increasing the use of renewable energy sources, further supporting climate resilience in the region's spatial and urban planning processes.

3.1.3. Strategic plans in Estonia

Tables 7 outlines the key spatial plans in Estonia by the Ministry of Economy and Industry and other development strategies and climate change-related plans in Estonia.

Table 7. Climate Change mitigation and adaptation plans in Estonia.

National level
Estonia 2035 Development Strategy focuses on labour market, sustainability of the nation, health and social protection, economy and climate, space and mobility, governance. Specifically, the economy and climate sections focus on encouraging Research, Development and Innovation in business, supporting responsible entrepreneurship and fair competition, and advancing the circular economy, energy security, and climate-neutral energy production (Republic of Estonia Government, 2021). **Adaptation & Mitigation** ***Fundamentals of Estonian Climate Policy until 2050 (FECP 2050)*** gives an overview of Estonia's long-term vision regarding climate policy, to achieve climate neutrality by 2050 (Ministry of Climate, 2024).[20] ***National Energy and Climate Plan (NECP) 2030*** informs citizens and companies about measures taken by Estonia to align with the climate and energy targets set by the European Commission (Ministry of Climate, 2023). **Adaptation** ***Climate Change Adaptation Development Plan until 2030*** aims to ensure climate change preparedness, increase resilience and adaptation measures on the national, regional and municipal level (while Table 5 outlines spatial development plans that incorporate climate change mitigation and adaptation actions.Ministry of Climate, 2025). ***National Spatial Plan Estonia 2030+*** National planning is drawn up for the whole territory of Estonia and its economic zone. Its aim is to guide the integrated development of the settlement structure and of the national networks. The national plan provides general guidelines for the preparation of regional and municipal plans and provides the basis for better spatial coherence between national strategies and sectoral development plans. ***National Designated Spatial Plan (NDSP)*** is drawn up for the construction of a building with a major spatial impact, the location or operation of which is of major national or international interest. Specifically, national designated spatial plans are not meant for reflecting long-term strategic planning goals and rather regulates the construction of infrastructure, such as a public railway, a defence installation, a high-voltage power line or a hazardous waste disposal site.[21]

[20] https://kliimaministeerium.ee/kliimapoliitika-pohialused-aastani-2050
[21] https://www.riigiplaneering.ee/en

Regional level
Tartu County 2030+ aligns with the national *Estonia 2030+* plan. The regional plan outlines principles for guiding settlement development, infrastructure planning, mobility, agricultural land preservation and landscape values. Its implementation aims to create a more sustainable settlement structure, optimise service locations, and preserve spatial values (Riigi Planeeringud, 2024).
County level
Adaptation & Mitigation ***Tartu County Development Strategy 2040*** focuses on five key areas: education and lifelong learning, entrepreneurship, infrastructure, health and well-being, and culture and tourism.[22] ***Tartu County Climate and Energy Plan*** contains actions to plan climate change mitigation and adaptation measures. [23]
Municipal level
Tartu 2030, a development plan for the city of Tartu will be drawn up for the shorter term, containing concrete actions, and a four-year budget strategy reflecting the financial means for its implementation. These documents will be updated annually. Links in the strategy with the functionality of the urban space will be established through planning. The urban development strategy and the master plan are reviewed after each regular election of the City Council (Tartu 2030, 2015). **Adaptation & Mitigation** ***Tartu Energy 2030 – Tartu City Energy and Climate Action Plan*** is an action plan in the domains of energy and climate, with a specific focus on climate change, adaptation measures and mitigating climate change impacts. The plan presents measures taken in different topics, including renewable energy, building and power management, governance, and housing (Tartu Energy 2030, 2021).
Tartu City Development Strategy 2025–2035 aims to provide a holistic view of the city's development trends and to be a daily management tool to ensure balanced development of the different areas of city life, to improve the quality of life of Tartu's citizens and to make Tartu more attractive to investors and visitors (Tartu City Government, 2025).

[22] https://www.tartumaa.ee/iabout-us/tartu-county-development-strategy-2040

3.2. Existing adaptation plans to hazard scenarios

This analysis outlines recent and ongoing initiatives at both municipal and district levels across the three RETIME pilot sites. While the focus is primarily local, relevant national initiatives with a direct impact may also be included. The initiatives covered relate to building stock renewal, urban resilience, risk management, and adaptation measures aimed at improving livelihoods, community resilience, municipal infrastructure, and building performance. Initiatives targeting crime, violence, healthcare, training, or other areas beyond the scope of this project have been excluded. *Sections 3.2.1*, *3.2.2*, and *3.2.3* highlight how the three pilot areas are currently benefiting from adaptation measures included in various initiatives. Annex A lists key EU-funded projects on climate, sustainability, and vulnerability involving the RETIME pilot sites. Furthermore, primary data gathered from local stakeholders are examined to demonstrate how key actors at the local level are benefitting from the implementation of existing adaptation solutions in alignment with the Sustainable Development Goals (SDGs 13, 11, and 9).[24, 25]

3.2.1. Status Analysis in Lisbon

As part of the municipal programmes identified in *Section 3.1*, the Lisbon Town Council has developed several initiatives. Table 8 provides a brief overview of key adaptation solutions, either proposed to citizens or planned or implemented by public authorities, in Lisbon. Annex A (Table 15) shows the main EU-wide initiatives.[26]

Among all urban resilience initiatives, ***Lisboa Cidade Resiliente (Lisbon Resilient City)*** is one of the most ambitious, addressing diverse climate stresses, community Engagement, and capacity building, through multiple pilot sites spread across the city aims to tackle natural disasters, climate change, and socio-economic crises, fostering a safer, inclusive, and sustainable city. It aligns with global commitments like the Sendai Framework, Paris Agreement, and 2030 Agenda, and other global initiatives like the 100 Resilient Cities program, supported by The Rockefeller Foundation (CML, 2020).

Table 8. Adaptation solutions for hazard scenarios within existing programmes in Lisbon.

Programme [Focus]	**Hazard Scenarios**	**Proposed Adaptation Solutions**	**Potential Benefits**
Lisbon			
Lisboa Cidade Resiliente	Urban flooding, urban heat waves, Urban Heat Island Effect (UHIE),	Improvement of urban green infrastructure (such as the main green	It contributes to enhanced resilience to extreme weather events and enhanced emergency

[24] *T2.1 - Analysis of socio-economic contexts, identification of vulnerable groups, and stakeholder mapping at pilot sites* (developed from June 2024 until December 2024).
[25] While not statistically representative (given that it was not based on a large sample) it remains a result worth considering.
[26] Other info can be found here: https://www.lisboa.pt/projetos-cofinanciados

[Urban and Environmental aspects]	droughts, storms and hurricanes, sea-level rise, biodiversity loss, pollution and air quality deterioration, vector-borne diseases, economic shocks, cybersecurity risks	corridor linking Monsanto Forest Park to the city centre) and drainage systems.	response systems, foster social cohesion, job creation in green sectors (such as renewable energy, sustainable transport, and urban planning), optimise resource use through smart city technologies.
ReSist [Social transformations and Community resilience]	Seismic hazard	Based on the building's construction type, the app (https://lx-resist.vercel.app/) provides insights into its structural limitations and recommends appropriate retrofitting measures	It helps citizens make informed decisions and reduce the impact of a potential earthquake on buildings
LIFE LUNGS project [Climate Adaptation policies]	UHIE and rising temperatures	i) Increase in tree and shrub coverage; ii) New rainfed ecosystems	It reduces surface temperatures, mitigating the UHIE, reducing surface runoff
	Water scarcity	i) Biodiverse rainfed meadows; ii) Rainfed ecosystems; iii) Improvement of irrigation system; iv) Zero (or reduced) rainwater waste zones	It allows water and nitrogen retention in the soil
	Flooding and soil erosion	i) Sheep grazing for vegetation control; ii) Stabilisation of green spaces (with new deep-rooted vegetation)	It reduces erosion risks and mitigates the impact of heavy rainfall in vulnerable areas
DECA [Climate Adaptation policies]	Governance	i) Enhance existing policy instruments, such as the Lisbon Climate Action Plan; ii) Improve capacity building; iii) Use nature-based solutions	Improve governance in climate adaptation plans

No adaptation measures sit directly in *Bairro da Boavista*, but two actions nearby benefit it:

- *Green Corridors:* 25 km of street-level trees/shrubs and 15 mini-parks citywide with enhanced plantings along Monsanto's eastern edge (*Estrada de Monsanto*).
- *Bioswales:* Small vegetated channels dug into Monsanto's lower slopes to capture runoff during heavy rains.

ReSist (https://resist-project.eu/regions/) includes activities developed between 2022 and 2024. It regards 47 actions aimed at enhancing the seismic resilience of the private and

municipal built environment, as well as of the municipal urban infrastructures in Lisbon. The program[27] aims to address the following strategic objectives:

- *Standardisation of Technical Standards and Methodologies:* Establishing criteria for assessing the seismic vulnerability of the city;
- *Operational Actions for Resilience Promotion*: Implementing inspection campaigns, projects, and retrofitting works;
- *Awareness Campaigns*: Conducting initiatives to engage the public and empower citizens regarding seismic risks and safety measures;
- *Information Management Systems*: Developing systems to facilitate knowledge sharing and execution of the program across various municipal structures;
- *Alert Criteria and Intervention Prioritisation*: Defining criteria to guide municipal services;
- *Strategic Partnerships*: Establishing collaborations with external entities to optimise the program's actions (CML, 2021).

ReSist involves 9 technicians' expert in Geology, environmental Engineering, Social Sciences, Civil Engineering, and Law, who are involved in the following activities:

i) training sessions designed to enhance knowledge and skills related to seismic resilience and disaster preparedness;
ii) exhibitions aimed at raising awareness about seismic risks and promoting resilience in urban areas;
iii) capacity building for strengthening the capabilities of various stakeholders, including the public, in understanding and responding to seismic threats.

LIFE LUNGS project (https://life-lungs.lisboa.pt/) *'Towards a more resilient Lisbon UrbaN Green Infrastructure as an adaptation to climate change'* (2019-2024), led by the Lisbon City Council and co-financed by the European Union under the LIFE Programme. It is backed by a funding of 2.7 million euros, with 55% provided through community funding. It is part of the climate policies adopted by the municipality, aimed to enhance the Lisbon's resilience to rising temperatures, mitigate the impacts of heatwaves, and address increasing water shortages, which are expected to become more frequent in the near future. However, March 2025 was classified as very rainy and cold on mainland Portugal. In terms of precipitation, the figure was 229.4% above normal (1990-2020 period), the fifth highest since 2000. Nine weather stations on mainland Portugal recorded extreme precipitation.[28]

[27] Although the total amount of funding is still being determined, the municipality intends to use the 2021-2027 Multiannual Financial Framework to support as many actions as possible. Other information: https://www.lisboa.pt/temas/seguranca-e-prevencao/sismos/programa-resist

[28] https://www.ipma.pt/pt/media/noticias/news.detail.jsp?y=2025&f=boletim_climatologico_marco_2025.html

Six crucial implementation actions[29] based on urban green infrastructure and nature-based solutions are developed:

1) Improvement, installation and operation of biodiverse rainfed meadows;
2) Flocks of sheep as a non-mechanical urban agent for vegetation control and soil conservation;
3) Water management measures;
4) Increasing the density of tree cover along Lisbon's urban green infrastructure;
5) Open Desk Office to promote project replication within LMA; and
6) Transfer and replication of results through stakeholder involvement (Life Lungs, 2019).

DECA (Delivering Effective Climate Actions, https://www.interregeurope.eu/deca) initiative aims to accelerate the response of local governments to disruptive climate events resulting from scenarios expected in the near future. In this context, eight European regions will present new cross-sectoral approaches and creative partnerships capable of strengthening strategic planning in response to climate challenges with a direct impact on city ecosystems. DECA aims to identify and share good practices, innovative solutions, and funding sources to strengthen city adaptation to climate risks. It also seeks to strength the capacity of eight public authorities through training, knowledge transfer, and collaboration. Additionally, it aims to improve the performance of eight relevant policy instruments to boost city leadership in climate resilience, with a focus on monitoring the Lisbon 2030 Climate Contract. The drafting of the *Climate Contract for the City of Lisbon 2030* (Lisboa Para Pessoas, 2024), recognised by the European Community (EC) with the Mission Label award, comes in response to the challenge launched by the '100 Climate Neutral and Smart Cities by 2030 Mission', to meet ambitious climate neutrality targets by 2030. As part of the DECA project, this transversal, dynamic, and structuring instrument will be monitored on a city-wide scale, continuing the ongoing climate resilience strategy and promoting the active participation of society, residents, companies, institutions, the educational and scientific community, associations and civil society.

3.2.1.1 Status Analysis in *Bairro da Boavista*

This analysis is based on data provided by Gebalis,[30] as well as findings from the social surveys conducted as part of this project. In 2009, the CML designated *Bairro da Boavista* as an 'Eco-Bairro' (Eco-Neighbourhood), recognising the need for investments and improvements to promote eco-friendly, energy-saving behaviours among residents while enhancing their quality of life. The goal was to transform the area into a model of environmental, social, and urban sustainability (Figure 8).

[29] https://life-lungs.lisboa.pt/acoes
[30] https://gebalis.pt/

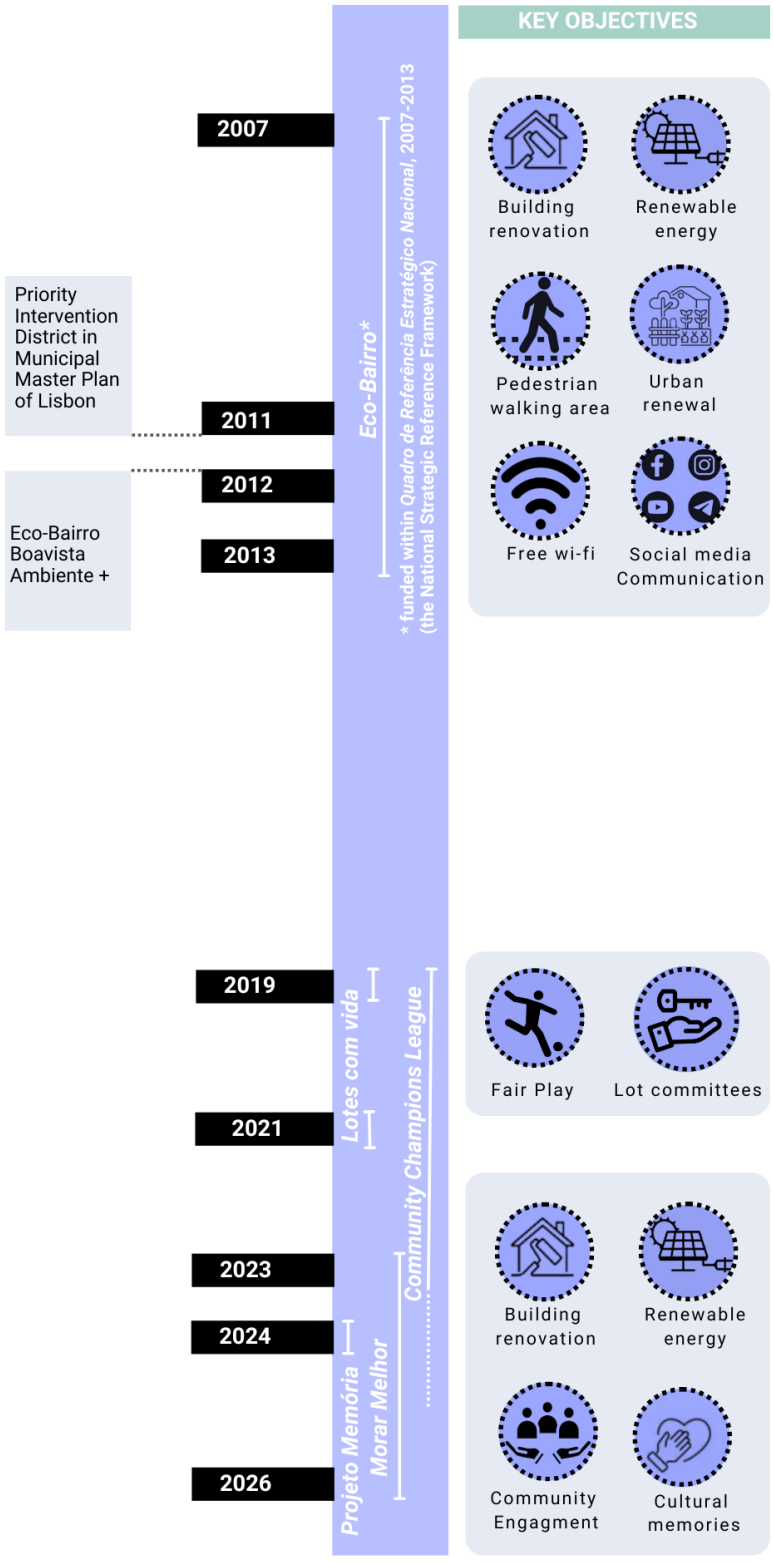


Figure 8. Timeline of the initiatives in Bairro da Boavista (Lisbon).

- The ***Eco-Bairro project*** (2007-2013) was funded within program *QREN - Quadro de Referência Estratégico Nacional 2007-2013* (the National Strategic Reference Framework), aimed at implementing economic and social cohesion policy among EU member states.[31] The use of structural funding for this initiative was crucial for the execution of this project, as the municipality lacked the necessary resources for the intervention. It includes: i) the renovation of multi-family residential buildings; ii) new neighbourhood facilities, including an Eco-Centre and Eco-Gardens; iii) the implementation of renewable solar thermal energy systems; iv) *Net-Verde*, a free-access wireless internet network in the neighbourhood; v) *PediBus*, a pedestrian walking area within the neighbourhood; vi) urban and architectural improvements for the '*Alvenarias*' area; vi) communication initiatives, such as launching the *Eco-Bairros* website[32] and social media, organising sports and recreational activities, and conducting energy and environmental awareness campaigns with monitoring.

  The main goals are: i) urban environment improvement and enhancing quality of life; ii) promotion of environmental sustainability through energy efficiency in buildings and public spaces; iii) social and environmental innovation involving businesses, universities, research centres, and the local community; iv) better civic, social, and environmental behaviour; and v) improvement of the attractiveness of *Bairro da Boavista*.

  In 2011, the *Municipal Master Plan of Lisbon* designated this neighbourhood a 'Priority Intervention District'. Within this project, the area has gone through several stages of rehousing. The 510 single-family 'Alvenarias' houses, built during the first phase in the 1940, were deemed uninhabitable and were demolished and rebuilt, with the work completed in 2018. The multifamily buildings and services (1980/1990) were refurbished. Before the renovation, the buildings were severely deteriorated, with cracked plaster facades. Gebalis surveys found residents frequently complained about cold indoor conditions, humidity, mould, and air infiltration, even in newer areas. To comply with thermal regulations and energy standards, such as the requirements of Decree-Law 118/2013, thermal insulation (black cork agglomerate) was added to the building facades. Later, single-glazed aluminium windows were replaced with PVC (Polyvinyl chloride) double-glazed ones. Additionally, solar thermal panels were installed at the pool and sports complex.

[31] On 26.05.2011, GABIP-Boavista was established to oversee the QREN operation, coordinate stakeholders, and support local partners like the Benfica Parish Council and Residents' Association. To regulate the rehousing process, the criteria for rehousing Boavista residents were established in Deliberation No. 793/2015, published in Supplement 3 of Municipal Bulletin No. 1138 on 10.12.2015.
[32] https://www.ecobairros.org/

- ***Eco-Bairro Boavista Ambiente+*** (2012) aims to reconvert and upgrade public spaces, improve the energy performance of buildings and create new facilities such as eco-centres and eco-gardens. It also included the installation of renewable energies (solar thermal, photovoltaic and wind) and the design of pedestrian walking area in the neighbourhood (Lisboa E-Nova, 2012).
- ***Morar Melhor (Live Better) Programme*** (2023-2026) in 14 lots, totalling 168 units, benefiting a population of 471 inhabitants, and involves interventions in roofs and facades. The programme aims to enhance thermal conditions, improve safety and liveability, and contribute to energy efficiency and greater comfort for residents (CML, 2023b).

Other projects promoted by Gebalis are:

- ***Lotes Com Vida (Plots with life) Programme*** (first phase in 2019 and second phase in 2021)[33] is being implemented in 291 lots located in 25 municipal neighbourhoods in Lisbon, including five building plots in the *Bairro da Boavista*. It supports the creation of lot committees, aiming to involve residents and local organisations in managing and organising the lots. It brings together key local players to assess needs, plan solutions, and foster a cooperative, engaged, and proactive community.
- ***Community Champions League*** (since 2019)[34] within the European Football for Development. A team selected by the Benfica Parish Council, involving 12 young people, to foster participatory processes and implement environmental sustainability practices.
- ***Memories Project: "Every House Tells a Story, Every Street Holds a Memory*** (2024). With the demolition of the area with masonry buildings, architectural heritage is lost. This project aims to preserve the memories of resettled residents and the rehousing, seeking to preserve the history of the *Bairro da Boavista*, while reinforcing the ties between the residents and Gebalis.

Social surveys conducted within this project in 2024 and 2025 in *Bairro da Boavista* revealed that the local community has been significantly benefiting from the adaptation measures promoted by Gebalis (some of those identified in Figure 8). These measures include the renovation of residential buildings, the construction of new eco-friendly housing, the construction of a church and educational facilities, as well as the implementation of diverse social and sports programs aimed at supporting the local population.

[33] https://gebalis.pt/iniciativa/lotes-comvida/
[34] https://gebalis.pt/iniciativa/community-champions-league/

3.2.2. Status Analysis in Žilina

3.2.2.1. Žilina (city level)

Interventions aimed at fostering a more climate-proof urban development in Žilina at city level were implemented within the *Strategy and Action Plan for Adaptation to the Adverse Consequences of Climate Change in the City of Žilina* (hereinafter referred to as the *Strategy*).[35] Developed under the Norway Grants-funded project *Mitigation and Adaptation to Climate Change in Žilina*, the *Strategy* outlines:

i) relevant national and EU-level adaptation documents;
ii) trends and projections for key climate indicators (temperature, precipitation, wind) in Žilina through 2100;
iii) risk analysis;
iv) mapping of vulnerabilities and adaptive capacity at the city level;
v) insights from a citizen survey;
vi) strategic and specific objectives;
vii) proposed adaptation and mitigation measures;
viii) implementation framework;
ix) recommendations for monitoring and evaluation.

The *Strategy* contributes to the development and maintenance of green areas and vegetation in the city and in the countryside to ensure biodiversity. It also aims to mitigate the impacts of extreme hydrological phenomena through water regime adjustments in the territory and responsible, efficient water management. Furthermore, it aims to contribute to the reduction of GHG emissions by increasing its energy self-sufficiency, development of environmentally friendly transport and sustainable resource management. In this context, an overview of recent adaptation projects is shown in Table 9. All projects are at local level, except for *Study - Mapping of the regional premises from the perspective of their potential for the implementation of green and blue measures* and renewable energy which covers the regional scale.

[35] https://zilina.sk/wp-content/uploads/2023/10/26.-Adaptacny-plan-zmena-klimy.pdf

Table 9. Adaptation projects in the Žilina Region and in the city of Žilina (2021–2026).

Adaptation Projects (**SC:** scheduled; **UC:** under construction; **PC:** partially completed; **CO:** completed)			
Žilina Region (ŽSK)			
Project [Period of funding]	**Status**	**Hazard**	**Potential Benefits**
Green roof included in total reconstruction of the premises - Secondary Vocational School of Business and Services in Čadca [2025-2026]	**SC**	Heat wave	Vegetational cover, well-being of users, thermal and sound insulation, reduction of rainwater drainage, improving air quality, reduction of energy costs, biodiversity
Storm sewer and infiltration system - Secondary Vocational School of Sports in Žilina [2025]	**SC**	Torrential rain	Protection of the property and nearby area
Storm sewer and infiltration system, water retention measures - Secondary Vocational School of Business and Services in Žilina – Bytčica [2025]	**SC**	Torrential rain, droughts	Protection of the property and nearby area, saving water
Water retention measures in the premises of seven selected secondary schools throughout the region [2024]	**CO**	Torrential rain, heat wave	Protection of the property and nearby area, supporting biodiversity, saving water, using water for watering greenery
Green roof - Secondary Grammar Schools in Bytča and of V.P. Tóth in Martin [2024]	**CO/UC**	Heat wave	Vegetational cover, well-being of users, thermal and sound insulation, reducing rainwater drainage, improving air quality, reducing energy costs, supporting biodiversity
Study - Mapping of the regional premises from the perspective of their potential for the implementation of green and blue measures and renewable energy [2023]	**PC** (1/3 of premises covered)	Heat and cold wave	It is a study whose benefits are thus indirect.
Green roof - HORIZONT Halfway house (social services facility) in Žilina – Bytčica [2022] Secondary Vocational School of Business and Services in Žilina – Bytčica [2022]	**CO**	Heat wave	Vegetational cover, well-being of users, thermal and sound insulation, reducing rainwater drainage, improving air quality, reducing energy costs, supporting biodiversity

City of Žilina (ŽC)			
Project [Period of funding]	**Status**	**Hazard**	**Potential Benefits**
Wetland revitalisation in the city park of St. George in the city part Trnové – Žilina [2023]	**CO**	Torrential rain, Heat wave	Increase of water retention capacity, biodiversity, expansion of city greenery, prevention from floods
Green roof - Municipal Office of the Žilina City [2023]	**CO**	Heat wave	Vegetational cover, well-being of users, thermal and sound insulation, reducing rainwater drainage, improving air quality, reducing energy costs, supporting biodiversity
Revitalisation of greenery in the city park Chrasť – Žilina [2023]	**CO**	Torrential rain, drought	Increase of water retention capacity, supporting biodiversity, expanding city greenery, prevention from floods
Replanting forests in the city part Zástranie – Žilina [2023]	**CO**	Torrential rain, drought	Increase of water retention capacity, supporting biodiversity, expanding city greenery, prevention from floods
Revitalisation and expansion of green areas in three elementary schools in the Žilina city [2023]	**CO**	Torrential rain, heat wave	Increase of water retention capacity, supporting biodiversity, expanding city greenery, prevention from floods

Table 10 presents local-level projects aimed at enhancing energy efficiency in public buildings across the Žilina Region (ŽSK) and the city of Žilina (ŽC) during the implementation period 2022-2024. Annex A (Table 16) includes key green initiatives financed by the European Commission.

Table 10. Projects for improving building energy efficiency in Žilina Region and the city of Žilina (2022-2024).

Energy efficiency projects [Period of implementation]
Žilina Region (ŽSK)
Insulation, new windows in training centre for hairdressers - Secondary Vocational School of Business and Services, Martin [2024]
Insulation - Regional Library in Žilina [2023/2024]
Insulation, new windows in the garages and backdrop warehouse - Slovak Chamber Theatre Martin [2023/2024]
Insulation, new windows in training centre for confectioners - Secondary Vocational School of Business and Services, Martin [2022/2023]
Roof renovation of administrative building - Hornooravská Hospital with Polyclinic, Trstená [2022/2023]
Heating system modernization - Secondary Grammar School of Jozef Lettrich, Martin [2023]
Insulation - Integrated Health Care Center, Námestovo [2023]
Study - Energy audits of buildings in the regional administration [2022]
Roof renovation - Secondary Grammar School Varšavská, Žilina [2022]
Roof renovation of the gym - Secondary Vocational School of Business and Services, Žilina – Bytčica [2022]
Boiler room - Hotel Academy, Žilina [2022]
Insulation - Secondary Combined Vocational School, Martin [2022]
Heating system renovation - Secondary Vocational School of Polytechnics, Dolný Kubín - Kňažia [2022]
Insulation, new windows - Secondary Vocational School of Business and Services, Dolný Kubín [2022]
City of Žilina (ŽC)
Insulation, new windows - Secondary Vocational School of Machinery in Kysucké Nové Mesto [2023]
Insulation - Secondary Vocational School of Business and Services, Námestovo [2023]
Insulation, new windows - Secondary Vocational School of Electrical Engineering in Žilina [2023]
Complete modernisation - Secondary Vocational Medical School in Liptovský Mikuláš [2023]
Complete modernisation - Halfway home ANTARES in Čadca [2023]

3.2.2.2. Zástranie neighbourhood (district level)

In Zástranie operates one of eight Žilina city's Voluntary Fireman Corps who are responding to emergency situations. Current interventions in the urban district Zástranie are implemented within the *Strategy* (described in *Section 3.2.2.1*).[36] The green areas (two biocentres and a bio-

[36] https://zilina.sk/wp-content/uploads/2023/10/26.-Adaptacny-plan-zmena-klimy.pdf

corridor) within Zástranie and forests nearby are protected areas. Most buildings in Zástranie are family privately owned houses. Therefore, public projects in this area are focused on revitalisation of public spaces. SSC Straník, the pilot building located in the urban district Zástranie, shows lower risk related to climate change effect compared to similar facilities in highly developed urban areas.

The following projects are intended to meet the goals of the *Strategy*:

i) revitalisation and maintenance of forests in Zástranie. The main activities have already been finished, while interventions are performed annually based on emerging needs;

ii) revitalisation of recreation area in the Stará Street in Zástranie (1st phase). This project is included in the *Action plan* of the Žilina city and is focused on revitalisation of the recreation area with a new design of playground elements and furniture for all age categories.

The *Strategy* also recommends additional actions to be taken:

i) the analysis of the revitalisation of two creeks that drain the urban district of Zástranie for slowing down water runoff in case of torrential rains;

ii) the assessment of the retention of rainwater from the kindergarten roofs in Zástranie and determining its appropriate use (e.g., irrigation, toilet flushing).

Another relevant document is the *Joint Program for Economic Development and Social Development of the City of Žilina and the Municipalities of Bitarová, Divinka, Horný Hričov, Lietavská Lúčka, Mojš, Ovčiarsko, Teplička nad Váhom, Višňové* (*2023 – 2032*)[37] that covers the city of Žilina and the other neighbouring municipalities. Currently, Zástranie does not have any sewage system. The principal project intended to be carried out in Zástranie is a construction of sewage system as the urban district still lacks this basic infrastructure. The document identifies Zástranie as an area with poor cycling access and suggests improvement measures.

From the analysis of the questionnaires of the Žilina respondents to the surveys[38] about the effects of climatic adaptation projects carried out on the city ground, it is clear that most of them have noticed changes in weather patterns (e.g., longer and warmer summers and increase in sudden emergency events such as torrential rains). Many participants of this social survey mentioned a lack of parks, trees, and greenery in the city. During a focus group held with Žilina city assembly members and city officials (within task T2.1), the participants highlighted the importance of raising public awareness and recommend focusing on education about climate

[37] https://zilina.sk/wp-content/uploads/2024/01/Spolocny-PHRSR-Zilina-2023_2032_19.1.2024.pdf

[38] organised within RETIME task *T2.1- Analysis of socio-economic contexts, identification of vulnerable groups, and stakeholder mapping at pilot sites*

change. All participants agreed that the previous information campaigns on the topic were insufficient what may result in public disapproval or indifferent attitudes towards realised measures.

3.2.3. Status Analysis in Tartu

Tartu was selected by the EU Mission 100 Climate-neutral and smart cities by 2030.[39] Tartu Regional Energy Agency acts as a strategic partner of the Tartu City Government throughout implementing the *Tartu Energy 2030 plan*. As per Tartu Energy 2030, the energy and climate action plan released in 2021, Tartu City Government has set the goal of cutting carbon emissions by 40% by 2030, compared to carbon emission levels of 2010, as well as reaching climate neutrality by 2050 the latest. This plan includes a community agreement, where local stakeholders (residents, companies, energy producers, for instance) commit to achieving the goals set out in Tartu Energy 2030. Tartu Energy 2030 is preceded by the *Tartu City Sustainable Energy Management Action Plan* for 2015–2020, which focused on reducing energy consumption and carbon emissions through activities of the municipal – but not private – sector. To attain this goal, the Government has identified several fields in which action must be taken, including energy management and consumption, production of renewables and housing (Tartu Energy 2030, p. 3). Both private and public sectors are included, with a focus on resident inclusion and contribution. The plan aims to cut carbon emissions,[40] shift to renewable energy, adapt to climate change, and achieve climate neutrality through collaboration with other European cities. Several other green initiatives have been implemented in Tartu, such as energy-efficient street lighting and public transport, with the following additionally standing out:

- ***Action plan for the reduction of environmental noise in the ambient air of the city of Tartu 2024-2028:*** The goal is to identify optimal actions to reduce the harmful effects of noise, particularly in areas with high impact and affected populations, while preventing noise levels from rising in quiet areas. Some measures are already in progress.
- ***Prediction of Flood Risk from Climate Change in Emajõgi River Basin (2018):*** The flood risk from climate change in the Emajõgi river basin has been forecasted, with mitigation measures identified for flood-prone areas in Tartu, as part of the iWater project.[41]

Also included are renewable-fueled public transportation, promotion of walking and cycling (including a bike-rental system), installation of electric car charging stations, and integration of smart-controlled LED street lighting.

[39] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en
[40] Emissions will be decreased from private transportation (by focusing on promoting cycling, walking and public transportation) and district heating (by creating a heating network, which would not depend on fossil energy).
[41] https://www.integratedstormwater.eu/about

3.2.3.1. Status Analysis in Tartu's historic centre

Given that the plans for increasing the reliance on renewable energy sources, focusing on climate change mitigation as well as reaching climate neutrality have been detailed in Tartu's strategic climate plans (Tartu Energy 2030, 2021), Tartu's historic centre has been the pilot site for several notable initiatives supporting these aims:

- ***SmartEnCity***[42] focuses on improving the energy efficiency of 18 apartment buildings within the area, successfully retrofitting them. SmartEnCity also promotes green transition and sustainable living practices among residents in the area more generally by introducing a lecture series and leveraging the work of active ambassadors.
- ***Herit4Ages***[43] focuses on improving the energy efficiency of buildings with a heritage background. City-wide initiatives such as installing sustainable street lighting, improving the network of cycling paths and adding bike-share systems to the city of Tartu (including the city centre) are among initiatives, which contributed to sustainability and renewable energy goals of Tartu's centre detailed in its energy plan.

When discussing benefits from climate-related initiatives with local stakeholders in Tartu city centre, some residents highlighted that while the issue of poor energy performance of certain buildings was addressed during SmartEnCity project, there is growing interest in adding tall vegetation, greenery, and covered parking. This would aid with cooling effects in apartments, as well as the urban space, especially as summers have become hotter and longer due to climate change in Estonia. The importance of finding the balance between increased renovations and construction in the centre and maintaining the natural diversity in the area to mitigate the effects of climate change was expressed. One local organisation advocating for individuals with disabilities added that green areas or outdoor sporting facilities are impactful for the wellbeing of their clients, given that they can benefit from non-standard sporting solutions. For this, residents and local authorities agreed that the city is an important informative body, both in advising on alternatives to using pavement in the urban space, as well as facilitating the uptake of greenery. On the other hand, local authorities found it useful and practical that Tartu City's climate plan has performance indicators integrated into it, reflecting expectations that the plan is impactful.

[42] http://smartencitynetwork.eu/
[43] https://www.herit4ages.eu/

4. Opportunities analysis across the RETIME pilot sites

The opportunity analysis in risk management services and tools across RETIME pilot sites regards the identification of potential value-added outcomes (*opportunities*) that can be realised through implementing risk management strategies, services, or tools, considering the specific landscape existing in each RETIME pilot site. The primary beneficiaries of this opportunity analysis are public decision-makers, while the ultimate beneficiaries are urban communities, particularly those from vulnerable groups.

Section 4.1 provides an overview of emergency services in the RETIME pilot sites, highlighting successful frameworks and practices that are either underutilised or have the potential to be scaled up.[44] *Section 4.2* outlines key opportunities for multi – hazard and multi – risk assessment tools already used in the pilot sites. *Section 4.3* underlines the highlighted opportunities, that align with EU visions, for pilot sites to benefit from existing urban risk assessment systems and solutions, while *Section 4.4* briefly outlines the specific hazards across the pilot sites, which require timely adaptation solutions.

4.1. Overview of urban risk emergency services

The multi-risk assessment approach within the RETIME project is based on three main components: disaster risk management tools (including early warning systems), spatial planning tools, and vulnerability assessments for at-risk groups.

Drawing on information gathered during visits to local emergency response centres in 2024 and 2025 in Lisbon (Portugal), Žilina (Slovakia), and Tartu (Estonia), as well as insights from local RETIME partners and analysis of legal documents, the current state of emergency service organisation is assessed across RETIME pilot areas. The civil protection and crisis management frameworks currently implemented feature the similarities and differences outlined below.

All countries manage civil protection and crisis management activities at the national level under the Ministry of the Interior.

The national system of civil protection in Portugal is characterised by a hierarchical model of governance. Nonetheless, the law defines the organisational structure of the system. Municipal civil protection services, often working in coordination with local parish-level services, are responsible for preparing emergency plans and implementing response measures. The principle of subsidiarity is enshrined in Portuguese law, stipulating that higher levels of government may only intervene when local resources and conditions are insufficient to manage the situation independently. Local civil protection committees operate on a continuous, 24/7 basis. Portugal

[44] This information will be used an input within the RETIME project for task *T4.1 - Development of site-specific emergency protocols to improve safety and resilience* for complementing the risk assessment and calculations and *T5.1 - Demonstration plan* to support the selection of scenarios for pilot demonstrations.

has a more structured and detailed crisis management system compared to the cities of Tartu and Žilina, particularly at the local administrative level. Civil protection and crisis management department is the umbrella organisation and is at the top of the crisis management pyramid. This is the platform where countries and districts exchange information and learn from each other. It operates within the Union Civil Protection Mechanism (UCPM), which was established by the EU to coordinate and manage assistance to countries affected by disasters. Through the UCPM, members share information and resources to improve collective response and preparedness.

The Municipal Department for Civil Protection of the Lisbon City Council is engaged in initiatives aimed at enhancing the safety of the city and its inhabitants. A recent development has been the implementation of an early warning system in Lisbon. This system is an application that sends messages to mobile phones to communicate in case of emergency. SMS alerts, digital platforms, and sirens powered by grids depend on the availability of electricity and telecommunications infrastructure, especially immediately after an emergency occurs. Therefore, this early warning system must be integrated with alternative communication devices, that do not depend only on the energy supply.

In Slovakia, crisis management and civil protection are on the same level as basic rescue units; they collaborate but operate independently, mainly linked by the 112 Coordination centre, which is led by the local crisis management department. Slovakia is currently establishing a centralised coordination centre to manage emergency responses under a unified structure. This 'all-in-one' approach (bringing together all emergency services, including police call operators) is unique within the Europe. At the local level, crisis committees are composed of municipal council members and are chaired by the mayor. These committees are not permanent bodies; they convene only in response to actual emergency events.

In Estonia, civil protection is managed primarily by the Rescue Board, which falls under the Ministry of the Interior and is the leading organisation in all phases of the DRM cycle but mainly for the response phase. Estonia has established four permanent regional crisis committees, which meet regularly and that can take the lead in addressing emergencies if needed and local/ municipal crisis committees will additionally be convened in a situation of crisis. These activities fall under the Rescue Board, which is the main operational entity responsible for civil protection tasks but mostly focused on fires.[45] Other entities, such as the Government Office, the Ministry of the Interior, Ministry of Social Affairs, Social Insurance Board and the Health Board in Estonia along with local governments are contributing to civil protection activities in mitigating effects, preparing risk analyses, emergency plans and policies (Vabariigi Valitsus, 2024).

[45] In Estonia, an updated civil protection framework has been introduced for the period of 2024–2027. Additionally, information campaigns and resources (e.g., maps of public evacuation spots, list of food items to keep at-hand), as well as civil protection training sessions are promoted, to ensure crisis preparedness and readiness among the wider public in Estonia.

4.2. Multi – hazard and multi – risk assessment tools used across RETIME pilot sites

Across the three RETIME pilot sites, the availability of (multi-) hazard and (multi-) risk assessments and tools varies significantly, which can impact the preparedness of the municipalities and regions. Below is a brief overview of available assessment tools.[46]

Portugal: InfoRiscos is a web platform for cartographic information related to the national risk assessment in Portugal, designed for local and regional authorities, civil protection, and emergency services, as well as researchers and general public.[47] It focuses on hazard susceptibility, specifically seismic, flood, forest fire, landslide, coastal erosion, and industry and technological hazards. Its main aim is to promote the adoption of self-protective behaviours among citizens through risk awareness in the face of potential natural, technological, or combined risks. This web platform is built based on the directive INSPIRE of the European Commission and indicates the metadata used, as well as the methods for collecting geographical information and risks (Silva et al. 2013). However, the related documentation would benefit from more detailed explanations regarding the data preparation methodology used in InfoRiscos. InfoRiscos refers a set of web services used in the platform;[48] however, these were off when this report was written. This potential lack of interoperability features or Application Programming Interface access hinders automatic integration with other risk modelling platforms or local datasets. As so, it is not used by Lisbon Municipality platforms. Nonetheless, the platform InfoRiscos highlights opportunities for collaboration, so it might be beneficial to contact them to exchange experiences and identify areas for mutual learning or joint initiatives, particularly focused on emergency preparedness and response actions.
Developed computer programs include the 'Future Weather Generator,' a Java application for researchers and professionals.[49] This tool allows users to modify existing hourly EPW weather files to simulate climate change scenarios and urban heat island effects within the time frames: 2050 (2036-2065) and 2080 (2066-2095). It leverages a novel ‘morphing’ technique that integrates historical weather data with projected climatic variables. The application is free, cross-platform, and open-access, used by researchers and design professionals.

Slovakia: The official risk assessment is done by a methodology developed in 2012. The methodology was derived from several internationally recognised approaches, primarily the

[46] This analysis will be complemented in the project within task *T3.1 - Hazard identification in three pilot areas*.
[47] InfoRiscos thematic mapping results from GIS (Geographic Information System) projects developed by the National Emergency and Civil Protection Authority (ANEPC-Autoridade Nacional de Emergência e Proteção Civil) in collaboration with other institutions (https://www.pnrrc.pt/index.php/geovisualizador/) [Accessed 26.05.2025]
[48] https://www.pnrrc.pt/index.php/descargas/
[49] It is developed under the CLING project, which is supported by the Portuguese Foundation for Science and Technology (grant number PTDC/EME-REN/3460/2021). https://future-weather-generator.adai.pt/

Hazard Impact Risk Vulnerability (HIRV) model, designed for risk assessment at various territorial levels. However, the identified risks do not reflect new challenges and hazards. The methodology determines affected areas together with the probability of impacts. The vulnerability assessment of the area considers the vulnerability of the population, critical facilities, and the living environment. For the RETIME, the most valuable input could be the information about the vulnerability of critical infrastructure. However, it needs to be disaggregated by type of critical Infrastructure and hazard type as the main outcome is relative risk score.
The information about potential interactions between emergency events and the selected site/building/property is provided by the Albert+ tool.[50] Albert+ builds on current and historical real estate registry data and outputs a summary report detailing information about the selected area such as land type and usage. Further, Albert+ informs about natural and anthropogenic hazards that can cause significant damage not only to infrastructure but also to human lives. The platform provides detailed threat descriptions and indicates the likelihood of risk occurrence. Albert+ tool is primarily dedicated to user who want to avoid unexpected problems when buying a property, as identifying hidden risks can help them to save future costs. The available documentation does not specify the details about methodologies or data inputs. A user manual states that Albert+ is primarily a preliminary orientation tool designed to assist with initial decision-making when purchasing real estates. It is not possible to use Albert+ for other countries since it just covers the Slovak Republic.

Estonia: The risk management system that is used to identify hazards and risks is mainly the Estonian Environmental Portal,[51] where several tools and map layers regarding hazards are available. In Tartu, the crisis coordination department of the Tartu City Administration in collaboration with the Rescue Board of Estonia organises crisis preparedness training sessions for housing associations as well as offers information on their public website regarding recommended actions in a situation of crisis. The updated multi-risk assessment of Tartu is currently in progress, and it will be completed in 2025. The monitoring and evaluation of climate-related risks provided by the Land and Spatial Development Board, Environmental Portal as well as the Estonian Environmental Agency is based on different geoportals reflecting risk areas (e.g., flood risks, heat islands). Additionally, the State Government Office coordinates the development of risks analyses at the national level, which are updated at least once a year, and completely renewed every four years (Riigi Teataja, 2024). The deadline for the completion of the first risk analyses at the municipality level (including Tartu city) is June 30, 2025. Afterwards, also local risk analyses must be updated at least once a year. While some parts of the national risk analysis are also published locally, it is required that all information about local risks must be

[50] https://www.albert.plus/
[51] https://keskkonnaportaal.ee/

publicly available.[52] The risk assessment has been done within the frame of the Tartu Energy and Climate Plan. The plan is prepared at a high-quality level and can inspire other pilot areas with its content and clarity.

4.3. Opportunities for RETIME climate risk assessment

The key challenge is to understand strengths and vulnerabilities in the city's systems over time, identifying current and future vulnerable groups along with critical areas of weaknesses.
In this context, climate risk assessment within the RETIME project presents opportunities to better address the needs of the citizens and especially vulnerable groups. RETIME promotes an integrated, cross-sectoral, participatory approach, which is particularly relevant for the pilot sites due to the strong interdependencies between different infrastructures and services. These opportunities align with its overall framework and pilot activities, reflecting the following emerging methodological trends from recent EU-funded initiatives, as outlined below:[53]



Compound risk modelling & Climate change adaptation scenarios: as outlined within the **MATRIX project**, compound risk modelling addresses cascading effects by integrating through multi-hazard and multi-risk approaches. This ensures that hazard interactions, including triggering, amplification, and compound relationships between hazards, are effectively considered when assessing urban vulnerabilities, leading to a more comprehensive and realistic understanding of potential risks across the pilot areas. The project also actively incorporates climate change adaptation scenarios into urban risk assessments, following recognised European best practices. Within this context, climate-related risks have been systematically integrated into vulnerability and risk scenarios. In Žilina, for instance, practical implementation of adaptation strategies is supported by the *Sustainable Energy and Climate Action Plan* (SECAP) and complemented by regional climate adaptation strategies, which inform local adaptation measures and contribute to the broader climate resilience objectives pursued within RETIME.



Social vulnerability model: Within the current cultural paradigm, there is a shift from quantitative risk models to hybrid models that combine qualitative social vulnerability factors with physical vulnerability and hazard data. Within the **Regions4Climate** project, a risk analysis has been developed in 12

[52] https://kriis.ee/kriisideks-valmistumine-eestis/kriisideks-valmistumine-eestis/elutahtsad-teenused
[53] e.g., CLIMAAX - *CLIMAte risk and vulnerability Assessment framework and toolboX* (https://www.climaax.eu/), MYRIAD-EU - *Multi-hazard and sYstemic framework for enhancing Risk-Informed mAnagement and Decision-making in the E.U.*(https://www.myriadproject.eu/), MATRIX - *New Multi-HAzard and MulTi-RIsK Assessment MethodS for Europe* (https://cordis.europa.eu/project/id/265138), and Regions4Climate (https://regions4climate.eu/).

European regions which adopts a holistic approach, integrating quantitative risk assessment for impact analysis with social, economic and environmental indicators to provide a more comprehensive assessment. Vulnerability to risks intersects several spheres of the representation of reality, which means that entities with the ability to act in these spheres have the potential to apply the results obtained. Obtaining intermediate indexes, criticality and support capacity, with the aim of characterising social vulnerability, produces results with differentiated applicability in different areas of municipal or local intervention.

In the RETIME project, the VS-CES-OSIRIS[54] methodology enables the assessment of social vulnerability at different scales (i.e., municipal in Estonia and Slovakia; and local in Lisbon). This approach reveals criticality and support capacity differences that would otherwise remain hidden, offering valuable insights for local decision-making. The varied geographical distribution of social vulnerability reflects long-standing sociocultural, urban, and economic development processes, which are ultimately expressed in both the physical landscape and social structures.

In civil protection, the development of strategies to promote the safety of people and property should consider and be adapted to the different risk groups identified. In conjunction with social intervention policies, action programs and protocols may be defined to prevent and respond to extensive risks, whether recurring and/or seasonal. It is also worth highlighting the application of the results in social vulnerability in the definition of articulated emergency response plans.

Another area of possible applicability of the results is related to social intervention. Targeted public policies can be developed for vulnerable groups, with the data helping to establish local support networks and improve monitoring. The information produced and its cross-referencing with data from other programs (Annex A, Tables 15, 16, 17), in coordination with different stakeholders, could drive the creation of local proximity networks to monitor the most vulnerable population. The results obtained can also contribute to preventive action that promotes social cohesion, as the components of social vulnerability identify not only vulnerability to natural and technological risks, but also potential situations of social fragility. In spatial planning and environmental management, social vulnerability data informs territorial planning tools, helping to reduce risk and strengthen resilience over the medium and long term. The development and refinement of emergency management instruments, based on information on social vulnerability, allows for preventive action, building resilience, in accordance with local specificities, enabling the optimisation of resources and the effectiveness of the emergency.



GIS-Based Decision Support Tools: The RETIME project addresses the growing urgency of systemic and compound climate risks affecting interconnected urban infrastructures through a **GIS-based decision support framework**. These tools form the analytical core of RETIME's spatial platform, enabling

[54] https://ces.uc.pt/osiris/inicio

stakeholders to model, assess, and respond to climate hazards through geographically and temporally explicit insights. Building on the experience of key EU projects such as **MYRIAD-EU** (Hochrainer-Stigler et al., 2023) and **CLIMAAX**, RETIME leverages geospatial decision support systems (DSS) that integrate BIM, CityGML, and digital twin technologies, advancing risk-informed planning and operational resilience. In alignment with the deliverable *D1.3 - Report on data specification requirements framework Part 1*, RETIME's architecture supports **semantic 3D and 4D modelling**, enabling GIS to operate beyond static 2D mapping. Through interoperability between BIM and GIS, and the use of **CityGML ADEs**, RETIME enables a unified and extensible urban data environment. Notably, in the Tartu pilot, the project expands this approach to include **Heritage-BIM (HBIM)**, allowing RETIME's decision support system to account for both cultural heritage preservation and hazard exposure, such as fire risk, structural degradation, or heat stress impacts on older buildings. To support evidence-based decision-making under climate uncertainty, RETIME integrates multi-scale hazard and impact indicators, drawing from the **CLIMAAX Toolbox**, **PESETA IV impact datasets**, and the **Risk Data Hub**.[55] These datasets offer harmonised European metrics for flooding, drought, and heat stress. However, due to their coarse spatial resolution, RETIME complements them with finer-scale national and regional datasets, such as **Intersucho** (Czech-Slovak drought monitoring) and locally validated proxy indicators. In Žilina, where high-resolution climate projections are limited, RETIME's DSS incorporates building typologies, hydrological proxies, and local knowledge to produce granular, context-aware risk profiles. Looking ahead, RETIME is expanding this toolset into a time-enabled, semantically enriched geospatial database using **PostGIS with temporal extensions** and **Open Geospatial Consortium (OGC)-compliant Application Programming Interfaces (APIs)**. This will support dynamic querying of hazard evolutions (e.g., hourly flood propagation, seasonal drought trends), real-time exposure tracking, and scenario testing. The integration of **linked geospatial data practices** will enable RETIME's GIS-based DSS to bridge 2D hazard maps, 3D building data, and 4D time series across multiple spatial and institutional layers. By anchoring RETIME platform in **GIS-based decision support tools** that are modular, standards-compliant, and interoperable, the project establishes a **scalable and replicable framework** for localised climate risk assessment. This geospatial core aligns directly with evolving data specifications[56] and ensures that the RETIME pilots can benefit from high-resolution, multi-dimensional insights that are adaptable to future climate conditions and policy needs (Guo et al., 2024).

[55] CLIMAAX Project, 2023. CLIMAAX Toolbox and Guidance for Regional Climate Risk Assessments. Horizon Europe CLIMAAX Project. Available at: https://climaax.eu [Accessed 22 May 2025].
[56] defined within *T1.3 - Data specification requirements of adaptation solutions in three pilot areas.*

4.4. Hazards in RETIME pilot sites

The EU has introduced National Threats Register, which should be used in all pilot sites, and made available for all EU member states by The Union Civil Protection Knowledge Network.[57]

Bairro da Boavista is a densely populated district that has developed gradually over time, featuring a variety of building types and construction methods. According to the official assessment,[58] multiple and interacting hazards coexist in the neighbourhood. *Bairro da Boavista* features a moderate susceptibility to flood events and slope movements in specific areas, alongside low to moderate seismic soil vulnerability. Although the wildfire risk is officially assessed as 'very low' to 'low', urban heat stress remains a concern due to the district's limited capacity to mitigate extreme heat events (CML, 2021). These vulnerabilities are further exacerbated by climate projections for the region, which predict more frequent and intense heatwaves and flood events. Addressing these risks requires a comprehensive assessment of their interconnections. Given the dense population, the heterogeneous building stock (that includes ageing infrastructure), public authorities and other stakeholders should analyse and prioritise different risks in an integrated view, considering cascading and compound effects.

Žilina and its municipal district of Zástranie face significant challenges related to radon exposure and the risk of landslides, which threaten infrastructure and transport routes, including the pilot site of the Straník Social Services Home. Seismic risks and wildfires are also notable threats, particularly in areas near forests. Although flood risks are present, they do not present as significant a threat as the other identified hazards, only extreme rainfalls. Historical data indicate insufficient mitigation measures, with the local housing stock dating back to the 1950s, often constructed from highly flammable materials. Fire protection measures are generally inadequate, and their effectiveness is further reduced by the limited availability and capacity of evacuation routes, increasing the risk during fire events. For the pilot site within the Zástranie district, the development of personalised evacuation plans would be beneficial, particularly considering the vulnerable population, as standard procedures may not be sufficient for individuals with mental disabilities, especially during night-time hours (Shields et al., 1999). Given the characteristics of the area and the presence of multiple hazards, it is also important to develop local multi-hazard profiles considering the socio-economic vulnerability of residents when planning adaptation and prevention measures (Antofie et al., 2025).

[57] https://civil-protection-knowledge-network.europa.eu/

[58] Map of natural and anthropic risks in *Bairro da Boavista* (2019) available at https://websig.cm-lisboa.pt/MuniSIG/visualizador/index.html?viewer=LxInterativa.LXi. At national level, the biggest hazard in Portugal is wildfire, the most likely disasters in Lisbon are floods, strong winds and urban fires, as indicated in the Municipal Plan of Civil Protection of Lisbon, Table 4 (PMEPCL, 2018).

Tartu and its historic centre are particularly threatened by flooding caused by the Emajõgi River, with climate change increasing the likelihood of such natural events. The city also faces vulnerabilities related to wildfire risks and challenges associated with energy poverty which may compromise the resilience of key heritage sites and public services during crisis situations. To enhance the protection of cultural heritage, it would be advisable to consider applying approaches similar to the UNESCO Risk Index (Valagussa et al., 2021), which enable the effective identification of the most at-risk historic sites and the prioritisation of measures to reduce their vulnerability to multiple hazards, particularly floods. To improve the flood resilience of Tartu's potential historic centre, the city could also draw inspiration from the Blue-Green Cities concept, successfully implemented in Newcastle following the floods of 2012 (Newcastle City Council, 2024).

5. Analysis of drivers and barriers to urban resilience

5.1. RETIME framework to assess drivers and barriers to urban resilience

This analysis identifies drivers and barriers to building and infrastructure resilience at the district level across the three RETIME pilot sites, using the Sendai Framework for Disaster Risk Reduction (SFDRR) at neighbourhood level (Tables 11 ,12, and 13).

Table 11. Drivers and barriers to urban resilience in Bairro da Boavista.

Bairro da Boavista (Lisbon)		
Sendai Priorities: PRIORITY 1 (P1): Understanding Disaster Risk; **PRIORITY 2 (P2):** Strengthening disaster risk governance to manage disaster risk; **PRIORITY 3 (P3):** Investment in Disaster Risk Reduction (DRR) for resilience; **PRIORITY 4 (P4)**: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction		
P1	**Drivers to urban resilience**	**Barriers to urban resilience**
	- Development of national and regional risk analyses and hazard maps - Implementation of fire safety plans, emergency response plans, evacuation strategies, and Occupational Safety and Health (OSH) plans - Large dataset availability related to the Municipality of Lisbon, including Open Access data in Georeferenced information platform - Active partnerships and collaboration with academic institutions and public authorities - A strong sense of community belonging and the desire to remain in the neighbourhood - Well-managed health and social services by the City Council, which created a pleasant and safe environment	- Critical documents are stored in analog formats across various, often difficult-to-access repositories and archives, hindering efficient information retrieval - The presence of ageing buildings with diverse construction typologies presents challenges for consistent and accurate risk assessments due to varying vulnerabilities - Inadequate integration of remote sensing technologies and on-site surveys results in information gaps in vulnerability evaluations - Current communication efforts fall short in delivering tailored risk information to *Bairro da Boavista* residents, especially those belonging to vulnerable groups
P2	- Civil protection policy is established across all levels -The Municipal Civil Protection Service is well-organised and maintains a strong local presence - Centralised municipal neighbourhood governance management, enabling coordination - Several partnerships between local authorities, civil society, and the private sector.	- Low financial and human resources hinder integrated risk governance - Absence of a systematic and regular mechanism to update information on individuals with special needs hampers preparedness - The layout of the neighbourhood does not permit a significant expansion of green spaces
P3	- Engagement in global networks enables the exchange of best practices and innovative solutions in resilience and civil protection - Experience in green financing mechanisms (e.g., climate bonds, resilience funds)	- Urban resilience initiatives are limited by restricted budgets and competing demands, affecting long-term planning and implementation - The absence of clear benchmarks for climate change resilience makes it difficult to prioritise and guide public interventions effectively

	- Authorities are actively enhancing thermal comfort, safety, liveability, energy efficiency, and overall resident well-being - Legal requirement for building energy certification supports sustainability and energy performance standards - Implementation of a national and municipal text message warning system ensures timely alerts	- Civil Protection early warning systems may fail to reach all segments of the population in a timely manner, particularly the most vulnerable groups
P4	- Robust systems are already in place in the district to monitor environmental quality, supporting early warning capabilities (namely tsunamis alarms and evacuations signage) - Automatic fire extinguishing systems integrated into refurbished buildings enhance fire preparedness	- Lack of integration of technological solutions for early warning systems - Limited usage of digital tools and devices among local inhabitants

Table 12. Drivers and barriers to urban resilience in the urban district Zástranie (Žilina).

Zástranie (Žilina)		
Sendai Priorities: PRIORITY 1 (P1): Understanding Disaster Risk; **PRIORITY 2 (P2):** Strengthening disaster risk governance to manage disaster risk; **PRIORITY 3 (P3):** Investment in Disaster Risk Reduction (DRR) for resilience; **PRIORITY 4 (P4)**: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction		
P1	**Drivers to urban resilience**	**Barriers to urban resilience**
	- Strong collaboration with academic institutions in the area of disaster risk assessment (help to prepare the project documentation to strengthen building resilience and safety of vulnerable group), - Advanced sense of belonging among community members, fostering social cohesion and mutual support	- Incomplete safety related documentation, such as fire plans, emergency plans, evacuation plans, Occupational safety and health plans (OSH) - Insufficient targeted and tailored information provided to Zástranie inhabitants about present risks while considering the needs of vulnerable groups.
P2	- Well-established cooperation among local authorities, non-governmental organizations, and the private sector supports coordinated resilience-building efforts	Heterogenous vulnerable groups living in the urban district requiring an individual approach when evacuated.
P3	- Green areas have been extended in the Zástranie district. Green areas contribute to environmental quality, reduction of impact of urban heat waves	- Lack of funds/resources for building renovation - Insufficient transport connection with the rest of the city, limiting access during emergencies - Insufficient local water supply capacity for firefighters
P4	- Strong local community activity and interest in crisis preparedness training	- Missing communication tools to deliver emergency information to most of members of vulnerable group - missing early warning system (smoke detectors and fire alarm) - Missing automatic fire extinguishing system

Table 13. Drivers and barriers to urban resilience in Tartu's historic centre.

Tartu's historic centre (Estonia)		
Sendai Priorities: PRIORITY 1 (P1): Understanding Disaster Risk; **PRIORITY 2 (P2):** Strengthening disaster risk governance to manage disaster risk; **PRIORITY 3 (P3):** Investment in Disaster Risk Reduction (DRR) for resilience; **PRIORITY 4 (P4)**: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction		
P1	**Drivers to urban resilience**	**Barriers to urban resilience**
	- Development of national and regional risk analyses and hazard maps - Availability of a good information system, including LoD2 / 3D drawings for spatial planning and risk modelling - Collaboration with academic institutions - Participation in EU initiatives focused on mapping vulnerabilities and enhancing public resilience and crisis-readiness	- Incomplete documentation of building information and modifications reduce the accuracy of vulnerability assessments - Dynamic and updated hazard mapping data limited at times (e.g., regarding flooding data, due to projection difficulties)
P2	- Multi-level governance frameworks have been established - Strong legal frameworks and policy enforcement - Partnerships between local authorities, civil society, and the private sector	- Tension between green space preservation and new construction in the city centre, as reflected in public surveys. - Potential misalignment between sustainable urban design (e.g., greenery) and continued reliance on concrete-based constructions in Tartu city centre
P3	- Several EU-initiatives in Estonia, regarding mapping vulnerabilities, stakeholders for increasing resilience and crisis-readiness among the public. - Collaboration with the private sector, as the continuity of vital services must be guaranteed during crises, as detailed in legal frameworks.	- Estonia's internal security framework (Estonian: STAK Siseturvalisuse arengukava) identifies the current need for further ensuring the quality security and safety services provided by the private sector.
P4	- Local, national, and international crisis response trainings, including large-scale simulations (e.g., operation SIIL, which is a military and civil defense exercise held in Estonia) to test communication systems and readiness - Ongoing public education and preparedness campaigns, supported by platforms like Ole Valmis	- Shortcomings in the national emergency communication system were observed during testing in May 2025, including delayed alerts and low siren volume - Estonia's internal security framework (STAK, 2020–2030) identifies the knowledge and skills of the public regarding disaster preparedness / management as a shortcoming to be addressed. - Building-based crisis plans are not widely adopted in the city centre of Tartu.

While in Lisbon and Tartu the key drivers and barriers to urban resilience are largely consistent across both the neighborhood and pilot building levels, the situation in Zástranie (Žilina) differs. At the building level, a more specific analysis is required, which is addressed through the case of the Straník building, as detailed in Table 14.

Table 14. Drivers and barriers to urban resilience in the building pilot in Zástranie (Žilina).

Straník building in Zástranie (Žilina)		
Sendai Priorities: PRIORITY 1 (P1): Understanding Disaster Risk; **PRIORITY 2 (P2):** Strengthening disaster risk governance to manage disaster risk; **PRIORITY 3 (P3):** Investment in Disaster Risk Reduction (DRR) for resilience; **PRIORITY 4 (P4)**: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction		
P1	**Drivers to urban resilience**	**Barriers to urban resilience**
	- Capable and flexible management of a social services centre Straník in Zástranie, which, despite barriers, has created a very pleasant and safe environment for this vulnerable group and is open to other challenges it brings. - Strong collaboration with academic institutions in disaster risk assessment (help to prepare the project documentation to strengthen building resilience and safety of vulnerable group), - Advanced feeling of belonging to the community.	- Ageing Straník building with challenges in evacuation routes and different diagnoses of the people living in it. - Second emergency exit on the first floor does is missing. - Incomplete safety related documentation, such as fire plans, emergency plans, evacuation plans, Occupational safety and health plans (OSH).
P2	- Well developed collaboration among local authorities, non-governmental organisations, and the private sector. - Leaders of vulnerable groups living in the Straník social centre are identified. They can lead others in case of emergency events and help others.	- Heterogenous vulnerable groups living in the Straník building (e.g., suffering from different kinds of diagnoses) requiring an individual approach when evacuated. - Restricted access to the Zástranie district for rescue services in the case of emergencies, combined with disrupted infrastructure such as roads, can pose a significant problem to deliver help.
P3	- Responsible authorities are already considering preparing a project for complete renovation of the Straník building. - Green areas have been extended in the Zástranie district.	- The Straník building and the equipment is not adequate for vulnerable inhabitants and this type of services. - Lack of funds/resources for the building renovation. - Insufficient local water supply capacity for firefighters - insufficient transport connection with the rest of the city
P4	- Strong local community activity and interest in crisis preparedness training.	- Missing communication tools to deliver emergency information to most of members of vulnerable group - Missing early warning system (smoke detectors and fire alarm) - Missing automatic fire extinguishing system.

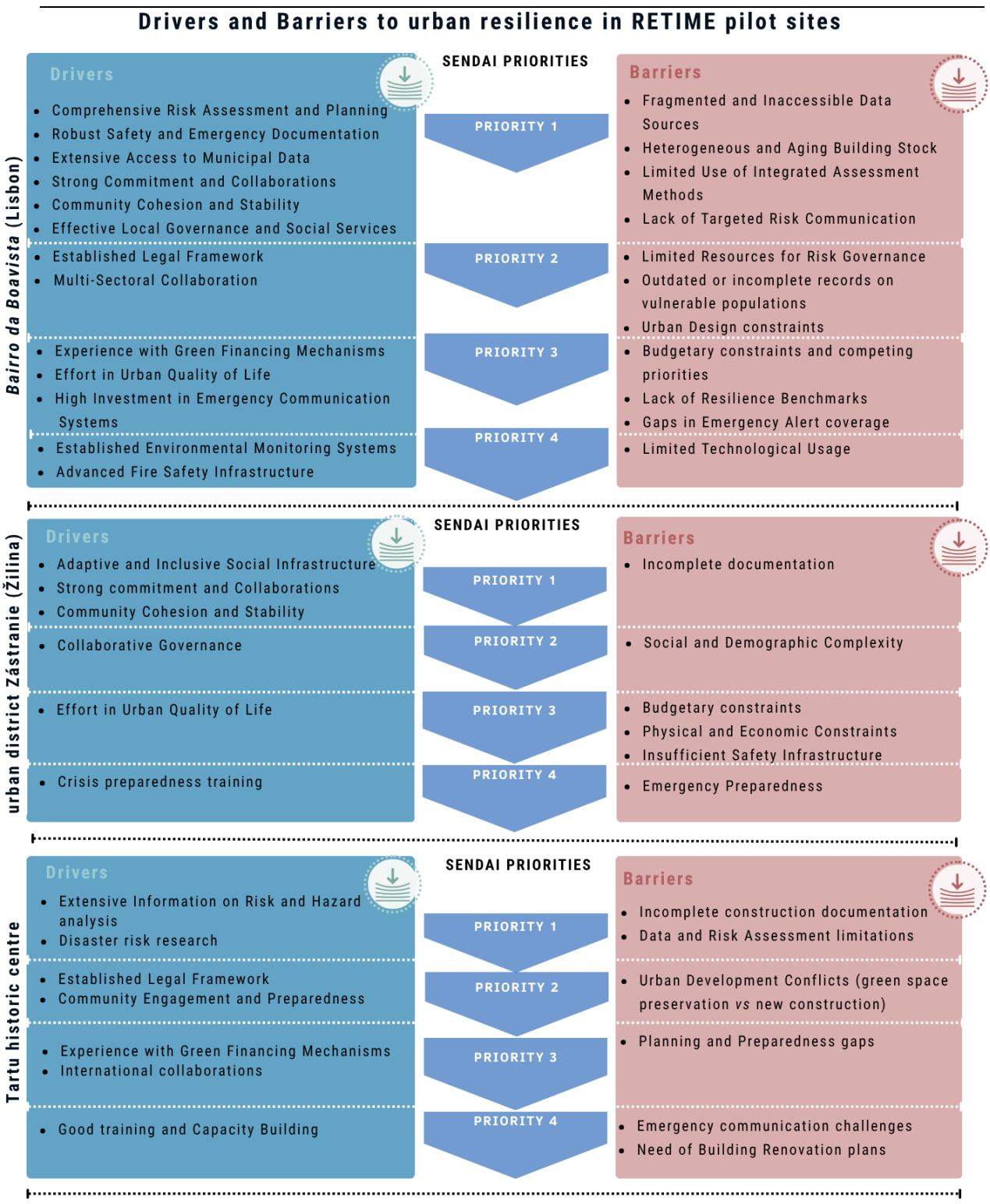
5.2. Cross-site insights on urban resilience

Across the three RETIME pilot sites, common themes emerge around the drivers and challenges of urban resilience (Figure 9). A significant enabler in each pilot site is the collaboration with academic institutions, which facilitates transfer of knowledge. Strong partnerships among government bodies, private sector actors, and civil society enhance governance capacity and coordination. Additionally, it is noted an active community engagement and a collective sense of belonging in the three RETIME pilot sites, which support resilience-building efforts.

Each pilot site faces significant barriers, starting from the documentation (e.g., analog or inaccessible archives, incomplete safety records, or gaps in building information), especially when buildings are privately owned, as observed in Žilina and Tartu. There is a need to develop integrated documentation systems that address gaps in building data, safety protocols, and vulnerability assessments. Improving cross-site knowledge exchange (with interoperability to existing data sources) is also necessary especially in Lisbon and Žilina. Communication strategies must be tailored to effectively reach vulnerable populations. Limited resources constrain the ability to implement comprehensive resilience strategies especially in Lisbon and Žilina, while in Tartu conflicts results between urban development and the preservation of green spaces. Moreover, there is a lack of targeted information for residents, particularly those in vulnerable groups. Each site also offers unique insights based on its specific context. In *Bairro da Boavista* (Lisbon), the presence of a strong open access data infrastructure, including georeferenced information platforms, supports advanced planning and monitoring. The area also benefits from well-developed civil protection mechanisms across multiple governance levels. However, the aging building stock presents a significant challenge, creating complex vulnerability profiles. The neighbourhood layout limits opportunities for expanding green spaces, a challenge also evident in Tartu's historic centre.

On the other hand, in *Bairro da Boavista* and in the urban district Zástranie in Žilina, there is a strong community cohesion and a sense of belonging. Social services are managed flexibly and respond to local needs, however, these areas exhibit major gaps in safety documentation and preparedness programs.

Tartu's historic centre has a more advanced technical systems, including detailed 3D models (LoD2), and robust legal frameworks that support policy enforcement. However, it also faces a particularly complex challenge in balancing historical preservation with resilience objectives. The conflict between maintaining historical authenticity and implementing necessary adaptation measures is especially pronounced in this setting.



PRIORITY 1: Understanding Disaster Risk
PRIORITY 2: Strengthening disaster risk governance to manage disaster risk
PRIORITY 3: Investment in Disaster Risk Reduction (DRR) for resilience
PRIORITY 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

Figure 9. Drivers and Barriers to urban resilience in RETIME pilot sites.

6. Recommendations and policy briefs

To support long-term resilience, adaptation solutions must be holistic, reflecting the inherently multidimensional nature of their drivers and barriers. So, it is required a comprehensive approach supported by strong public commitment and future-oriented policy reform. To enhance urban resilience across these diverse contexts, several key recommendations emerge. The recommendations outlined below for strengthening public policy practices in the RETIME pilot sites are based on government reports and international empirical insights on climate action. They are aligned with broader EU climate policies and contribute to the implementation of the European Green Deal and the targets of the Paris Agreement. They are organised around the four key dimensions of urban resilience defined in the City Resilience Framework by the Rockefeller Foundation and Arup (2016):

i) Health and Wellbeing;
ii) Economy and Society Networks;
iii) (Technological) Infrastructure and Environment;
iv) Leadership and Strategy.

6.1. Health and Wellbeing

Recommendation: Improve access to healthcare services and promote public health initiatives.
Policy Brief: Develop policies that ensure equitable access to healthcare facilities, enhance mental health support, and promote healthy lifestyles through community programs and education. The following recommendations are intended to provide a practical framework for consideration by the municipalities of Lisbon, Žilina, and Tartu:

i) **Safe, Adequate & Affordable Housing:** Promote future retrofitting programmes complying with mandatory updated building codes related to urban resilience;
ii) **Universal Healthcare & Social Services:** Establish mobile public health and climate resilience units in vulnerable areas, offering support for heat-related illnesses and mental health care; Support decentralised health services near elderly populations and vulnerable households in pilot sites and other priority districts;
iii) **Clean, Reliable & Affordable Energy:** Promote local energy communities through photovoltaic cooperatives in municipal housing; Scale up the Solar Action Plan in energy-vulnerable areas using public-private financing tools;
iv) **Safe Water & Sanitation:** Expand green infrastructure solutions such as bioswales and permeable pavements to manage pluvial flooding in low-lying areas; Ensure equitable access to safe water supply and proper stormwater drainage in social housing clusters;

v) **Green Areas and Air Quality:** Increase tree canopy and green spaces in heat-vulnerable neighbourhoods, with a focus on air quality improvement; Expand green infrastructure solutions such as bioswales and permeable pavements to manage pluvial flooding in low-lying areas; Ensure equitable access to safe water supply and proper stormwater drainage in social housing clusters; Use the LIFE LUNGS model to prioritise urban green infrastructure, air quality, and urban climate resilience; Monitor and publicly report on air quality across all parishes and counties using digital displays and open data dashboards.

6.2. Economy and Society Networks

Recommendation: Strengthen social capital and community networks to foster economic resilience and social cohesion. Community participation in resilience planning should be continued to be strengthening through peer-to-peer learning mechanisms, similar to those used in the Making Cities Resilient 2030 (MCR2030) initiative.[59]

Policy Brief: Implement policies that support local businesses, encourage community engagement, and enhance social services. Promote initiatives that build trust and cooperation among residents, such as community centres and local events. The following are examples of practical recommendations that should be taken into consideration:

i) **Sustainable Economy & Livelihoods:** Launch a green jobs programme targeting low-income residents, linked to building retrofits and circular economy projects; Provide incentives for SMEs developing climate-resilient solutions (e.g., early warning systems, thermal retrofitting);

ii) **Effective Education & Skills:** Integrate resilience, climate adaptation, and civil protection topics into local school curricula and adult education programmes; Offer vocational training in green construction and emergency response skills.

iii) **Community Cohesion, Equity & Inclusion:** Support place-based initiatives[60] and expand to other districts to strengthen local resilience capacity; Enhance co-design practices in resilience planning by embedding community members in municipal advisory groups; Institutionalise peer-to-peer learning mechanisms inspired by the Making Cities Resilient 2030 (MCR2030) initiative; Recognise and promote voluntary civil protection and community resilience actions (e.g., through annual resilience awards); Promotion and development of databases indicating individuals with

[59] https://mcr2030.undrr.org/

[60] Some examples are the meetings among citizens and city representatives, public consultations in the three RETIME pilot sites, *Lotes com Vida* in Lisbon, housing and renovation support initiatives led by the Estonian Union of Co-operative Housing Associations or different State institutions in Tartu.

disabilities or other risk factors to assist Civil Protection in its disaster response operations.

iv) **Mapping and Communication Tools for Social Resilience:** Develop and deploy interactive visualisation tools to map vulnerable areas and ongoing resilience efforts (e.g., planned RETIME pilot site dashboards); Use visual storytelling techniques and participatory GIS-BIM workshops to build shared understanding of local risk landscapes.

Focusing on society networks, social surveys conducted as part of the RETIME project in 2024 and 2025,[61] in collaboration with local organisations, highlighted both the valuable role of volunteers and the need to increase volunteer participation. However, difficulties arise when considering the vulnerable groups these organisations advocate for, making the volunteer recruitment and vetting process longer and more thorough, introducing the need for more commitment on the part of potential volunteers, which might thus become a barrier.

6.3. (Technological) Infrastructure and Environment

Recommendation: Modernise and maintain technological infrastructure to ensure environmental sustainability and resilience.
Policy Brief: Invest in upgrading ageing infrastructure, integrate renewable energy sources, and enhance grid stability. Develop comprehensive contingency plans to address potential infrastructure failures and emergencies. Promote nature-based solutions to enhance urban resilience and environmental sustainability.

Enhancing energy resilience in the built environment is of paramount importance for developing effective strategies and policies to mitigate the impacts of disruptions. Resilience in the built environment encompasses key concepts such as vulnerability, resistance, robustness, and recoverability, and addressing these aspects is vital for a comprehensive understanding. Energy resilience in the built environment refers to the inherent and adaptive capacity of buildings, infrastructure, and urban energy systems to anticipate, absorb, recover from, and adaptively respond to disruptions in energy supply and demand, while ensuring sustained functionality, efficiency, and equitability both in the short and long term. Resilience enhancement strategies categorised into five main groups: i) design; ii) retrofit; iii) predictive control; iv) micro-grid; and v) other approaches. These strategies offer numerous benefits, such as enhancing building environments during extreme weather events, prolonging survival time during power shortages,

[61] See footnote 20

utilising renewable energy for demand, and employing advanced controls to mitigate disaster impacts (Wei et al., 2025).

Urban resilience is a multifaceted challenge that requires robust and flexible infrastructure to support critical services and protect citizens. As cities grow and evolve, the ageing building stock presents significant risks to both technological infrastructure and the environment. The April 2025 blackout in the Iberian Peninsula highlighted the vulnerabilities in existing energy infrastructure systems, underscoring the need for diligent maintenance, resourceful planning, and effective contingency measures. The incident highlighted the challenges of maintaining grid stability and frequency regulation. It also underscored the importance of having robust contingency plans and the need for continuous investment in infrastructure to prevent such failures in the future. The following are some examples of practical recommendations for RETIME pilot sites:

i) **Healthy Ecosystems, Green Spaces & Biodiversity:** Implement biodiversity-focused urban planning guidelines in coordination with the RETIME municipalities master plans;

ii) **Protective Infrastructure:** Audit existing civil protection and all infrastructure against updated hazard scenarios in RETIME pilot sites; Prioritise retrofit and maintenance works in socially vulnerable areas; Introduce backup systems to mitigate cascading infrastructure failures, referencing lessons from the Iberian Peninsula blackout; Invest continuously in advanced technologies for monitoring, maintaining and managing infrastructure systems to increase reliability and efficiency.

iii) **Sustainable Transport & Active Mobility:** Integrate enhanced resilience goals into sustainable urban mobility plans, focusing on equitable access in peripheral districts; Expand infrastructure for low-emission zones and last-mile active mobility solutions.

iv) **Accessible Digital Services:** Continue the development and promoting of the use of digital risk-awareness tools with citizen-friendly interfaces; Ensure universal access to digital civil protection alerts, including multi-language support;

v) **Resilience of Ageing Building Stock:** Develop vulnerability assessments of buildings focusing on seismic instability, fire risk, heat/winter stress and floods risks; Implementation at city level regulations to provide tax incentives or grants for the retrofitting of ageing housing infrastructure; Develop contingency plans for infrastructure service disruptions, including backup power for elevators and lighting in social housing.

6.4. Leadership and Strategy

Recommendation: Foster leadership and strategic planning to guide resilience-building efforts. **Policy Brief**: Encourage transparent and inclusive governance practices. Develop long-term strategic plans that prioritise resilience and sustainability. Engage stakeholders in decision-making processes and promote collaboration across sectors, as the following examples:

i) **Accountable Local Government:** Publish a resilience dashboard that tracks the implementation of climate adaptation and risk mitigation actions at the neighbourhood level; Institutionalise resilience offices within spatial planning departments, ensuring intersectoral coordination.

ii) **Inclusive Civic Engagement & Participation:** Create a city-wide participatory resilience budget to allow communities to propose and vote on micro-adaptation projects; Use digital platforms and neighbourhood assemblies to co-design emergency response and adaptation plans;

iii) **Effective Emergency Preparedness:** Expand early warning systems and evacuation drills to cover socially vulnerable neighbourhoods; Create training hubs in each parish to simulate multi-hazard response scenarios, using Virtual Reality and Building Modelling based tools;

iv) **Evidence-Based Planning:** Ensure alignment with organizational and strategic goals by embedding City Resilience Framework-aligned indicators into key urban planning and climate resilience documents. These include *Lisbon's General Drainage Plan*, *Climate Action Plan (PAC)*, and *Municipal Master Plan for Lisbon*; *Strategy and Action Plan for Adaptation to Negative Impacts of Climate Change*, *Urban Plan of the City of Žilina*, and eventually into the *City dashboard for Žilina*, energy use and adaptation indicators into *Tartu Energy* 2030 *(Tartu City Energy and Climate Action Plan)* for Tartu.
Evidence-based research supports the identification of high-impact initiatives, enabling the efficient allocation of both economic and human resources. Furthermore, it equips public decision-makers with the necessary justification for implementing strategic changes and structural investments.

These preliminary recommendations provide a roadmap for creating a more resilient, sustainable, and inclusive urban environment. To foster truly resilient communities, spatial planning in the RETIME pilot sites should integrate adaptive zoning regulations based on evolving risk profiles and interoperable vulnerability mapping. By leveraging new technologies and open-access data, policymakers can make inclusive and future-proof decisions that account for both physical exposure and social fragility.

List of References

Adesão do Município de Lisboa à Rede de Cidades C40 – 2019. https://www.am-lisboa.pt/301000/1/011923,000561/index.htm

Agência Portuguesa do Ambiente (APA). (2020a). *Estratégia Nacional de Adaptação às Alterações Climáticas (ENAAC 2020)*. https://apambiente.pt/clima/estrategia-nacional-de-adaptacao-alteracoes-climaticas

Agência Portuguesa do Ambiente (APA). (2020b). *Plano Nacional Energia e Clima 2030 (PNEC 2030). Metas de Ação*. https://apambiente.pt/clima/plano-nacional-de-energia-e-clima-pnec

Agência Portuguesa do Ambiente (APA). (2020c). *Roteiro Nacional para a Adaptação 2100 (RNA 2100). Planeamento de Adaptação*. https://apambiente.pt/clima/roteiro-nacional-para-adaptacao-2100

Antofie, T.-E., Luoni, S., Tilloy, A., Sibilia, A., Salari, S., Eklund, G., Rodomonti, D., Bountzouklis, C., & Corbane, C. (2025). Spatial identification of regions exposed to multi-hazards at the pan-European level. *Natural Hazards and Earth System Sciences, 25*(1), 287–304.

Área Metropolitana de Lisboa (2009). *Plano Especial de Emergência para o Risco Sísmico*. https://www.aml.pt/areas-atividade/protecao-civil/#:~:text=O%20Plano%20Especial%20de%20Emerg%C3%AAncia%20para%20o%20Risco,Da%20ocorr%C3%AAncia%20de%20um%20evento%20s%C3%ADsmico%20na%20regi%C3%A3o

Área Metropolitana de Lisboa (2020). *Plano Metropolitano de Adaptação às Alterações Climáticas da AML (PMAAC-AML)*. https://documentacao.aml.pt/wp-content/uploads/2023/06/ebook-plano-metropolitano-adaptacao-alteracoes-climaticas-aml.pdf

Assembleia da República (2019). *Primeira revisão do Programa Nacional da Política de Ordenamento do Território*. Diário da República, Lei n.º 99/2019, de 5 de Setembro.

Assembleia Municipal de Lisboa (2018). *Plano Municipal de Emergência de Proteção Civil de Lisboa (PMEPC Lisboa)*. https://www.lisboa.pt/temas/seguranca-e-prevencao/protecao-civil/planeamento-de-emergencia

Autoridade Nacional de Emergência e Proteção Civil (2023). *Plano Nacional de Emergência de Proteção Civil (PNEPC)*. https://planos.prociv.pt/Documents/130313331474961281.pdf

Autoridade Nacional de Emergência e Proteção Civil (ANEPC). (2024). *Plano Distrital de Emergência de Proteção Civil de Lisboa (PDEPC Lisboa)*. https://planos.prociv.pt/Documents/132128656248421116.pdf

Caixa Geral de Depósitos (2020). *Lisboa Capital Verde Europeia 2020*. 2020. https://www.cgd.pt/Sustentabilidade/Responsabilidade-Ambiental/Pages/Lisboa-Capital-Verde-Europeia-2020.aspx

Câmara Municipal de Lisboa (2012). *Plano Diretor Municipal de Lisboa*. Publicado pelo Aviso n.º 11622/2012 no Diário da República, 2.ª série, N.º 168.

Câmara Municipal de Lisboa (2017). *Estratégia Municipal de Adaptação às Alterações Climáticas de Lisboa (EMAAC). Qualidade Ambiental e Alterações Climáticas*. https://www.lisboa.pt/temas/ambiente/qualidade-ambiental/alteracoes-climaticas

Câmara Municipal de Lisboa (2018). *Projeto Ondas de Calor*. https://www.lisboa.pt/temas/ambiente/qualidade-ambiental/alteracoes-climaticas/ondas-de-calor#c1008

Câmara Municipal de Lisboa. (2019). *Plano Municipal de Identificação de Riscos e Vulnerabilidades de Lisboa*. https://lisboaparapessoas.pt/wp-content/uploads/2022/02/pmaacaml_lisboa.pdf

Câmara Municipal de Lisboa. (2020). Lisboa Cidade Resiliente. Município de Lisboa - Resiliência Urbana - Informações e Serviços

Câmara Municipal de Lisboa. (2021). *Programa ReSist*.Programa ReSist

Câmara Municipal de Lisboa. (2023a). *Estratégia Energético-Ambiental para Lisboa*. https://www.lisboaenova.org/images/stories/EstrategiaEnergeticoAmbiental/Brochura_Lisboa_e_nova_240809_.pdf

Câmara Municipal de Lisboa. (2023). *Reabilitação do Bairro da Boavista – Programa Morar Melhor*. Bairro da Boavista - Gebalis

CLIMAAX Project, 2023. CLIMAAX Toolbox and Guidance for Regional Climate Risk Assessments. Horizon Europe CLIMAAX Project. Available at: https://climaax.eu

Comissão Sub-Regional do Sistema de Gestão Integrada de Fogos Rurais. (2024). *Programa Sub-regional de Ação de Gestão Integrada de Fogos Rurais da Área Metropolitana de Lisboa*.

Desouza, K.C. & Flanery, T.H. (2013). Designing, planning, and managing resilient cities: A conceptual framework. Cities, 89-99.

Direção Geral de Energia e Geologia (DGEG). (2019). *Roteiro para a Neutralidade Carbónica 2050 (RNC 2050)*.

EIC. (2020). *Environmental investment centre*. https://kik.ee/en/about-us

Environmental Board. (2024). *Estonia environmental board introduction*. https://keskkonnaamet.ee/en/organization-contacts/organization/introduction

European Comission. (2022). *Missão Cidades*. https://portugal.representation.ec.europa.eu/news/guimaraes-lisboa-e-porto-entre-100-cidades-participantes-na-missao-da-ue-cidades-com-impacto-neutro-2022-04-28_pt

Estonian Government Office. (2024). *Elanikkonnakaitse arengusuunad kokkuvõtlikult* [Summary of Civil Protection Development Directions]. https://valitsus.ee/sites/default/files/documents/2024-02/elanikkonnakaitse%20arengusuunad%20kokkuv%C3%B5tlikult.pdf

Guo, F., Ma, L., Wu, J., Chen, K., Fang, W. and Broyd, T., 2024. A Systematic Review of Multi-scale Digital Modelling in Sustainable Urban Design and Management. Sustainable Cities and Society, p.106103.

Hochrainer-Stigler, S., Trogrlić, R. Š., Reiter, K., Ward, P. J., de Ruiter, M. C., Duncan, M. J., Torresan, S., Ciurean, R., Mysiak, J., Stuparu, D., & Gottardo, S. (2023). Toward a framework for systemic multi-hazard and multi-risk assessment and management. *iScience, 26*(5), 106712.

Kommunikatsioonibüroo. (2024). *Elanikkonnakaitse raamdokument*. https://kriis.ee/sites/default/files/documents/2024-02/Elanikkonnakaitse%20raamdokument.pdf

Life Lungs. (2019). *Projeto Life Lungs*. https://life-lungs.lisboa.pt/

Lisboa E-Nova (2012). *Eco-Bairro Boavista Ambiente+* . https://www.lisboaenova.org/images/stories/Conferencias/2013/BoavistaAmbiente9Maio.pdf

Lisboa Para Pessoas (2024). *Contrato Climático Cidade de Lisboa 2030* [Lisbon Climate City Contract 2030]. https://lisboaparapessoas.pt/wp-content/uploads/2024/07/lisboacontratoclimatico2030.pdf

Manca, A.R., Benczur, P. & Giovannini, E. (2017). Building a scientific narrative towards a more resilient EU society, Part 1: a conceptual framework, EUR 28548 EN.

Ministry of Climate. (2023). *National Energy and Climate Plan*. https://kliimaministeerium.ee/en/national-energy-and-climate-plan

Ministry of the Interior. (2021). *Kriisireguleerimis-Poliitika Ülevaad*. https://www.siseministeerium.ee/sites/default/files/documents/2021-12/Kriisipoliitika%20kokkuvote_2021.pdf

Ministry of the Interior. (2023a). *Ensuring internal security*. https://www.siseministeerium.ee/tegevusvaldkonnad/kindel-sisejulgeolek/sisejulgeoleku-tagamine

Ministry of the Interior. (2023b). *Preparedness for crises*. https://www.siseministeerium.ee/en/activities/guaranteed-internal-security/crisis-management

Ministry of the Interior. (2025). *Internal Security Development Plan 2020-2030*. https://www.siseministeerium.ee/stak2030#kiire-ja-asjatundlik

Newcastle City Council. (2024). *Blue-Green Newcastle: Flood Management*. https://new.newcastle.gov.uk/planning-building-development/flood-management/blue-green-newcastle

Plano de Ação Climática Lisboa 2030 (2021). *PAC Lisboa 2030*. Câmara Municipal de Lisboa.

Plano Geral de Drenagem de Lisboa (PGDL) (2015). https://planodrenagem.lisboa.pt/sobre-o-plano?utm_source=chatgpt.com

Plano Municipal de Defesa Da Floresta Contra Incêndios de Lisboa (2020).

Presidência do Conselho de Ministros. (2002). *Plano Regional de Ordenamento do Território da Área Metropolitana de Lisboa (PROT-AML)*. Diário da República, 1.ª série-B, N.º 82. .

Rede de Municípios para a adaptação às alterações climáticas (adapt.local). (2016). *Projeto ClimAdaPT.Local*. https://www.adapt-local.pt/

Riigi Planeeringud (2024). *Koostamisel riiklikud planeeringud*. https://www.riigiplaneering.ee/en

Riigi Teataja (2021). *Emergency Act*. https://www.riigiteataja.ee/en/eli/ee/529122024011/consolide

Saja, A.M.A. , Goonetilleke, A., Teo, M. & Ziyath, A.M. (2019). A critical review of social resilience assessment frameworks in disaster management, International Journal of Disaster Risk Reduction. https://doi.org/10.1016/j.ijdrr.2019.101096

Silva, H., Mariano, A.C., Assis, M., & Antunes, L. (2013) Perfil MIG v. 2 - Perfil Nacional de Metadados de Informação Geográfica - DRAFT 8 de Julho de 2013.
https://snig.dgterritorio.gov.pt/sites/default/files/Documentos/55/PerfilMIG_v2_Draft8Julho2013.pdf

Tartu City Government & Tartu Regional Energy Agency. (2021). *Tartu Energy 2030: Tartu City Energy and Climate Action Plan*. https://www.tartu.ee/sites/default/files/uploads/Linnavarad/SECAP/TartuEnergy2030.pdf

Tartu City Government. (2025). *Kriisideks Valmisolek*. https://tartu.ee/et/kriisideks-valmisolek#kriisiolukorras-abi-saamine/Kriiside-lahendamine

The Rockefeller Foundation & Arup. (2015). City Resilience Framework. https://www.rockefellerfoundation.org/wp-content/uploads/City-Resilience-Framework-2015.pdf

The Rockefeller Foundation & Arup. (2016). City Resilience Index: Understanding and Measuring City Resilience. http://publications.arup.com/publications/c/city_resilience_index.

United Nations Office for Disaster Risk Reduction (UNISDR) (2012). Making Cities Resilient Report 2012: My City is Getting Ready, United Nations Office for Disaster Risk Reduction, www.unisdr.org/files/28240_rcreport.pdf.

Shields, T. J., Boyce, K. E., & Silcock, G. W. H. (1999). Evacuation behaviours of occupants with learning difficulties in residential care premises. *Fire Safety Journal, 32*(4), 331–357. https://doi.org/10.1016/S0379-7112(98)00065-7PubMed

Valagussa, A., et al. (2021). Hazard ranking of the UNESCO World Heritage Sites (WHSs) in Europe by multicriteria analysis. *Journal of Cultural Heritage Management and Sustainable Development, 11*(2), 123–145.

Wei, M., Jiang, Z., Pandey, P., Liu, M., Li, R., O'Neill, Z., Dong, B., & Hamdy, M. (2025). Energy resilience in the built environment: A comprehensive review of concepts, metrics, and strategies. *Renewable and Sustainable Energy Reviews, 210*, Article 115258.

Annex A: EU-funded projects on Climate Action across RETIME pilot sites

Table 15. List of green EU-funded projects using Lisbon and Portugal as pilot sites (2020-2027).

Project [Date of Execution]	**Aim**	**Case study**
AGEO - Platform for Atlantic Geohazard Risk Management [01.06.2019 to 31.05.2023] https://ageoatlantic.eu/	Develop and promote innovative tools and strategies for improving the monitoring, prevention, and management of geohazards across the Atlantic area.	Funchal area on Madeira Island
B-WaterSmart - Accelerating Water Smartness in Coastal Europe [01.09.2020-31.08.2024] https://b-watersmart.eu/	Drive the transition toward water-smart economies and societies across coastal Europe and beyond.	Lisbon
CIRCOFIN - Circular Construction Finance [01.01.2025-31.12.2027] https://cordis.europa.eu/project/id/101180525	Promote the development of a circular economy in the construction and building sectors.	Lisbon
COMPILE - **Integrating community power in energy islands** [01.09.2018-31.10.2022] https://www.compile-project.eu/	Foster the usage of renewable energy sources by using decentralised solutions that interoperated with existing centralised energy infrastructure.	Lisbon (neighbourhood *Alta de Lisboa*, 8 buildings comprising a total of 150 apartments).
CONEXUS - CO-producing Nature-based solutions and restored Ecosystems: transdisciplinary neXus for Urban Sustainability [01.09.2020-31.08.2024] https://www.conexusnbs.com/	Co-create Nature-based Solutions to restore urban ecosystems and promote sustainable and inclusive urban development.	Lisbon (*Vale da Montanha Park in Areeiro Parish*, *Bela Vista Park*, *Ruas Verdes+ Pilot in Areeiro*, *Arroios*, and *Penha de França* Neighborhoods)
DECA - Delivering Effective Climate Actions [04-2024-05.2028] https://www.interregeurope.eu/deca	Enhance climate change adaptation in European regions by developing policies and strategies to boost investment, reduce costs, and improve climate action effectiveness.	Lisbon (*Praça de Espanha* to be converted into the *Gonçalo Ribeiro Telles Urban Park*)
INCLUDING - Innovative cluster for radiological and nuclear emergencies [01.08.2019-31.07.2024] https://www.including-h2020.eu/	Provide a comprehensive training in the radiological and nuclear threats.	Portugal

LIFE LUNGS - Towards a more resilient Lisbon UrbaN Green InfraStructure as an adaptation to climate change [16.09.2019-31.08.2025] https://life-lungs.lisboa.pt/	Implement Lisbon's climate adaptation strategy by using urban green infrastructure to enhance resilience, manage water sustainably, reduce urban heat, and support ecosystem services.	Lisbon
RESILENS - Realising European ReSILiencE for Critical INfraStructure [01.05.2015-30.04.2018] https://cordis.europa.eu/project/id/653260	Promote the implementation of resilience across all critical infrastructure sectors.	Lisbon
Shift2MaaS - Shift2Rail IP4 enabling Mobility as a Service and seamless passenger experience [01.12.2018-30.06.2021] https://cordis.europa.eu/project/id/826252	Increase the uptake of mobility as a service platform.	Lisbon Metropolitan Area

Table 16. List of green EU-funded projects using Žilina as a pilot site (2023-2025).

Project [Date of Execution]	**Aim**	**Case study**
CLIMAAX- CLIMAte risk and vulnerability Assessment framework and toolboX [01.01.2023 - 31.12.2026] https://www.climaax.eu/project/	Provide financial, analytical, and practical support to improve regional climate and emergency risk management plans.	Žilina city
FutureFor - Copernicus Applications for Next-Generation Forest Monitoring [01.11.2024-30.04.2027] https://futurefor.eu/	Support the set-up and implementation of the proposed EU Regulation for a monitoring framework for resilient European forests.	EU
HURRICANE - Holistic UGV-based Resilient and Real-time Intelligence for Crisis and Natural Emergency [01.01.2025-31.12.2028] https://cordis.europa.eu/project/id/101168017	Use robotics to transform disaster response, by combining ground and aerial robots with smart technologies like real-time data sharing, laser-based charging, and advanced communication systems.	EU-wide responders training modules
SPINE – Smart public transport initiatives for climate-neutral cities in Europe [01.01.2023-31.12.2026] https://www.spine-project.eu/	Accelerate progress towards climate neutrality by integrating public transport systems with new mobility services, sharing schemes, active transport modes, and micro-mobility.	Žilina city
WinWin4WorkLife - Healthy, inclusive and sustainable remote work futures as a Win-Win for employees and employers in urban, rural and cross-border areas [1.2.2024 - 31.7.2027] https://winwin4worklife.eu/	Study optimal work from home scenarios regarding benefits and impacts, focusing on transport and land use.	Slovakia (Bratislava, Košice and Žilina cities)

Table 17. List of green EU-funded projects using Tartu and Estonia as pilot sites (2021-2027).

Project [Date of Execution]	**Aim**	**Case study**
BSR ELECTRIC [10.2017–09.2020]https://www.bsr-electric.eu/partners/	Promote the use of e-mobility transportation option (e.g., E-bikes)	Tartu city
Cities.multimodal [10.2017–03.2021] https://www.cities-multimodal.eu/	Promote the alternative means of transportation to the use of private cars	Tartu city
ClimaGen [01.2025-12.2028] https://enoll.org/project/climagen/	Increase climate resilience and creating low carbon public spaces through the use of green spaces	Annelinn district in Tartu
DrOp [10.2022–10.2026] https://drop-project.eu/drop/	Transform social housing neighbourhoods into smart neighbourhoods	Elva city, located in Tartu rural municipality
eRural Resilience [11.2023–10.2026]https://www.tartumaa.ee/projects/erural-resilience // 11.2023 - 10.2026	Support bio-businesses in rural areas	Tartu county
GOOD CITIES [04.2024–06.2028]https://www.interregeurope.eu/good-cities	Reduce consumption and ecological footprints, mitigation of environmental impacts from consumption	Tartu County
HEAT [04.2018–03.2021]https://database.centralbaltic.eu/project/78	Promote cycling and light mobility to create green/healthy urban areas	Tartu city
Herit4Ages [11.2023–11.2027]https://www.herit4ages.eu/	Energy-efficient, data-based and inclusive renovations of buildings of heritage background	Vironia Society building in Tartu historic centre
INCREASE [11.2023–07.2028]https://www.increaseipv.eu/about	Using integrated solar panels, encourage their wider use in different categories of buildings	Tartu Hansa School's greenhouse
iWATER project Prediction of Flood Risk from Climate Change in Emajõgi River Basin [12.2015–05.2018]	Forecast flood risks and prepare mitigation mechanisms	Emajõgi river basin in Tartu city
oPEN Lab [10.2021–03.2026] https://openlab-project.eu	Update districts and neighbourhoods to operate as Positive Energy Neighbourhoods	Annelinn district in Tartu
OptiTrans [02.2017-12.2021]	Promote the wider use of public transportation	Tartu city

https://tartu.ee/en/sustainable-tartu#project-optitrans		
RENOVERTY [11.2022–10.2025] https://ieecp.org/projects/renoverty/	Update houses to be more energy efficient in households that are energy poor (Central and Eastern Europe, Southeastern Europe, South-Eastern countries)	Tartu
SmartEnCity [02.2016-07.2021] https://smartencity.eu/	Create better quality and more environmentally friendly living environments for residents, in order to motivate the population to make green choices more generally.	18 buildings in Tartu City Centre area renovated from Khrushchevka to Smartovka style buildings
SYNERGIES [12.2023–11.2026] https://synergiesproject.eu/	Contribute to disaster preparedness, cultivating a culture of knowledge in the area of action	Estonia
Tartu County Climate and Energy Plan	Create development goals regarding both climate change adaptation as well as climate change mitigation	Municipalities in Tartu County
Tartu County Development Strategy 2040 https://www.tartumaa.ee/iabout-us/tartu-county-development-strategy-2040	Wellbeing, living environment, entrepreneurship, and mobility are the four key areas for the development strategy.	Tartu County
Tartu Energy 2030	Align with European Green Deal climate goals by setting mitigation and adaptation measures.	Tartu City