RESIST

Needs Assessment for Twinning Regions

Deliverable 1.10

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Abbreviations

AR	Augmented reality
AR5	5th Assessment Report
AR6	6th Assessment Report
CAB	County Administrative Board
CBA	Cost-benefit analysis
CCA	Climate change adaptation
CDR	Central Denmark Region
CEREMA	French Centre for Studies and Expertise on Risks
CIMBAL	Inter-municipal community of Baixo Alentejo
CRA	Climate Risk Assessment
EEA	European Environment Agency
EMT	Eastern Macedonia and Thrace
ENAAC	National Strategy for Adaptation to Climate Change
ERDF	European Regional Development Fund
FSL	Fire Smart Landscape
GHG	Greenhouse gas
GIEC Normand	Norman Intergovernmental Panel on Climate Change
IPCC	Intergovernmental Panel on Climate Change
LEGMC	Latvian Environment, Geology and Meteorology Centre
MCCE	Mapa del Cambio Climático en Extremadura
MSB	Swedish Civil Contingencies Agency
NAS	National Adaptation Strategy to Climate Change
NbS	Nature-based Solutions
NC	National Communication
NCCAS	National Climate Change Adaptation Strategy
OFB	French Biodiversity Agency
PCAET	Territorial climate-air-energy plans
PEIEC	Extremadura's Integrated Energy and Climate Plan
PIAAC BA	Intermunicipal Plan for Adaptation to Climate Change in Baixo Alentejo
PNACC	National Climate Change Adaptation Plan
RAAP	Regional Adaptation Action Plan
RBMP	River Basin Management Plan
RCCAS	Regional Climate Change Adaptation Strategy
RCP	Representative Concentration Pathway
SDAGE	Master Plan for Water Development and Management
SECAP	Sustainable Energy and Climate Action Plans
SMHI	Swedish Meteorological and Hydrological Institute
SRADDET	Regional Scheme for Planning, Sustainable Development and Territorial Equality
SW Finland	Southwest Finland
UNFCCC	United Nations Framework Convention on Climate Change
VR	Virtual reality

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ZPR	Zemgale Planning Region

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1 Introduction

1.1 Purpose of the needs assessment

Task 1.1, which this needs assessment is part of, aims at supporting the regions in the RESIST project in their climate adaptation actions. In order to develop a plan of action for this support as well as a basis for designing innovative adaptation solutions, it is first necessary to understand the status quo in each of these regions. This includes an analysis of the challenges they are facing and the needs they have, regarding both the immediate project activities that will be implemented as part of Work Package 3, as well as in the wider regional adaptation context. Examining the baseline from which the regions are starting into the project is therefore a core component of this analysis.

The needs assessments form the first step in the climate change adaptation (CCA) framework of Task 1.1. As described in the proposal, this framework follows several overarching principles, which are integrated into the analytical approach of this needs assessment:

1. Following a flexible and context-specific approach in which the developed solutions are tailored to the needs and vulnerabilities of each individual region. To implement this approach, it is essential to have detailed insights into the context in which climate adaptation takes place in each region. This is a prerequisite for solutions being designed to fit the needs of the region.
2. The design of adaptation solutions and decision-making process is based on a participatory approach, considering the most vulnerable population groups and accounting for the gender-specific impact of climate change. Contributing to just resilience is therefore a central principle of this framework. Examining in how far these considerations are already integrated into adaptation activities is a core component of the needs assessment.
3. The facilitation of Nature-based Solutions (NbS), in line with the new EU Adaptation Strategy. Understanding whether NbS already play a role in regional adaptation measures or if they could be integrated into future adaptation activities.
4. Following, where possible, a transformative adaptation approach (see section 2.1.2) which enables large-scale and long-lasting impacts. The results of the needs assessment can in the subsequent steps point towards possible paths of upscaling solutions, using currently planned activities as a basis for designing more transformative options.

Identifying starting points for possible support to regional partners allows adelphi and other partners to tailor their next steps to the most important needs and challenges. It also gives an indication of ways in which the effectiveness or scale of adaptation activities could be increased in order to achieve large-scale impacts.

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It is crucial to understand that the purpose of these assessments is not to evaluate the regions' work on climate change adaptation. On the contrary, it is to find ways in which to most effectively support their work and understand the context in which regional partners operate. Another goal of the needs assessment is to identify questions that remain open at this point in time but will be answered as soon as the necessary information is available in order to support regional climate change adaptation in the most effective way.

1.2 Overview of this document

This deliverable contains the individual needs assessment for each of the eight twinning regions that are part of RESIST. Chapter 2 details the methodological approach to these assessments and outlines the different parts of the analysis. It also describes the information sources that were included in the analysis and how these were utilized. Limitations in some of the data used, specifically the ESPON dataset, are pointed out. Chapter 3 contains the eight needs assessments of the twinning regions. Each of these assessments follows the same structure: The first part looks at the region's climate risks and the already existing climate risk assessments (either at local, regional or national level). The second part examines existing and planned adaptation measures and points to ways in which these might be improved or their implementation might be supported by the horizontal partners. The subsequent sections of each needs assessment examine the stakeholder engagement as well as capacity constraints the region is facing. The final section summarises the results and gives an overview of the identified regional needs and challenges. It also contains some initial ideas of potentials for transfer between regions. Chapter 4 provides an overview of the most important results of the assessment, identifies common themes in the eight regions and discusses some of the experiences made during the needs assessment process. Finally, this chapter looks ahead at the next steps and discusses what the update process of the needs assessment for D1.11 will involve. Annex A and Annex B contain documents that formed part of the needs assessment process. Annex C and Annex D describe details about a dataset (ESPON) that was used as part of this assessment.

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2 Methodological approach

2.1 Analytical concept for the needs assessments

The needs assessment collects information on currently existing climate risk assessments, adaptation policies and measures as well as information about stakeholder involvement and different capacities and identifies any gaps, challenges or needs for support in each region (see Figure 1). For the first two components (climate risk assessments and adaptation measures), which constitute the main focus of this analysis, we applied a list of “best practice”-criteria. These criteria are framed as guiding questions for the analysis and constitute characteristics of adaptation that, when fulfilled, lead to effective, just and sustainable adaptation actions.

Following this structured approach allows to identify any areas of potential improvement or further development of adaptation measures as well as determining more general challenges the regions are facing in the context of climate adaptation. The results will indicate possible angles for support from horizontal partners.

For each region, the structure or focus of the assessment may be changed slightly to accommodate the individual circumstances, available information and adaptation dimensions of the respective region.

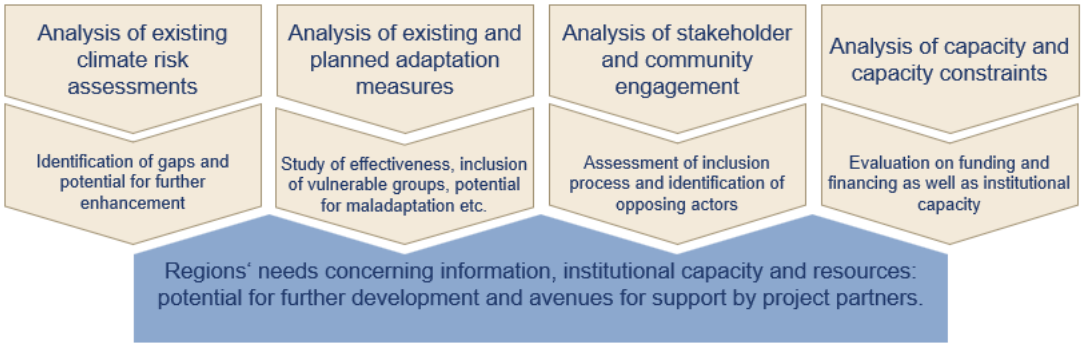

Figure 1: Schematic illustration of applied methodology for needs assessments.

Many of the questions and analytical components outlined in the following sections may not be answered at this moment since the information available regarding planned adaptation measures is not sufficiently detailed. However, this lack of detail is in no way to the detriment of this needs assessment.

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Each section of the regions' needs assessment summarises information about the status quo, existing climate risk information and adaptation measures as well as the stakeholder community and institutional and financial capacities. It then examines whether criteria of good practice are met, where gaps exist and how the existing information or plans can be improved. This assessment of information, institutional capacity and resource needs on the one hand points to further development potential and possible avenues for support by the horizontal partners of measures planned within RESIST. On the other hand, it indicates ways in which the overall goal of the project can be achieved, i.e. developing and upscaling innovative solutions and supporting systemic adaptation.

2.1.1 Analysis of climate risk assessments

Not all regions that are part of RESIST have their own climate risk assessment. What we refer to here as climate risk assessments are any documents that contain an analysis of or information about climate hazards, exposure or vulnerability to the impacts of climate change that cover the region or parts of the region. The information provided in these documents is analysed by adelphi to identify in how far certain good quality characteristics for climate risk assessments (CRAs) are fulfilled.

Following the international standard EN ISO 14091 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment (ISO 14091:2021) and the requirements of the EU Taxonomy for climate risk assessments (see EU Delegated Act 2021/2178 (European Commission 2021) and corresponding interpretation) a number of key steps for CRAs can be identified. As part of the needs assessment, the project team will check in how far the past climate risk assessments in the target regions have included these steps. This is beneficial for putting the findings of past assessments into context and determining possible needs and approaches with respect to future risk assessments. The key steps or features are as follows:

1. The analysis covers at least two Representative Concentration Pathway (RCP) scenarios. Preferably, scenarios should be used that conform to current emission pathways, i.e. RCP8.5.
2. The analysis looks at medium- and long-term changes, e.g. mid-century and end of century.
3. The analysis touches on a wide range of climate-related hazards, not only changes in temperature and rainfall.
4. The analysis considers both extreme events (such as flooding or heat waves) as well as slow onset changes (such as sea level rise).
5. The analysis includes examination of the main risk components and is not simply looking at hazards or only operating with aggregated factors like risk or vulnerability. The main risk components are:
    - sensitivity, defined as "the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change" (IPCC 2022),

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- exposure, defined as “the presence of […] assets in places and settings that could be adversely affected” (IPCC 2022), and
- adaptive capacity, defined as “the ability of systems […] to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCC 2022).

6. When looking at exposure, sensitivity and adaptive capacity, temporal aspects are taken into account, e.g. it is considered how these factors are likely to change over time. For example, sensitivity might change to due changes in the population structure.
7. The analysis outlines impact chains in a transparent way. Impact chains are a tool to better understand, visualize, systemize and prioritize the factors that drive climate risk (ISO 14091:2021).
8. Uncertainties and data sources used are highlighted.
9. The results of the analysis have a spatial component, e.g. indications where certain risks are most prevalent.

It is not expected that an analysis of climate risks in the twinning regions comply with all of these features. Some regions may not have any climate risk assessments to begin with. In these cases, the analysis will look at information available from international datasets. The list provides a framework for assessing the information already covered in existing analysis to identify potential gaps. Climate risk assessment containing information on all the aspects listed above provide a meaningful basis for the design and prioritization of adaptation measures. For example, pointing out particular spatial “risk hotspots” or areas with a population particularly sensitive to the impacts of heat waves allows policy makers to design adaptation measures specifically targeted to these areas and vulnerabilities.

2.1.2 Analysis of adaptation measures

A similar approach is applied to the analysis of the existing and planned adaptation measures in each region. The project team defined a number of characteristics that these measures should exhibit. Many of these are process-based, meaning that the process of designing and implementing adaptation measures should include certain steps and considerations and the analysis looked at whether these were integrated in steps already taken in the regions. As already mentioned, the aim of this approach is not to point out deficiencies in past or ongoing work in the regions, but to allow the horizontal partners to tailor their support services in the most effective way. Any gaps or needs pointed out in this analysis provide the horizontal partners with crucial information on how to design their activities in this project.

Are measures effective in addressing identified climate risks?

For adaptation measures that are already implemented in the regions, any information available on their effectiveness, such as evaluations of adaptation action plans, is collected and analysed.

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The effectiveness of adaptation measures in reducing climate risks is a central criterion for their quality. Effectiveness of adaptation measures refers to the impact they have on one or more climate change risks in the area where they are applied. Common indicators for effectiveness are their wide-ranging impact (reducing risk not just in one specific location), their long-term impact, the extent to which they reduce one or more climate risks, or the number of people they benefit.

Estimating the effectiveness of measures that are not yet implemented involves an ex-ante perspective on the anticipated effects these will have and whether they are deemed suitable to address relevant climate risks.

Are measures designed in a gender-sensitive way and explicitly consider the implications on different genders?

This question is also part of the gender framework being developed in Task 1.4. A person's gender is one attribute that can contribute to their vulnerability. Gender is a cross-cutting dimension in climate adaptation. Integrating a gender-sensitive perspective in adaptation means considering gender differences in access to information and training, access to resources, position in society or differences in risk perception (Lager et al. 2023).

Are measures designed in a way that considers the needs of particularly vulnerable population groups?

Vulnerability is defined as "the propensity or predisposition to be adversely affected due to the inequalities in the socio-economic system" comprising "sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC 2022). As mentioned in the previous paragraph, a person's vulnerability is determined by a number of attributes. Groups that are potentially particularly vulnerable include, amongst others, older people, people with disabilities, marginalised groups, minorities, lower-income groups and certain genders (Lager et al. 2023).

There is growing evidence on how the most vulnerable people are disproportionately at risk from the impacts of climate change (Lager et al. 2023). Vulnerable population groups have fewer capacities to adapt to these impacts and are less likely to be heard in the adaptation process. It is therefore essential to ensure adaptation actions benefit vulnerable groups. Where these aspects have not yet been specifically considered, this can be a useful indication for support to be provided by adelphi in the future in order to promote just resilience through adaptation.

Do the measures avoid the risk of maladaptation?

Maladaptation means that planned or implemented adaptation measures have negative side-effects such as increasing vulnerability, impairing wellbeing or otherwise undermining sustainable development. These negative consequences can occur in the same or in other locations, systems or population groups than those initially concerned by the adaptation action. When designing an

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adaptation action, possible unintended negative impacts on climate mitigation, ecosystems, resources, other geographical areas, the same or other sectors than the one addressed by the adaptation action should always be considered at an early stage.

The newly developed self-assessment tool to spot risks of maladaptation from the EU-funded REGILIENCE project provides detailed support in identifying possible risks of maladaptation. It contains a checklist of 17 questions to which the user can respond to by selecting either “yes”, “no”, or “partially”. The tool is designed for actors responsible for planning and implementing regional adaptation actions. The questions are divided into different sections. Some of these comprise questions that are already listed in earlier in this chapter. Many questions look at the information that was considered for the identification and design of adaptation options.

Within our analysis, we first check whether a consideration of possible negative side-effects is already integrated in the planning and design process of adaptation measures. Where this is not the case, the next step involves, wherever suitable and sufficient information is available, applying this list to the planned adaptation activities of RESIST regions.

Do the adaptation measures have social equity impacts?

This question can be seen as a sub-component of addressing the avoidance of maladaptation. One way in which maladaptation can occur is when an adaptation measure has negative social equity impacts. Thus, it should be checked whether any dimension of social equity could be impacted by the planned activities. In many cases these potential impacts can be difficult to predict, particularly at an early stage of the design and planning process. However, it is important to include this dimension of possible side-effects in the analysis before implementing climate adaptation measures.

Is a preference for or prioritisation of NbS discernible?

One of the priorities of the EU’s new adaptation strategy is the support for NbS for climate change adaptation. The term NbS refers to “solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.” NbS must therefore benefit biodiversity and support the delivery of a range of ecosystem services (European Commission 2023).

Within this analysis, we therefore also consider the integration of NbS. If NbS are not part of the planned activities within the RESIST project, further steps will include a closer look at whether or how adaptation measures that go beyond the immediate scope of RESIST can include NbS. Of course, it will be taken into consideration that some adaptation activities are more suitable to including NbS than others.

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Are measures designed in a transformative instead of an incremental way?

The RESIST project aims at innovative and large-scale solutions. Therefore, one of the aspects to analyse is whether adaptation measures are designed in a way that supports transformative, large-scale adaptation and goes beyond incremental adaptation. Incremental adaptation refers to adaptation that maintains the essence and integrity of a system or process (Pelling 2011). Transformative adaptation, on the other hand, refers to actions aiming at adaptation to climate change resulting in significant changes in structure or function which go beyond existing practices (Pelling 2011). In other words, incremental adaptation aims at maintaining the status quo in spite of changes in the climate. Transformative adaptation aims at a new way of doing things that can be adopted at a large scale, can lead to new strategies in a region, transform places or potentially shift locations.

These guiding questions do not only provide a framework for this needs assessment. They will be continuously applied throughout the project in the process of designing and implementing adaptation measures. They provide useful guidance for all involved partners regarding what steps should be taken and what aspects should be considered in order to design best possible adaptation solutions.

This approach of checking for good quality adaptation constitutes one core component of the climate adaptation framework that will be applied throughout the project and will guide the framing of adaptation activities.

2.1.3 Analysis of stakeholder involvement and capacities

The involvement of relevant stakeholders should form an integral part of planning and implementing climate adaptation. Analysing who these stakeholders are, how they are being included in the adaptation process and what interests they represent is therefore a further component of this needs assessment.

Opposing interests can be a significant barrier to the success of climate adaptation. At the same time, to avoid unintended effects that could lead to maladaptation, the involvement of and discussion with relevant stakeholders is crucial. In this way, previously neglected information can be brought to the attention of those responsible for adaptation measures.

This part of the analysis will provide indications of where there might be a necessity to expand stakeholder involvement or what activities might be helpful in convincing relevant actors to participate in and support the projects' actions. The main guiding questions for this component of the assessment are:

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1. Who are the main regional stakeholders involved in climate adaptation? What are the main opposing interests?
2. How are stakeholders being involved in the planning and implementation process?

Lastly, the needs assessment analyses the existing institutional and financial capacities in the eight regions and identifies the main capacity constraints. This step involves the consideration of current funding opportunities for adaptation and possible financial constraints as well as institutional or other relevant capacity constraints.

2.2 Sources of data and information

2.2.1 Desk research

For this deliverable, an extensive desk research was conducted by adelphi. The most important sources that were consulted include:

- Country profiles on the Climate-ADAPT platform,
- The 7th National Communications under the United Nations Framework Convention on Climate Change (UNFCCC),
- Information provided as part of the reporting under EU Governance Regulation 2018/1999,
- Country fiches from the European Commission Adaptation Preparedness Scoreboard.

These documents provide information on national level adaptation policies, climate risks and institutional contexts. Further detailed information was collected from national adaptation strategies, action plans and, where possible, evaluations of adaptation policy. In some cases, these documents also look at the challenges and climate risks in specific regions, identifying hotspots for certain risks or particular regional challenges. They are therefore an important source for this analysis.

Another starting point for the desk research were documents mentioned in the RESIST proposal that provided crucial insights into the political, social and institutional context of the adaptation activities that are planned by the regional partners. Where available, regional climate plans and similar policy documents were consulted for the analysis. In addition, relevant scientific literature was included in the research wherever suitable.

2.2.2 Information provided by regional partners

Given the focus on the regional level, a crucial source of information were the regional partners themselves. To elicit the necessary information, a two-track approach was followed: First, a questionnaire was sent to the regional partners asking for important documents and information.

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This questionnaire was designed in close cooperation with other partners from WP 1 and included information requests necessary for other tasks in this work package. To provide regional partners with one consolidated information request, questions by WP 1 partners were collected and aligned before finalizing the questionnaire. The full questionnaire that was designed as part of the needs assessment is included in Annex A: Questionnaire. All twinning regions filled in the questionnaire and provided adelphi with valuable information and links to relevant resources.

Second, in order to collect supplementary information from the regional partners, virtual interview sessions were conducted by adelphi and KU Leuven in cooperation with WP 1 partners. These sessions were scheduled between July and September 2023 and lasted two hours. Participants in the meeting were sent a pre-read document with information about the purpose and agenda of the sessions as well as guiding questions that would structure the discussion between WP 1 partners and twinning regions. This pre-read document is included in Annex B: Information about virtual interview sessions. For each region, additional specific questions were added to this pre-read document addressing unclarities, data gaps and preliminary results.

2.2.3 ESPON Data

ESPON-CLIMATE is a project that aims to enhance the understanding of climate change impacts and vulnerability in European regions, including E27 countries (Switzerland, Iceland, Liechtenstein, Norway, and the United Kingdom) at NUTS3 level. The assessment was recently updated in 2022 based on the latest IPCC Assessment Reports (AR5 and AR6), utilizing data from diverse sources such as satellite and census data. The ESPON-CLIMATE dataset is thus a comprehensive source of aggregated data that offers information on climate risks based on impact chains. The primary purpose of the ESPON-CLIMATE dataset is to assist policymakers, researchers, and stakeholders in comprehending the challenges and opportunities posed by climate change in Europe (Navarro et al. 2022).

The following list outlines the impact chains / risk scenarios identified by the ESPON-CLIMATE Update 2022 based on the causal model of risk which links hazards and receptors:

- Heat stress on population
- Coastal flood on infrastructure, industry and service sectors
- River flood on population
- River flood on infrastructure, industry and service sectors
- Flash floods on cultural sector
- Wildfire on environment
- Droughts on primary sector

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Each impact chain in the assessment consists of hazard, exposure, and vulnerability (sensitivity and adaptive capacity) indicators. These are comprised of aggregated proxy variables. The selection of these proxy variables was based on scientific frameworks, normative decision on what is to be included and assessed, and data availability. The data sources varied, depending on the type of indicators, including i.a. the Copernicus Climate Data Store, Risk Data hub, EUROSTAT Gisco, UNESCO, ESPON-TITAN and others, see Annex C: ESPON-CLIMATE: Data sources for more information (Navarro et al. 2022). Important to note is that only hazard indicators are projected for different emissions scenarios (RCP2.6, RCP4.5, and RCP8.5) for the time period of 2070-2100, not for vulnerability and exposure.

The ESPON-CLIMATE dataset can be a valuable resource for the RESIST project regions, providing additional information on climate risks. It allows for comparisons with regional climate risk assessments and offers insights into key hazards, exposure, and vulnerability for regions without regional-specific assessments. The indicators used in the dataset, described in Annex D: ESPON-CLIMATE: Framework of Impact Chains, contribute to a better understanding of the factors which are influencing climate risks. For each twinning region, the climate impact chains were extracted and analysed. The results are presented within the chapters describing climate risks which are prevalent in the region and can assist in determining the priority areas that require specific attention due to the identified risks (Navarro et al. 2022). However, further detailed, more context-specific analysis in the region is necessary to thoroughly examine and validate the results. In addition, the following limitations have to be considered. As mentioned above, projections based on the three RCP scenarios are only simulated for hazard indicators. Exposure, sensitivity and adaptive capacity are solely based on historical data. This can particularly lead to incorrect assumptions and interpretations when it comes to the aggregated risk indicator. Furthermore, uncertainty has to be taken into account for future scenarios regarding the hazard indicators (Navarro et al. 2022). The ESPON-dataset is thus used as a supplementary source of information about regional climate risk and vulnerability factors.

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3 Needs assessments for twinning regions

3.1 LSDT 1: Introduction

This chapter covers the twinning regions Normandy, located in north-west France, and the Eastern Macedonia and Thrace region (EMT), located in north-east Greece. The lead region to LSDT 1 is Southwest Finland (SW Finland).

3.1.1 Needs Assessment Normandy

3.1.1.1 Introduction

Located in north-west France on the banks of the Channel (see Figure 2), the region Normandy covers an area of 29,906 km² with a population of around 3.3 million people. In terms of economic activity, it is categorized as a European Regional Development Fund (ERDF) transition region with major business sectors in the fields of automotive industry, oil and related products, aviation, pharmacy, agri-food, cosmetics, energy, transport and logistics (Préfet de la Région Normandie 2023). Normandy is an ancient geographical and cultural territory which shaped the region's historic heritage, landscape and climate.

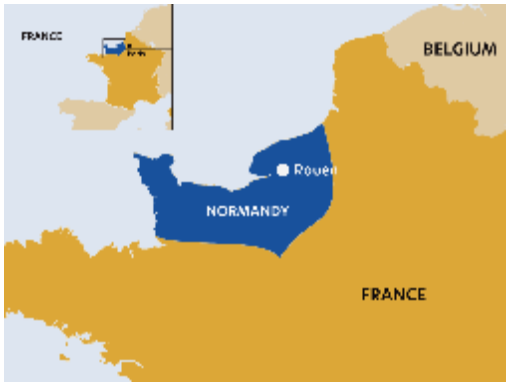

Figure 2: Location of Normandy (taken from Description of the Action).

The region is characterized by a temperate oceanic climate with mild winters and moderately warm summers (Préfet de la Région Normandie 2020). However, the temperature rise of the past decades led to an increase in the number of summer days, hot and extremely hot days while frost and cold days decreased and extremely cold days nearly disappeared, especially in areas under oceanic influence. Between 1970 and 2020 annual temperature increased by 1.8 °C, with the rising trend in heat affecting the intracontinental areas more severely than the littoral as the influence of the Channel limits intensity and duration of heat waves (GIEC Normand 2020b). The 600 km coastline is highly vulnerable to erosion and flooding. Two thirds are already eroding today, showing a severe retreat of sedimentary cliffs (GIEC Normand 2020h). Annual precipitation is around 860 mm per year indicating no statistically significant trend in the past, except for less precipitation in form of snow (GIEC Normand 2020b).

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3.1.1.2 Climate risks

3.1.1.2.1 Regional climate risk assessments and identified risks

The region of Normandy has commissioned a group of 23 researchers and experts to assess its climate risks, the so-called **GIEC Normand** (Groupe d'experts Intergouvernemental sur l'Evolution du Climat). The expert group provides the knowledge base for understanding the potential impacts of climate change in Normandy and informing political action (GIEC Normand 2020b). Results of their assessments are summarized in concise **syntheses** which present the central documents on climate risks in the region. Currently, syntheses exist in the fields of meteorological parameters, water, biodiversity, agriculture, air quality, coastal systems, health and fishing (GIEC Normand 2020b, 2020c, 2020a, 2020g, 2020e, 2020h, 2020f and 2020d). Addition of further topics, i.a. on socio-economic and psychological impacts, are planned for the future.

The analysis is based on meteorological data, both from Météo-France for the historical period and from the Centre National de Recherches Météorologiques for future climate projections up to 2100, as well as multiple hydrological modelling projects and impact models, and a review of previous studies carried out in Normandy (GIEC Normand 2020b). Concerning future developments, the GIEC Normand considers the scenarios RCP2.6 and RCP8.5 (see Table 1).

Table 1: Selected climate indices and their trends in the region Normandy in the reference period (1976-2005) and short- to long-term future under scenario RCP8.5 (GIEC Normand 2020b).

	Reference period (1976-2005)			**Short-term future (2021-2050)**			**Mid-term future (2041-2070)**			**Long-term future (2071-2100)**		
	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Mean temperature (°C)	**10.2**	9.1	11.4	**11.3**	10.1	12.3	**12.1**	11.0	13.1	**13.7**	12.6	14.6
		baseline		+1.1	+1.0	+0.9	+1.9	+1.9	+1.7	+3.5	+3.5	+3.2
Frost days	**34.5**	5	67	**22.9**	3	48	**16.9**	1	40	**11.5**	1	28
		baseline		-11.6	-2	-19	-17.6	-4	-27	-23.0	-4	-39
Hot days	**13.6**	0	26	**20.2**	2	39	**33.2**	3	58	**54.3**	9	87
		baseline		+6.6	+2	+13	+19.6	+3	+32	+40.7	+9	+61
Annual precipitation (mm)	**859**	670	1126	**894**	670	1156	**850**	633	1101	**775**	587	996
		baseline		+35	+28	+30	-9	-9	-25	-84	-55	-130
Heavy rainfall days	**4.0**	1	10	**4.8**	2	10	**4.9**	2	10	**4.8**	2	10
		baseline		+0.8	+1	0	+0.9	+1	0	+0.8	+1	0
Consecutive dry days	**22.4**	19	25	**23.9**	22	29	**26.5**	23	30	**29.5**	25	35
		baseline		+1.5	+5	+4	+4.1	+4	+5	+7.1	+6	+10

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Diminishing surface and underground reserves, deteriorating water quality and more frequent and intense flooding are threatening Normandy's *water resources*: Annual river flow is expected to decrease by 10 to 30% in the Seine basin, mainly in summer. Similarly, groundwater recharge could fall by 15 to 30%, reducing groundwater levels substantially. Heavy rainfall and subsequent run-off and soil erosion increase the turbidity and contamination of watercourses; low water levels reduce the dilution of pollutants. As a result, water supplies will become problematic at certain times of the year. Additionally, sea level rise in coastal areas leads to salinisation and consequent reduction in availability of drinking water (GIEC Normand 2020c).

Sea-level rise also increases the risk of *coastal flooding and erosion*, which is already severe today, threatening seaside economic activities and critical infrastructure. Inland consequences of rising sea levels are flooding from storms and increasing water tables, and blocking of river flows (GIEC Normand 2020h). Due to water acidification, rising surface temperatures, reduced phytoplankton production and reduced nutritional input from coastal rivers as well as silting up of estuaries, climate change severely menaces *fishing and aquaculture* in Normandy. Species most important to Normandy's fishing industry today could suffer a sharp decline or even disappear (GIEC Normand 2020d). *Coastal and terrestrial ecosystems* are under severe pressure, not least from climate change. Rising temperatures and changing precipitation patterns impact the distribution of species and their habitats and the life rhythms and reproduction cycles. This can lead to the destruction of natural habitats and loss of biodiversity, with consequences for human livelihoods and economic activities (GIEC Normand 2020a).

Greater exposure of soils to erosion, run-off and the formation of an impermeable crust on the (sub-)surface of soils can lead to a decline in soil quality, damage to fields and mudflows. This will have a severe impact on the *agricultural sector* in Normandy, together with changes in crop yields due to climate change and heat stress in livestock (GIEC Normand 2020g). As the frequency and intensity of heatwaves increase in the future, people in Normandy could suffer more from heat stress, especially vulnerable groups such as the elderly, children and outdoor workers. Furthermore, rising temperatures foster the development and spreading of vector-borne diseases, and the cumulative effects of reduced rainfall, warmer water and increased flooding give rise to viral and bacterial diseases (GIEC Normand 2020f). Deteriorating air quality can have *health impacts*, particularly on cardiovascular and respiratory diseases. However, future trends are unclear due to the complex interplay of anthropogenic and climatic influences (GIEC Normand 2020e).

In addition to the syntheses by the GIEC Normand, the Regional Scheme for Planning, Sustainable Development and Territorial Equality (SRADDET) identifies the following major climate risks in the region as a basis to determine areas of intervention and propose corresponding measures (Région Normandie 2019, 2020):

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- The predicted retreat of the coastline and the risk of marine submersion for Normandy's seafront,
- Increased exposure to storms and hurricanes, as well as elevated risk of flooding and landslides, impacting inhabitants, housing and infrastructure, and thus continuity of economic activities,
- Increased frequency of heat waves and drought, with a lasting impact on the development of natural areas and populations as well as agricultural land and activities,
- The relevance of the SRADDET as a regional framework document in terms of regional planning, and particularly the fight against climate change and adaptation to it, will be analysed in more detail in chapter 3.1.1.3.1.

3.1.1.2.2 Comparison with ESPON data

While the ESPON CLIMATE dataset does not provide as comprehensive an assessment as that published by the GIEC Normand, it is a source of comparable data across regions and thus very valuable to the analysis within RESIST. In addition, the ESPON CLIMATE data, with its clear distinction between the risk components of hazard, exposure and vulnerability, complements the picture drawn above, in particular with regard to the interplay between the occurrence of climate extremes and the region's vulnerability towards these.

For the ESPON analysis, the region of Normandy is further divided into its five Départements, namely Calvados (FRD11), Manche (FRD12), Orne (FRD13), Eure (FRD21) and Seine-Maritime (FRD22). Considered hazards are heat stress, droughts, different types of flooding (river, coastal and flash floods) and wildfires. In the baseline scenario (1981-2010), all five departments are moderately affected by droughts and flash floods. In Eure and Orne wildfires also play a smaller role. Coastal and river flooding as well as heat stress are currently not very relevant. However, drought exposure of the primary sector and heat exposure of the population are comparatively high, with the Département Seine-Maritime most exposed to all hazards. Vulnerability is highest concerning the impacts of river flooding on the population, followed by heat stress. The aggregation of these factors indicates a moderate risk of river flooding for the population, flash flooding for the cultural sector and drought for the primary sector in all five departments.

Under the high emission scenario RCP8.5 until the end of century (2070-2100), all considered hazards gain relevance, with coastal flooding affecting the region severely, followed by heat stress. Wildfires, drought and flash floods are generally associated with a medium high occurrence, with slight differences between departments. Compared to the baseline, river flooding plays a larger role but still is the least relevant hazard. Under the dataset's assumption of unchanged exposure and vulnerability, these changes in the importance of the hazards cause all the risks considered, i.e. droughts on primary sector, heat stress on population, coastal flooding and river flooding on

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infrastructure, river flooding on population, flash flood on the cultural sector, and wildfire on the environment, to rise to a medium to medium high level of concern. Most pronounced are effects of heat stress and river flooding on the population, closely followed by the other risks considered.

By focusing on five key risks, the ESPON dataset cannot capture regional specificities such as the threat of climate change to coastal erosion or fisheries. However, the results support the analysis that heat stress and coastal flooding will become increasingly important in the future. Simultaneously, the risks associated with drought, wildfires as well as river and flash floods should also not be neglected.

3.1.1.2.3 Potential improvements for climate risk information

The syntheses by the GIEC Normand provide a detailed dossier of climate change impacts in Normandy concerning meteorological hazards, water, coastal systems, biodiversity, agriculture, fishing, air quality and health in eight concise synthesis reports with appealing visualization. The analysis is based on two RCP scenarios that reflect a broad bandwidth of possible climate futures, and looks at medium- as well as long-term changes. It considers both extreme events and slow onset changes of a wide range of climate-related hazards. Data sources are clearly stated and uncertainties extensively discussed. The assessment is not based on climate impact chains but cause-effect relationships are debated in the text.

The analysis could benefit from further improvement concerning the underlying risk framework. Currently, the assessment does not strictly differentiate between risk, exposure, sensitivity and vulnerability. The syntheses demonstrate how hazards interact and result in impacts on human and natural systems. However, there is only superficial analysis, if any, of the sensitivity or susceptibility of these systems to harm and their coping or adapting capacities. Furthermore, the division into separate syntheses on specific topics complicates the assessment of compounding and cascading risks.

A more detailed evaluation of vulnerabilities, especially concerning vulnerable population groups, could lead to their needs being taken more into account when planning adaptation measures and prevent maladaptation. Similarly, a more integrated view of cross-cutting risks could promote synergies between sectors and reduce the risk of maladaptation. However, these suggestions are cherries on the cake. The syntheses by the GIEC Normand offer a comprehensive and vividly presented review of climate risks in Normandy, thus establishing a sound knowledge base for developing adaptation measures in the region.

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3.1.1.3 Adaptation measures

3.1.1.3.1 Existing plans and measures

Important policy documents at national level

France is presently drafting its third **National Climate Change Adaptation Plan (PNACC)**, scheduled for release by the end of the year (République Française 2023). The current plan PNACC-2 covers the period 2018–2022 with the general objective to implement necessary actions to adapt mainland France and overseas departments until 2050 (Ministère de la transition écologique at solidaire 2018). Contrary to the third PNACC which works with the hypothesis of a 3 °C global warming, PNACC-2 was established under the assumption of limiting temperature rise to the Paris agreement 2-degree-goal. It identifies six fields of action including governance, knowledge and information, prevention and resilience, economic sectors, nature and environment, and international action. These six fields are broken down into 29 themes and 389 operational measures.

A large focus lies on strengthening the governance and monitoring framework, improving knowledge on the impacts of climate change and raising awareness in a variety of public and private sectors. In all these fields, the plan makes several references to the regional level which also point to potential current deficits in adaptation governance. Planned actions include:

- Increasing coordination between the local to national level by creating a network of regional committees during establishing or revising regional plans,
- Mainstreaming adaptation into jurisdiction, norms and technical standards at all levels,
- Ameliorating observation and forecasting, information and warning of the population,
- Integrating climate change impacts into management plans for cultural heritage to preserve and safeguard cultural assets, and
- Promoting and implementing spatial reorganisation of the coastline at relevant territorial scales together with regions.

The status of implementation and financial resources spent were assessed in the mid-term evaluation of PNACC-2 (Ministère de la transition écologique at solidaire 2021). Of the 389 operational measures 106 were completed, 225 were in implementation, and 58 had not been started in 2021. Meanwhile the budget had increased from € 300 million to € 8.2 billion to finance implementation of additional measures deemed necessary. In addition to quantifying actions taken and resources spent, the mid-term review also provides an overview of current needs and gaps in national and regional adaptation efforts:

- Removing data constraints and improved monitoring on national level,

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- Lack of an integrated climate policy strategy despite a rapprochement between PNACC-2 and the National Low Carbon Strategy,
- Stronger incentives for both public and private players to take account of the impacts of climate change,
- Unclear picture on progress in the finance, banking and insurance sectors due to difficulty of gaining access to these actors,
- Necessity for strengthening the coherence and effectiveness of adaptation policies conducted at national, regional and local levels,
- Limited visibility of climate adaptation in the SRADDETs, decoupled from the objectives; and implementation of adaptation actions left to sub-regional local authorities,
- Lack of operational measures and monitoring of adaptation in the PCAETs, and
- Lack of regional or local climate data and knowledge.

Beyond these issues identified in the mid-term evaluation, one additional structural obstacle to effective implementation and mainstreaming of climate adaptation should be highlighted: PNACC-2 is not legally binding. This also applies to other highly ambitious documents at national level that include the cross-cutting issues of biodiversity and adaptation, but have limited or no binding legal scope (Paillat 2023). PNACC-2 is subject to a relationship of compatibility, i.e. a relationship of non-contradiction which leads to review by the administrative judge following an overall analysis, or a relationship of taking into account, meaning that a text of lesser legal scope cannot ignore a document of greater legal scope. Certain programmes, such as the regional and the national forest and timber programme are required to be compatible with PNACC-2 or contribute to its implementation, but the underlying legal framework remains very flexible and complex to implement.

Overview of relevant policy documents at regional and municipal level

The above-mentioned **Regional scheme for planning, sustainable development and territorial equality (SRADDET)** constitutes a reference framework for the action of the Region and its inhabitants in terms of regional planning. It aims at adapting the region to the challenges and changes underway (demographic change, climate change, digital revolution, etc.) and promote sustainable development in environmental, social and economic dimensions. The SRADDET is made up of three documents: a. a report, setting out the regional strategy and objectives, b. a leaflet, containing the rules the SRADDET sets itself to implement the objectives as well as planned monitoring and evaluation measures, and c. appendices with supplementary information (Région Normandie 2019, 2020).

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According to the law on the new territorial organisation of the Republic (NOTRe) (2015) the SRADDET shall cover eleven obligatory subjects from achieving balance and equality between regions to waste prevention and management. In contrast to combatting climate change, adaptation is not explicitly stated as one of the legally required topics but could be integrated into the topics of infrastructure siting, efficient use of space as well as protection and restoration of biodiversity. Despite this shortcoming in the legal basis, the region of Normandy decided to specifically address climate change adaptation as one of the six main strategic objectives that are transversal to all the fields of the SRADDET (Région Normandie 2019, 2020). These six over-arching objectives are broken down into numerous thematic and specific regional goals, e.g. reducing natural risks related to water and preventing impact of climate change and rules, as well as rules such as “In coastal, retro littoral and estuarine areas, allow development and construction only if they are adapted to the foreseeable natural risks on the horizon of 2050 (flooding, marine submersion, erosion, retreat of the coastline)".

The six main areas of intervention identified in the SRADDET are the coastline, where risk of flooding increases with rising sea level; the rivers and estuaries which are particularly vulnerable to climate change impacts and human activities; agriculture, affected parallelly by rising temperatures and changes in precipitation; forestry, impacted from changing precipitation, prolonged drought and new pests and diseases; water resources, with areas most at risk located in the Armorican massif, but the question of resource allocation during dry periods in regions with growing population also affecting the western Normandy; and urban areas, as development and urban planning documents must anticipate and reflect the changes. Concerning this last field of action, the SRADDET points out the central role of urban development choices and planning documents to preserve and strengthen ecosystems and sensitise the general public and elected representatives. More specifically, the SRADDET recommends considering expected changes in sea level and frequency of flooding and submersion events when defining zones to be urbanised (for settlement, economic activities, etc.) as well as integrating concerns of clay shrinkage and swelling, stress on water resources and urban heat island effects into city planning.

However, it is noted that planning documents do not address these issues adequately: When it comes to e.g. flood risk management or considerations concerning the necessary relocation of housing or economic activities, the current perimeters do not necessarily correspond to those of planning documents. Regulations are often outdated or overtaken by climate change reality.

In this context, the SRADDET points out that administrative boundaries do not always address the issues identified. Examples include changes to the coastline, flood risk or water resource management, where broader approaches need to be developed, and therefore cooperation on the scale of the issues to be addressed: a coherent approach on the scale of a catchment area, from the source to the mouth of a river, work on the scale of the hydro-sedimentary unit, etc.

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The law NOTRe requires the president of the regional council to present a report on the implementation of the SRADDET six months after its adoption (2015). In this context, the region set up a monitoring and evaluation system that helps assess the progress towards and achievement of the objectives, the contribution from regional stakeholders to its implementation as well as developments in the region resulting from its realisation (Région Normandie 2021). The review is built around 78 monitoring indicators relating to major issues defined in the objectives and rules of the SRADDET, complemented by 15 indicators providing additional context information to a allow a more comprehensive overview of the regional situation. Unfortunately, the indicators do not relate to the six major objectives formulated in Normandy's SRADDET but to the eleven obligatory subjects of which climate adaptation is not an explicit part (see above). However, several indicators can be used to assess different aspects of adaptation, such as the amount of local authorities with sustainable development strategies dealing with climate risks, density and accessibility of health facilities, amount of local water management strategies, amount of revised urban planning documents, terrestrial and marine protected areas, and fragmentation of water courses and (semi-) natural areas.

Six months after the adoption, such an assessment cannot be exhaustive. However, it can reveal first successes and short-term obstacles. Besides, building a systematic monitoring system from the start makes a strong case for the Normandy. Concerning integration of adaptation into municipal planning and access to health facilities no results were available. In terms of revision of urban planning documents, the region supported local actors in diffusing knowledge on the SRADDET and analysing the status quo of current documents. Regarding the fragmentation of water courses, the 2020 status was analysed to create a baseline for further monitoring. Similarly, the report assessed the status quo of water management strategies in 2021. 16 intercommunities were implementing strategies with an additional three under development.

The subject of adaptation is clearly represented in the SRADDETs and widely mentioned at the level of objectives, with references to numerous varied levers. However, it is markedly less mentioned in the rules, and most of these rules relegate to measures taken by local authorities and thus depend on the ambition shown for adaptation in the SRADDET to be translated into local policies. Furthermore, the SRADDET does not refer to the PNACC and thus fails to create a relationship between national and regional adaptation policies. Similarly, the SRADDET could establish a stronger link to existing sectoral approaches to foster coordination of objectives and rules, and working towards a cross-sectoral vision. Climate change adaptation is well integrated at a conceptual level but has room for improvement concerning definition at an operational level.

In order to strengthen climate change adaptation in the SRADDETs, assessments of regional climate risk, such as provided by the GIEC Normand (see 3.1.1.2.1), should be integrated prior to the preparation phase to give a clearer picture of the impacts and enable these issues to be incorporated consistently. Given that climate change is a cross-cutting objective of the strategies, and that the

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development of adaptation measures requires a multidisciplinary approach, it would be appropriate to either reread the whole document with a clear vision of climate change adaptation or ideally plan from the outset a structure in which adaptation is a guiding principle. Additionally, to make the SRADDETs more effective and operational, the strategic objectives should be translated into more concrete actions. Setting up a monitoring and evaluation system as in the Normandy is a valuable starting point for assessing the implementation. However, to enable a more meaningful monitoring, the objectives and rules must be associated with quantified data and timetables for implementation which can then serve as a benchmark to assessing the progress in implementation and execution.

The goals and rules stated in the SRADDET are interlinked with territorial and local planning as they guide the **territorial climate-air-energy plans (PCAETs)**, and through them the local urban development plans and all the activities of the territory. In terms of legal scope, PCAETs have an obligation of compatibility with the general rules of the SRADDET and an obligation to take the objectives of the SRADDET into account.

The PCAETs translate regional, national and international objectives concerning energy, climate and air quality into targets at the level of intercommunities. The plans define a. strategic and operational objectives to mitigate and adapt to climate change, and b. a programme of actions to reduce greenhouse gas (GHG) emissions and energy dependency, improve energy efficiency, increase renewable energy production, control energy consumption, while helping to adapt to climate change in the short, medium and long term (Olei 2020). They must include an assessment of the current situation in terms of carbon footprint and the area's vulnerability to climate change, quantified targets based at least on national and European references, strategic and operational objectives both for mitigation and adaptation, and a scheme for monitoring and assessing the measures initiated.

The current status of the PCAETs (as of December 2022) is visualized in Figure 3. 14 intercommunities have already adopted a plan, 17 were in regulatory consultation. In 20 intercommunities PCAETs were under development in December 2022, four obliged intercommunities were not engaged (yet).

A recent study within the project Life intégré ARTISAN aiming to contribute to the implementation of PNACC-2 and France's Biodiversity Plan analysed the relevance of climate change adaptation and NbS in the PCAETs (Salmon et al. 2021). Generally, most of the adaptation measures proposed are so-called soft or upstream solutions, i.e. organisational, strategic, institutional or regulatory. The majority of NbS suggested in the PCAETs refer to urban development, water, agriculture and forestry. In the urban context, the measures mainly address risks from rising temperatures such as heat waves and the urban heat island effect through greening and renaturation of public spaces, and to a lesser extent increased runoff and surface permeability. When it comes to quantitative and

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qualitative water management, several PCAETs rely more on grey infrastructure than NbS. Concerning agriculture, the focus is on flooding, drought and erosion. Envisaged measures encompass planting hedges, diversifying crops and preserving and restoring wetlands. To mitigate the impacts of climate change on forests, especially disappearance of species and loss of biodiversity, the PCAETs refer to preserving the green-blue network (Salmon et al. 2021).

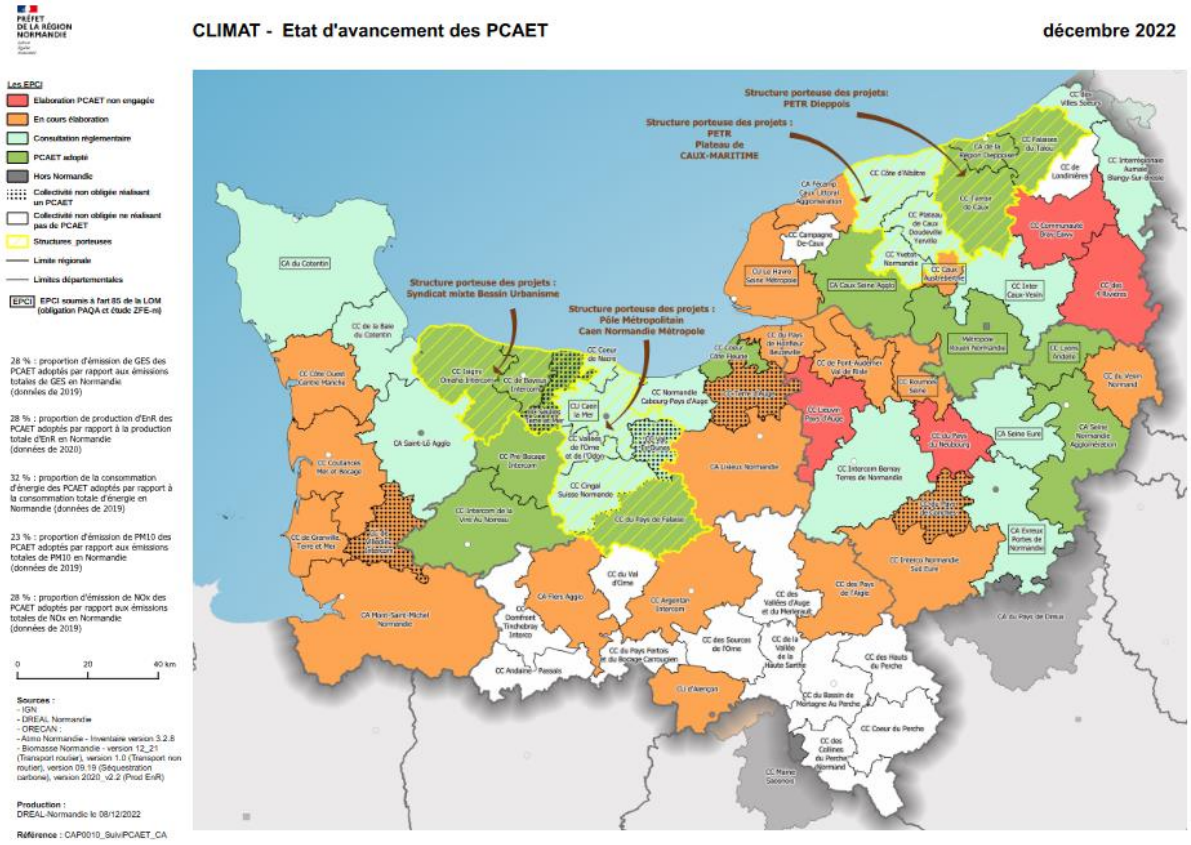

Figure 3: Current status of PCAETs in the Norman intercommunities (Préfecture de la Région d'Île-de-France 2022).
Legend: red – no elaboration yet, orange – under development, mint – regulatory consultation, green – adopted PCAET, dotted – non-obliged community realising a PCAET, white – non-obliged community not realising a PCAET, yellow border and diagonal lines – intercommunities with support structures.

What is lacking, however, is a clear operationalisation of the measures, with specific and adequate funding, reliable indicators and long-term monitoring and evaluation. In other fields of action besides those mentioned above, the PCAETs do not establish an explicit link to climate change adaptation. It is unclear whether the local authorities were aware of its relevance and took it into account when drawing up the plan. Several intercommunities do not see adaptation as their main area of concern and do not integrate measures due to budgetary reasons. The PCAETs addressing climate change

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adaptation and NbS rarely introduce a new dynamic or new solutions, but mainly rely on measures already implemented or planned. Often, these measures are projects, plans or complementary strategies of joint players in the field (agricultural plans, projects to combat salinization, forestry charters) (Salmon et al. 2021). This integrative approach can allow adaptation actions to be visible and firmly anchored in the region. However, the PCAETs need to facilitate this integration by embedding the different sectoral strategies in an over-arching vision.

As the focus of the measures taken within RESIST lies on water resources (see chapter 3.1.1.3.2), it is worthwhile to also briefly consider the **Master Plan for Water Development and Management (SDAGE)**. It is a planning tool for water resource and aquatic ecosystem management at the level of large catchment areas. For the Seine basin and coastal rivers in Normandy, the SDAGE covering the period 2022-2027 was adopted in March 2022, accompanied by a programme of measures (Préfecture de la Région d'Île-de-France and L'agence de l'Eau Seine-Normandie 2022b, 2022a). The plan sets out fundamental guidelines and associated objectives and the necessary provisions to fulfil these. It is the political framework instrument for the basin's water policy, aiming order to ensure a balanced and sustainable management of water resources. Administrative decisions in the water sector and regional planning documents must be compatible or rendered compatible with the SDAGE, i.e. must not present any major contradiction or conflict with its objectives, guidelines and provisions (Préfecture de la Région d'Île-de-France and L'agence de l'Eau Seine-Normandie 2022b).

Concerning climate change adaptation, the plan recurs to the major risks identified in the basin adaptation strategy in 2016 including reduced river flows, increased pressure on water demand and greater concentration of pollutants, increased risk of run-off due to heavy rainfall and sealing, saline intrusion into freshwater, threatening the drinking water supply of coastal towns, and erosion of the coastline and risks of flooding (L'agence de l'Eau Seine-Normandie 2016).

According to the strategy, priority should be given to no-regret measures which are beneficial regardless of the extent of climate change, flexible, inexpensive and resource-efficient. They should further be multifunctional, benefitting mitigation, in solidarity between the different local stakeholders, and avoid maladaptation. Building on the adaptation strategy, three of five fundamental guidelines explicitly refer to adaptation and increasing resilience in terms of balanced management of water resources, restauration and preservation of ecosystems and biodiversity, and sustainable management of the coastline (Préfecture de la Région d'Île-de-France and L'agence de l'Eau Seine-Normandie 2022b). In the programme of measures, climate change adaptation is seen as a cross-cutting topic. Hence, the majority of the actions contribute to adaptation, with varying degrees of effectiveness depending on the field and the technical choices made during implementation. The proposed measures are of two kinds: direct environmental actions such as reestablishing ecological continuity, limiting surface sealing and restoring flood expansion, and secondly knowledge or

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governance measures, such as promoting research and development or translating guidelines into local water development and management plans (Préfecture de la Région d'Île-de-France and L'agence de l'Eau Seine-Normandie 2022a).

Addressing climate change adaptation as a cross-sectoral topic in the SDAGE and corresponding programme of measures is a strong lever for increasing resilience of water masses and ecosystems, especially as the plan has a distinctive legal status. Concerning certain topics, the plan formulates clear, measurable targets, e.g. on the ecological status of water bodies or the reduction of nitrate concentration, that could be monitored and evaluated to track the success of proposed measures. However, the SDAGE also points out that achieving the set targets implies a breakthrough that requires sectoral public policies dealing with water topics to take these issues into account and contribute accordingly.

Beyond the actions already taken by the region through its competences and policies set out in the SRADDET and additional sectoral strategies, Normandy strives to contribute further to climate change adaptation. Hence, the **GIEC Normand** put forward an **action plan** with 34 proposals aiming at mitigating and adapting to climate change in Normandy which was adopted by the Regional Council in December 2022 (GIEC Normand 2022). The plan covers eight main topics, from renewable energies and energy efficiency to research and development. One of the eight topics is explicitly dedicated to climate change adaptation, “Adapting activities to the consequences of climate change”, and several topics either explicitly or implicitly refer to adaptation.

Actions under the header of adaptation are of two kinds: half of the measures are more in the nature of objectives or overarching guiding principles (improving the resilience of fish farms, resilient design and development of public spaces). The remaining actions are a list of three concrete support programmes, namely “Norman Coastline”, “Tomorrow’s water in Normandy” and “Territorial Strategy and Climate”, launched after the adoption of the plan by the Regional Council in July, May and April of 2023, respectively.

Besides, climate change adaptation is mentioned when referring to new agricultural and forestry practices, in all actions under the topic of innovation and research, as well as in measures concerning professional training and raising awareness. Out of 34 actions, 18 address questions of climate change impacts in terms of capacity building and increasing resilience. In contrast to other regional strategies dealing with climate change, which mainly focus on reducing GHG emissions, the action plan accomplishes to consider climate mitigation and adaptation jointly in a number of cross-cutting themes. Additionally, by establishing corresponding funding opportunities, it pre-empts and remedies one of the biggest obstacles usually put forward against climate adaptation.

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However, the action plan lacks a clear target architecture based on which over-arching goals and concrete measures could be deduced. It does not differentiate between different types or depths of actions and fails to link proposed measures to the major impacts identified in its 2020 syntheses (GIEC Normand 2020a–2020h).

3.1.1.3.2 Planned adaptation measures within RESIST

Planning of adaptation measures is still in its early stages. In collaboration with the French Centre for Studies and Expertise on Risks (CEREMA) and the French Biodiversity Agency (OFB) the region will implement measures focusing on (coastal) water management in three pilot sites. In order to identify suitable sites, the following criteria for site selection were established:

- Major problems relating to erosion and run-off, pollutant transfer, flooding and heat islands, all of which are exacerbated by climate change
- Cumulative and overlapping problems in the same pilot area
- Favouring a catchment area approach
- Status of project sites: two established sites, one site under development
- Ability to invest in and implement an operational solution
- Diversity of issues / types of territory: urban / rural / industrial
- Comparative contribution of NbS and grey solutions
- Availability of data enabling to assess the changes that will be measured in order to make the implemented solutions replicable in other areas
- Size of the area should correspond to the problem being tackled (catchment scale or sub-catchment scale if necessary)
- Replicability of the context and the solution
- Eligibility criteria for regional funding
- Presence of local partners to involve in the pilot area
- Impact / population affected by the issues
- Intensity of risk / climate change adaptation issues
- CEREMA affiliate

Based on these criteria, the regional consortium is currently in the process of identifying sites and organizing meetings with elected representatives to discuss propositions. Potential sites cover different problematics, spatial scales and thus varied possible adaptation solutions.

At the current status, the largest challenge is to convince local and regional stakeholders to participate in RESIST. Within the project, the region cannot support local financing of NbS. Hence, essential stakeholders and the wider community need to be convinced of the necessity and benefits of implementing adaptation solutions within RESIST, especially concerning the suitability of

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NbS – despite common misconceptions of NbS as inefficient or expensive and structural obstacles (lack of reference system, regulatory complexity, incompatibility with external technical standards). According to the region, the largest added value for stakeholders participating in RESIST would be a vulnerability assessment and a CBA. Carrying out these analyses would also address two of the main challenges in the further implementation of adaptation measures: integrating potential impacts for most vulnerable groups and the gender dimension, and showcasing the benefits of the planned measures beyond adaptation. Adding to this, an ex-ante assessment of the measures can also help anticipate possible side effects and avoid maladaptation.

3.1.1.3.3 Stakeholders and capacities

At this early stage, without knowing the final pilot sites, it is not possible to carry out a detailed analysis of the key stakeholders involved. Once the sites have been decided, this creates great leeway for designing engagement formats for the different actors, i.e. industrials, farmers, urban planners, elected representatives, civil society, etc., and incorporate the needs of vulnerable groups.

In this context, the region can build on past stakeholder processes for the regional littoral adaptation strategy “Notre Littoral pour Demain” which has made it possible to mobilize and support the elected representatives, so that they commit to sustainable and integrated management of the coastline. Within RESIST, the region is currently planning meetings between the environmental vice-president and elected representatives in the potential sites. The subsequent process of stakeholder engagement can be supported by adelphi (see 3.1.1.3.4).

As mentioned above, the region cannot provide local funding for pilot sites within RESIST. However, the ERDF as well as the State-Region planning contracts (“contrats de plan État-Région”) can close this gap. Following the GIEC Normand action plan (see 3.1.1.3.1), the region established the programme “Adaption du littoral” (“Coastal adaptation”) co-financed with ERDF funds which aims at enabling communities to adapt to coastal risks linked to flooding and the retreat of the coastline under the combined effect of rising sea levels and erosion. Additionally, it might be interesting for smaller communities to help them attract private funding. In the long-term, the region is also planning on setting up a participatory funding platform which supports smaller projects with 50% public and 50% participatory funding. Besides creating a low-threshold funding opportunity, this also raises awareness for climate adaptation in the region and enables involvement of citizens. In terms of structural constraints, the region pointed out that the strict legal framework for the allocation of funds in France is based on competition, making it difficult to support suitable projects without going through this arduous process. To make the implementation of adaptation measures more attractive, this process would have to be simplified.

In addition to these financial capacity constraints, the region also faces institutional and governance challenges that hinder systematic adaptation. There is still in-depth information lacking with regards to the vulnerabilities of population, properties, systems, etc. on varying time scales. Furthermore,

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the societal communication and information sharing about climate-related impacts and adaptation measures is key, however, this is complicated for certain shares of the population that are not yet integrated into ongoing debates, but who are often most vulnerable to climate-related risks. In terms of institutional capacities and collaboration, there is lacking coordination between the various relevant stakeholders and actors in the Normandy, and the lack of critical resources, such as time and qualified personnel, combined with institutional inertia, is hindering the regulation and implementation of an effective and integrative adaptive scheme.

As the existing administrative boundaries are not always sufficiently scaled to address climate-related issues effectively, broader approaches and cooperation across scales are necessary. This is particularly relevant for coastline changes, flood risks, or water resource management in large-scale basins, where coherent policy approaches from the headwaters / sources to the mouth of the river are needed. Yet, due to the uneven distribution of institutional responsibilities (e.g. the regional competences of biodiversity topics, or the coordination of water-related issues by the prefecture of the Départements), cross-sectoral coordination on climate change issues and adaptation is so far not taking place. This systemic and integrative planning is key for the translation of national and regional policies into action and the successful on-site implementation of adaptation measures.

Furthermore, regulations are partially contradictory in terms of their objectives and implementation. Current parameters do not necessarily correspond to those of planning documents, there is a limited scope of the existing documents treating adaptation, and objectives might be outdated or redundant in the light of climate change reality.

3.1.1.3.4 Support needed

Normandy could benefit from support for the planning, design and implementation of measures in the following areas and focal points:

- **Facilitate stakeholder engagement.** The integration and engagement of actors relevant to respective activities was identified as a key challenge in the successful implementation of adaptation actions. Stakeholder consultations enhance the update and implementation of measures, and CBA of NbS ensure long-term acceptance and potentially also facilitate the investment of private sectors. In this context, adelphi can contribute in assessing and integrating potential impacts for highly vulnerable groups and incorporating the gender dimension into adaptation action. By ensuring the inclusion of vulnerable communities, the acceptance and equity of adaptation actions is increased.
- **Initiate an integrative and targeted planning.** The expertise and assistance by the RESIST consortium ensures that adaptation activities maximize their positive impact and effectiveness. Linking individual measures can create additional positive effects and increase co-benefits, both concerning adaptation goals and positive social impact. Systemic planning

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strengthens the coherence and impact of adaptation policies across scales and sectors. At the same time, it makes sure that measures are not inadvertently leading to negative side effects or exacerbate vulnerabilities. Robust screening processes and ex-ante assessments of adaptation actions identify and mitigate potential unintended consequences, thus leading to more sustainable and climate-resilient outcomes.

- **Leading the pathway to transformative and innovative adaptation on the basis of NbS.** Through RESIST, ecosystem-based approaches to adaptation are fostered, which provide additional synergies and co-benefits between and beyond measures. NbS offer no-regret measures that are cost-effective, flexible and resource-efficient, which is in alignment with the priority stated in the SDAGE. Knowledge-sharing and capacity-building will facilitate the implementation of innovative measures that shift adaptation to fostering long-term solutions and addressing the root causes of climate risks.
- **Enhancing the climate risk understanding.** Although the existing regional climate risk assessments rest upon a sound knowledge base, improvements can be made that increase the integrity of adaptation schemes. This concerns updating the underlying risk framework to include the latest standard of knowledge according to the IPCC AR5/AR6 (2014, 2022); the inclusion of notions regarding cascading and compounding risks; the adjustment of parameters to the current reality of climate change; and the in-depth evaluation of sensitivities, especially those of highly vulnerable groups within the population.

3.1.1.4 Potentials for transfer

Normandy can benefit from knowledge and know-how from the LSD region SW Finland and the Twinning Region EMT but similarly provide helpful insights for other regions and the development of the transfer scheme:

- **Knowledge transfer on cost-benefit analysis.** An implemented CBA for NbS in SW Finland can serve as a good practice example for this type of analysis and lessons learned by the Finnish partners would be very valuable to Normandy, especially with SW Finland's diverse range of pilot sites.
- **Engaging and convincing stakeholders.** Normandy would benefit from experience on stakeholder mapping and planning of the involvement, from identifying goals and understanding priority stakeholders to integrating the results in the intended use. As the concepts of vulnerable population groups and gender-sensitivity have not been in the focus of Normandy's action planning, it would be helpful to learn from best practices in regions which have identified major vulnerabilities in the population, including concerning gender, and developed approaches to address these.

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- **Identifying suitable sites.** The site-specific selection criteria developed by Normandy to localize NbS applications can support other regions in identifying suitable locations for (NbS) measures and systematically examine the assumptions that lie behind site selection.

3.1.1.5 Results

The syntheses by the GIEC Normand provide a detailed dossier of climate change impacts in Normandy concerning meteorological hazards, water, coastal systems, biodiversity, agriculture, fishing, air quality and health in eight concise synthesis reports with appealing visualization. The analysis could be further improved or refined in terms of the underlying risk framework. A more detailed evaluation of vulnerabilities, especially concerning vulnerable population groups, could lead to their needs being taken more into account when planning adaptation measures and prevent maladaptation. Similarly, a more integrated view of cross-cutting risks could promote synergies between sectors and reduce the risk of maladaptation.

The largest challenges regarding the implementation of planned measures in Normandy concern planning the stakeholder engagement. In-depth information on the vulnerabilities, especially of the population, as well as public communication and engagement of all relevant stakeholders is key to design inclusive measures and create acceptance. adelphi can both support the analysis of vulnerable groups as well as the process of stakeholder and community engagement once the pilot sites have been decided. Based on this, adelphi can help communicating with and convincing stakeholders that might be opposed as well as integrating the consideration of gender aspects, particularly vulnerable population groups and their needs in the design of the adaptation measures.

To enable a comprehensive adaptation scheme going beyond the planned measures within RESIST, Normandy can draw from various regional strategies for sustainable development, climate change mitigation and adaptation. However, to realise the full potential and set out on the path towards transformative adaptation, the region would benefit from establishing a comprehensive climate adaptation strategy. This strategy should be built on a clear target architecture based on which over-arching goals and concrete measures can be deduced. It would differentiate between different types or depths of actions, integrate existing sectoral approaches and link proposed measures to the major impacts identified in the GIEC Normand syntheses.

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3.1.2 Needs Assessment Eastern Macedonia and Thrace

3.1.2.1 Introduction

Figure 4: Location of Eastern Macedonia and Thrace (taken from Description of the Action).

The Eastern Macedonia and Thrace (EMT) region is located in north-eastern Greece, encompassing the islands of Thasos and Samothrace, as well as the eastern part of Greek Macedonia and the western part of Thrace (see Figure 4). The region covers 14,157.76 km, and it shares borders with Bulgaria to the north and Turkey to the east; it is divided into six regional units and 22 municipalities. The most prominent cities are Alexandroupolis, Drama, Kavala, Xanthi, and Komotini, which serves as the region's capital. EMT has a population of 608,000 people, representing 5.6% of the Greek population. The agricultural sector employs the greatest number of individuals in the region. Unfortunately, the region has experienced a decline in GDP over the last six years, coupled with an increase in the unemployment rate, which stands at 22.8% of the population (2023). The ERDF has identified Eastern Macedonia and Thrace as one of the poorest regions in Europe, thus indicating its underdevelopment. The terrain of the region is markedly varied, featuring numerous mountains and plains, along with a lengthy coastline spanning 480 km. Additionally, it boasts an abundance of rivers, deltas and wetlands.

The region has experienced significant exposure to the impact of climate change. In recent years, the prefectures of Evros, Rhodope and Xanthi have endured severe flooding, resulting in numerous economic losses to residential and agricultural areas. The substantial variability of precipitation generates various water risks such as inland flooding and coastal erosion. Rising temperatures are aggravating hazards such as water shortage and drought, and are also associated with the severe wildfires the region was encountering this summer (2023).

3.1.2.2 Climate risks

3.1.2.2.1 Regional climate risk assessments and identified risks

The main document addressing climate risks in the EMT region is the **Regional Adaptation Action Plan (RAAP)** of April 2022 (Envirometrics 2022). The report aims to provide a comprehensive picture of existing and future climate-related risks for the region. It starts by identifying relevant climate hazards in the region based on which a vulnerability assessment is conducted. These findings subsequently feed into the impact assessment for the region, which is differentiated by sector and activity, and finally lead to the identification of appropriate adaptation measures.

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The analysis of climate risks for EMT is based on the simulation of regional climate models in the framework of EURO-CORDEX. In line with the IPCC AR5 and the European Environment Agency (EEA), the numerical climate models provide parameters of temperature, drought, wind, heat waves, cold intrusion/frost, sea level rise and waves. Climate risks are assessed for the RCP4.5 and RCP8.5 scenarios following guidelines of the AR5 (IPCC 2014). Climate risks are assessed for the mid-century period (2021-2025) and the end-of-century period (2071-2100). In the analysis, the six regions of Evros, Thasos, Rhodope, Xanthi, Kavala and Drama are considered individually to present a differentiated picture of the region.

The analysis examines a range of severe climate risks for the region, distinguishing between long-term changes in average climate and the frequency and intensity of extreme weather events. According to RCP4.5, average temperature is expected to increase by 2.2 to 2.6 °C by the end of the century, while under RCP8.5, temperature rise is projected to 3.6 to 4.6 °C. This will particularly affect areas far from the sea, such as Drama and Evros. Precipitation is expected to decrease throughout the year. In both scenarios the greatest decrease in precipitation is estimated for the regions of Xanthi and Kavala, with an average decline of 5% and 11% by the middle of the century.

As far as extreme weather phenomena are concerned, EMT will face an increase in maximum precipitation, wildfires, droughts and hot summers. Regarding droughts, it is anticipated that the number of days with less than 1 mm of precipitation will rise from 10 to over 70 by the end of this century in almost all parts of EMT. However, until mid-century the six regions reveal a differentiated picture: the maximum duration of drought will increase by up to 20 days in Drama and most of the Evros regional unit, and decrease by up to 20 days in Kavala and Rhodope. Regional differences also show when analysing the maximum amount of precipitation occurring within 48 hours: while for Evros, Thassos and Samathrace an increase of 10 to 20% is expected, for the southern regions a decrease of 10% is estimated. In the long term, heavy precipitation will increase in a significant part of the region by the end of the century under both scenarios. These trends of prolonged droughts and increasing heavy rainfall can go hand in hand and show that in EMT both extremes, i.e. very little and very large amounts of precipitation, become more frequent. In addition to water-related hazards, extreme temperatures pose a particular risk to the region. The report highlights a winter temperature increase of 1.0 to 3.2 °C by the end of the century and a summer temperature increase of 2.3 to 2.8 °C based on RCP4.5. In both scenarios, the number of days with temperatures above 35 °C increase across the region, particularly affecting lowland areas such as Evros. In addition, urban centres are especially exposed to days of discomfort based on the HUMIDEX index, hence presenting health risks for the cities Drama, Komotini and Xanthi. Additionally, forest fires pose a significant threat to the region. The number of days with extremely high risks of fire will rise to seven additional days under RCP4.5, and 18 to 26 additional days until the end of the century under RCP8.5. Based on this analysis, the report points out that the region, like many other Mediterranean regions, is particularly exposed to extreme water-related hazards as well as extreme heat and its consequences such as droughts or forest fires.

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Building on these findings, the RAAP provides a climate vulnerability assessment, examining the vulnerability of activities in different sectors according to climate parameters such as drought, temperature increase, wind, heat waves, cold spells/frost, heavy rainfall/snowfall, sea level rise and waves (storm surges). Activities considered include the primary sector with agriculture and livestock, industry, manufacturing, energy, waste, transport and categories such as health, biodiversity and cultural monuments. The assessment is based on an activity-specific quantitative and qualitative evaluation of literature on the sensitivity of each sector, international risk assessments reported in annual reports of boards of directors, and the assessment of project team members. In addition to the aspect of sensitivity, the probability of occurrence of the meteorological parameter, the geographical extent of climate change, the size of the population affected and the complexity and interactions of the phenomena are considered. The assessment also integrates the existing adaptive capacity of the sectors. The final rating follows a 5-point scale, ranging from no information on vulnerability (rating 0) and low vulnerability (rating 1) to extreme vulnerability (rating 4), with positive impacts included with a negative sign.

Both average temperature changes and extreme weather events make forests, agriculture and livestock, and thus the primary sector extremely vulnerable. Agriculture is highlighted as being extremely vulnerable to rising temperatures and also highly vulnerable to various climate risks such as increasing cold, droughts and heavy rainfall. The region's population, in particular vulnerable groups, are extremely sensitive to heat waves, heavy rain and snowfall, and highly exposed to cold spells and frost. The climate risk of heavy rain and snow also highly affects buildings, ski resorts and beaches. Beaches and harbours are furthermore highly vulnerable to waves and rising sea levels. The natural environment, wetlands and protected areas show extreme sensitivity to droughts and sea-level rise. In general, wetlands and protected areas are extremely vulnerable to warming, reduced precipitation and longer seasons. Finally, road and rail transport infrastructure as well as the built environment, including cultural heritage sites, were found to be highly vulnerable to more frequent and more intense extreme weather events.

The assessment also considers the effects of adaptive capacity, reducing vulnerability despite changing climate parameters. Summer and urban tourism as well as education might become slightly less vulnerable despite rising temperatures as interventions in these areas facilitate adaptation to climate change and reduce its negative impacts. Additionally, the resilience of wind energy might increase in the future. However, in the energy sector hydropower plants remain highly vulnerable to increasing droughts.

In addition to the RAAP, the 8th National Communication (NC) to the UNFCCC also includes a vulnerability assessment of the different regions (Ministry of Environment and Energy 2022). Here, the region's highest vulnerability is found in the general water supply sector, followed by the sectors of agriculture and forests. Since the preceding report in 2018, the vulnerability of health and fisheries has increased.

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The concluding impact assessment in the RAAP combines climate parameters and vulnerability to determine the overall risk of each activity field in the different sectors. Hereby risk is calculated as the sum of the individual risk of each climate parameter and is ranked on a 5-point scale from negligible (0), small (1) to extreme (4). The assessment covers two scenarios and two time periods, and the overall risk is differentiated by geographical area, time period and scenario. This analysis builds the foundation for identifying specific adaptation measures and prioritizing according to immediate and long-term impacts.

Concerning topics of priority up to mid-century, the report highlights primary sector activities such as agriculture and forest systems as well as protected areas, wetlands and biodiversity. In terms of economic sectors, winter tourism is seen as very important. In addition, public health is emphasized, especially regarding the impact of climate change on vulnerable groups. Overall, water resources such as irrigation or water supply for various sectors are highlighted as a priority until mid-century. When assessing the long-term priorities (2071-2100), climate risks increase for most of the identified sectors at risk. Here, the impacts on the region's forest systems, agriculture and livestock, protected areas, water resources and health are highlighted. Medium and high long-term risks are also expected for fisheries and aquaculture, road, rail and secondary port transport, building infrastructure, the tourism sector and the terrestrial and aquatic environment. Other sectors such as mining, manufacturing, aerospace and energy are considered to be at low to medium risk in both the short and long term. In line with the priorities identified, the region highlights the climate risk of the agricultural sector and the variability of groundwater used for irrigation. The region also highlighted farmers and citizens as well as regional authorities and municipalities as highly vulnerable in the interview. People living in the mountainous areas of EMT largely depending on farming are particularly vulnerable as all economic activity in these regions is linked to agriculture and dairy production.

3.1.2.2.2 Comparison with ESPON data

The RAAP identified increasing temperatures, drought and heat waves to have a high impact on the primary sector, especially on agriculture and forestry, with forest fires posing a major threat to natural and human systems alike. Both slow-onset trends as well as extreme events affect natural systems and biodiversity. The population is highly vulnerable to heat waves, especially in urban areas. More frequent and intense extreme weather such as drought and flooding impact the built environment, i.e. housing and (critical) infrastructure as well as the population.

The ESPON CLIMATE dataset confirms this picture. As in the RAAP, the analysis differentiates between the six regions Drama, Evros, Rhodope, Xanthi, Kavala and Thasos but considers the last two jointly. Of the five climate-change related risks assessed within the ESPON project, the impacts of droughts on the primary sector, wildfires on the environment and heat stress on the population are identified as major threats in the baseline scenario (1981-2010). This is uniform across all

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regions, with overall risk levels higher than in the LSD SW Finland as well as the Twinning Region Normandy. EMT does not show higher levels of exposure or vulnerability compared to SW Finland and Normandy, but the assessed climate hazards drought, wildfires and heat occur with higher frequency and intensity in the region thus increasing the overall risk.

This picture solidifies when looking at the long-term future under RCP8.5. Drought, wildfires and heat remain highly relevant hazards and thus do the associated risks. Additionally, coastal flooding becomes extremely important in all regions but Drama, which has no access to the sea. In the long-term future, EMT should hence also consider adaptation towards increased coastal flooding which poses a severe threat to infrastructure, industry and the service sector.

3.1.2.2.3 Potential improvements for climate risk information

The Regional Adaptation Action Plan includes an in-depth assessment of hazards, vulnerabilities and climate risks for the region. The climate risk assessment follows the approach of the IPCC AR5 and includes two scenarios (RCP4.5 and RCP8.5) and considers medium- and long-term changes (2021-2050 and 2071-2100). The report incorporates specific considerations such as sensitivity, exposure, and adaptive capacity, in addition to aggregated factors like risk and vulnerability. Besides the clear presentation of the aspects, the assessment describes these factors as static over time. Therefore, the report does not address the variability over time, such as changes in adaptive capacity. The climate risk assessment showcases various long-term changes and extreme weather events. Furthermore, the methodological approach of the report provides transparency regarding existing uncertainties, data, and methodologies. The analysis benefits from a unique component of the climate risk assessment, highlighting the areas in which particular risks are most concentrated amongst the six subregions.

Apart from the above-mentioned profoundness of the assessment, the RAAP does not outline the impact chains in a transparent manner. In addition, vulnerable groups are partly considered, but the important distinction between different vulnerable groups is missing. While the existence of such groups is mentioned at several points in the assessment, it is not elaborated who these vulnerable groups are and how they were determined. It is also not specified which population groups are vulnerable to certain climate impacts, such as heat or flooding. To design adaptation measures in a way that is sensitive to the needs of particularly vulnerable people it is important to differentiate between climate impacts and identify who is vulnerable to which impacts. According to the regional partners one potentially vulnerable group is a large Muslim minority living in EMT which to a large extent lives in more mountainous areas and is mostly reliant on agricultural activities for income. Since these activities are particularly sensitive to climate change impacts, this population group can be highly vulnerable. However, further analysis is needed regarding vulnerable population groups in this region.

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The assessment also lacks explicit consideration of maladaptation and its impacts. The report presents a profound assessment with a differentiated presentation of climate risks and impacts, thus providing a solid foundation for the adaptation process. However, the specific consideration of different vulnerable groups is essential in order to later define adaptation measures in a socially just manner.

3.1.2.3 Adaptation measures

3.1.2.3.1 Existing plans and measures

Important policy documents at national level

Greece's National Adaptation Strategy to Climate Change (NAS) was endorsed in 2016. Law 4414/2016 includes the formal endorsement of this strategy and defines the Ministry of Energy and Environment as the competent national authority for national climate adaptation policy (Ministry of Environment and Energy 2022). The strategy states as its core objectives, amongst others, the systematization and improvement of short- and long-term decision making for climate change adaptation, the establishment of a monitoring mechanism for the evaluation and review of adaptation policies and measures, and the linking of climate change adaptation with sustainable development through regional and local actions plans. Regarding the last objective, the NAS requires each of the 13 regional authorities to develop, implement and monitor a RAAP within seven years after the adoption of the NAS. The strategy also mentions the establishment of a National Climate Change Adaptation Committee, a formal coordination and advisory body for adaptation policy at the national level. In 2022 the new National Climate Law, covering both the transition to climate neutrality and adaptation to climate change came into force. According to this legislation, the NAS covers a period of at least ten years and will be evaluated at least every five years by the Ministry of Climate Crisis and Civil Protection.

Overall, the NAS constitutes an overarching policy document, defining goals, principles and guidelines for adaptation. However, the responsibility for planning and implementing adaptation measures is delegated to the regional authorities. National adaptation policy therefore does not follow a top-down approach, instead giving a central role to the regions in downscaling the guidance and priorities that are outlined in the NAS. For certain priority sectors (including agriculture, water resources, natural ecosystems and biodiversity) the national strategy suggests potential adaptation options as guidance for the regional authorities but does not assess the effectiveness or feasibility of individual adaptation measures. The selection, prioritisation and design of adaptation actions falls within the responsibility of regional authorities.

The NAS also details some of the content that each RAAP shall include, providing detailed guidance for the regional authorities in developing these plans. This includes the requirement to conduct an analysis on the regional level of trends of the main climate parameters for the short, mid-, and long-

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term for more than one climate scenario, an assessment of the vulnerability of specific sectors and/or geographical areas and the identification of priority sectors and geographical areas for action. In addition, the RAAPs should contain an examination of the potential actions included in the NAS based on the regional situation. Adaptation measures should be prioritized based on a cost-effectiveness analysis (Ministry of Environment and Energy 2022).

Concerning the management and climate adaptation of water resources, the national objectives in Greece are mostly based on various EU water-related directives which are sometimes supplemented with additional provisions. Important policy documents in this context are River Basin Management Plans (RBMP). The Regional Water Directorates in each of Greece's regions are responsible for the formulation and implementation of each of these plans, which are revised and updated every six years.

Overview of relevant policy documents at regional level

At the regional level of EMT, the **Regional Adaptation Action Plan** constitutes the central policy document for adaptation to the impacts of climate change. As already elaborated in section 3.1.2.2.1, this action plan contains a detailed assessment of climate impacts, risks and vulnerabilities, including the identification of geographical hotspots and priority sectors. The second part of the RAAP focuses on regional actions for climate change adaptation and lists 65 adaptation measures. The overall policy objectives of the RAAP are to strengthen the administrative capacity of relevant institutions and developing a system for monitoring the implementation of adaptation measures; the dissemination of knowledge and skills; and to strengthen resilience in the sectors that were identified as a priority.

The adaptation actions included in the RAAP have a particular focus on infrastructure projects that have an immediate and medium-term effect on reducing risks from hazardous situations, on studies aimed at improving the knowledge and understanding of climate impacts in the priority sectors, and on the application of information and communication technologies. Each of the 65 adaptation measures in the RAAP is described in a detailed manner and their cost-effectiveness is assessed. The description of individual measures contains the objective, implementing bodies, cost and funding source, timetable for implementation and other information.

Water-related risks play a large role in this list of adaptation measures and are addressed by a number of them. One of the main priority measures is the establishment of a regional Climate Change Observatory. It is supposed to enable the exchange and collaboration of various stakeholders, particularly regional and municipal authorities, as well as managers of protected areas and researchers. Also, through CCA an infrastructure should be created that supports regional authorities in implementing and monitoring measures and facilitates public communication.

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Another main priority is the implementation of adaptive measures directly related to extreme weather events, predominantly flood risks and drought. The description of the Flood Risk Prevention and Management Measures comprise the planning, designing, and constructing of infrastructure and sets the focus on flood protection in highly vulnerable urban and peri-urban areas. Specific measures described include restoration projects in mountainous areas, fill removal projects, rehabilitation of existing infrastructures, and the management coastal agricultural areas. Other flood-related measures mentioned address the development of early warning systems, the updating of flood protection-related strategic plans, and specifically interventions for the protection of Lake Vistonida and Lake Ismarida from flooding. Although NbS, namely ecosystem-based adaptation measures to reduce the risk of loss and damage due to flooding, such as afforestation, wetland restoration, or dry polders, are partially included within the Flood Risk Prevention and Management measures, their potential implementation and the effectiveness in Flood Risk Management and the multiple provided co-benefits have not been acknowledged in detail (Mirli et al. 2022; Kourtis et al. 2022).

Drought is addressed with the planned update of the Water Scarcity and Drought Response Plan, which describes the creation of an integrated drought management study and measures to reduce drought-related risks. Drought is also reflected in the program for sustainable rural development based on vulnerability levels that must integrate climate change adaptation actions and are closely linked with climate change impacts on agriculture. Measures addressing the agricultural sector include an assessment of climate change impacts to existing crops and their vulnerabilities and the development of irrigation management and control tools that involve the assessment of existing irrigation efficiency, study of monitoring systems, and implementation of closed irrigation networks. Apart from flood and drought hazards, the risk of forest fires is addressed in the planned establishment of an early warning system for forest fire detection via remote-controlled aircraft, drones, and early-detection sensors.

Overall, the RAAP provides a very detailed and solid foundation for implementing adaptation measures in the region. The measures listed in this plan are well thought-out and assessed based on their effectiveness.

Two other important policy documents are the region's **River Basin Management Plans** (first version from 2009-2015; 1st updated version from 2016-2021). In these plans, surface and groundwater bodies were identified and characterized, reporting conditions and classifications of the potential of surface water bodies were reviewed, significant pressures and impacts assessed, and the progress of environmental objectives evaluated. The first updated version considered the implemented actions, acknowledged new implementation methodologies, and incorporated the measures and sub-actions of the National Strategy for Adaptation to Climate Change. The RBMPs play a significant role in adaptation efforts due to the data collection activities conducted. The collected high-quality data on water flow in general and flooding, in particular, can be used to prepare models that inform the design of adaptation measures.

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While data on climate risk components is available and the ex-ante assessment of the predicted effectiveness and costs of proposed measures in the RAAP is relatively detailed, the existing regional adaptation scheme can be enhanced in several realms. Although highly vulnerable groups are mentioned in the plans, they are not clearly defined, thus increasing the uncertainty on how to consider the needs of vulnerable groups and design and plan adaptation measures accordingly. Furthermore, it is unclear whether vulnerable groups and their perspective was included in the design process and establishment of the RAAP.

Secondly, the RAAP lacks to acknowledge the risk of maladaptation, that is, "*Adaptation with negative consequences that increase the climate vulnerability of a system, sector or group, that shift vulnerability or exposure, or that erode sustainable development, now or in the future*" (Reckien et al. 2023). By identifying and addressing maladaptation risks, the plans can be optimized to avoid actions that might inadvertently exacerbate vulnerabilities or create new problems in the long term (Institute for European Energy and Climate Policy (IEECP) et al. 2023).

Thirdly, the potential of NbS for climate adaptation is not yet acknowledged in full terms, especially the contribution of ecosystem-based approaches to reduce flood risks. A study conducted in the EMT region found that NbS can especially benefit the water quality, however, the lacking consideration in respective measures is due to missing stakeholders' knowledge, funding shortages, and lack of mitigation hierarchy strategies (Mirli et al. 2022)

Furthermore, the findings of the conducted interviews reveal that gaps in the RAAP exist regarding the specific implementation roadmap of the proposed adaptation measures and the inclusion of different stakeholders in the planning, implementation, and continuation process.

3.1.2.3.2 Planned adaptation measures within RESIST

The activities planned by within RESIST focus on the water sector and are very data-driven. One planned adaptation measure is the development of an application that contains flood warning systems as well as information on water quality. Existing flood warning systems will be enhanced through the integration of machine learning and artificial intelligence in automated data analysis.

Another line of activities includes the collection of data on costs and benefits of NbS. With the help of this data, a thorough CBA for NbS is planned. In addition, stakeholders will be informed about the benefits of NbS and involved in the co-creation of activities (see 3.1.2.4). More strategic work is planned in developing a roadmap for using NbS in flood retention, improvement of water quality through pollution reduction, and mitigation of water scarcity in irrigation.

For the implementation of adaptation measures in RESIST, two pilot sites have already been selected: the river basins of the Kosynthos and Laspias rivers. Both of these are peri-urban rivers of

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Xanthi, but are in varying contexts. They were selected specifically because of the differences in circumstances and challenges.

The Kosynthos river basin comprises an area of 240 km² with an extensive hydrological network of 88.9 km and a large average land slope of 60%. The entirety of this network will be part of the pilot. The river basin comprises a variety of land-uses, including agricultural and residential. Other areas are covered in forests. Previous flood events in the area have caused extensive damages to buildings and infrastructure. Most recently, the city of Xanthi and surrounding villages were flooded in 1996.

The Laspias River is located in the Nestos Basin, which comprises an area of 221.8 km². The area is mostly flat and characterised by intensive agricultural activity as well as some natural areas with low vegetation. The river basin includes two modified water bodies and is characterised by habitat fragmentation. It is subject to nitrate pollution and receives organic loads (sanitary landfill, bio-waste treatment plant, industry). The main point sources of pollution are the municipal waste water treatment plant of Xanthi, the landfill and the industrial area of Xanthi. In terms of non-point sources of pollution in the watershed, the main source of pollution is agricultural run-off and several livestock units that dump their waste in the torrent.

The area covered by the water districts under study is of high environmental importance due to the diversity of ecosystems (from mountainous to coastal), rich biodiversity, habitat coverage and transboundary rivers. The area includes five national parks and more than 20 Natura 2000 sites. While the Kosynthos river has been affected by flooding in the past and therefore provides an appropriate test site for flood protection measures, the Laspias river is more affected by drought issues and water pollution. The regional project team has worked with both of these river basins before and therefore has a detailed knowledge of the topography, water quality and water flow.

Main challenges

The technical information, data, and expertise needed for the implementation of the planned adaptation activities in RESIST appears to mostly be available and existing gaps can be filled with data from regional authorities. However, it is essential to integrate a social equity and gender-perspective into this technical dimension of adaptation. This concerns both the data that is being used, especially when socio-economic data is relevant, and the specific design-decisions that are made based on the data. For example, if data sets are incomplete and do not include the particular vulnerabilities of certain population groups, adaptation solutions can be designed in a way that exacerbates existing inequalities. One of the challenges in this region will therefore be ensuring that all relevant perspectives and sources of information are included. The stakeholder engagement process will be a central role in this.

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In contrast to the RAAP, the activities within RESIST have a clear focus on NbS and can help promote this type of adaptation measure in the region and beyond. At the moment, the common misconception persists that NbS are less effective or more expensive than other adaptation solutions. A lack of knowledge and expertise regarding the monetary and non-monetary benefits of NbS exacerbates this problem. Addressing this knowledge gap is therefore an important challenge in the region (as in some of the other project regions). Another element that impedes the implementation of NbS is the lack of financial evaluation of these solutions. The CBA which will be conducted as part of this project can hopefully act as a catalyst for increasing the use of this type of adaptation solution.

A further challenge lies in finding synergies between the NbS for adaptation and the management of national parks and Natura 2000 sites in the region. These areas are under the management of the Natural Environment and Climate Change Agency and a common approach will be necessary to ensure long term success in their climate resilient management.

3.1.2.3.3 Support needed

Several areas and activities exist where support would be helpful in the planning, design, and implementation of adaptation measures and beyond:

- **Prioritisation and integrative planning.** adelphi can assist in ensuring that adaptive measures are being assessed in terms of their effectiveness and benefits in depth and that respective projects are implemented in an integrated and encompassing manner. Linking individual measures together can create synergies and result in additional benefits that do not only apply to the planned adaptation objectives, but reach further beyond in terms of social co-benefits. The long-term efficiency of measures is thus increased.
- **Leading the pathway to transformative and innovative adaptation, especially by promoting NbS.** Through knowledge sharing and capacity building, RESIST can facilitate the implementation of innovative measures in the EMT region. This shift aims at fostering innovative and long-term solutions in ways that address the root causes of vulnerability and climate risks, in contrast to incremental actions. Here, RESIST can especially contribute in the implementation of adaptive measures that rely on Nature-based Solutions. These offer entry points for co-benefits and synergies between and beyond measures, such as measures that contribute to both flood and drought reduction and additionally provide climate mitigation benefits.
- **Avoiding maladaptation.** adelphi can provide expertise and assistance in conducting maladaptation screening to ensure that the adaptation measures do not inadvertently lead to negative consequences or exacerbate vulnerabilities. Through a robust screening process and ex-ante assessment of planned measures, potential risks and unintended impacts can be identified and mitigated, leading to more sustainable and climate-resilient outcomes.

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- **Facilitation and support of stakeholder consultations together with municipalities.** adelphi can support stakeholder consultations, bringing together various actors such as municipalities, NGOs, small-scale private companies in the forestry sector, and the tourism cluster to take up and contribute to implementation of resilient land management practices. By fostering collaboration and engagement among these stakeholders, the uptake of measures can be enhanced and implementation can be sped up, and the acceptance, especially for NbS, is facilitated.

3.1.2.4 Stakeholders and capacities

The RAAP mentions as one of its priority axes the “promotion and dissemination of knowledge and skills”, establishing the education of stakeholders and information transfer as an overarching goal. However, according to the interview with regional project partners, the RAAP lacks detail on how to engage with stakeholders and including them in the further process. The RESIST project should play a central role in addressing this shortcoming by establishing different formats of interactions and engagement with stakeholders. One way the knowledge generated in these discussions will be utilised beyond the activities of RESIST is through an exchange with regional authorities. The feedback collected from stakeholders will directly feed into the implementation and evaluation of the RAAP.

Within the RESIST project, a number of activities are planned to engage different stakeholders. One of the main focus areas of these activities is raising the awareness of landowners and farmers in order to promote more sustainable water management practices. To increase the uptake of NbS, several events are planned to educate stakeholders on the true costs and benefits of NbS and how to best design NbS in a way to minimise costs and maximise benefits. In addition, the development of information, guidance and participatory co-creation methods to increase stakeholder interest and motivation to invest in NbS for water retention are planned.

In order to reach as many stakeholders as possible, the regional consortium plans to implement workshops, interviews and citizen science approaches. The aim of these activities is to inform people about the RAAP and collect information on their specific needs and concerns regarding climate change adaptation and how their lives and economic situation will be impacted be climate change. The regional consortium already has a strong relationship with several stakeholder groups, particularly within the field of civil protection. These relationships can provide a helpful distribution channel in order to provide relevant information to people affected by the impacts of climate change.

Initial activities are already planned and a first workshop will be conducted towards the end of 2023. The initial list of stakeholders that will be involved in this workshop includes scientists from the technical and geotechnical chamber of Greece, farmer associations which control irrigation systems,

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associations of aquaculture systems, relevant regional and municipal authorities, and central government bodies in charge of managing protected natural areas in the region. Additionally, an open invitation is extended to any interested citizen. Similar activities are planned at several points during the lifetime of the project.

With regard to potential opposing interests in the region, these do not seem to play a significant role in climate adaptation. While people may have a general scepticism towards governmental dialogue processes, they are normally not opposed to climate adaptation in general and can be convinced of the need for action by referring to recent flooding and other extreme weather events. The regional consortium can also profit from the existence of a large group that is active in disaster protection and that can act as multipliers for information and awareness raising around climate change. Instead of showcasing the necessity of climate change adaptation itself, it seems more relevant for the success of this project to ensure stakeholders that the purpose is to discuss solutions with them and tailor them to their needs, not to impose something they did not agree to. It will be essential to convince stakeholders that their input has real weight and will influence the design of adaptation measures.

Potentials for support by adelphi mainly concern additional input on relevant entities to include in the stakeholder engagement activities. Here, a special focus should be on ensuring vulnerable population groups and all genders are represented in the workshops and other formats. This way, their particular challenges and needs can be integrated in the design of adaptation measures. In addition, help can be provided to the regional consortium on ways to approach sceptical actors and convince them of the value of the engagement activities.

Capacities and capacity constraints

In terms of financial capacities, the main source of funding for the region in the area of climate change adaptation are various EU funds, including LIFE, INTERREG, ERDF, ESF and Cohesion Fund. For the most part, this funding is deemed sufficient for the adaptation measures that are planned in the near future. Up to now, private funding has not played any significant role in adaptation in Greece. The same is true of public-private partnerships in adaptation financing, although the potential synergies in this kind of partnership are slowly being explored. Providing examples of private funding for adaptation measures can be of interest for the region to support this process.

The institutional capacity in the region has improved over the past decades and is now at a suitable level. However, constraints remain an issue in implementing important activities for adaptation. The establishment of a Climate Change Observatory, as stated in the RAAP, is impeded by a lack of resources. The regional administration is tasked with monitoring and implementation of the RAAP, which means a large additional administrative burden.

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3.1.2.5 Potentials for transfer

The integrated and contrastable implementation of measures with the RESIST project allows for the local consortium to receive knowledge and know-how from the respective LSD region (SW Finland), so that outputs in the EMT region can be demonstrated:

- **Cost-benefit analysis.** An implemented CBA for NbS in SW Finland can serve as a good practice example for this type of analysis and lessons learned by the Finnish partners in this process will be suitable for transfer to EMT.
- **Flood modelling tools and data.** Data and used algorithms and programme code, e.g. for statistical analysis, are transferrable through open source libraries and licenses. Algorithms will be tested for the EMT region and might subsequently be applied to other regions. This transferability will be targeted through the development of a universal approach, but its applicability remains context specific.
- **Experience with One Digital Health approaches.** The regional partners in the EMT region are involved in another cross-European project (OneAquaHealth) and offered to transfer potentially relevant insights gained in this project to other RESIST regions.

3.1.2.6 Results

Current climate risk assessments on the regional level could be improved by clearly defining the underlying risk framework and considering a wide range of weather and climate events, both slow onset trends and hazards. Additionally, special focus should be laid on the analysis of vulnerable groups and the identification of cause-effect-relationships and impact chains.

At the current planning status, the largest need is to integrate dimensions of vulnerability, such as gender and socio-economic status, in the layout of the measures at the three demonstration sites, and to design the stakeholder engagement processes in an inclusive and collaborative way. When plans have evolved further, the measures should be checked for possible negative side effects and the potential of maladaptation.

The greatest challenge to creating more systemic solutions is bridging the gap between existing individual measures and establishing a long-term cross-sectoral adaptation strategy. Impulses from the co-creation processes and the results of the CBA can provide a momentum for upscaling solutions but institutional and policy innovations are needed to allow for more profound transformations:

With the Regional Adaptation Action Plan, an in-depth roadmap to the implementation of various adaptation measures is already in place. Furthermore, the River Basin Management Plans can contribute to the design of actions by data provision. However, despite the solid and profound

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creation of regional adaptation measures and its assessment in the RAAP, the existing plans fall short in some aspects which are deemed critical for the establishment of a socially just and long-termed adaptation scheme. This concerns the inadequate acknowledgement and inclusion of highly vulnerable groups, missing consideration of maladaptation risks, lacking priority to Nature-based Solutions, and an unclear implementation roadmap and time schedule. To address this, the findings and measures developed through the RESIST project and the knowledge sharing with other regions can make a substantial benefit in ensuring an integrated, socially just, and efficacious adaptation design.

Planned measures within RESIST are focusing on the water sector and data-driven. Spatially, the planned measures are focusing on basin areas of the Kosynthos and the Laspias river, which share similarities but feature important differences in terms of their characteristics, main hazards and sources of pollution. One entry point to create adaptive capacity is the built-up of information provision regarding flood warnings and water quality conditions. Another emphasis will be put on the development of CBA for various NbS, in a process that will be facilitated through a knowledge transfer by other regions. It will be especially important to acquire regionally relevant information for various stakeholders on the immediate and co-benefits of NbS and the potential of savings they provide over time versus investments. The availability of solid empirical evidence will decrease the obscurity regarding social acceptability and thus promote their uptake and upscaling. RESIST thus supports the implementation of NbS through clearing existing knowledge gaps, providing expertise on the design and planning, and the CBA. Finally, the risk of maladaptation and the avoidance strategies will be addressed. The stakeholder engagement process in these regions will play a key role in ensuring social equity and the integration of gender perspectives.

adelphi can support the region in effectively prioritizing measures and ensuring an integrative planning process; identify and address the needs of highly vulnerable groups and incorporate a gender perspective into adaptation actions; leading the pathway to innovative and transformative solutions; contribute to the avoidance maladaptive practices; and facilitate the stakeholder consultations.

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3.2 LSDT 2: Introduction

This chapter assesses the twinning regions Blekinge, located in Sweden, and Zemgale, located in Latvia. The lead region to LSDT 2 is the Central Denmark Region (CDR).

3.2.1 Needs Assessment Blekinge

3.2.1.1 Introduction

Figure 5: Location of Blekinge (taken from Description of the Action).

Blekinge Region, located in Sweden (population: 160,000), is situated along the Baltic Sea and boasts an expansive archipelago consisting of over 1,000 islands, encompassing five municipalities (see Figure 5). As a well-developed region, its experience in CCA remains relatively incipient. Sweden has outlined 16 national environmental quality objectives targeted for 2030. The County Administrative Board spearheads the regional initiatives focused on energy transition, mitigating climate impact, and monitoring progress towards these environmental goals. Regrettably, a 2021 assessment indicated that the region is unlikely to achieve any of the 16 objectives by the 2030 deadline. Characterized by its rural landscape and sparse population, Blekinge grapples with significant demographic shifts and urbanization challenges. The evident changes along its extensive coastline and archipelago underscore the pressing threat of the climate crisis to its inhabitants. Yet, Blekinge's smaller population and favourable political climate position it uniquely to pilot transformative innovations swiftly and cost-effectively. A recent emphasis, aligned with the local smart specialization strategy, aims to cultivate Blekinge as a mission-driven region. Particular attention is drawn to urgent climate-related concerns: i) The deterioration of marine ecosystems, especially near coastlines and in inland waters, which impacts coastal communities – a situation exacerbated by insufficient data and monitoring; ii) The decline in groundwater reserves, anticipated to worsen due to climate change; and iii) A heightened susceptibility to flooding.

3.2.1.2 Climate risks

3.2.1.2.1 Regional climate risk assessments and identified risks

While the regional climate risk and vulnerability assessment for Blekinge ("**Översiktlig klimat- och sårbarhetsanalys - naturolyckor**") published in 2012 (Blekinge County Board) does not present the most up-to-date information after more than 10 years since publishing, it still gives a systematic overview over the identified changes of climate conditions and resulting climate risks for the region under two different time periods (currently in 2012 and up to year 2100). Flood risks occur due to

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heavy rainfalls or rising water levels both in the sea as well as in-land waters. Risks from coastal (beach) erosion appear due to rising sea levels as well. An increase in precipitation especially during the vegetation-free period is expected to intensify landslide risks, mainly in coastal areas or along waterways. The assessment report also investigates how the different hazards pose risks to society and infrastructure (Blekinge County Board 2012). Apart from the mentioned assessment report, regional representatives highlighted during interviews that risks from flooding (rather long-term) and drought as well as heatwaves (rather short-term) present the most pressing climate risks in the region of Blekinge.

The main dataset on climate risks is available through the Swedish Meteorological and Hydrological Institute (SMHI), which is a leading authority on weather, water, and climate. SMHI gathers and processes vast data, offering timely decision support for both short-term and long-term planning. SMHI's team produces forecasts, climate scenarios, and studies. They also share knowledge through their website, media, and training programs. Their services cater to various sectors, providing weather forecasts, warnings, and specialized industry insights. SMHI operates through government funding, assignments from other agencies, and commercial activities, with offices in Norrköping, Gothenburg, and Uppsala.

SMHI considers a wide range of climate indicators, three emissions scenarios (RCP2.6, RCP4.5, RCP8.5), four seasons and periods until 2100 and provide basic risk maps in open access. They also provide data on Hydrology and Oceanography. SMHI's data collection includes temperature, precipitation, and wind, supplemented by satellites and radars. This data supports their diverse weather services. They also offer integrated services to the private sector and authorities, grounded in their expertise. Their research spans meteorology, hydrology, and climate, with historical observations aiding in understanding Sweden's climate shifts.

Regarding the data generated by SMHI and its integration into specific risks and adaptation plans, the interviewee believes that the data will be referenced and linked to the adaptation plan in some manner. However, there is uncertainty about the full extent of its integration. It is evident that the data is instrumental for action plans, helping municipalities gauge their current position and future direction. The data has been employed in places like Karlskrona and Karlshamn, serving as a foundational resource for risk assessments. In addition, municipal climate action plans are available. However, they do not follow the same directive. There is a recognition that while there is an abundance of data, it is not well-organized, an aspect the project aims to improve.

3.2.1.2.2 Comparison with ESPON data

The ESPON CLIMATE dataset provides valuable insights into climate hazards, exposure, and vulnerability in Blekinge region. For the analysis, the region is not divided into further sub-units. Considered hazards in the analysis comprise of heat stress, droughts, wildfires and different types of flooding (river, coastal and flash floods).

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When looking at the hazard component specifically within the baseline scenario (1981-2010), droughts play the most prominent role, affecting the primary sector of Blekinge region more than moderately. All other hazards are assessed to play a smaller role according to ESPON data, with flash floods still occurring slightly more than wildfires and river floods as well as heat stress.

Comparing this to the RCP8.5 high-emission scenario (2070-2100), drought impacts still appear similarly severe, while the coastal floods increase drastically, highly affecting the infrastructure, industry and service sectors. Heat stress affecting the population, river floods affecting the infrastructure and flash floods affecting the cultural sector are rising to become comparatively prominent (more than moderate) hazards. Exposure analysis shows that Blekinge is rather strongly exposed to river floods, droughts and heat stress. The analysis shows that the population is moderately sensitive and rather strongly exposed to river floods, coastal floods and flash floods, but as the hazard levels are relatively low in the baseline scenario, the population's overall risk from river floods remains moderate in Blekinge. However, this changes with a high-emission scenario, exacerbating the mentioned risks.

3.2.1.2.3 Potential improvements for climate risk information

For Blekinge at the current stage, available information on regional climate risk does appear to be comprehensive enough to provide an initial foundation for the region's adaptation process. However, despite the wealth of the available data, it is recommended to organize the wealth of information for various purposes and stakeholders. The region would benefit from an in-depth climate risk assessment report for various sectors, especially considering that the data is already available. Ideally, such a risk assessment would also formulate clear impact chains that outline the exposure, sensitivity and adaptive capacity of the system considered. In addition, different vulnerable groups within the region should be explored. This would serve as a more solid foundation for strategically building Blekinge's climate resilience.

This could also benefit municipal level adaptation plans and make sure that the common structure and approach is followed throughout. This would allow for a more comprehensive and well-founded approach in improving climate resilience in Blekinge's municipalities.

3.2.1.3 Adaptation measures

3.2.1.3.1 Existing plans and measures

Important policy documents at national level

The Swedish government has introduced the **National Strategy for Climate Adaptation** to address the challenges of climate change (Swedish Government 2018). This strategy aligns with international commitments, including the Paris Agreement and the European Union's climate adaptation strategy.

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The main goal is to strengthen Sweden's resilience against climate-related adversities and to identify and act on opportunities. This aligns with global objectives, especially those in Agenda 2030. Recognizing the changing nature of climate challenges, the strategy will be reviewed every five years, ensuring its continued relevance and effectiveness.

The document highlights the increasing frequency and intensity of extreme weather events, such as more intense rainfall leading to increased risks of flooding and heatwaves, which can have adverse effects on health. The energy sector, particularly hydropower, is vulnerable to changes in precipitation and temperature, affecting production. There is an anticipated rise in the risk of landslides and avalanches in certain areas due to more intense and frequent rainfall, posing threats to infrastructure, buildings, and roads. Erosion, especially in coastal areas, is a significant concern, with rising sea levels and frequent storm surges leading to increased coastal erosion, threatening infrastructure and settlements.

To address these challenges, the strategy proposes several measures:

- **Preventive Measures.** Studies indicate that the costs of addressing damages to the built environment due to landslides, erosion, and flooding are significantly higher than the costs of preventive measures. The proposal suggests that municipalities assess the risk of damages and present a strategy to reduce or eliminate these risks, thereby enhancing preventive actions.
- **Risk Management.** In situations with high risk, where the likelihood and severity of an event's consequences are significant, preventive measures should be taken, warning systems designed, and responsibilities clarified. Adaptation measures should consider events with very low probabilities but high consequences. Robust measures that work across a range of future scenarios should be prioritized.
- **Flexibility and Integration.** Adaptation measures should be designed to be flexible and robust, favouring various future action alternatives. Where possible, adaptation strategies should be integrated into existing strategies and plans.
- **Support for Municipalities.** Several agencies have developed freely available planning materials to support municipal analyses. This provides a strong foundation for municipal work.
- **Identification of Special Risk Areas.** There is a need to identify specific risk areas in Sweden concerning landslides, erosion, flooding, and other related risks that threaten communities, infrastructure, and businesses.

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Overview of relevant policy documents at regional level

The **Klimat- och energistrategi för Blekinge** (Länsstyrelsen Blekinge 2019) presents the climate and energy strategy for the Blekinge region, aligning with the regional development strategy for Blekinge 2050 and focusing specifically on mitigation and does not address adaptation. The goal is to make Blekinge a fossil-free region by 2045. Sweden aims to have zero net greenhouse gas emissions by 2045, with emissions from activities within its borders being 85% lower than the 1990 levels. The remaining emissions will be offset by complementary measures. The vision for Blekinge is to create a region resilient to climate change, supported by a sustainable energy infrastructure that enhances residents' quality of life.

To achieve this vision, the strategy sets several goals, including reducing greenhouse gas emissions, expanding renewable energy, and enhancing energy efficiency. Key sectors like transportation, industry, agriculture, and housing are identified, each with specific measures to drive progress.

The **Åtgärdsprogram för vatten 2022-2027 Södra Östersjöns vattendistrikt** is the action program for water in the Southern Baltic Sea water district for 2022-2027 (Vattenmyndigheterna i Sveriges fem vattendistrikt 2022). The primary objective is to achieve and maintain a good water status in the region, emphasizing the significance of water quality and the challenges in attaining it. This program is driven by the need to prevent the deterioration of water status and to enhance the aquatic environment. It provides an overview of the current water status, pinpointing areas that meet the desired standards and those that require attention. Factors such as pollution and human activities are identified as primary influencers of water quality.

The strategy stresses the importance of collaboration between authorities, organizations, and the public. It outlines steps for effective implementation of the proposed measures and emphasizes continuous monitoring to gauge their success. The program also highlights the challenges in implementation, emphasizing the need for adequate resources and funding.

3.2.1.3.2 Planned adaptation measures within RESIST

Blekinge's approach to addressing climate risks and adaptation focuses on several key areas:

- **Awareness and Engagement.** A primary focus for Blekinge is to enhance awareness among its citizens and decision-makers. The City Expo Karlskrona initiative exemplifies this, aiming to engage the public and stakeholders through various demonstrations. An informed populace is crucial for effectively addressing and adapting to climate challenges.
- **Data Collection and Decision-making Tools.** Monitoring and data collection are pivotal for informed decision-making. Blekinge is keen on implementing decision-making tools backed by accurate and comprehensive data. The region plans to test these tools in at least two of its municipalities in relation to their Risk Management Plans.

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- **Increased Policy Coherence.** Blekinge recognizes the importance of aligning all strategies and actions with the region's overarching goals. Ensuring policy coherence means that different initiatives and strategies complement rather than contradict each other, leading to more effective and efficient outcomes.
- **Addressing Conflicts in Development and Adaptation.** There is a notable interest in understanding the conflicts between the demand for increased building development and the imperative need for climate adaptation and risk management. This will involve stakeholder rounds to facilitate knowledge exchange and gather diverse perspectives.
- **Specific Climate Risks.** The region is especially concerned about the marine ecosystem, decreasing groundwater levels, and increased risks of flooding. Despite ongoing efforts, groundwater levels and flooding continue to be primary issues. The region aims to adopt a mission-oriented approach, bringing all stakeholders on board to address these challenges cohesively. The precise mission statement, outlining the region's approach and objectives for 2030/2050, is still in development but is expected to be finalized soon. This mission will also involve insurance companies and industries.
- **Future Plans and Collaborations.** The mission adaptation forum has been a significant focus, with discussions initiated with the County Administrative Board (CAB), which collaborates with the municipalities. The goal is to gather more data on the coastal line, including insights from a cultural perspective, especially concerning UNESCO heritage sites. The challenge is ensuring that adaptations do not compromise these cultural landmarks. Several areas will be selected for this project, symbolizing a joint effort to address this unique challenge. The upcoming months are crucial, with stakeholder meetings planned to outline the region's scope and objectives until 2027.

Challenges include:

- **Regulations and Legislation.** One of the primary challenges faced in the implementation of activities is navigating the complexities of regulations and legislation. Determining responsibility at both local and regional levels can be ambiguous. This ambiguity extends to property owners who are responsible for their own properties but must ensure they do not adversely affect others. However, there is no clear entity responsible for overseeing the collective well-being of the region.
- **Property Ownership and Responsibility**. The principle that property owners are responsible for their own properties, coupled with the stipulation that municipalities cannot favour individual property owners, creates a challenging dynamic. This can lead to potential conflicts and hinder coordinated efforts for regional development and adaptation.
- **Financing Models.** The absence of clear financing models poses a significant challenge. Without established models, it becomes difficult to secure consistent funding for projects and initiatives, potentially stalling or delaying their implementation.

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- **Drinking Water Regulation.** While municipalities are responsible for drinking water, the presence of numerous individual wells complicates the situation. There is a pressing need for regulations to ensure the safety and availability of drinking water for all residents.
- **Coastal Built Environment.** A significant portion of the built environment is situated along the coast. This location makes it vulnerable to rising sea levels, coastal erosion, and other climate-related challenges, necessitating careful planning and adaptation strategies.

Opportunities include:

- **Vinnova KA-Project.** Partners are exploring the possibility of a KA-Project with funding from Vinnova. If successful, this project could bring additional resources and expertise to the region, aiding in its climate adaptation efforts.
- **Funding from MSB.** The Swedish Civil Contingencies Agency (MSB) offers funding related to natural disasters. This presents an opportunity for Blekinge to secure financial support for projects aimed at mitigating the effects of natural disasters and enhancing the region's resilience.

3.2.1.3.3 Support needed

The following areas of support were identified:

- **Improve understanding of climate risks.** While current data for climate risk assessments is well-founded, there is room for enhancement to ensure a more robust adaptation framework. This includes updating the risk model with the latest knowledge standards (like IPCC AR5), recognizing interconnected and escalating risks, adjusting to the present-day climate change scenario, and analysing vulnerabilities, especially those affecting the most at-risk populations.
- **Improve understanding of well-functioning adaptation plans.** A valuable insight would be to discern patterns in effective adaptation action plans, as such feedback could be instrumental in enhancing future strategies. This could be provided as a support from project partners or transferred from other regions.
- **Stakeholder engagement for increased policy coherence.** The current coordination structure faces several challenges. Determining clear responsibilities is complex due to the involvement of numerous stakeholders, each with their distinct agendas. Consolidating these varied agendas into a unified action plan is a significant challenge. Successfully implementing a holistic adaptation plan in Blekinge requires the active participation of relevant stakeholders. Engaging these actors not only improves the update and execution of strategies but also enhances the CBA. This can lead to long-term support and even attract private sector investments.

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3.2.1.4 Stakeholders and capacities

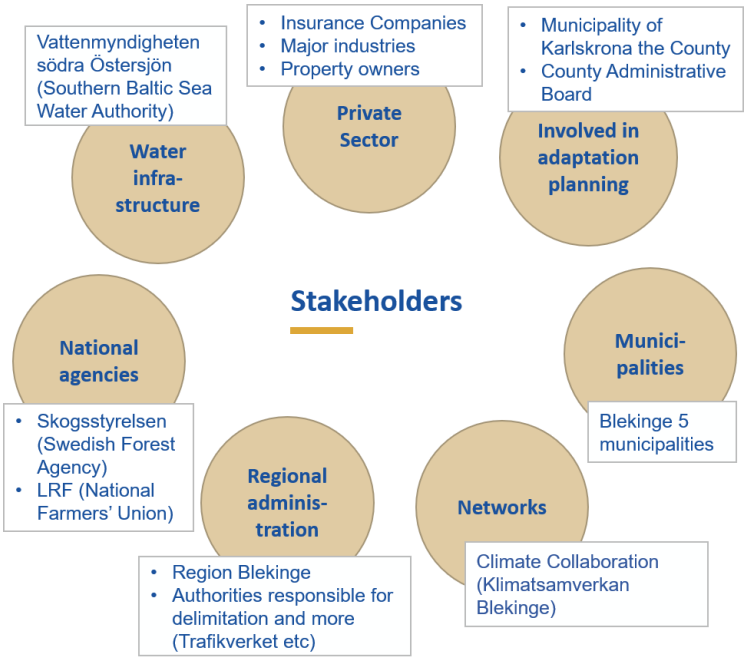

Figure 6 shows an overview of stakeholders in the region relevant in the project context. Central actors include national agencies, regional administrative units, municipalities and authorities involved in adaptation planning as well as water infrastructure construction and maintenance. Additionally, networks and the private sector were identified as relevant stakeholders.

Figure 6: Relevant stakeholders in Blekinge.

The following capacity constraints were highlighted during the interview:

- **Funding Constraint.** One of the primary challenges faced in the region is the significant funding constraint. Securing adequate financial resources is a persistent issue, which has led the region to adopt a strategic approach to address this limitation. The prevalent method has been to amalgamate various projects, ensuring that they align with and support the region's long-term goals. The CAB, a key institutional player, unfortunately, lacks the necessary funds to drive these initiatives independently. However, there is a glimmer of hope as there are indications that some financial support could be channelled from the national level. Additionally, the region anticipates receiving some funds from the HORIZON program, which could alleviate some of the financial pressures.
- **Institutional Constraint.** The CAB faces its own set of challenges, primarily stemming from its limited resources. This scarcity of resources poses a significant hurdle in enhancing policy cohesiveness, a critical aspect of ensuring that various initiatives and strategies align seamlessly. The constraint also means that the CAB needs to collaborate with a diverse range of stakeholders to achieve its objectives. This necessity for collaboration, while beneficial in many ways, can also introduce complexities given the varied interests and priorities of different stakeholders.

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- **Stakeholders Constraint.** Navigating the diverse political interests of stakeholders presents a significant challenge, especially when it comes to CCA at a strategic level. These varying interests can introduce risks, potentially obstructing the smooth execution of CCA strategies. To address this, there is an imperative need to establish clear goals and communicate transparently with all stakeholders. It is essential to elucidate the reasons for their involvement and the value they bring to the table. For instance, a landowner with considerable influence and power in the region must be made aware of their role and the broader vision, ensuring alignment of interests and fostering collaboration for the collective good of the region.

3.2.1.5 Potentials for transfer

- **Evaluating social risks and vulnerabilities,** with an intensified focus on vulnerable populations and gender dynamics, is essential. It is crucial to probe into the susceptibilities faced by diverse community groups and discern the underlying social threats. Incorporating these identified risks into Blekinge's regional adaptation blueprint will ensure that the concerns of the most vulnerable and gender-specific nuances are adequately addressed in the adaptation interventions and actions.
- **Begin comprehensive and focused planning.** With adelphi's expertise, adaptation efforts can be optimized for maximum positive outcomes. By interconnecting various strategies, we can amplify their benefits, both in terms of adaptation goals and societal advantages. Holistic planning enhances the consistency and effectiveness of adaptation policies across different areas and industries.
- **Best practices on strategic adaptation action.** A valuable insight would be to discern patterns in effective adaptation action plans, as such feedback could be instrumental in enhancing future strategies. This could be provided as a support from project partners or transferred from other regions.

3.2.1.6 Results

The national and regional action strategy for climate change adaptation is pivotal, serving as a guiding direction primarily for municipalities. There is an emphasis on enhancing these strategies at the municipal level. A regional plan has been in existence since 2014, but its implementation has faced challenges, underscoring its significance. Despite the acknowledged importance of climate change issues, they often lack adequate funding. Further discussions amongst regional stakeholders in September 2023 aimed to delve into the plan's importance, its relevance, and the key stakeholders involved. While climate change topics are recognized as crucial, they often do not receive the priority

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they deserve. As a starting point here, understanding main criteria for effective adaptation action plans could be instrumental in enhancing future strategies.

The coordination structure for climate change adaptation is primarily overseen by the CAB. However, the presence of regional responsibilities poses challenges, especially since municipalities hold the legal authority to act independently. The CAB, while tasked with numerous responsibilities, often faces capacity constraints. They aim to spearhead discussions and devise an exit plan, ensuring a smooth transition of responsibilities post-project. It is also noted that adaptation strategies differ between existing and new buildings, and not all aspects can be addressed within the project's framework.

The current coordination structure faces several challenges. Determining clear responsibilities is complex due to the involvement of numerous stakeholders, each with their distinct agendas. Consolidating these varied agendas into a unified action plan is a significant challenge. The RESIST project is acknowledged as a valuable initiative in addressing these coordination complexities, aiding in streamlining the process. Transferring solutions from other regions can help with systematization and re-organization of data that would benefit the region.

Finally, considering vulnerable groups and gender aspects in early planning stages would be a valuable addition. RESIST plays a role in evaluating and including the potential effects on highly vulnerable populations, ensuring that gender considerations are part of the adaptation process. By including these communities, we boost the fairness and acceptance of adaptation strategies.

3.2.2 Needs Assessment Zemgale

3.2.2.1 Introduction

Figure 7: Location of Zemgale (taken from Description of the Action).

Located in the southern part of Latvia (see Figure 7), the region Zemgale covers an area of approximately 10,733 km² with a population nearing 500,000 people. This region, also historically known as Semigallia, is notably a flat territory rich in agriculture due to the fertile plains of the Zemgale upland. In terms of economic activity, Zemgale is recognized as a prominent ERDF transition region, where the primary business sectors include agriculture, dairy farming, forestry, light industry, and tourism. The region boasts a unique blend of Latvian history and culture, with ancient Semigallian fortresses and an assortment of medieval landmarks that contribute to its identity.

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Zemgale experiences a temperate oceanic climate, transitioning to a humid continental climate. This means the winters can be cold, while summers tend to be moderately warm. Data from the Latvian Environment, Geology and Meteorology Centre (LEGMC) for 2020 suggests that the region's average temperature has risen by 1.5 °C between 1970 and 2020. Like other parts of Latvia, Zemgale has experienced a significant decrease in cold days and an increase in hotter summer days, indicative of global warming trends. As the region is landlocked, it does not face the same challenges as coastal regions; however, the increasing temperatures may impact its agricultural yield, which is a primary economic activity in the area. On the matter of precipitation, Zemgale receives around 650 mm annually. Although there has been no significant trend in annual precipitation, there is a noted decrease in snowfall events and a slight increase in intense rainfalls, which may pose challenges to the region's farming and infrastructure.

3.2.2.2 Climate risks

3.2.2.2.1 Regional climate risk assessments and identified risks

Zemgale does not have any regional climate risk assessment and has no concrete intend yet to prepare such a document in the near future. However, the regional representatives expressed general interest in developing such a regional climate risk assessment. Climate risk assessments and relevant plans and strategies are existing on a national level, but show no systematic evidence of climate risks specifically at the regional level. Nevertheless, interviews with Zemgale representatives highlight the importance of existing national level documents in guiding adaptation efforts within the region. On national level, in the years 2016 and 2017, climate risk and vulnerability assessments in six different areas of action have been published alongside adaptation indicators and measures (VARAM 2020), but these assessments consider the regional level only marginally. Also, the 2017 report on "Climate change scenarios for Latvia" (Avotniece et al. 2017) makes some reference to projected climate trends for some of Latvia's regions, but not for Zemgale. Finally, scientific literature was also not found to provide relevant insights and findings regarding Zemgale's regional climate risks.

However, the Zemgale Planning Region (ZPR) published an environmental report "ZPR AP Vides pārskats" (SIA Estonian, Latvian & Lithuanian Environment 2021) alongside its regional **ZPR Development Program** ("ZPR Attīstības programma 2021-2027") which formulates a moderate trend for both rising air temperatures as well as increasing average precipitation amounts in the region. Further clarifications on the impacts of these climatic trends in Zemgale were not formulated though. However, selective references are made primarily to existing flood risks and marginally to erosion risks. Interviews with Zemgale representatives showed that flood risks are perceived as the most pressing climate risk in the region, followed by impacts from extreme weather events like heatwaves, heavy precipitation (in both urban areas and rural sites) and hailstorms and its damages on roofs, solar panels and agricultural land. It was also mentioned that the current network of

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meteorological observation stations in Zemgale cannot precisely forecast such extreme weather events.

On the municipal level, there is no common framework and process of developing local climate risk assessments. However, the LEGMC performed detailed analysis on long-term historical climate data for 22 selected Latvian municipalities (only three of them in Zemgale: Jelgava, Dobele, Bauska) and presents its findings accessible online in the Climate Change Analysis Tool for local governments to use and integrate it into municipal adaptation plans and strategies. It shows four different climate index risks (heat waves, cold waves, snow blanket thickness, severe rainfall) under the scenarios RCP4.5 and RCP8.5 for the three time periods 2011-2040, 2041-2070 and 2071-2100. Additionally, the LEGMC provides flood risk information and data for all river basin districts in the flood risk information system (see Figure 8).

The information system presents various risk areas mapped per city (e.g. flood risk areas, population at risk, buildings at risk, roads in flooded areas, agricultural land at risk. These findings “allow flood risk to be integrated in a timely and qualitative manner into planning documents of various levels of territories, as well as providing high-quality information for the institutions responsible for the coordination of actions in case of floods” (Interview with ZPR, 05 Sep 2023).

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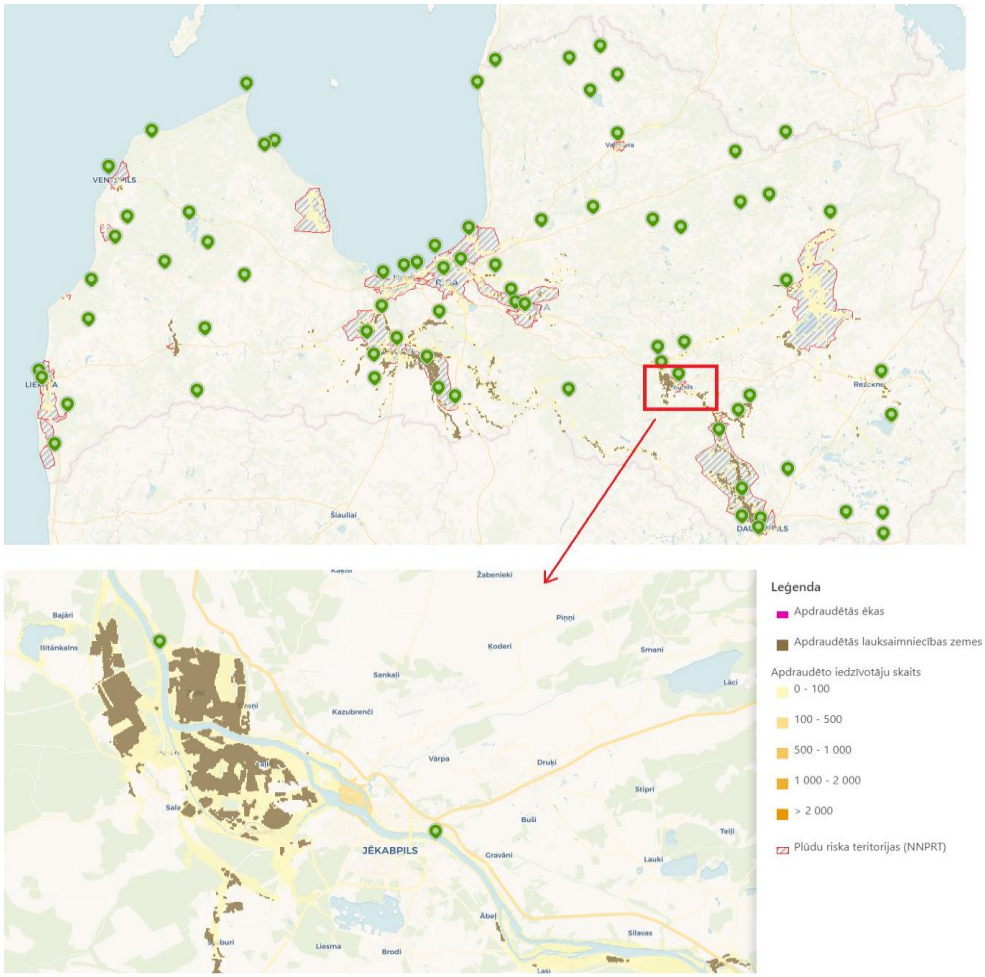

Figure 8: Latvian Flood Risk Information System - exemplary municipality Jēkabpils in Zemgale region showing layers on flood risk areas, buildings at risk, agricultural land at risk and population at risk (own illustration; after LEGMC 24.08.2023).

Next to these online portals, several Latvian municipalities have developed **Sustainable Energy and Climate Action Plans** (SECAPs) which are performed on a voluntary basis. While some municipalities do integrate climate risk assessments and climate adaptation strategies into their SECAP, other municipalities do not cover these topics at all.

For example, Saldus municipality (Kurzeme region, not within Zemgale) published a SECAP in the frame of the C4S project, which performs a detailed climate risk and vulnerability assessment (partly grounded in the online data portals mentioned above) for various hazards like extreme heat, extreme cold, extreme precipitation, floods, drought, storms and forest fires (low, moderate, high intensity) under three different climate scenarios RCP2.6, RCP4.5 und RCP8.5 and its impacts on various

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areas of action (low, moderate, high influence). It also gives some consideration to vulnerable groups at risk, like elderly and unemployed persons (Ekodoma 2020). Instead, other Latvian municipalities like Jelgava municipality (Zemgale region) do not cover these topics within their SECAPs at all and focus solely on climate mitigation aspects (ZREA 2010). According to interviews with Zemgale representatives, there is no central online platform existing that provides complete overview of all published municipal SECAPs in order to analyse the state of Zemgale's municipal SECAPs.

3.2.2.2.2 Comparison with ESPON data

The ESPON CLIMATE dataset provides valuable insights into climate hazards, exposure, and vulnerability in Zemgale. This is especially the case since regional climate risk assessments have not been conducted for the region yet. For the analysis, Zemgale region is not divided into further sub-units. Considered Hazards in the analysis comprise heat stress, droughts, wildfires and different types of flooding (river, coastal and flash floods).

When looking at the hazard component specifically within the baseline scenario (1981-2010), droughts play the most prominent role, affecting the primary sector of Zemgale region more than moderately. This is especially relevant "considering the importance of the region in agriculture at the national level" and the fact "that in the Zemgale plain, where large areas of agricultural land are concentrated, periods of continuous drought are longer than in other parts of the country" (SIA Estonian, Latvian & Lithuanian Environment 2021). All other hazards are assessed to play a smaller role according to ESPON data, with wildfires still occurring slightly more than river and flash floods as well as heat stress (Navarro et al. 2022). Coastal floods play no role in Zemgale due to its geography.

Comparing this to the RCP8.5 high-emission scenario (2070-2100), drought impacts on the primary sector still appear similarly severe, while heat stress affecting the population and flash floods affecting the cultural sector are rising to become comparatively prominent (more than moderate) hazards in Zemgale. Exposure analysis shows that Zemgale is rather strongly exposed to river floods and wildfires, but since the hazard levels for these phenomena remain rather low, the overall risk occurring from river floods and wildfires also continues to play a rather small role in the high-emission scenario, according to ESPON data. The analysis shows that the population is moderately sensitive and rather strongly exposed to river floods, but as the hazard levels are relatively low, the overall populations' overall risk from river floods remains rather less than moderate in Zemgale.

The identified risks in the ESPON dataset do not align with the insights gained through desk research and interviews with Zemgale representatives, which showed a strong focus on flood-related hazards and climate risks. These findings indicate that the region's current emphasis on flood risks might be too narrow, when considering future climate scenarios, and suggests considering appropriate measures to also enhance Zemgale's resilience towards heat stress and drought-related risks.

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3.2.2.2.3 Potential improvements for climate risk information

For Zemgale at the current stage, available information on regional climate risk does not appear comprehensive enough to provide a solid foundation for the region's adaptation process. The current lack of a regional climate risk assessment and the focus on flood risk may overlook very relevant additional hazards and vulnerabilities (as assessed with ESPON datasets). Therefore, it is recommended to perform a regional in-depth assessment of (various) hazards, vulnerabilities and climate risks, that considers at least two different climate scenarios (e.g. RCP4.5 and RCP8.5) and both medium- as well as long-term changes (e.g. 2021-2050 and 2071-2100). Ideally, such a risk assessment would also formulate clear impact chains that outline the exposure, sensitivity and adaptive capacity of the system considered. In addition, different vulnerable groups within the region should be explored. This would serve as a more solid foundation for strategically building Zemgale's climate resilience than currently exists.

Such a regional climate risk assessment could serve as a baseline for municipal level adaptation plans and strategies to also perform municipal climate risk assessments, or if not possible, to let municipal adaptation efforts be guided by the findings obtained from regional level assessment. The current inconsistency regarding identification of municipal climate risks could thereby be compensated to some extend or even be improved. This would allow for a more comprehensive and well-founded approach in improving climate resilience in Zemgale's municipalities.

3.2.2.3 Adaptation measures

3.2.2.3.1 Existing plans and measures

Important policy documents at national level

According to interviews with Zemgale representatives, national level plans and strategies play an important role in guiding the regions' adaptation efforts due to a lack of climate adaptation strategitization in Zemgale. In the years 2016 and 2017, **Risk and Vulnerability Assessments** in six different areas of action (health and well-being, landscape planning and tourism, biodiversity and ecosystem services, agriculture and forestry, civil protection and emergency assistance, construction and infrastructure planning) were published along-side proposals for adaptation indicators and recommendations for prioritized adaptation. In 2019, Latvia published its **National Adaptation Plan 2030** ("Latvia's Climate Change Adaptation Plan for the period up to 2030) which formulated 5 strategic objectives (briefly summarized as: health and well-being; economy; infrastructure and construction; nature, cultural and historical values; and information and scientific reasoning) split into 14 dimensions of action and substantiated with more than 80 priority adaptation measures (VARAM 2019). Latvia's 8th NC and Fifth Biennial Report under the UNFCCC takes up the content of the National Adaptation Plan and highlights in relation to its first strategic objective that "(i)n the area of health and welfare, additional assistance should be provided to vulnerable

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groups of society (elderly people, children, people needing social care etc.) and to reduce the load on the health care system" (Lupkina et al. 2013).

Overview of relevant policy documents at regional level

On the regional level in Zemgale, there are two main guiding policy documents according to interviews with Zemgale representatives: the medium-term ZPR Development Program 2021-2027 and the long-term ZPR Sustainable Development Strategy 2015-2030. Both regional plans pay only very limited attention to climate adaptation as a strategic objective for the region

The **ZPR Development Program 2021-2027** ("ZPR Attīstības programma 2021-2027") formulates "climate change, environmental and circular economy" as one priority field amongst several with a sub-goal formulated "climate change adaptation and mitigation". While there is a strong dominance of mitigation-related recommendations and measures, adaptation comes in the form of the following exemplary measures: management of water resources, green and blue infrastructure, restoration of natural habitats and ecosystems to prevent flood risks municipal climate adaptation strategies, and educational activities related to climate change (ZPR 2021). However, the more long-term oriented **ZPR Sustainable Development Strategy 2015 – 2030** ("Zemgales plānošanas reģiona ilgtspējīgas attīstības stratēģija 2015-2030") shows no references to the topic of climate change at all (ZPR 2015), indicating a blind spot in the regions' strategic long-term sustainable development planning. Both regional policy documents do not refer to vulnerable groups specifically.

In the context of Zemgale's climate resilience, the HORIZON IMPETUS project takes place. Predicated on enhancing regional early warning and monitoring apparatuses, the project aims to craft a robust, evidence-based climate adaptation strategy specific to the Zemgale context. One of the focal areas within IMPETUS is evaluation of mid-term socio-economic variables, which is instrumental in delineating comprehensive strategies for climate change adaptation. A roadmap for IMPETUS aims to finalize a regional adaptation plan by 2024. Notably, an integral synergy exists between the IMPETUS and RESIST projects, requiring operational and strategic alignments. While the emphasis of IMPETUS predominantly lies in the area of early warning mechanisms, the project has made demonstrable advancements. To elucidate, optimal location for new equipment installation have been identified, and there is an effort to assimilate national data repositories with the intent of transitioning a city-level flooding alert mechanism to a more encompassing regional paradigm. Concurrently, a structured plan has been delineated for the conceptualization and assimilation of a regional digital twin. It is projected that the tools and methodologies created by IMPETUS can also have a contribution in the RESIST project, thereby ensuring empirical and contextually relevant interventions.

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3.2.2.3.2 Planned adaptation measures within RESIST

Zemgale continues to align with its original objectives. Groundwater level monitoring aims to establish a network of data loggers in coastal towns and urban areas to measure groundwater levels. Additionally, the project envisions citizen engagement to provide supplementary groundwater and precipitation data. This aligns with Zemgale's plans to procure groundwater level monitoring sensors.

Plans to implement NbS in urban areas are in place. Zemgale exhibits strong interest in NbS, especially "blue-green solutions in rivers" that can aid in flood risk management. This component focuses on establishing a dialogue with citizens about possible NbS implementations and the associated impacts, like risk mitigation and biodiversity enhancement. While initial plans considered the construction of flood-resistant buildings and early warning systems, Zemgale has streamlined its focus. The region now plans to solely prioritize groundwater level monitoring and has shifted early warning systems to the IMPETUS project.

In the interview it was indicated that capacity-building exercises remain ongoing and that coordination groups to embed climate change considerations into local strategies are underway.

Although the precise priorities might be hard to pin down at this stage of the project, the Zemgale region aims to:

- Procure equipment for data collection and analysis.
- Engage in a twinning partnership with Denmark to adopt their expertise in data collection, analysis, and data-driven decision-making processes.
- Engage stakeholders, especially municipalities, to ensure the effective realization of project goals. All six municipalities in Zemgale are involved in RESIST, and Zemgale's Planning Region (ZPR) is open to participation from other municipalities, emphasizing them as pivotal stakeholders.
- There is a drive to integrate climate change considerations into municipal planning documents. This will be supported through workshops on knowledge transfer, capacity building related to CCA plans, governance processes, and the organization of virtual interactive exhibitions.

Three main challenges were highlighted by the project team:

- **Capacity limitations of partners**. Partners have varying scope of their commitments. The discrepancy between their commitments and their capacities poses a tangible threat to the realization of advanced solutions. Such over-commitments may result from optimistic projections and might hinder the successful implementation of solutions, such as the flood warning system, which at the moment appears to be a unique initiative in the region.

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- **Complexity of the project**. The RESIST project, while offering an avenue for progress, is inherently intricate. Many complex actions are predominantly tailored for large research institutions. Zemgale, being neither a technical nor a research institution, finds itself in the middle ground. Navigating the delicate balance between technical implementation and research-oriented objectives emerges as a formidable challenge. This institutional mismatch might intensify the difficulties of harnessing the full potential of the project.
- **Human resource constraints**. While financial resources appear to be sufficient, thanks to project budgets, the real impediment lies in human resource constraints. There is a noticeable deficiency of specialists from research and academia, especially within state institutions. As Zemgale depends on such actors as third-party entities, especially for the implementation of sophisticated technical solutions, the scarcity of expert human resources becomes a significant bottleneck. The essence of the challenge is not about availability of funds, but the ability to leverage and manage expertise efficiently and effectively.

3.2.2.3.3 Support needed

In addressing Zemgale's adaptation challenges within the RESIST framework, several supportive activities have emerged as essential. It is crucial for Zemgale to address the existing knowledge gaps, diversify its risk assessment criteria, institutionalize climate risk and vulnerability assessments at the grassroots level, and adopt a forward-thinking regional climate risk strategy.

- Firstly, a fundamental challenge for Zemgale is its current lack of expertise in conducting **Climate Risk Assessments**. Addressing this requires a dual approach. On one hand, securing external funding can enable the region to onboard experts or consultancy firms with a proven track record in these assessments. Concurrently, by organizing workshops and knowledge transfer sessions, Zemgale can ensure that the expertise of these external entities filters down to the local stakeholders, cultivating a sustainable local skill set.
- Next, it is imperative for Zemgale to **re-evaluate its climate risk priorities**. While the region's current risk assessments predominantly focus on flood risks, preliminary findings imply that this might not be a holistic approach considering potential future climate scenarios. Zemgale's significant contribution to national agriculture makes it especially vulnerable to threats like heat stress and drought. Therefore, it would be important for the region to expand its risk assessment parameters to account for these threats. Engaging with experts or regions that have successfully integrated such risks into their adaptation strategies can provide Zemgale with valuable insights and best practices.
- Another area of focus should be the **integration of climate risk assessments at the municipal level**. Currently, there is a conspicuous absence of a cohesive approach in this respect. By establishing a standardized framework or guidelines, Zemgale can ensure a harmonized integration of climate risk assessments into SECAPs. To further this, training

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sessions and workshops for municipal stakeholders can be pivotal, ensuring that individual municipal SECAPs resonate with the overarching regional climate adaptation objectives.

- Lastly, Zemgale's current stance on regional climate risk assessment — where there is neither a comprehensive assessment nor immediate plans to commission one — warrants a strategic shift. The region would benefit immensely from a **well-structured strategy** that clearly delineates its approach to climate risks. This strategy should be flexible, allowing for adjustments based on emerging challenges or opportunities. Engaging with national and international stakeholders can offer Zemgale a starting point, allowing them to adapt best practices rather than starting from scratch.

3.2.2.4 Stakeholders and capacities

In the Zemgale region, the primary stakeholder is ZPR, responsible for coordinating and overseeing climate adaptation efforts. The comprehensive knowledge ZPR possesses regarding other stakeholders in the region makes the idea of a detailed stakeholder involvement mapping redundant for them. They are well-acquainted with the roles and functions of all regional players.

However, a challenge emerges with civil society's involvement. Civil society often becomes active at the latter stages of planning processes, and public participation levels remain disappointingly low, especially when compared to the contributions of ministries. This late-stage involvement can result in unforeseen resistance after plans have been approved. ZPR, thus, must exercise caution when involving civil society, ensuring that their concerns and perspectives are addressed proactively.

From a financial standpoint, funding mechanisms in Zemgale are still nascent. While ministries operate activities of national importance using the state budget, municipalities finance their initiatives through their own budgets. Meanwhile, ZPR actively engages in EU programs, funding their activities through successful project bids.

ZPR has identified human capacity constraints as a significant concern. Despite having ambitious goals, especially concerning the unique flood warning system they aim to implement, there is concern about the feasibility of these aspirations. Partner institutions, while optimistic, sometimes fall short on delivering due to their limited capacities. This challenge is further compounded by the regional representatives' impression that the technical intricacies of programs like HORIZON are designed primarily for research institutions. ZPR finds itself at a crossroads, balancing between technical deliverables and research expectations, given that they do not strictly align with either category. The key constraint, however, is not financial, as there are ample project budgets available. Instead, the primary challenge lies in the limited human resource capacities of partner institutions. The lack of science-based specialists in state institutions leaves ZPR dependent on these third-party entities.

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3.2.2.5 Potentials for transfer

Incorporating the following aspects into Zemgale's climate adaptation measures can provide a more holistic, inclusive, and systematic approach to addressing the region's unique challenges.

- **Diversification of Climate Risk Assessment**. Zemgale's emphasis on flood risks might benefit from expansion to consider other potential climate scenarios, such as heat stress and drought-related risks, especially given the region's significant contribution to national agriculture.
- **Mainstreaming Climate Risk Assessments**. Instituting a common approach for climate risk assessments at the municipal level can ensure a cohesive and standardized adaptation strategy across Zemgale. This would facilitate more uniform planning and execution of adaptation measures.
- **Early engagement with civil society**. Given the challenge of civil society engaging late in the planning process, proactive outreach might be effective. By involving civil society at earlier stages, Zemgale can reduce potential resistance and ensure a more inclusive planning process. The engagement should ensure that the concerns of the most vulnerable and gender-specific nuances are adequately addressed.
- **Technical and research partnerships**. Since Zemgale is caught between the intricacies of technical implementations and research requirements, forging alliances with dedicated technical institutions or research bodies might offer specialized guidance and ease the project's execution.
- **Capacity-building initiatives**. Recognizing the limited human resource capacities of partners, Zemgale could prioritize capacity-building sessions. This could encompass training sessions, workshops, and exchange programs to enhance the skill sets of the involved entities.
- **Stakeholder involvement mapping**. While Zemgale feels well-acquainted with its stakeholders, establishing a more comprehensive stakeholder involvement map could help in understanding potential synergies, risks, and the broader interests of each party. This not only ensures a systematic approach but also aids in foreseeing potential challenges.
- **Budget allocation and funding schemes**. While monetary resources seem available, a structured funding scheme might be beneficial. This could outline the allocation of funds for specific tasks, ensuring efficient utilization and transparent financial governance.
- Zemgale stands to gain significantly from **transferring NbS from other regions, especially in the context of urban spaces**. With a pronounced inclination towards "blue-green solutions in rivers" to manage flood risks, the region should prioritize fostering community discussions on potential NbS implementations. By doing so, Zemgale can heighten awareness of the dual benefits of these solutions: reducing risks and augmenting biodiversity.

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Drawing insights and best practices from other regions can provide Zemgale with a comprehensive roadmap to harness NbS optimally.

3.2.2.6 Results

Zemgale's unique set of challenges in climate adaptation, stakeholder engagement, and capacity constraints necessitates tailored solutions. Through a comprehensive, collaborative approach that addresses these identified needs, the region can lay the groundwork for an effective adaptation strategy, ensuring the needs of all stakeholders are considered and resilience is enhanced.

- **Capacity constraints**. Capacity limitations, particularly in human resources, among partner institutions present significant challenges. Ambitious aspirations, such as the flood warning system, may be jeopardized by these constraints.
- **Diversification of climate risks**. The region's primary focus has been on flood risks. However, given Zemgale's importance in national agriculture, there is a pressing need to diversify and consider other climatic threats.
- **Structured and cohesive planning**. A standardized and unified approach to climate risk assessments across municipalities can streamline the planning and execution of adaptation measures.
- **Nature-based Solutions**. While there is a keen interest in "blue-green solutions" for flood risk management, an exploration into broader NbS, influenced by insights from other regions, can offer substantial benefits.
- **Stakeholder coordination**. While the Zemgale Planning Region is a central organisation in the region's climate adaptation efforts, there could potentially be a gap in the engagement of the broader civil society.
- **Financial mechanisms**. Although this is not a predominant concern, Zemgale could potentially face bigger challenges with its funding mechanisms in the future. Despite having ministries and municipalities with their respective funding sources, there is a predominant reliance on EU programs that are contingent upon the success of project bids.

3.3 LSDT 3: Introduction

In the following, the twinning regions of Baixo Alentejo, located in south-eastern Portugal, and Puglia, located in southern Italy, will be assessed based on their needs for climate adaptation. The lead region to LSDT 3 is Catalonia, located in the north-eastern part of Spain.

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3.3.1 Needs Assessment Baixo Alentejo

3.3.1.1 Introduction

Figure 9: Location of Baixo Alentejo (in dark green) (Guias Essenciais 2013).

Baixo Alentejo, a sub-region in south-eastern Portugal, comprises 13 municipalities within the larger Alentejo region. The sub-region comprises an area of 8,542 km² and thus constitutes approximately 10% of the country's total land area (Sociedade Portuguesa de Inovação et al. 2018). Bordered by Spain to the east and the Algarve to the south (see Figure 9), this sub-region is characterized by a unique geographical and socio-economic landscape. The region is rich in cultural heritage, including archaeological sites, castles, churches, old mines, and traditional villages as well as natural heritage with the presence of protected areas like Guadiana and Moura (LCA4Regions Interreg Europe 2022).

According to the Koeppen Climate Classification, most of Baixo Alentejo is characterized by temperate climate with dry and/or hot summers. An exception is the Beja district, where the climate is characterized as dry and semi-arid. The average minimum temperature in Baixo Alentejo during the coldest months of December to February registers at around 6°C, whereas the average maximum temperature during the peak summer months of June to August reaches 33 °C, with maximum air temperatures of up to 45 °C. Precipitation levels exhibit their peak during October to December, averaging at 70 mm. During the summer months, precipitation reaches its lowest average level which remains below 22 mm from June to August. The prevailing climate aligns with the climate averages of southern Portugal and Spain's Extremadura region (Sociedade Portuguesa de Inovação et al. 2018).

The geographical makeup of the territory is characterized by a lowland plain, with altitudes generally below 250 m (Sociedade Portuguesa de Inovação et al. 2018). The landscape also encompasses small, gently sloping mountains and is nourished by small water courses. Crossing the eastern expanse of Baixo Alentejo, the Guadiana river valley extends from north to south, influencing the region's hydrological dynamics and is one of the most valuable natural resources of the region, connecting Portugal and Spain (LCA4Regions Interreg Europe 2022). Despite its vast expanse, Baixo Alentejo is home to a relatively sparse population of approximately 115,000 inhabitants, amounting to roughly 14 inhabitants per km², which is in stark contrast to the national average of 112 inhabitants per km² (United Nations, Department of Economic and Social Affairs 2022). A notable

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demographic trend over recent decades is the consistent population decline, attributed to an ageing population and migratory balances (Sociedade Portuguesa de Inovação et al. 2018).

Baixo Alentejo's economic system is characterised by a diverse range of sectors. Mining, forestry, livestock farming, and agri-products like cork, olive oil, cheeses, sausages, hams, and wines form the cornerstone of the region's economic activities (LCA4Regions Interreg Europe 2022). Additionally, the sub-region strategically leverages its proximity to tourism hubs, particularly the Algarve, to foster regional development. However, challenges related to accessibility and in mobility persist, due to insufficient transport infrastructure, warranting focused attention to ensure future development (Sociedade Portuguesa de Inovação et al. 2018).

Baixo Alentejo faces an array of climate risks and has already been experiencing negative impacts from different extreme weather events over the last decade (Sociedade Portuguesa de Inovação et al. 2018; World Bank Group 2021). These include excessive precipitation, which led to repercussions such as road cuts, damage to property, and disruptions of (mainly agricultural) production chains. Moreover, heat waves and high temperatures have already caused detrimental effects on human health, triggered wildfires, induced ecosystem changes (such as alterations in tree varieties), and damage to production chains (mainly agriculture). Another concern stems from droughts, leading to constraints and interruptions of water supply, impacting agricultural and livestock production, degradation of ecosystems and an increased incidence of fires. Further, strong winds have led to culminating property damage (Sociedade Portuguesa de Inovação et al. 2018; Portuguese Institute of the Sea and Atmosphere (IPMA) 2022). In addition, changing seasonality of frost events have resulted in considerable harm to the agricultural sector. While frost overall is becoming less frequent in the region due to increasing temperatures, out-of-season frost in the month of April and May have led to devastating effects on vineyards and horticultural crops (Agencia Portuguesa Do Ambiente 2015; Sociedade Portuguesa de Inovação 2022).

3.3.1.2 Climate risks

3.3.1.2.1 Regional climate risk assessments and identified risks

Climate risks for the region are analysed in the regional adaptation strategy: the **Intermunicipal Plan for Adaptation to Climate Change in Baixo Alentejo** (PIAAC BA) (Sociedade Portuguesa de Inovação et al. 2018). The plan first provides a detailed analysis of past weather events and their impacts in Baixo Alentejo from 2007 to 2017. The following events are considered: excessive precipitation, heat waves, strong wind, drought, frost, as well as high particles concentration and dust. For each event type, past impacts are analysed differentiating between types of impacts (such as property damage, damage to production chains, changes in ecosystems, etc.). Additionally, the key impacts are summarized for several priority sectors, namely: agriculture and forest, biodiversity, economy, energy, health, safety of people and property, and transport and communications. The

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sectors considered are based on those identified in the National Strategy for Adaptation to Climate Change (Agencia Portuguesa Do Ambiente 2015).

In a second step, the plan includes an analysis of historical climate data and climate projections. Regional climate models are used for the simulations, using 1979-1999 as reference time period and modelling three future time periods: 2006-2035, 2036-2065, and 2066-2095. The simulations are conducted for two emission scenarios, namely RCP4.5 and RCP8.5. The main climatic variables considered in the simulations are precipitation (daily and monthly temporal resolution), minimum temperature (daily and monthly temporal resolution), average temperature (monthly temporal resolution) and maximum temperature (daily and monthly temporal resolution). Based on these variables, annual and seasonal climate indexes are computed.

The simulation results suggest that both minimum and maximum temperature will rise significantly in the region until the end of the century: simulations suggest an increase by +1.7 °C (RCP4.5) to +3.2 °C (RCP8.5) for minimum temperatures, and by +1.8 °C (RCP4.5) to +3.5 °C (RCP8.5) for maximum temperatures. An increase in in the number of hot days is further expected. Total annual precipitation is expected to decrease by the end of the century by 9% (RCP4.5) to 10% (RCP8.5) over the entire region. The projected number of consecutive days with precipitation less than 1 mm, however, does not deviate substantially from the reference time periods. For the end of the century, an average increase of +2 days in autumn/winter and +4 days in spring/summer is expected according for the RCP8.5 simulations. These results therefore do not suggest a sharp increase in the duration of dry spells in the future. However, given projected rising annual temperatures and decreasing annual total precipitation, more arid climatic conditions might nevertheless be expected in the region for the end of the century. Based on the simulation's results, the following five climatic trends are identified as having the highest potential for negative impacts on the region under future climatic conditions: 1) increase in average temperature, 2) more frequent heat waves, 3) more frequent heavy precipitation events, 4) decrease in annual average precipitation, 5) overall more arid conditions. Potential impacts of these climatic changes are then discussed in detail for the different priority sectors.

Based on the previous results of the assessment and on expert opinions, the frequency and severity of selected weather events is then qualitatively evaluated for the current time period as well as for the middle of the century. A number between one and three is attributed to the frequency and severity of each event type, representing the categorisation into low (1), medium (2), or high (3) frequency / severity. This is done for the following event types: excessive precipitation, heat waves, strong wind, drought, frost, high particles concentration and dust. The risk by such events is then determined by the product of frequency and severity. On this basis, the following four climatic trends are prioritized as bearing most risks for the region:

- Increase in average annual temperature

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- Increase in the frequency and intensity of heat waves
- Increased frequency and intensity of drought
- Increased frequency and intensity of heavy precipitation events

3.3.1.2.2 Comparison with ESPON data

The ESPON CLIMATE dataset is a valuable resource for RESIST's analysis as it offers consistent data that can be compared across different European regions. Considered climate hazards are heat stress (on the population), negative impacts from droughts (on the primary sector), different types of flooding (river, coastal and flash floods) and wildfires. In the baseline scenario (1981-2010), Baixo Alentejo is most strongly affected by droughts and wildfires. Impacts from flash floods on the cultural sector and heat stress are also discernible as important hazards. River flooding does not display a high relevance. Under the high emission scenario RCP8.5 and looking at the end of century (2070-2100), hazards from droughts, heat stress and wildfire amplify to reach a very high level, while flash flood occurrence decreases slightly. Hazards from river flooding remains of low importance.

The findings from the EPSON dataset support the results of the Plan for Adaptation to Climate Change of Baixo Alentejo with regard to the increasing importance of heat stress and droughts in the future. They additionally highlight damages from wildfires as key hazard, which is already very relevant today and will become even more prominent in the future.

3.3.1.2.3 Potential improvements for climate risk information

The Plan for Adaptation to Climate Change in Baixo Alentejo provides an important knowledge base for the region's climate adaptation efforts. While the plan may not cover all aspects of a standard CRA, it offers vital information and insights concerning key hazards and a thorough analysis of impacted sectors. For further analysis, the region should consider applying a risk concept which clearly differentiates between vulnerability, exposure and hazard. Especially the explicit consideration of vulnerability (and factors contributing to it) is so far lacking. Additionally, the region should integrate the explicit consideration (and if feasible, also the modelling) of further secondary hazards, such as from wildfires, landslides, river flooding and flash floods, and soil erosion in future assessments. These should also include an investigation of how these hazards might change over time.

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3.3.1.3 Adaptation measures

3.3.1.3.1 Existing plans and measures

Important policy documents at national level

Through the **National Strategy for Adaptation to Climate Change 2020 (ENAAC)**, extended until the end of 2025, Portugal put in place both objectives and a robust implementation pathway for sectoral climate adaptation (Agencia Portuguesa Do Ambiente 2015). ENAAC covers various sectors, such as agriculture, biodiversity, economy, energy and energy security, forests, human health, safety of people and goods, transport, communication, and coastal areas. ENAAC serves a dual purpose: enhancing awareness about climate change and integrating adaptive measures into sectoral and territorial planning. It is a relevant resource for national, regional, and local administrations. Thus, the strategy holds practical value at the regional level, offering a comprehensive national overview and guidelines for climate adaptation. Furthermore, the **Action Program for Adaptation to Climate Change** complements and systematizes the work of ENACC 2020 by offering concrete lines of action for direct interventions (Diario de Republica 2019).

The **National Roadmap for Adaptation 2100** is currently being developed and is expected to be published by the end of 2023. It is expected to provide important guidance for both national and regional policy, addressing climate adaptation in both territorial and sectoral planning, as well as estimating the costs of climate adaptation for different sectors (Agencia Portuguesa Do Ambiente 2023).

Lastly, the **National Climate Framework Law (Law n.°98/2021)** consolidates objectives, principles, and obligations for the different levels of climate action through public policies. It establishes obligations concerning the necessity to develop new climate policy instruments, such as the Regional Climate Action Plans and Municipal Climate Action (Diario de Republica 2021).

Relevant plans, strategies and measures at the regional level

The **Baixo Alentejo Intermunicipal Climate Change Adaptation Plan** represents a robust regional-level strategy to address climate change adaptation effectively. This plan comprehensively analyses historical extreme weather events and regional climate scenarios (see Section 3.3.1.2.1). It identifies action areas for adaptation in response to the identified four climatic trends bearing most risks for the region (increase in average annual temperature, increase in the frequency and intensity of heat waves, increased frequency and intensity of drought, increased frequency and intensity of heavy precipitation events). It then categorises the action areas according to “sector priorities”, differentiating whether actions have the largest positive effect on society, the economy or on ecosystems. Additionally, three transversal action areas are identified. Overall, 26 action areas are included in the Adaptation Plan. An overview is provided in Table 2.

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A series of measures have been implemented to operationalize the regional adaptation strategy. One example is the “Living the Climate in Alentejo” (Viver) project (2022), which centres on restoring ecological balance within agro-ecosystems. Another measure is the “ACityZen” project (2019-2023), which fosters scalable innovation and new business models based on urban farming through the establishment of urban gardens, which not only serve to promote traditional agricultural practices but also aims at catalysing social and economic transformation.

Table 2: Adaptation actions proposed for Baixo Alentejo (adapted from (Sociedade Portuguesa de Inovação et al. 2018).

	Society	Economy	Ecosystem	Transverse Measures
Increase in average annual temperature and increase in frequency and intensity of heatwaves	**AA1**. Urban renaturalization and introduction of Nature-based Solutions **AA2.** Elaboration of the Seasonal Health Contingency Plan – Summer Module **AA3.** Promotion of bioclimatic design measures for buildings	**AA5.** Promotion of new agricultural practices, agricultural species, and varieties adapted to new climate patterns **AA6.** Monitoring new agricultural pests and diseases and anticipating ways to combat them	**AA7.** Adoption of forest management measures and fire prevention mechanisms **AA8.** Operationalisation of Municipal Forest Defence Plans against Fires (PMDFCI) **AA9.** Control and monitoring of invasive species **AA10.** Monitoring impacts on ecosystems	**AA24.** Establishment of Early Warning Systems **AA25.** Conducting awareness and education campaigns **AA26.** Adoption of measures to combat depopulation
Increased duration of dry spells	**AA11.** Rationalization and management of the water supply systems **AA12.** Promotion of water-saving measures and efficient water use **AA13**. Elaboration of Intermunicipal Contingency Plans for prolonged periods of drought	**AA15.** Adoption of new practices in livestock systems adapted to new climate patterns **AA16.** Operationalization of Alqueva Dam Hydraulic Use Projects **AA17.** Use of efficient irrigation systems	**AA10.** Monitoring impacts on ecosystems	

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	AA14. Use of rainwater and wastewater	**AA18.** Creation of retention basins and water infiltration	
Increased frequency and intensity of heavy precipitation	**AA19.** Adoption of Sustainable Drainage Measures **AA20.** Identification and intervention for containment and stabilization of slopes in critical areas of slope movements **AA21.** Elaboration of an Intermunicipal Plan for Flood Risk Management	**AA18.** Creation of retention basins and water infiltration	**AA10.** Monitoring impacts on ecosystems **AA22.** Cleaning of water lines **AA23.** Renaturalization of water lines

The **Baixo Alentejo Supramunicipal Housing Strategy** is a regional strategy targeting action in the field of housing (Sociedade Portuguesa de Inovação 2022). This strategy can be considered a relevant addition to the region's overall adaptation approach, as housing is a crucial factor playing into vulnerability of different population groups to climate impacts. Although the strategy does not explicitly consider adaptation aspects, it promotes a housing strategy which addresses the needs of vulnerable groups, promoting innovative approaches and affordable housing in the region.

Other important plans exist for the region. Significantly, all municipalities have developed **Municipal Civil Protection Emergency Plans** to ensure preparedness to various risks and swift response in the case of emergency at the local level (Ministerio da Administracao Interna 2016; Sociedade Portuguesa de Inovação 2022).These plans are currently undergoing updates with the overarching goal of creating a cohesive inter-municipal civil protection plan.

Moreover, a comprehensive effort is in place to counter risks posed by forest fires through **Municipal Fire Defense Plans**. All thirteen municipalities that are part the Baixo Alentejo region have approved Municipal Fire Defense Plans. These follow the structure of the National Forest Fire Defense Plan and are organized along the same strategic axes, ensuring comparability and alignment.

Overall, the region stands out as displaying strong and well-integrated municipal planning in the areas of civil protection and wildfire management. The Baixo Alentejo Intermunicipal Climate Change Adaptation Plan remains the cornerstone of the region's overall adaptation strategy. Although it

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identifies comprehensive action areas to address current and future climate impacts, it does not provide concrete adaptation measures. How the action areas are translated into actions remains unclear. Additionally, gender and vulnerable groups are not specifically considered in the adaptation measures. Vulnerable groups do play an important role in the Baixo Alentejo Supramunicipal Housing Strategy, which, however, does not explicitly consider climate adaptation issues in the field of housing. A stronger interconnection of both strategies could therefore be envisaged in the future.

3.3.1.3.2 Planned adaptation measures within RESIST

Within the framework of the RESIST project, a diverse set of measures is envisaged, although many are still in the early planning phase. As one of the key measures within the RESIST project, the region aims to enhance and strengthen stakeholder and community engagement capabilities. Therefore, meetings with relevant stakeholders, such as civil protection and forest managing authorities, have been set up to better understand their needs, gain access to relevant information and collect data from these actors, as well as identify relevant data gaps. Additionally, the region envisages to set up measures to enhance the competencies within the regional workforce, exemplified by enhanced coordination mechanisms within Civil Protection. The exact scope and format, however, are not yet fully defined.

A key interest of the region involves supporting adaptation efforts in small, rural, and dispersed villages. This includes identifying transformative solutions tailored to the specific contexts of these communities, including water management (to address the risk of water scarcity), forest management (to mitigate the threat of forest fires), and energy (to counter the potential reduction in hydroelectric power production). However, no defined measures have been set up yet to address this topic.

Another interest of the region lies with strengthening and improving early warning systems and the localisation of vulnerable groups. Particularly vulnerable individuals, such as the elderly, may necessitate supplementary assistance during extreme weather events, especially in sparsely populated regions with long distances to health facilities and sparse infrastructure. As a result, accurate information regarding their locations becomes pivotal for amplifying efforts of civil protection in rural areas. This information, however, is not yet available. Addressing this issue is therefore another key interest of the region within the RESIST project.

A central challenge for successful implementation of adaptation measures within the region revolves around the availability of information and data at the municipal levels. While high quality data at the regional and national level is predominantly accessible, a significant deficiency emerges for issues specific to the municipal level. This gap in municipal-level data is pivotal for advancing early warning systems and facilitating proactive response by regional and local authorities in instances of emergency. Additionally, municipal authorities do not always have the necessary technical skills to

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process and utilise available data resources by themselves. The regional level, however, is confronted with limited monetary and personnel resources.

3.3.1.3.3 Support needed

The required support for the RESIST initiative in the Baixo Alentejo region is multifaceted. Key aspects revolve around utilizing technology, identifying good practices, and ensuring their effective application, for instance for supporting adaptation action in small, rural villages and localising vulnerable groups. Here, support in improving early warning systems and utilising digital solutions would be highly beneficial. Another area where support is required is innovative financing models, potentially involving the private sector, to increase the region's financial resources for adaptation. Moreover, pursuing more innovative and efficient ways to engage stakeholders is of interest to the region. Lastly, support would be welcomed to identify and integrate social risks into the regional adaptation strategy.

3.3.1.4 Stakeholders and capacities

In the Baixo Alentejo region, municipalities, local networks and civil protection are considered the most important stakeholders, as they act at the local level. CIMBAL, the inter-municipal community of the region (in Portuguese: Comunidade Intermunicipal do Baixo Alentejo), is the local authority coordinating climate adaptation efforts and is responsible for the regional adaptation strategy. Important local authorities from the civil protection sector include the National Emergency and Civil Protection Authority, the National Republican Guard, and the fire brigades. Further, the Parish Councils are considered crucial stakeholders due to their proximity to the population and importance in identifying vulnerable groups.

Regional administrative entities, including the Institute for the Conservation of Nature and Forests in Alentejo (ICNF Alentejo), along with the central administration of Alentejo (CCDR Alentejo), represent additional crucial stakeholders. They play a pivotal role in accessing information pertaining to climate change and adaptation. An overview of important stakeholders as identified by CIMBAL is provided in Figure 10.

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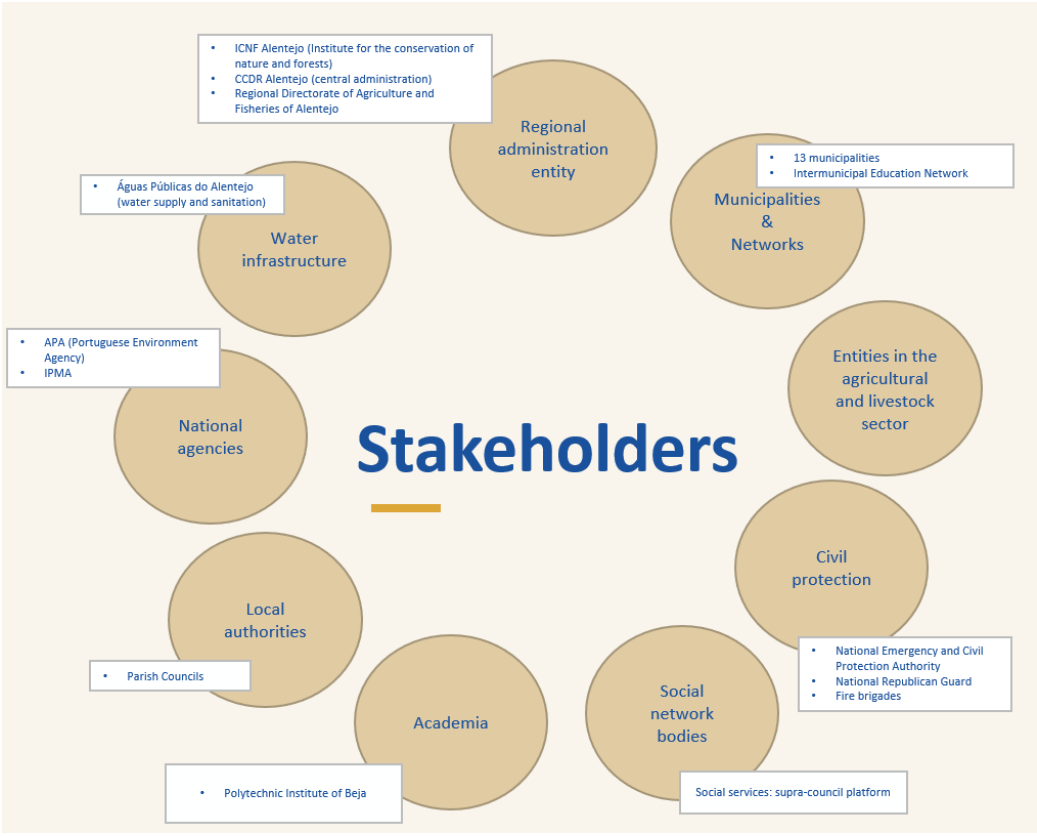

Figure 10: Relevant stakeholders in Baixo Alentejo

Baixo Alentejo encounters two primary capacity constraints constraining the implementation of adaptation measures. Foremost is the challenge of funding. CIMBAL, as the executing public entity of the RESIST project, relies on financial support from national resources, EU projects, and has also used funding from EEA Grants for a recently completed project. Consequently, it is crucial to actively navigate these avenues to ensure sufficient funding for future adaptation efforts. The second constraint pertains to data availability at municipal level. The situation is further compounded by issues relating to technical and human resources within municipalities, particularly concerning their capacity to effectively utilize data.

3.3.1.5 Potentials for transfer

Based on this assessment's results, various entry points for transfer activities with other regions were identified, based on the region's explicit interests and the identified needs. The following topics could be further explored for transfer activities:

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- **Digital solutions and early warning systems.** Investigating how LSDTs' activities and good practices have contributed to improving early warning systems and the localization of vulnerable populations (potentially addressing civil protection issues in rural areas), and whether these approaches can be transferred.
- **Innovative financing models.** Assessing the potential of innovative financing models, such as private sector financing, to access additional funding for future adaptation efforts. If other twinning regions or LSDTs already have experience with innovative financing models, learnings and best practice cases could be shared.
- **Considerations of social risks and vulnerabilities, stronger consideration of vulnerable groups and gender aspects.** Investigating the vulnerability of various population groups, and identifying social risks. Integrating these risks into the regional adaptation strategy, considering the needs of vulnerable groups and gender aspects in adaptation strategies and measures.
- **Data and information availability.** Identifying data gaps and improving municipal-level data availability to enhance the effectiveness of early warning systems and proactive responses in case of emergencies.
- **Engagement of stakeholder and communities.** Baixo Alentejo expressed a strong interest in developing innovative ways to engage stakeholder and the communities which are part of the region. This interest extends to seeking support from other twinning regions or LSDTs in exploring innovative means and potential approaches.
- **Upskilling the regional workforce.** Baixo Alentejo intends to implement measures to enhance the competencies of the regional workforce, including improved coordination mechanisms within Civil Protection. However, as the scope and format are not fully defined yet, solutions and activities from other twinning regions or LSDTs that align with the specific needs of Baixo Alentejo could be considered as entry point.
- **Adaptation actions in small, rural and dispersed villages.** Identification and implementation of transformative solutions in rural areas with small, dispersed villages, particularly in the sectors of water management (addressing the risk of water scarcity), forest management (addressing the risk of forest fires), and energy (addressing the risk of reduced hydroelectric power production). Experiences from other twinning regions or LSDTs may provide valuable insights.

3.3.1.6 Results

The Plan for Adaptation to Climate Change in Baixo Alentejo serves as a valuable foundation for the region's climate adaptation endeavours. While it may not encompass all aspects of a standard CRA, it provides essential insights into key hazards and an in-depth analysis of affected sectors. To enhance future risk assessments, the region should consider a risk framework that distinguishes between vulnerability, exposure, and hazard, with particular attention to vulnerability factors.

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Moreover, secondary hazards like wildfires, landslides, river flooding, flash floods, and soil erosion should be explicitly considered, along with their potential changes over time.

Baixo Alentejo demonstrates robust municipal planning in civil protection and wildfire management, with the Intermunicipal Climate Change Adaptation Plan as the cornerstone of the regional adaptation strategy. The plan does not explicitly address vulnerable groups, an aspect which could be further explored in future revisions. Furthermore, there is potential for synergies between the adaptation plan and the Baixo Alentejo Supramunicipal Housing Strategy, which does address vulnerable groups but not climate adaptation in housing.

Within the RESIST project, a diverse set of measures is envisaged, although many are still in the early planning phase. As one of the key measures, the region aims to enhance and strengthen stakeholder and community engagement capabilities. A special interest lies in supporting adaptation in small, rural villages, addressing water management, forest management, and energy issues, although specific measures for this are yet to be defined. Strengthening early warning systems and localizing vulnerable groups, particularly the elderly, is another priority, given the challenges of extreme weather events in sparsely populated regions. A central challenge lies in the availability of municipal-level information and data. While regional and national data is accessible, municipal data is lacking, hindering early warning systems and proactive response. Municipal authorities also face technical limitations, and the regional level has constrained resources.

adelphi can offer valuable support to the municipality of Baixo Alentejo within the RESIST framework in several key areas. Overall, adelphi can support with identifying synergies and common interests across RESIST regions, as well as support the process of identifying concrete transfer activities. Additionally, adelphi can assist in the development of innovative and efficient methods for engaging stakeholders, fostering collaboration, and ensuring a more inclusive and efficient decision-making process. Further, adelphi can help identify entry points to integrate social risks into the regional adaptation strategy, ensuring a comprehensive approach to build resilience in the region. adelphi could also support identifying innovative financing models which suit the region’s interests and planned measures.

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3.3.2 Needs Assessment Puglia

3.3.2.1 Introduction

Located at the south-east tip of the Italian Peninsula (see Figure 11), the territory of Puglia (Apulia) comprises an area of 19,345 km² with a population of about 4 million (roughly 210 inhabitants per km²). The region is bordered by the Adriatic Sea and the Ionian Sea, giving it the longest coastline of any Italian region (Santini et al. 2014). Puglia has a typical Mediterranean climate with long hot-dry summers with irregular and scarce precipitation and mild wet winters (Lionello et al. 2014; Elferchichi et al. 2017). Between 400 and 550 mm of rainfall each year primarily occur in the winter (Renna et al. 2018).

Figure 11: Location of Puglia (taken from Description of the Action).

Puglia stands out for having the most agricultural land used (about 66.4%) and the most farms per area in Italy. The sector is mainly driven by wine, olive oil and wheat production (Santini et al. 2014). As a result, both economically and socially, agriculture is crucial in Puglia (Labianca et al. 2016). Also, the region plays an important role in the Italian tourist economy. Although the sector is characterized by a rather pronounced seasonality, with about half of the total arrivals concentrated in the summer months. In the region tourism activities generate a value added of about 9 billion euros, which represents 13.6% of the regional GDP. A total of 52,000 businesses, or 15.4% of the labour force in the region, employ more than 135,000 people across the whole tourist value chain (CDP S.p.A 2021).

3.3.2.2 Climate risks

3.3.2.2.1 Regional climate risk assessments and identified risks

The Puglia region is developing the Regional Climate Change Adaptation Strategy (RCCAS) to identify appropriate measures to strengthen the resilience of territories to improve their ability to respond positively to the stresses caused by climate change. It is being developed by an external agency, which will include some climate change projections for the next 15 and 30 years together with risk sheets for each municipality in Puglia. The strategy is expected to be completed and approved in autumn 2023. Following the initial approval, the participation phase with stakeholders will commence.

Literature indicates that the region is considered one of the hotspots for desertification risk in southern Europe as well as one of the most vulnerable regions to degradation in Italy (Nickayin et al. 2022). There are few rivers and little surface water because to the high substrate permeability.

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Water scarcity is a severe and enduring issue, aqueducts convey drinking water from neighbouring regions (Lionello et al. 2014). The limitation of available water stocks could trigger severe limitations on productivity in different sectors and worsen the water quality (Ronco et al. 2017). Statistically significant climate trends in Puglia were observed regarding decreasing rainfall intensity and increasing temperature, landslides as well as damaging hydrogeological events (Polemio and Lonigro 2015). Coastal zones, where one can find numerous industries like tourism and fishing that are crucial to the socio-economic growth of the area, are also vulnerable to climate risks (Santini et al. 2014).

The Global Facility for Disaster Reduction and Recovery developed the ThinkHazard! Tool which offers a general overview of the dangers for a specific location that should be considered throughout project planning and implementation. The tool rates the likelihood of different natural hazards (very low, low, moderate, and high; see Figure 12) which can have an influence on a project area and provides guidance on how to mitigate their effects and where to search for further information. The risk levels given are based on hazard data published and made available by a number of institutions. However, they are no substitute for detailed risk assessments and must be used in addition to the data provided by the competent authorities and institutions.

Figure 12: ThinkHazard! Tool (GFDRR 2023): Hazard Risk Levels

Future climate forecasts based on models indicate that there will likely be a greater probability of wildfires in all parts of Puglia, including higher temperatures and more variable rainfall. Also, a high risk for coastal floods is indicated. The northern province Foggia a high risk for volcanic hazard with potentially damaging eruptions is assessed (GFDRR 2023).

This information also overlaps with the climate projections from the EU project Orientgate from 2014, which has analysed Puglia's climate risks, among other regions in south-eastern Europe. Table 3 shows that the calculations come to the result that the average annual temperature will increase by at least 1.4 °C by 2050 and by at least 2.3 °C by 2070 (both RCP4.5). This is accompanied by a reduction of the mean precipitation by at least 3% by 2050 and at least 14% by 2070 (both RCP4.5). The increase of temperature will lead to an increased evapotranspiration rate (until 2070 +7-10%). The northernmost area of Puglia, which is agriculturally productive, will experience the most significant increase in evapotranspiration. In combination with the decrease of precipitation arid

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conditions will spread all over Puglia. The projections of the worst emission scenario RCP8.5 revealed a mean sea level anomaly of around 10 (2021-2050) and 21 cm (2041-2070). In both scenarios, only 2% of the coastal lands of the Puglia Region are at risk. In the mid-term scenario, around 25% (212 km) of the 865 km Puglia coastline was classified as at risk (falling within the low and very low risk categories). In the long-term sea-level rise scenario this risk extended to approximately 29% (250 km) (Santini et al. 2014).

Table 3: Different RCPs for Puglia region (M. Santini et al. 2014).

	Baseline 1976 - 2005	2021-2050 RCP4.5	2021-2050 RCP8.5	2041-2070 RCP4.5	2041-2070 RCP8.5
Mean Annual Temperature	15.4°C	16.8°C	17.1°C	17.7°C	18.4°C
Annual Precipitation	348.3 mm	309.3 mm	337.9 mm	298.1 mm	281.8 mm

The findings presented here from the ThinkHazard! Tool and the Orientgate project cannot really be compared, because the ThinkHazard! Tool is a qualitative assessment of current hazards and Orientgate is focused on future scenarios. One thing that is clearly noticeable, however, is that in the Orientgate, flood risks were classified relatively low, while in the ThinkHazard! tool, the risk of flooding was rated among the highest.

3.3.2.2.2 Comparison with ESPON data

The ESPON project has identified several prevalent risks for the region of Puglia under current climate conditions. These include:

- flash floods posing a risk to the cultural sector,
- river floods with dangers for population,
- droughts affecting the primary sector and
- wildfires impacting the environment.

Additionally, risks from heat stress on the population are projected to become increasingly prevalent during the time period 2070-2100 (under a the RCP8.5 high emission scenario). In this category Puglia is showing the highest risk among the three regions of LSDT3 while the previously mentioned risks remain high.

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3.3.2.2.3 Potential improvements for climate risk information

As the regional climate change adaptation strategy has not yet been published, it is not possible to make any statements on potential improvements for climate risk information, as the strategy should be the central document for this. However, it is evident that the gender agenda for Puglia, which was approved in 2021, makes no reference to climate issues or the vulnerability of specific groups to climate risks (Puglia Region 2023). A reference to the Strategy for Sustainable Development Puglia Region is made on the website, but it is not clear to which aspects exactly.

The civil protection plans of Puglia addresses forest fires in detail and touches upon “predicting, preventing and mitigating risks, managing emergencies and overcoming them”. However, other “meteorological, hydrogeological and hydraulic risk scenarios” or “natural disasters or those caused by human activities” are only vaguely mentioned, e.g. there are no specific measures to protect the population from flooding, the consequences of heavy rainfall or tectonic events (SAS 2019).

3.3.2.3 Adaptation measures

3.3.2.3.1 Existing plans and measures

*As described in 3.3.2.2.1 the central document for the analysis of **regional** climate change risks for Puglia is currently in the preparation phase. It will be published shortly after the submission of this assessment and the findings from it will be updated for the next phase of this task. At this stage, it is not yet apparent to what extent this document will evaluate climate risks and whether it will define measures with specific timeframes.*

Important policy documents at national level

The **National Climate Change Adaptation Strategy** (NCCAS) was completed by the Italian government in July 2014 and approved by the State-Region Conference in October 2014. Currently the **National Plan for Adaptation to Climate Change** (PNACC) is in its last phase of approval process after the draft was published in December 2022. It contains measures such as defences for the population and infrastructures from sea level rise. The PNACC also includes a national observatory for climate change adaptation for monitoring and updating of the adaptation plans (Moraca 2023). Also in 2022 the Ministry of Environment and Energy Security launched a National Platform on Climate Change Adaptation “(…) to promote the exchange of information between the central administration, local authorities and all stakeholders, starting from citizens, with respect to the issue of adaptation to climate change (…)” (MASE 2023b).

Apart from that the region applied to the European Commission to serve as the Territorial Coordinator of the Covenant of Mayors for Climate & Energy in 2018. The aim is to establish a “Climate Pact” with the mayors of Puglian municipalities, assisting them in the implementation of a common strategy and in the planning of coordinated actions to deal with the potential impacts of

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climate change and mitigation policies. Since January 2022, Puglia has been supporting its municipalities in the drafting process of the SECAP, the Sustainable Energy and Climate Action Plan, which Puglia's municipalities will have to adopt. In addition, the Puglia Region will fund the SECAPs and acknowledge contributions from the municipalities in drafting the plans.

The Puglia Region is also developing the **Regional Climate Change Adaptation Strategy** (RCCAS) to identify appropriate measures to strengthen the resilience of territories to improve their ability to respond positively to the stresses caused by climate change. It's being developed by an external agency, which will include some climate change projections for the next 15 and 30 years together with risk sheets for each municipality in Puglia. The strategy is expected to be completed and approved in the upcoming months. Following the initial approval, the participation phase with stakeholders will commence. Additionally, a strategic document has been prepared in the framework of the Interreg project ADRIACLIM, focusing on coastal areas. This document features a special focus on tourism.

In 2021 an "Experimental programme of interventions for adaptation to climate change in urban areas" ("Programma sperimentale di interventi per l'adattamento ai cambiamenti climatici in ambito urbano") was launched in 2021 by the Italian Ministry of Environment and Energy Security. This programme subsidises adaptation measures in urban areas with a population more than 60.000 inhabitants targeting the implementation of green, blue, grey measures (e.g. creation of green spaces, rainwater collecting systems, removal of existing pavement) as well as "soft interventions" (e.g. awareness raising, training, participation measures, forecasting, improving local knowledge) (MASE 2023a). At the time of this report, the contact persons from Puglia were not aware of any measures supported by this programme.

Former EU programmes, namely the LIFE RACES and PONGAS Programmes, had been implemented at the municipal level in the region several years ago. However, the interview partners were not familiar with these projects and their outcomes.

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3.3.2.3.2 Planned adaptation measures within RESIST

So far, nothing concrete is planned because the region is still relatively at the beginning of the deliberations. However, this should change with the release of the regional climate adaptation strategy and it will then become clearer which measures should be planned within the project on the basis of the needs outlined.

3.3.2.3.3 Support needed

As the tourism sector has become economically very important for Puglia in the last 10 to 20 years, the measures of the project will be centred around strengthening the resilience of the sector. Climate change impacts in coastal regions were identified as particularly critical, as there is a lot of pressure on these regions in the summer months, with high tourist numbers and the public sector under stress. The historical problem of water scarcity comes to a peak during these months. However, the region's counterparts do not want to focus exclusively on the water issue, as there are other challenges posed by climate change. For example, fires are a big problem because there are many pine trees along the coast in the tourist areas. Other extreme weather events as small tornados are also of relevance to include into the RESIST adaptation actions.

In addition, the future of tourism in Puglia should be thought of in a very fundamental way because due to the more extreme heat periods the main tourist season could be spread more around the summer months and the tourist flows could also shift northwards. This requires innovative policies that are important for the development of tourism. So far, no climate adaptation measures have been implemented in the tourism sector but some cities have started to work on this themselves, still relatively at the beginning.

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3.3.2.4 Stakeholders and capacities

The stakeholders encompass various entities and organisations with an interest in climate change adaptation and mitigation and sustainable tourism development in the Puglia region. The notable stakeholders are shown in Figure 13 and further described in Table 4.

Figure 13: Overview of relevant stakeholders for climate change adaptation in Puglia region.

The discussion with the regional partners highlighted the need to focus efforts on specific areas, such as a particular region within Salento peninsula, and focus on engaging a select number of municipalities. However, stakeholders at the regional level remain important, particularly for policy-level activities. In addition to the overview provided, it was mentioned in the interview that stakeholders in the tourism sector in particular are missing. For example, those responsible for coastal / beach management (which is partly organised by the region and partly privately) are not listed here, but will be important if measures under RESIST are to target adaptation in coastal areas.

There might be a lot of resistance from some stakeholders as they find it hard to accept the current very positive trend in tourism will change. Some adaptation measures might not be very feasible due to this kind of resistance. In general, the need for capacity and the need to develop guidelines for professionals in the tourism sector for emergency preparedness and response were highlighted.

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Table 4: Descriptions of stakeholders in Puglia relevant for measures within RESIST.

Type	Organisation name	Short description
Political System	Municipalities adhering to Covenant of Mayors for Climate & Energy	Supports local authorities in planning actions to address the potential effects of climate change and mitigation policies in a coordinated way with a common strategy. The Regional Coordination Structure utilises the support of the Technical-Scientific Committee.
Political System	Associazione Nazionale Comuni d'Italia* (ANCI) Puglia **National Association of Municipalities of Italy*	Regional association, comprising 248 municipalities out of a total of 258 in the region. ANCI Puglia serves as the primary point of contact for the regional institutions regarding all matters of interest to the municipalities. It represents the local councils to the Region, and in coordination with the National Association, to the State, and also to the European Community via the Region.
NGO	Fondazione Centro euro-Mediterraneo Cambiamenti Climatici* **Euro-Mediterranean Center on Climate Change*	Carries out studies, produces forecasts, conducts quantitative analyses on the climate system and its interactions with society.
Regional Company	Acquedotto Pugliese* **Pugliese Aqueduct*	Manages the integrated water cycle which includes the collection, purification, adduction, accumulation and distribution of water for civil use, but also the sewerage, purification, disposal and reuse of treated water. → Main stakeholder in water supply
Regional Agency	Agenzia Regionale per la Prevenzione e la Protezione dell'Ambiente* (ARPA) Puglia **Regional Agency for Environmental Prevention and Protection*	Responsible for carrying out activities and tasks in the field of prevention and environmental protection as a technical Body of the Puglia Region. → Monitoring climate change
Regional Agency	ASSET Puglia	It is a regional strategic agency for the eco-sustainable development of the territory. It is an operational technical body in support of the Region for the definition and management of policies for mobility, urban quality, public works, ecology and the landscape, for the prevention and protection of the territory and hydrogeological and seismic risk. Also, the agency is dedicated to strategic planning, integrated programming, design and implementation of public works.
Regional Entity	Autorità Idrica Pugliese* **Pugliese Water Authority*	Representative entity of the municipalities for the public governance of water.
Interregional Authority	Autorità di Bacino Distrettuale dell'Appennino Meridionale Sede Puglia	It deals with the defence, protection, use and sustainable management of soil and water resources, the protection of environmental aspects and contributes to the defence, protection and rehabilitation of the soil and subsoil, the qualitative and quantitative protection of water resources, the mitigation of hydrogeological risk, the fight against desertification, the protection of the coastal strip and the rehabilitation of the coast.
Academia	Università degli Studi di Bari	University of Bari
Academia	Politecnico di Bari	Polytechnic University of Bari
Academia	Consiglio Nazionale delle Ricerche* (CNR) **National Research Council*	Conducts thematic research activities within the Department of Earth System Sciences and Environmental Technologies. The institute is involved in European projects.
National Agency	Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile* (ENEA) **National Agency for New Technologies, Energy and Sustainable Economic Development*	Public law body dedicated to research, technological innovation and the provision of advanced services to businesses, the public administration and citizens in the fields of energy, the environment and sustainable economic development.

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3.3.2.5 Potentials for transfer

The primary focus was on adopting a targeted approach to assess the transfer of LSDTs actions for Puglia's tourism sector. The following specific issues were identified for further exploration:

- **Land management.** Investigating how LSDTs' activities can contribute to effective land management practices within the tourism sector, potentially addressing issues related to coastal management.
- **Nature-based Solutions.** Assessing the potential in implementing NbS strategies, which may involve ecosystem-based approaches for sustainable tourism development.
- **Groundwater management.** Evaluating the applicability of LSDTs in managing groundwater resources, especially in regions with tourism activities that may impact water availability.
- **Raising awareness.** Examining how awareness raising targeted at stakeholders and the general public about sustainable tourism practices could be applied in Puglia.

Furthermore, the discussion highlighted a preference for initiating activities on a smaller scale, focusing on collaboration with specific municipalities. This approach would involve testing various activities and solutions to determine their feasibility and effectiveness within the local context.

Regarding Puglia's perspective on its needs, the following key points were emphasized:

- **Interest in innovative policies.** Puglia expressed a strong interest in developing innovative policies within the tourism sector. This interest extends to seeking support from external sources and exploring potential synergies with other regions.
- **Local-scale piloting.** Puglia intends to initiate pilot projects at the municipality level. This involves considering the adoption of solutions and activities from other twinning regions or LSDTs that align with their specific needs. The discussion highlighted the need to focus efforts on specific areas, such as particular regions within Salento peninsula and engaging a select number of municipalities. However, stakeholders at the regional level remain important, particularly for policy-level activities.
- **Development of a forecasting tool.** Interest in modelling the impact of climate change on the tourism sector in the coming decades.
- **Concrete planning.** The first step for Puglia is to develop a concrete plan within the RESIST framework, outlining Puglia's objectives and strategies for sustainable tourism development.

Puglia is encouraged to develop clearer ideas in the coming months, ideally by the end of the year, to initiate activities in the new year 2024. The region would welcome inputs from partners how they

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could assist in the process of refining project ideas. Suggestions from partners including overviews of what other LSDTs are currently implementing are very appreciated.

KU Leuven offered support in developing digital tools once the main issues are identified. These tools could be instrumental in implementing adaptation measures effectively in Puglia's tourism sector.

3.3.2.6 Results

The needs assessment of the region Puglia is not yet completed at this stage, as the regional strategy will only be published in autumn 2023 and only then will it be possible to say exactly where additional needs for adaptation measures exist. So far, however, the following points can be noted on the basis of a literature research and interviews conducted with regional partners.

Within the context of the needs assessment several critical climate risks have been identified in the Puglia region for focused attention. These risks encompass **water scarcity, forest fires, extreme weather events such as heatwaves and tornadoes, and the potential for flooding.** To address these challenges, a set of potential measures aimed at enhancing the region's resilience to climate change were discussed with the regional partners. The primary areas of focus include the **development of interventions specifically tailored to make the tourism sector in Puglia more resilient** to the impacts of climate change. This involves not only safeguarding the region's vital tourism industry but also fostering sustainability in the face of changing environmental conditions. Furthermore, a goal is to formulate **innovative policies geared towards the tourism sector**. These policies will not only be designed to mitigate climate risks but also seek to identify synergies and opportunities for collaboration with other regions participating in the project. To guide these efforts, there is the willingness to **develop comprehensive guidelines** that consider the various climate-related risks affecting the tourism sector in Puglia. These guidelines will serve as a **roadmap for stakeholders, ensuring that climate considerations are integrated into planning** and decision-making processes. An update of the **emergency preparedness and response plans** can also be a crucial component of RESIST measures. **Knowledge sharing and capacity building** should be facilitated through the transfer of expertise **from LSDTs and twinning regions**, with a particular focus on topics such as land management, NbS, groundwater management, and awareness-raising activities. To test and refine these measures, the region would like to undertake **pilot projects** in collaboration with selected municipalities, **for example in the Salento area**. Lastly the **need for a development of a forecasting tool** specifically for the tourism sector was mentioned with models on the impact of climate change on the sector in the coming decades.

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3.4 LSDT 4: Introduction

In the following, the twinning regions of Extremadura, located in western Spain, and Vesterålen, located in coastal Norway, will be assessed based on their needs for climate adaptation. The lead region to LSDT 4 is Centro Portugal.

3.4.1 Needs Assessment Extremadura

3.4.1.1 Introduction

Extremadura is a region renowned for its warm climate in Spain, has an average maximum temperature of 22 °C. It encompasses a substantial land area of approximately 41,634 km^2, making it one of the country's large regions. Extremadura faces distinctive demographic patterns with a low population density of 25.55 inhabitants per km² (Pérez Fernandes et al. 2011c). Around 1.09 million people live in the region, distributed across 388 municipalities, where Las Hurdes and Sierra de Gata constitute two distinct municipalities in which the RESIST project will be active in 24 municipalities (Interview with University of Extremadura; Junta de Extremadura; Fundecyt, 2023).

Figure 14: Location of Extremadura (taken from Description of the Action).

The landscape of Extremadura is characterized by thick forests. The region experiences an annual forest growth rate of approximately 2%, further contributing to the complexity of its ecological dynamics. These dense forests hold an abundance of fuel wood resources, rendering the susceptibility to the emergence of forest fires. In addition, population decline and the decline in land management increase the risk of forest fires. Climate change also plays an important role in the increased risk for forests. Rising temperature and a decline in precipitation lead to higher fire risks, whereas torrential rainfall can lead to erosion and the loss of fertile soil, threatening the forests.

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Las Hurdes and Sierra de Gata

Northern Cáceres mountainous province in which Las Hurdes and Sierra de Gata are located is characterized by a sub-humid Mediterranean climate. Las Hurdes covers 46,268 ha across five municipalities, while Sierra de Gata encompasses 111,024 ha across 18 municipalities. Despite its vast area, the population in this region is relatively sparse, with only 17,675 inhabitants and a population density of 11.9 persons per km² (Interview with University of Extremadura; Junta de Extremadura; Fundecyt, 2023). The prevailing demographic trend reveals the highest rate of rural population in overall Spain with 49.1%, with the majority (59%) residing in municipalities with fewer than 5,000 inhabitants in the region (dRural 03.04.2023). One notable demographic trend in the region is the age distribution, where a significant fraction of the population is over 60 years old (Pérez Fernandes et al. 2011c).

Table 5: Facts about Las Hurdes and Sierra de Gata.

Facts	Las Hurdes	Sierra de Gata
Area (ha)	46,268	111,024
Population decline since 1960s	48.4%	41.4%
Forest cover (of total area)	81.0%	91.7%

Over the years, both areas have experienced a substantial decline in population, with Sierra de Gata witnessing a decline of 41.4% since 1960, and Las Hurdes experiencing an even more significant decline of 48.4% during the same period.

Sierra de Gata is predominantly covered by forests, accounting for 91.7% of its area, while Las Hurdes has 81.0% forest cover. The most prevalent forest stands in these regions are pine (31.1%) and oak (15.5%). However, the dense shrubland, covering 43.8% of the landscape, and a dense shrub layer especially in the pine-dominated regions, makes it susceptible to forest fires. Large forest fires, with an area greater than 100 ha, have been relatively frequent. The population decline has had significant effects on land management practices. With fewer people living in the area, the direct involvement of the population in land management has decreased drastically over the years. In 1976, 48.4% of the population was engaged in direct land management activities, whereas by 2021, this number had reduced to 14.8% (Interview with University of Extremadura; Junta de Extremadura; Fundecyt, 2023).

3.4.1.2 Climate risks

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3.4.1.2.1 Regional climate risk assessments and identified risks

In 2014, regional bodies developed the **Estrategia de Cambio Climático de Extremadura 2013-2020** (2014), based on the **Estrategia de Cambio Climático para Extremadura 2009-2012** (2009) with a simplified but more ambitious structure. The strategy summarises targets and activities to be taken in order to tackle challenges regarding climate change. Actions and targets are based on the following sectors, integrating approaches to reduce GHG emissions and promote adaptation measures: transport, industrial, residential and urban planning, tertiary sector, administration, waste, governance, research and development, agriculture, and energy. The strategy includes 187 measures compared to previously 51 in the former strategy, that comply with a total of 46 objectives, structured into 11 activity sectors. Per sector, objectives and measures are proposed, mainly for mitigation within a limited number also for adaptation to climate change, such as the optimisation of irrigation techniques in the agricultural sector and the reduction of water consumption. Out of the 187 measures, there is one measure (No. 151) on forest fires, namely the development of prevention plans in Extremadura (Pérez Fernandes et al. 2009; Bastos Martín et al. 2014).

Within the previous climate change strategy (2009-2012), one immediate measure was implemented by Junta de Extremadura, the development of a study mapping the climate risks in Extremadura and the most important sectors. The **Mapa del Cambio Climático en Extremadura** (hereafter abbreviated as MCCE) was conducted in 2011. It serves as a baseline knowledge for climate risks in the region is so far the central document analysing the impacts and risks of climate change in the region. The MCCE analyses changes in precipitation and temperature patterns as well as extreme weather events within the twelve geographical areas of Extremadura. The MCCE includes the following sectoral plans: livestock, agriculture, forest, biodiversity, water, energy, tourism, health and insurance. The sectoral analyses entail specific climate risks relevant for the specific sectors and outline suitable adaptation measures (Pérez Fernandes et al. 2011c).

Within the scope of the MCCE and the relevant sectoral plans, the RESIST project area encompassing Las Hurdes and Sierra de Gata (Zone I in the MCCE) has undergone an analysis of key meteorological parameters, namely temperature and precipitation (see Table 6). Regarding future maximum temperatures in the project area, it is projected that temperatures will increase. Maximum temperatures are expected range between 25 °C and 26 °C in the project areas by 2025 and 2050. At the same time, projected minimum temperatures exhibit a significant increase, with a rise of 2 °C compared to the reference period, reaching up to 12-13 °C by 2050 in the RESIST project area. This projected rise in minimum temperatures will also lead to a decrease in the number of frost days (Pérez Fernandes et al. 2011c).

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Table 6: Increase and decrease of climate variables (Pérez Fernandes et al. 2011b).

Variations compared to 1961-1990	2011-2040 Scenario A2	2011-2040 Scenario B2	2041-2070 Scenario A2	2041-2070 Scenario B2
Minimum ° C	1.5-2	1.5-2	3-3.5	2.5-3
Maximum ° C	2-3	2.5-3	4.5-5	3.5-4.5
Average mm	-150 to -100	-150 to -100	-150 to -250	-150 to -100

The region's annual rainfall during the baseline period exceeded 700mm. Nonetheless, concerning projections reveal a substantial decrease in precipitation, with an annual reduction of up to 115mm until 2025 and an estimated decline of 500mm per year until 2050. This reduction in rainfall poses a significant threat to the native flora and fauna, as well as the agricultural, energy, and industrial sectors within the area. The implications are particularly concerning for rainfed agriculture. Notably, in the B2 scenario, projections reveal an increase in rainfall for the project area by 2050 (Pérez Fernandes et al. 2011c).

Extreme events

Extreme events in the RESIST project area pose significant challenges and potential risks. *Flooding* is a concern, as it can cause severe damage to the infrastructure of the livestock sector. Moreover, *heavy precipitation* is associated with *soil erosion*, leading to loss of crop productivity and soil quality, as well as reduced soil retention capacity. In Extremadura, rainfall-induced erosion is the primary cause of fertile soil loss and ultimately contributes to desertification. Some regions within the RESIST area are at high and medium risk of erosion, future projected occurrence varies for different climate scenarios, with a decreasing probability for A2 scenario and an increasing probability for the B2 scenario for 2041-2070 (over 176 mm of rainfall in 24 hours). The RESIST project areas, with their geomorphological characteristics of steep slopes and narrow valleys, are particularly prone to flash floods after heavy rain (Pérez Fernandes et al. 2011c).

Regarding *forest fires*, Extremadura has experienced a considerable number of fires, with intentional human activities triggering almost half of the incidents in 2009. The evolution of extreme temperatures associated with climate change plays a crucial role in the ignition and propagation of forest fires. Higher temperatures increase the likelihood of fires starting on forested land and facilitate their spread due to heightened flammability of materials under increased heat. Climate change will likely influence the fire regime, leading to more ignitions and easier propagation, as aridity increases, summer rainfall decreases, and extreme temperatures become more likely, drying out fuels and

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promoting ignition. It is projected that in 2045-2054 in both A2 and B2 scenarios, the number of days with extreme fire risk (>41°C) will reach up to 150-275 days/ decade and 300-450 days/ decade for high risk (>39°C) (Pérez Fernandes et al. 2011b; Pérez Fernandes et al. 2011c).

Risk levels that the authors used are the following:

Table 7: Temperature thresholds for fire risk (left) and number of days per decade where thresholds are exceeded under the emission scenarios (right) (Pérez Fernandes et al. 2011a).

Risk Type	Temperature threshold in °C
Moderate risk	35
High risk	39
Extreme risk	41

Number of days per decade above	2021-2030 A2	2021-2030 B2	2045-2054 A2	2045-2054 B2
Moderate risk >35 °C	500-650	500-600	650-750	600-700
High risk >39 °C	250-350	150-300	300-450	300-450
Extreme risk >41 °C	50-200	50-200	150-250	150-275

In addition, *heat waves* pose a significant threat particularly to the RESIST project area, where the percentage of the elderly population is higher compared to other areas in Extremadura. The frequency, duration, and intensity of heat waves are expected to increase from June to September (Junta de Extremadura 2011). The heat wave intensity index for the project region indicates the severity of heat waves for different periods. In the baseline, the index ranges from 40-50 °C, while under the A2 and B2 scenarios, it varies from 30-40 °C to 40-45 °C and 45-55 °C to 35-45 °C, respectively (Junta de Extremadura 2011). Droughts and aridification are likely to affect Zone I, with a reduction in precipitation and more unequal distribution. The annual water balance is projected to decrease significantly under both A2 and B2 scenarios, leading to water deficits ranging from -275 to -250 mm for 2011-2040 and -500 to -475 mm for 2041-2070, compared to the average baseline period. Zone I will experience one of the greatest water deficits, and reservoirs will suffer from reduced water levels (Corzo Pantoja et al. 2011c).

The entire area is classified as arid, with a trend towards *aridification* in both scenarios and time frames. By 2041-2070, 70% of Extremadura will have desert characteristics under the A2 scenario, and 20% of the area will be arid. For the B2 scenario, 66% of the area will have desert characteristics, and 33% will be arid. This aridification, coupled with reduced water resources and higher temperatures, can lead to desiccation of forest fuels, increasing the risk of *forest fires* and a loss in

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agricultural production and livestock rearing. Additionally, agriculture and rainfed farming in Las Hurdes and Sierra de Gata will face specific challenges due to the adverse effects of heat waves and aridification on the edaphic and agrological potential of the area (Pérez Fernandes et al. 2011b).

3.4.1.2.2 Comparison with ESPON data

The ESPON CLIMATE dataset provides valuable insights into climate hazards, exposure, and vulnerability in Extremadura, Cáceres region (in which Las Hurdes and Sierra de Gata are located in). In the baseline scenario, the main climate risks identified are wildfires affecting forests and protected areas, flash floods impacting cultural heritage, and heat stress affecting the population living in the area (Navarro et al. 2022).

Looking specifically at the RCP8.5 scenario and considering the hazard component, wildfires emerge as the most prominent, followed by heat stress and droughts affecting the primary sector. The risk of heat stress is high due to the region's high population exposure, rising temperatures, and a significant rise in the number of tropical days and nights. Additionally, a high level of sensitivity, as measured by the age dependency ratio, contributes to the risk. Furthermore, wildfires pose a dominant risk as the region experiences numerous days with fire danger, and there is a large exposed area of forests and protected areas. Droughts affecting the primary sector also present a risk, given the hazard of reduced annual mean precipitation and an increased number of consecutive dry days. The agricultural, forested, and mixed areas of the region are exposed to these droughts. On the other hand, flash floods on cultural heritage lose significance in the high emissions scenario, as the hazard (precipitation) reduces. Sensitivity analysis shows that the population is highly sensitive to river floods, but the exposure and hazard levels are relatively low, resulting in less dominant risk compared to other hazards in the region (Navarro et al. 2022; Pérez Fernandes et al. 2011c).

The identified risks in the ESPON dataset align with the results of the climate risk assessment conducted in Extremadura. Droughts, wildfires, and heat waves are indeed among the most pressing risks in the region, supported by available data. These findings underscore the importance of addressing these climate risks and implementing appropriate measures to enhance the region's resilience.

3.4.1.2.3 Potential improvements for climate risk information

The MCCE, along with its sectoral plans, serves as a knowledge base for the Extremadura region to plan further adaptation actions to address climate risks. Although the MCCE does not follow all aspects relevant to a standard CRA, it provides crucial data and knowledge regarding affected sectors and risks. The assessment includes two climate projections (A2 and B2) based on IPCC AR4 with emission scenarios based on IPCC SRES from 2000 and compares them with the reference period of 1961-1990, short-term projection period of 2025, and medium-term projection

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period of 2050. Complementarily, an analysis of the averages of the variables has been carried out for the periods 2011-2040 and 2041-2070. The analysis involves the variability of temperature and rainfall, utilizing data from weather stations downscaled to the regional scale by regionalized climate models of the State Meteorological Agency of Spain (Pérez Fernandes et al. 2011c).

Various climate hazards and extreme events, such as heat waves, flooding, forest fires, erosion, snowfall, and heavy precipitation, are considered relevant for the region, more specifically in the sectoral plans. These risks are based on regional data but are assessed based on general literature reviews for each sector. The analysis is thus not necessarily regional-specific but rather outlines potential risks and its consequences in a broader term. For each risk simple cause-and-effect relationship matrices are established between temperature and rainfall changes, the affected sectors, and their implications on sustainable development. However, the analysis lacks specific impact chains that are disaggregated by hazard, exposure, sensitivity, and adaptive capacity. Solely within the sectoral plan on health, sensitivity and exposure are considered as relevant factors contributing to the overall climate risk on e.g. heat.

While the assessment acknowledges uncertainties in broader terms regarding climate projections, further elaboration is limited. The assessment acknowledges uncertainties at the beginning but lacks further elaboration on them. The spatial component of the CRA is considered to identify areas in the region, where certain risks are most pertinent. The analysis incorporates a spatial element, varying depending on the sector and parameters under examination (Pérez Fernandes et al. 2011c; Junta de Extremadura 2011; Pérez Fernandes et al. 2011d; Pérez Fernandes et al. 2011b; Corzo Pantoja et al. 2011b; Corzo Pantoja et al. 2011c; Corzo Pantoja et al. 2011a).

Recommendations

The most important need that is to mention is an update of the MCCE and its sectoral plans based on the current standards of the IPCC AR5 by using RCP4.5 and RCP8.5 with medium and long-term projections (IPCC 2022). By updating the datasets and models used in the assessment (conducted in 2011), more concrete recommendations and actions regarding adaptation could be extracted and more recent data used. Additionally, the development of impact chains would significantly enhance the quality of the MCCE. By disaggregating the aspects of hazards, exposure, sensitivity and adaptive capacity, the main drivers of risk and vulnerability can be better understood and tailor-made adaptation measures can be developed. Specifically, the identification and modelling of hazards can be improved by integrating more variables besides solely temperature and precipitation for further analysis of certain hazards, such as forest fires or floods. Within the sectoral strategies, it is valuable to establish a clear link between the adaptation options developed per sector and the specific hazard, exposure, and vulnerability. By understanding the unique challenges faced by each sector and tailoring adaptation measures accordingly, the region can maximize its capacity to cope with climate risks and enhance its overall resilience by efficiently allocating resources to the most harmful climate

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risks and to solutions, that offer the most effective risk reduction. In addition, the development of a dedicated sectoral plan for forests should be considered, since forest fires are a very important risk in the region. In the forestry sector, valuable and up-to-date information and assessments are readily available from various projects, as outlined in chapter 3.4.1.3.1. These resources can serve as a solid foundation for designing effective adaptation measures tailored to the specific needs of the forestry industry.

3.4.1.3 Adaptation measures

3.4.1.3.1 Existing plans and measures

Important policy documents at national level

The **National Plan for Adaptation to Climate Change (PNACC) 2021-2030** serves as the fundamental planning instrument for the country's climate change adaptation and resilience efforts and is part of the strategic energy and climate framework of Spain. It focuses on 18 areas of work, including health, water resources, and biodiversity. The plan advocates for improved governance to enhance coordination and innovation in climate action, encompassing legislation, cost-benefit assessment, planning, and management for both public and private sectors. The Climate Change Adaptation 3° Working Programme of the PNACC has established a three-year work program to ensure continuity and progress, outlining specific adaptation measures for each sector. It consists of four axes and two pillars to continue the PNACC's ongoing efforts effectively. The axes involve generating knowledge related to climate change impact assessment, vulnerability, and adaptation, integrating adaptation into regulations, mobilizing key actors, and establishing a system of indicators and evidence for climate change impacts and adaptation in Spain. The work programs within the PNACC provide detailed measures and plans within specific timeframes, with the first program covering 2021-2025 and specifying relevant organizations, budgets, and timelines to effectively implement the adaptation measures outlined (Ministerio para la Transición Ecológica y el Reto Demográfico 2020).

A recent **royal decree-law of 2022 adopting urgent measures on forest fires** (15/2022, of 1 August), based on the forest law of 2003 (43/2003, of November 21), has the goal to manage forest fires more effectively on a national, intersectoral level, considering growing threats like global warming and rural demographic changes. It forces autonomous regions to adapt their services and provisions regarding prevention, extinction and maintenance and restoration of affected forest land. The Ministerio para la Transición Ecológica y el Reto Demográfico aims at developing a tool for forest fire zoning with the goal to improve forest fire forecasts and decision-making of actions. In addition, it eases state aid for forest restoration in respective fire-prone areas (Jefatura del Estado 2022).

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Based on the national strategies and the actions defined that affect the regions such as regionalised climate assessments, the autonomous communities have developed their own adaptation strategies and plans as outlined in chapter 3.4.1.2.1.

Overview of relevant policy documents and adaptation measures at regional level

The **Plan Extremeño Integrado de Energía y Clima 2021-2030 (PEIEC)** focuses on climate change actions in Extremadura, prioritizing mitigation, adaptation, research, innovation, and social engagement. It addresses decarbonization, renewable energies, and energy efficiency while considering the region's unique challenges and opportunities, while tailoring them to the reality of Extremadura. PEIEC currently has two adaptation measures compared to 33 mitigation measures, as one major measure within adaptation is to develop an updated Climate Change Adaptation Strategy that will contain adaptation actions within sectoral adaptation plans (Consejería para la Transición Ecológica y Sostenibilidad 2021). Within the PEIEC, the outline of the Climate Change Adaptation Strategy is already developed, following the IPCC AR5 for climate risk assessments, as proposed in chapter 3.4.1.2.3.

As there is currently no updated version, the Climate Change Strategy of Extremadura 2013-2020, the MCCE together with the sectoral adaptation plans (see chapter 3.4.1.2.1) are the most recent documents outlining adaptation measures in the region (Bastos Martín et al. 2014; Consejería para la Transición Ecológica y Sostenibilidad 2021). Adaptation plans were developed for the following sectors: agriculture, livestock, risks and securities, energy, tourism, water resources and health. They all contain a dedicated assessment of risks based on the MCCE document with a specific focus on the sectoral risks (Pérez Fernandes et al. 2011c; Junta de Extremadura 2011; Pérez Fernandes et al. 2011d; Pérez Fernandes et al. 2011b; Corzo Pantoja et al. 2011b; Corzo Pantoja et al. 2011c; Corzo Pantoja et al. 2011a). The plans outline dedicated measures supporting the adaptation process in the region. They were intended to be dynamic documents that needed constant updating and revision. This to our knowledge however has not been the case.

Another important document that takes a wider approach is the **Estrategia para el Desarollo Sostenible de Extremadura**. It contains a framework for a broader field of action based on sustainable development regarding the environment, economic and social aspects. Within the chapter on environment, climate change is taken up and mainly includes aspects based on the Climate Change Strategy for Extremadura 2009-2012 (Pérez Fernandes et al. 2011a).

The **Extremadura 2030 Plan** is a visionary Green and Circular Economy Strategy that sets ambitious goals for sustainable economic and social development in the region. It aims to enhance the region's economic power while addressing pressing environmental and climate change issues, including biodiversity loss and aridification. The strategy follows international frameworks such as

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Agenda 2030 and the Paris Agreement, aiming at alignment with global sustainability targets. It emphasizes broad inclusion, targeting the entire region with a specific focus on empowering women and young people. Public participation is central to the plan, ensuring that stakeholders have a say in shaping its implementation. Within the framework, a **new forest plan is proposed**, aiming to foster sustainable forest management practices and maximize the positive impact on the environment. An essential aspect of the Extremadura 2030 plan is the envisioned strategy for forest bio-economy, which seeks to unlock the potential of forests as a source of sustainable economic activities. By integrating a circular approach, the plan envisions using forest resources in a manner that ensures their regeneration and long-term viability, while simultaneously supporting the economic prosperity of the region, e.g. through biomass valorisation (Junta de Extremadura 2017).

The Plan Forestal (PFEx) is an instrument of strategic planning of the forest policy. It includes an assessment of the current status of Extremadura forest landscapes and regulates forest management, including a methodology for forest fire defence and risk management. The **Plan de Prevención de Incendios Forestales de Extremadura** (PREIFEX) is a comprehensive framework aimed at addressing specifically the forest fire risks in the region. Extremadura is categorized into four zones based on forest fire danger, with the RESIST region falling into zone 4, representing high risk areas. The plan mandates the establishment of prevention plans for all forest areas >400 ha or if located in high risk areas with a forest size >200 ha, encouraging forest owners to collaborate by forming unions known as prevention and extinction groups to jointly develop these plans. To ensure effectiveness, the prevention plans encompass detailed descriptions of the existing vegetation, available infrastructure such as accessible water points, roads, and constructed fire breaks. Additionally, city councils are obligated to create peri-urban prevention plans to safeguard areas at the interface between urban centres and forested landscapes. In addition, it includes actions that have to be taken for fire prevention. Reviews of the prevention plans are scheduled every four years to incorporate new data and adapt strategies to evolving conditions, reinforcing the region's commitment to proactive forest fire management and safeguarding its valuable natural resources (Junta de Extremadura 2006).

The **Plan de Lucha contra los Incendios Forestales de Extremadura** (INFOEX) is an action plan designed to actively combat forest fires in the region. It uses the same categorisation as the plan named above, and organizes forest fire fighting actions and efforts through management plans. The plan emphasizes social participation in fire extinction activities and is overseen by a technical advisory body and a permanent commission. During firefighting operations, coordination is ensured through a regional operating centre responsible for managing fire response and resources effectively (Junta de Extremadura 2010).

The sectoral adaptation measures developed by Junta de Extremadura are based on the MCCE and the Climate Change Strategy 2009-2012 of Extremadura. In general, the adaptation section of the sectoral strategies is organized into adaptation programs, addressing thematic areas with specific

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goals. For example, one program might aim to "[i]ncrease the availability of water resources through the application of water retention and storage techniques." These programs are developed based on climate impact assessments relevant to each sector. They outline intended objectives, impacts, and benefits, as well as reference documents from international, national, and regional levels, such as frameworks, laws, plans, and ongoing projects that pertain to the adaptation actions. However, the descriptions of actions within each program are relatively brief and generic and the link to the climate risk is not outlined via a clear impact chain that outlines the exposure, sensitivity and adaptive capacity of the system considered (Corzo Pantoja et al. 2011c).

For instance, an action may focus on “Development and implementation of technologies for rainwater and dew collection, water storage, and distribution,” with the indicator “annual volume of rainwater collected.” The actions often lack specific baseline or target values for impact monitoring. This makes it challenging to measure and track the effectiveness of the adaptation measures over time. To enhance the effectiveness of adaptation strategies, it would be beneficial to provide more detailed and quantifiable targets for each action, allowing for better assessment and accountability in achieving the intended benefits and goals of the adaptation programs. To increase the focus further, one could also formulate the overall goals for each programme in a way that makes the progress towards each goal more measurable.

Additionally, gender and vulnerable groups are not specifically considered in the adaptation measures with one exemption that is the adaptation plan for the health sector. Within that sectoral plan, vulnerable groups, including the elderly, children under ten years, and individuals with health conditions, are given significant consideration. These groups are recognized as sensitive populations, as they are more susceptible to the impacts of climate change. Both sensitivity and adaptive capacity are assessed and considered for the development of adaptation measures. In every adaptation program and action, special attention is devoted to acknowledging and addressing the specific needs and challenges faced by these vulnerable populations (Junta de Extremadura 2011).

Specifically considering forest fires as an important climate risk, it is barely presented in adaptation measures within the sectoral plans although it was determined as a significant threat within the MCCE. Forests are recognized as important areas for water retention and storage to ensure a functioning hydrological cycle in the sectoral plan of water resources, in addition within the energy sectoral plan, adaptation measures consider forests as valuable sources for biomass for energy production (Corzo Pantoja et al. 2011b; Corzo Pantoja et al. 2011c). Lastly within the sectoral plan of Natural Risks and Insurance, forest fires are considered and analysed (Pérez Fernandes et al. 2011b). Aside from this, forests do not play a significant role within the adaptation actions.

A dedicated sectoral plan for forestry is necessary to account for needed and important adaptation actions that are assessed and tailored to the specific hazard, exposure and vulnerability within

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Extremadura. The plan should specifically have an intersectoral perspective, considering the effects of forest fires on other sectors such as tourism, energy, water, livestock and agriculture. There are numerous projects that already provide a good database for adaptation measures in the region. Additionally, floods are solely indirectly addressed in adaptation measures, another climate risk that should be represented in adaptation measures more prominently.

The adaptation actions in the current strategy are primarily incremental, addressing specific issues such as water deficits in agriculture through the proposal of new irrigation technologies and water loss reduction. However, there is a lack of direct focus on general changes in management. To enhance the effectiveness of the adaptation strategy, it would be beneficial to incorporate adaptation measures with a cross-sectoral character. This would allow for a more comprehensive and integrated approach, considering the interconnectedness of various sectors and their vulnerabilities to climate change. By adopting a cross-sectoral perspective, the adaptation strategy can better address complex climate challenges and promote synergies among different sectors, ultimately leading to more effective and sustainable climate resilience.

Furthermore, the sectoral plans should be revised and updated with the latest available data and information. As the existing plans are more than 11 years old, they may not accurately reflect the current conditions and vulnerabilities in the region. Updating the plans with recent data will ensure that they are based on the most relevant and up-to-date information, enabling more effective and targeted adaptation actions.

Lastly, it would be very beneficial to introduce maladaptation screening (e.g. based on the Self-Assessment Tool for Maladaptation developed by the REGILIENCE project) as part of the adaptation planning process. This involves assessing potential unintended negative consequences. By identifying and addressing maladaptation risks, the plans can be optimized to avoid actions that might inadvertently exacerbate vulnerabilities or create new problems in the long term (Institute for European Energy and Climate Policy (IEECP) et al. 2023).

3.4.1.3.2 Planned adaptation measures within RESIST

The RESIST project's pilot areas cover 82,990 ha in Sierra de Gata and 37,477 ha in Las Hurdes (see chapter 3.4.1.1 for description of the area). It aims to create a Fire Smart Landscape (FSL), by implementing cost-effective fire prevention actions through social engagement and multi-actor cooperation. The FSL concept is based on cost-effective productive fuel breaks (like mosaic patterns of the landscape, a traditional management technique for reducing the risk of forest fires) managed by local farmers to prevent fires, and suppression infrastructures, so that official fire services can more easily extinguish fires. The project will leverage traditional knowledge and coordinate efforts of local forest owners, farmers and shepherds to diminish fuel in the forests and shrubland. Collaboration with fire suppression bodies and strategic farming activities in designated areas will enhance the region's capacity for fire resilience. The University of Extremadura, Regional

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Government, and Fundecyt will work together to design and execute the first FSL in the region, building upon their previous experiences for building social-ecological networks. The project benefits from a network of around 300 local land managers and in-depth scientific knowledge of the pilot area, focusing on wildfire management. The project partners are the Junta de Extremadura, University of Extremadura and Fundecyt, who are currently in the process of conducting a stakeholder survey and are updating maps of wild fire risks in the region by the end of the year. To implement fire prevention measures effectively, the project focuses on pilot regions and selects critical areas within them using complex fire modelling. These selected areas hold particular importance for fire prevention efforts. Once identified, the project engages with the local communities and stakeholders living and working in these areas. Regarding vulnerable population groups, the survey that will be conducted will bring more clarity, however to the current status, old-aged people, people dependent on the forest for economic income as well as people depending on the tourism sector are vulnerable to forest fires.

In line with the sectoral plan for Tourism, the project aims to promote the FSL initiative through various activities. The RESIST project aligns with the sectoral adaptation plan for Tourism by proposing actions to adapt and specialize tourist activities and attractions. The main objective is to capitalize on the changing climate and its consequences to diversify tourism offerings and attract tourists through specialized experiences and educational activities in the region. Tourism companies will design trails and tours that showcase productive fuel breaks and the agro-silvo-pastoral practices of local farmers engaged in fire prevention. Restaurants will contribute by offering products from the FSL areas on their menus, emphasizing the connection between tourism, local culture, and sustainability. Additionally, shops will sell Mosaico products to tourists, creating a market for goods produced within the FSL and supporting the economic development of communities involved in fire prevention efforts (Pulido et al. 2023; Corzo Pantoja et al. 2011a).

According to the regional partners and additional sources, the main challenges and obstacles for the successful implementation of the CATA activities in the pilot area include:

- **Coordination and governance**: Effective fire prevention requires the collaboration and participation of various stakeholders, including forest owners, farmers, herders, fire services, and government agencies. Establishing a well-coordinated governance system that involves all relevant parties is crucial for the successful implementation of fire prevention measures.
- **Recognition of private forest owners' prevention measures**: Private forest owners play a significant role in fire prevention efforts through land management changes, but their contributions are often not recognized or considered by the government and are not reflected in policy yet. There is a need to acknowledge and involve private owners as key partners in fire prevention initiatives.

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- **Complex bureaucratic procedures**: The dispersion of property ownership and small plot sizes make bureaucratic procedures complicated, especially due to the low profitability of the plots. Simplifying administrative processes can facilitate fire prevention measures.
- **Abandoned areas and fuel build-up**: Abandonment of large private areas has led to the accumulation of fuel, increasing the difficulty of wildfire prevention and suppression. Revitalizing and managing these abandoned areas are crucial for effective fire prevention.
- **Carbon farming***:* Carbon farming can pose a challenge to fire risk prevention, as companies buy carbon certificates of forests and leave them unmanaged which increases the fuel accumulation in these forests. These stakeholders should be approached and involved in the project and stakeholder consultations.
- **Low human population density***:* The low human population density in the farming and forestry sectors can pose challenges in implementing fire prevention measures. Ensuring engagement and participation of communities from these sparsely populated areas is essential.

3.4.1.3.3 Support needed

There are a few areas and activities where support within the adaptation measure and beyond is needed:

- **Identification and integration of vulnerable population groups into planned measures.** RESIST can assist in stakeholder involvement processes and adaptation of activities that specifically focus on identifying and integrating vulnerable groups, including women, into the planned adaptation measures. By ensuring the inclusion of vulnerable communities, the effectiveness and equity of the adaptation actions can be enhanced.
- **Facilitation and support stakeholder consultations together with municipalities.** RESIST can support stakeholder consultations, bringing together various actors such as municipalities, NGOs, carbon farming companies, small-scale private companies in the forestry sector, restaurants, and the tourism cluster to take up and contribute to implementation of resilient land management practices. By fostering collaboration and engagement among these stakeholders, the uptake of measures can be enhanced and implementation can be speeded up.
- **Support for avoiding maladaptation.** RESIST can provide expertise and assistance in conducting maladaptation screening to ensure that the adaptation measures do not inadvertently lead to negative consequences or exacerbate vulnerabilities. Through a robust screening process, potential risks and unintended impacts can be identified and mitigated, leading to more sustainable and climate-resilient outcomes.
- **Governance, policy and legal framework.** The project can serve as an exemplary model for fire prevention, with insights and recommendations for future plans for fire prevention;

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RESIST can support the development of policy recommendations to involve private forest owners in fire prevention efforts through effective legislation and governance.

3.4.1.4 Stakeholders and capacities

In the project, important stakeholders include farmers and forest owners and associations who will play a crucial role in implementing landscape modifications for fire prevention. The project also aims to integrate vulnerable population groups who will be identified based on survey results, acknowledging socio-economic vulnerabilities. The forest industry as well as carbon farming companies is another key stakeholder, and getting them on board may require addressing changes in their management systems. Additionally, engaging NGOs in the field of conservation is crucial, with the need to resolve potential conflicts of interest (conservation of forests versus active landscape management through FSL) through co-creation, joint planning, and dialogue. For the involvement of the tourism sector, collaboration with municipalities and the tourism cluster is essential, with potential engagement plans to foster cooperation.

The following table outlines the main stakeholders:

Table 8: Main stakeholders of the RESIST action in Extremadura.

Organization name	Type	Website	Location	Short description	Involvement/Importance for RESIST	Con-tact
University of Extremadura	1	www.indehesa.unex.es	Plasencia	Leading R+D centre for NBSs	Long term experience with NBS in pilot area	UNEX
CICYTEX	1	www.cicytex.juntaex.es	Extremadura	Leading R+D in agricultural sector	General support for implementing productive initiatives	UNEX
ADISGATA	2	https://sierradegata.org/	Pilot area	Local rural development	General support for disseminating RESIST activities + financial support for microprojects	UNEX
ADICHURDES	2	https://todohurdes.com/	Pilot area	Local rural development	General support for disseminating RESIST activities + financial support for microprojects	UNEX
Asociación Mosaico	2	https://www.facebook.com/asociacionmosaico/	Pilot area	Association of local farmers	Land use initiatives promoting fire prevention and local development	UNEX
Asociación de Propietarios Forestales del Valle del Árrago	2	https://www.facebook.com/carlosgardelgado	Pilot area	Association of local forest owners	Forestry and agricultural initiatives on private land	UNEX

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Asociación de Propietarios del Castañar de Hoyos	2	https://www.facebook.com/asociacionmosaico/	Pilot area	Association of local forest owners	Forestry and agricultural initiatives on private land	UNEX
TURISGATA	2	https://turisgata.com/	Pilot area	Association for local agrotourism	Dissemination and marketing of routes and local products	UNEX
ATHUR	2	https://todohurdes.com/athur/	Pilot area	Association for local agrotourism	Dissemination and marketing of routes and local products	UNEX
ASOMANCA	2	https://www.facebook.com/people/Agricultores-Manzanilla-Cacere%C3%B1a/100089491552657/	Pilot area	Local association of olive producers	Recovery of mountain olive groves which are essential for fire prevention	UNEX
APIHURDES	2	https://apihurdes.es/	Pilot area	Local association of beekeepers	Marketing of local products	UNEX
AMBIENTA INGENIERÍA	2	https://www.ambientaing.es/	Plasencia	SME with large experience in ecosystem restoration, landscape management and forestry	Forestry and agricultural initiatives on private land Support in forestry management and ecosystem restoration	FUNDECYT-PCTEX
AGROECOLOGY SOLUTIONS	2	https://asociacionaprisco.org/?lang=es	Plasencia	Spin-off from the Agricultural Ecology group at ETH Zurich, Switzerland, dedicated to applied research and consulting in agroecology	Support in education activities Lab facility for processing of plant, animal and soil samples 50 ha of mapped agroforest	FUNDECYT-PCTEX
ECOHABITAT	2	https://www.ecohabitatiberico.com/	Plasencia	SME with large knowledge of forestry problems and especialised in engineering projects and studies, consulting and technical assistance services.	Synergies with company's innovation projects in different fields related to the forestry sector and agribusiness.	FUNDECYT-PCTEX
AGROFOREX	2	https://www.agroforex.com	Plasencia	Company specialised in the protection, conservation and improvement of the environment.	Experience in reforestation and regeneration works on agricultural land, recovery, restoration and improvement of degraded surfaces.	FUNDECYT-PCTEX
AREX	2	https://arexmedioambiente.es/	Mérida	SME with 40-year experience in the agricultural, forestry and environmental sectors in rural areas.	Experience in the execution of environmental monitoring plan' measures.	FUNDECYT-PCTEX

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ADENEX	5	https://www.adenex.org/	Extremadura	Association for the Defence of Nature and Resources of the region that informs, promotes, encourages the preservation of natural resources.	Support in regional engagement and communication activities	FUND ECYT-PCTE X
FUNPASOS	5	https://www.funpasos.org/	Extremadura	Foundation for the participatory sustainability aimed at promoting research, inclusive development and advice for the implementation of public policies, in terms of social and environmental sustainability and civic participation.	Support to foster inclusive and participatory processes to improve the application and design of regulations	FUND ECYT-PCTE X

3.4.1.5 Potentials for transfer

One of Extremadura's main climate risks are forest fires, similarly to Centro Portugal. There are thus various areas where collaboration can enhance synergies and knowledge exchange:

- Extremadura and Central Portugal share common goals of reducing fire risks and clearing forest fuels for a fire smart landscape. They can **collaborate and exchange knowledge on forest management techniques**, specifically on biomass valorisation, such as biofuel production.
- Central Portugal and Extremadura can explore **strategies to engage the private sector** in enhancing forest management practices more actively, in Centro Portugal specifically the pulp and paper industry whereas in Extremadura carbon credit companies.
- Both regions can exchange concepts on including vulnerable populations in FSL management and **community engagement** efforts.
- Collaboration can extend to **improving economic incentives for private forest owners** who adopt FSL management practices, which would ease the adoption of the management technique.
- Both regions face demographic challenges that affect **land management**, an issue that is not easily solved. Both regions can exchange on ideas and concepts on how to manage these circumstances.
- Lastly, the exchange of **data and models** for enhancing fire management systems should be encouraged between the regions.

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3.4.1.6 Results

The following aspects are to be named regarding the overall results of the analysis:

- **Update of MCCE and sectoral adaptation plans.** The existing MCCE requires together with the sectoral adaptation plans updating, as they stem from 2011/2012 and are based on outdated data not the state-of-the-art CRA methodology. To achieve this, it is essential to integrate impact chains based on hazards, exposure, and vulnerability into the analyses and to incorporate the latest available data. Also, the assessment should integrate climate scenarios from the latest IPCC AR6 report, RCP4.5 and RCP8.5 with a long- and medium-term time span.
- **Sectoral adaptation strategy for forest management.** A dedicated sectoral adaptation plan is recommended for the forestry sector, with a particular emphasis on fire management, as currently, adaptation measures regarding forests are only partly reflected in the other existing sectoral plans. The plan should account for climate change impacts, including potential shifts in fire patterns and intensity.
- **Transition to transformative adaptation.** The updated adaptation activities should focus on transformative rather than incremental actions. This shift aims to foster innovative and long-term solutions that address the root causes of vulnerability and climate risks.
- **Establishing a supportive political setting.** From a policy and legal perspective, modifications that enable and encourage both public and private preventive actions should be proposed. It is crucial to recognize private individuals and organizations as essential stakeholders in prevention efforts that are based on FSL.
- **Integration of gender and vulnerable groups.** The action will consider gender and vulnerable groups to ensure inclusive and equitable adaptation to forest fires, as incorporating their perspectives and needs will result in more effective and sustainable solutions. This however needs dedicated approach and strategy, an aspect that RESIST can support with.
- **Engaging the private sector and NGOs.** The successful implementation of FSL strategies relies on robust partnerships with the private sector and NGOs. It is essential to foster collaboration, understanding, and mutual goals to effectively integrate these stakeholders into the adaptation solutions.
- **Supporting screening with Maladaptation Tool.** A screening for maladaptation could be considered, both in general terms for adaptation measures developed within the sectoral adaptation plans and within the RESIST action.

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3.4.2 Needs Assessment Vesterålen

3.4.2.1 Introduction

Vesterålen, situated in northern Norway within Nordland County (see Figure 15), encompasses a vast expanse of islands covering approximately 3,100 km², where approximately 32,000 residents live. This island region is characterized by its steep topography, with steep terrain. Vesterålen boasts a notable competency in marine technology and entrepreneurial industries, with fishing and salmon aquaculture serving as pivotal pillars of the local economy. However, this region is not without its vulnerabilities, particularly in the face of sea-level rise, which poses risks to both residential buildings and industrial areas within Vesterålen (Description of the Action).

Figure 15: Location of Vesterålen (taken from the Description of the Action).

Generally, Nordland is one of the cooler regions in Norway. The coastal areas of Nordland are categorized with a mild, precipitation-rich climate, primarily due to the moderating effects of the North Atlantic Ocean, whereas inland parts of Nordland have colder temperatures and less precipitation. Winters in these coastal regions are relatively mild compared to more inland areas. This maritime influence also results in a significant amount of rainfall throughout the year, with over 3000 mm in some areas, specifically in the coastal area. During the winter season in the outer regions of Vesterålen, polar low-pressure systems can bring rapidly increasing winds and heavy snowfall. This phenomenon can lead to challenging weather conditions, including snowstorms and storms (Norsk Klima Service Senter 2022). From 1900-2014, temperature increased in the wider region of Nordland with 1.2 °C with the highest temperature increase occurring in spring and autumn (Hanssen-Bauer et al. 2017).

3.4.2.2 Climate risks

3.4.2.2.1 Regional climate risk assessments and identified risks

For the region of Vesterålen, no climate risk assessment exists up to now. Within this analysis, the authors thus used the Climate Profile of Nordland and Climate in Norway2100 study. The Climate Profile is currently the central document outlining future climate risks, it however does not specifically include details of the region of Vesterålen (Norsk Klima Service Senter 2022). Data for the Climate Profile was retrieved by the Norsk Klimaservicesenter platform.

It has to be noted that the effects of climate change and the overall climate differentiates among Nordland due to its differing geography. Under RCP4.5 (2071-2100), a temperature increase is

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expected by 3 °C for Nordland whereas under RCP8.5 an increase of up to 5 °C is expected. Winters are expected to experience the most significant temperature increase, with a rise of up to 5 °C, while summer temperature will increase by about 4.5 °C under RCP8.5. This warming will lead to an extended growing season, particularly noticeable in the outer coastal areas, and a decrease in the occurrence of winter days with extremely low temperatures (see Table 9). There will be a notable reduction in snowfall and the number of snow days, resulting in a snow season up to 3-4 months shorter. Nonetheless, high mountain ranges may experience an increase in snowfall until the middle of the century (Norsk Klima Service Senter 2022; Hanssen-Bauer et al. 2017).

Precipitation patterns are also set to shift, with an estimated annual increase of approximately 20% in Nordland. Winters are expected to become wetter with a 10% increase, while for summer, a substantial 30% increase in precipitation is projected. These changes come with rise in episodes of heavy precipitation in all seasons, intensifying both in frequency and intensity by approximately 20%. Flood calculations thus predict a 20% to 40% increase in water flow, particularly impacting smaller rivers that react swiftly to heavy rainfall, posing a threat to populated areas. Landslide risks are also on the rise, influenced by local terrain conditions and weather factors, including snowfall, rainfall, and snowmelt. Landslides, rock falls/slides, and avalanches are exacerbated by periods of heavy rainfall, further heightening the region's vulnerability. The region currently experiences a fall in number of snow days. The number is expected to fall by 180 days under RCP8.5. Summer precipitation is anticipated to increase significantly, accompanied by greater evaporation, which may result in longer periods of low river flow, groundwater deficits, and elevated forest fire risks (Norsk Klima Service Senter 2022; Hanssen-Bauer et al. 2017).

Table 9: Climate change in Nordland (Norsk Klima Service Senter 2023).

Changes compared to baseline period (1971-2000)	**Mid-term future (2031-2060)**		**Long-term future (2061-2100)**	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Mean temperature (°C)	1 – 2	2 – 3	2 – 3	4 – 5
Change in Days below 0°C	-20 – -10	-30 – -20	-40 – -20	<-40
Change in precipitation (%)	2.5 – 17.5	-2.5 – 17.5	7.5 – 22.5	7.5 – 27.5
Growing season increase (No. of days)	30 – 60	30 – 60	30 – 90	90 – 120

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Sea level rise, averaging 1.9 mm per year along the Norwegian coast, is expected to extend storm surges and waves further inland, posing a threat to buildings and infrastructure which were not previously impacted (Hanssen-Bauer et al. 2017). The projected sea level rise under different emission scenarios (RCP2.6: up to 0.3 m, RCP4.5 up to 0.35 m, RCP8.5 up to 0.55 m) indicate a relative sea level rise for most of Norway, albeit below the global mean rise. The closest metering to Vesterålen is in Andenes, which indicates a return level in 200 year storm surge of 208 cm above mean water level (Direktoratet for samfunnssikkerhet og beredskap 2016). Ocean acidification is an additional risk that is stated in the Norwegian Report on climate vulnerability, by 2010 the pH level has been falling by 0.1 pH units, a threat that can have impacts on marine life (NOU 2010).

In addition to these challenges, changes in sea temperature are can disrupt commercial fish stocks and aquaculture breeding, which needs a deeper understanding of climate change consequences on marine ecosystems for effective adaptation within the fisheries and aquaculture. The migration of fish can have effects on fisheries, as fishing quotas might need to be changed. Additionally, fish composition will change, as already new fish species were identified at the Norwegian coast, such as sea bass and swordfish. An increase in ocean temperature can also raise the risk of salmon lice, which is already observed in Norway (NOU 2010).

3.4.2.2.2 Comparison with ESPON data

The ESPON dataset is used as a comparison and backup for the region. It also solely exists on county-level (NUTS3) in Norway, and thus for Nordland. As ESPON is disaggregated by hazard, exposure and vulnerability, it provides valuable insights specifically on exposure and vulnerability level for the region. As stated above, there are in total seven risks considered, ranging from heat and drought to wildfires, coastal floods, and river and flash floods. In the baseline scenario (1981-2010), climate hazards are low besides flash floods from pluvial rain. The exposure is highest for droughts on primary sector, thus agricultural and forested land, as well as heat and river floods on population, followed by flash floods on museums and world heritage sites. Concerning sensitivity, Nordland is specifically vulnerable to river floods on population, where young- and old-age dependency play a significant role, flash floods, where vulnerability is measured in terms of touristic arrivals and droughts on primary sector, based on the GVA, employment rate in the sector and the share of irrigated land, followed by coastal flood (also measured in terms of employment rate in industry as well as generated GVA) and wildfires (Navarro et al. 2022).

Considering the medium emission scenario RCP4.5, flash floods and coastal floods, are ranked as the most pressing hazards in the region, whereas under the high emission scenario RCP8.5, the same hazards are relevant but the region becomes even more prone to coastal floods.

This is in line with the Climate Profile of Nordland which also identifies sea-level rise and storm surges as a main risk together with flooding both flash floods and river floods. At the same time, some risks pertaining to sea level rise to fisheries and aquaculture as well as land-slides in different

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forms was not captured by ESPON and it thus undermines the importance of developing a regional-specific assessment.

3.4.2.2.3 Potential improvements for climate risk information

As stated above, the Climate Profile of the county of Nordland, which encompasses diverse geographical features, including both islands and inland areas. This presents a challenge as the data provided is not tailored to the specific circumstances of Vesterålen, an island region facing unique climate-related challenges. The Climate Profile gives a first overview on climate hazards which are prevalent in the county, with information based on the "Climate in Norway 2100" assessment (Hanssen-Bauer et al. 2017; Norsk Klima Service Senter 2022). The Climate Profile is a rather short document, summarising the complex information and data given in the report for whole Norway. It thus lacks precision regarding the utilization of RCPs, which are critical for understanding the emissions scenarios used in the analysis. While the Norway 2100 document is referenced clearly, it is not clear which RCPs were employed in the Climate Profile. To enhance transparency, specifying the RCPs used in the analysis within the Climate Profile report would be beneficial. Moreover, the Climate Profile predominantly emphasizes long-term climate changes (2071-2100) while largely neglecting medium-term changes. Medium-term assessments, which are available in other reports, provide valuable insights into climate risks that might have more immediate implications.

The report briefly highlights various climate-related hazards, encompassing both extreme events (e.g., flash floods) and slow-onset events (e.g., sea level rise and ocean acidification). However, the analysis remains shallow, lacking the development of impact chains. The absence of impact chains, which outline the causal relationships between hazards (such as temperature rise or sea level rise), exposure (such as infrastructure, buildings, land), sensitivity (old-aged population GDP, irrigated area etc.), and adaptive capacity (social, institutional, economic, infrastructure and technological capacity), represents a significant limitation. A robust understanding of climate risks necessitates the comprehensive evaluation of these elements. Furthermore, the report omits the consideration of vulnerable population groups, a crucial aspect in climate risk assessment. Failing to account for the specific needs and vulnerabilities of these groups hinders the development of effective adaptation strategies.

Additionally, cross-cutting risks, which could have far-reaching and interconnected impacts, receive insufficient attention in the report. These risks require a more in-depth analysis to identify potential cascading effects and interdependencies. To enhance the utility of the assessment, it is highly recommended to conduct a more spatially explicit analysis tailored to Vesterålen. This would provide a nuanced understanding of region-specific climate risks and their geographic prevalence, thereby enabling the targeted development of adaptation measures and risk mitigation strategies.

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3.4.2.3 Adaptation measures

3.4.2.3.1 Existing plans and measures

Important policy documents at national level

The 2012 developed white paper on climate adaptation in Norway "**Meld. St. 33 (2012–2013) Klimatilpasning i Norge**" serves as a foundational guide for climate resilience. It introduces climate change risks and potential associated policy instruments, with a focus on core objectives related to climate impacts on nature and society (mainly on food production, health, infrastructure, economy, cultural heritage and the indigenous Sami culture and heritage). It lays out a framework for developing adaptation strategies and measures across sectors. It additionally proposes the establishment of a National Center for Climate Services and emphasizes the importance of disaster risk reduction, understanding uncertainties and clear roles and responsibilities to address climate risks effectively. Additionally, it provides insights into sector-specific impacts, such as agriculture, environment, and fisheries, underlining the need for targeted adaptation measures and outlining sectors, for which adaptation strategies are already existing, such as for fisheries and aquaculture, where the Ministry of Fisheries and Coastal Affairs has developed an adaptation strategy to adapt to warmer ocean water, sea level rise and storms (Det Koneglige Miljødepartment 2013).

The **Statlige planretningslinjer for klima- og energiplanlegging og klimatilpasning** (State planning guidelines for climate and energy planning and climate change adaptation) updated in 2018, aims to prioritize greenhouse gas emission reduction and climate adaptation in municipal and county planning and enhance energy efficiency. The dedicated section on adaptation it emphasizes the need for updating and developing county and municipal climate profiles, developing adaptation plans, and assessing the impact of climate change on long-term goals and strategies of municipalities. It requires municipalities to map ecosystems and relevant land use, consider climate-related impacts on societal security, critical infrastructure, environment, health, and industries. It also requires risk and vulnerability assessments of areas that are to be developed, particularly for areas vulnerable to hazards like floods and landslides. The guidelines also promote the use of NbS for preservation, restoration, or establishment *(Kommunal- og distriktsdepartementet 2008).*

In addition to the mentioned reports, Norway has a public report on climate change adaptation and vulnerabilities **Tilpassing til eit klima i endring** (2010:10; Norway's public reports: Adapting to a changing climate) along with an update **Oppdatering av kunnskap om konsekvenser av klimaendringer i Norge** (2018:14; Updating knowledge about the consequences of climate change in Norway). These reports provide a detailed overview of climate risks and vulnerabilities, thus a climate risk assessment, categorized by sector, including physical infrastructure, health, natural environment, and businesses (agriculture, fisheries and forestry). The update also highlights extreme events and elaborate on the associated risks, along with their socio-economic consequences, mostly through CBA using gathered studies. Furthermore, it emphasizes the

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importance of considering the social costs of maladaptation. Additionally, there is a dedicated chapter addressing adaptation at regional level, underscoring the significance of localized approaches to climate resilience. It concludes with an assessment of Norway's adaptive capacity regarding the different hazards, the exposure and sensitivity of the country. It also integrates data from the "Climate in Norway 2100" study and the data platform developed for climate data of Norway, the National Center for Climate Services. The assessment of socio-economic consequences show a relatively low impact with a temperature rise of up to 2.5 °C for 2031-2060, whereas impacts are called "dramatic" concerning a temperature increase of 4.5 °C by 2100 (Cicero and Vestlandforsking 2018; NOU 2010). Regarding sea level rise, the report outlines the importance of strengthening the planning system so that climate change risks are accordingly included in community planning and it emphasizes the use of ecosystem-based adaptation approaches.

Based on documents relevant for climate adaptation in Norway between the period of 2013-2021, such as the Act on Municipal Preparedness, Civil Protection Measures and Defense, the Forestry Act, or the Act on Protection against Natural Damage, the **Riksrevisjonens undersøkelse av myndighetenes arbeid med å tilpasse** assessment was conducted to understand how Norway manages climate adaptation, to understand gaps and chances for future improvement. One finding is that there is a concerning lack of knowledge and understanding among authorities in municipalities and on county level regarding climate risks and climate adaptation. This knowledge gap raises significant concerns, as it implies that municipalities may be permitting development in areas prone to future hazards or in areas vulnerable to climate change. Moreover, a deficiency in comprehending the vulnerability of transportation infrastructure to climate-related future impacts has been identified at national level. Additionally, at the national level, there exists an information shortage regarding adaptation actions on national/ regional and local level (implementation and monitoring) and key sectoral challenges, hindering effective evaluation of the current state of climate change adaptation. Another finding corresponds to weak coordination efforts for climate change adaptation that have been noted nationally, emphasizing the need for improved collaboration and communication. Furthermore, the assessment highlights that a substantial number of municipalities (71%) are not adequately considering future climate conditions with a 50-year time horizon when conducting risk and vulnerability assessments, potentially overlooking the impact of climate hazards on existing and planned infrastructure and buildings which heightens the risk of not taking preventive measures. Lastly, the underutilization of regional climate profiles (Climate Profile) prepared by the Norwegian Climate Service Center in municipal planning processes has been identified as a significant challenge. The overall recommendation included that national authorities should be stronger in pinpointing on existing documents, frameworks and solutions for enhancing climate adaption (Riksrevisjonen 2022).

The **Meld. St. 26 (2022-2023) Klima i endring– sammen for et klimarobust samfunn** (Changing climate – together for a climate-robust society), presents a follow-up to the **Meld. St. 33 Klimatilpasning i Norge report** from 2012-2013 and is aimed at establishing a climate-robust

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environment in Norway. It focuses on creating an integrated and coordinated framework for climate adaptation efforts with an improved management system. The government aims to enhance climate considerations in risk and vulnerability assessments at local and regional levels, emphasizing the impacts on various sectors, such as food production, economy and business, health, cultural heritage, infrastructure and buildings as well as nature and ecosystems. The government plans to develop a national climate vulnerability assessment every four years, with the first scheduled for 2026, along with regular updates to adaptation policies. The second part of the report outlines the structure of the 2024-2028 national adaptation framework, emphasizing cross-sectoral measures, integrating climate change considerations into sectoral decision-making, expert committees, amendments to the Planning and Building Act for outlining minimum considerations that have to be included for vulnerability and climate change analysis, data and hydrological projections provision to municipalities, stronger focus on stormwater management, development of county-level risk and vulnerability assessments for both regional and local levels, improved natural hazard event notification, and tools for climate adaptation in fisheries and aquaculture, including mitigating ocean acidification (Det Koneglige Klima- og Miljødepartment 2023).

The 2021 **Klimarisiko i kommunene** report (Climate risks in municipalities) published by the Miljødirektoratet focuses on climate risks at the municipal level in Norway. The basis for this report stems from the Ministry of Climate and the Environment and the Ministry of Local Government and Modernization, which recognized the lack of a solid foundation for assessing how municipalities incorporate climate risk into their administrative processes. The report underscores the need for increased knowledge of municipalities on how they are exposed to climate risks and how they manage it. The Norwegian Environment Agency was tasked with reviewing and describing the nature of climate risks faced by municipalities, the current state of climate risk description, and an assessment of municipalities' competence and efforts in addressing climate risk. Municipalities play a crucial role as both authorities and owners/operators, particularly in managing physical risks associated with climate change. This includes considering climate change implications in spatial planning and maintaining municipal buildings and infrastructure. For instance, municipalities must assess the suitability of future building locations in light of flood and landslide risks, rising sea levels, and ensure that drainage networks can withstand more frequent and intense rainfall events. Climate risk assessment is relevant across various planning levels but is especially critical in the overall municipal plan to guide underlying plans effectively. The report provides municipalities with suitable tools and guidelines for assessing and addressing climate risks. It highlights relevant data sources, climate profiles of counties, and other data and it showcases best practice examples on reducing vulnerability and exposure levels (Miljø-Direktoratet 2021).

There are additionally several other guidelines on sea-level rise and municipal planning that this needs assessment will not go into detail that could however be important for further project activities (Simpson et al. 2015; Direktoratet for samfunnssikkerhet of beredskap (DSB) 2016). A central document is the **Integrating Sea Level Rise and Storm Surges in Local Planning guidance**,

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which provides guidance on planning and building infrastructure in sea-level-rise-prone areas, advising municipalities on strategies to minimize exposure risk, including redirecting construction areas. It also outlines assessment methods for existing infrastructure, and on how to utilise the Risk and Vulnerability Assessment described in the Civil Protection Act (Norwegian Directorate for Civil Protection 2017).

Overview of relevant policy documents at regional level

On a regional level, as mentioned above, only documents for Nordland were identified, no dedicated strategy was identified for Vesterålen.

The **Regional plan for klima og miljø - Grønn omstilling i Nordland** (Nordland regional plan for climate and the environment) 2022 serves as a crucial link between state, municipal, and regional authorities, with Nordland County Council taking responsibility for aligning national goals and guidelines within a regional and local setting. This strategic plan aims to enhance regional climate and environmental efforts while promoting a collaborative and comprehensive approach involving municipalities, the county council, the state, regional authorities, businesses, and voluntary organizations. The plan sets forth clear goals, subgoals, and strategies, with the primary objective being the readiness of Nordland's municipalities to adapt, manage climate risks, and capitalize on opportunities arising from climate change. Subgoals encompass regional cooperation for conserving natural diversity, promoting holistic climate action, and enhancing regional collaboration. Another subgoal focuses on knowledge and innovation, emphasizing locally relevant knowledge and preventive measures. Furthermore, the plan highlights the role of regional spatial planning in mitigating financial damages caused by flood, erosion, and landslides, with support from the building act. Nature-based solutions take precedence in the plan's approach to environmental challenges and climate resilience (Nordland Fylkeskommune 2022b).

The **Handlingsprogram 2022/2023** (Action Plan), derived from the Nordland Regional Plan for Climate and Environment, shares the primary goal of enabling Nordland to adapt effectively to climate change and manage climate risks. It includes three parts of which the last is dedicated to climate adaptation. Municipalities are encouraged to participate in regional conferences and meetings on municipal planning such as the Klimapartnere Nordland forum. Key actions include renewing regional cooperation assessing and potentially implementing advice from the Directorate for Cultural Heritage's climate strategy, and promoting the UN decade for nature restoration. The plan emphasizes the importance of generating local knowledge through vulnerability analysis and a broader focus on climate adaptation in relevant areas. It additionally includes a catalogue with indicators for monitoring and evaluating progress of adaptation in Nordland. These include the age of municipal plans, climate-related claim payments, grant applications for climate adaptation, and

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the presence of planning and climate networks. Additionally, the plan mandates to include climate risks in the risk and vulnerability analyses for new infrastructure projects in communities to enhance preparedness (Nordland Fylkeskommune 2022a).

On a regional level (both Nordland and Vesterålen) a dedicated adaptation plan or adaptation action plan with detailed measures exists, however rather superficial in its nature. The Nordland Action Plan. The measures identified are rather on a strategic level not directed towards a climate risk. A clear link between measures identified and identified climate risks and impact chains is thus missing. It identified focus areas like participation in events, following up on ongoing projects and including recommendations in municipal guidance documents. A major aspect is the development of a vulnerability analysis for Nordland as a dedicated action area. In addition, within the strategic document, a focus on nature-based solutions was given, which is however so far not reflected in the Action Plan. Overall, measures appear rather incremental than systemic.

Generally, though not per action, indicators were elaborated that are intended to measure progress on adaptation:

- Age of municipal plans
- Claim payments linked to natural events
- Number of applications for the grant scheme for climate adaptation
- Number of regions with planning and climate networks.
- Number of applications for the grant scheme for climate adaptation

The identified measures do not touch upon vulnerable groups or gender and are not developed with a focus on social equity. These are aspects that should be taken up in future updates of the documents, to ensure that measures are targeted towards population groups that have fewer adaptive capacity and a higher sensitivity compared to other groups. Groups that were identified vulnerable in Vesterålen are communities located at the coast with low adaptive capacity, fishermen and people working for fish farms, as through changes in ocean temperature, migration patterns might change and thus fish stock might decrease. Additionally, indigenous communities are vulnerable population groups, as their dependencies on natural resources, such as reindeer herding and fishing is threatened by climate change impacts. Lastly, elderly people and children are a vulnerable group, being more sensitive to changes in temperature and to extreme events.

3.4.2.3.2 Planned adaptation measures within RESIST

The planning of measures within RESIST is ongoing, and within the first three quarters of the project, some activities have already been implemented. The adaptation measures within RESIST are of a different nature and follow the goal of enhancing climate resilience towards sea level rise, ocean acidification and ocean warming. The tasks can be grouped in four different aspects:

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- **Model and map.** Setup of the GaiaVesterålen platform with AR and VR technology and real-time 3-D modelling and mapping of sea level rise, climate change impacts (such as algae blooming, effects on fish) on coasts and exposed elements under different climate scenarios in Vesterålen and Lofoten; showcasing of direct effects that climate drivers have as well as showing possible solutions, such as displaying and mapping Andfjords technology; the goal is to showcase the fishing and aquaculture industry, industry at the shore, as well as coastal population and public planning offices the impact of climate change on the coast
- **Inform and assess.** Development of a Regional Risk and Vulnerability Assessment together with a Regional plan for adaptation and a toolbox for urban planners
- **Communicate and collaborate.** Organisation of the GAIA Vesterålen summit; Expert Network development and consolidation of the structures to support decision-making in the future; Setup of environmental contracts with households and businesses for climate resilient actions through a WebApp; stakeholder workshops for the development of the GaiaVesterålen platform with AR and VR technology with youth, fisheries, aquaculture industries etc.
- **Nature-based Solutions.** Andfjord Salmon intends to recycle bio waste from salmon production for biogas and other products

To move forward with understanding the perceptions of climate change, climate risks and the understanding of climate adaptation of the local population, GaiaVesterålen has developed and executed a citizen survey. Results have not been available fully yet at the point of writing the report, these will be taken up in the update in December.

Additionally, GaiaVesterålen and Vesterålen Regional Council have started implementing the environmental contract with support of the WebApp with 30 pilot families in the region to test the App and understand how support to the families and, at one point, businesses can be enhanced. With that, youth and children are also engaged in measures.

Challenges

A main obstacle is the lack of a climate risk assessment in the region. Many stakeholders are aware of climate risks in the region, however a clear and concise document outlining the most important impact chains is so far lacking. The region thus requires assistance for creating a comprehensive climate risk assessment and action plan in collaboration with municipalities and the Vesterålen Regional Council. Within this action plan, RESIST can play a vital role in identifying adaptation measures tailored to the region, especially those based on NbS.

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Another challenge is concerned with the change of administration based on elections that is currently underway, Vesterålen will have a new board within the next months. Once this is settled, the involvement of local planners and decision-makers will continue.

The proposed model and mapping approach show significant promise in enhancing climate change awareness, and facilitating the simulation of existing solutions. By employing the interactive map and model, it becomes possible to not only raise awareness about climate change but also to simulate and assess solutions. While the technical details and capacities necessary for developing these maps and models are clear, they require further organization and the clear assignment of roles and responsibilities among the participating organizations. This need for a more defined framework has been emphasized by a partner, highlighting the importance of expertise in modelling and access to relevant data. Careful organization and allocation of these resources are essential for project success. Additionally, the main challenges revolve around obtaining enough expertise to create high-quality 3D visualizations and augmented reality (AR) and in adapting and converting data in a way that is accessible for the map system. The technology is relatively new, and there is no consensus among mobile manufacturers regarding a standard for displaying AR on mobile devices. Consequently, the primary focus is on developing a tool that can display 3D content in a uniform format. This way, users will not need to install various mobile apps to view content on their devices.

Identifying vulnerable population groups is essential. While Vesterålen has made progress in this area, further refinement is necessary within a climate risk assessment or a separate assessment. This refinement will provide a clearer understanding of the sensitivities and adaptive capacities of these groups to key climate risks. Additionally, RESIST can ensure that vulnerable groups and gender considerations are integrated into existing and planned measures to promote social benefits, equity, and acceptance of these measures.

Maladaptation has not been adequately considered so far, with a primary focus on communication and data-related actions. RESIST can provide support in facilitating a maladaptation screening to avoid adaptation measures unintendedly leading to unplanned or even harming outcomes, thus increasing vulnerability.

3.4.2.4 Stakeholders and capacities

An overview of the project partners in Vesterålen can be found in Table 10. The primary objective of the RESIST Vesterålen project is to engage the local population in building climate resilience. Various activities, as mentioned earlier, are being carried out to raise awareness and involve young individuals and families specifically. Initial survey results were presented during the interview, indicating that the public is relatively uninformed about climate change risks and adaptation. The citizen survey serves as the first step in engaging the public and stakeholders. It will guide the customization of further actions based on the results. Given that some stakeholders demonstrated

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a lack of interest or knowledge about climate change, it is crucial for RESIST to take measures to reach these population groups through their activities and initiate communication with them. Addressing opposing interests, the survey results highlighted a certain degree of disinterest and scepticism regarding climate change and adaptation. Therefore, it is crucial to leverage these survey results to develop communication campaigns, offer information, and organize easily accessible events at the Gaia Museum. These efforts aim to enhance understanding of the importance of climate action and ensure that the interests and needs of the community are acknowledged and heard. Additionally, these initiatives will emphasize the urgency and necessity of taking adaptation measures in Vesterålen, particularly considering the severe implications of sea-level rise for some communities.

Furthermore, RESIST involves public planners, who are accessible through a professional network that is planned to be formalized and equipped with advisory authority in public administration and decision-making processes. This becomes particularly important when developing a climate risk assessment for Vesterålen, as this group can play a pivotal role in shaping the content and process.

Another significant stakeholder group that certain activities target comprises local companies, including those in the fisheries and aquaculture industries and agriculture. By utilizing the GaiaVesterålen platform with AR and virtual reality (VR) technology, the industry can obtain a visual overview of algae bloom locations and visualize the effects of rising sea temperatures on different fish species due to climate change. To get them engaged and informed of the opportunity, workshops and dialogue events can be of importance. Additionally, these companies will participate in trials and at a later stage in the implementation related to environmental contracts, meaning that the project's goal is to involve these stakeholders in contributing with voluntary environmental actions, such as recycling, to climate resilience in Vesterålen.

Table 10: Project partners in Vesterålen.

Organi-sation	Type	Website	Location	Short description	Involvement/Importance for RESIST	Contact
Andfjord Salmon	Seafood company, Salmon farming on land	https://www.andfjordsalmon.com/en/	Andøya og Sortland	Andfjords goal is to build the world's most environmentally friendly and fish-friendly aquaculture facility.	Is involved in research and development of a digital twin. The aim is to be able to show technological solutions and ocean models for the seafood industry and other companies in the region.	Stig H. Pettersen
SINTEF	Academia research organisation	https://www.sintef.no/en/	OSLO	SINTEF is one of Europe's largest independent research organisations.	Is involved in the development of GAIA-tech and the digital twin for the region. The GAIA model. (Vesterålen)	Konstantinos Boletsis Jan Håvard Skjetne

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Museum Nord Gaia Vesterålen	Museum and research organisation	https://www.museumnord.no	Melbu/ Sortland	Museum Nord is a non-profit, government-supported organisation within the national museum network,	Is involved in developing the digital twin for the region. Develops web tools to be able to display narratives on the GaiaModel, and on digital 3D maps. Develops AR and 3D visualizations.	Ane Høyem John Håkon Pettersen
Vesterålsrådet (Vesterålen regionråd)	Public administration	https://vestreg.no/	Sortland Vesterålen	Vesterålsrådet is an inter-municipal political council for the municipalities of Andøy, Bø, Hadsel, Sortland and Øksnes.		

3.4.2.5 Potentials for transfer

The following aspect can be of interest for other regions to learn from Vesterålen:

- **Digital mapping with interactive VR technology.** Exploring digital mapping and interactive VR technology to visually convey climate change risks to industry, agriculture, public planning and the general public is an interesting approach that, if it proves successful, it may demonstrate the potential benefits of adopting similar technology in other regions.

The following aspects can be of interest for Vesterålen to exchange with other regions from RESIST:

- **Knowledge exchange on stakeholder involvement.** Sharing insights and experiences with other regions to improve the engagement of stakeholders in climate adaptation efforts can be interesting for Vesterålen. Specifically, with regions facing similar risks and that take innovative approaches to strengthen the engagement of both civil society and the industry as well as the agricultural sector. In this context, Vesterålen should also explore strategies and involvement processes from other regions to ensure that adaptation measures are inclusive and address the specific needs and vulnerabilities of marginalized or vulnerable population groups.
- **Exchange on best practices for developing climate risk assessments with LSDs.** For Vesterålen it can be very beneficial to exchange with other regions from RESIST on developing sound and thorough climate risk assessments, how to best structure it and how

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to involve stakeholders. This way Vesterålen can potentially avoid pitfalls that other regions faced when developing the assessments.

- **Successfully mainstreaming Climate Risk Assessments and getting stakeholders to use the information.** Learning from regions that have successfully integrated climate risk assessments into decision-making processes and engaging stakeholders effectively to ensure that the valuable information is put to practical use, both in the public and private sectors.
- **Exchange on adaptation measures with regions also facing sea-level rise, such as Normandy.** Collaborating with sea-level rise-affected regions like Normandy to exchange ideas and experiences regarding effective adaptation measures and strategies.

3.4.2.6 Results

The following aspects are to be named regarding the overall results of the analysis:

- **Developing a climate risk assessment for Vesterålen** holds paramount importance, as it enables the understanding of specific risks and establishes clear impact chains upon which adaptation measures can be constructed.
- **adelphi can provide valuable support** by advising on best practice standards for creating a climate risk assessment in line with current international standards and guidelines. Additionally, adelphi can facilitate knowledge exchange with other regions on the development and utilization of climate risk assessments in the Vesterålen region.
- **Developing an adaptation plan** grounded in the climate risk assessment, with a strong emphasis on transformative adaptation, and a dedicated area that considers sectoral adaptation measures is essential for effective climate resilience.
- **Ensuring the active participation of vulnerable groups** both in activities as well as in developing strategies and plans is vital to guarantee an inclusive and equitable adaptation process.
- **Further assistance** is essential for the development of a visual and interactive platform, particularly regarding the integration of data and maps into the interactive tool using VR and AR technology by the organizations involved.

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4 Results

4.1 Summary of results

The climate risk assessments in the twinning regions show a very mixed picture. While some regions do not yet have such analyses or the currently available assessments were performed more than a decade ago and are thus outdated, other regions can rely on robust and detailed climate risk assessments, providing a solid foundation for adaptation planning. In the latter category, assessments could still be improved by clearly defining an underlying risk framework that explicitly distinguishes between vulnerability, exposure, and hazard; and in some cases, also by considering a larger variety of potential hazards and impacts.

In most regions, planning of adaptation measures is still in its early stages. Nevertheless, some key needs and avenues for support can already be identified that are emerging in several regions: designing and coordinating stakeholder engagement processes in an inclusive and collaborative way, knowledge-sharing and capacity-building concerning NbS and CBA, and tapping the potential of transformative adaptation. Additionally, some regions are also interested in innovative financing and developing strategies to engage the private sector, as well as establishing and advancing early warning and forecasting systems and utilisation of data and modelling tools for innovative land management. Addressing these challenges at an early planning state creates great leeway for designing innovative solutions for climate resilience.

Many of the identified financial and institutional capacity constraints in the twinning regions are similar to the ones determined for the four large-scale demonstrator regions, including the presence of varying and sometimes interfering responsibilities on the national to local level, the lack of an adequate governance and policy background to enable transformative adaptation, and, in some regions, limited public and private funding. All regions can thus benefit from the transfer of adaptation solutions within RESIST both in terms of knowledge sharing and peer-to-peer learning in concrete practical questions, such as exploring the variety of potential NbS, performing cost-benefit analyses and convincing opposed stakeholders. But similarly in exchanging ideas and strategies on how to overcome structural barriers to transformative adaptation and create more systemic solutions.

4.2 Looking ahead

The needs assessments for the twinning regions give a comprehensive overview of the challenges these regions are facing in realising effective climate change adaptation activities. The process also highlighted that the regions differ in the information about climate risks and planned adaptation

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measures that is already available and the aspects of the adaptation process for which support from horizontal partners is required.

On the basis of this first overview, adelphi will perform an update and review of the needs assessment until the end of December 2023. In this process, a prioritisation of identified needs and challenges will be performed in collaboration with regional partners. The aim of this is to determine which challenges or needs have the biggest influence on the work of the regional partners or which are the biggest barriers to successful adaptation. In this way, adelphi will identify which needs are most pressing to address within the RESIST project in order to enable regional partners to achieve their goals and implement their planned projects. In addition, it will be assessed which of the identified needs that go beyond the immediate activities planned by the regions can be addressed by support from horizontal partners in RESIST.

In addition, this deliverable, together with the needs assessment for the four large-scale demonstrator regions, will provide an important basis for identifying relevant transfer opportunities between the regions and explore the full potential of the digital technologies developed in WP 1, e.g. the Graphical Digital Twin.

Any questions that remained open during this first analysis will be looked at in more detail. In cases where new information has become available this will be integrated in the update process. All of this will lay the foundation for the next steps of the project and point towards possible angles for developing innovative solutions for climate change adaptation.

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Annex A: Questionnaire for needs assessment

WP1: Needs assessment and status quo analysis.

A COLLABORATIVE NEEDS ASSESSMENT TO SUPPORT THE REGIONS

The Questionnaire below is part of the needs assessment and status quo analysis, which forms the basis for RESIST transversal project partners, to tailor their services and support in developing innovative solutions with your Region.

The Questionnaire has been co-created by WP1 task-leaders in very close relation with WP3 leader ERRIN, to ensure that you, as an LSD or Twinning Region, are asked for information in a coordinated and efficient manner.

A series of interviews will be held in May and co-organized with your LSD leads and coordinators, ensuring that we have collected the key information and references from the right contacts, informing us of a clear picture of your needs; the goal is to provide you with the best qualitative support and services.

HOW TO WORK WITH THE NEEDS ASSESSMENT:

First of all, we encourage the regional ecosystem to **collaborate and to prepare their answer together**.

This is an initial questionnaire, to share the information available in your region. Not all questions are mandatory but based on the availability of information. Regional authorities are a good starting point for information gathering, if not, they can point in the right direction of the person responsible.

It is not necessary to process and edit all information, please share the documents with their source. Please share all documents, including those that may have been shared previous, such as the climate risk assessments or existing adaptation plans and strategies. Any additional and detailed information you can give us will be much appreciated.

Documentation does not have to be in English, feel free to add it and we will use a digital tool for translation.

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Once we have the information, the different partners in WP1 will process it to determine the baseline and status quo of regions' climate change adaptation activities. We will analyse how planned adaptation measures that effectively address climate risks have already been implemented. Based on an initial analysis we will prepare bilateral dialogues with each region to discuss findings.

We thank you in advance for the hard work and your effort into this process 😊

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QUESTIONNAIRE

POLICY, PLANS & IMPLEMENTATION

- Documentation and results of **performed climate risk assessments** (frontrunner regions should have completed CRAs);
  - with information on the most pressing climate impacts; hotspot areas; critical infrastructure
  - Who are the groups/actors that are particularly vulnerable to the impacts of climate change in the region?

- Key documents describing strategy, policy and measures already implemented on adaptation for the region*
  - adaptation strategies, adaptation plans, etc. - ideally with a level of detail which includes descriptions of whether it is politically approved/legally binding; on planned measures, key actors, whether finance has already been secured/approved, and timelines
  - Monitoring reports or evaluations of adaptation actions at the regional or municipal level
  - Existing or planned political commitments related to climate adaptation, including through membership to dedicated agreements/covenant networks
  - Existing NbS**

- Information about planned adaptation measures at the regional level (both within and outside of the RESIST project)
  - What is planned?
  - Who is involved?
  - What are the main obstacles/ challenges? What are the key opportunities/levels in the hand of the region? e.g. Competency for spatial planning regulation, Cohesion Fund managing authority, etc.
  - What is the NbS** that are planned?

- If available: overview of regional, national, or any other relevant:
  - Regulations /laws
  - Subsidy or incentive programs
  - Plans and strategies that impact the respective region with regard to CC adaptation

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Feel free to emphasize where the transversal partners could support on policy, plan and implementation.

DATA, KNOWLEDGE MANAGEMENT and TOOLS

- Overview of **existing digital tools / services to evaluate CC risks and potential adaptation measures**. Please include a brief description of your experience and level of satisfaction with these tools.
  - Examples are, but not limited to:
    - Software tools (e.g. Remote Sensing tools),
    - Modelling tools (e.g. to map flood risks),
    - Data analytics tools,
    - Algorithms (e.g. for AI/ML/DL), etc.
  - Tools developed at the national / European level or by international organizations, as long as they are known and used by the regions
- Overview of available knowledge, process, and method resources used to make decisions with CCA.
  - either used by the region authorities themselves,
  - or publicly available resources targeting actors from specific sectors or the general public
- Please **describe and share examples of the existing data** connected to CCA, adding any links, screenshots or any other means to describe the data
  - Examples are, but not limited to:
    - geospatial data (Digital Terrain Model);
    - water courses,
    - hydrographic network,
    - underground water table;
    - statistical data; population data (numbers, distribution);
    - meteorological information,
    - location of Nature Based Solutions; etc.
- Describe how the data are collected, stored, processed and presented

Feel free to emphasize where the transversal partners could support on data, knowledge management and tools

COMMUNITY ENGAGEMENT

- Information about important stakeholders:

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- Stakeholders that are involved in existing or planned adaptation activities
- Stakeholders that are very knowledgeable about the regional CC challenges
- Policy/government/agency actors on all levels that shape the context of the regional CC adaptation
- NGOs (or other initiatives) which are active in the field of CC in the region
- Other key actors that play an important (positive or negative) role in the regional context

Organization name	Type***	Website	Location	Short description	Involvement/Importance for RESIST	Contact
Example Stakeholder	*Academia*	*www.example.com*	*City in your region (or beyond)*	*Innovative SME that has done research on NBS in the context of our regional challenge*	*To be involved in the pilot for …* *OR* *Not directly involved but still important because...*	*Name of the project partner who can help establish a contact*

***Type:** Selection of fixed Categories: 1) Academia, universities, higher education system, 2) Industry, firms, economic system, 3) State, government, political system, 4) media and cultural NGOs and civil society 5) Environment/natural protection NGOs and civil society.

Feel free to emphasize where the transversal partners could support on community engagement.

FUNDING and FINANCING

- Information on **funding options / financing strategies** for adaptation measures
  - How were past adaptation measures financed?
  - How are planned adaptation measures financed?
  - If possible: Overview of available financial resources for further adaptation measures

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- Have innovative / blended finance strategies (e.g. with the private sector) explored?

Feel free to emphasize where the transversal partners could support on funding and financing

GENDER FRAMEWORK

Please note that every organization have to fill-up the gender framework information individually.

You have declared in the Form A at proposal preparation stage whether you have a Gender Equality Plan (GEP). Has this changed since? Provide answers in yes or no.

If you have a GEP (either declared at proposal stage or prepared since), please provide the link to it. If it is an intranet link, please share the document.

If you do not have a GEP, do you have any diversity / inclusion-related policy/certification in place at your organization? Please specify the name (in English) if a certification. Or, provide a summary of the policy or the document.

Feel free to emphasize where the transversal partners could support on genders framework

OTHER

Feel free to share any other inputs, questions or remarks that you feel are necessary to support this process

Note:

**For the steps already taken by the Region in terms of adaptation policy, A reference can be the urban adaptation support tool that will be adapted to Regions through the Mission platform:*
1 Preparing the ground for adaptation
2 Assessing climate change risks and vulnerabilities
3 Identifying adaptation options
4 Assessing and selecting adaptation options
5 Implementing adaptation
6 Monitoring and evaluating adaptation

*** Please use EC definition of NbS: Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions."*

Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.

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Annex B: Information about virtual interview sessions

Overview of most important information

- Virtual meeting with the main partners of the LSD regions
- One session is scheduled for each LSD, lasting two hours
- The sessions will be organized and led by adelphi
- Each session will be recorded
- Interested partners are welcome to join

Purpose of these sessions

- One session is scheduled for each LSD, lasting two hours
- Clarify questions that adelphi and KU Leuven have after reviewing the material for the needs assessment and status quo analysis
- Collect more detailed information regarding the questions from the needs assessment
- Collect opinions and estimation of the regional partners on identified issues, challenges, gaps and needs
- Gather supplementary information that cannot be derived from documents → expert opinions

Tentative agenda

- Welcome and brief introduction of purpose of the meeting (5 min)
- Explain purpose of needs assessments and status quo analysis (5 min)
- Presentation of work done by adelphi and KU Leuven as part of Task 1.1 and 1.3 (10 min)
- Presentation of initial results of analysis until now (15 min)
- Discussion of interim results, following guiding questions (30 min)
- Discussion based on guiding questions (60 min)

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Initial list of guiding questions

- According to your expertise, which issues, needs and gaps that we identified so far (according to interim results) are valid? Do you see further adaptation needs and gaps in your region? How would you prioritize the identified needs?
- What are the anticipated effects of the adaptation actions planned within RESIST? i.e. What do you hope to achieve with what has been planned / What are your goals? To which extent can these goals be achieved with what has been planned in RESIST?
- What obstacles to further, more systemic action can be identified (funding, qualified personnel, institutional inertia, lack of awareness for the need for adaptation)? Systemic action here is (but not only) an approach that involves many streams of data, tools and technologies, a diversity of stakeholders, a clearly defined and adjustable strategy as well as regular communication.
- Do you see any major data or information gap to be able to implement, monitor and evaluate CCA measures / solutions? If so, what data / information is currently missing?
- Who are the main stakeholders opposing adaptation measures? What are their interests? Which of their interests could be used to convince them?
- Who are relevant stakeholders that could support the process as partners?
- Are gender aspects being considered in the design of adaptation measures? If yes, what are those aspects? How are vulnerable population groups considered?
- Are you aware of initiatives taken in other regions in your country or in other countries? If yes, are you in contact with them and should we involve them in the RESIST project? Which regions are you thinking about?
- Based on the information about the main challenges you are facing, how could adelphi and KU Leuven support the design and implementation of adaptation measures? What type of support are you hoping for, for which steps in your process and when will this support be useful?

Examples of support adelphi can provide:

- Integrating the consideration of gender aspects in the design of adaptation measures
- Integrating the consideration of particularly vulnerable population groups and their needs
- Integrating the consideration of cross-border and cascading risks, cross-sectoral interactions, complex and compound risks
- Ensuring the design of solutions in a way that avoids maladaptation
- Identifying possible funding opportunities or value-capture mechanisms
- Communicating with and convincing stakeholders that might be opposed

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Examples of support KU Leuven can provide:

- Identifying similar practices and initiatives in other regions of Europe
- Providing a mechanism to compare CCA initiatives in different regions in Europe
- Provide a platform to access all relevant information on CCA actions, the data and tools used through an easy to use interface

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RESIST

Annex C: ESPON-CLIMATE: Data sources

Impact chain	Indicators (hazards)	Data Source	Data calculation
Heat stress on population	Annual mean temperature (°C)	Copernicus Climate Data Store	**Mean value of daily mean temperature over 10 days;** aggregated at annual level by averaging all 10-day periods. Second, these annual values were averaged for the baseline (1981-2010) and future periods (2071-2100)
Droughts on primary sector	Annual mean precipitation (mm)	Copernicus Climate Data Store	**Sum value of daily precipitation sum over 10 days**; 10-day accumulated precipitations were summed annually and then aver-aged for the baseline and future period, resulting in four annual mean precipitations values per NUTS3 region
Droughts on primary sector	Consecutive dry days (days/year)	Copernicus Climate Data Store	**Longest period of consecutive days when daily precipitation sum < 1 mm in each trimester**; maximum number of consecutive dry days among the four trimesters that belong to each specific year was selected. Then, these annual maxima were averaged for the baseline and future period, resulting in four annual maximum consecutive dry days values per NUTS3 region
Flash Floods on cultural centres	Very heavy rainfall days (days/year)	Copernicus Climate Data Store	**Number of days per 10 days when daily precipitation sum > 20 mm**; Annual number of very heavy precipitation days was obtained by summing all 10-day periods. Then, these annual values were averaged for the baseline and future period; the higher the number of very heavy rainfall days, the higher the hazard;
Heat stress on population	Summer days (days/year)	Copernicus Climate Data Store	**Number of days per 10 days when the daily maximum temperature > XºC.** X refers to the different thresholds that are provided by the agroclimatic indicators dataset: 20ºC, 25ºC, 30ºC, and 35ºC; annual number of summer

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			days was obtained by summing all 10-day periods. Then, these annual values were averaged for the baseline and future period, resulting in four annual summer days values per NUTS3 region
Heat stress on population	Tropical nights (days/year)	Copernicus Climate Data Store	**Number of days per 10 days that have a daily minimum temperature > 20°C,** it is accounted as a tropical night; for aggregation: annual ∑ of 10 day periods; then that value was averaged for the baseline and future periods
River flood on population River flood on infrastructure, industry and service sector	River flooding frequency (return period in years)	PESETA IV River floods	**Changes in frequency of the current 100 years river flood event** under different climate change scenarios; PESETA IV Model indicator was the change in frequency of the 100-year return period event of the reference period, weighted average of a grid cell (5x5km) was aggregated for NUTS3 , the weight was set by the proportion of flooded areas inside each grid cell;
Coastal flood on infrastructure, industry and service sectors	Coastal flooding frequency (return period in years)	PESETA IV Coastal floods	**Extreme Sea Levels** (ESL) for coastlines, baseline is 100-year return period; future return periods based on ESL values of (5-,10-,20-,50-,100-,200-,500-,4000- year return period)
Wildfire on environment	Days with fire danger (days/year)	Copernicus Climate Data Store	Based on **Canadian Fire Weather Index System**: combination of responses of soil moisture to atmospheric forcing at different soil depths; input on a daily basis is air temperature, relative humidity, wind speed and daily accumulated precipitation data (from EU Cordex; downscaled GCMs); fire danger index is classified in moderate, high, very high

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Annex D: ESPON-CLIMATE: Framework of Impact Chains

Indicators / Impact chain	Hazard Indicators	Exposure Indicators	Vulnerability	
			Sensitivity	**Adaptive Capacity**
Heat stress on population	• Annual mean temperature (°C) • Number of Summer days, Number of Tropical Nights	• Population	• Age dependency	Social capacity • investment in education • persons with tertiary education • risk perception • social capital • gender equality index Infrastructure capacity • medical doctors
Droughts on primary sector	• Annual mean precipitation (mm) • Consecutive dry days (days/year)	• Agricultural area • forested area • mixed area	• Primary sector employment • primary sector GVA • share of irrigable and irrigated areas in utilised agricultural area	

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Flash Floods on cultural centres	• Very heavy rainfall days (days/year)	• Museums • world heritage sites	• Touristic arrivals	• hospital beds • settlement compactness Technological capacity • research staff • patent applications • research and development investments Economic capacity • employment rate • risk of poverty • regional GDP • national GDP • Institutional capacity • national adaptation strategies • regional quality of gov. Index
River flood on population	• River flooding frequency (return period in years)	• population	• Young-age dependency • old-age dependency • disabled with need for assistance	
River flood on infrastructure, industry and service sector	• River flooding frequency (return period in years)	• Roads • Railways • Railway station • Airports • Harbours • Settlements • industrial areas • thermal power plants • Refineries • educational facilities	• Industrial service sector employment • Industrial service sector GVA	

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Coastal flood on infrastructure, industry and service sectors	• Coastal flooding frequency (return period in years)	• Roads • Railways • Railway station • Airports • Harbours • Settlements • Industrial areas • Thermal power plants • Refineries	• Industrial service sector employment • Industrial service sector GVA	• municipalities signatories of the covenant of mayors
Wildfire on environment	• Days with fire danger (days/year)	• Protected areas • Forested area		

For calculating climate risk, the following formula is used:

$$Risk_t = Hazard_t^{1/3} \cdot Exposure_t^{1/3} \cdot Vulnerability_t^{1/3}$$

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An example for such an impact chain and its composition is shown below for “Heat on population”:

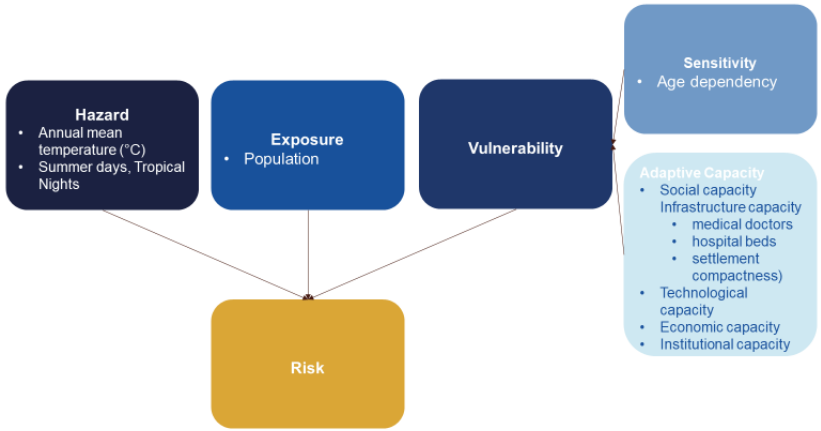

Figure 16: Impact Chain for "Heat on population" based on (Navarro et al. 2022).

The hazard is composed of the annual mean temperature and the number of summer days and the number of tropical nights. It is then combined with the exposed population in the region. The vulnerability component considers the sensitivity of the population, which is described by age dependency, as well as the adaptive capacity, which includes various capacities to adapt to the hazard. As an example, the infrastructure capacity includes indicators such as the number of medical doctors, the number of hospital beds, and settlement compactness.

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5 Bibliography

Agencia Portuguesa Do Ambiente 2015: ENAAC: Estratégia Nacional de Adaptação às Alterações Climáticas.

Assemblé nationale 2015: LOI n° 2015-991 du 7 août 2015 portant nouvelle organisation territoriale de la République (1).

Avotniece, Zanita; Svetlana Aniskevich and Edgars Malinovskis 2017: Climate Change Scenarios for Latvia. Report summary.

Bastos Martín, M.; J. Alberto Domínguez; D. López Piñero; E. Redondo Luengo; F. Corzo Pantoja and F. Gonzalez Iglesias 2014: Estrategia de Cambio Climático de Extremadura 2013-2020. Adaptación y Mitigación.

Blekinge County Board 2012: Blekinge län - Översiktlig Klimat- och sårbarhetsanalys.

CDP S.p.A 2021: L'ECONOMIA PUGLIESE: le 5 eccellenze da cui ripartire. Retrieved 26 Aug 2023, from https://www.cdp.it/sitointernet/page/en/the_apulian_economy__5_areas_of_excellences_for_the_restart?contentId=TNK35370.

Cicero and Vestlandforsking 2018: Oppdatering av kunnskap om konsekvenser av klimaendringer i Norge. REPORT 2018:14.

Consejería para la Transición Ecológica y Sostenibilidad 2021: Plan Extremeño Integrado de Energía y Clima (PEIEC) 2021-2030.

Corzo Pantoja, F.; M. Bastos Martín; J. Alberto Domínguez and F. Gonzalez Iglesias 2011a: Plan de Adaptación al Cambio Climático de Extremadura. Turismo.

Corzo Pantoja, F.; M. Bastos Martín and J. A. Domínguez 2011b: Plan de Adaptación al Cambio Climático del sector de la Energía en Extremadura.

Corzo Pantoja, F.; M. Bastos Martín; J. A. Domínguez and F. G. Iglesias 2011c: Plan de Adaptación al Cambio Climático del sector recursos hídricos en Extremadura.

Det Koneglige Klima- og Miljødepartment 2023: Meld. St. 26 (2022-2023) Melding til Stortinget. Klima i endring – sammen for et klimarobust samfunn.

Det Koneglige Miljødepartment 2013: Meld. St. 33 (2012–2013) Melding til Stortinget. Klimatilpasning i Norge.

Direktoratet for samfunnssikkerhet of beredskap (DSB) 2016: Havnivåstigning og stormflo. samfunnssikkerhet i kommunal planlegging.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Direktoratet for samfunnssikkerhet og beredskap 2016: Havnivåstigning og stormflo. – samfunnssikkerhet i kommunal planlegging.

dRural 03.04.2023: Spain. Extremadura. Retrieved 21 Jul 2023, from https://drural.eu/regions/extremadura/.

Ekodoma 2020: Saldus novada Ilgtspējīgas Enerģētikas un Klimata Rīcības plānu 2020.-2030.gadam.

Elferchichi, Abderraouf; Giuseppina Giorgio; Nicola Lamaddalena; Maria Ragosta and Vito Telesca 2017: Variability of Temperature and Its Impact on Reference Evapotranspiration: The Test Case of the Apulia Region (Southern Italy). In: Sustainability 9:12, p 2337.

Envirometrics 2022: Regional Climate Change Adaptation Plan. Region of Eastern Macedonia and Thrace.

European Commission 2021: Commission Delegated Regulation (EU) 2021/2178 of 6 July 2021.

GFDRR 2023: Think Hazard - Puglia - Wildfire. Retrieved 29 Aug 2023, from https://thinkhazard.org/en/report/1628-italy-puglia/WF.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020a: Biodiversité. Continentale et Marine.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020b: Changement climatique et aléas météorologiques.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020c: L'éau. Disponibilité, qualité, risques naturels.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020d: Pêche et conchyliculture.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020e: Qualité de l'air.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020f: Risques sanitaires émergents et enjeux territoriaux en Normandie.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020g: Sol, Agronomie et Agriculture.

Groupe Interdisciplinaire sur l'Evolution du Climat (GIEC) Normand 2020h: Systèmes côtiers. Risques naturels et restauration des écosystèmes.

Hanssen-Bauer; I.; E. J. Førland; I. Haddeland; H. Hisdal; D. Lawrence; S. Mayer; A. Nesje and J.E.Ø. Nilsen 2017: Climate in Norway 2100. - a knowledge base for climate adaptation.

Institute for European Energy and Climate Policy (IEECP); European Federation of Agencies and Regions for Energy and Environment (FEDARENE); ICLEI Local Governments for Sustainability –

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

European Secretariat (ICLEI Europe); Resilient Cities Network (R-CITIES); F6S Network Limited (F6S); Associação para a Investigação e Desenvolvimento de Ciências (FC.ID); adelphi (adelphi); North-West Croatia Regional Energy Agency (REGEA) and Fresh thoughts Consulting (FT) 2023: The REGILIENCE self-assessment tool to spot risks of maladaptation. Retrieved 26 Jun 2023, from https://regilience.eu/self-assessment-tool-for-maladaptation/.

IPCC 2014: Climate change 2014.

IPCC 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability.

ISO 14091:2021 2021: Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment.

Jefatura del Estado 2022: Real Decreto-ley 15/2022, de 1 de agosto, por el que se adoptan medidas urgentes en materia de incendios forestales.

Junta de Extremadura 2006: Plan de Prevención de Incendios Forestales de Extremadura (Plan PREIFEX). Retrieved 04 Aug 2023, from http://extremambiente.juntaex.es/index.php?option=com_content&id=577&.

Junta de Extremadura 2010: Plan de Lucha contra Incendios Forestales de la Comunidad Autónoma de Extremadura (Plan INFOEX). Retrieved 04 Aug 2023, from https://www.infoex.info/planes/infoex/.

Junta de Extremadura 2011: Plan de Adaptación al Cambio Climático del sector Salud en Extremadura.

Junta de Extremadura 2017: Extremadura 2030. Estrategia de economía verde y circular. PLan de Acción de la Junta de Extremadura.

Kommunal- og distriktsdepartementet 2008: Statlige planretningslinjer for klima- og energiplanlegging og klimatilpasning.

Kourtis, Ioannis M.; Chrysaida-Aliki Papadopoulou; Maria P. Papadopoulou; Chrysi S. Laspidou and Vassilios A. Tsihrintzis 2022: A Multi-Criteria Analysis Framework for Assessment of Nature-Based Solutions (NBS). In: Proceedings of the 7th IAHR Europe Congress 39, 449-450.

Labianca, Marilena; Stefano de Rubertis; Angelo Belliggiano and Angelo Salento 2016: Innovation in rural development in Puglia, Italy: critical issues and potentialities starting from empirical evidence. In: Studies in Agricultural Economics 118:1, pp 38–46.

L'agence de l'Eau Seine-Normandie 2016: Stratégie d'adaptation au changement climatique du bassin Seine-Normandie.

Lager, Frida; Ingrid Coninx; Margaretha Breil; Inès Bakhtaoui; Anders Branth Pedersen; Kati Mattern; van den Berg; Eugenio Sini; Galluccio; Richard Klein and Kati Vierikko 2023: Just Resilience for Europe: Towards measuring justice in climate change adaptation: ETC CA.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Länsstyrelsen Blekinge 2019: Klimat- och energistrategi för Blekinge. Med sikte mot ett klimatneutralt Blekinge.

LCA4Regions Interreg Europe 2022: Bem-vindo ao Baixo Alentejo.

LEGMC 24.08.2023: Latvijas Vides, ģeoloģijas un meteoroloģijas centrs. Retrieved 22 Sep 2023, from https://videscentrs.lvgmc.lv/iebuvets/pludu-riska-informacijas-sistema.

Lionello, P.; L. Congedi; M. Reale; L. Scarascia and A. Tanzarella 2014: Sensitivity of typical Mediterranean crops to past and future evolution of seasonal temperature and precipitation in Apulia. In: Regional Environmental Change 14:5, pp 2025–2038.

Lupkina et al. 2013: Latvia's Eight National Communication (NC) and Fifth Biennial Report under the United Nations Framework Convention on Climate Change.

MASE 2023a: Programma sperimentale di interventi per l'adattamento ai cambiamenti climatici in ambito urbano - Allegato 1.

MASE 2023b: What is the Italian Platform on Adaptation to Climate Change? | National Climate Change Adaptation Platform.

Miljø-Direktoratet 2021: Klimarisiko i kommunene. Rapport M-1956, 2021.

Ministère de la transition écologique at solidaire 2018: Le plan national d'adaptation auch changement climatique. PNACC 2.

Ministère de la transition écologique at solidaire 2021: Trois ans d'adaptation au changement climatique. Synthèse de l'évaluation à mi-parcours du 2e plan national d'adaptation au changement climatique (2018-2021).

Ministerio da Administracao Interna 2016: Plano distrital de emergência de proteção civil de beja.

Ministerio para la Transición Ecológica y el Reto Demográfico 2020: Plan Nacional de Adaptación al Cambio Climático 2021-2030. Madrid:

Ministry of Environment and Energy 2022: 8th National Communication and 5th Biennial Report under the United Nations Framework Convention on Climate Change.

Mirli, Anastasia; Dionissis Latinopoulos and Ifigenia Kagalou 2022: Knowledge Gaps in NBS Implementation for Managing Water Quality Challenges and SDG Approaching in a Mediterranean Area. In: Proceedings of the 39th IAHR World Congress 39, pp 199–208.

Moraca, Sara 2023: Italy's climate plan nears completion.

Navarro, D.; J. Lizundia-Loiola; J. Paz; B. Abajo; C. Cantergiani; G. García and E. Feliu 2022: Updating and Integrating CLIMATE Datasets and Maps. Final Report. ESPON 2020 data and maps updates // September 2022.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Nickayin, Samaneh Sadat; Rosa Coluzzi; Alvaro Marucci; Leonardo Bianchini; Luca Salvati; Pavel Cudlin and Vito Imbrenda 2022: Desertification risk fuels spatial polarization in 'affected' and 'unaffected' landscapes in Italy. In: Scientific Reports 12:1, p 747.

Nordland Fylkeskommune 2022a: Handlingsprogram 2022/2023. Regional plan for klima og miljø Grønn omstilling i Nordland.

Nordland Fylkeskommune 2022b: Regional plan for klima og miljø. Grønn omstilling i Nordland.

Norsk Klima Service Senter 2022: Climate profile Nordland. Retrieved 15 Sep 2023, from https://klimaservicesenter.no/kss/klimaprofiler/nordland.

Norsk Klima Service Senter 2023: Climate Projections. Retrieved 15 Sep 2023, from https://klimaservicesenter.no/climateprojections.

Norwegian Directorate for Civil Protection 2017: Integrating Sea Level Rise and Storm Surges in Local Planning.

NOU 2010: Tilpassing til eit klima i endring. Report 2010:10 Innstilling frå utval nedsett ved kongeleg resolusjon 5. desember 2008 Lagt fram for Miljøverndepartementet 15. november 2010.

Olei, S. 2020: Le plan climat-air-énergie territorial (PCAET). Retrieved 26 Jul 2023, from https://outil2amenagement.cerema.fr/le-plan-climat-air-energie-territorial-pcaet-r438.html.

Paillat, Emmanuelle 2023: Solutions d'adaptation au changement climatique fondées sur la Nature. Étude de l'intégration croisée des enjeux d'adaptation au changement climatique et de protection de la biodiversité dans les politiques publiques françaises.

Pelling, Mark 2011: Adaptation to climate change. Abingdon, Oxon, England, New York: Routledge.

Pérez Fernandes, M. A.; R. García Laureano; J. Moreno Pérez; M. MOreno Pecero; F. Gonzalez Iglesias; Navarro Santa Mónica, R. M.; F. Corzo Pantoja; L. Vallés; R. Madrigal Martínez; A. Toribio Sevillano; M. Martínez Alcántra and E. Santiago Mateos 2011a: Estrategie para el Desarollo Sostenible de Extremadura.

Pérez Fernandes, M. A.; R. García Laureano; J. Pérez Moreno and F. Corzo Pantoja 2011b: Plan de Adaptación al Cambio Climático del sector Seguros y Riesgos Naturales en Extremadura.

Pérez Fernandes, M. A.; R. G. Laureano; G. Pecero; F. C. Corzo Pantoja; A. Toribio Sevillano and J. Robles Gil 2011c: Mapa Impactos del Cambio Climático en Extremadura.

Pérez Fernandes, M. A.; J. Pérez Moreno; F. G. Iglesias; R. García Laureano and E. DeMiguel Gordillo 2011d: Plan de Adaptación al Cambio Climático del Sector Agrícola de Extremadura.

Pérez Fernandes, M. A.; J. Rodriguez Gómez; R. García Laureano and Pérez Ledesma J. 2009: Estrategia de Cambio Climático para Extremadura 2009-2012. Mitigación y adaptación.

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Polemio, M. and T. Lonigro 2015: Trends in climate, short-duration rainfall, and damaging hydrogeological events (Apulia, Southern Italy). In: Natural Hazards 75:1, pp 515–540.

Portuguese Institute of the Sea and Atmosphere (IPMA) 2022: Situação de seca meteorológica 15 de fevereiro de 2022.

Préfecture de la Région d'Île-de-France 2022: Carte des plan climat air énergie territorial (PCAET) en Normandie. Retrieved 26 Jul 2023, from https://www.normandie.developpement-durable.gouv.fr/IMG/pdf/carte_suivipcaet_decembre2022.pdf.

Préfecture de la Région d'Île-de-France and L'agence de l'Eau Seine-Normandie 2022a: Programme de mesures 2022-2027 du bassin de la Seine et des cours d'eaux côtiers Normands.

Préfecture de la Région d'Île-de-France and L'agence de l'Eau Seine-Normandie 2022b: Schéma Directeur d'Aménagement et de Gestion des Eaux (SDAGE) 2022-2027 du bassin de la Seine et des cours d'eaux côtiers Normands.

Préfet de la Région Normandie 2020: Le climat en Normandie. Rouen: DREAL Normandie.

Préfet de la Région Normandie 2023: Chiffres clés de la Dreets de Normandie. Édition 2022.

Puglia Region 2023: Agenda di genere - Parità di genere. Retrieved 09 Nov 2023, from https://www.regione.puglia.it/web/pari-opportunita/agenda-di-genere.

Pulido, Fernando; Javier Corbacho; Manuel Bertomeu; Álvaro Gómez; Nuno Guiomar; Enrique Juárez; Beatriz Lucas; Gerardo Moreno; Javier Navalpotro and Gonzalo Palomo 2023: Fire-Smart Territories: a proof of concept based on Mosaico approach. In: Landscape Ecology 38, pp 1–18.

Reckien, Diana; Alexandre K. Magnan; Chandni Singh; Megan Lukas-Sithole; Ben Orlove; E. Lisa Schipper and Erin Coughlan de Perez 2023: Navigating the continuum between adaptation and maladaptation. In: Nature Climate Change 13:9, pp 907–918.

Région Normandie 2019: Schéma Régional d'Aménagement, de Développement Durable et d'Egalité des Territoires pour la Normandie. Rapport.

Région Normandie 2020: Schéma Régional d'Aménagement, de Développement Durable et d'Egalité des Territoires pour la Normandie. Document synthétique.

Région Normandie 2021: Schéma Régional d'Aménagement, de Développement Durable et d'Egalité des Territoires pour la Normandie. Bilan de la mise en oeuvre du SRADDET.

Région Normandie 2022: Plan d'actions GIEC Normand. Année 1 - 2022-2023.

Renna, Massimiliano; Francesco Montesano; Angelo Signore; Maria Gonnella and Pietro Santamaria 2018: BiodiverSO: A Case Study of Integrated Project to Preserve the Biodiversity of Vegetable Crops in Puglia (Southern Italy). In: Agriculture 8:8, p 128.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

République Française 2023: Adaptation de la France au réchauffement climatique : une consultation publique en ligne. Retrieved 14 Sep 2023, from https://www.vie-publique.fr/en-bref/289497-rechauffement-climatique-une-consultation-sur-un-scenario-4-degres.

Riksrevisjonen 2022: Til Stortinget: Riksrevisjonens undersøkelse av myndighetenes arbeid med å tilpasse infrastruktur og bebyggelse til et klima i endring. Dokument 3:6 (2021-2022).

Ronco, P.; F. Zennaro; S. Torresan; A. Critto; M. Santini; A. Trabucco; A. L. Zollo; G. Galluccio and A. Marcomini 2017: A risk assessment framework for irrigated agriculture under climate change. In: Advances in Water Resources 110, pp 562–578.

Salmon, B.; C. Da Cunha; ADEME and CEARC 2021: L'adaptation au changement climatique dans les PCAET. Etude du niveau d'intégration des Solutions d'Adaptation Fondées sur la Nature (SafN). Life intégré ARTISAN - Synthèse.

Santini, M.; S. Torresan; A. Trabucco; D. Balzarolo and A. L. Zollo 2014: Pilot study 3 Orientgate Report: Adaptation in water and coastal areas in Puglia, Italy.

SAS, EDIPRESS 2019: LEGGE REGIONALE 12 dicembre 2019, n. 53 “Sistema regionale di protezione civile”.

SIA Estonian, Latvian & Lithuanian Environment 2021: Zemgales plānošanas reģiona attīstības programmas 2021.-2027. gadam.

Simpson, M.J.R.; J.E.Ø. Nilsen; O. R. Ravndal; K. Breili; H. Sande; H. P. Kierulf; H. Steffen; E. Jansen; M. Carson and O. Vestol 2015: Sea Level Change for Norway. Past and Present Observations and Projections to 2100 (NCCS report: Kartverket; Nansensenteret; Bjerknes Centre for Climate Research.

Sociedade Portuguesa de Inovação 2022: Estratégia Supramunicipal de Habitação do Baixo Alentejo.

Sociedade Portuguesa de Inovação; Instituto do Ambiente e Desenvolvimento - IDAD and Universidade de Évora 2018: Plano intermunicipal de adaptação às alterações. Climáticas do baixo alentejo.

Swedish Government 2018: National Strategy for Climate Change Adaptation.

United Nations, Department of Economic and Social Affairs 2022: World Population Prospects: The 2022 Revision. Retrieved 08 Sep 2023, from https://population.un.org/dataportal/home.

Interview with University of Extremadura; Junta de Extremadura; Fundecyt, 2023: Needs Assessment Survey and Interview.

VARAM 2019: Latvia's Climate Change Adaptation Plan for the period up to 2030.

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VARAM 2020: Projekta ietvaros veikto pētījumu nodevumi. Retrieved 22 Sep 2023, from https://www.varam.gov.lv/lv/projekta-ietvaros-veikto-petijumu-nodevumi?utm_source=https%3A%2F%2Fclimate-adapt.eea.europa.eu%2F.

Vattenmyndigheterna i Sveriges fem vattendistrikt 2022: Åtgärdsprogram för vatten 2022-2027 Södra Östersjöns vattendistrikt.

World Bank Group 2021: Climate Change Knowledge Portal - Portugal. Retrieved 15 Aug 2023, from https://climateknowledgeportal.worldbank.org/country/portugal/trends-variability-projections.

ZPR 2015: Zemgales plānošanas reģiona ilgtspējīgas attīstības stratēģija 2015-2030.

ZPR 2021: Zemgales plānošanas reģiona attīstības programma 2020-2027. Retrieved 22 Sep 2023, from https://www.zemgale.lv/lv/media/98/download?attachment.

Interview with ZPR, 05 Sep 2023: Needs Assessment Survey and Interview 2023.

ZREA 2010: Sustainable Energy Action Plan of Jelgava City for the years 2010 – 2020. Retrieved 22 Sep 2023, from https://mycovenant.eumayors.eu/docs/seap/488_452_1301901045.pdf.

Co-funded by the European Union

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