Transfer Plans of solution-providing regions in LSDT-2

Deliverable 3.12 DK Transfer plans for twins

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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

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List of abbreviations

Andfjord – Andfjord Salmon AS
AR – Augmented Reality
AU – Aarhus University
BTH – Blekinge Tekniska Högskola
CBA – Cost Benefit Analysis
CCA – Climate Change Adaptation
CCS – Cascading Style Sheet
CDR - Central Denmark region
CRA – Climate Risk Assessment
CTT - Climate Tech Tour
DUTH - Demokritio Panepistimio Thrakis
EMT - East Macedonia and Thrace
FS – Future Scenario
GDT – Graphical Digital Twin
GIS – Geographical Information System
HTML – Hyper Text Markup Language
IoT – Internet of Things
ML – Machine learning
MR – Mixed Reality
Museum Nord – Stiftelsen Museum Nord
NBS – Nature-based Solution
NGO – Non-governmental Organization
NIRAS – NIRAS AS
PHP – Hypertext Preprocessor
PPP – Public Private Partnerships
R&D – Research and Development
RCP - Representative Concentration Pathway
RICAP - Regional Innovative Climate Adaptation Platform
RM – Region Midtjylland
RTU - Riga Technical University
SME – Small and Medium-sized Enterprises
SMHI – Swedish Meteorological and Hydrological Institute
SSL – Secure Socket Layer
Vesteralen – Vesteralen Regionrad
VIA UC - VIA University College
VPS – Virtual Private Server
VR – Virtual Reality
ZPR – Zemgales Planosanas Regions
XR – Extended Reality
XR Pathfinder – Extended Reality Pathfinder

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1 Introduction

This transfer plan for the partners in LSDT2 describes the transfer of climate change adaptation (CCA) solutions that have been decided between the receiving regions from Region Blekinge, Zemgales Planosanas Regions and Vesteralen Region and the provider region from Central Denmark Region.
Its objective is to guide the transfer of the chosen CCA solutions and to provide a plan for the coming project period when the solutions will be transferred, tested and implemented in the receiving regions. The transfer plan will thus help the receiving regions adapt to climate change-related needs and challenges and contribute to increasing their climate resilience.

1.1 Motivation

1.1.1 Blekinge Region

Blekinge region is placed in a temperate maritime climate on the shore to the Baltic Sea and is especially vulnerable to sea-level rise, increasing precipitation and an increase in extreme precipitation events which will be caused by an increase in temperatures because of climate change. Multi-level governance and directionality are two of the main barriers to climate change adaptation (CCA), where the many different entities in Sweden responsible for different CCA tasks lack in resources and efficiency. The needs analysis deliverable D1.11 emphasizes key areas where support is required to enhance Blekinge's climate adaptation efforts. A major outcome concerns the opportunity to deploy XR technologies for improving climate risk assessments by integrating advanced standards, simulating escalating risks, and analysing vulnerabilities, particularly for at-risk populations. Furthermore, XR tools have been seen to provide critical support for stakeholder engagement by visually aligning diverse agendas and facilitating better collaboration, addressing challenges in policy coherence and responsibility distribution. This comprehensive approach ensures that climate strategies are robust, actionable, and inclusive. It also increases the likelihood of long-term support, streamlines the implementation process, and attracts private sector investments, solidifying Blekinge's resilience against climate change challenges.

To improve collaboration across administrative levels and with relevant stakeholders, which is vital for development of holistic CCA solutions, Blekinge Lans Landsting (Blekinge) is interested in exploring the experimental dimension that Extended Reality (XR) enables and examine how XR can be used as a tool to drive policy innovation and involve stakeholders in decision making processes. The solution transfer between Blekinge region (BR) and Central Denmark region (CDR) will thus be focussed on XR technology and how this can be used in stakeholder involvement processes. In relation to this, Blekinge Tekniska Högskola (BTH), VIA University College (VIA UC), Aarhus Universitet (AU) and Region Midtjylland (RM) have initiated a collaboration on knowledge sharing

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and development of a comprehensive web-based guide designed for municipal and regional stakeholders that can be used to identify and develop suitable XR solutions and provide a guide on how they could be used with different stakeholder groups which in the end should increase stakeholder involvement, cross-cutting collaborations and support and engagement in CCA projects.

The following partners are involved in this transfer:
Demonstrator region
VIA UC
AU
RM

Solution-receiving region
Blekinge Tekniska Höskola
Blekinge Region

1.1.2 Zemgales Planosanas Regions

Large parts of the Zemgales Planosanas Regions (ZPR) have a high risk of flooding due to its topography and soil conditions. Especially in the Bauska Municipality, where the Lielupe River basins are located, the flood risk is high and has thus been chosen as focus area for this transfer. This area is a low-lying area with clayey soils that have a high content of impermeable rocks which reduces infiltration capacity. Combined with a registered increase in yearly precipitation and more frequent cloud bursts which are expected to increase even further in the future due to climate change, the need for adaptive measures is also increasing to prevent flooding and damages on existing buildings and infrastructure.

One of the urgent challenges in the Bauska municipality is related to the high groundwater table which during heavy rain events causes floodings.

To understand how different climate aspects and climate change affect the soil hydrology and groundwater table in this area, which is vital for the development of adaptation solutions, ZPR and Riga Technical University (RTU) will conduct a transfer with VIA UC on their project regarding Internet of Things (IoT) loggers. These loggers can be used to monitor and collect data about development in the groundwater table and relevant climate data. IoT loggers will thus be installed in the Bauska municipality to collect data that will be included in a hydrological model developed in the transfer between ZPR and Demokritio Panepistimio Thrakis (DUTH), which is part of the East Macedonia and Thrace (EMT) region in LSDT1. By using the data from the IoT loggers in the hydrological modelling, RTU will be able to model future flood scenarios that be used and contribute to local CCA planning and increase flood resilience in the Bauska municipality.

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The following partners are involved in this transfer:
Demonstrator region
VIA UC
RM
AU

Solution-receiving region
Zemgales Planosanas Regions
Riga Technical University

1.1.3 Vesteralen Region

Vesteralen region is located in Norway's Nordland County. It is marked by rugged, steep terrain that spans around 3,100 km² and is home to approximately 32,000 residents. The region is renowned for its expertise in marine technology and entrepreneurial industries, with fishing and salmon aquaculture being key drivers of the local economy. The coastal area is generally characterized by a precipitation-heavy climate and rapidly intensifying winds, especially during winter. Combined with sea-level rise, and with the increasing amount and intensity of storm surges, these conditions threaten local livelihoods, industries, and ecosystems. However, whilst being one of Norway's most exposed regions to climate events, Vesteralen region is also ranked among those with the least adaptive measures in place against them. Furthermore, a certain degree of disinterest and scepticism regarding climate change and adaptation flourishes among the local populace.

These challenges require a target effort on multiple levels. First, the region needs a deeper understanding of the consequences of climate change on maritime ecosystems and coastal areas. This is necessary to effectively develop a holistic adaptation plan for the region. Second, this knowledge needs to be translated into concrete practices to secure the environmental and economic sustainability of coastal areas, including local fishing and aquaculture industries. Third, beyond simulating and assessing local solutions for CCA and adapting local industries to changing climates, work is needed on enhancing climate awareness among the local population.

Based on these reflections, the solution transfer between Vesteralen region and CDR will focus on the 'Extended Reality Pathfinder' (XR Pathfinder) solution and on the CCA planning tool 'Best Adapt'.

The following partners are involved in this transfer:
Demonstrator region
VIA UC
NIRAS AS

Solution-receiving region
Vesteralen Regionrad (Vesteralen)

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Stiftelsen Museum Nord (Museum Nord)
Andfjord Salmon A/S (Andfjord)

1.2 Overview of planned transfers within RESIST for all regions

The RESIST project addresses climate-related challenges and needs of twelve climate-vulnerable regions in Europe, each with distinct socioeconomic profiles. These regions are Southwest Finland (Finland), Central Denmark (Denmark), Catalonia (Spain), Central Portugal (Portugal), Normandy (France), Eastern Macedonia and Thrace (Greece), Blekinge (Sweden), Zemgale (Latvia), Puglia (Italy), Baixo Alentejo (Portugal), Vesterålen (Norway), and Extremadura (Spain).

As part of the project, adaptation solutions developed by RESIST regions are transferred to other "receiving" project regions. The original project structure organizes the regions into four clusters, each consisting of one more advanced region, known as a Large Scale Demonstrator Region, and two Twin Regions. Each cluster is referred to as an "LSDT". While the Large Scale Demonstrator Regions — namely Southwest Finland, Central Denmark, Catalonia, and Central Portugal — were pre-selected as providing regions, any region within the project could choose to offer solutions for transfer. Figure 1 shows an overview of all planned transfers, which will be implemented within the remaining project time (2025-2027).

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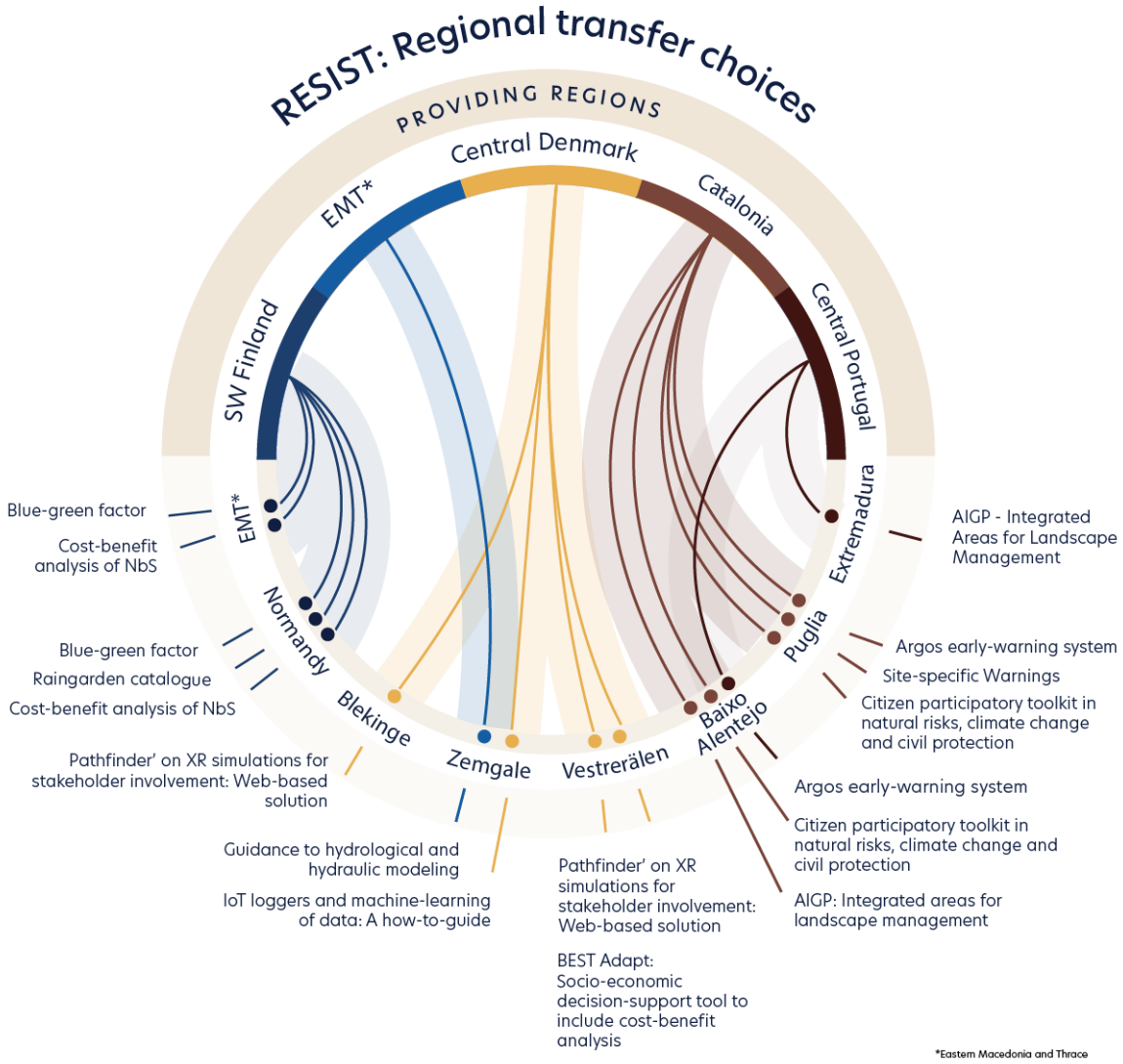

Figure 1: Overview of transfers between the regions.

South-West Finland (LSDT1) is transferring five innovative solutions. These include the "Blue-green factor", a policy instrument used to increase blue- and green infrastructure in urban areas, and "Cost-Benefit analysis of NBS", which provides a systematic method for identifying the benefits and costs of Nature-based Solution (NBS) projects over their lifetime. Both solutions are transferred to the regions of Normandy (LSDT1) and Eastern Macedonia and Thrace (LSDT1). Additionally, South-West Finland transfers the “Raingarden catalogue” to Normandy. This catalogue provides valuable insights into raingardens, promoting sustainable water management in residential areas. All three regions belong to LSDT1, no transfers outside the original LSDT are performed by South-west Finland.

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Eastern Macedonia and Thrace (LSDT1), a region that joined RESIST as a twin-region, is also contributing a solution to the transfer process. The "Guidance to Hydrological and Hydraulic Modelling" solution is transferred to Zemgale (LSDT2). This solution provides comprehensive guidance for hydrologic and hydraulic modelling, enhancing water management and increasing resilience to flood-related hazards.

Central Denmark (LSDT2) is sharing its expertise with Zemgale (LSDT2) through the solution "IoT Loggers." This guide facilitates the deployment and use of IoT groundwater loggers, supporting effective data collection and analysis. Furthermore, Central Denmark transfers "BEST Adapt: Socio-economic Decision-Support Tool to Include Cost-Benefit Analysis" to Vesteralen region (LSDT4). This tool integrates socio-economic factors to enhance informed decision-making in climate adaptation efforts, particularly focusing on flood-related hazards. Additionally, Central Denmark provides the "Pathfinder on XR Simulations for Stakeholder Involvement – Web-Based Solution," an online tool designed to support the selection and implementation of XR solutions for immersive stakeholder engagement. This solution is transferred to both Vesteralen and Blekinge (LSDT2). Central Denmark, therefore, facilitates solution transfers both within and beyond its LSDT.

Catalonia (LSDT3) contributes the "Argos Early-Warning System," an early-warning and decision-support tool designed to assist emergency managers and other stakeholders in anticipating impacts and managing weather-related emergencies more effectively. It also offers the "Citizen Participatory Toolkit in Natural Risks, Climate Change, and Civil Protection," which is a compilation of various formats and methods for engaging citizens in climate adaptation, tailored to different social groups. Both solutions are transferred to Baixo Alentejo (LSDT3) and Puglia (LSDT3). Additionally, Catalonia transfers the "Site Specific Warnings" solution to Puglia, which integrates site-specific warnings into the Argos early-warning system. Catalonia does not transfer solutions outside of LSDT3.

Central Portugal (LSDT4) shares the "AIGP – Integrated Areas for Landscape Management", a comprehensive approach aimed at promoting the collective management and utilisation of agroforestry spaces in smallholdings and areas with high fire risk. This approach is grounded in an integrated territorial strategy that addresses the need for effective landscape planning and management. It aims to increase the area of managed forest at a scale that enhances resilience to fires, boosts natural capital, and in a way that supports the rural economy. This solution will be transferred to Extremadura (LSDT4) and Baixo Alentejo (LSDT3).

1.3 LSDT-2: Parties and content of the transfer plans

This Transfer Plan describes the planned transfers from CDR to the regions of Blekinge, Zemgale and Vesteralen. From the various solutions CDR could offer for transfer (see full list in Section 1.4.2), the solutions chosen for transfer by the receiving regions, and the main project partners involved, are listed in Table 1 below.

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Table 1. List of solutions for transfer and involved partners

Solution for transfer	Key project partners involved
D3.6 - Network of loggers (IoT loggers)	Partners from the solution-providing region • VIA University College (VIA UC) • Aarhus Universitet (AU) • Region Midtjylland (RM) Partners from the solution-receiving region, Zemgale • Zemgale Planosanas Regions (ZPR) • Riga Technical University (RTU)
D3.7 - XR Pathfinder	Partners from the solution-providing region • VIA UC in cooperation with BTH • AU • RM Partners from the solution-receiving region, Blekinge • BTH • Blekinge Partners from the solution-receiving region, Vesteralen • Stiftelsen Museum Nord • Vesteralen Regionrad • Andfjord Salmon AS
D3.11 Socio-economic decision support tool for CCA – BEST Adapt	Partners from the solution-providing region • NIRAS • AU Partners from the solution-receiving region,Vesteralen • Stiftelsen Museum Nord • Vesteralen Regionrad • Andfjord Salmon AS

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1.4 Solution-providing region: Strength and expertise

1.4.1 Key regional expertise in the field of climate resilience and climate change adaptation

The Central Denmark region partners, AU, RM, Naturstyrelsen, NIRAS and VIA UC, offer a variety of strengths and expertise, represented in the Danish projects which will be described in the following. This section combines information on the strengths and expertise from the Needs Assessment (D1.11) and solutions shortlisted for the twinning regions, which have been introduced since the needs assessment.

1.4.1.1 Aarhus Universitet

Stakeholder involvement using XR visualization.
AU, in collaboration with RM, conducts research on how the use of XR-solutions affects the dialogue and involvement of decision makers and citizens in climate adaptation projects and thereby develop approaches for the use of XR-solutions that could benefit stakeholder involvement in climate adaptation planning in general. The research is conducted as part of the development of the XR Pathfinder and the results will thus be included in the tool.

Moreover, AU will conduct research on the use of the BEST ADAPT cost-benefit tool in policy-makers' decision-processes, examining how such cost-benefit tools affect comprehension of synergies and trade-offs in climate adaptation planning.

AU has expertise on governance processes and stakeholder involvement in climate adaptation planning and local planning more broadly. The participating political scientist from the Dept. of Environmental Science has conducted extensive research on partnerships and collaboration between municipalities in climate adaptation as well as on implementation barriers for comprehensive climate adaptation planning including the lack of attention and adaptive capacity among key stakeholders at the local level.

1.4.1.2 Region Midtjylland

Stakeholder involvement using XR visualizations
RM will, in collaboration with AU, conduct research on how the use of XR-solutions affects the dialogue and involvement of decision makers and citizens in climate adaptation projects and thereby develop approaches for the use of XR-solutions that could benefit stakeholder involvement in general. The research is conducted as a part of the development of the XR Pathfinder and the results will thus be included in the tool.

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RM has comprehensive knowledge and experience in stakeholder involvement from other climate adaptation projects where new tools for engagement of stakeholders have been developed such as the Climate game and Connective Negotiation game. RM has also conducted research on governance challenges and stakeholder involvement and has published a variety of reports and publications on this and will use all of the knowledge and experiences mentioned above in the collaboration with AU.

1.4.1.3 Naturstyrelsen

Stakeholder involvement in relation to demo houses
In connection with the development of the demo houses, Naturstyrelsen will conduct a study among citizens living in flood-prone areas and examine how the flood risk affects their everyday lives, how previous floodings have affected their properties, and how they adapt to potential floodings. The results from this study will be presented through a guided tour of and between the two demo houses that will be built to raise awareness on flood risks.

Naturstyrelsen is the national authority regarding coasts in Denmark. They are responsible for national coastal protection and coastal CCA and thus have significant experience with coastal climate challenges and adaptation approaches which will be used in this project.

1.4.1.4 NIRAS

Socio-economic decision support tool (BEST Adapt)
NIRAS is the lead on the development of the BEST Adapt decision support tool, which is based on flood maps, flood risks and damage costs and calculates the socio-economic optimum protection level of an area. The tool can be used to prioritize areas in need of CCA efforts and to determine the level of protection to be planned for, thereby avoiding either over - or under investing in climate adaptation solutions.

In RESIST, new modules for groundwater and recreational elements will be developed which will be included in the calculations of adaptation solutions.

NIRAS, which is a consultancy company, has great experience within CCA and has managed and participated in a wide range of different projects. Furthermore, NIRAS was the developer of the original BEST tools. Development of the new modules for the BEST tool will thus be based on the existing experience and knowledge within the organization together with data input from AU that has conducted research on the value of recreational elements in CCA.

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1.4.1.5 VIA UC

VIA UC is a university for applied science and in RESIST the Research & Development (R&D) Centre for Built environment, Climate and Water technology conducts interdisciplinary research across three research programs:

- Research program for water technology
- Research program for digital and sustainable processes
- Research program for sustainable built environment

IoT loggers

In the RESIST project, VIA UC research group on CCA apply their expertise on near-surface groundwater management. VIA has designed, established, maintained and utilized groundwater logger data for local CCA plans. VIA will provide project knowledge, experience, and technical guidance on establishing IoT groundwater logger networks for better groundwater resource management.

Machine Learning & app

Researchers from VIA UC has expertise in data mining, machine learning (ML) modelling, environmental forecasting and software and is developing a warning app on groundwater flooding, which is demonstrated in a low-lying area of Juelsminde town. VIA UC provides scientific knowledge gained regarding development of such apps, e.g. knowledge and data needs of the local circumstances, data mining, forecasting machine learning models. VIA UC will assist transferring on this technology with scientific papers, technical guidelines, examples of app design and programming design.

XR pathfinder

VIA UC holds comprehensive expertise in developing methodologies and conceptual frameworks designed to visualize climate change and adaptation scenarios. This allows VIA UC to support the creation of adaptable frameworks that can be applied in diverse regions, promoting informed decision-making and collaborative development of local adaptation strategies. Drawing on insights from RESIST activities and similar projects, VIA UC provides digital tools and knowledge to leverage processes for citizen and stakeholder engagement through immersive XR-technologies, such as Augmented Reality (AR) which will be used in the development of the XR Pathfinder. This competency includes the production of various applications and supporting access to guidelines and information about best practices that can empower communities and organizations to design impactful, context-sensitive adaptation strategies.

Demo houses (large scale demonstrators)

The task of showcasing CCA on a building scale, as one important strategy to protect the built environment in the future from rising water levels, demands new innovative approaches and a cross-

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disciplinary collaboration of fields within different sectors without compromising ambitious building standards on low carbon construction.

VIA UC contributes to this task with researchers from the research program 'sustainable built environment' affiliated with the education of architectural technology and construction management.

Their expertise covers state-of-the-art knowledge on low carbon and biogenic building materials and constructions (from a Danish perspective) combined with building physics and indoor climate. Regarding the temporary demo house constructions, VIA UC provides in-depth knowledge on circular reversible design combined with new added demands for a resilience agenda. By facilitating the construction process and monitoring the construction during the operational phase, VIA UC gains furthermore knowledge and experience along the way which will be part of the dissemination.

1.5 Overview of solutions available for transfer

1.5.1 IoT loggers

Description of the solution
IoT loggers play a crucial role in CCA by providing real-time data and insights that help monitor and manage environmental conditions. IoT loggers installed at a given monitoring site collect data on water levels every hour, monitoring and documenting time-variation in ground water levels, while multiple loggers will map spatial variations across the monitoring area. This data provides basic knowledge of the site for local hydrology and better management of near-surface groundwater.

Stakeholder engagement is an integral part of the use of IoT loggers. Installation of the loggers requires permits to drill boreholes, which may involve the local authority, local water utility and/or private property owners. Local authorities and water utilities also assist with communication to local residents regarding VIA UCs field trips related to the IoT logger network.

The IoT logger network also facilitated citizen engagement with CCA. Property owners in the area have been informed about, involved in and allowed the installation of loggers, and they have received logger-generated data on groundwater levels from the loggers positioned close to their properties. Data on groundwater levels has also been shared with citizens through local news media. Moreover, the relevant homeowner associations and the local Dike Association have been involved in the installation of the network of loggers.

The transfer potential from this project will include:

- Knowledge on how to design a network of IoT loggers for local groundwater monitoring
- Technical guidance for installation of IoT groundwater loggers

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- Setting up technical and research working group
- Advice on best practices on stakeholder engagement regarding IoT ground water logger installation
- Advice on best practice regarding citizen involvement in network of IoT loggers

1.5.2 Warning app

Description of the solution
Warning apps are integral to enhance community resilience and safety in future climate change scenarios with more extreme whether events and climate hazards. In the RESIST project, VIA UC develops a warning app for the local residents regarding groundwater flooding in Juelsminde town. This app utilizes the real-time data derived from the IoT loggers and a forecasting model based on ML to provide proactive alerts regarding groundwater flooding. Moreover, the app incorporates features such as interactive maps, emergency contact information, and safety guidelines, rendering them comprehensive tools for disaster preparedness.

The transfer potential of this project includes:

- Knowledge on warning apps and their application
- Technical guidance on developing warning apps, including programming language, software platforms and information needed
- Experience of stakeholder involvement and citizen involvement on warning apps
- Transferring knowledge on the use of warning apps in flood risk prevention

1.5.3 XR Pathfinder – a web-based guidance tool

Description of the solution
The XR Pathfinder is a web-based tool designed to help decision-makers choose suitable XR technologies for CCA planning and resilience initiatives. XR encompasses both Virtual Reality (VR) and Augmented Reality (AR). These tools are used to engage citizens and stakeholders by providing science-based visualizations of climate impacts and adaptation measures, supporting processes of public engagement and targeted knowledge dissemination.

The XR Pathfinder acts as a virtual assistant, intended to lower barriers to XR adoption among decision-makers by addressing challenges such as awareness of XR's value, knowledge of different XR modalities, and understanding of the cost-benefit trade-off. The XR Pathfinder solution consists of two parts. The first part guides users through the entire lifecycle of XR technology, from initial investment to long-term maintenance and aims to support internal decision-making processes in CCA and it is informed by lessons from the RESIST project (e.g., the different XR solutions developed by VIA UC). Important inputs for the development of XR Pathfinder come from the work conducted in Juelsminde, where a table-top XR simulation of groundwater flooding was demonstrated to members of the dike association to collect feedback on the simulation. The second

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part of the solution provides best practice guidance on how to conduct stakeholder engagement using tailored XR-solutions. This part is based on experiences from the Juelsminde case and a second case in Horsens that demonstrates the use of XR for visualization of nature-based solutions for climate adaptation in urban areas. These examples highlight the XR Pathfinder's role in promoting effective XR application for decision-making and community engagement in climate-related projects.

The transfer potential includes:

- Web-based guidance tool to facilitate decision-makers' choice of XR technologies, including:
  - Collection of tailored solutions and how to implement them
  - Best practice guidance on stakeholder involvement using XR solutions

1.5.4 Demo houses

Description of the solution
VIA UC builds two demo houses in the bay of Lemvig in collaboration with the partners from Naturstyrelsen supported by Lemvig Municipality as a local partner involved via sub-contracting as a municipality partner.

The demo houses physically demonstrate several adaptation strategies to cope with rising water levels and flooding on a building scale. They aim to inspire visitors on how buildings in the future can be designed to accept the water thread without compromising ambitious CO2 targets in the building sector and the necessary focus on climate-friendly building materials.

A selection of low carbon building materials implemented in the demo house will be exposed during the winter flooding season and various construction details tested regarding their drying abilities. Moisture within the construction is monitored with loggers to keep track on moisture levels. Design for disassembly as a construction principle allows to access the inner construction for visual documentation.

Knowledge transfer will be provided through guided tours, lectures and local information at the demo houses in combination with the support of XR technology.

Transfer potential from this solution includes:

- Experience from the design process of the two demo-houses, including considerations regarding choices of materials and construction
- Knowledge on moisture data in the construction gathered through monitoring and logging in an ongoing research project
- Experience on the potential of demo houses for stakeholder engagement

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1.5.5 Socio-economic decision support tool – BEST Adapt

Description of the solution

BEST Adapt is a decision support tool that, based on flood maps, flood risks and damage costs, calculates the socio-economic optimum protection level of an area. It aids in prioritizing the areas in need for climate adaptation and defining the level of protection and thereby avoiding either over - or under investing in CCA solutions. For the twinning regions, NIRAS delivers a report with a list of data needed to use the tool, as well as a description of the applied best practice socio-economic methods of the tool.

Transfer potential of this solution will include:

- Guidance on the data needed to use the tool
- Descriptions of the applied best practice socio-economic methods of the tool.

Table 2. Overview of solutions available for transfer by CDR

Solutions for transfer		
Name of solution	**Solution type**	**Short description**
IoT loggers	Tool for data collection	IoT loggers that can be used for assessment of local hydrology and monitoring of changes and development in the ground water table. This solution includes recommendations and support for the installation and maintenance of the loggers as well as support for data collection and stakeholder involvement.
XR Pathfinder	Digital/online tool	An online guide for public authorities containing guidelines on how to develop XR solutions and recommendations for using it in stakeholder involvement processes.
Demo houses	Physical constructions, Knowledge and experiences	2 physical demo houses testing materials and construction solutions regarding rising water levels and exposure to water in the flooding season. Knowledge exchange is provided both by accessibility of the houses on site in Lemvig combined with customized XR applications in the story telling.
Machine learning and app	Scientific and technical support	Processing of data collected from the IoT loggers through Machine Learning to identify patterns and tendencies in the data. The

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		results are used in the development of a warning app that can warn citizens about ground water flooding.
Socio-economic decision support tool – BEST Adapt	Digital, web-based; process tool	Decision support tool based on predicted flood maps, flood risks, and damage costs that calculates the socio-economic optimum CCA protection level of an area, including groundwater and recreational elements.

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2 Transfer Plan – Central Denmark Region to Region Blekinge

2.1 Solution-receiving region: Challenges, needs and climate adaptation solutions

2.1.1 Key regional needs in the field of climate resilience and climate change adaptation

Challenges

Blekinge experiences a temperate maritime climate, with relatively mild winters and cool summers. The proximity to the Baltic Sea influences the local climate, leading to milder temperatures compared to inland areas of Sweden. Given its extensive coastline, Blekinge is particularly vulnerable to sea-level rise, which can lead to increased flood risks.

In a scenario of Representative Concentration Pathway (RCP) at 4.5 emissions (middle scenario in the future climate service of the Swedish Meteorological and Hydrological Institute (SMHI)) (SMHI, undated), Blekinge's average temperature is set to increase by 2.7°C. An increase of 2.1 tropical days (with minimum temperatures above 20 °C), an increase in precipitation, and an increase in extreme precipitation are also in the forecast for the period 2017 – 2100. These changes are likely to have effects on healthcare, societal security, cultural heritage, biodiversity, forest fires, and economic disruption.

Despite being challenged by various climate hazards, within the RESIST project, Blekinge will focus on the most impactful climate challenges, namely droughts and floods. Addressing these issues is in all and every way a complex matter and requires new tools (technological innovation) and innovative ways of using and implementing them (policy innovation). For a more in-depth description of challenges and needs, please see the Needs Assessment compiled by Adelphi (D1.11).

Floods related to cloud bursts are both a short-term and a long-term concern, while a rising sea level makes for more of a long-term concern. On the other hand, rising sea level is the most pressing issue when looking at impact on infrastructure and economy.

By the year 2150, a sea level rise of +1,1 m is foreseen. In a scenario combining sea level rise with wind, waves and storm surge, that number is +3,6 m.

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All of these are well-known facts, but only among a limited stakeholder group. For the wider group of stakeholders and the population at large, these facts are not well known, and in several cases the relevance of working with CCA-measurements is directly questioned by politicians both at the national and regional level, as well as at the municipal level. In short, multi-level governance and directionality are two of the main barriers where the many different entities in Sweden responsible for different CCA tasks lack in resources and efficiency.

Needs and implementation

With regards to the above background information and the eight dimensions of transformative innovation to address climate change, Blekinge needs to work towards a raised awareness of climate change adaptation (CCA) issues, amongst citizens as well as decision makers. Furthermore, the many entities all holding different crucial keys to succeeding with the CCA-work need to come together and form stronger collaborations with shared goals, implementing CCA in various policy documents, action plans etc.

Blekinge sees a benefit in exploring the potential that Extended Reality (XR Pathfinder) enables. This solution addresses primarily three of the dimensions for transformative innovation: Raising Awareness, Directionality and Making room for experimentation (reference: Transformative Innovation for better Climate Change Adaptation - Case Study: Blekinge and Värmland, Sweden ISBN:978-92-68-14299-8).

BTH is also interested in using XR as a visual decision-support tool from a research perspective, and exploring advanced knowledge transfer and cross-domain synergies with VIA UC in this topic. From a regional development innovation perspective, it is also valuable to use XR as a tool to drive policy innovation and involve stakeholders in decision-making processes. Region Blekinge has broad and long experience in involving different stakeholders from the public sector and to some extent also private companies such as Small and Medium-sized enterprises (SMEs) and large industries. However, to address these complex questions of climate change using the EU Missions Methodology is crucial (reference: Missions Playbook ISBN: 978-91-89905-07-8). It enables us to involve stakeholders from all sectors. To use digital simulations to drive policy innovation is something we can both benefit from and contribute to. One arena that will be used to gather decision makers in order to showcase CCA-simulations is Karlskrona Blue Port Studio (https://www.vpsl.se/the-space/).

2.1.2 Solutions chosen for transfer

One of the main barriers and challenges for regional CCA in Blekinge is involvement and collaboration with stakeholders and decision makers that are important for planning and implementation of holistic CCA solutions. Since both VIA UC and BTH are already working with XR

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this has been decided to be the most appropriate solution for transfer as there is great potential for development of this technology. Furthermore, since Central Denmark Region (RM) and Blekinge have extensive experience with stakeholder involvement it has been assessed to be the most beneficial solution for transfer.

The specific solution for transfer – XR Pathfinder - will be an online guide tool that can be used by authorities in getting the best out of XR in both internal decision-making processes for climate adaptation and in participatory with citizens and other stakeholders. XR Pathfinder specifications and content are draw from knowledge and solutions emerging from the Danish projects, RESIST case studies and other relevant sources. By informing on needs and objectives in the tool, the user will be provided with guidelines on how to develop the most appropriate XR solutions, what will be needed to develop a given solution and recommendations on how to use it in relation to stakeholder involvement. If the user is not able to develop the XR themselves, the XR pathfinder will also be able to provide guidelines for a developer that has the competences.

Table 3. Overview of chosen transfer solutions from CDR to Region Blekinge.

Chosen transfer solution from CDR to Region Blekinge		
Name of solution	**Solution type**	**Short description**
XR Pathfinder	Digital/online tool	An online guide for public authorities containing guideline on how to develop XR solutions and recommendations for using it in stakeholder involvement processes.

2.1.3 Additional activities and solutions being developed within the receiving region

Based on Blekinge's Research and Innovation Strategy for Smart Specialization, our ambition is to apply tech to the EU Missions. Specifically, Climate adaptation and societal transformation and possibly finding synergies with the EU Mission "Restore our Ocean and Waters". We do so by working with an array of different activities:

- **The Climate Tech Tour (CTT)** is designed to raise awareness amongst citizens and decision-makers. Showcasing XR solutions including XR Pathfinder.
- **Through the Regional Innovation Climate Adaptation Platform (RICAP)** we implement an innovation perspective onto existing processes trying to identify barriers and creative ways forward. The goal is to increase innovation capability in a multi-level governance perspective and drive policy innovation.

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- **Future Scenario (FS)** aims to be an arena to support RICAP activities by enhancing internal capabilities of simulation and modelling of future scenarios.

Table 4. Overview of additional solutions developed within the recipient Region Blekinge.

Additional solutions developed within the recipient Region Blekinge		
Name of solution	**Solution type**	**Short description**
Climate Tech Tour (CTT)	Educational framework. Information and awareness	CTT aims to be where citizens are to raise awareness about climate issues and future state. At the same time showing the possibilities of using XR as a visual decision arena. This activity includes; Using XR to raise awareness among decision makers and citizens, citizen science, using arts to drive awareness and explore new narratives, hackathons and storytelling. XR-pathfinder can be implemented in this activity as a tool to guide and facilitate citizen engagement in climate-related projects. Typical places to deploy CTT is Libraries, schools, festivals, museums, open arenas, stages, etc.
Regional Innovative Climate Adaptation Platform (RICAP)	Educational framework. Information and awareness	A regional arena for public sector of different levels to share and build knowledge of how innovation can accelerate climate resilience. Focuses on how to address multi-level governance issues, policy innovation as well as being an arena to experiment with and explore technological innovations. It includes analyzing policy documents, attending regional and national climate forums, aggregating knowledge of barriers in reports etc.
Future Scenario (FS)	Data centre (simulation tool)	Gathering of decision-makers to foster a common goal and roadmap towards climate resilience by using visual decision tools and platforms such as Karlskrona Blue Port Studios, making use of the GDT. XR-pathfinder can be implemented in this activity as a tool to enhance internal decision-making processes as well as quintuple helix processes.

2.1.4 Systemic perspective on regional adaptation efforts

Blekinge is taking a systemic approach to climate change adaptation, integrating technology, policy, and innovation to strengthen its resilience. This involves recognizing the interplay between societal,

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environmental, technological, and economic systems to address complex climate-related challenges. A systemic perspective acknowledges that climate adaptation requires coordinated efforts across all sectors, aligning diverse stakeholders' visions and strategies within the quintuple helix framework. The latter integrates five domains: academia, industry, government, civil society, and the environment. By emphasizing co-creation, the systemic perspective brought forward by the Region Blekinge is that of creating synergies between the different domains of the quintuple helix to address climate adaptation challenges holistically.

The chosen transfer solution, XR Pathfinder, and the additional solutions developed within Region Blekinge come together to form a systemic approach to climate adaptation. XR Pathfinder serves as a comprehensive online guide for public authorities, offering guidelines on developing XR solutions and recommendations for stakeholder involvement. This tool is integrated into various regional initiatives such as the CTT, which raises awareness among citizens and decision-makers by showcasing XR solutions, and the RICAP, which fosters innovation and policy development. Additionally, the Future Scenario platform supports these efforts by enhancing simulation and modelling capabilities. Together, these solutions create a cohesive framework that leverages technology, policy, and innovation to address climate adaptation challenges holistically, aligning diverse stakeholders' efforts within the quintuple helix framework.

2.2 Planned transfers

2.2.1 Transfer: XR Pathfinder

2.2.1.1 Solution description and transfer goals

XR Pathfinder is a comprehensive web-based guide designed for municipal and regional stakeholders to identify the most suitable Extended Reality (XR) technologies. XR Pathfinder offers a collection of generic solutions derived from the experiences of the RESIST project, showcasing how XR can be applied across various settings to support local decision-makers and foster stakeholder involvement.

It offers guidance on the design of XR experiences and selection of ad-hoc XR tools going beyond immediate needs, but rather considering the entire lifecycle of XR technologies, from initial investment, learning curve, reception and long-term maintenance. XR Pathfinder's recommendations are based on lessons learned and best practices developed within the RESIST

project, including, for instance, purchase costs, installation requirements, usability, data ownership, durability, data security, and necessary IT support.

The tool is purposely designed to help authorities in getting the best out of XR in both internal decision-making processes for climate adaptation and in participatory activities with citizens and other stakeholders. Its primary purpose is to support decision-making in the planning and design of climate adaptation solutions and other initiatives aimed at building resilience to climate change. By helping decision-makers leverage XR effectively, the tool ensures they select the right technology to enhance both internal processes and community engagement in climate-related projects.

About the dual function of the tool

1. **Supporting Decision-Making in Planning:**
   The primary function is to assist municipalities, regional authorities, and urban planners in selecting the XR technology (Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR)) that best supports their internal decision-making processes. As they design climate adaptation solutions, stakeholders can leverage XR technologies to visualize future climate scenarios, simulate infrastructure changes, and model the impacts of rising sea levels, extreme weather events, and urban development on existing infrastructure. XR Pathfinder guides users through the selection process, offering insights into which XR tools will be most effective for their specific planning goals, from predicting outcomes, to assessing risks, and to optimizing designs before physical implementation.
2. **Engaging Citizens and Stakeholders:**
   A secondary (but not less important) function is to pinpoint experiences and technologies that can effectively engage citizens and external stakeholders in the design and development of climate adaptation solutions. Whether through virtual town halls that allow residents to explore proposed green infrastructure or AR applications that demonstrate the impact of climate interventions in their neighbourhoods, XR Pathfinder helps decision-makers select XR solutions that foster community engagement and transparency, leading to more inclusive and collaborative efforts between government and the public.

More Than a Simple Tool Selector:

The XR Pathfinder transcends basic tool recommendations by adopting a holistic approach that considers the entire lifecycle of XR technologies—from initial acquisition to long-term maintenance. This ensures stakeholders make informed decisions not only based on immediate needs but also regarding the sustainability, practicality, and cost-effectiveness of their chosen tools over time.
Key lifecycle factors evaluated include:

- **Purchase and Initial Investment:** XR Pathfinder considers the costs associated with acquiring XR technologies, considering in its recommendations both affordable, high-performing solutions and higher-end options with additional features.

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- **Installation and Setup:** XR Pathfinder considers the ease of installation, and the level of technical expertise required, ensuring municipalities choose XR technologies that align with their internal capabilities.
- **Convenience and Usability:** XR Pathfinder considers aspects related to the user experience and accessibility of each XR solution, pinpointing the right trade-off between user-friendliness (to reach a broad audience) while maintaining efficiency for internal decision-making.
- **Ownership and Management:** XR Pathfinder considers data ownership and management aspects, determining whether municipalities or external vendors control the XR environment and data.
- **Wear and Durability:** For hardware components like VR headsets or AR glasses, the tool considers aspects related to durability and lifespan, helping municipalities select reliable technology.
- **Data Security:** Given rising concerns about privacy and cybersecurity, XR Pathfinder highlights integrated data security measures, especially for sensitive urban planning data or community feedback.
- **Modelling Time and Complexity:** The tool considers the time required to create accurate models and the complexity involved, guiding municipalities on whether they need to hire additional staff or collaborate with external vendors.
- **Facilitation and IT Support:** XR Pathfinder considers aspects related to the necessary facilitation and IT support to ensure decision-makers understand potential ongoing costs related to infrastructure, troubleshooting, and system updates.
- **Hardware Maintenance and Replacement:** XR Pathfinder considers aspects related to maintenance requirements and timelines for hardware replacements,

Goals to be achieved with the transfer: The XR Pathfinder will be developed in three stages, i.e. through the iterative development of three prototypes/demonstrators (‘alpha’, ‘beta’, and ‘final’) with the latter intended to be fully operational at the end of the RESIST project.

2.2.1.2 Measures to overcome barriers and customization needs

Outside of the RESIST project, once implemented, the solution should be used within different departments in the municipalities.

A key distinction between RM and Blekinge lies in their respective mandates. While neither BTH nor Region Blekinge is explicitly mandated to address climate adaptation, Region Blekinge does have a clear role in advancing research and innovation. This mandate defines the tools and approaches available to Blekinge for addressing climate change adaptation. RM does not have such a mandate, but the regional authority cooperates with research partners.

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A significant challenge is the lack of resources within municipalities and Region Blekinge's Administrative Board, which limits their capacity to address CCA effectively. However, because the solution is being co-developed collaboratively, it requires minimal adaptation when applied to the receiving region, ensuring seamless integration.

To address the identified barriers, the development strategy follows a spiral process that is commonly used in software and technology innovation. This approach emphasizes iterative development and testing, with progressively refined prototypes demonstrated at each stage. As outlined above, three main prototypes will be created, corresponding to three development iterations.

The outcomes of these prototyping efforts will be showcased in live "probing" sessions, where initial modelling concepts and technologies will be demonstrated to potential end users. These sessions aim to gather valuable feedback on the tool's desired functionalities and aesthetic features, ensuring it aligns with user needs.

The municipalities of Karlskrona and Karlshamn have been identified as primary target groups. Within these, the spatial planning department and Karlskrona's cultural department—responsible for the preservation of the city's UNESCO World Heritage site—are recognized as lead users for need identification and prototype testing.

Table 5. Measures to address barriers and customization needs.

NAME OF THE SOLUTION: XR Pathfinder			
Type of barrier	**Barrier description**	**How can the barrier be overcome?**	
		Measure to address barrier	**Customization of solution**
Lack of long-term resources	Decision competencies lie with the municipalities. Long-term embedding in the organization must be ensured: both resist partners (the platform) and users (municipalities and the solutions they develop) I.e. it is not clear who is responsible for running the platform and solutions after the project.	Promote external competence. Commitment from politicians and civil servants. Through: stakeholder dialogue, discuss value of solution Help them define what organizational support it will take.	N/A

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	Manpower: Who will be responsible for maintenance, updates, running. Etc. Cost of servers and tech requires resources .		
Internal resistance	Low willingness to change already existing processes.	Change management. Education and communication.	N/A
Knowledge gaps	Technical threshold. Low understanding among users	Education and communication.	N/A

Table 6. Solution profile for XR Pathfinder, customized to Region Blekinge.

Solution profile		
Name of the adaptation solution XR Pathfinder	**Solution provider region** CDR, co-developed between VIA UC and BTH	**Climate impacts addressed** Depends on the user needs
Solution description		
Type of solution Digital solution, processing tool, knowledge	**Short solution description** A web-based tool offering guidance on developing and using Extended Reality (XR) simulations, which includes Virtual Reality (VR) and Augmented Reality (AR) for stakeholder involvement in local climate adaptation projects, specifically: • Knowledge and demonstration of XR technologies and their use for simulating location-specific climate changes and climate adaptation solutions • Best practice guidance for design of user-friendly AR	**Spatial scope** Applicable to municipal and regional climate adaptation projects across various locations, focusing on decision making of best possible XR solution.

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	interfaces • Best practice guidance for integration of AR tools for enhanced public engagement.	
Value proposition		
Target group Local authorities (municipal and regional authorities)	**Main benefits for the target audience** • Streamlines the selection, development and implementation of XR tools • Helps visualizing and simulating climate scenarios/adaptation solutions and impacts through XR • Improves decision-making.	**Social and environmental co-benefits for target group and other groups** • Promotes stakeholder involvement in climate projects • Enhances transparency and collaboration between authorities and citizens • Supports long-term sustainability and resilience in urban planning • Increases knowledge and capacity among relevant stakeholders.
Value creation and delivery		
Key resources *Most important assets necessary to create and deliver the solution* • Expertise • Support from municipalities related to pilot testing	**Key activities** *Most important steps to deliver the solution* <u>Development of the XR Pathfinder</u> • Conduct needs assessment • Develop XR Pathfinder • Identify municipalities for piloting of XR Pathfinder • Pilot first version of XR Pathfinder with 2-4 municipalities and collect key lessons • Adapt XR Pathfinder • Workshop discussing CCA solutions using XR • Plan for continuance of XR Pathfinder past RESIST	**Project owner and key partners** *Which organization owns the project, who are key partners involved in delivering the solution?* Project owner: • VIA UC • BTH (co-owner) Key partners: • Local authorities (municipal and regional) • Public Private Partnerships (PPPs) • Possible subcontractors within XR development

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	• Introduce final XR Pathfinder.	• Universities and research centers.
Costs and planning		
Estimated costs (implementing and operating) BTH costs (approximated): 46,5 k€ structure • 2,5 PM for senior researcher/professor, approx. 24 K€ • 2,5 PM for PhD student approx. 14 k€ • 1 PM for post-doc approx. Approx. 6 k€ • Travel costs (for co-located interviews, observations, demonstrations in the Blekinge region:) 1 k€ • Travel costs for co-located meeting and syncing with VIA: 1,5 K€ Operating cost (uncertain estimates): 2,5k€ • 0.5 k€ per year (hosting, domain renewal and SSL certificates) • Energy, consumables, spare parts for devices: 1 k€ • Renting of equipment and facilities (for demonstration, and testing): 1K€	**Revenues / monetized benefits** *If information is available* In the long run (post-RESIST) the XR Pathfinder could become commercialized Possibly co-financing from other projects .	**Time frame for planning and implementation until fully functional** 3 years (2025-2027).
Context		

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Necessary prerequisites *e.g. availability of specific data, skills, etc.* <u>Related to development of a potential XR solution based on XR Pathfinder output.</u> • Access to XR technology: Municipalities must have access to XR tools (hardware and software) and the necessary infrastructure to support their use. • Technical expertise: Staff may require training in XR technologies, or municipalities may need to partner with external vendors for technical support. • Data availability: Municipalities will need access to climate data and other relevant information to ensure that the XR simulations and models are accurate and informative. • Technical and administrative capacity: Successful implementation of XR tools requires a certain level of technical expertise and administrative support, which may be lacking in some regions.	**Success factors** *(optional)* • Understanding of the target audience(s) • Functional / operational solution • Community engagement in the local municipality or region • Commitment of local decision makers to engage with stakeholders.	**Limiting factors** *(optional)* • Not sufficient funds for XR development and CCA projects • Not sufficient knowledge in municipalities for XR development and CCA projects • Lack of support from local decision makers.

2.2.1.3 Resources and costs

The development of the XR Pathfinder involves two primary resource and cost components. As this is a new solution still under development (rather than a ready-to-customize turn-key system), it will require an investment of person months to gather requirements and build / program the tool. Below

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is a breakdown of the planned activities, detailed later in the document with a Gantt chart, along with the total estimated effort for BTH and Region Blekinge for each milestone.

Milestone 1: Total Estimated Effort of 360 Hours

- A1 Need finding Iteration 1: Estimated effort of 115 hours, including 75 hours for conducting 8 interviews and 3 focus groups (preparation, execution, and analysis; 5 hours per session) and an additional 50 hours for systematically mapping existing solutions and academic results in the field.
- A2 Development Work Iteration 1: Estimated effort of 95 hours to code and populate the basic XR Pathfinder platform.
- A3 Discussions with Municipalities: Estimated effort of 90 hours to collaborate with municipalities in identifying pilots and cases for implementation (includes attending decision-making meetings, events, and online discussions, along with preparation and follow-up).
- A4 Piloting: Estimated effort of 60 hours for deployment, training, and data analysis from the pilot results.

Milestone 2: Total Estimated Effort of 390 Hours

- A1 Need finding Iteration 2: Estimated effort of 80 hours, including 40 hours for conducting 6 interviews and 2 focus groups (preparation, execution, and analysis; 5 hours per session) and an additional 40 hours for updating existing solutions and academic results in the field.
- A2 Development Work Iteration 2: Estimated effort of 80 hours to refine the design of the basic XR Pathfinder platform.
- A3 Discussions with Municipalities: Estimated effort of 80 hours to collaborate with municipalities in identifying pilots and cases for implementation (includes attending decision-making meetings, events, and online discussions, along with preparation and follow-up).
- A4 Piloting: Estimated effort of 70 hours for deployment, training, and data analysis from the pilot results.
- A5 Customization Iteration 1: Estimated effort of 40 hours for customizing the second iteration of XR Pathfinder for the cases.
- A6 CCA Solution Discussion: Estimated effort of 40 hours for discussions with municipalities on how XR Pathfinder will impact the design, implementation, and deployment of the items under investigation.

Milestone 3: Total Estimated Effort of 295 Hours

- A1 Need-finding Iteration 3: Estimated effort of 100 hours, including 60 hours for conducting 6 interviews and 2 focus groups (preparation, execution, and analysis; 5 hours per session) and an additional 40 hours for updating existing solutions and academic results in the field.

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- A2 Development Work Iteration 3: Estimated effort of 60 hours to refine the XR Pathfinder platform further.
- A5 Customization Iteration 2: Estimated effort of 40 hours for customizing the second iteration of XR Pathfinder for the cases.
- A6 CCA Solution Discussion: Estimated effort of 40 hours for discussions with municipalities on how XR Pathfinder will impact the design, implementation, and deployment of the items under investigation.
- A7 Introducing the Final XR Pathfinder: Estimated effort of 55 hours, including 30 hours for final refinement of the tool and 25 hours for training and information dissemination activities.

After Milestone 3: Total Estimated Effort of 40 Hours

- A8 Post-RESIST Deployment: Estimated effort of 40 hours for discussions related to the commercialization and post-RESIST deployment of XR Pathfinder.

Table 7. Planned personnel resources.

	Providing region	**Receiving region**
Person Months (PMs) planned for the transfer of the XR Pathfinder	VIA = 7 PM RM = 1 PM AU = 1 PM	BTH = 901 hours corresponding to app. 6,5 PM Region Blekinge = 184 hours corresponding to app. 1,5 PM
Person Months (PMs) total RESIST	VIA = 72 PM RM = 70 PM AU = 26	BTH total= 36,3 PM / BTH remaining 2025-2027 = 25,7 PM Region Blekinge total = 37,9 PM

With regards to software and hardware cost, at this stage, it is not possible to accurately determine the exact effort required for coding and implementation, nor the precise financial resources needed. A rough estimation of operational costs is provided below, but it is intended primarily for illustrative purposes.

A possible architecture for the XR Pathfinder is one that uses Hypertext preprocessor (PHP) as backend technology, a popular server-side scripting language. PHP scripts run on the server to generate the HTML seen by the user. The server fetches relevant data on a database (e.g. MySQL) or static files and embeds it into the HTML. The site is expected to be dynamic. PHP is used to query a database to retrieve content based on the user's actions (e.g., navigating different principles). The server sends a response containing the HTML for the requested page. This HTML includes links to Cascading Style Sheets (CSS) (for styling) and JavaScript (for interactivity).

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XR Pathfinder is expected to have a simple structure and to attract approximately 100 visitors/month at its peak. Shared hosting plans are a possibility for this scale, costing €5–€15/month. These plans provide PHP support, a small database (e.g., MySQL), and sufficient bandwidth for the expected traffic. Providers like Bluehost or HostGator are suitable for this option. If XR Pathfinder requires better performance or minor scalability, a Virtual Private Server (VPS), priced at €20–€100/month, offers dedicated resources and greater reliability.

Additional costs include domain name renewal at €10–€50/year and a Secure Socket Layer (SSL) certificate. SSL is often free through services like Let's Encrypt but can cost €50–€200/year for premium options. Given the simplicity of the application and the traffic expectations, these costs remain manageable. **In total, hosting XR Pathfinder at this stage is expected to cost €75–€300/year**, covering shared hosting, domain renewal, and SSL certificates. If future traffic or complexity increases, the hosting setup can scale up to meet demand, such as upgrading to a VPS or cloud hosting service.

2.2.1.4 Planning the transfer

Objective, purpose, results, and planned activities

The logframe Maxtrix outlined in table 7 outlines the objectives and purposes of the transfer of the XR Pathfinder as well the expected results and the specific activities that must be implemented to achieve these objectives and results.

Table 8. Logframe Matrix for the planned transfer.

Logframe Matrix XR Pathfinder CDR -> Blekinge			
Transfer project description	**Indicators**	**Source of verification**	**Assumptions**
Overall objective			
Increased application of digital decision support tools for successful CCA action	(Change in) number of CCA activities found in strategic CCA documents linked to or resulting from using technical visualization tools.	Desktop study	
Increased awareness and knowledge among citizens about specific climate	Percentage of people who demonstrate a high level of awareness to climate	Interviews (in which experienced progression is measured)	

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hazards and adaptation solutions	risks and possible solutions.		
Better planning documents that take climate into consideration at an early planning stage	(Change in) times CCA solutions are mentioned in new/updated strategic plans and documents (for example spatial planning).	Desktop study comparing old and new/updated documents.	
Purpose			
Municipalities use XR Pathfinder to find XR solutions that can help with a climate adaptation problem.	Number of monthly visitors on XR Pathfinder.	Survey + data from XR Pathfinder	Using digital support tools will move actors (municipalities, local politicians) towards action and alignment. XR technologies facilitate successful stakeholder engagement. Successful stakeholder engagement will lead to more acceptance and higher prioritization of CCA measures.
Cross sectorial use of XR pathfinder as a decision support tool to include XR technologies and CCA perspective in forming strategies.	(Change in) times XR solutions are mentioned in new plans and strategies.	Desktop study	
Results			
XR Pathfinder is up and running as online platform.	Fully functional XR Pathfinder is online	Website of XR Pathfinder and project report	Municipalities understand the potential impact of the technology (how can you use XR as an efficient support tool) Local politicians support working with XR to address CCA.
Municipalities have been introduced to the final XR Pathfinder.	3 municipalities	Project report	
Workshops have been conducted with	8 workshops conducted with	Project report	

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municipalities to discuss needs / interests for XR solutions	municipalities to discuss needs/interests for XR solutions.		Municipalities receive enough resources to implement XR solutions. XR solutions address needs of municipalities, and multiple levels within the municipalities see that need.
Plan exists on how the XR Pathfinder will continue after RESIST	Agreement exists for continuation of XR Pathfinder	Agreement document	
Activities			
Conduct needs assessment with businesses and municipalities regarding using XR for driving climate adaptation action and stakeholder involvement.			Pilots generate useful lessons. Resources suffice to develop the online platform. Municipalities are interested and cooperative. Local politicians support working with XR to address CCA, and to keep the XR pathfinder alive after RESIST.
Develop XR Pathfinder: development of the platform itself based on existing needs assessment results, include knowledge and results of former projects.			
Find municipalities for piloting the XR pathfinder.			
Pilot first version of XR path finder with 2-4 municipalities in Blekinge and assess key lessons learned.			

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Adapt XR path finder based on lessons learned.			
Make plan for how XR Pathfinder will continue after RESIST (possibly cooperating with businesses).			
Introduce the final XR path finder to municipalities and other relevant stakeholders.			
Conduct workshop with municipalities to discuss possible XR solutions to address their CCA needs based on XR Pathfinder usage.			

Next steps

The table below provides a visual representation of the short- and long-term activities related to the development of XR Pathfinder, with a focus on the 3 critical milestones for the development of the solution, which are synced with the planned dates for the consortium meetings.

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Table 9. Timeline and milestones for the development and deployment of XR Pathfinder (abbreviated as XRPF in the table).

Milestone 1 (M1): Verified XR Pathfinder alfa prototype

The first milestone focuses on the development and delivery of the initial XR Pathfinder prototype for piloting, along with preliminary results from initial testing within the pilot. The creation of this first version is primarily based on Activity A1, which aims to gather detailed information about the solution's needs and requirements through stakeholder interviews, surveys, and workshops with municipalities, decision-makers, and other relevant stakeholders. The primary focus of Activity A1 is to understand specific climate adaptation needs, identify the challenges stakeholders face, and explore how they envision using XR technology in their decision-making processes.

The second step, Activity A2, involves developing the XR Pathfinder platform itself. As explained in a previous section, this includes implementing PHP as the backend technology and integrating it with the supported database (e.g., MySQL) or static files that embed the relevant XR Pathfinder

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information. This work is closely aligned with and informed by Activity A3, which focuses on identifying municipalities in the Region Blekinge suitable for piloting.

Additionally, A3 is coupled with Activity A6, which involves establishing a continuous dialogue with municipalities and other stakeholders to explore potential XR solutions for addressing climate change adaptation (CCA) needs, using the XR Pathfinder as a guide. During the first year, Activity A6 will be conducted at a lower intensity compared to other tasks but will aim to leverage existing opportunities and foster potential collaborations.

Milestone 2 (M2): Validated XR Pathfinder beta prototype
The second milestone focuses on achieving a validated, 90%-ready XR Pathfinder release for internal use by the Large Scale Demonstrator (LSD). Notably, the design process for XR Pathfinder will follow a classical spiral approach, consisting of three iterative cycles to progressively identify knowledge gaps, highlight priorities for climate adaptation, and determine the most critical XR features needed to effectively address these challenges.

The second iteration of Activity A1 will take place at the end of 2025 and into early 2026. This will subsequently inform the second iteration of Activity A2, which focuses on further development of the platform to introduce additional functionalities and content. The emphasis will also shift towards creating a seamless user experience and interface, building upon the functionality-based prototype developed during Milestone 1.

The efforts to define municipalities for piloting will be intensified under Activity A3, alongside further work on Activity A6, which involves discussions on CCA solutions in relation to XR Pathfinder. During the spring and early summer of 2026, the focus will transition from development to adaptation and customization (Activity A5), driven by inputs from Activities A3 and A6.

Piloting activities for the XR Pathfinder beta prototype (Activity A4) will be conducted after the summer break, with the goal of presenting the results at the 7th Consortium Meeting in late 2026.

Milestone 3 (M3): Final XR Pathfinder release
The final iteration will focus on delivering the complete XR Pathfinder release at the final consortium meeting. This release—featuring a fully functional solution available online for RESIST-wide use and external partners—will benefit from a new round of need-finding and development work under Activities A1 and A2.

Particularly, A1 will monitor the use of the beta prototype delivered at Milestone M2 to gather insights and feedback. This includes, for instance, monitoring the number of civil servants at municipalities that made use of the solution during a specified timeframe, together with other relevant indicators extracted from the analysis of the tools and/or surveys. The work will increasingly emphasize Activity

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A5, making necessary adjustments to improve usability, enhance functionality, and better align the tool with user needs. The overarching goal is to ensure the XR Pathfinder is fully functional and ready for broader deployment.

Workshops under Activity A6 will also be conducted to evaluate the effectiveness of the XR Pathfinder in addressing specific CCA challenges and decision-making complexities. This activity will further monitor how often and how much XR solutions are mentioned as design support tools in official documentation related to new plans and strategies for climate adaptation solutions. This will ensure that the solution remains relevant, practical, and capable of tackling real-world needs effectively. The introduction of the final XR Pathfinder (Activity A7) will take place after the summer of 2027 and will include a range of activities, such as the development of marketing materials, establishing a social media presence, conducting demonstrations, and hosting mini-training sessions. Furthermore, the final release will be tested and validated during these sessions, and the lessons learned will be documented for future use.

This final step will lay the groundwork for the concluding work under Activity A8, which will explore post-RESIST opportunities related to the commercialization of the tool and its approach through the definition of agreement documents between the RESIST team and the external parties.

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3 Transfer plan – Central Denmark Region to Zemgales Planosanas Regions

3.1 Solution-receiving region: Challenges, needs and climate adaptation solutions

3.1.1 Key regional needs in the field of climate resilience and climate change adaptation

Zemgales Planosanas Regions (ZPR) is a region located in the southern part of Latvia and is located in a terrain situated only 30 to 50 meters above sea level.

The area is characterized by a flat terrain with clayey soil and a high content of impermeable rocks. There is a high groundwater table and a dense network of rivers averaging 0.27 kilometers of river per square kilometer. This means that there is a high risk of flooding in ZPR and especially in the Bauska municipality including the Lielupe River basin, due to its geographical location, hydrological characteristics, and increasing frequency of extreme weather events linked to climate change.

Weather data shows that heavy rain events (storm water) related to climate change are becoming more often and with higher amount of water each time. As an example – data show a doubling in precipitation during storm water event from 50 mm over 24h in year 2017 to 80 mm over 24h in 2024 and every 4 years it increases by 10 mm in critical rainy days.

The effects of this can already be seen through more rapid and powerful flood events which causes damages on existing buildings and infrastructure, and it is only expected to worsen in the future due to climate change.

Adaptation measures are thus needed to accommodate these increases in precipitation and prevent flooding. In relation to this it is crucial to study soil conditions including hydrological dynamics and how this is affected by climate change as this together with climate scenarios will provide important local knowledge about water dynamics which is important for the development of climate change adaptation (CCA) measures.

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3.1.2 Solutions chosen for transfer

To increase flood resilience and promote a sustainable landscape development in the Bauska municipality, the solution “Network of loggers” (will also be referred to as Internet of Things “IoT” loggers) will be transferred from the Central Denmark Region (CDR) partner, VIA University College (VIA UC) to ZPR.

This solution will assist ZPR in examining groundwater dynamics and monitor how increasing precipitation, caused by climate change, will affect the groundwater level in development areas like the Bauska municipality and will thereby aid physical planning and CCA in this area.

The focus of this transfer will be on the groundwater level as it is one of the key challenges in the area. And before choosing the relevant CCA solutions e.g. Nature-based Solutions (NBS) it is crucial to understand the groundwater dynamics to understand to what extent we can rely on infiltration and to what extent NBS will have to be connected to the drainage network, or if water reused on site would be problematic.

Table 10. Overview of chosen transfer solution from CDR to ZPR.

Chosen transfer solution from CDR to ZPR		
Name of solution	**Solution type**	**Short description**
IoT loggers	Physical installation of IoT groundwater loggers in the project area and digital solution for data use.	On-going scientific and technical support for physical installation, data gathering and setting up a data base is provided through regular online working group meetings, site visit, knowledge workshop etc.

3.1.3 Additional activities and solutions being developed within the receiving region

1. After having complete investigation on hydrological data, including the IoT logger study, as well as having received guidelines regarding several types of NBS, a decision will be made if NBS is a relevant solution to improve the conditions in the project area for water flood management and reduce flood risks. Thereafter the appropriate NBS will be chosen and preparation of a technical project for implementation after the end of RESIST project will be made.

2. Guidelines for local, regional and national legislation in relation to CCA and society resilience building would widen the scope of view and perspective of engaging stakeholders. During the project

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and the revised experiences there will be developed a list of suggestions for regional and national legislation – like local terms of use and construction of the territory (local level) and national Construction law and relevant regulatory acts.

3. Dynamic monitoring of soil moisture will be conducted by Riga Technical University (RTU) together with other project activities and will provide an idea of soil moisture and its water absorption properties which is important to understand for decision-makers. This is an important indicator for compliance with construction conditions in the case of new buildings. When developing a new territorial development plan, it is important to take this into account in order to ensure the sustainable existence and development of both buildings and the territory as a whole.

Table 1111. Overview of additional solutions developed within ZPR.

Additional solutions developed within ZPR		
Name of solution	**Solution type**	**Short description**
1. Nature-based Solution technical project	Project of physical solution	In collaboration with the university, a technical project on NBS will be designed using data collected during the two transfer plan activities.
2. Guidelines for local, regional and national level legislation in relation to CCA and society resilience building	Report with best practice guidelines/policy guidelines	By having an overview and insight of RESIST project activities, ZPR will develop a list of conditions that need to be adjusted or implemented in relevant/appropriate legislation, to enable the government to create a more resilient future and mitigate the adverse impacts of climate change. Will be developed in collaboration with CDR.
3. Soil moisture dynamic monitoring	Digital platform	Conducting soil sampling and deploying soil moisture sensors to analyse the physical infiltration of water into the soil, RTU and ZPR will create a digital platform for the potential impact of stormwater flooding

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		on building construction conditions.

3.1.4 Systemic perspective on regional adaptation efforts

As the ZPR landscape corresponds to a description of as a flat area, the river basin (Lielupe) is usually under the influence of various floods and climatic conditions. Therefore, the close surroundings of the river basin is indicated as vulnerable to floods and in many areas there are restrictions placed for the house building. Through the RESIST activities, ZPR find it relevant to awaken awareness of the public and private sectors about these issues and give an insight of tools showing how to deal with climate changes in a local scope through the IoT loggers.

From a state system perspective – in Latvia's "National development plan 2021 – 2027" (https://www.mk.gov.lv/lv/media/15165/download?attachment) the RESIST project supports the implementation of priority "Qualitative development of the living environment and territories" where the goal is improving the quality of the living environment for balanced regional development.

In the Bauska municipal Development programme 2022 - 2028 the goal is to have a sustainable and smart environment management as well as a dynamic business environment, human capital potential and mobility.

By participating in the RESIST project ZPR and RTU can go deeper in an investigation for the nuanced needs of the local government. ZPR will involve the research team from the Water System and Biotechnological institute at RTU to collaborate on the identification and monitoring of the ground water level, precipitation measures and completion of the soil moisture dynamic observation in Bauska municipality. This gives a fundamental scientific and technological approach which the municipality has been missing for some time. The establishment of hydrological and hydraulic models will support monitoring of water flow in the local river and inland territories to help the municipality in managing water storage after heavy rains. The NBS approach will have an innovative impact on developing the limit of environmental risks of flooding. Meanwhile it increases community awareness of CCA and provides a new scale of water management tools.

3.2 Planned transfers

3.2.1 Transfer: IoT loggers

3.2.1.1 Solution description and transfer goals

"IoT loggers" is a solution that includes results and knowledge from the CDR project, "Network of loggers". The transfer will be conducted in a close collaboration between the 2 project partners and knowledge institutions, VIA UC and RTU and ZPR with ongoing support and knowledge exchange. The solution will be directed towards public authorities working with holistic water management including groundwater management and will be customized to a local context in the Bauska municipality.

The goal of this transfer will be to increase local resilience and adaptive capacity in the Bauska municipality by helping the local authorities monitor and learn more about groundwater dynamics and floodings in the project area and enable them to integrate this knowledge into their physical planning and CCA.

The solution will specifically include support and guidance on:

- How to identify and involve relevant stakeholders in the installation of the loggers
- Identification of appropriate location for the loggers
- Installation of the loggers
- Maintenance of the loggers
- Data collection and quality assurance
- Data preprocessing for hydrological model input

According to the timeline in chapter 3.2.1.6 we expect to conduct a full transfer and implementation of the solution within the project period.

Pilot activities in the LSDT2 transfer will be directly linked to activities in the transfer between ZPR and East Macedonia and Thrace (EMT) in LSDT1 as they work in the same project area, with the same climate challenges and because the activities will benefit each other.

The LSDT1 transfer will focus on the hydrological modelling of groundwater dynamics and the establishment of NBS as a CCA solution. In relation to this, different climate scenarios will be developed through hydrological modelling, and it will be assessed and visualized how they will affect the groundwater table and flood risks. Furthermore, it will be examined through hydrological modelling how NBS can affect flood scenarios and be used as a CCA solution.

As input data to these hydrological models, data from the IoT loggers can be used as they provide real time data on the groundwater table. Activities in the transfer between LSDT1 and LSDT2 will thus be coordinated closely which can be seen in the GANTT chart in chap. 3.2.1.6.

3.2.1.2 Measures to overcome barriers and customization needs

In relation to the LSDT2 transfer a couple of barriers and needs for customization have been identified and will be addressed in the following.

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There is one main difference in the project context between CDR and ZPR which is the need and level of stakeholder engagement that differs a lot. In CDR there is a higher demand and requirement for stakeholder involvement compared to ZPR. For this reason, project activities in the project "IoT loggers" in CDR, include the development of an Augmented Reality (AR) solution to visualize what the logger data shows. The visualizations will be directed towards laymen and decision-makers to increase their understanding of the climate challenge, which is shown in the data.
In ZPR, the demand and resources for the creation of visualizations are less pronounced and the visualizations plans will thus be customized when the solution is transferred to ZPR. Instead of visualizing the logger data through an AR solution the data will instead be used to develop a hydrological model and respective visualisations. This is directed towards a narrower stakeholder group. But it is estimated to be sufficient for the level of stakeholder involvement required in the Bauska municipality.

The main barriers related to the solution "IoT loggers" includes:

1. A lack of knowledge and understanding among relevant stakeholders concerning the technology and approach that will be used. Landowners and other relevant stakeholders who will be involved in the project will most likely have no knowledge about the technology and approaches that will be used. There is thus a risk that the landowners might oppose to the project as they are presented to the project as they might fear how this will affect them.
   To overcome this barrier, ZPR will make sure to communicate project objectives and plans to the involved stakeholders and ensure them that everything is complying with national legislation. The climatic challenges and relevance of the project will also be communicated very clearly to underline the importance of the project.

2. Another barrier is about communication and collaboration between the involved stakeholders who are either not interested in engaging in a dialogue or oppose to the project.
   To overcome this barrier ZPR will develop communication material that underline the importance and benefits of the project and use inspiration for stakeholder engagement from other RESIST partners.

3. Finally, the weather could become a barrier for the timeline of the project. There is a risk for a delay as installation of the loggers, as data collection and logger maintenance are very dependent on dry and not too cold weather conditions. If we experience longer periods with floodings or extreme cold, it could delay the delivery timeline. Planning of the transfer will thus include a buffer for small delays.

Overall, it is however estimated that the direct transfer does not require a high level of customization of the original solution, as the IoT technologies adopted here are mature and sound. This means that a limited number of modifications will be needed as the demonstration in Zemgale is quite similar

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to the Danish case. The most urgent needs for customization are thus related to the barriers mentioned above and in table 12.

Table 1212. Measures to address barriers and customization needs.

NAME OF THE SOLUTION: IoT loggers			
Type of barrier	**Barrier description**	**How can the barrier be overcome?**	
		Measure to address barrier	**Customization of solution.**
1. Customization of data visualization.	Lack of resources and skills to develop XR visualizations of data from IoT loggers. Other requirements and needs for stakeholder involvement in ZPR.	Identification of other possible visualization tools. Analysis of best practice examples for visualization.	Development of hydrological models for visualization Testing of new approaches.
2. Knowledge and understanding of the tool (IoT loggers).	Lack of understanding among the users about the loggers and the hydrological modelling might cause resistance from relevant stakeholders to engagement in the project.	Identify knowledge gaps and issues that stakeholders oppose to. Insurance that data collected will be used according to national legislation (data protection). Clear communication about the goals of the project and its benefits. Communicating the importance of having the data which will be collected and how they will contribute to reduce climate risk. Provide information about the tool and project.	Provide educative performance in municipality.

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3. Collaboration and communication between stakeholders (municipality, landowners and others).	Lack of interest among landowners to engage in the project. Resistance among landowners and relevant stakeholders to collaborate.	Knowledge exchange with other RESIST partners about stakeholder involvement.	Develop visualizations of project benefits and description of how the project will contribute to the development and climate adaptation of the area.
4. Delay in the timeline due to wet and cold weather conditions.	Very wet and cold weather conditions can challenge installation of the loggers, data collection and logger maintenance and can thereby delay the timeline.	Planning.	Buffer in timeline for small delays.

3.2.1.3 Key elements of the solutions provided

Transfer of the solution “IoT loggers” will include technical support and guidance through the entire transfer and all the steps included. See table 13 for an elaborative description of the solution elements provided.

Table 1313. Solution profile for IoT loggers

NAME OF SOLUTION: IoT loggers		
Short description of the adaptation solution To collect detailed data on shallow groundwater, enabling adaptation measures to be undertaken, a series of IoT loggers is installed to continuously monitor the groundwater table. Data is collected online and can be	**Type of solution** Physical installations of IoT loggers. Digital platform of online database.	**Solution provider region** CDR - VIA UC

accessed in real-time. The extensive data set can be used to gain significant insights into groundwater responses to various climatic conditions, allowing for the identification of the best possible adaptation solutions.		
VALUE PROPOSITION		
Target group Local civil society Entrepreneurs on site Civil protection specialists Entrepreneurs and professionals within the building sector, Investors of development for the local area Local and national politicians	**Main benefits for the target group (purpose)** The project area will become attractive for entrepreneurship establishment, which gives workplaces for persons from near surrounding. The case study area will pioneer an example of science and technology synergy where climate change will be embraced as an example of support for development and thinking "outside the box".	**Social and environmental co-benefits for target group and other groups** Social: The local authorities will be able to increase flood resilience as data and knowledge from the IoT loggers will give more precise information about groundwater changes which can be used in CCA and physical planning. Environmental: Through the data and knowledge obtained from the IoT loggers the local authorities will be able to place new industrial and development areas away from flood prone areas and thereby decrease flood damages and pollution from industry entailed by flooding. E.g. contaminant from industry that could be led to water courses during a flood.
SOLUTION DETAILS		
Climate impacts addressed Flooding from increasing precipitation and raising groundwater.	**Delivered results** Collected IoT logger data will be used for hydrological model calibration and validation.	**Spatial scope** Bauska municipality.

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	Online database will provide real time ground water dynamics for relevant parties, such as water management, urban planning department, etc. Real time ground water level data will assist forecasting of floods in the area.	
VALUE CREATION AND DELIVERY		

Key resources
 	
The most important resources for the project are:
• IoT loggers
• Landowner permission to install the loggers
• Educated staff for:
  ○ Implementation of IoT loggers
  ○ Collection data from the loggers
	Key activities
	
	• Geological and hydrological investigation for locations for IoT loggers
	• Installation of IoT loggers
	• Maintenance of IoT logger devices
	• Data collection and quality assurance
	• On-going support from VIA UC on establishing network of IoT loggers
		Project owner and key partners
		
		Project owner:
		• VIA UC
		Key partners:
		• ZPR
		• RTU
		• Landowners
		• Bauska municipality

COSTS AND PLANNING		
Estimated costs (implementing and operating) ZPR share ~26000 EUR with RTU for agreed activities – incl. 7 PM for RTU. ZPR allocate 14 PM for this activity and whole CDR LSDT2 transfer. VIA UC allocate 15.000 EUR (staff cost and travel cost) for capacity buildings and transfer	**Revenues / monetized benefits**	**Time frame for planning and implementation until fully functional** Year 2025 – 2027.

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activities – incl. 2 PM for VIA.		
CONTEXT		
Necessary prerequisites The following prerequisites are necessary for completion of the project: • Political support for the project activities in Bauska Municipality. • Skilled staff in working with IoT loggers machine learning competences.	**Success factors** Established great teamwork with RTU for IoT loggers for data management and use in different type hydrological models.	**Limiting factors** Politicians understanding, knowledge and interest in climate change topic itself.

3.2.1.4 Resources and costs

Costs for installing IoT loggers varies according to the soil types in the project area as specific equipment will be needed to bore the wholes where the loggers will be installed. Installing in clay soils is more demanding and thus more expensive. In comparison installation of loggers in sandy soils might be cheaper. Costs must be expected for drilling and staff to handle the drill.

Costs of installation depend on:
Number of sites in clay soil vs sandy soils respectively
Time for drilling per hole (sandy vs clay) x labour costs for drilling
Costs of renting drill per day
Analysis of catchment hydrology

The total amount for equipment is about 13000 EUR, including hole drilling.

Table 14. ZPR share out of its RESIST budget with the Water System and Biotechnology Institute at RTU in (EUR)

Works and services total	**13.000**
Borehole drilling	4.500
Installation of sensors	1.100
Maintenance visits	2.000

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Soil sampling and analysis	3.000
IoT platform - sensor data storage and visualisation	2.400
Equipment total	**13.000**
Rain gauge: sensor for precipitation data, needed for hydrologic/hydraulic model (1 pcs)	825
Depth, temperature, electric conductivity logger (with LoraWan transmitter): loggers for measuring groundwater level changes as well as surface water infiltration (10 pcs)	7150
LoraWan Gateway - Gateway/modem for data (2 pcs)	1.430
Soil moisture sensor (6pcs)	2.275
Solar panel and battery pack (2 pcs)	1.320
Travel for cooperation with CDR and VIA	**5000**
Total	**31000**

Maintenance of loggers and monitoring data quality – staff will need 1 day a month for at least a year, depending on how long ZPR wants to collect the data.

Table 15. Planned personnel resources

Efforts	**Providing region**	**Receiving region**
Person Months (PMs) planned for transferring IoT logger solution	VIA UC: 2 RM: 0,5 AU: 0,5	ZPR: 14 RTU: 8
Person Months (PMs) total RESIST	VIA: 73 PM RM: 70 AU: 26	ZPR: 64 PM RTU: 30 PM In total: 94 PM

3.2.1.5 Planning the transfer

Objective, purpose, results and planned activities

The overall objective of the transfer with ZPR is to increase climate resilience and adaptive capacity in the Bauska municipality by supporting the municipality in the process with the IoT loggers (an elaborative description can be found in table 13).

More information about the objective, purpose and results can be found in table 16.
A GANTT chart and an elaborative project plan can be found in table 17 and below.

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Table 1616. Logframe Matrix for the planned transfer.

Logframe Matrix for IoT Loggers CDR to ZPR			
Transfer project description	**Indicators**	**Source of verification**	**Assumptions**
Overall objective			
Reduction of flood damages in the ZPR.	Difference in costs from flood damages (2024 – 2027 - 2030).	Municipalities.	
Development of entrepreneurial areas outside of risk zones.	Yearly costs from flood damages in new entrepreneurial areas.	Municipalities.	
Online data support gives the opportunity to develop technologies for waterproof building technology development.	Regulatory acts for the construction of residential and industrial buildings include conditions for building options in wet and flooded areas, which allow a person to build buildings with certain technical parameters in flooded areas.	Ministry of Economics, Republik of Latvia.	
Purpose			
Better knowledge of groundwater dynamics in case area.	Number of municipalities for which recommendations for hydrological system management have been developed.	Recommendation and documents for municipalities Municipal development plans.	Uptake and integration of modelling results by municipal planning. Risk awareness in population,

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	Number of development plans take into account hydrological dynamics and challenges (after project timeline).		municipalities, and industry.
Better hydrological modelling.	Good calibration and validation results of the hydrological models.	Project reporting from Transfer EMT – ZPR.	
Better planning and more implementation of NBS solutions in the region.	Number of NBS in planning / implemented to mitigate floodings.	Physical plans at municipal and regional level.	
VIA UC is experienced in transferring the solution to different regions.	IoT loggers are installed and running properly at new project area.	Project reporting.	
ZPR has expertise in maintaining IoT loggers at site.	RTU is maintaining IoT loggers successfully from 2027 onwards.	Project reporting.	
Results			
Geological and hydrological knowledge of the case region.	Map with geological and hydrological information has been produced.	Map output and project reporting.	Successful implementation of hydrological models (transfer from EMT). Successful cooperation between EMT transfer team and RTU. Political will and sufficient resources to utilize data in NBS
IoT loggers are installed and running.	Number of IoT loggers installed and running.	Physical loggers and project reporting.	
High-quality data for hydrological models is generated.	Online database available.	Online database and project reporting.	

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Delivery of successful formats for technical support and expertise building.	Number of days sent on provision of technical supports.	Work plan / activity plan.	planning and implementation. Municipalities are able to work with the project results.
Activities			
Geological investigation of soil properties at the case region and plan positions for IoT loggers.			Weather conditions are suitable for IoT logger implementation and precise data output. Geological conditions are suitable for installing IoT groundwater loggers (drilling boreholes). RTU has required expertise in understanding geological, hydrological background of the region and has technical staff to install the loggers.
Procurement of IoT loggers.			
Installation of IoT loggers.			
Hardware maintenance of IoT logger devices.			
Data maintenance and quality assurance of IoT loggers.			
Providing ongoing technical support and scientific expertise.			

3.2.1.6 Next steps/Timeline until 2027

The following timetable shows how transfer activities between ZPR and CDR (LSDT2) and EMT (LSDT1) have been scheduled, followed by an elaboration of the activities and milestones below.

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Table 1717. GANNT chart with planned activities related to the transfer in LSDT2 and 1.

Acitivity	2025				2026				2027			
Quarter of the year (QX)	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Activities in LSDT1												
1. HECRAS and HECHMS guidelines			x	x	x	x	x					
2. Development of model by use of HECRAS and HECHMS tool						x	x	x	x			
3. NBS supply					x	x						
4. NBS analyses in regard to local needs						x	x	x				
Activities in LSDT2												
1. Procurement and purchase of IoT loggers and tender for borehole drilling for groundwater loggers	x	x										
2. Locate where to install the loggers	x	x										
3. Dialogue with landowners about permissions to install the loggers		x										
4. Obtain necessary permissions (*e.g. legal permissions)	x	x										
Milestone 1. All preparations for installation of loggers completed (Milestone 1)		**x**										
5. Installation of loggers in field (incl. Boreholes)		x	x									
6. Stakeholder involvement (municipality, landowners, real estate agents, university, NGO's)		x				x					x	
7. Meeting with municipality and landowners		x	x	x		x	x	x		x	x	
8. Loggers maintenance			x	x	x	x	x	x	x	x	x	x
9. Data collection				x	x	x	x	x	x	x	x	x
Milestone 2 Data collected from IoT loggers All loggers are installed and running (online data collected from loggers)				**x**				**x**				
10. Interpretation and transfer of data and transfer of data for hydrological modelling (LSDT1)						x	x	x	x	x	x	

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11. Presentation of results and integration of IoT practise in Bauska Municipality												x
Milestone 3 IoT data have been transferred and used for the hydrological model in the transfer with EMT.												**x**

Step 1.
RTU will initiate and complete a procurement process to find the best “Value-for-money" offer for IoT loggers and drilling services on the market in Latvia. Based on this RTU will purchase the required IoT loggers.

Step 2.
Simultaneously to step 1, a more specific location for the installation of the loggers will be identified. Locations will be chosen based on the hydrological and geological investigations conducted by RTU. Apart from that, locations should be accessible for installation, and it should be possible to get permissions from relevant landowners.

Step 3.
After the locations have been decided for loggers, ZPR and Bauska Municipality will engage in a dialogue with the landowners and get permission to install the IoT loggers on their property.

Step 4.
Besides permission from the landowners, other relevant permissions for installation of the IoT loggers will be collected. This includes all relevant legal permissions from the state or municipality.

Milestone 1.
By 1. July 2025 all preparatory activities necessary for installation of the loggers should be completed.

Step 5.
When all permissions have been collected the installation of the loggers will be initiated. This will first of all include drilling holes for the loggers and afterwards installation of the loggers.

Step 6.
Once a year through the project period relevant stakeholders (municipality, landowners, real estate agents, universities, NGO's) will be gathered to be informed about project activities, progress and results. But also to get input from the stakeholders to the project.

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Step 7.
Regular meetings with Bauska municipality and landowners whose property is involved in the project will be held to maintain a constant dialogue with the stakeholders about project activities and keeping them informed and involved in the project.

Step 8.
From the moment the loggers have been installed and throughout the project period, maintenance of the loggers will be required. VIA UC will guide this process with the ambition that RTU/Bauska municipality will eventually be able to handle this themselves.
Maintenance of the loggers includes borehole maintenance, hand measurement of ground water levels for periodic calibration and checking their physical condition e.g. battery level.

Step 9.
Data from the loggers will be collected and saved in an online database (provided by the IoT logger provider) from the moment they have been installed and throughout the project period and will be provided to the municipality.

Milestone 2.
All loggers planned at ZPR are installed (physical assets) and a series of 1 year data from the loggers will be gathered and transferred to LSDT1 for the hydrological model. By gathering 1 year of data all seasonal variations should be presented in the data resulting in more valid models.
Only 1 year of data will be transferred as time will be needed to process the data.

Step 10.
The data gathered will be analysed for tendencies and patterns and will be transferred to LSDT1 for the hydrological modelling.

Step 11.
The results of this project will be presented to the Bauska municipality for use in relation to their development and climate adaptation plans. Transfer of the expertise and knowledge of IoT loggers will also be transferred to the municipality with the target of building up capacity in the municipality.

Milestone 3.
Marking the end of the LSDT2 transfer is a complete transfer and use of the IoT loggers and data for the hydrological model developed as a part of the transfer between EMT and ZPR. Furthermore, the final milestone marks a step where both data and the model will contribute to the local CCA planning and increasing climate resilience.

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4 Transfer plan – Central Denmark Region to Vesteralen Region

4.1 Solution-receiving region: Challenges, needs and climate adaptation solutions

4.1.1 Key regional needs in the field of climate resilience and climate change adaptation

General Overview

Vesteralen region, a coastal region in Northern Norway, is highly exposed to the impacts of climate change due to its geography, economy, and socio-political context. The region's dispersed population, reliance on primary industries like fishing and aquaculture, and vulnerable ecosystems make it particularly susceptible to rising sea levels, extreme weather events, and changes in marine ecosystems. Current adaptive measures are limited, and the region lacks a comprehensive Climate Risk Assessment (CRA), which poses challenges in planning and implementing effective climate adaptation strategies.

Key Climate-Related Risks

1. **Extreme Weather and Surface Water Management**
   Increased precipitation and storm surges lead to flooding, landslides, and challenges in managing surface water, particularly in urban and infrastructural settings.

2. **Sea Level Rise**
   Coastal settlements, ports, and agricultural areas are at risk from rising sea levels, which threaten both the physical environment and economic activities.

3. **Changes in Marine Ecosystems**
   Ocean warming and acidification pose significant threats to fish stocks and aquaculture, jeopardizing cornerstone industries and regional economic stability.

4. **Vulnerable Ecosystems and Natural Resources**
   Shifts in temperature and precipitation patterns affect local vegetation, wildlife, and recreational areas, impacting both environmental sustainability and the quality of life for residents.

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5. **Infrastructure and Energy Systems**
   Critical infrastructure, including transportation, water supply, and energy systems, faces mounting pressures from climate impacts such as permafrost degradation and extreme weather events.

Needs Addressed Through Solution Transfers

To meet these challenges, the transfer of innovative solutions such as the Extended Reality Pathfinder (XR Pathfinder) and BEST Adapt tools will address critical gaps:

- **Enhanced Decision-Making:** Providing tools for visualizing and planning climate adaptation measures tailored to regional risks.
- **Stakeholder Engagement:** Raising awareness and fostering collaboration among local authorities, industries, and citizens.
- **Improved Data Utilization:** Facilitating data collection, integration, and application to support evidence-based climate adaptation strategies.
- **Capacity Building:** Strengthening local capabilities by using advanced tools and methodologies for effective climate resilience planning.

These initiatives aim to provide a foundation for developing a shared CCA Plan for Vesteralen region, aligning with local and regional sustainability goals while enhancing climate awareness and resilience.

4.1.2 Solutions chosen for transfer

One of the specific challenges for regional CCA in Vesteralen region is collecting the necessary local data and generating adequate information and visualizations to take key decisions to secure the area. Also, the region faces a challenge in raising awareness about climate change among the local population. Therefore, a combination of XR Pathfinder and Best Adapt has been chosen as the most appropriate solution for transfer.

In a collaboration between VIA University College (VIA UC), Aarhus Universitet (AU), Region Midtjylland (RM), Stiftelsen Museum Nord (Museum Nord), the Vesteralen Regionrad (Vesteralen), Andfjord Salmon AS (Andfjord), and with participation of Blekinge Tekniska Högskola (BTH), the transfer of XR Pathfinder entails adapting a comprehensive web-based guidance tool that aids different stakeholders in identifying the most suitable Extended Reality (XR) solutions for specific challenges. Being originally developed for stakeholder involvement, cross-cutting collaborations, support, and engagement in CCA projects for municipal and political actors, XR Pathfinder will be adapted to the local circumstances and challenges in Vesteralen region. Thus, the transfer also offers an occasion to experiment with adapting XR Pathfinder to the needs of other stakeholders, such as the fishing industry and museum visitors. Within the fishing industry, the solution will be used to experiment with XR to identify potential future sustainable pathways with customers and other

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stakeholders. For local museums, the transfer offers the possibility to explore how XR solutions could potentially serve to raise awareness about climate change among museum visitors.
In a collaboration between the consultancy company NIRAS, Central Denmark Region, and Vesterålrådet, the transfer will also adapt the CCA decision support tool "Best Adapt" to the local circumstances and challenges in Vesteralen region. The transfer will support local municipalities in building a digital knowledge basis for taking critical decisions to secure local enterprises and households and take the first steps towards developing a holistic and shared CCA plan for Vesteralen.

Table 1818. Overview of chosen transfer solutions from Central Denmark Region to Vesteralen Region .

Chosen transfer solution from Central Denmark Region to Vesteralen Region		
Name of solution	**Solution type**	**Short description**
XR Pathfinder	Digital/online tool	An online guide for public authorities containing guidelines on how to develop XR solutions and recommendations for using it in stakeholder involvement processes.
BEST Adapt	Digital tool	Decision support tool based on predicted flood maps, flood risks, and damage costs that calculates the socio-economic optimum CCA protection level of an area, including groundwater and recreational elements.

4.1.3 Additional activities and solutions being developed within the receiving region

Vesteralen region is a region of exceptionally high climate scepticism, with just over half of the local population believing that human activity is the primary driver of climate change. Like most Norwegian municipalities, the municipalities of Vesteralen region are also under pressure to make difficult priorities due to limited funds, and proactive climate resilience work is nowhere near the top of the list of political priorities. Two initiatives are currently being developed within the region to address these challenges:

- Miljøkontrakten is a social initiative that invites private and business members of the community to commit to mutually agreed sustainability goals. The initial phase of development consisted of workshops with members of the local community where goals and parameters for reporting were decided. The first pilot phase for testing was conducted with families, and the second will involve businesses. The next steps include the development of a user-friendly app, developed by Sintef

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in collaboration with Museum Nord/GaiaVesteralen and other regional partners, that enables easy reporting and motivation for users to keep making sustainable decisions.

- Vesterålsmodellen is a highly technical 3D model of the Vesteralen archipelago which uses projection mapping to display historical and contemporary data on topics that include wildlife, climate, fisheries and aquaculture, infrastructure, waste management, local mythology, agriculture and more. The goal is to boost user participation by building a direct connection between the Miljøkontrakten app and the Model. The Model is part of Museum Nord/GaiaVesteralen's permanent exhibition and is subject to continuous development led by the Museum together with Sintef and regional partners.

Both solutions – Miljøkontrakten and Vesterålsmodellen – are aimed at helping to boost local engagement with sustainability issues and create incentives for local authorities to prioritise policies for climate resilience. Vesterålsmodellen will be at the heart of Sortland's new museum from the summer of 2025, where locals and tourists will be invited to explore the region's past, present, and possible futures. Underpinned by robust research from the large projects that Stiftelsen Museum Nord (Museum Nord) participates in, the Model is expected to function as a trusted educational tool which brings predicted manifestations of climate change to life. Furthermore, the planned connection between Miljøkontrakten and Vesterålsmodellen is designed to inspire users to think more carefully about the choices they make daily, and to see that collective effort can make a difference for the climate.

Table 1919. Overview of additional solutions developed within Vesteralen Region

Additional solutions developed within Vesteralen Region		
Name of solution	**Solution type**	**Short description**
Miljøkontrakten (The Environmental Contract)	Social initiative with digital and other components	Miljøkontrakten aims to bring local communities together in commitment to democratically defined sustainability goals. The first of two pilot phases was conducted with local families, and the second will involve businesses.
Vesterålsmodellen (The Vesteralen Model)	3D projection of data on physical model	Vesterålsmodellen is a 15 m2 physical 3D model of the Vesteralen archipelago brought to life with projections of historical and contemporary data.

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4.1.4 Systemic perspective on regional adaptation efforts

Integration of Transferred Solutions: XR Pathfinder and BEST Adapt

The transferred solutions—XR Pathfinder and BEST Adapt—serve as foundational tools to enhance Vesteralen's capacity to address systemic climate adaptation challenges. These solutions contribute to a larger adaptation effort by:

1. **Building Knowledge and Capacity**
    a. XR Pathfinder provides a comprehensive framework for utilizing XR technologies in climate adaptation planning. By visualizing complex climate scenarios, XR solutions can support decision-makers in understanding and communicating risks and solutions effectively.
    b. BEST Adapt integrates socio-economic assessments with flood maps and damage cost evaluations, enabling municipalities to prioritize areas for CCA based on data-driven insights.

2. **Enhancing Stakeholder Engagement**
    a. Both tools promote active involvement of stakeholders, including local authorities, industries, and citizens, fostering a collaborative approach to climate adaptation.
    b. The XR Pathfinder supports the development of XR solutions that can involve, for instance, visual storytelling and interactive simulations to facilitate public awareness and buy-in, which are critical in a region with high levels of climate scepticism. This key quality has potential both in terms of planning at a municipal level, but also in terms of knowledge sharing and awareness rising from an industrial perspective and with museum visitors.

3. **Providing Tailored Solutions**
    a. XR Pathfinder and BEST Adapt will be customized to address Vesteralen region's specific challenges, such as rising sea levels, changes in marine ecosystems, infrastructure vulnerabilities, industrial disruption, and climate scepticism. By doing so, they ensure that adaptation strategies are not only scientifically robust but also locally relevant.

Contributions of Regionally Developed Solutions

In addition to the transferred solutions through RESIST, locally developed initiatives like Miljøkontrakten and Vesterålsmodellen contribute to a systemic adaptation effort by:

- **Miljøkontrakten**: Encouraging community-driven commitments to sustainability goals, enhancing grassroots engagement, and fostering a culture of accountability in climate actions.

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- **Vesterålsmodellen**: Leveraging advanced visualization tools to educate residents and stakeholders about the impacts of climate change, thus linking knowledge with actionable insights.

Alignment with Key Needs and Challenges

The solutions collectively address Vesteralen region's core adaptation needs:

- **Extreme Weather and Sea Level Rise**: By simulating future risks and enabling targeted decision-making, the solutions help mitigate the impacts of these challenges on settlements and infrastructure.
- **Marine Ecosystem Changes**: Enhanced planning tools support the fishing and aquaculture industries in adapting to ecological shifts, safeguarding economic sustainability.
- **Public Awareness and Participation**: The solutions enhance climate literacy and community involvement, addressing the region's scepticism and fostering collective action.

Contribution to Overarching Adaptation Goals

Together, the transferred and locally developed solutions advance Vesteralen region's overarching adaptation goals by:

1. **Creating a Shared Climate Adaptation Strategy**: The tools and frameworks serve as a basis for developing an integrated and cohesive regional plan.
2. **Promoting Sustainability and Resilience**: By addressing environmental, economic, and social dimensions, the solutions contribute to long-term regional resilience.
3. **Fostering Systemic Change**: The combination of innovative technologies and community-driven initiatives ensures a holistic and scalable approach to climate adaptation.

By integrating external expertise with local knowledge and needs, these solutions collectively strengthen Vesteralen region's ability to adapt to current and future climate challenges while aligning with its long-term vision for resilience and sustainability.

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4.2 Planned transfers

4.2.1 XR Pathfinder

4.2.1.1 Solution description and transfer goals

The XR Pathfinder is a comprehensive web-based guide designed for municipal and regional stakeholders to identify the most suitable XR technologies for different scenarios. The XR Pathfinder offers a collection of generic solutions derived from the experiences of the RESIST project, showcasing how XR can be applied across various settings to support local decision-makers and foster stakeholder involvement.
It offers guidance on the design of XR experiences and the selection of ad-hoc XR tools going beyond immediate needs, but rather considering the entire lifecycle of XR technologies, from initial investment, learning curve, reception, and long-term maintenance. The XR Pathfinder recommendations are based on lessons learned and best practices developed within the RESIST project, including purchase costs, installation requirements, usability, data ownership, durability, data security, and necessary IT support.

The tool is purposely designed to help authorities in getting the best value from XR in both internal decision-making processes for climate adaptation and in participation with citizens and other stakeholder groups. Its primary purpose is to support decision-making in the planning and design of climate adaptation solutions and other initiatives aimed at building resilience to climate change. By helping decision-makers leverage XR effectively, the tool ensures they select the right technology to enhance both internal processes and community engagement in climate-related projects.

About the dual function of the tool

1. **Supporting Decision-Making in Planning:**

The primary function is to assist municipalities, regional authorities, and urban planners in selecting the XR technology (Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)) that best supports their internal decision-making processes. As they design CCA solutions, stakeholders can leverage XR technologies, for instance, to visualize future climate scenarios, simulate infrastructure changes, and model the impacts of rising sea levels, extreme weather events, and urban development on existing infrastructure. The XR Pathfinder guides users through the selection process, offering insights into which XR tools will be most effective for their specific planning goals, from predicting outcomes, to assessing risks, to optimizing designs before physical implementation.

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2. **Engaging Citizens and Stakeholders:**

A secondary and equally important function is the determination and knowledge of relevant digital immersive experiences and technologies that can effectively engage citizens and external stakeholders in the design and development of climate adaptation solutions. The XR Pathfinder can help decision-makers select XR solutions that foster community engagement and CCA transparency based on specific needs.

Additional value of the XR Pathfinder:

The XR Pathfinder goes beyond basic tool recommendations by adopting a holistic approach that considers the entire lifecycle of XR technologies - from initial acquisition to long-term maintenance. This ensures that stakeholders make informed decisions not only based on immediate needs but also regarding the sustainability, practicality, and cost-effectiveness of their chosen tools over time.

Key lifecycle factors evaluated include:

- **Purchase and Initial Investment:** The XR Pathfinder considers the costs associated with acquiring XR technologies, considering in its recommendations both affordable, high-performing solutions and higher-end options with additional features.
- **Installation and Setup:** The XR Pathfinder considers the ease of installation, and the level of technical expertise required, ensuring municipalities choose XR technologies that align with their internal capabilities.
- **Convenience and Usability:** The XR Pathfinder considers aspects related to the user experience and accessibility of each XR solution, pinpointing the right trade-off between user-friendliness (to reach a broad audience) while maintaining efficiency for internal decision-making.
- **Ownership and Management:** The XR Pathfinder considers data ownership and management aspects, determining whether municipalities or external vendors control the XR environment and data.
- **Wear and Durability:** For hardware components like VR headsets or AR glasses, the tool considers aspects related to durability and lifespan, helping municipalities select reliable technology.
- **Data Security:** Given rising concerns about privacy and cybersecurity, the XR Pathfinder critically considers integrated data security measures, especially for sensitive urban planning data or community feedback.
- **Modelling Time and Complexity:** The XR Pathfinder involves estimations on the time required to create accurate models and the complexity involved, guiding municipalities on whether they need to hire additional staff or collaborate with external vendors.

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- **Facilitation and IT Support:** The XR Pathfinder considers aspects related to the necessary facilitation and IT support to ensure decision-makers understand potential ongoing costs related to infrastructure, troubleshooting, and system updates.
- **Hardware Maintenance and Replacement:** The XR Pathfinder considers aspects related to maintenance requirements and estimates timelines for hardware replacements.

Goals to be achieved with the transfer:

The XR Pathfinder will be developed in three stages, i.e. through the iterative development of 3 prototypes/demonstrators ('alpha', 'beta', and 'final') with the latter intended to be fully operational at the end of the RESIST project. Beyond the RESIST project, once implemented, the solution should be used within different departments in local municipalities for CCA and planning tasks as well as in the salmon aquaculture industry, and for communication campaigns and citizen awareness raising initiatives at local museums.

4.2.1.2 Measures to overcome barriers and customization needs

The development of the XR Pathfinder takes into consideration that certain differences and challenges are expected as part of the cross-regional transfer of digital solutions, including an understanding of the contextual differences between the provider and the recipient region. The development of relevant XR applications, digital twins, or visualization platforms, is often context-dependent and operates within specific socio-economic, technological, and regulatory conditions. In order to accommodate these differences, the further development of the XR Pathfinder will involve a process for understanding the region-specific infrastructures, technical levels of expertise, and the aforementioned regional CCA challenges.

Addressing these differences involves not only transferring the technology itself but also considering the need for tailored support, capacity-building, and adapting the tool to local needs. As part of the development of the XR Pathfinder these contextual variances will be taken into account.

Description of potential barriers and challenges

Technological disparity: A challenge often being identified is technological disparity, concerning provider regions having access to certain types of technological infrastructures, while recipient regions and involved partners may have limited access to similar digital resources. However, it is only expected that for the Vesteralen region partners such disparities will be minor and depending on very specific levels of access to the different relevant technologies.

Technical skills and expertise: Another barrier concerns the potential lack of technical skills, expertise, and capacity in recipient regions and their involved partners. Effective deployment and operation of XR tools, digital twins, or visualization apps often require specialized knowledge which depends on the recipient region's ability to provide adequate technical support in order for the solution to be fully utilized or maintained, leading to implementation failure.

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Financial constraints: Financial constraints is a well-known barrier to implementing digital solutions which can require significant investment in hardware, software, and training. For this solution it is mainly expected to concern clarification about, for instance, licensing fees, data storage costs, and possible cybersecurity requirements.

Cultural and organizational resistance: This represents a challenge. In some recipient regions, local authorities, stakeholders, or communities may be sceptical of new technologies or reluctant to change established processes. This resistance may stem from a lack of understanding of the technology's benefits, fear of job displacement, or concerns about privacy and data security.

Data compatibility and availability: This technical aspect can impede the transfer process. Digital tools often rely on large datasets to function effectively. If recipient regions lack accurate, up-to-date, or interoperable data, the tool's effectiveness may be limited. Additionally, differing data governance policies, such as privacy regulations, can restrict data sharing between regions.

NB. It should be noted here that some of the barriers and challenges described above are of a more generic kind. A more detailed assessment of these will be carried out as the solution development process is initiated.

Description of how the original solution is planned to be adapted to customize the solution to the receiving region's context and to overcome barriers.

To ensure the transfer of the XR Pathfinder, the original solution profile from the provider region will be tailored, as far as possible, to align with the recipient region's specific needs, including closer considerations of the identified barriers. The process will entail a contextual assessment of the recipient region and its involved partners focused on the above-mentioned factors such as technological infrastructure, digital literacy, financial constraints, etc. Based on this assessment, the solution will include customized content and knowledge relevant for the recipient region. The format for this process will be further specified through direct dialogue with the involved partners to ensure that relevant activities are organized as to provide the necessary insights for how to effectively operate and maintain the solution. Additionally, the solution might incorporate modular or scalable features that allow for incremental implementation based on the recipient region's readiness.

Description of additional measures to overcome barriers and challenges.

To further support the successful transfer of the digital solution, other measures can be implemented to address common barriers and challenges. A key activity is to establish relevant collaborative dialogues and activities between provider and recipient regions, in order to facilitate knowledge exchange, resource sharing, and joint problem-solving.

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To address data-related challenges such as data standardization and interoperability, this will happen on a need-to-basis as the development process unfolds. If data privacy and compliance concerns are significant, certain protocols can be established for this.

Fostering community engagement and stakeholder buy-in is critical for overcoming cultural and organizational resistance. As far as the XR Pathfinder can support activities related to this, the relevant factors will be considered in the development of the tool.

Table 2020. Measures to address barriers and customization needs.

NAME OF THE SOLUTION: XR Pathfinder			
Type of barrier	**Barrier description**	**How can the barrier be overcome?**	
		Measure to address barrier	**Customization of solution**
			Overall: will happen according to the agreed alignment between providing and recipient region based on identified needs and risk profiles.
Technological Disparity:	Limited access to certain technological infrastructures in recipient regions compared to provider regions,	Assess and consider disparity levels.	
Insufficient clarification of technical skills and expertise requirements.	Can affect the effective use and maintenance of XR tools.	Assess and clarify skills and expertise levels.	
Financial Constraints	Costs related to hardware, software, training, licensing fees, data storage, and cybersecurity could hinder implementation.	Assess expected resources available.	

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Data Compatibility and Availability.	Can restrict tool functionality,	Exchange knowledge about data governance policies and frameworks.	
Cultural and Organizational Resistance.	local authorities, stakeholders, or communities may be sceptical of new technologies or reluctant to change established processes.	Clarify how the solution can support a better understanding of the technology's benefits.	
Other specific details of potential barriers will be assessed further during the active development process for the solution.			

Table 21. Solution profile for the XR Pathfinder

Name of solution: XR Pathfinder		
Short description of the adaptation solution A web-based tool offering guidance on developing and using XR simulations, which includes VR and AR for stakeholder involvement in local climate adaptation projects, specifically: • Knowledge and demonstration of XR technologies and their use for simulating location-specific climate changes and climate adaptation solutions • Best practice guidance for design of user-friendly AR interfaces • Best practice guidance for integration of AR tools for enhanced public engagement.	**Type of solution** Digital solution, processing tool, knowledge sharing	**Solution provider region** RM, co-developed between VIA UC and BTH

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VALUE PROPOSITION		
Target group Local authorities (municipal and regional authorities). Local museums. Local industry stakeholders.	**Main benefits for the target group (purpose)** Streamlines the selection, development, and implementation of XR tools. Helps processes for visualizing and simulating climate scenarios/adaptation solutions and impacts. Improves decision-making and stakeholder engagement.	**Social and environmental co-benefits for target group and other groups** Promotes stakeholder involvement in climate projects. Enhances transparency and collaboration between authorities and citizens, between product owners and customers, and between museums and visitors. Supports long-term sustainability and resilience in urban planning. Increases knowledge and capacity among relevant stakeholders.
SOLUTION DETAILS		
Climate impacts addressed Depends on the user needs but with a point of departure in the above-mentioned identified challenges specific to the region.	**Delivered results** **Functioning XR Pathfinder** A fully operational web-based tool including specific information based on the recipient region's identified needs. Includes guidance for XR applications in climate change adaptation contexts based on learnings from RESIST.	**Spatial scope** Applicable to municipal and regional climate adaptation projects across various locations, focusing on decision making for best possible XR solutions.
VALUE CREATION AND DELIVERY		
Key resources Related to the use of XR	**Key activities** Development of a potential XR	**Project owner and key partners** Local authorities and

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Pathfinder. • Local engagement from authorities through allocating staff resources and time. Related to the development of a potential XR solution. • Basic knowledge about XR and stakeholder mapping and engagement processes. • Staff with competences or access to competences in working with software for development of XR solutions.	solution using XR Pathfinder • Internal decision about objective and scope in municipalities and other beneficiaries. • Identify relevant partners/subcontractors. • Co-creation workshops. • Continuous communication. • Testing of demo-solutions with target audience. • Validation process. • Apply the solution in stakeholder engagement processes.	beneficiaries should take ownership of the project. If a subcontractor is involved, discussions during the initial meetings should address how to establish ownership arrangements for maintenance, server management, and other technical requirements essential for the project's continuity. Project owner: Vesteralen Regionrad (Vesteralen) Key partners: • Local authorities (municipal and regional). • PPP (Public Private Partnerships). • Possible subcontractors within XR development. • Universities and research centres.
COSTS AND PLANNING		
Estimated costs (implementing and operating) VIA: 4 PMs RM: 1 Vesteralen: 3 PMs Operating cost (uncertain estimates): 75-300 EUR per year (hosting, domain renewal and SSL certificates)	**Revenues / monetized benefits** No direct monetization: benefits come from improved decision-making and com-munity engagement, potentially leading to more cost-effective climate adaptation solutions.	**Time frame for planning and implementation until fully functional** 3 years (2025-2027)
CONTEXT		
Necessary prerequisites	**Success factors**	**Limiting factors**

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<u>Related to development of a potential XR solution based on XR Pathfinder output.</u> • Access to XR technology: Beneficiaries must have access to XR tools (hardware and software) and the necessary infrastructure to support their use. • Technical expertise: Staff may require training in XR technologies, or municipalities may need to partner with external vendors for technical support. • Data availability: Municipalities will need access to climate data and other relevant information to ensure that the XR simulations and models are accurate and informative. • Technical and administrative capacity: Successful implementation of XR tools requires a certain level of technical expertise and administrative support, which may be lacking in some regions.	• Understanding of the target audience(s). • Functional / operational solution. • Community engagement in the local municipality or region. • Commitment of local decision makers to engage with stakeholders.	• Not sufficient funds for XR development and CCA projects. • Not sufficient knowledge for XR development and CCA projects. • Lack of support from local decision-makers.

4.2.1.3 Resources and costs

The development of the XR Pathfinder involves two primary resource and cost components. As this is a new solution still under development (rather than a ready-to-customize turn-key system), it will require an investment of person months to gather requirements and build / program the tool. Below is a breakdown of the planned activities, detailed later in the document with a Gantt chart, along with the total estimated effort for Vesteralen for each milestone.

Milestone 1: Total Estimated Effort of 135 Hours

• A1 Need finding Iteration 1: Estimated effort of 42 hours, including 30 hours for conducting interviews and focus groups (preparation, execution, and analysis; 5 hours per session) and an additional 14 hours for systematically mapping existing solutions and academic results in the field.

• A2 Development Work Iteration 1: Estimated effort of 36 hours to code and populate the basic XR Pathfinder platform.

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• A3 Discussions with Municipalities: Estimated effort of 35 hours to collaborate with municipalities in identifying pilots and cases for implementation (includes attending decision-making meetings, events, and online discussions, along with preparation and follow-up).
• A4 Piloting: Estimated effort of 22 hours for deployment, training, and data analysis from the pilot results.

Milestone 2: Total Estimated Effort of 145 Hours
A1 Need finding Iteration 2: Estimated effort of 30 hours, including 15 hours for conducting 6 interviews and 2 focus groups (preparation, execution, and analysis; 5 hours per session) and an additional 15 hours for updating existing solutions and academic results in the field.
• A2 Development Work Iteration 2: Estimated effort of 30 hours to refine the design of the basic XR Pathfinder platform.
• A3 Discussions with Municipalities: Estimated effort of 30 hours to collaborate with municipalities in identifying pilots and cases for implementation (includes attending decision-making meetings, events, and online discussions, along with preparation and follow-up).
• A4 Piloting: Estimated effort of 26 hours for deployment, training, and data analysis from the pilot results.
• A5 Customization Iteration 1: Estimated effort of 15 hours for customizing the second iteration of XR Pathfinder for the cases.
• A6 CCA Solution Discussion: Estimated effort of 14 hours for discussions with municipalities on how XR Pathfinder will impact the design, implementation, and deployment of the items under investigation.

Milestone 3: Total Estimated Effort of 117 Hours
• A1 Need finding Iteration 3: Estimated effort of 39 hours, including 24 hours for conducting 6 interviews and 2 focus groups (preparation, execution, and analysis; 5 hours per session) and an additional 15 hours for updating existing solutions and academic results in the field.
• A2 Development Work Iteration 3: Estimated effort of 24 hours to refine the XR Pathfinder platform further.
• A5 Customization Iteration 2: Estimated effort of 15 hours for customizing the second iteration of XR Pathfinder for the cases.
• A6 CCA Solution Discussion: Estimated effort of 15 hours for discussions with municipalities on how XR Pathfinder will impact the design, implementation, and deployment of the items under investigation.
• A7 Introducing the Final XR Pathfinder: Estimated effort of 24 hours, including 15 hours for final refinement of the tool and 9 hours for training and information dissemination activities.

After Milestone 3: Total Estimated Effort of 22 Hours
• A8 Post-RESIST Deployment: Estimated effort of 22 hours for discussions related to the commercialization and post-RESIST deployment of XR Pathfinder.

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A possible architecture for the XR Pathfinder is one that uses Hypertext Preprocessor (PHP) as backend technology, a popular server-side scripting language. PHP scripts run on the server to generate the Hyper Text Markup Language (HTML) seen by the user. The server fetches relevant data on a database (e.g. MySQL) or static files and embeds it into the HTML. The site is expected to be dynamic. PHP is used to query a database to retrieve content based on the user's actions (e.g., navigating different principles). The server sends a response containing the HTML for the requested page. This HTML includes links to CSS (for styling) and JavaScript (for interactivity).

XR Pathfinder is expected to have a simple structure and to attract approximately 100 visitors/month at its peak. Shared hosting plans are a possibility for this scale, costing €5–€15/month. These plans provide PHP support, a small database (e.g., MySQL), and sufficient bandwidth for the expected traffic. Providers like Bluehost or HostGator are suitable for this option. If XR Pathfinder requires better performance or minor scalability, a Virtual Private Server (VPS), priced at €20–€100/month, offers dedicated resources and greater reliability.

Additional costs include domain name renewal at €10–€50/year and a Secure Socket Layer (SSL) certificate. SSL is often free through services like Let's Encrypt but can cost €50–€200/year for premium options. Given the simplicity of the application and the traffic expectations, these costs remain manageable. **In total, hosting XR Pathfinder at this stage is expected to cost €75–€300/year, covering shared hosting, domain renewal, and SSL certificates.** If future traffic or complexity increases, the hosting setup can scale up to meet demand, such as upgrading to a VPS or cloud hosting service.

Furthermore, an estimation of needed personnel resources is provided in the table below.

Table 22. Planned personnel resources.

	Providing region	**Receiving region**
Person Months (PMs) planned for the transfer of the XR Pathfinder	VIA = 4 RM = 0,5 AU = 0,5	Vesteralen = 1,5 Andfjord Salmon = 0,5 Stiftelsen Museum Nord = 0,5
Person Months (PMs) total RESIST	VIA = 72 RM = 70 AU = 26	12

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4.2.1.4 Planning the transfer

Objective, purpose, results, and planned activities.

The logframe matrix in table 23 outlines the objectives and purposes of the transfer of XR Pathfinder as well as the expected results and the specific activities that must be implemented to achieve these objectives and results.

Table 2323. Logframe Matrix for the planned transfer.

Logframe Matrix XR Pathfinder CDR -> Vesteralen Region			
Transfer project description	**Indicators**	**Source of verification**	**Assumptions**
Overall objective			
Increased application of digital decision support tools for successful CCA action. **Increased awareness and knowledge among citizens** about specific climate hazards and adaptation solutions. **Better planning documents that take climate into consideration** at an early planning stage.	(Change in) number of CCA activities found in strategic CCA documents linked to or resulting from using technical visualization tools. Percentage of people who demonstrate a high level of awareness to climate risks and possible solutions. (Change in) times CCA solutions are mentioned in new/updated strategic plans and documents (for example spatial planning).	Desktop study Interviews (in which experienced progression is measured). Desktop study comparing old and new/updated documents.	
Purpose			

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Municipalities use XR Pathfinder to find XR solutions that can help with different CCA challenges. **Cross sectorial use of XR pathfinder as a decision support tool** to include XR technologies and CCA perspective in forming industrial, municipal, and communication strategies. **Municipalities use XR solutions** for broader stakeholder engagement, including citizens. **Museums** use XR solutions for better climate change awareness rising and communication. **Industries** use XR in their stakeholder engagement activities.	Number of monthly visitors on XR Pathfinder. Number of industrial actors using XR Pathfinder Number of municipalities in the region that use XR solution for stakeholder / citizen engagement. Number of museum employees engaging with XR Pathfinder. Change in times XR solutions are mentioned in new plans and strategies.	Data from XR Pathfinder (visitors per month. Desktop study. Survey Survey Industrial project plans	Using digital support tools will move actors (municipalities, local politicians, industry actors, museums) towards action and alignment. XR technologies facilitate successful stakeholder engagement. Successful stakeholder engagement will lead to more acceptance, higher prioritization of CCA measures, and increased climate change awareness among the local population.
Results			
XR Pathfinder is up and running as an online platform.	Fully functional XR Pathfinder is online.	Website of XR Pathfinder and project report.	Municipalities and other stakeholders understand the potential impact of

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Relevant stakeholders have been introduced to the final XR Pathfinder. **Workshops have been conducted** with potential stakeholders to discuss needs / interests for XR solutions. **Plan** exists on how the XR Pathfinder will continue after RESIST.	2-4 stakeholders (municipalities, museums, and/or industrial actors) are involved. 8 workshops conducted with municipalities to discuss needs/interests for XR solutions. Agreement exists for continuation of XR Pathfinder.	Project report. Project report. Agreement document.	the technology (how can you use XR as an efficient support tool). Local politicians and industry stakeholders support working with XR to address CCA. Municipalities, industry actors, and museums receive/prioritize enough resources to implement XR solutions. XR solutions can address needs of municipalities, the fishing industry and of the communication ambitions of local museums at multiple levels.
Activities			
Conduct needs assessment according to the resources available from the providing region partners. As far as this allows for direct interaction with relevant public and private stakeholders regarding the use of XR technologies for driving climate adaptation action,			Pilots generate useful lessons. Resources suffice to develop the online platform. Municipalities and other stakeholders are interested and cooperative. Local politicians and the industry support working with XR to

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stakeholder involvement processes, and climate awareness rising initiatives. **Develop XR Pathfinder**: development of the platform itself based on existing needs assessment results, include knowledge and results of former projects. **Find municipalities and other stakeholders for piloting** the XR Pathfinder. **Pilot first version of XR Pathfinder** with 2-4 municipalities and other stakeholders in Vesteralen and assess key lessons learned. **Adapt XR Pathfinder** to local needs and context based on lessons learned. **Make plan for how XR Pathfinder will continue after RESIST** (possibly cooperating with businesses).			address CCA, and to keep the XR Pathfinder alive after RESIST.

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Introduce the final XR Pathfinder to municipalities and other relevant stakeholders. **Conduct stakeholder workshop with to discuss possible XR solutions** to address their CCA needs based on XR Pathfinder usage.			

4.2.1.5 Next steps

The table below provides a visual representation of the short- and long-term activities related to the development of XR Pathfinder, with a focus on the 3 critical milestones for the development of the solution, which are synced with the planned dates for the Consortium meetings.

The chart below provides a visual representation of the short- and long-term activities related to the development of XR Pathfinder.

The development process involving Vesteralen region will be aligned with the process for Region Blekinge, and the activities visualized, thus, resemble overall what is presented for the latter region with potential adjustments to be expected. The core of the tool will be developed across (and independently from) regions and then customized with the included adjustments needed as the processes is going on.

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Table 2424. Timeplan and milestones for the development and deployment of XR Pathfinder (abbreviated as XRPF in the table).

A1 Conduct needs assessment XRPF
A2 Develop XR Pathfinder
A3 Find municipalities for piloting
A4 Piloting the XRPF prototype
A5 Customize and adapt XRPF
A6 CCA solution discussion with XRPF
A7 Introduce the final XRPF
A8 After-RESIST plan for XRPF

High intensity
Low intensity

Milestone 1 (M1): Verified XR Pathfinder alfa prototype

The first milestone focuses on the development and delivery of the initial XR Pathfinder prototype for piloting, along with preliminary results from initial testing within the pilot. The creation of this first

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version is primarily based on Activity A1, which aims to gather detailed information about the solution's needs and requirements through stakeholder interviews, surveys, and workshops with municipalities, decision-makers, and other relevant stakeholders. The primary focus of Activity A1 is to understand specific climate adaptation needs, identify the challenges stakeholders face, and explore how they envision using XR technology in their decision-making processes.
The second step, Activity A2, involves developing the XR Pathfinder platform itself. As explained in a previous section, this includes implementing PHP as the backend technology and integrating it with the supported database (e.g., MySQL) or static files that embed the relevant XR Pathfinder information. This work is closely aligned with and informed by Activity A3, which focuses on identifying municipalities in the Region Blekinge suitable for piloting.
Additionally, A3 is coupled with Activity A6, which involves establishing a continuous dialogue with municipalities and other stakeholders to explore potential XR solutions for addressing CCA needs using the XR Pathfinder as a guide. During the first year, Activity A6 will be conducted at a lower intensity compared to other tasks but will aim to leverage existing opportunities and foster potential collaborations.

Milestone 2 (M2): Validated XR Pathfinder beta prototype
The second milestone focuses on achieving a validated, 90%-ready XR Pathfinder release for internal use by LSDT. Notably, the design process for XR Pathfinder will follow a classical spiral approach, consisting of three iterative cycles to progressively identify knowledge gaps, highlight priorities for climate adaptation, and determine the most critical XR features needed to effectively address these challenges.
The second iteration of Activity A1 will take place at the end of 2025 and into early 2026. This will subsequently inform the second iteration of Activity A2, which focuses on further development of the platform to introduce additional functionalities and content. The emphasis will also shift towards creating a seamless user experience and interface, building upon the functionality-based prototype developed during Milestone 1.
The efforts to define municipalities for piloting will be intensified under Activity A3, alongside further work on Activity A6, which involves discussions on CCA solutions in relation to XR Pathfinder. During the spring and early summer of 2026, the focus will transition from development to adaptation and customization (Activity A5), driven by inputs from Activities A3 and A6.
Piloting activities for the XR Pathfinder beta prototype (Activity A4) will be conducted after the summer break, with the goal of presenting the results at the 7th Consortium Meeting in late 2026.

Milestone 3 (M3): Final XR Pathfinder release
The final iteration will focus on delivering the complete XR Pathfinder release at the final Consortium meeting. This release—featuring a fully functional solution available online for RESIST-wide use and external partners—will benefit from a new round of need-finding and development work under Activities A1 and A2.

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In particular, A1 will monitor the use of the beta prototype delivered at Milestone M2 to gather insights and feedback. This will include, for instance, monitoring the number of civil servants at municipalities that made use of the solution during a specified timeframe, together with other relevant indicators extracted from the analysis of the tools and/or surveys. The work will increasingly emphasize Activity A5, making necessary adjustments to improve usability, enhance functionality, and better align the tool with user needs. The overarching goal is to ensure the XR Pathfinder is fully functional and ready for broader deployment.
Workshops under Activity A6 will also be conducted to evaluate the effectiveness of the XR Pathfinder in addressing specific CCA challenges and decision-making complexities. This activity will further monitor how often and how much are XR solutions mentioned as design support tool in official documentations related to new plans and strategies for climate adaptation solution. This will ensure that the solution remains relevant, practical, and capable of tackling real-world needs effectively. The introduction of the final XR Pathfinder (Activity A7) will take place after the summer of 2027 and will include a range of activities, such as the development of marketing materials, establishing a social media presence, conducting demonstrations, and hosting mini-training sessions. Furthermore, the final release will be tested and validated during these sessions, and the lessons learned will be documented for future use.
This final step will lay the groundwork for the concluding work under Activity A8, which will explore post-RESIST opportunities related to the commercialization of the tool and its approach through the definition of agreement documents between the RESIST team and the external parties.

Timeline until 2027

See above timeplan / gantt chart for overview. The elements to be considered after the end of RESIST still remain to be clarified, again due to the late involvement of Vesteralen region in the initial phase of the XR Pathfinder tool conceptualization.

4.2.2 BEST Adapt

4.2.2.1 Solution description and transfer goals

BEST Adapt is a web tool designed to determine the optimal climate adaptation level to flood-related risks, using flood hazard maps, value maps, risk assessments, damage cost calculations, and input of adaptation costs. It employs a cost-benefit approach in six steps: 1) Input of flood hazard maps and value maps, 2) Calculation of restoration damage costs associated with flood events, 3) Calculation of expected annual damage and accumulated period costs, 4) Development of costs associated with adaptation measures in different scenarios, 5) Calculation of benefits due to reduced damage costs in scenarios, and 6) Calculate adaptation costs and benefits, select the most cost-effective option, and conduct a sensitivity analysis.

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The tool calculates damage costs for buildings, roads, business interruptions, farming, and infrastructure (primary mode aimed at socio-economic analysis). It also prioritizes other risk categories like public services, cultural values, critical infrastructure, and ecosystems using a scoring system (secondary mode aimed at a more holistic approach).

The transfer aims to demonstrate the tool for evaluating cloudburst and storm surge risks with focus on the first three calculation steps (see above), helping municipalities prioritize risk management and develop protective measures. During and possibly after the timeline of the RESIST project, municipalities can use the tool for cost-benefit analysis based on CCA investment plans.

The demonstration level is a pilot project (e.g., for the city of Sortland), where BEST is tailored to the local contexts. Full implementation in Vesteralen region extends beyond the pilot phase and possibly the timeline of the RESIST project.

4.2.2.2 Measures to overcome barriers and customization needs

To further support the successful transfer of BEST Adapt, some measures can be implemented to address common barriers and challenges. A potential barrier for the successful transfer of the tool is gaining access to relevant data. Therefore, a key activity is to establish open data sharing and engage in concrete dialogues about local CCA challenges and circumstances between provider and recipient stakeholders, in order to ensure the most accurate adaptation of the tool.

To address data-related challenges such as data standardization and interoperability, this will happen on a need-to-basis as the development process unfolds. In any case, transferring BEST Adapt to Vesteralen region entails not a customization of the tool as such, but rather the adoption of data from local data sources.

Table 2525. Measures to address barriers and customization needs.

NAME OF THE SOLUTION: BEST Adapt			
Type of barrier	**Barrier description**	**How can the barrier be overcome?**	
		Measure to address barrier	**Customization of solution**
Data availability 1	Data is not free / open access.	Vesteralen and/or the pilot municipality provides the necessary data	Certain features of Best Adapt may remain unused, depended upon the data provided.
Data availability 2	GIS data lacks relevant damage types.	Vesteralen and/or the pilot municipality digitises the necessary data.	Certain features of Best Adapt may remain unused, depended upon the data provided.

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Data availability 3	Local-scale representative damage data (unit prices) is currently unavailable.	National unit prices are used if local data is unavailable.	Increased uncertainty of the results
Accurate flood maps	Accurate flood maps, particularly those for cloudburst events, often necessitate detailed mapping.	Simple 'static' flood maps of cloud burst are provided and evaluated in a preliminary task.	An option may be to develop more costly hydrodynamic flood maps

Table 2626. Solution profile for BEST Adapt, customized to Vesteralen Region

NAME OF SOLUTION: BEST Adapt		
Short description of the adaptation solution A web tool designed to determine the optimal climate adaptation level using flood hazard maps, value maps, risk assessments, damage cost calculations, and input of adaptation costs.	**Type of solution** Digital solution, decision support, knowledge, socio-economic calculation tool.	**Solution provider region** Central Denmark Region – developed by NIRAS.
VALUE PROPOSITION		
Target group Municipal and regional authorities	**Main benefits for the target group (purpose)** Calculating the socio-economic impact of climate change through flood risks. Visualizing flood damage risks to buildings, infrastructure, businesses, public services, cultural values, and ecosystems. Improving flood risk area prioritization.	**Social and environmental co-benefits for target group and other groups** Enhances public awareness of climate change. Supports long-term sustainability and resilience in urban planning. Increases knowledge and capacity among relevant stakeholders.

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	Enhancing decision-making and stakeholder engagement.	
SOLUTION DETAILS		
Climate impacts addressed Increased flood risk from cloudburst and rising sea-level / storm surges.	**Delivered results** A web-GIS tool that presents relevant map layers for flood risk analysis and analyses inputs for a potential cost-benefit assessment.	**Spatial scope** The tool is set up for demonstration purposes for a pilot area (e.g. the city of Sortland), with the potential for scaling up to the remaining municipalities.
VALUE CREATION AND DELIVERY		
Key resources Authorities assigning personnel to supply the required data to set up the tool. Basic understanding of the relevant authorities is essential for providing accurate data related to flood risk assessment.	**Key activities** Needs assessment and Pilot Selection. Data Collection for Pilot city/municipality (e.g. Sortland). Implementing BEST Adapt in the Pilot, Iteration 1. Evaluation and Data Adjustment. Implementation in the Pilot, Iteration 2. Prioritization of Areas. Evaluation of Pilot. Training course in Best Adapt and CCA plans. Summary report with the results of the pilot and potential for upscaling.	**Project owner and key partners** Vesteralen Regionrad owns the project in collaboration with the pilot municipality. NIRAS is the key partner delivering the solution.
COSTS AND PLANNING		

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Estimated costs (implementing and operating) Providing region: NIRAS: - 3 PM - 3250 Euro other costs Receiving region: Vesteralen: - 1 PM	**Revenues / monetized benefits** Improved decision-making in prioritizing and adapting to climate change can lead to more cost-effective solutions.	**Time frame for planning and implementation until fully functional** 3 years (2025-2027).
CONTEXT		
Necessary prerequisites Data availability: Necessary prerequisites include flood hazard maps pertaining to cloud bursts and storm surges. Additionally, Geographic Information System (GIS) data on buildings, cadastres, infrastructure, nature types, etc., as well as register data on building and housing conditions for all properties in the pilot, are required.	**Success factors** All necessary data for the analysis is provided. A useful analysis is provided by the tool.	**Limiting factors** Some of the data may not be free of charge, nor immediately available.

4.2.2.3 Resources and costs

The following tables illustrates the planned steps from “data collection” to “implementation in a pilot 2”. Beyond this step, the table includes a suggestion of potential activities/costs to be further coordinated with the receiving region.

Table 27.27 Planned personnel resources

	Providing region	**Receiving region**
Person Months (PMs) planned for transfer of BEST Adapt	NIRAS A1-A6: (approx. 200 hours) = 1.5 PM A7: 3 days, 2 persons + prep time: 0.5 PM A8-A10: 1 PM	A1: Data collection A7: x no. of officials, 1 day A8-A10: Meetings and commenting of report

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	Technical and economic reporting Total = 3 PM RM: 0,5 AU: 0,5	Technical and economic reporting Total: 1 PM
Person Months (PMs) total RESIST	NIRAS = 24 + 3 = 27 RM = 70 AU = 26	12

Table 28.28 Other costs in the providing and receiving regions

	Region	**Amount (Euro)**	**Short cost description**	**Further information** *One-time costs or recurring? Are maintenance costs included? Could costs incur after RESIST project lifetime?*
Scalgo License	Providing	250	Fee for using Scalgo as GIS software to conduct flood maps as input data to BEST Adapt	One-time cost within the Resist project lifetime.
Transport	Providing	3000	Transport and hotel costs of A7	One-time costs within the Resist project lifetime

4.2.2.4 Planning the transfer

Objective, purpose, results, and planned activities

The logframe matrix below outlines the objectives and purposes of the transfer of BEST Adapt, the expected results, and the specific activities that must be implemented to achieve these objectives and results.

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Table 2929. Logframe Matrix for the planned transfer

Logframe Matrix BEST Adapt CDR -> Vesteralen Region			
Transfer project description	**Indicators**	**Source of verification**	**Assumptions**
Objective			
Public authorities use data-based decision-support tools to objectively prioritize future investments on CCA based on risk-areas and risk types.	Number of public authorities which used the results from the risk assessment for municipal planning activities.	Municipal plans Meeting notes within the cross-municipal network of planners, Klimanetværket.	
Purpose			
Better insights on flood-related risks and potential damages in specific areas. Improved flood risk prioritisation. Planners are better supported to take relevant decision and prioritizations in terms of CCA planning.	Number of analyses done through the tool in the region. Number of municipal planning documents or strategies using an updated flood risk prioritisation. Level of satisfaction of planners with provided support for CCA planning and prioritisation of measures.	Data from Best Adapt on usage. Questionnaires for planners and meeting notes.	
Results			
Web-tool designed to determine the optimal climate adaptation level using flood hazard maps, value maps, risk	Number of pilot sites for which Best Adapt is fully implemented and has produced results	Data from Best Adapt	Misunderstandings about how the tool should and can be used among receiving community of planners.

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assessments, damage cost calculations, and input of adaptation costs. Summary report incl. information on km2, sectores and buildings in risk of being flooded for the pilot site.			
Activities			
Needs assessment and Pilot Selection Data Collection for Pilot city/municipality (e.g. Sortland) Implementing BEST Adapt in the Pilot, Iteration 1 Evaluation and Data Adjustment Implementation in the Pilot, Iteration 2 Prioritization of Areas Evaluation of Pilot Training course in Best Adapt and CCA plans Summary report with the results of the pilot and potential for upscaling.	No. of participating regional and municipal officials	Participant list	Depends on the quality and quantity of available data Tbd. whether it is an online or in-person meeting

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4.2.2.5 Next steps

Timeline until 2027

Table 3030. Timeline for the transfer with Vesteralen Region

ID	Activity	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	Q2 2026	Q3 2026	Q4 2026	Q1 2027	Q2 2027	Q3 2027	Q4 2027
A1	Need assessment and pilot selection												
A2	Data collection for pilot												
M1	Milestone 1: Data collection done			X									
A3	Implementing in a pilot, iteration 1												
A4	Evaluation and data adjustment												
A5	Implementing in a pilot, iteration 2 (final)												
M2	Milestone 2: Pilot calculation done					X							
A6	Prioritization of areas and critical infrastructure												
A7	Training course in BEST Adapt and CCA plans												
A8	Evaluation of pilot												
A9	Writing report												
A10	Decision on full implementation in Vesterålen												
M3	Milestone 3: Summary report done									X			

Activities

Activity 1 (A1): Needs Assessment and Pilot Selection

- Identify specific climate adaptation needs, climate scenarios and time perspective.
- Select pilot area based on vulnerability and potential impact.

Activity 2 (A2): Data Collection for Pilot

- Gather baseline data on flood hazard maps.
- Gather GIS- and register data on buildings, cadastres, etc.
- Gather data from national sources or insurance companies on unit prices (damage costs).
- Use genetic data and assumptions.

Activity 3 (A3): Implementing BEST Adapt in a Pilot, Iteration 1

- Implement initial assumptions.
- Implement flood maps and GIS data.
- Make the first run of calculations.

Activity 4 (A4): Evaluation and Data Adjustment

- Analyse data from the first iteration.
- Adjust genetic strategies based on findings.

Activity 5 (A5): Implementing in a Pilot, Iteration 2 (Final)

- Apply refined genetic adaptations.
- Ensure comprehensive monitoring and data collection.

Activity 6 (A6): Prioritization of Areas

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- Identify and prioritize areas and infrastructure most at risk.

Activity 7 (A7): Training course in BEST Adapt and CCA plans

- Full day training course for selected regional and municipal officials of Vesteralen region in the use of BEST Adapt and in conducting CCA plans.

Activity 8 (A8): Evaluation of Pilot

- Conduct a thorough evaluation of the pilot's success.
- Assess the effectiveness of genetic adaptations.

Activity 9 (A9): Writing of report

- Formulation of summary report of the pilot results and the potential for full-scale implementation.

Activity 10 (A10): Decision on Full Implementation in Vesteralen region

- Based on pilot results, decide on the feasibility of full-scale implementation.
- Plan for scaling up the adaptation process.

Milestones:

Milestone 1 (M1): Pilot area has been selected, climate scenarios have been established as well as assumptions for the analysis, and data collection is underway.

Milestone 2 (M2): Calculations for the pilot have been performed in relation to damage assessments for various sectors for the selected analysis period which provides as basis for prioritizing of climate adaption actions.

Milestone 3 (M3): Summary report done
The summary report will present the results in a non-technical language and include the purpose, results and replicability of the pilot. It will further incl. flood risk maps, numbers of buildings and sectors in risks, and recommendations for future planning and actions. The summary report will serve as basis for the decision on whether to continue with full implementation in Vesteralen region.

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