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D7.3-Results from the participatory socio-economic assessment of EBA interventions

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Meaning / Full text
ARMAAG	Agencja Regionalnego Monitoringu Atmosfery Aglomeracji Gdańskiej (Agency of Regional Air Quality Monitoring in the Gdańsk)
BAT	British American Tobacco
CCLL	Coastal City Living Lab
CNR	Consiglio Nazionale delle Ricerche (National Research Council)
CSO	Central Statistics Office (Ireland)
CVM	Community Voice Method
DART	Dublin Area Rapid Transit
DLRCC	Dún Laoghaire Rathdown County Council
EBA	Ecosystem-based Adaptation
ENoLL	European Network of Living Labs
EU	European Union
GDP	Gross domestic product

Acronym / Abbreviation	Meaning / Full text
GSI	Geological Survey Ireland
GURS	Geodetska uprava Republike Slovenije (Surveying and Mapping Authority of the Republic of Slovenia)
IHS	Institute for Housing and Urban Development Studies
INE	Instituto Nacional de Estadística (Statistics Portugal)
IVE	Institut Valencià d'Estadística (Valencian Institute of Statistics)
LaMMA	Laboratorio per il Monitoraggio e la Modellistica Ambientale (Environmental Monitoring and Modeling Laboratory for the Sustainable Development)
LAWPRO	Local Authority Water Programme (Ireland)
MCA	Multicriteria Analysis
METI	Messaging Extraterrestrial Intelligence
NASA	National Aeronautics and Space Administration
NBS	Nature-Based Solutions
RDOŚ	Regionalna Dyrekcja Ochrony Środowiska w Gdańsku (Regional Directorate for Environmental Protection in Gdansk)
RPOs	Recovery Point Objective
SCC	Sligo County Council
SMEs	Small medium-sized Entreprises
SUDS	Sustainable Drainage Systems
UA	Universitat d'Alacant (University of Alicante)
UIRS	Urbanistični inštitut Republike Slovenije (Urban Planning Institute of the Republic of Slovenia)
UNESCO	United Nations Educational, Scientific and Cultural organization
UPC	Universitat Politècnica de Catalunya (Polytechnic University of Catalonia)
UPV/EHU	Universidad del País Vasco/Euskal Herriko Unibertsitatea (University of the Basque Country)
URA	Uraren Euskal Agentzia (Basque Water Agency)
USGS	United States Geological Survey
WP	Work Package
ZRS	Znanstveno-raziskovalno središče Koper (Science and Research Centre of Koper)

BACKGROUND: ABOUT THE SCORE PROJECT

SCORE is a four-year EU-funded project aiming to increase climate resilience in European coastal cities.

The intensification of extreme weather events, coastal erosion and sea-level rise are major challenges to be urgently addressed by European coastal cities. The science behind these disruptive phenomena is complex, and advancing climate resilience requires progress in data acquisition, forecasting, and understanding of the potential risks and impacts for real-scenario interventions. The Ecosystem-Based Approach (EBA) supported by smart technologies has potential to increase climate resilience of European coastal cities; however, it is not yet adequately understood and coordinated at European level.

SCORE outlines a co-creation strategy, developed via a network of 10 Coastal City 'Living Labs' (CCLLs), to enhance coastal city climate resilience rapidly, equitably, and sustainably through EBA measures and sophisticated digital technologies.

The 10 coastal city living labs involved in the project are: Sligo and Dublin, Ireland; Barcelona/Vilanova i la Geltrú, Benidorm and Basque Country, Spain; Oeiras, Portugal; Massa, Italy; Piran, Slovenia; Gdansk, Poland; Samsun, Turkey.

SCORE will establish an integrated coastal zone management framework for strengthening EBA and smart coastal city policies, creating European leadership in coastal city climate change adaptation in line with The Paris Agreement. It will provide innovative platforms to empower stakeholders' deployment of EBA measures to increase climate resilience, business opportunities and financial sustainability of coastal cities.

The SCORE interdisciplinary team consists of 28 world-leading organisations from academia, local authorities, RPOs, and SMEs encompassing a wide range of skills including environmental science and policy, climate modelling, citizen and social science, data management, coastal management and engineering, security, and technological aspects of smart sensing research.

EXECUTIVE SUMMARY

This document is a deliverable of the SCORE project, funded under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003534.

The main aim of this document is to present the results of Work Package (WP) 7's task 7.3 (Participatory socio-economic assessment of EBA interventions), notably regarding the development of a participatory socio-economic assessment of Ecosystem-based adaptation (EBA) interventions based on a Multicriteria Analysis (MCA) in the 10 Coastal City Living Labs of the SCORE project. More specifically, the analysis focused on the prioritization of EBA measures to address different climate hazards (*i.e.*, coastal and inland flooding, coastal erosion, droughts, heatwaves, and storm surges) across SCORE CCLLs. The implementation of the MCA involved conducting 10 workshops in the CCLLs from February to December 2023. These participatory sessions were adapted to the local specificities, in terms of the definition of the intervention area, main climate hazards and climate sectoral impacts to be addressed, and EBA interventions to assess. This analysis implements the main methodological guidelines presented in WP7's deliverable 7.2 entitled "Methodological framework for the socio-economic assessment of adaptation measures to climate change".

The remaining sections of this report are structured as follows: introduction (section 1), methodological considerations (section 2), presentation of the MCA results (section 3), concluding remarks with the discussion of co-creation processes across case study areas and the identification of lessons learnt and opportunities for improvement (section 4).

LINKS WITH OTHER PROJECT ACTIVITIES

Within **WP7**, this report builds on the identification of socioeconomic assessment methods identified in Task 7.1 and the participatory-based methodology further developed under Task 7.2. The EBA measures prioritised as a result of the 10 workshops undertaken across SCORE CCLLs, might inspire the implementation of measures under the project funding.

The identification of key hazards and their map representation developed by **WP1** for each CCLL was a relevant input to define the MCA assessment context. This process also aided the proposal of a preliminary list of EBA options, inspired on the **SCORE EBA catalogue**, which was developed by **WP7** in collaboration with **WP4**.

The MCA approach is directly connected to **WP2**, responsible for the CCLLs set up. The identification and mapping of stakeholders participating in the MCA workshops, and the different engagement tools available is part of the governance model under the scope of this WP.

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1. INTRODUCTION

This document presents the main outcomes derived from the workshops held in the 10 SCORE Coastal City Living Labs (CLLs). The analysis aimed at prioritising Ecosystem-Based Adaptation (EBA) measures to address various climate risks, such as coastal and inland flooding, coastal erosion, or droughts. The foundation of our approach lays on a comprehensive literature review detailed in *D7.1 Synthesis of socio-economic assessment methods, databases, and studies addressing EBA and other adaptation strategies* (Riera - Spiegelhalder et al., 2022). This literature review provided valuable insights about potential methods to analyse EBA from a socioeconomic perspective. Moreover, it influenced our decision to adopt the Multicriteria Analysis (MCA) as a reliable method to prioritise EBA measures tailored to address the most relevant climate risk of each study area.

MCA offers a dynamic framework that facilitates inclusive decision-making by engaging relevant stakeholders with different backgrounds, knowledge, and professional expertise. It enables the integration of individual values, understandings, and perceptions to rank and prioritise adaptation alternatives against a predefined set of criteria. As recalled in *D7.2 Methodological framework for the socio-economic assessment of adaptation measures to climate change* (Etxebarria et al., 2022)*,* stakeholders assign values to indicate their preferences, enabling the integration of non-monetary metrics in the assessment. To ensure a comprehensive evaluation, it was defined a set of criteria encompassing social, environmental, economic, and risk reduction implications.

Within WP2, the SCORE project has established 10 CCLLs in seven European countries: Ireland, Poland, Turkey, Slovenia, Italy, Spain, and Portugal. Based on an iterative approach, these CCLLs co-defined, co-designed, and co-created climate change adaptation solutions with stakeholders from the Quadruple Helix group, comprising industry, government, academia, and citizens. In a close collaboration with WP2, the WP7 team organised participatory workshops using the MCA approach. During these workshops, selected stakeholders evaluated and ranked the proposed adaptation options.

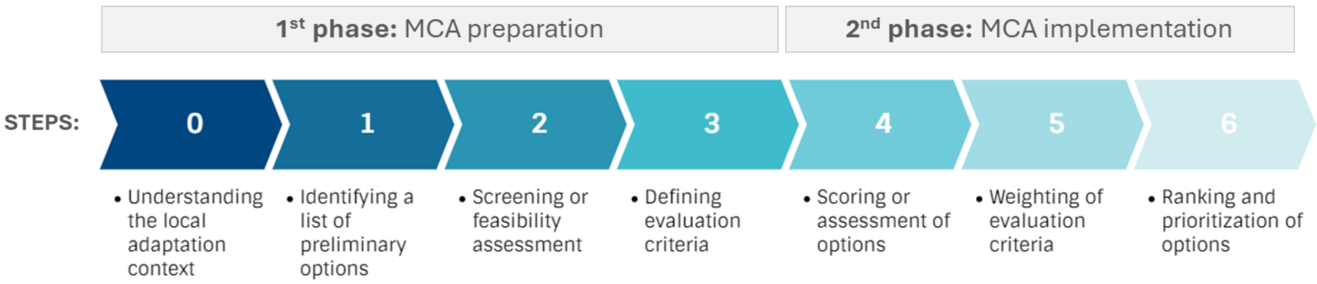
The primary objective of the MCA was to address the most relevant climate hazard in the study areas and propose suitable EBA measures to mitigate the associated risk(s). It is important to recognize the diversity observed across study areas, where geographical and socioeconomic features, climate hazards, and proposed solutions vary significantly across territories. For instance, while some regions proposed EBA options to address flooding and coastal erosion municipality-wide, others focused on specific locations such as intermittent rivers, perennial rivers, or old town city centres, proposing measures for hazards such as inland flooding or droughts.

The remainder of this document is organised as follows. Section 2 delves into the methodological variations observed across different MCA workshops. Section 3 starts by presenting an overview of the main results, including the type of assessment undertaken and the corresponding objectives, the study area, the hazards addressed, and the top three prioritisation for EBA. Subsequently, it provides a comprehensive analysis of the design and outcomes of the MCA steps in each CCLL, presented through factsheets. Section 4 concludes with a comparative diagnostic of the results across CCLLs, followed by the main takeaways regarding the implementation of MCA in the context of living labs, and opportunities for replication.

2. METHODOLOGICAL CONSIDERATIONS

The results included in this report build upon the MCA methodology developed in *D7.2 Methodological framework for the socio-economic assessment of adaptation measures to climate change* (Etxebarria et al., 2022). The MCA approach has been designed to be adapted to the different local contexts of the ten CCLLs. The MCA process unfolds in two main phases (preparation, implementation) by a sequence of seven steps. There is a preliminary step, step 0, to understand and define the study area, followed by 7 steps, ranging from 0 to 6, to prepare and implement the MCA (Figure 1):

Figure 1: MCA steps



- Phase 1. MCA Preparation

0. **Understanding the local adaptation context**: WP7 facilitators, based on the needs and preferences shown by the CCLL, co-define the study area and the objective of the exercise.

1. **Identifying a list of preliminary options**: inspired on the SCORE | EBA catalogue[1], the inputs from the CCLL, and the review of complementary practices when appropriate, WP7 facilitators elaborate a preliminary list of EBA options suitable to the case studies. A full list of EBA options considered in the MCA is available in Appendix 1.

2. **Screening of feasibility assessment**: participants are invited to assess the proposed measures, scoring them from 1 (very low) to 5 (very high). The feasibility assessment criteria are: stakeholder acceptability, technical feasibility, ease of implementation, and financial feasibility. An online voting tool (Mentimeter) facilitates the collection of individual assessments. After presenting the results, discussion is initiated among participants to reach a consensus.

3. **Defining evaluation criteria**: WP7 facilitators propose an initial set of criteria close to six (Ivanova Boncheva & Hernández-Morales, 2022), to be discussed and agreed with participants. The criteria are defined according to the potential benefits associated with the proposed measures, as outlined in the Nature-based Solutions (NBS) catalogue for urban resilience (World Bank, 2021). A preliminary list of criteria was developed and organized into four core categories, closely related to ecosystem services:

   - **Risk reduction:**

   (1) Perception of risk reduction function concerning the primary hazard identified in the CCLL.

[1] The EBA SCORE catalogue includes adaptation solutions for coastal areas within combined urban and natural contexts, offering case study examples, and the possibility of filtering the solutions by climate hazard and land category. In: https://storymaps.arcgis.com/stories/6cdbb2f6ab0744b89dffda2664dd877e.

(2) Perception of risk reduction function concerning additional hazards identified in the CCLL.

- Social implications:

(1) Increase in recreational opportunities.

(2) Improvement in social cohesion.

(3) Improvement in human health.

- Economic implications:

(1) Creation of job opportunities.

(2) Reduction of public costs.

(3) Provision of goods (specify the good(s) according to the EBA proposed, *e.g.*, timber, food, water, etc.).

- Environmental implications:

(1) Maintenance and enhancement of biodiversity.

(2) Increase in habitat area.

(3) Water quality improvement (relevant depending on the hazard addressed).

(4) Air quality improvement (relevant depending on the hazard addressed).

(5) Carbon storage and sequestration.

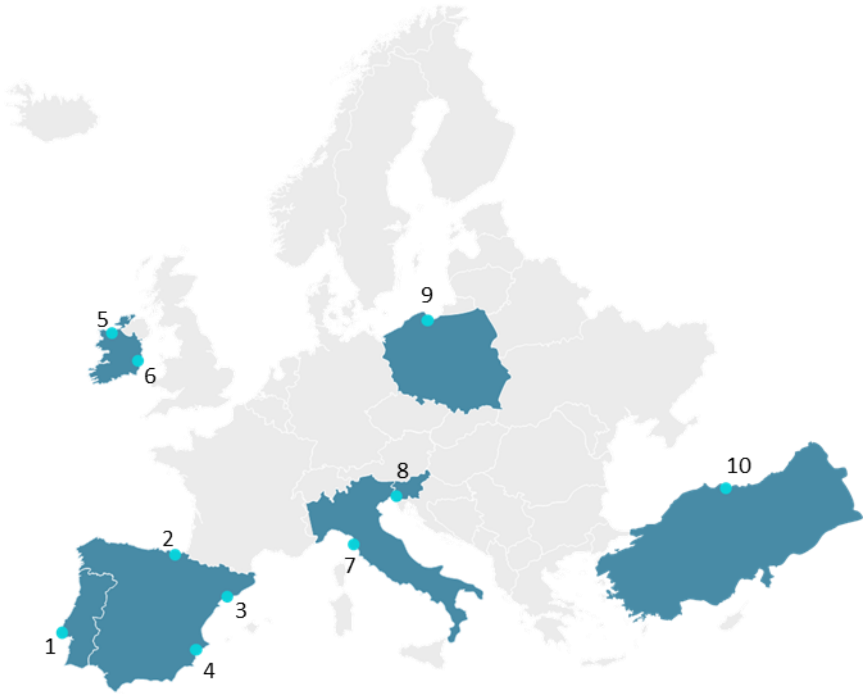
- Phase 2. MCA implementation

4. **Scoring of EBA options**: each EBA option is individually assessed by the participants in terms of its contribution towards the proposed criteria, using a scale from 1 (very low) to 5 (very high). An online voting tool (Mentimeter) facilitates this process. Measures are then ranked, according to their aggregated mean score. These results are discussed among the participants to achieve a consensus.
5. **Weighting of evaluation criteria**: participants must show their preference for each of the criteria assigning a weight, being 0% the least preferred and 100% the most preferred. The sum of all weights must be 100%. The individual weighting is based on an online voting tool, followed by an overall weighting aggregation, which is open for discussion among participants.
6. **Ranking and prioritization of options**: WP7 facilitators calculate the final score and ranking combining the scores given to EBA options (step 4), and weights assigned to the criteria (step 5). This is based on a weighted sum method, where scores for each criterion are weighted according to the mean value and aggregated on a linear function. The final ranking is reviewed by the participants to achieve consensus.

From February to December 2023, ten workshops were organised across the SCORE CCLLs (**Error! Reference source not found.**). Stakeholders invited to participate in the MCA followed the Quadruple Helix approach, including representatives from the industry, academia, government, and citizens. Gender balance, age and culture diversity were additional factors considered. When setting up the sessions, different approaches were followed according to the local specificities, such as stakeholder availability. For example, in some cases (*e.g.*, Vilanova i la Geltrú, Piran, Gdansk), two sessions were organised: an online session for the preparation phase, and an on-site session for the implementation phase. In these situations, participants could get familiar with the MCA approach during the online session, when the feasibility assessment was conducted (step 2), and the evaluation criteria were discussed (step 3). Scoring (step 4), weighting (step 5), and final ranking (step 6) were undertaken during the on-site session. A one-day on-site meeting, encompassing both phases, was the approach followed in CCLLs such as

Massa, Sligo, Dublin, and Samsun. These workshops had a longer duration than the previous approach, basically to accommodate the whole MCA process (Phases 1 and 2) in one day. Table 1 gives details of the workshop dates and the format followed in each CCLL.

Figure 2: SCORE CCLLs' locations



Legend: 1. Oeiras (Portugal); 2. Oarsoaldea (Spain); 3. Vilanova i la Geltrú/Province of Barcelona (Spain); 4. Benidorm (Spain); 5. Sligo (Ireland); 6. Dublin (Ireland); 7. Massa (Italy); 8. Piran (Slovenia); 9. Gdańsk (Poland); 10. Samsun (Turkey).

Table 1: Workshop dates and approach

CCLL	Workshop dates (2023)	Workshop approach
Oarsoaldea (Spain)	February 16 and 24	Virtual meeting and On-site session
Piran (Slovenia)	February 20 March 3	Virtual meeting and On-site session
Sligo (Ireland)	March 16	On-site session
Vilanova i la Geltrú (Spain)	March 24 and 29	Virtual meeting and On-site session
Massa (Italy)	November 16	On-site session
Dublin (Ireland)	November 28	On-site session
Oeiras (Portugal)	November 30	On-site session
Gdansk (Poland)	November 23 December 5	Virtual meeting and On-site session
Samsun (Turkey)	December 8	On-site session
Benidorm (Spain)	December 11 and 14	Virtual meeting and On-site session

3. RESULTS

The following subsections present an overview of the results obtained in the ten SCORE CCLLs (3.1), and the specific results for each case (3.2), respectively.

3.1. Summary of results

The primary objectives of the MCA, shared by all SCORE CCLLs, were to understand stakeholders' perceptions about EBA measures, particularly in terms of prioritizing these measures for mitigating climate change-related hazards and generating additional socio-economic and environmental co-benefits. Table 2 provides an overview of the MCA applied in the ten CCLLs, detailing the following information: the type of assessment based on the status of the EBA analysed (*ex-ante* for unplanned, *ex-post* for already implemented, or *interim* for planned but not yet implemented);the type of study area, ranging from specific location(s) within the municipality to the entire municipality or region; the main hazard(s) addressed; and the top three prioritised EBA measures in each CCLL's MCA.

Table 2: Overview of the MCA applied in the SCORE CCLLs

CCLL	Type of assessment	Study area	Hazard(s)	Top-3 prioritised EBA
Oarsoaldea (Spain)	*ex-ante*	Specific location (floodplains of the Oiartzun river basin; Pasaia bay/port and its surrounding urban areas; old centres of the four municipalities)	Inland flooding, coastal flooding, landslide, heatwaves	1st Green spaces 2nd Planting of trees 3rd Riparian reforestation
Piran (Slovenia)	*ex-ante*	Specific location (historic town of Piran at top of the peninsula)	Coastal flooding, droughts, heatwaves	1st Historic wells and water reservoirs 2nd Sustainable permeable pavements 3rd Green spaces
Sligo (Ireland)	*ex-ante*	Entire Sligo County	Coastal flooding	1st Afforestation 2nd Peatland restoration 3rd Wetland restoration
Vilanova i la Geltrú (Spain)	*ex-ante*	Specific location (Intermittent river "Torrent de la Piera")	Inland flooding	1st Combination of measures (renaturalisation, restitution of the original riverbed depth, increase in riverbank height) 2nd Renaturalisation and stabilisation of riverbed and slopes 3rd Restitution of the original riverbed depth
Massa (Italy)	*ex-ante*	Specific location ("Marina di Massa")	Coastal flooding, storm surge, coastal erosion	1st Floodplain enlargement 2nd Riparian reforestation 3rd High water channel

CCLL	Type of assessment	Study area	Hazard(s)	Top-3 prioritised EBA
Dublin (Ireland)	*ex-ante*	Specific location (Dun Laoghaire decarbonization zone)	Coastal flooding, storm surge, coastal erosion	1st Floodable Park 2nd Saltmarsh restoration 3rd Green infrastructure
Oeiras (Portugal)	*ex-post*	Specific location ("Eixo Verde Azul" – The Green and Blue Axis, in the Jamor River)	Inland flooding	1st Planting indigenous vegetation 2nd Floodplain enlargement 3rd Maintenance of the river network
Gdansk (Poland)	*ex-ante*	Specific location (Wrzeszcz District; old historic central area; Orunia district)	Inland flooding, storm surge	1st Water parks and retention ponds 2nd Green spaces 3rd Planting of trees
Samsun (Turkey)	*ex-ante*	Specific location (Kizilirmak Delta in the Black Sea coast)	Coastal flooding coastal erosion	1st Floodplain enlargement 2nd Bank restoration/naturalisation 3rd Seagrass meadow introduction/restoration
Benidorm (Spain)	*interim*	Various sites in the municipality near intermittent rivers, beaches, and urbanizations	Coastal flooding, inland flooding, coastal erosion	1st Floodable Park 2nd Riparian reforestation 3rd Planting of trees

3.2. MCA factsheets

This subsection presents the detailed results of the MCA exercise for the 10 SCORE CCLLs. Each case study is presented on a factsheet format, including a brief description and spatial context of the study area, the main hazard(s) addressed, and the objective of the analysis. An explanation then follows of the decision process accompanying the problem definition space, the stakeholder selection, and detailed results of the MCA assessment.

3.2.1. Oarsoaldea - Inland and coastal flooding, landslide, and heatwaves

CCLL OARSOALDEA (BASQUE COUNTRY, SPAIN)

Brief description of the area

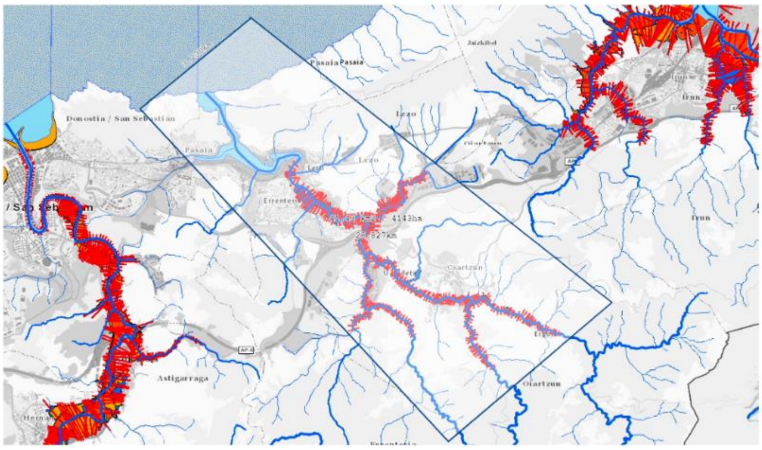
Oarsoaldea, which is comprised of four municipalities (Errenteria, Lezo, Oiartzun, and Pasaia) and 72,701 inhabitants (Eustat, 2023), has a diverse landscape with the Oiartzun river, its basin, the Pasaia Bay and its related port infrastructures and activities. The Oiartzun river is short in length (16.6 km) and has a steep average slope (4.5%), with an intertidal zone or estuary that encompasses two urban areas (Errenteria and Pasaia bay). The bay of Pasaia, which has fjord characteristics and is surrounded by districts of the municipality of Pasaia, is threatened by coastal flooding. Oarsoaldea is one of the rainiest areas in the Iberian Peninsula, with an annual precipitation of 1700mm. Its average annual temperature is 12.8ºC (Lezo, 2024).

The CCLL team selected a wide study area for the project, encompassing four municipalities over 5.8 km^2. This area includes three priority zones:

1. The Pasaia bay and port and its surrounding urban areas at risk of coastal flooding and landslides.
2. The floodplains of the Oiartzun river basin at risk of land flooding, including the urban areas adjacent to the river, with higher risk of flooding.
3. The old centres of the four municipalities, with increased risk of heat waves, are important when thinking of the mid-term future. However, due to stringent urban planning regulations, it is more difficult to implement solutions there.

Study area

Figure 3 : Map of the study area in Oarsoaldea – tailored cut



Source: GeoEuskadi Visor https://www.geo.euskadi.eus/geobisorea.

Notes: Study area specified by the CCLL team, tailored cut, including the Oiartzun river basin, the Port of Pasaia, and the 4 old-towns.

Main hazard(s) considered

Three main climate change hazards were selected by the CCLL team:

a) Coastal and inland flooding, both caused by storms with heavy rainfall, intense sea waves and strong gusts of wind from the Cantabrian Sea, which are frequent in the study area. According to the CCLL team, simultaneous occurrence of both risks, especially when coinciding with spring tides, could be catastrophic.
b) Landslides, which occur relatively frequently in some parts of the region.
c) Heat waves, which although were not identified as past climatic events, are increasing in frequency, intensity, and duration. Accordingly, the CCLL team considers heat waves a relevant climate hazard, especially looking to the near future.

These hazards have an impact on tourism, cultural heritage, residential buildings, and energy and transport networks (Iturriza et al., 2022).

MCA objective

The objective of the MCA was to prioritize and rank a predefined list of EBA options to address the previously identified climate change hazards. The MCA allowed local stakeholders to give their opinions and get involved in the assessment of the EBA measures. Moreover, it allowed for the identification of social, environmental, and economic co-benefits of the evaluated options.

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The selection of hazards and study area was done by the CCLL team, which opted for a broader area that included all four municipalities that are part of the Agency of Economic Development of Oarsoaldea. The purpose of selecting a wider study area was to explore various EBA options within the region. These options could be integrated in future strategic plans, with an active involvement of different (public and private) entities in each of the municipalities. Also, within this step, to further understand the local context, the CCLL team conducted a stakeholder analysis utilizing tools such as the Power Interest Matrix and Stakeholder Journey. The goal was to identify which stakeholders should be involved in the MCA process, while keeping a balance between the different groups in the Quadruple Helix model (government, civil society, academia, and industry). The team noted that because of the broad focus on four municipalities, it would be beneficial to invite more representatives from the public sector. Following the stakeholder mapping, a communication strategy was drafted to plan how to tailor communication actions to each stakeholder.

Step 1. Identifying a list of preliminary options

A total of 12 EBA measures were chosen by the CCLL team as preliminary options to address the climate hazards identified in the study area, namely:

1. Cliff stabilization
2. Riparian reforestation/rehabilitation along riverbanks
3. Watershed restoration
4. Open green spaces
5. Tree plantation
6. Green roofs and walls
7. Urban agriculture
8. Floodable parks
9. Sustainable drainage
10. Bioswales
11. Estuary protection & regeneration
12. Green dike

Step 2. Screening or feasibility assessment

The EBA feasibility assessment, and the final selection of the measures and evaluation criteria were conducted during an online session on the 16th of February 2023. This activity involved the following stakeholders: Oarsoaldea Development Agency, Errenteria City Council (Environment), Lezo City Council (Environment), Oiartzun City Council (Environment), Provincial Council of Gipuzkoa (Environment and Hydraulic), Pasaia Port Authority (Prevention and Environment), UPV/EHU – SAREN Sustainable and Resilient Built Research Group, UPV/EHU – CAVIAR Quality of Life in Architecture Research Group, UPV/EHU – CAVIAR Quality of Life in Architecture Research Group, AZTI – Marine Science and Technology, Naturklima – Climate Change Foundation, Capital Energy, and Albaola – Sea Culture Factory.

The feasibility of the 12 proposed EBA measures was evaluated according to four categories: stakeholder acceptability, technical feasibility, financial viability, and ease of implementation. Each one of the proposed EBA measures was assessed according to the four feasibility criteria, on an increasing scale of feasibility of 0 to 5. The four scores were then summed per EBA. As a result, the top 7 most feasible EBA were selected.
Table 3 below summarizes this step.

Table 3: Feasibility assessment of the EBA measures in Oarsoaldea

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Tree plantation	4.00	4.67	4.25	4.00	**4.23**	1
Open green spaces	3.92	4.17	3.83	3.42	**3.83**	2
Urban agriculture	3.00	3.75	3.67	3.67	**3.52**	3
Riparian reforestation/ rehabilitation along riverbanks	3.92	3.58	3.08	3.25	**3.46**	4
Watershed restoration	4.00	3.67	2.75	2.67	**3.27**	5
Sustainable drainage	3.75	2.67	3.08	3.00	**3.13**	6

Green roofs and walls	3.00	3.08	3.33	2.92	3.08	7
Cliff stabilization	3.67	3.17	2.67	2.67	3.04	8
Floodable parks	2.92	3.33	2.83	2.75	2.96	9
Bioswales	3.17	3.08	2.50	2.50	2.81	10
Estuary protection & regeneration	3.00	3.00	2.00	2.50	2.63	11
Green dike	2.33	2.33	1.83	1.83	2.08	12

Five out of the seven most feasible options were actions related to urban green (tree plantation, open green spaces, urban agriculture, sustainable drainage, and green roofs and walls), addressing terrestrial flooding and heat waves. The other two were river restoration actions (riparian reforestation/ rehabilitation along riverbanks and watershed restoration), addressing fluvial floodings. The third climate hazard, coastal flooding, was not addressed by any of the EBA measures considered as most feasible. Some of the stakeholders who participated were representing organizations dedicated to sea and coastal matters, and they stated that coastal interventions were probably more complicated to execute, and hence had lower scores in the feasibility assessment. Nevertheless, they were still considered as interesting and relevant for the needs of the region. Thus, cliff stabilization was included in the list of EBA that would continue the process, to have at least one option addressing each of the three identified climate hazards. Moreover, including this additional EBA ensured engagement of those stakeholders dedicated to the sea and coast.

During the discussion of the results, it was mentioned that the profile of the participating stakeholders was quite technical, since the civil society group was underrepresented, which could have influenced the results.

<u>Step 3. Defining evaluation criteria</u>

This step was done in a participatory way, presenting suggested options, and opening the discussion for stakeholders to give their opinions. WP7 facilitators proposed as an initial set of criteria: 1) perception of reduction of the addressed risk; 2) increase recreational and leisure opportunities; 3) increase in social cohesion, or as an alternative, the increase in human health; 4) maintain and increase biodiversity; 5) carbon storage and sequestration, or as an alternative, improve water/air quality; 6) job creation (stimulation of local economy), or as alternatives, public cost reduction or provision of resources or goods (wood, food, water).

After an interesting interactive discussion, the six criteria defined to evaluate the EBA options were: 1) perception of reduction of the addressed risk; 2) increase recreational opportunities & social cohesion; 3) human health improvement (mental & physical); 4) biodiversity maintenance and increase; 5) water/air quality improvement; 6) job creation (stimulation of local economy).

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop, held on the 24th of February 2023, brought together stakeholders from the different municipalities and administrative levels, as well as academics, researchers, and representatives of the private sector. Unfortunately, the civil society was not represented in the workshop. In total, there were 16 voting participants in the workshop. From the government – public sector, stakeholders included local environmental technicians from Errenteria and Oiartzun and representatives from the Pasaiako Portua (port authorities). From academia – research institutions, stakeholders came from AZTI and EHU/UPV. Lastly, from industry – private sector, attendants included Naturklima, Albaola, and Ingeniera.

<u>Step 4. Initial scoring or assessment of options</u>

The participants were invited to evaluate each EBA against specific criteria using an online voting tool. The evaluation scale ranged from 1 (minimum) to 5 (maximum), representing the contribution of the assessed measure against the criteria. Table below provides a summary of average scores per criterion, the total average score, and the prioritisation ranking. The results indicate a preference among participants for the adoption of open green spaces, followed by tree plantation, riparian reforestation/ rehabilitation along riverbanks, and watershed restoration.

Table 4: Initial scoring of EBA measures in Oarsoaldea

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Perception of hazard risk reduction	Increase of opportunities for leisure and social cohesion	Human health improvement	Biodiversity maintenance and increase	Water or air quality improvement	Job creation		
Open green spaces	3.88	4.75	4.63	4.06	4.31	3.31	4.16	1
Tree plantation	3.94	3.94	4.38	4.31	4.69	3.00	4.04	2
Riparian reforestation/ rehabilitation along riverbanks	4.06	3.50	4.06	4.63	4.63	3.31	4.03	3
Watershed restoration	3.75	3.56	3.63	4.88	4.69	3.50	4.00	4
Urban Agriculture	2.94	4.00	4.25	3.06	3.13	3.50	3.48	5
Sustainable drainage	3.75	2.38	2.44	2.25	3.56	3.19	2.93	6
Cliff stabilization	3.94	1.81	1.81	2.88	2.63	3.00	2.68	7

<u>Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)</u>

Afterwards, participants were invited to allocate weights to the criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The average weights for each criterion displayed below show that participants gave more importance to 'human health improvement' (23%), followed by 'biodiversity maintenance and increase' (19%), and 'water/air quality improvement' (17%). The final score was then obtained by combining the weights with the previous assessment (step 4) using the weighted sum method. The results show that the ranking remained consistent between steps 4 and 5.

Table 5: Final scoring of EBA measures in Oarsoaldea

Name of the EBA	Evaluation criteria						Weighted sum scores	Final ranking
	Risk reduction perception	Increase of opportunities for leisure and social cohesion	Human health improvement	Biodiversity maintenance and increase	Water or air quality improvement	Job creation		
Weights ⇨	16.3%	15.0%	22.5%	19.2%	16.7%	10.4%		
Open green spaces	0.63	0.71	1.04	0.78	0.72	0.35	4.23	1
Tree plantation	0.64	0.59	0.98	0.83	0.78	0.31	4.14	2
Riparian reforestation/ rehabilitation along riverbanks	0.66	0.53	0.91	0.89	0.77	0.35	4.10	3
Watershed restoration	0.61	0.53	0.82	0.93	0.78	0.36	4.04	4
Urban agriculture	0.48	0.60	0.96	0.59	0.52	0.36	3.51	5
Sustainable drainage	0.61	0.36	0.55	0.43	0.59	0.33	2.87	6
Cliff stabilization	0.64	0.27	0.41	0.55	0.44	0.31	2.62	7

'Open green spaces' was the highest scored option, and the one that occupied a larger part of the discussion. Stakeholders mentioned that citizens of the region require more green spaces, since a lot of the space is used for industrial activities. It was pointed out that some areas need to be analysed in terms of ground contamination. The fact that open green spaces can become multi-functional having a clear environmental purpose, but also becoming social spaces, was very attractive for the participants. Recovering degraded or unused spaces in the region to transform them into multi-functional spaces, where neighbours can meet, children play, elderly rest, seemed to be the most exciting option for participants. It was suggested that creation and maintenance of these spaces could become an opportunity to generate employment for individuals with functional diversity. This approach would merge social co-benefits and economic aspects of this measure. In this way, this EBA could become a holistic intervention that responded to the needs of many social groups of the study area.

'Tree plantation', as the second highest scored option, was seen as an intervention that could be combined with open green spaces. Creating green corridors through street canopy could connect the different green areas of each municipality, establishing a grid or network of urban green spaces, with higher ecological connectivity.

'Riparian reforestation/ rehabilitation along riverbanks' was the third highest scored EBA, and interestingly there were already some plans of recovering degraded areas of the urban rivers by Uraren Euskal Agentzia (URA), the regional water agency and the municipalities. Watershed restoration also placed in the upper half of the list, and some interventions were suggested in Antxo or current fluvial areas that are now occupied by illegal gardens or under industrial usage. Both EBA measures referring to river interventions seemed like an opportunity for collaboration between administrations of different municipalities or various legislative levels (local and regional), since the river is an area that is shared and present in all the parts of the region.

Additional remarks

The workshop constituted a great opportunity to share the ongoing and planned projects from each actor, and to promote synergies and potential collaborations. The CCLL team has identified several plans and projects coming from different organizations, which often tackle similar issues. One of the main goals of the CCLL is to become an orchestrator of EBA measures and coastal adaptation at regional level, through enhanced engagement of key stakeholders and citizens. Hence, providing a space for sharing plans and exploring synergies was of utmost importance during the physical workshop. All identified plans - local, regional, and national - were written in cards and portrayed in the wall. Stakeholders identified additional plans and added them, as well as finding common objectives and strategies between them.

The CCLL team aims to develop a climate action plan, that will serve as a foundation to a regional strategy for climate adaptation. The first day of the physical workshop included a session to define this plan and its steps. The goal of the CCLL is to link this plan to existing local plans and strategies, including the way of involving the relevant stakeholders for it. They aim to create a new SCORE-specific climate action plan related to the EBA solutions that are being developed in the framework of the project. In this way, they can connect and contribute to the already existing climate adaptation plans.

The MCA was also useful in this regard, since it provided a space where stakeholders informed about the different local and regional plans in the area. Hence, the workshop was used as an opportunity to give visibility to the project, present the goals to the stakeholders, and start exploring potential synergies with them.

3.2.2. Piran – Coastal flooding, droughts, and heatwaves

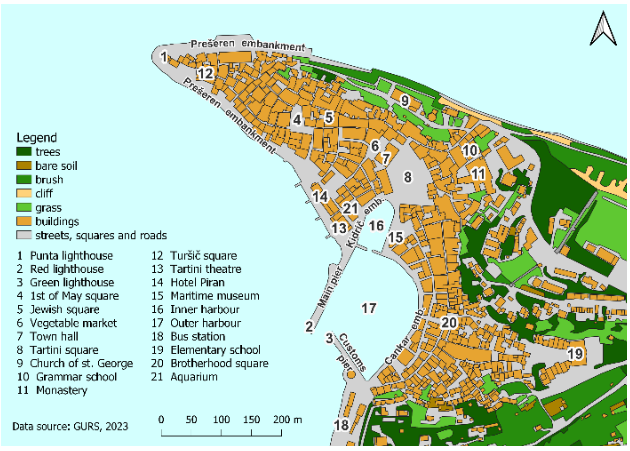
CCLL PIRAN (SLOVENIA)

Brief description of the area

The Municipality of Piran is located at the North Adriatic Sea of the Mediterranean basin. It covers an area of 44 km^2 from coast to hinterland, with approximately 18,500 inhabitants (UIRS, 2022). For SCORE, the focus is specifically on the coastal town of Piran, which comprises the town's historic centre located on the peninsula. Most of this area lies less than 2 meters above sea level, while the highest points, on the slope towards the northeastern hills, reach over 70 meters. The peninsula, from its southern to northern borders, widens from 250 meters at the tip to 1200 meters over the central Tartini square. The town is a densely built urban environment, with typical terracotta-coloured Mediterranean rooftops, and narrow alleys separating the mixture of residential and cultural heritage buildings constructed during various periods, with Venetian rule being the most predominant influence. Apart from the green belt directly below the high lying Church of St. George, there is no large space available for ecosystem-based adaptation, except for smaller urban pocket parks and gardens. The marine area at the peninsula's tip is part of the natural monument named Cape Madona, a site of great biodiversity.

Study area

Figure 4: Map of the historic town of Piran, highlighting land use and key landmarks



Source: Map prepared by Erik Kralj using data from Geodetska uprava Republike Slovenije (GURS).

Main hazard(s) considered

Piran's historic town and the whole of its wider area face many coastal climate hazards, including sea level rise, cliff destabilization, coastal erosion, intensification of extreme weather events through storm surges, and even landslides. For the scope of the SCORE project and the MCA, the Piran CCLL has selected coastal winter flooding and summer heatwaves and droughts as the main hazards affecting the historic town centre on the peninsula.

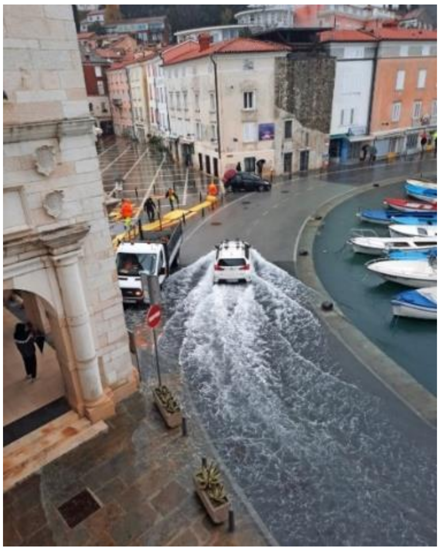
Figure 5: Aerial photo of the wider Piran town

Credits: Jaka Ivančič.

MCA objective

The MCA was undertaken to understand: 1) the stakeholders' perception of EBA measures in general; and 2) the preferred EBA to address coastal winter flooding and summer heatwaves and droughts in Piran. Although it will be hard to address the former hazard solely with EBA, it is essential to discuss the potential of these solutions among Piran stakeholders, as well as to incorporate them at the local policy level. Due to the limited solutions given by the geographic limitations, the remaining of the MCA exercise mainly focussed on summer droughts and heatwaves and the freshwater scarcity often experienced in recent years.

Figure 6: Piran coastal flooding episode at the embankment in inner harbour making way to Tartini square



Credits: Zlatica Kasal.

Main results of the 1st phase - preparation of the MCA

<u>Step 0. Understanding the local adaptation context</u>

The selection of the hazards and study area resulted from a collaborative effort between WP7 facilitators led by the Science and Research Centre Koper Mediterranean Institute for Environmental Studies (ZRS MIOS Koper - *Znanstveno-raziskovalno središče Koper, Mediteranski inštitut za okoljske študije*) and Piran stakeholders, through several interviews. Several stakeholders indicated summer droughts/heatwaves and winter floodings as crucial climate hazards for the historic town centre. The MCA process aimed at addressing two main questions: (i) To what extent can the stakeholders' view on climate adaptation be understood and fed with SCORE's goals on implementing EBA?; and (ii) What are the stakeholders' preferred EBA for implementation in Piran?

<u>Step 1. Identifying a list of preliminary options</u>

SCORE's WP7 facilitators proposed an initial set of five measures, taken from the SCORE | EBA catalogue, aimed at addressing the two identified climate issues in the study area:

1. Green dykes.
2. Bioswales & raingardens.
3. Open green spaces.
4. Green walls and green roofs.
5. Tree plantation.

Based on the content of the interviews, previously executed small pilot projects in Piran and its surroundings, as well as the historic nature of the urban setting of the town centre, three additional measures, not included in the EBA catalogue, were proposed:

6. Restoration of dry-stone wall terraces - stone walling is an UNESCO recognized practice often implemented in the hilly Mediterranean agricultural landscapes, including olive groves and vineyards. These walls are built without the use of mortar, providing stability to soil and reducing the speed of water runoff.
7. Sustainable water-permeable pavement made from locally available natural stone.
8. Revalorization and restoration of historical water wells and cisterns (as comparable to water retention ponds).

Step 2. Screening or general feasibility assessment

The EBA feasibility assessment, and the final selection of the measures and evaluation criteria were conducted during an online session on the 20th of February 2023. This activity involved the following stakeholders: Municipality of Piran (*Občina Piran*); Company for municipal waste management and maintenance of Piran (*Okolje Piran d.o.o.*); Company for Applied Ecology (*Limnos d.o.o.*); Civil community group (*Krajevna skupnost Piran*); Water directorat of the Republic of Slovenia (*Direkcija Republike Slovenije za vode)*; Regional administration of the Republic of Slovenia for Protection and Rescue *(Uprava RS za zaščito in reševanje*). Including ZRS Koper, these stakeholders collectively form the Quadruple Helix group, with the following distribution: Citizens (14%); Government (43%); Industry (29%); and Academia (14%). All measures received favourable feasibility assessments, with total average scores ranging from 2.83 to 4.92 (on an increasing scale of feasibility of 0 to 5). All EBA obtained a high feasibility, except for 'Green dykes' that scored a strikingly lower overall score.

Table 6: Feasibility assessment of the EBA measures in Piran

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Tree plantation	4.83	5.00	5.00	4.83	4.92	1
Revalorization of historic wells and water reservoirs	4.83	4.83	4.17	4.00	4.46	2
Open green space	4.50	4.50	4.33	4.33	4.42	3
Restoration of dry-stone terraces	4.17	4.50	4.50	4.33	4.38	4
Sustainable permeable pavement system for draining rainwater	4.67	4.67	4.17	3.67	4.29	5
Green walls and green roofs	4.00	4.17	3.17	3.50	3.71	6
Bioswale/rain garden	3.17	3.67	4.17	3.83	3.71	6
Green dikes	2.50	3.67	2.83	2.33	2.83	7

Step 3. Defining specific evaluation criteria

SCORE's WP7 facilitators began by proposing an initial set of criteria: 1) Reducing the risk of natural disasters (both winter coastal floods and summer droughts); 2) Improving public health through enhancement of general (environmental and physical) well-being and quality of life; 3) Preservation and use of cultural heritage (respecting the traditional use and knowledge of infrastructure); 4) Reduction of public and private costs after the implementation of the EBA; 5) Improving the quality and quantity (volume) of fresh water and the possibility of water re-use and conservation; and 6) Improving air quality (reducing volatile pollutants from traffic and food preparation, etc.); 7) Reduction of heat stress.

All the previous criteria were adopted in the following steps of the MCA. However, it is important to indicate that previous versions were discussed and adjusted upon stakeholders' suggestions. For example, it was suggested to split the criteria "reducing the risk of natural hazards" into seasonal hazards. This idea was not approved as the MCA's combination of selected hazards and EBA was making any subcriteria for seasonal hazards redundant. It was also suggested to include a subcriteria that assessed the recovery of the EBA after natural hazards. However, due to lack of scientific evidence, this option was excluded. Public health was more specified to be comprising both environmental and physical health. Cultural heritage was extended to include knowledge and traditions. Improving quantity and quality of fresh water was better described to acknowledge water re-use and conservation. Air quality was specified to include examples like volatile pollution from traffic and food preparation.

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop, held on March 3rd, 2023, had a total of 12 voting participants. Including ZRS Koper there were distributed in the Quadruple Helix groups as follows: citizens (8.3%), government (50%), industry (33.3%), and academia (8.3%). The participants' profile included representatives from Municipality of Piran (*Občina Piran*); Company for municipal waste management and maintenance of Piran (*Okolje Piran d.o.o.*); Company for applied ecology (*Limnos d.o.o.*); Civil community group (*Krajevna skupnost Piran*); Water directorat of the Republic of Slovenia (*Direkcija Republike Slovenije za vode)*; Regional administration of the Republic of Slovenia for Protection and Rescue, unit Koper *(Uprava RS za zaščito in* *reševanje*); Institute for the protection of cultural heritage, unit Piran (*Zavod za varstvo kulturne dediščine Slovenije Območna enota Piran*); Public institute for the landscape Park Strunjan (*Javni zavod krajinski park Strunjan*); Institute for sustainable seascape (*Zavod za trajnost morske krajine*); Institute for landscape, culture and art, Piran (*Abakkum - Zavod za krajino, kulturo in umetnost*); and the Environmental Agency of the Republic of Slovenia (*Agencija republike Slovenije za okolje*).

Step 4. Initial scoring or assessment of options

The participants were invited to evaluate each EBA against specific criteria using an online voting tool. The results indicate a shared preference among participants for the 'Open green spaces' (1), followed by 'Planting trees' (2), and the 'Restoration and revalorization of historic rainwater wells and cisterns' (3).

Table 7: Initial scoring of EBA measures in Piran

Name of the EBA	Evaluation criteria: Reduce the risk of natural disasters	Improving public health	Conservation and use of cultural heritage	Reduction of public and private costs after the implementation of a sustainable solution	Improving water quality and quantity	Improving air quality	Heat load reduction	Average score	Initial ranking
Open green space	3.78	3.78	3.13	2.89	3.11	4.60	4.50	3.683	1
Planting trees	3.22	4.00	3.25	3.22	2.78	4.70	4.60	3.682	2
Revalorization of historic wells and water reservoirs	4.11	4.00	4.38	4.00	4.44	1.80	2.40	3.59	3
Sustainable permeable pavement system for draining rainwater	4.33	3.89	4.13	4.22	4.22	1.80	1.80	3.48	4
Restoration of dry stone terraces	3.44	3.11	3.75	3.78	2.67	2.30	2.70	3.11	5
Green walls and green roofs	2.11	2.78	2.38	2.33	2.56	3.70	4.00	2.84	6
Bioswale/rain garden	2.33	2.33	2.25	2.00	3.11	2.50	3.40	2.56	7
Green dykes	1.56	1.67	1.50	1.44	1.78	1.70	1.60	1.61	8

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

Afterwards, participants were invited to allocate weights to the specific evaluation criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The average weights for each specific criterion show that participants gave more importance to 'Reducing the risks of natural disasters' (23%), followed by 'Improving water quantity and quality' (19%), 'Improving public health' (17%), 'Preservation of cultural heritage' (14%), 'Reduction of heat stress' (13%), with least weights to 'Reduction of costs' (8%), and 'Improving air quality' (6%). The final score was then obtained by combining these weights with the previous assessment (step 4) using the weighted sum method. The results indicate a shift in the ranking between steps 4 and 5, with stakeholders now preferring 'Restoration and revalorization of historic rainwater wells and cisterns' as the top choice, followed by 'Sustainable historic water-permeable pavement' and by 'Open green space'.

Table 8: Final scoring of EBA measures in Piran

Name of the EBA	Evaluation criteria: Reduce the risk of natural disasters	Improving public health	Conservation and use of cultural heritage	Reduction of public and private costs after the implementation of a sustainable solution	Improving water quality and quantity	Improving air quality	Heat load reduction	Weighted sum scores	Final ranking
Weights ⇨	23.1%	16.9%	14.4%	8.1%	18.8%	6.2%	12.5%		
Revalorization of historic wells and water reservoirs	0.95	0.68	0.63	0.32	0.84	0.11	0.30	3.83	1
Sustainable	1.00	0.66	0.59	0.34	0.79	0.11	0.23	3.72	2

permeable pavement system for draining rainwater									
Open green space	0.87	0.64	0.45	0.23	0.58	0.29	0.56	**3.63**	3
Planting trees	0.74	0.68	0.47	0.26	0.52	0.29	0.58	**3.54**	4
Restoration of dry-stone terraces	0.80	0.53	0.54	0.31	0.50	0.14	0.34	**3.15**	5
Green walls and green roofs	0.49	0.47	0.34	0.19	0.48	0.23	0.50	**2.70**	6
Bioswale/rain garden	0.54	0.39	0.32	0.16	0.58	0.16	0.43	**2.58**	7
Green dykes	0.36	0.28	0.22	0.12	0.33	0.11	0.20	**1.61**	8

Additional remarks

The participants' profile included representatives from local and regional public administrations, local SMEs, environmental NGOs, and a citizens' association, with ZRS Koper as the SCORE partner representing academia. While individual citizens were attending the physical workshop, some were not willing to vote, and indicated to be represented by their elected members of the citizen's association. Interestingly, for many of the representatives of both the local public authorities and the industry, it should be noted that they are citizens of Piran, but attended the meeting as representative of their organisations, thus adding their professional expertise. However, discussion often revealed their opinion as citizen, over and next to, their professional opinion.

Hence, and this is crucial for the overall conclusion of the MCA implemented in the CCLL of Piran, the discussion of the results of steps 4-6 led to a modification in the ranking of measures: 'Planting trees' moved from the fourth position in step 6 to the first place after discussion; 'Restoration and revalorization of historic rainwater wells and cisterns' moved from the first to the second position; and a new measure was proposed by stakeholders as the best third option, namely the 'introduction of multi-purpose EBA sites'. The latter measure emerged as an interesting option during the discussion due to its suitability for the limited space of the study area (historic town centre at the tip of the peninsula). Moreover, there was a consent among stakeholders about the multiple benefits of multi-purpose EBA that would be good to combine in the limited space available (e.g., provision of shading, reduction of heat stress, water retention, and support of urban farming).

3.2.3. Sligo - Coastal flooding

CCLL SLIGO (IRELAND)

Brief description of the area

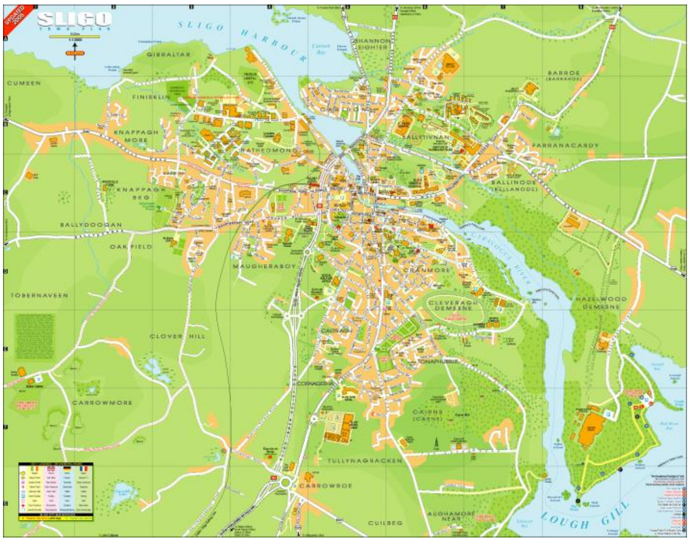
Sligo is a coastal town facing the Atlantic Ocean, located on Garavogue river, and surrounded by Ox mountains. The study area is the Sligo town and neighbouring areas, part of Silgo town Municipality. The population is about 30,000 people (SCC, 2024). The study area is part of the Sligo Coastal City Living Lab, which comprises the entire Sligo County.

Main hazard(s) considered

The main hazard considered was coastal erosion as well as coastal flooding (typically as a result of intense coastal storms). There has been a noticeable increase in coastal storms, floods, and erosion. Moreover, studies are projecting up to 1 meter sea level rise by 2100 (SCC, 2023). These hazards can result in damage to infrastructure, including energy supply systems, transport networks, and buildings (SCC, 2023).

Study area

Figure 7: Map of Sligo Town



Source: Sligo-Ireland, 2024.

MCA objective

The objective of the MCA exercise was to assess and prioritize the existing and planned EBA measures by the Sligo County Council. The analysis allowed to select the most relevant EBA measures based on a range of feasibility and evaluation criteria.

Figure 8: Study area – Strandhill beach in the aftermath of a storm

Credits: Declan Feeney, 2023.

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The study area and hazard were selected by the local Climate Action Office, part of the Sligo County Council. The CCLL team consists of the Sligo County Council as well as ATU, and the decision was taken in collaboration based on municipality data and academic/research insights.

Step 1. Identifying a list of preliminary options

The first phase was to select the EBA relevant to the workshop, as well as conduct a comprehensive stakeholder power-interest mapping exercise in order to select the most influential and interested stakeholders from the living lab Quadruple Helix model. This included stakeholders from the public sector, civil society, industry, and academia. The EBA were selected in consultation with the Sligo County Council, specifically:

1. Afforestation
2. Peatland restoration
3. Wetland restoration
4. SUDS
5. Sand dune management
6. Shellfish and seaweed aquaculture
7. Green roofs
8. Rainwater parks.

Step 2. Screening or feasibility assessment

The first step in the in-person workshop with stakeholders included the evaluation of the feasibility of the eight EBA measures. The ranks obtained from the feasibility assessment were as follows: (1) dune management and marram grass planting, (2) afforestation, (3) wetland restoration, (4) SUDS, (5) peatland restoration, (6) green roofs, (7) shellfish and seaweed aquaculture, and (8) rainwater parks.

During this feasibility assessment, stakeholders indicated that they felt dune management could be resource-intensive in the long run, and therefore ranked it lowest. However, their perceptions changed after the representatives from Sligo County Council explained that this is not the case. Therefore, stakeholders opted to include all EBA in the subsequent steps of the MCA, as they wanted to discuss and deliberate further upon them.

Table 9: Feasibility assessment of EBA measures in Sligo

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Dune management and marram grass	4.62	4.33	4.00	4.08	**4.26**	1
Afforestation	3.31	3.89	3.00	4.00	**3.55**	2
Wetlands	3.69	3.78	3.17	3.38	**3.51**	3
SUDS	3.62	3.44	3.17	3.15	**3.35**	4
Peatland restoration	3.46	3.89	2.69	3.31	**3.34**	5

Green roofs	3.77	3.33	2.83	2.92	3.21	6
Shellfish and seaweed aquaculture	3.08	3.11	2.92	2.92	3.01	7
Rainwater parks	3.08	2.44	2.75	2.92	2.80	8

Step 3. Defining evaluation criteria

The evaluation criteria were defined by the CCLL team and inspired by the SCORE Deliverable 7.2 (Methodological framework for the socio-economic assessment of adaptation measures to climate change). This consisted of carbon capture, biodiversity conservation, improving water quality, job creation, recreational opportunity, and flood/erosion risk reduction. The criteria were shared with stakeholders during the CCLL workshop, and no changes were suggested by them.

Main results of the 2nd phase – MCA implementation

Step 4. Initial scoring or assessment of options

The scoring of EBA options led to the following ranking: (1) afforestation, (2) peatland restoration, (3) wetland restoration, (4) dune management and marram grass planting, (5) rainwater parks, (6) SUDS, (7) green roofs, and (8) shellfish and seaweed aquaculture. During the discussion of the results, stakeholders revealed that they were unable to establish a clear connection between shellfish and seaweed aquaculture with flood/erosion risk reduction, resulting in its lowest ranking.

Table 10: Initial scoring of EBA measures in Sligo

Name of the EBA	Assessment criteria						Average score	Initial ranking
	Flood/erosion risk reduction	Recreational opportunities	Conserve biodiversity	Carbon capture	Water quality	Job opportunities		
Afforestation	4.08	4.00	4.57	4.50	4.00	3.80	4.16	1
Peatland Restoration	4.17	3.10	5.00	5.00	4.40	3.20	4.14	2
Wetlands	4.08	3.00	5.00	4.50	4.60	3.00	4.03	3
Dune management and Marram Grass	4.08	3.56	4.00	2.40	2.20	3.10	3.22	4
Rainwater Parks	2.92	3.30	3.43	2.50	3.70	3.20	3.17	5
SUDS	3.33	2.30	2.86	2.40	4.10	3.50	3.08	6
Green roofs	2.83	2.90	2.86	2.90	3.60	3.30	3.07	7
Shellfish and Seaweed Aquaculture	1.67	1.40	1.71	1.80	1.90	4.20	2.11	8

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

The next step in the exercise was weighting, and the results were as follows: job opportunities (28.1%), flood/erosion risk reduction (25.0%), recreational opportunities (19.4%), carbon capture (16.3%), water quality improvement (5.6%), and biodiversity conservation (5.6%). Stakeholders deliberated that job opportunities were highest as most participants were from civil society or citizens from the local community who prioritised increased economic opportunities over environmental attributes such as biodiversity conservation. The final rankings in Step 6 were very similar to the rankings from scoring of EBA options, they were as follows: (1) afforestation, (2) peatland restoration, (3) wetland restoration, (4) dune management and marram grass planting, (5) rainwater parks, (6) SUDS, (7) green roofs, and (8) shellfish and seaweed aquaculture. The stakeholders were in general happy with these rankings and agreed with final results. They were interested in seeing the results of this exercise be incorporated in the local climate action plan and create meaningful impact.

Table 11: Final assessment of EBA measures in Sligo

Name of EBA option	Evaluation criteria						Weighted sum scores	Final Ranking
	Flood/erosion risk reduction	Recreational opportunities	Conserve biodiversity	Carbon capture	Water quality	Job opportunities		
Weights ⇨	25.0%	19.4%	5.6%	16.3%	5.6%	28.1%		
Afforestation	1.02	0.78	0.26	0.73	0.22	1.07	4.08	1
Peatland Restoration	1.04	0.60	0.28	0.82	0.25	0.90	3.88	2
Wetlands	1.02	0.58	0.28	0.73	0.26	0.84	3.72	3
Dune management	1.02	0.69	0.22	0.39	0.12	0.87	3.32	4
Rainwater Parks	0.73	0.64	0.19	0.41	0.21	0.90	3.08	5

SUDS	0.83	0.45	0.16	0.39	0.23	0.98	3.04	6
Green roofs	0.71	0.56	0.16	0.47	0.20	0.93	3.03	7
Shellfish and seaweed Aquaculture	0.42	0.27	0.10	0.29	0.11	1.18	2.36	8

Additional remarks

Stakeholders in Sligo discussed that the presentation and interpretation of EBA measures can affect the perception of their efficacy. For example, the stakeholders struggled to see the connection between flood risk reduction and shellfish and seaweed aquaculture initially. There was also a discussion on the feasibility of wetland restoration depending on their private ownership. Stakeholders also mentioned government-funded initiatives where such planting is encouraged and remunerated. The takeaway from this discussion was that while some stakeholders have generic knowledge of some EBA, not all did. Therefore, these workshops are opportunities to start dialogues on, and spread awareness about, EBA. In Sligo, it was also noted that peatland hold historical and cultural importance, and therefore 'banning' peat extraction/harvesting for restoration efforts could be protested by locals. The representatives from the public sector emphasised that this may not be understood in a wholly accurate manner, as peatland restoration is in fact respecting the Irish culture by protecting their heritage. Thus, framing narratives is important to stakeholder collaboration in EBA initiatives. The group also discussed the value of afforestation and the governments' reforestation scheme – afforestation could lead to monoculture resulting in forests (such as pine forests) with limited biodiversity. The stakeholders argued that implementing EBA is not enough, and community-based adaptation approaches are equally important. In Sligo, the public sector highlighted the availability of funding for regreening, agricultural, and biodiversity. It was shared that all the EBA discussed were feasible, and that interest in EBA has been growing both within the general community and specifically in the farming sector. The top selected EBA were generally on-land solutions that required buy-in from landowners. Consequently, dune management might be more feasible for implementing smaller changes. Alternative comments suggested that the top three selected EBA reduce the impact of inland flooding, which impacts more of Ireland compared to storm-surge. Overall, there was a relative level of agreement from the group about the final ranking.

3.2.4. Vilanova i la Geltrú - Inland flooding

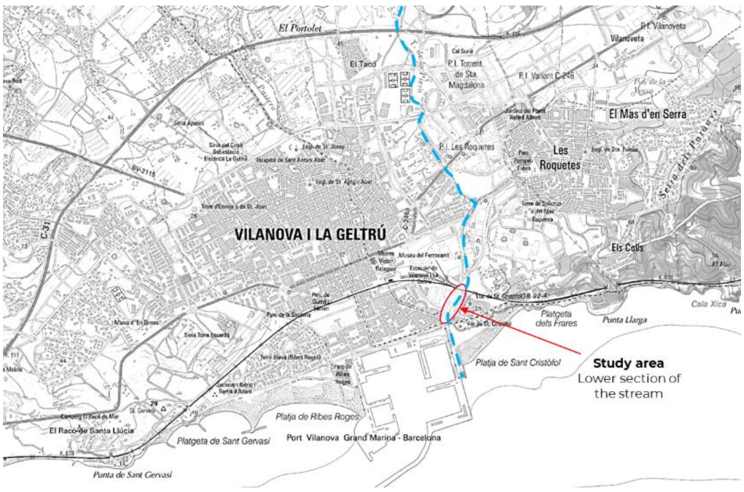
CCLL VILANOVA I LA GELTRÚ|PROVINCE OF BARCELONA (SPAIN)

Brief description of the area

This case study takes us to the Municipality of Vilanova i la Geltrú in the Province of Barcelona (Catalonia, Spain). This city covers an area of 33.99 km² and is home to 68,768 inhabitants as of 2023 (according to Idescat, 2023). The focus of the analysis lies on the 'Torrent de la Piera', an intermittent river stream located within the urban boundaries of Vilanova i la Geltrú. Specifically, we explore a lower section of Torrent de la Piera, which is located closer to the sea, and covers an extension of approximately 240 meters. Within this part of the stream, there is a parallel road known as Ronda d'Europa, which serves as a key connection between the east and the north ends of the city. Both the road and the stream pass underneath a railway. Furthermore, the study area is adjacent to residential and commercial zones.

Study area

Figure 9: Map of the study area in Vilanova i la Geltrú



Source: Adapted with changes from Visor SigPac: https://sigpac.mapama.gob.es/fega/visor/

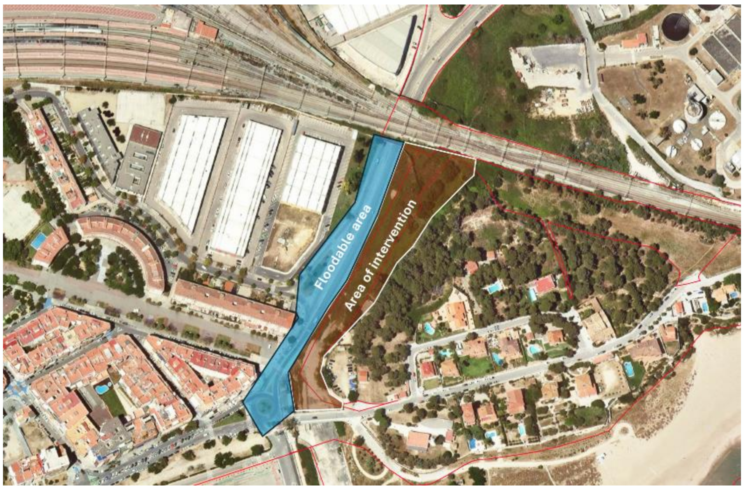
Figure 10: Satellite view of the study area in Vilanova i la Geltrú

Main hazard(s) considered

The analysis focuses on inland flooding. During periods of intense rain, the water level rises along the stream's banks, overflowing into various adjacent areas. The flooding episodes significantly affect roads, sidewalks, residential neighbourhoods, and commercial zones. These events disrupt both road traffic and pedestrian movement, thereby blocking the connection between the north and east ends of the city.

MCA objective

The objective of the MCA is to prioritise potential EBA measures aimed at addressing flooding in the river stream of Torrent de la Piera, particularly the lower section, through an *ex-ante* analysis. By following this process, the goal is to assist decision makers in identifying suitable measures for this specific location, considering stakeholders' perceptions and preferences regarding a diverse set of proposed measures. The prioritisation of measures resulting from this process will serve as the initial step for further analysis of the costs and benefits associated with the top-ranked measure(s) (Task 7.4).



Source: Adapted with changes from Visor SigPac: https://sigpac.mapama.gob.es/fega/visor/

Figure 11: Flooding event in the study area in Vilanova i la Geltrú

Credits: Aïgues de Vilanova i la Geltrú.

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The selection of the hazards and study area was a collaborative effort involving city council representatives. During various meetings, local technicians identified the study area as a hot spot susceptible to pluvial flooding. Their interest lied in discussing potential interventions to mitigate flooding in this location. The MCA process aimed at addressing two main questions: (i) To what extent can the proposed measure reduce the risk of flooding in the study area? and (ii) Beyond flood risk reduction, what other relevant benefits can be enhanced with each measure?

Step 1. Identifying a list of preliminary options

SCORE's WP7 facilitators proposed an initial set of four measures aimed at mitigating flooding issues in the study area (See Appendix 1 for a full description of EBA measures):

1. Renaturing along river stream banks
2. Restitution of river stream-bed depth and renaturing
3. Heightening the river stream bank
4. Implementing a filter strip

Step 2. Screening or feasibility assessment

The EBA feasibility assessment, and the final selection of the measures and evaluation criteria were conducted during an online session on the 24th of March of 2023. This activity involved the following stakeholders: Vilanova i la Geltrú City Council; Provincial Council of Barcelona (*Diputació de Barcelona*); *Companyia d'Aigües* de Vilanova i la Geltrú (local water agency); local school attending 3-18 years-old students; local school attending students aged 0 to 18 years; social economy enterprise; environmental association; Polytechnic University of Catalonia (UPC); and *Neàpolis* (Public Innovation Agency). These stakeholders collectively form the Quadruple Helix group, with the following distribution: Citizens (36%); Government (36%); Industry (14%); and Academia (14%).

All measures received favourable feasibility assessments, with aggregate scores ranging from 2.5 to 4 (on an increasing scale of feasibility of 1 to 5). After stakeholder discussions, a fifth measure was proposed for assessment in the MCA: a combined intervention involving renaturing, restitution of river stream-bed depth, and heightening the river stream bank.

Table 12: Feasibility assessment of EBA measures in Vilanova i la Geltrú

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Renaturing along river stream banks	4.00	3.90	3.41	3.14	3.61	1
Heightening the river stream bank	3.76	3.81	3.36	3.10	3.51	2
Implementing a filter strip	3.48	3.62	3.27	3.19	3.39	3
Restitution of river stream-bed depth and renaturing	3.29	3.43	2.68	2.57	2.99	4

Step 3. Defining evaluation criteria

SCORE's WP7 facilitators began by proposing an initial set of criteria: 1) Perception of flood risk reduction; 2) Maintenance and improvement of biodiversity (or the alternative option of 'increase habitat areas'); 3) Heat stress reduction; 4) Water quality improvement; 5) Landscape aesthetic value; and 6) Carbon capture and sequestration. Additionally, the option of 'Resource production' was suggested as a potential alternative criterion. Following discussions with stakeholders, it was determined to retain criteria 1 to 6. However, the previous criterion 2 was modified to 'Conservation and Improvement of Biodiversity'.

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop, held on March 28, 2023, had a total of 22 voting participants, which were distributed in the Quadruple Helix groups as follows: citizens (36%), government (36%), industry (14%), and academia (14%). The participants' profile included representatives from local and regional public administrations, local primary and secondary schools, environmental NGOs, citizens' associations, universities, an innovation agency, and private local SMEs. The workshop had a wide audience, ranging high school students, who represented the youngest cohort, to retired individuals affiliated with environmental organizations, who were the eldest participants.

Step 4. Initial scoring or assessment of options

The participants were invited to evaluate each EBA against specific criteria using an online voting tool. The evaluation scale ranged from 1 (minimum) to 5 (maximum), representing the contribution of the assessed measure against the criteria. Table below provides a summary of average scores per criterion, the total average score, and the prioritisation ranking. The results indicate a strong preference among participants for the adoption of a combination of measures, followed by the sole implementation of renaturing along riverbanks, and river stream-depth restitution and renaturing.

Table 13: Initial scoring of EBA measures in Vilanova i la Geltrú

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Perception of flood risk reduction	Biodiversity conservation and improvement	Heat stress reduction	Water quality improvement	Landscape aesthetic value	Carbon capture and sequestration		
*Combination of measures**	4.25	4.06	3.38	3.70	4.05	3.62	3.80	1
Renaturing along river stream banks	3.55	3.94	3.62	3.20	4.19	3.48	3.70	2
Restitution of river stream-bed depth and renaturing	3.85	3.39	2.33	2.70	2.67	2.52	2.90	3
Heightening the river stream bank	3.70	2.89	2.33	2.20	2.90	2.48	2.80	4
Implementing a filter strip	2.50	2.67	2.71	2.30	3.05	2.52	2.60	5

*Note: * Refers to the combination of all measures apart from the implementation of a filter strip.*

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

Afterwards, participants were invited to allocate weights to the criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The average weights for each criterion displayed below show that participants gave more importance to the 'Perception of flood risk reduction' (48%), followed by 'Biodiversity conservation and improvement' (18%), and 'Landscape aesthetic value' (13%). The final score was then obtained by combining these weights with the previous assessment (step 4) using the weighted sum method. The results indicate a slight decrease in the average score between steps 4 and 5, while maintaining the same ranking.

Table 14: Final scoring of EBA measures in Vilanova i la Geltrú

Name of the EBA	Evaluation criteria						Weighted sum scores	Final ranking
	Perception of flood risk reduction	Biodiversity conservation and improvement	Heat stress reduction	Water quality improvement	Landscape aesthetic value	Carbon capture and sequestration		
Weights ⇨	45.5%	18.3%	8.1%	8.0%	13.1%	7.0%		
*Combination of measures**	1.91	0.73	0.27	0.30	0.53	0.25	3.99	1
Renaturing along river stream banks	1.60	0.71	0.29	0.26	0.54	0.24	3.64	2
Restitution of river stream-bed depth and renaturing	1.73	0.61	0.19	0.22	0.35	0.18	3.27	3
Heightening the river stream bank	1.67	0.52	0.19	0.18	0.38	0.17	3.10	4
Implementing a filter strip	1.13	0.48	0.22	0.18	0.40	0.18	2.58	5

*Note: * Refers to the combination of all measures apart from the implementation of a filter strip.*

Additional remarks

During the workshop discussions, participants shared additional remarks. Complementary information was also collected using post-it notes. For example, it was stressed the need to include local and climate-resilient vegetation, and to regularly ensure the maintenance of the area. Several actors agreed on the need of installing water collection tanks in different points of the river stream. This action could mitigate excessive water flow into the study area and prevent overflows. In addition to natural restoration efforts, it was proposed to expand the area, allowing to accommodate a pedestrian path, a bike lane, and green spaces to promote social interaction. However, the feasibility of this idea may be constrained by the road connecting the northern part of the city to the beach. Further mobility planning actions would be required to address this limitation. Finally, during the discussions, some participants highlighted the historical context of the study area, which was once a marshland and included a pond. When asked about additional measures to propose, the idea of restoring the former pond emerged. This restoration could serve to capture water overflows during flooding episodes. As with the previous case, mobility planning actions would be necessary to fully implement this proposal.

3.2.5. Massa - Coastal flooding, storm surge, and heatwaves

CCLL MASSA (ITALY)

Brief description of the area

The study area, which is Marina di Massa, is part of the CCLL established in the region of Massa-Carrara in Tuscany, Italy. Marina di Massa is a beach area located about ten minutes away by car from the town of Massa. Massa, which is located in Italy's north-west, is a coastal resort close to La Spezia and Pisa. With a total population of 65,987 (Istat, 2021), the population density is 728 inhabitants/km², which grows significantly during summer months due to the large influx of tourists. The CCLL aims to bring together stakeholders from academia, industry, public sector and civil society to co-create coastal resilience.

Study area

Figure 12: Map of the study area in Massa

Source: Google Maps

Main hazard(s) considered

This region is prone to flood, erosion, and storm damage, and has had limited studies conducted on suitable interventions for hazard risk reduction. The selected study area of Marina di Massa suffered an intense storm and flooding in early November 2023, which caused huge wreckage on the beachfront, and even loss of lives within Tuscany.

MCA objective

This MCA aimed at assessing the stakeholders' acceptability and local knowledge of different EBA options. The objective was to rank the different adaptation measures. The results were shared with the local municipality and relevant stakeholders and would potentially be included in the region's climate action plans.

Main results of the 1st phase - preparation of the MCA

<u>Step 0. Understanding the local adaptation context</u>

The bilateral meetings with the stakeholders followed the stakeholder mapping, which was conducted according to the power interest matrix. Identified stakeholders in Massa included representatives from academia, industry, government, and civil society, with a focus on coastal environment research and protection:

- Academia & University, such as the universities of Firenze and Pisa, the National Research Council (CNR), as well as several types of high school, and the LaMMA Consortium.
- Industry & Business: Coastal associations that collaborate with groups representing merchants, artisans, farmers, and hoteliers. Additionally, these include professional associations of engineers, architects, geologists and surveyors of Massa Carrara.
- Government & Public Sector: These include the Tuscany Region, the Port Authority, the Municipality of Massa (with its various departments), and the Province of Massa Carrara.
- Civil Society: numerous environmental protection organizations, both local and international, as well as volunteer associations and cultural groups.

For the subsequent steps, most of the participants represented the government and public sector.

Step 1. Identifying a list of preliminary options

Six EBA measures were proposed for the case study area in Massa:

1. Riparian reforestation
2. Bioswale
3. High water channels
4. Infiltration ponds
5. Filter strips
6. Floodplain enlargement

These EBA were selected in collaboration with the CCLL team and inspired by the SCORE | EBA catalogue. Regarding the MCA process, the workshop was conducted in person in one day, as opposed to being split into two days (hybrid) as was initially planned in D7.2 (Methodological framework for the socio-economic assessment of adaptation measures to climate change).

Step 2. Screening or feasibility assessment

Based on the results, high water channels ranked first, followed by bioswale and riparian reforestation with the same scoring. Next in line were filter strips, infiltration ponds, and floodplain enlargement.

Table 15: Feasibility assessment of EBA measures in Massa

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
High water channels	4.10	3.80	3.35	2.95	3.55	1
Bioswale	3.85	3.30	3.35	3.30	3.45	2
Riparian reforestation	3.50	3.80	3.40	3.10	3.45	2
Filter strips	3.35	3.05	2.70	2.40	2.88	3
Infiltration ponds	3.45	2.75	2.45	2.00	2.66	4
Floodplain enlargement	3.05	2.50	1.95	1.95	2.36	5

Step 3. Defining evaluation criteria

Six evaluation criteria were selected: perception of flood risk reduction; improvement of water quality; improvement of human health; conservation and enhancement of biodiversity; carbon capture and storage; increase in recreational opportunities; and job opportunities. These were selected in collaboration with the CCLL, who wanted to add the criterion on human health. The evaluation criteria were pre-selected as opposed to during the workshop. The stakeholders were provided with printed pamphlets and posters containing descriptions of the EBA as reference points and were allowed ample time for discussion in addition to the collating of quantitative data.

Main results of the 2nd phase – MCA implementation

Step 4. Initial scoring or assessment of options

The initial ranking was as follows: riparian reforestation, floodplain enlargement, infiltration ponds, filter strips, bioswale, and high-water channels.

Table 16: Initial scoring of EBA measures in Massa

Name of the EBA	Evaluation criteria							Average score	Initial ranking
	Flood risk reduction	Increase recreational opportunities	Water quality improvement	Biodiversity maintenance and improvement	Carbon capture and sequestration	Increase labour opportunities	Improve human health		
Riparian reforestation	3.2	3.4	3.1	4.5	4.6	4.1	4.5	3.91	1
Floodplain enlargement	4.5	3.2	2.1	3.5	3.4	4.0	3.6	3.46	2
Infiltration ponds	4.0	2.3	3.5	3.9	2.9	3.1	3.7	3.32	3
Filter strips	3.4	2.5	3.4	3.5	3.4	2.6	4.0	3.26	4
Bioswale	3.7	2.4	3.4	2.7	3.5	2.5	4.0	3.17	5
High water channels	4.5	2.0	2.7	3.6	2.9	2.7	3.6	3.14	6

<u>Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)</u>

The weighting from different stakeholders showed that flood risk reduction was the most important with 41%. This is followed by improvement of water quality, improvement of human health, conservation and enhancement of biodiversity, carbon capture and storage, increase job opportunities, and increase in recreational opportunities. With the weighting process, there was a shift in the ranking of EBA measures. The top-ranked measure is now floodplain enlargement, followed by riparian reforestation, high-water channels, infiltration ponds, bioswale, and filter strips.

Table 17: Final scoring of EBA measures in Massa

Name of the EBA	Evaluation criteria							Weighted sum scores	Final ranking
	Flood risk reduction	Increase recreational opportunities	Water quality improvement	Biodiversity maintenance and improvement	Carbon capture and sequestration	Increase labour opportunities	Improve human health		
Weights ⇨	41.4%	5.8%	14.3%	11.4%	8.8%	6.0%	12.3%		
Floodplain enlargement	1.9	0.2	0.3	0.4	0.3	0.2	0.4	3.73	1
Riparian reforestation	1.3	0.2	0.4	0.5	0.4	0.2	0.6	3.69	2
High water channels	1.9	0.1	0.4	0.4	0.3	0.2	0.4	3.64	3
Infiltration ponds	1.6	0.1	0.5	0.4	0.3	0.2	0.5	3.60	4
Bioswale	1.5	0.1	0.5	0.3	0.3	0.1	0.5	3.42	5
Filter strips	1.4	0.1	0.5	0.4	0.3	0.2	0.5	3.39	6

Additional remarks

Some of the problems faced by the Massa CCLL also affect the implementation of the assessed EBA measures. Examples include excessive bureaucracy in Italian research institutions; lack of defined roles within the CCLL; challenging relationship with the municipality; lack of support with technical aspects such as calibrating sensors and building hydrological models; lack of funding for the implementation of EBA; and the potential destruction of monitoring equipment such as smart pebble sensors by intense coastal storms. In contrast, facilitating factors include the opportunity for stakeholder discussions, facilitation of the workshop in local language (Italian), and setting the workshop on shorter time (half a day).

3.2.6. Dublin - Coastal flooding, storm surge, and heatwaves

CCLL DUBLIN (IRELAND)

Brief description of the area

Dublin, Ireland's capital, had a population of 1,458,154 inhabitants (CSO, 2022), and was the richest European city based on GDP per capita in 2022 (Worldlistmania, 2024). Dublin is located along the Irish Sea coastline, crossed by River Liffey, and bordered by the Wicklow Mountains. This city is characterized by a temperate oceanic climate, with mild summers and cold winters. Climate change is having several impacts on Dublin, including harsher storms, erosion, and floods, increased droughts, and heatwaves ((DLR, 2023)). In addition, it is also facing the urban heat island effect. These problems are affecting infrastructure and the quality of life.

Main hazard(s) considered

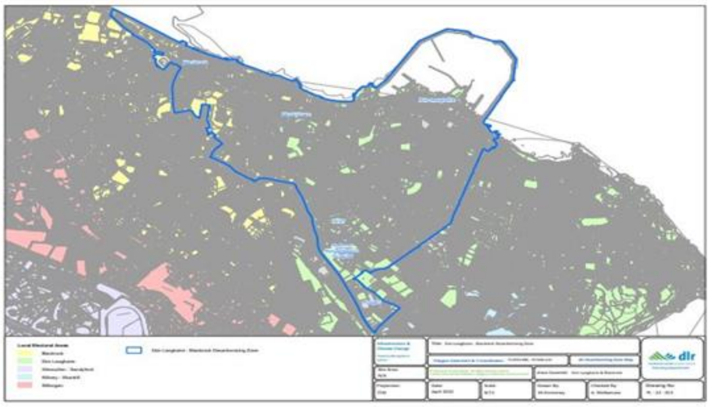
The selected hazards were coastal flooding and coastal erosion, with the study area focusing on the decarbonization zone in the coastal town of Dun Laoghaire in County Dublin (DLRCC, 2024). Floods have already affected the coastal DART (Dublin Area Rapid Transit) trainline, which connects Dun Laoghaire to Dublin city centre.

MCA objective

To assess and rank six EBA in collaboration with stakeholders from academia, public sector, civil society, and industry in order to determine the most suitable EBA to reduce flood/erosion risk affecting the DART in Dun Laoghaire. Stakeholders were instructed that the objective of this MCA exercise was to consider options to reduce flood, storm, and erosion damage in the Dún Laoghaire decarbonization zone, specifically to protect the DART against flooding damage. This workshop was aimed at assessing the stakeholders' acceptability and local knowledge of different EBA options.

Study area

Figure 13: Map of the study area in Dublin



Source: Dun Laoghaire Council Climate Action Plan, 2024.

Figure 14: Decarbonization zone, Dun Laoghaire, Dublin

Credit: Irish Rail, 2018.

Main results of the 1st phase - preparation of the MCA

<u>Step 0. Understanding the local adaptation context</u>

The hazard and hazard area were selected by the CCLL team, consisting of the Dun Laoghaire County Council as well as local researchers from University College Dublin. The CCLL team selected the hazard area as it is frequently flooded, which disrupts local transportation and affects the quality of life. It was selected in the Dun Laoghaire decarbonization zone, as this zone already has a lot of funding for NBS implementation and would encourage actual implementation of the results of the MCA exercise.

<u>Step 1. Identifying a list of preliminary options</u>

The six selected EBA measures for the MCA exercise include:

1. Sand dune management
2. Saltmarsh restoration
3. Floodable park

4. Green infrastructure
5. SUDS
6. Rainwater harvesting

The EBA were inspired from the SCORE | EBA catalogue and selected in collaboration with the local county council based on their feasibility as well as local needs. The stakeholders were happy with the selected EBA and added suggestions for their implementation during the workshop.

Step 2. Screening or feasibility assessment

The Dublin MCA workshop took place on 28th November of 2023 at the Dun Laoghaire – Rathdown County Council house. In attendance were members of Dún Laoghaire Rathdown County Council (DLRCC); Local Authority Waters Programme (LAWPRO); Geological Survey Ireland (GSI); Tidy Towns Dalkey. Most of the stakeholders were from related organisations and had a strong understanding of EBA and the local area. The main results of the feasibility assessment are summarized in the table below. Green infrastructure, rainwater harvesting, and SUDS were classified as the top three measures in terms of feasibility.

Table 18: Feasibility assessment of EBA measures in Dublin

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Green Infrastructure	4.75	4.58	4.09	3.40	4.21	1
Rainwater harvesting	3.75	4.33	4.08	4.09	4.06	2
SUDS	4.17	4.45	3.00	3.80	3.86	3
Saltmarsh Restoration	3.33	3.50	3.42	2.90	3.29	4
Floodable park	3.25	3.18	2.91	2.30	2.91	5
Sand dune management	2.33	2.58	2.00	2.50	2.35	6

Step 3. Defining evaluation criteria

The evaluation criteria were defined based on the pre-existing work in EU SCORE project deliverable 7.2, and consulted with the local CCLL team as well as stakeholders during the in-person workshop. These criteria included, carbon capture, flood risk reduction, job creation, recreational opportunity, biodiversity conservation, and improving water quality.

Main results of the 2nd phase – MCA implementation

Step 4. Initial scoring or assessment of options

The results of the scoring of EBA options are as follows: Green infrastructure (1), floodable park (2), saltmarsh restoration (3), SUDS (4), Sand dune management (5), rainwater harvesting (6).

Table 19: Initial scoring of EBA measures in Dublin

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Flood/Erosion Risk Reduction	Recreational Opportunities	Water Quality	Biodiversity Conservation	Carbon Capture and sequestration	Job Opportunities		
Green Infrastructure	N/A*	3.09	4.09	4.55	4.00	3.64	3.87	1
Floodable Park	3.82	3.82	3.82	3.73	3.45	3.00	3.61	2
Saltmarsh Restoration	3.50	2.90	3.80	4.30	4.30	2.73	3.56	3
SUDS	3.18	2.18	4.27	2.73	2.64	3.55	3.09	4
Sand dune management	3.50	2.50	2.20	4.00	2.30	2.20	2.78	5
Rainwater harvesting	2.60	2.27	3.27	2.00	2.73	2.73	2.60	6

*Note: * N/A refers to not applicable. Green infrastructure was not included in the online voting process for the criteria of perception of flood/erosion risk reduction due to a technical error. For this matter, the results of this measure, including the associated ranking, should be interpreted with caution.*

Stakeholders had extensive knowledge of the water quality issues of the local area, and were particularly interested in EBA options that would improve water quality. They also expressed concern about voting, as they were uncertain which of the assessed options could be implemented in the local area. There was also discussion surrounding the terminology being used for measures such as green infrastructure. They noted that some designations were a bit general which made it challenging to envision the feasibility of various solutions. Moreover, the discussion focused on how the language and terminology can contribute to "mixed messaging", potentially leaving the public uncertain about whom to trust when presented with information about green solutions.

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

The results of the weighting of evaluation criteria are as follows: flood/erosion risk reduction (24%), water quality improvement (20%), biodiversity conservation (18%), recreational opportunities (15%), carbon capture (15%), and job opportunities (8%). Table below shows that the ranking of EBA measures changed in the three top positions after the weighting process. Floodable park obtained the highest score, followed by saltmarsh restoration, and green infrastructure.

Table 20: Final scoring of EBA measures in Dublin

Name of the EBA	Evaluation criteria						Weighted sum scores	Final ranking
	Flood/erosion risk reduction	Recreational opportunities	Water quality	Biodiversity conservation	Carbon capture and sequestration	Job opportunities		
Weights ⇨	24.0%	14.8%	20.2%	18.1%	15.4%	7.5%		
Floodable Park	0.92	0.57	0.76	0.67	0.52	0.24	3.68	1
Saltmarsh restoration	0.84	0.44	0.76	0.77	0.65	0.22	3.67	2
SUDS	0.76	0.33	0.85	0.49	0.40	0.28	3.12	3
Green infrastructure	N/A*	0.46	0.82	0.82	0.60	0.29	2.99	4
Sand dune management	0.84	0.38	0.44	0.72	0.35	0.18	2.90	5
Rainwater harvesting	0.62	0.34	0.65	0.36	0.41	0.22	2.61	6

*Note: *N/A refers to not applicable. Green infrastructure was not included in the online voting process for the criteria of perception of flood/erosion risk reduction. For this matter, the results of this measure should either be considered invalid or interpreted with caution.*

Discussions about the results led participants to once again rank green infrastructure as the preferred option. This preference likely stems from its feasibility on a smaller scale, if necessary, and its potential to serve as a community-based initiative that encourages individual involvement. The stakeholders wanted to include rainwater harvesting within green infrastructure, to be reflected in the top three ranked EBA, as they felt rainwater harvesting is extremely feasible. It was also discussed that long term solutions should be a priority, as short-sighted solutions are often ineffective.

Additional remarks

Further discussions centred around the siloing of different interest groups. For example, engineers and environmentalists were interested in similar goals but had different interests in achieving them. Moreover, there was discussion surrounding SUDS feasibility in the study area. Though there was an interest among stakeholders, there are difficulties in getting funding and public support for these types of EBA. Moreover, where to locate SUDS was also discussed.

Other comments focused on the potential hybridisation of adaptation options. On this topic, participants first addressed the flood wall building by Dodder River – there was a discussion that floodable parks encourage the use of grey infrastructure, even when not necessary. It was also discussed that while building grey infrastructure, there must be a consideration for the long-term influence on the environment.

Other discussed points included the need for planning and regulations to restrict the use of certain materials; the potential benefits resulting from smaller scale changes; the importance of municipalities providing alternative, and effective, solutions to their inhabitants; and the notion that sometimes the best solutions involve leaving nature undisturbed, as in the case of floodable parks.

Finally, participants talked about an ongoing local activity involving a sensor installation in Booterstown marsh. This initiative was highlighted as a good example of successfully getting the public involved in conversations about ecosystem and water quality issues at a community event.

3.2.7. Oeiras - Inland flooding

CCLL OEIRAS (PORTUGAL)

Brief description of the area

The Municipality of Oeiras is in the Lisbon Metropolitan Area (Portugal). This city covers an area of 45.75 km² and is home to 171,658 inhabitants (INE, 2021). The focus of the analysis lies on the 'Eixo Verde Azul' (The Green and Blue Axis), a restoration project along Jamor River. The neighbouring municipalities of Sintra, Amadora and Oeiras, signed a memorandum of understanding to restore the ecological values of the river in 2016. The restoration was based on EBA measures and other interventions to increase runoff absorption capacity of the area, improve environmental protection, and promote social interactions, among others. The study area was chosen for its significance in the implementation of innovative approaches to environmental challenges. During the workshop it were evaluated some of the measures implemented along an extension of 2,800m, from Santuário de Nossa Senhora da Rocha (Carnaxide) to Cruz Quebrada.

Main hazard(s) considered

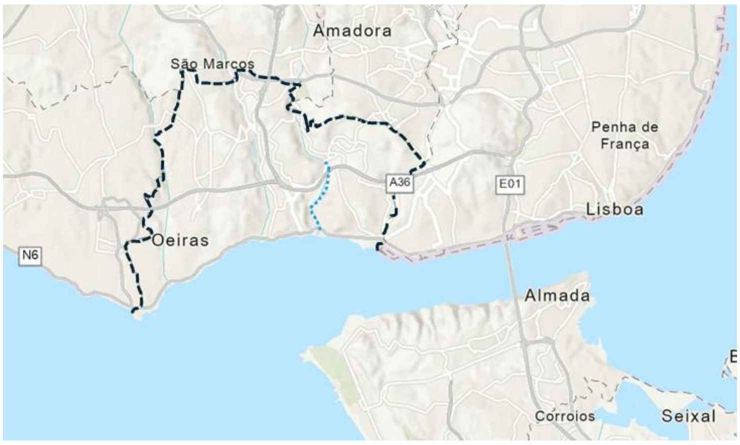
The analysis focuses on inland flooding. This was identified by the CCLL team to be the principal hazard affecting the municipality. During heavy rainfall episodes, flooding occurs along Rio Jamor. To address this issue, various inter-municipal interventions were deemed necessary, notably the expansion of floodplain areas and the increase in permeable surfaces next to the riverbanks, among others.

MCA objective

To assess the performance of preselected EBA implemented along Rio Jamor, in the city of Oeiras. Some of the measures were implemented within the context of the first stage of "Eixo Verde Azul" project. The MCA intended to collect the perception of various stakeholders about the selected measures, which were analysed against environmental, social, and economic criteria. The results of this exercise could be considered by decision makers in case these measures were to be replicated in other local and regional river streams.

Study area

Figure 15: Map of the study area in Oeiras



Sources: Instituto Geográfico Nacional, Esri, TomTom, Garmin, Foursquare, GeoTechnologies, Inc., METI/NASA, and USGS. Adapted with minor changes from: https://www.arcgis.com/apps/mapviewer/index.html.

Notes: The darker black dot line delineates the boundaries of the Municipality of Oeiras, while the blue dotted lines represent the partial route of the Jamor River considered in the analysis

Figure 16: Satellite view of the study area in Oeiras

Source: Parques de Sintra.

Note: The green line from south to north marks the partial route of the Eixo Verde Azul.

Figure 17: Flooding event in the study area in Oeiras

Credits: Maria João Costa, Renascença.

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The selection of the hazards and study area was a collaborative effort involving the CCLL team. During various meetings, the CCLL team and the MCA facilitators discussed the most appropriate location and measures to assess during the workshop. Their interest lied in assessing already implemented interventions to mitigate flooding in the section of the "Eixo Verde Azul" described above. The MCA process aimed at assessing some of the good practices implemented along this section of the river, which could be suitable for adoption in other locations.

Step 1. Identifying a list of preliminary options

SCORE's WP7 facilitators and the CCLL team proposed an initial set of six measures aimed at mitigating flooding issues in the study area:

1. River regularisation, involving desilting the riverbed and unblocking and reconfiguring the flow section.
2. Riverbanks stabilization through the assemblage of wooden and rock-based structures to ensure its stability.
3. Plantation of native riparian vegetation, with a high degree of adaptation to humid soils and periods of flooding, combined with the elimination of invasive exotic species.
4. Maintenance of the river network, including the periodic cleaning and clearing of river sections.
5. Floodplain enlargement, while ensuring compatibility with leisure and sport areas.
6. Implementation of permeable pavements alongside some sections of the river, designed for soft mobility and leisure purposes.

Step 2. Screening or feasibility assessment

During this workshop, the feasibility assessment was not undertaken as all measures proposed had been already implemented.

Step 3. Defining evaluation criteria

SCORE's WP7 facilitators proposed an initial set of criteria: 1) Perception of flood risk reduction; 2) Increase recreational opportunities; 3) Carbon capture and sequestration; 4) Increase labour opportunities; 5) Improve human health; 6) Biodiversity conservation and valorisation; 7) Water quality improvement. These criteria were presented to the stakeholders and were all considered appropriate for the assessment.

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop, held on November 30, 2023, had a total of 14 voting participants, which were distributed in the Quadruple Helix groups as follows: citizens (14%), government (29%), and academia (57%). The participants' profile included representatives from local public administrations, research institutes, secondary school teachers, and universities.

Step 4. Initial scoring or assessment of options

The participants were invited to evaluate each EBA against specific criteria using an online voting tool. The results in the table below highlight that river regularisation, maintenance of river network, and the expansion of floodplain areas are the top three measures perceived to contribute the most to flood risk reduction. When aggregating the results into the total average score and corresponding ranking, the plantation of indigenous vegetation emerges as the top measure, followed by the expansion of floodplain areas, and the maintenance of river network.

Table 21: Initial scoring of EBA measures in Oeiras

Name of the EBA	Evaluation criteria							Average score	Initial ranking
	Perception of flood risk reduction	Carbon capture and sequestration	Conservation and improvement of biodiversity	Water quality improvement	Improve human health	Increase recreation opportunities	Increase labour opportunities		
Planting indigenous vegetation	3.25	3.75	4.81	3.94	3.50	2.69	2.94	3.55	1
Floodplain areas with recreational purposes	4.19	2.56	3.00	2.44	4.25	4.50	3.00	3.42	2
Maintenance of river	4.00	2.31	3.56	3.50	3.19	3.00	3.44	3.29	3

network									
River regularisation	4.44	1.81	3.00	3.31	2.56	3.00	2.69	**2.97**	4
Riverbank restoration	3.60	1.69	2.44	2.81	2.38	2.88	2.44	**2.60**	5
Permeable pavements	3.25	1.56	2.19	2.63	3.31	3.25	1.94	**2.59**	6

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

Afterwards, participants were invited to allocate weights to the criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The average weights for each criterion displayed below show that participants gave more importance to the 'Perception of flood risk reduction' (38%), followed by 'Improve human health' (16.0%), and 'Conservation and improvement of biodiversity' (15.7%). The final score was then obtained by combining these weights with the previous assessment (step 4) using the weighted sum method. The results indicate a slight decrease in the aggregated scores between steps 4 and 5, while maintaining the same ranking.

Table 22: Final scoring of EBA measures in Oeiras

Name of the EBA	Evaluation criteria							Weighted sum scores	Final ranking
	Perception of flood risk reduction	Carbon capture and sequestration	Conservation and improvement of biodiversity	Water quality improvement	Improve human health	Increase recreation opportunities	Increase labour opportunities		
Weights ⇨	38.0%	9.3%	15.7%	10.7%	16.0%	7.0%	3.3%		
Planting indigenous vegetation	1.24	0.35	0.75	0.42	0.56	0.19	0.10	**3.32**	1
Floodplain areas with recreational purposes	1.59	0.24	0.47	0.26	0.68	0.32	0.10	**3.24**	2
Maintenance of river network	1.52	0.22	0.56	0.37	0.51	0.21	0.11	**3.18**	3
River regularisation	1.69	0.17	0.47	0.35	0.41	0.21	0.09	**3.09**	4
Riverbank restoration	1.37	0.16	0.38	0.30	0.38	0.20	0.08	**2.59**	5
Permeable pavements	1.24	0.15	0.34	0.28	0.53	0.23	0.06	**2.53**	6

Additional remarks

During the workshop, participants shared additional remarks. Opportunities for replicating successful measures in other sites of the Municipality of Oeiras were explored, paving the way for a collaborative and forward-looking discourse. Complementary information related to the additional benefits and replication possibilities of the measures assessed were also suggested. For example, it was considered similar river regularisation measures could be undertaken in other local rivers or streams such as Ribeira de Reinaflotos. Similarly, permeable pavements could be a valid option in the river side of the Municipality of Algés and the Oeiras' neighbourhood of Lage, as well as in frequently floodable areas such as parking slots. It was also stressed the need to maintain the river network across the entire municipality. Moreover, it was identified the opportunity of creating a flora and fauna gene bank with characteristic species of Oeiras' river ecosystems. Finally, some stakeholders stated that environmental and sustainability educational activities should be implemented along with the measures of riparian reforestation and the enlargement of floodable areas with recreational purposes.

3.2.8. Gdansk - Inland flooding and storm surge

CCLL GDANSK (POLAND)

Brief description of the area

Gdansk, as the largest city in the north of the country, is also the biggest centre of maritime economy, food industry and transport. It is also a major centre for trade, communication, and transportation. Located on the Bay of Gdansk, at the mouth of the Dead Vistula, the city has specific climatic and terrain conditions such as the proximity of the Baltic Sea, topographic diversity and location within the impact area large baric centres. The total area covered by the city is 262 km², and the number of inhabitants is 487 thousand (as of December 2023, data of the Municipality of Gdansk). Gdansk is a perfect example of a city where dynamic economic development is having adverse effects on the environment, particularly affecting the hydrological conditions within its catchment areas (the adaptation plan of the City of Gdansk to climate change up to 2030, 2018). The rapid development of the upper terraces of the city, together with newly built large-scale centres commercial and service areas, parking lots, communication infrastructure and residential estates located on the moraine hills surrounding the city, drastically deteriorate the permeability of the catchment area.

Main hazard(s) considered

A consequence of progressive urbanization is the intensification of surface runoff, the negative effects of which are particularly felt during heavy rainfall episodes. Thus, the main climate hazard are torrential rains - pluvial flooding (inland flooding) from waterways (e.g., rivers, streams within the city's borders reach maximal water retention capacity) occurring during the months June-August. In addition, coastal flooding through storm surges (backwater and ice jams) appears as a minor, but still relevant, hazard.

MCA objective

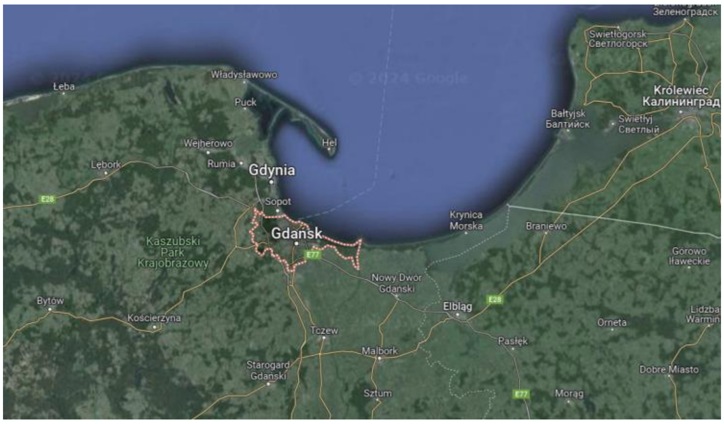
The objective of this MCA was to propose and assess EBA implementation for the mitigation of summer torrential rain and pluvial flooding in three districts (Wrzeszcz District; old historic central area; Orunia district). For that purpose, a workshop was organized to assess stakeholders' acceptability and local knowledge about different EBA options. The MCA approach facilitated the ranking of different adaptation measures. The results were shared with the local municipality and relevant stakeholders, with the possibility of incorporating them into the region's climate action plans.

Study area

Figure 18: Location of Gdansk

Source: Britannica.

Figure 19: Aerial photo of Gdansk



Source: *Google Earth.*

Figure 20: Flood hazard map of Gdansk

Source: Melioracje company modified by University of Gdansk.

Notes: 3 marked study areas 1- Gdansk Wrzeszcz, 2- Main Gdansk, 3- Gdansk Orunia.

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The University of Gdansk team recognized during the SCORE project duration that effective EBA measures against summer torrential rain and pluvial flooding are crucial for enhancing Gdansk's climate resilience. They also emphasized that NBS have been implemented over the past two decades, even though the terminology associated with NBS during those periods was not widely recognized. Nevertheless, three study areas at risk of pluvial flooding were examined: 1) Wrzeszcz District – In 2001, the overflow of Strzyza streams led to flooding of different areas (e.g., built environment, new apartments, offices, road and airport infrastructures); 2) Old historic centre – this area is prone to flooding of main railway and municipal offices (low-lying area) and historic parts of the city; 3) Orunia district – the main concern for this area refers to the potential overflow of Radunia channel and the road connecting the city centre (residential quarters) to Warsaw. Despite varying in location and having different vulnerable infrastructure, these three study areas share the limited amount of implemented measures that address the pluvial floodings, as compared to the areas receiving NBS implementation of the past two decades.

Step 1. Identifying a list of preliminary options

SCORE WP7 facilitators proposed an initial set of seven measures, taken from the catalogue on coastal EBA, aimed at addressing summer torrential rain and pluvial floodings in the three study areas:

1. Rain gardens
2. Water parks and retention ponds
3. Filter strips
4. Green walls and green roofs
5. Urban farming and community gardens
6. Planting trees
7. Introduction and/or renovation of open green spaces

Step 2. Screening or general feasibility assessment

The EBA feasibility assessment and the final selection of the evaluation criteria was undertaken during an online session on the 23rd of November of 2023. Sixteen stakeholders participated in the workshop, with the following entities represented: Gdansk Waters; Gdansk Municipality; Agency for Regional Atmospheric Monitoring of the Gdansk Agglomeration (ARMAAG); University of Gdansk; and Technical University of Gdansk. All of them belong to the Quadruple Helix group in the following proportion: Citizens (37.5%); Government (25%); Industry (12.5%); and Academia (25%).

The following table presents the mean results of this assessment. All the proposed preliminary EBA obtained a mean score of 3.8 points or higher (out of a maximum possible score of 5), making them feasible for implementation. Planting trees received the highest score (4.23), whereas water parks and retention ponds scored the lowest (3.83). The discussion of the results with the stakeholders revealed that all the proposed EBA were generally accepted as able to contribute to the mitigation of the primary hazard, pluvial summer flooding. However, solutions that were less intrusive on the natural landscape were considered as more desirable compared to large structures.

Table 23: Feasibility assessment of EBA measures in Gdansk

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Planting trees	4.13	3.94	4.56	4.31	4.23	1
Introduction and/or renovation of open green spaces	3.81	4.06	4.38	4.25	4.13	2
Urban farming and community gardens	3.81	3.56	4.31	4.50	4.05	3
Rain gardens	3.88	3.88	4.06	4.13	3.98	4
Filter strips	3.25	3.31	4.50	4.44	3.88	5
Green roofs and green walls	4.00	3.25	4.19	3.88	3.83	6
Water parks and retention ponds	3.94	3.25	3.94	3.88	3.75	7

Step 3. Defining specific evaluation criteria

SCORE WP7 facilitators presented an initial set of six evaluation criteria, which were approved by the stakeholders participating in the online session: 1) Perception of flood risk/damage reduction associated with heavy rains; 2) Protection and use of urban and housing infrastructure; 3) Reduction of public and private costs after the implementation; 4) Protection/use of cultural heritage (infrastructure, traditions); 5) Increase in recreational opportunities; and 6) Maintenance and enhancement of biodiversity.

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop took place on the 5th of December of 2023. This session had the participation of 16 stakeholders from the different municipalities and different administrative levels, as well as academics, researchers, representatives of the private sector and civil society. The following entities took part in this process: Gdansk Municipality; Regional Directorate for Environmental Protection (ARMAAG); Institute of Meteorology and Water Management; Port of Gdansk; University of Gdansk; and Technical University of Gdansk. All of them belong to the Quadruple Helix group in the following proportion: Citizens (12.5%); Government (50%); Industry (12.5%); and Academia (25%). The overrepresented group (6 persons) were officials from the Regional Directorate for Environmental Protection. However, they were representatives from various departments, both regular employees and those in management positions.

Step 4. Initial scoring or assessment of options

The initial assessment of EBA (without weighting) indicated that water parks and retentions ponds received the highest score (4.1), while green roofs and green Walls were ranked as the lowest scoring option (2.8).

Table 24: Initial scoring of EBA measures in Gdansk

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Perception of flood risk/damage reduction	Protection/use of urban/housing infrastructure	Protection/use of cultural heritage (infrastructure, traditions)	Reduction of public and private costs after implementation	Increase in recreational opportunities	Maintenance and enhancement of biodiversity		
Water parks and retention ponds	4.29	4.00	3.94	4.13	4.13	4.13	**4.10**	1
Introduction and/or renovation of open green spaces	4.00	4.12	3.59	3.56	4.19	4.19	**3.94**	2
Planting trees	3.59	3.53	3.41	3.63	3.94	4.06	**3.69**	3
Rain gardens	3.41	3.65	3.53	3.63	3.19	3.44	**3.47**	4
Filter strips	3.71	3.76	3.47	3.19	2.13	3.19	**3.24**	5
Urban farming and community gardens	2.76	2.82	2.88	3.25	3.31	3.31	**3.06**	6
Green roofs and green walls	2.88	3.00	3.12	2.44	2.94	2.50	**2.81**	7

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

Afterwards, the participants were invited to allocate weights to the specific evaluation criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The average weights for each specific criterion show that participants gave more importance to 'Perception of flood risk/damage reduction' (29.3%), followed by 'Protection/use of urban/housing infrastructure' (20%), 'Reduction of public and private costs after implementation' (15.7%), 'Maintenance and enhancement of biodiversity' (15.5%), 'Increase in recreational opportunities' (10.2%), and 'Protection/use of cultural heritage (infrastructure, traditions)' (9.3%).

Table 25: Final scoring of EBA measures in Gdansk

Name of the EBA	Evaluation criteria						Weighted sum scores	Final ranking
	Perception of flood risk/damage reduction	Protection/use of urban/housing infrastructure	Protection/use of cultural heritage (infrastructure, traditions)	Reduction of public and private costs after implementation	Increase in recreational opportunities	Maintenance and enhancement of biodiversity		
Weights ⇨	29.3%	20.0%	9.3%	15.7%	10.2%	15.5%		
Water parks and retention ponds	1.26	0.80	0.37	0.65	0.42	0.64	**4.13**	1
Introduction and/or renovation of open green spaces	1.17	0.82	0.33	0.56	0.43	0.65	**3.97**	2
Planting trees	1.05	0.71	0.32	0.57	0.40	0.63	**3.68**	3
Rain gardens	1.00	0.73	0.33	0.57	0.33	0.53	**3.48**	4
Filter strips	1.09	0.75	0.32	0.50	0.22	0.50	**3.37**	5
Urban farming and community gardens	0.81	0.56	0.27	0.51	0.34	0.51	**3.00**	6
Green roofs and green walls	0.85	0.60	0.29	0.38	0.30	0.39	**2.80**	7

The personalised weighting did not change the ranking, even though 'Pluvial Risk/Damage Reduction' got the most average support (29%) and 'Protection of Cultural Heritage and Traditions' received the lowest average support (9%): the criteria were valued of importance within this narrow range (9-29%), most likely indicating that no extreme outliers beyond this range were applied by individual persons. The stakeholders were in general satisfied with these rankings and agreed with final results. They were interested in seeing the results of the MCA to present them in their institutions and disseminate them further (e.g., in the local action plan).

Additional remarks

Stakeholders unanimously emphasized that they are "very glad that meetings such as this workshop are taking place, because you can never have too many joint conversations about the natural environment and counteracting climate change in Gdansk".

It was also said that in recent years there had been many new investments in EBA in the city, including in the 3 study areas. One significant challenge refers to the need to carry out investments in a very narrow area, without considering the broader environmental context. Here, a Regional Directorate for Environmental Protection (RDOŚ) employee presented an example of a recently transformed, beautiful-looking garden part in Brzezieski Park, which negatively drained the adjacent historic row of alder trees. He emphasized that from his observations as a naturalist in Gdansk, there were no detailed natural inventory in the city. Additionally, unfortunately, there is a lack of knowledge about nature even among officials, which results from the nature curriculum that has been inappropriate for years. All this means that the problem of biodiversity is sometimes neglected. The RDOŚ manager added that unfortunately, mistakes did happen, and they were the result of many issues. They are often related to planning and legal issues in various areas, as well as to the interests of some investors. As a positive example, she added that changes made in the Madaliskiego Reservoir in Ujecisko (new trees and plants, gym, better location of park infrastructure) took place over time. The issue of flood problems in the area near the Municipal Office was also discussed in more detail.

The stakeholders mentioned what the Siedlecki Stream (now covered underground) and the surrounding areas had looked like historically. Moreover, it was analysed the severity of the impact of dense buildings and the very high coverage of the city surface with concrete. Similarly, the area of Strzya and the Garnison area were mentioned. The stakeholders returned to the issue how this area had been historically drained. One of the people recalled the existence of a retention reservoir from the interwar period until the 1970s at Stary Maneż. It was concluded that, unfortunately, it was impossible to return to the times when there were many retention areas in the city. It is now necessary to use the smallest possible areas to increase urban retention. The RDOŚ director added that her institution only provided opinions on environmental activities and, unfortunately, they were not always considered in the business calculation. However, despite everything, there is a lot going on in the city when it came to ecosystem-based approaches. Compared to other Polish large cities, Gdansk and its various institutions try to prevent the negative effects of extreme climate events.

3.2.9. Samsun – Coastal erosion

CCLL SAMSUN (TURKEY)	
Brief description of the area	Study area
The CCLL of Samsun is located on the Black Sea Coast, encompassing the fertile Kizilirmak Delta, which was once a Greek settlement. Samsun is a rapidly expanding city characterized by a Mediterranean climate, featuring hot summers and mild winters. This region is particularly vulnerable to climate-related risks such as floods, erosion, heatwaves, and droughts, which significantly impact water resources, agriculture, and public health. As a bustling port city, Samsun is home to approximately 700,000 residents and plays a crucial role in trade and transportation.	*Figure 21: Satellite view of the study area in Samsun*  Source: [Google Maps]().

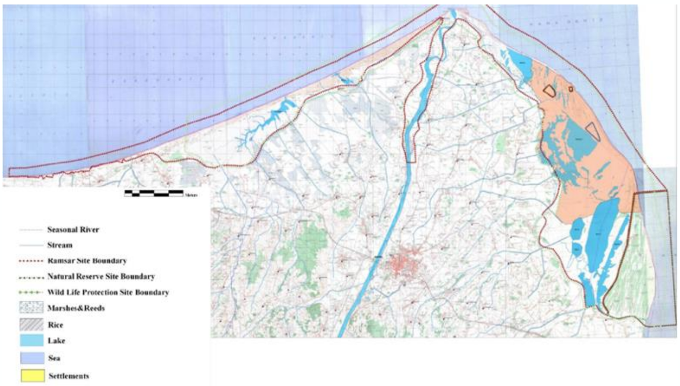
Main hazard(s) considered

The Kizilirmak Delta, 40km East from Samsun, stands as the biggest and most important wetland ecosystem of South Black Sea Basin region. However, its vulnerability to flooding and erosion is escalating, attributed to its adjacency to the Black Sea coast and the presence of over 20 lakes within its boundaries. These environmental challenges are significantly affecting local agriculture and biodiversity, necessitating urgent measures to mitigate their impact.

MCA objective

To assess and prioritise a predefined list of EBA options to address coastal erosion and river/land flooding the coastal area of the Kizilirmak Delta.

Figure 22: Map of the study area in Samsun



Source: [Ramsar Sites information Service]

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The selection of the hazard and hazard area was a collaborative effort involving the local CCLL team, which included academics from Samsun University and representatives from the Samsun governorship. Although the municipality is not an official CCLL partner, they were invited to the workshop, and their feedback was taken into account. The Kizilirmak Delta was chosen as the hazard area due to its high susceptibility to flooding and erosion, exacerbated by the presence of numerous lakes, climate change, and sea-level rise. The delta is of critical importance to local stakeholders and the CCLL team because of its rich cultural heritage, biodiversity, food production, and water supply. These factors underscored the decision to focus on this area.

Step 1. Identifying a list of preliminary options

Based on discussions with the local CCLL team defining Step 0, the SCORE WP7 facilitators conducted thorough research and proposed a set of six initial ecosystem-based adaptation strategies (EBA) to begin the exercise. Therefore, the following six EBA measures were preselected and agreed upon with the local CCLL team for the feasibility assessment:

1. Marram grass planting
2. Seagrass meadow restoration
3. Sand dune management
4. Floodplain enlargement
5. Beach nourishment
6. Riverbank restoration/naturalization

Step 2. Screening or feasibility assessment

The feasibility assessment was conducted, revealing the top three preselected EBA: 1) Marram grass planting, 2) Riverbank restoration/naturalization, and 3) Seagrass meadow introduction/restoration. During the MCA workshops, there was initial confusion among the stakeholders regarding whether sand dune management would involve protective measures in a preventative capacity or the creation of man-made dunes. After discussion, it was clarified that both options were acceptable.

Table 26: Feasibility assessment of EBA measures in Samsun

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Marram grass planting	4.36	4.38	4.46	4.38	4.40	1
Bank restoration/naturalization	3.71	3.92	3.46	3.31	3.60	2
Seagrass meadow introduction/restoration	3.64	3.31	3.08	3.69	3.430	3
Flood plain enlargement	3.71	3.23	3.38	3.38	3.429	4
Dune restoration	3.36	3.23	3.54	3.23	3.34	5
Beach nourishment	3.07	3.31	2.85	2.46	2.92	6

Step 3. Defining evaluation criteria

A comprehensive set of predefined evaluation criteria was initially developed by the SCORE WP7 facilitators in close collaboration with the local CCLL team. These criteria included: 1) Flood/erosion risk reduction, 2) Increase of recreational/leisure activities, 3) Improvement of social cohesion, 4) Improvement of water quality, 5) Preservation and protection of biodiversity, 6) Enhancement of local economy. These well-considered criteria were subsequently presented to the stakeholders during the MCA workshop. The stakeholders reviewed and endorsed the criteria, with no changes being suggested.

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop, held on December 8, 2023, had a total of 18 participants, which were distributed in the Quadruple Helix groups as follows: Civil society (22%), Government (33%), Private sector (6%), and Academia (39%). The participants' profile included representatives from local and regional public administrations, private companies, local agencies and cooperatives, universities, as well as citizens.

Step 4. Initial scoring or assessment of options

The participants were invited to evaluate each EBA against specific criteria using an online voting tool. The three highest scored EBA measured ranked as follows: Floodplain enlargement; bank restoration/naturalization; and seagrass meadow introduction/restoration. During the discussions, participants explored various aspects of the EBA measures. One key topic was the role of dune management in improving water quality. Additionally, the presence of endangered species in the Kizilirmak Delta was highlighted as a crucial factor to consider when planning EBA. Participants emphasized the importance of ensuring that the measures do not interfere with the spawning processes of fish species that enter the river. This underscores the need to avoid EBA that could negatively impact these critical ecological processes.

Table 27: Initial scoring of EBA measures in Samsun

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Flood/erosion risk reduction	Increase of recreational/leisure activities	Improvement of social cohesion	Improvement of water quality	Preservation and protection of biodiversity	Enhancement of local economy		
Floodplain enlargement	4.24	3.56	3.33	3.72	3.53	3.78	**3.69**	1
Bank restoration/naturalization	3.53	4.17	3.44	2.94	3.59	3.72	**3.57**	2
Seagrass meadow introduction/restoration	3.65	2.56	2.28	4.17	4.47	3.44	**3.43**	3
Beach nourishment	2.88	3.72	3.56	2.94	2.59	4.17	**3.31**	4
Dune restoration	3.12	3.56	3.11	3.06	3.29	3.67	**3.30**	5
Marram grass planting	3.59	2.17	2.11	3.89	4.29	2.67	**3.12**	6

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

For the final ranking, the participants were invited to allocate weights to the criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The results obtained with the weighting process are presented in the table below. As shown, according to the weights assigned to each criterion, participants prioritised the 'flood/erosion risk reduction' (29.2%), the 'increase of recreational/leisure activities' and the 'preservation and protection of biodiversity' (22.5% each). The final score was then obtained by combining these weights with the previous assessment (step 4) using the weighted sum method. The results indicate a slight change in the ranking, notably between 4th and 5th EBA. The top three EBA measures remained the same, namely the floodplain enlargement, the bank restoration/naturalization, and the seagrass meadow introduction/restoration.

Table 28: Final scoring of EBA measures in Samsun

Name of the EBA	Evaluation criteria						Weighted sum scores	Final ranking
	Flood/erosion risk reduction	Increase of recreational/leisure activities	Improvement of social cohesion	Improvement of water quality	Preservation and protection of biodiversity	Enhancement of local economy		
Weights ⇨	29.2%	22.5%	8.9%	5.8%	22.5%	11.1%		
Flood plain enlargement	1.24	0.80	0.30	0.22	0.79	0.42	**3.76**	1
Bank restoration/naturalization	1.03	0.94	0.31	0.17	0.81	0.41	**3.67**	2

Seagrass meadow introduction/restoration	1.06	0.58	0.20	0.24	1.01	0.38	3.47	3
Dune restoration	0.91	0.80	0.28	0.18	0.74	0.41	3.31	4
Beach nourishment	0.84	0.84	0.32	0.17	0.58	0.46	3.21	5
Marram grass planting	1.05	0.49	0.19	0.23	0.97	0.30	3.21	6

During this step, the participants discussed the benefits of planting marram grass in the Kizilirmak Delta, noting its effectiveness in reducing wind and water erosion. They also addressed the implementation of seagrass meadows, acknowledging that while these could alter biodiversity and potentially negatively impact marine tourism, they are beneficial for preventing flooding. Regarding beach nourishment, stakeholders argued that it is not necessarily a natural solution; it can cause more environmental damage and is expensive.

Fish farmers who rely on the fresh water of the Meriç River reported that decreased river flow during the summer months leads to saltwater intrusion, resulting in fish deaths. They suggested that sand dune management could help mitigate this issue but emphasized the need for better monitoring of EBA. In Turkey, flood control in rivers can be costly due to unconsolidated coastlines. While bank restoration was considered a potential option, the enlargement of the floodplain was viewed as the most ideal solution.

Additional remarks

While conducting the final calculations for the ranking and prioritization of the EBA, we organized a parallel activity aimed at eliciting further insights and perspectives from participants regarding the EBA under consideration. This session served as a brief, yet fruitful, brainstorming exercise, during which participants actively engaged in sharing and deliberating upon various aspects of the EBA. Among the ideas discussed were potential benefits beyond those initially identified, including but not limited to enhanced ecosystem resilience, increased biodiversity, and opportunities for community engagement and empowerment.

Additionally, participants offered valuable suggestions regarding potential locations for EBA implementation in the future, highlighting areas where ecological restoration efforts could yield significant environmental and socio-economic benefits. Specific implementation strategies were also explored, with participants proposing innovative approaches tailored to address unique ecological challenges, such as targeted interventions for bank restoration or the integration of green infrastructure within urban landscapes. The diverse range of ideas generated during this session underscored the importance of collaborative dialogue in shaping effective EBA measures and underscored the rich potential inherent in nature-based solutions for climate adaptation and mitigation.

3.2.10. Benidorm – Inland and coastal flooding, and coastal erosion

CCLL BENIDORM (SPAIN)

Brief description of the area

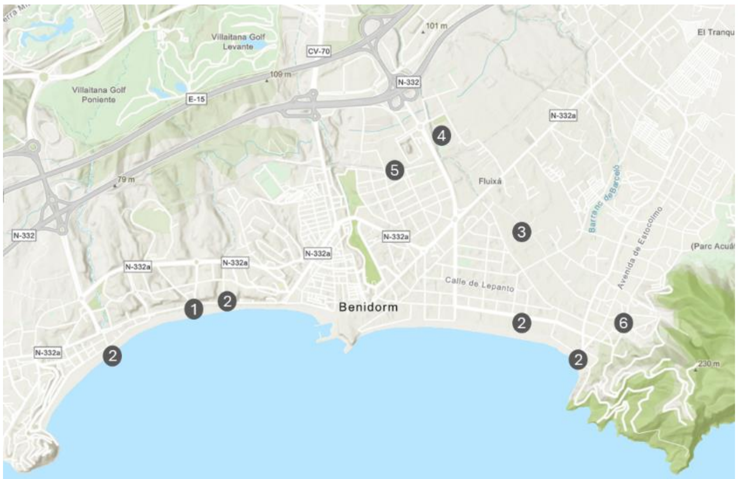
The city of Benidorm is located by the Mediterranean Sea on the east boarder of Spain, in the Province of Alicante. The city covers an area of 38.51 km^2 and is home to 69,738 permanent inhabitants as of 2022 (IVE, 2023). Several intermittent rivers and streams cross the city from west to east. The occurrence of flooding episodes following heavy rainfall is a significant concern in these areas. The focus of the analysis is the entire municipality, where different EBA measures have been already planned by the city council to address inland and coastal flooding problems in the area.

Main hazard(s) considered

The analysis primarily examines inland and coastal flooding, while also considering coastal erosion. During periods of intense rain and storm surge, different flood-prone areas have been identified. On

Study area

Figure 23: Map of the critical floodable areas of Benidorm



Sources: Instituto Geográfico Nacional, Esri, TomTom, Garmin, Foursquare, the seafront, notably the beaches of Levante and Poniente, these episodes result in damage to urban furniture and beach infrastructure. Inland flooding occurs in the adjacent areas to the urban rivers and streams, posing a threat to roads, sidewalks, residential neighbourhoods, and commercial zones. The effects can vary, ranging from direct damage to buildings to disruptions in road traffic and pedestrian movement or even temporary closures of commercial activities.

GeoTechnologies, Inc., METI/NASA, and USGS. Adapted with minor changes from: https://www.arcgis.com/apps/mapviewer/index.html.

Legend: Various sites and measures are identified in the map as follows: (1) Urban dune near the promenade of the beach of Poniente; (2) Sand dike, located next to the mouths of four intermittent rivers (Murtal, Xixó, Lliriet and Barceló); (3) Floodable park near the intermittent river Lliriet; (4) Permeable pavements, close to the car parking area of Salto del Agua; (5) Riparian reforestation in Murtal and Aigüera intermittent rivers; and (6) Tree plantation at the Playmon Park urbanization.

MCA objective

The objective of the MCA was to evaluate EBA measures that are already planned for implementation by the city council. These measures aim to address inland and coastal flooding. Within this context, it was particularly interesting to understand stakeholders' perceptions regarding the social, environmental, and economic benefits of the evaluated options, as these insights can ultimately inform decision-making processes.

Figure 24: Flooding event in the study area of Benidorm

Credits: Laboratorio climatologia UA.

Main results of the 1st phase - preparation of the MCA

Step 0. Understanding the local adaptation context

The selection of the hazards and study area was a collaborative effort involving the CCLL and city council representatives. In different meetings, the CCLL team identified different hotspots in the city that are vulnerable to pluvial and coastal flooding. Their interest lied in discussing previously planned actions to mitigate flooding in this location.

Step 1. Identifying a list of preliminary options

The CCLL team and WP7 facilitators proposed an initial set of four measures aimed at mitigating flooding in the municipality:

1. Urban dune
2. Sand dike
3. Floodable Park
4. Permeable pavements
5. Riparian reforestation
6. Tree plantation

Step 2. Screening or feasibility assessment

The EBA feasibility assessment, and the final selection of the measures and evaluation criteria were conducted during an online session on the 11th of December of 2023. This activity counted with the participation of the following stakeholders: engineering company; Tourism foundation; SMEs related to the tourism sector; representatives of the Ministry for Ecological Transition; representatives from Benidorm City Council; University of Alicante. These stakeholders belong to the following groups: Government (41%); Industry (41%); and Academia (18%). All measures received favourable feasibility assessments, with aggregate scores ranging from 2.5 to 4.5 (on an increasing scale of feasibility of 1 to 5). Therefore, all measures initially proposed were accepted to be evaluated in the following steps of the MCA.

Table 29: Feasibility assessment of EBA measures in Benidorm

Name of the EBA	Feasibility criteria				Average score	Feasibility ranking
	Stakeholder acceptability	Technical feasibility	Ease of Implementation	Financial Feasibility		
Tree plantation	4,63	4,75	4,88	4,00	4.56	1
Urban dune	4,50	4,63	4,38	4,13	4.41	2
Sand dike	4,38	4,63	4,25	4,00	4.31	3
Riparian reforestation	4,25	4,75	3,63	3,63	4.06	4
Permeable pavements	4,00	3,63	4,25	3,25	3.78	5
Floodable park	4,63	3,63	3,75	2,50	3.63	6

Step 3. Defining evaluation criteria

SCORE's WP7 facilitators proposed an initial set of criteria: 1) Perception of flood risk reduction; 2) Conservation and improvement of biodiversity; 3) Water quality improvement; 4) Carbon capture and sequestration; 5) Increase recreational opportunities; 6) Landscape aesthetic value (or Increasing labour opportunities as an alternative). Following discussions with stakeholders, it was determined to retain all criteria with the exception of 'Increasing labour opportunities'.

Main results of the 2nd phase – MCA implementation

The MCA in-person workshop, held on December 14, 2023, had a total of 17 voting participants, which were distributed in the Quadruple Helix groups as follows: government (41%), industry (41%), and academia (18%). The participants' profile included representatives from local, regional and national public administrations, universities, foundations, and private local SMEs.

Step 4. Initial scoring or assessment of options

The participants were invited to evaluate each EBA against specific criteria using an online voting tool. Table 29 below provides a summary of average scores per criterion, the total average score, and the prioritisation ranking. The results indicate a strong preference among participants for the adoption of a floodable park, followed by tree plantation, and riparian reforestation of intermittent rivers.

Table 30: Initial scoring of EBA measures in Benidorm

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Perception of flood risk reduction	Biodiversity maintenance and improvement	Water quality improvement	Carbon capture and sequestration	Increase recreation opportunities	Landscape aesthetic value		
Floodable park	4.21	4.21	4.08	3.77	4.77	4.62	**4.28**	1
Tree plantation	2.64	4.57	3.54	4.54	3.92	4.77	**4.00**	2
Riparian reforestation	3.29	4.57	3.54	4.31	3.46	4.31	**3.91**	3
Permeable pavements	3.50	2.93	3.69	2.85	2.62	3.54	**3.19**	4
Urban dune	4.07	3.21	2.54	2.54	2.54	3.77	**3.11**	5
Sand dike	3.71	3.00	2.38	2.15	2.23	3.54	**2.84**	6

Steps 5 (weighting of evaluation criteria) and 6 (ranking and prioritization of options)

Afterwards, participants were invited to allocate weights to the criteria based on their own perceptions and preferences, ensuring that the total sum of weights equalled 100%. The average weights for each criterion displayed below show that participants gave more importance to the 'Perception of flood risk reduction' (41.25%), followed by 'Biodiversity maintenance and improvement' (15%), and 'Water quality improvement' (13.75%). The final score was then obtained by combining these weights with the previous assessment (step 4) using the weighted sum method. The results indicate a slight decrease in the average score between steps 4 and 5. The top three positions of ranking were the same, but there were changes in the remaining ones.

Table 31: Final scoring of EBA measures in Benidorm

Name of the EBA	Evaluation criteria						Average score	Initial ranking
	Perception of flood risk reduction	Biodiversity maintenance and improvement	Water quality improvement	Carbon capture and sequestration	Increase recreation opportunities	Landscape aesthetic value		
Weights ➪	41.3%	15.0%	13.8%	12.9%	9.2%	7.9%		
Floodable park	1.74	0.63	0.56	0.49	0.44	0.37	**3.86**	1
Tree plantation	1.09	0.69	0.49	0.59	0.36	0.38	**3.21**	2
Riparian reforestation	1.36	0.69	0.49	0.56	0.32	0.34	**3.40**	3
Permeable pavements	1.44	0.44	0.51	0.37	0.24	0.28	**3.00**	4
Urban dune	1.68	0.48	0.35	0.33	0.23	0.30	**3.07**	5
Sand dike	1.53	0.45	0.33	0.28	0.20	0.28	**2.79**	6

Additional remarks

Complementary information to the proposed measures was collected using post-it notes. For example, it was stressed accessibility problems to the beaches while constructing the urban dune and sand dike, and how this could affect tourism activity. Several stakeholders agreed on the need to highlight and raise societal awareness about the carbon capture and sequestration potential of sand dune ecosystems, which represents a significant co-benefit of these measures. Participants also agreed on the convenience of extending the implementation of permeable pavements and tree plantation to additional locations in the city.

4. CONCLUSIONS

This section presents the main conclusions drawn from the MCA implementation in the 10 CCLLs. For that purpose, it starts by performing a comparative analysis of the results across the CCLLs in subsection 4.1. Unlike the detailed examination of individual CCLL's MCAs already covered in the factsheets of section 3.2, this subsection highlights commonalities and differences of the MCA application across the CCLLs. Finally, subsection 4.2 focuses on the practical application of the MCA within the context of living labs, emphasizing lessons learnt and potential replicability.

4.1. Comparative analysis of MCA application across CCLLs

4.1.1. MCA process and results

The **MCA unfolded in two main phases: i) Preparation (steps 0-3); and ii) Development (steps 4-6)**. Steps 0 and 1 were generally undertaken through direct contact between the WP7 and the core CCLL team. The CCLLs of Oarsoaldea, Piran, Gdansk, Vilanova and Benidorm chose a two-session structure, conducting the first online session to cover steps 2-3, followed by an on-site session to implement steps 4-6. The CCLLs of Dublin, Massa, Oeiras, Samsun and Sligo implemented steps 2-6 on a condensed single on-site session. The MCA phases are detailed in the following sub-sections, along with considerations about similarities and differences among the CCLLs.

a) MCA preparation phase (steps 0-3)

In **Step 0 (understanding the local adaptation context)**, SCORE's WP7 partners, responsible for the analysis in each CCLL, prepared the identification of the climate hazards and relevant study areas. This action was mainly based on relevant knowledge retrieved from the CCLL core team to understand the local adaptation context.

Regarding the **MCA objectives**, most CCLLs together with WP7 facilitators chose to assess and prioritize predefined EBA options for addressing particular climate hazards and contributing to socioeconomic and environmental co-benefits. The **climate hazards** that were addressed in the CCLLs (listed in Table 2) ranged from: coastal flooding (7x mentioned), inland flooding (5x mentioned), coastal erosion (4x), storm surges (3x), heatwaves and droughts (2x), to landslides (1x). Obviously, these hazards pose urgent climate threats that these coastal communities must address in the future. However, it should be noted that they do not encompass all their climate risks. The selection of the assessed hazards step 0 benefited from earlier inputs by the CCLLs for the development of Deliverable 1.2 (Map and report of key climate-change hazards; Laíño Rebollido & Gregorio Iglesias, 2022). Nonetheless, the process of selection was also influenced by the identification of the most suitable hazards to be addressed with EBA/NBS, or stakeholders' readily understanding of a climate hazard. Much dependent on best available short-terminology-defined climate threat. For example, Gdansk CCLL mentioned torrential summer rains as a cause of summer fluvial (inland) flooding, while Piran mentioned storm surges as a cause of winter coastal flooding. The temporal distinction, its seasonal character, was later added to the initial short-terminology-defined threats. On the other hand, although all CCLLs need to be dealing with sea level rise to any degree, whether on short- to long-term notice, this hazard was not selected in the present MCA procedure, even though sea level rise has been recognized as a threat throughout SCORE's other work packages. MCA's co-creation character and involvement of quadruple stakeholders might have obscured this long-term and steadily growing climate threat. Instead, sea level rise throughout the duration of SCORE and the executed MCA procedure has been indirectly recognized by the identified threats in the form of instant storm surges, coastal flooding, and erosion.

Regarding the **timing of the evaluations**, most CCLLs implemented an *ex-ante* MCA, which allowed to collect new perceptions/improve the understanding of CCLL stakeholders' knowledge about potential future measures. However, in Benidorm CCLL, the city council chose to perform a stakeholder prioritization assessment of EBA measures already planned (*interim* type of MCA), while Oeiras CCLL opted to assess measures already implemented (*ex-post* type of MCA). The chosen format of the MCA was closely related with the definition of **study areas**. Both Benidorm and Oeiras CCLL's study areas corresponded with already established flood intervention areas. In contrast, in the other CCLLs like Dublin, Gdansk, Massa, Oarsoaldea, Samsun and Vilanova, it was necessary to identify flood- and degradation/erosion-prone zones within the city and/or their wider areas to determine the study areas. Moreover, the CCLLs of Piran and Sligo did not specifically defined study areas. In the former CCLL, this might have occurred because the urban area of the respective town is relatively small as compared to the other CCLLs, giving less surface area to choose from as an intervention pilot area. As for the latter CCLL, the decision was made to focus not only on the town but also on the surrounding areas, expanding the scope to match that of the CCLL County. This situation provided CCLL stakeholders with the opportunity to use the MCA procedure to better determine areas potentially suitable for EBA implementation.

The **preparation of a preliminary list of EBA options, developed in Step 1,** was made with the contribution of the CCLL core team, as well as of key stakeholders in some case studies. Most of the predefined EBA options were chosen from SCORE | EBA catalogue, while the more specific EBA selections can be found in both Table 2 and in section 3.2 with the overview of the MCA factsheets. Additionally, some EBA emerged that were mentioned multiple times during the CCLL-specific MCA procedures but have not (yet) been included in the catalogue: permeable pavement (Benidorm; Oeiras; Piran) and sustainable drainage systems (Dublin; Oarsoaldea; Sligo). Besides, Piran listed the renovation of dry-stone wall terraces and historic water cisterns as new options for rainwater retention, while Benidorm opted for two deviations from the EBA catalogue by including urban dune and sand dyke.

Overall, for the 10 CCLLs, the predefined EBA options during the **feasibility assessment (step 2)** reached favourable acceptability. The four components tested – stakeholder acceptability, technical feasibility, ease of implementation, and financial feasibility – yielded medium (3) to high (5) degrees of acceptability, indicating a generally well-prepared preliminary phase. Certain outliers could be identified that did not reach a threshold of minimally 3 on average. For example, 'Green Dykes' in Piran and Oarsoaldea CCLLs and 'Dune management and marram grass' in Sligo and Dublin CCLLs. Please note that the arbitrary threshold of an average of three was not established in advance as a benchmark for excluding a proposed EbA. Instead, it should be interpreted as an indication of the participating stakeholders' limited support for that specific measure.

The **definition of the evaluation criteria, developed in Step 3**, was included as a clear co-creation process that was fed by input from stakeholders: upon initial formulation of evaluation criteria, usually further fine-tuning of each specific criteria followed, leading, in some cases, to criteria being removed or added to the initial proposal. On average, the CCLLs opted to apply 6 criteria. Besides the criterion referring to the reduction of the climate risk, which was applied in all case studies, the most repeated criteria included biodiversity improvement and conservation (9x), improvement in water quality and availability (9x), increase in recreational opportunities (8x), carbon capture and sequestration (6x), and the creation of job opportunities and the strengthening of the local economy (6x). Other criteria referred to the improvement of human health, preservation and use of cultural heritage, landscape aesthetic value, among others.

b) MCA implementation phase (steps 4-6)

This phase required intensive stakeholder participation in the **scoring of the EBA assessment options (step 4)**, **weighting of the evaluation criteria as defined in step 3 (step 5)**, and **ranking and prioritization of the EBA options (step 6)**.

Overall, the rankings remained consistent between steps 4 and 6, usually changing by only one position in the rank in some CCLLs. This might have been caused by the narrow points attributed to the weighted ranking (1-5) and might have yielded better results with a wider range (*e.g.*, 0-100). The exceptions were the CCLLs of Massa, Piran and Sligo were there were significant changes between the unweighted and weighted highest-ranking positions.

The **final step of the MCA procedure (step 6)** was concluded with a stakeholder discussion on the difference between the ranking of the weighted and unweighted scoring. Interestingly, in some case studies such as in Massa and Samsun, the discussion of results led stakeholders to establish a different order of preference of EBA measures in comparison with the weighted and unweighted ranks. Moreover, in Piran, participants proposed to include as a top EBA, the combination of EBA measures as an effective action for a particular area. In Dublin, hybrid options were also mentioned, but not proposed.

Based on the results from the ten workshops conducted, conclusions can be drawn regarding the **most suitable measures for addressing specific climate hazards.** For coastal flooding, the highest-scoring EBA included floodplain enlargement (in Samsun and Massa), afforestation, peatland restoration (in Sligo), and saltmarsh or wheatland restoration (in Dublin and Sligo). Sustainable Urban Drainage Systems (SUDS), such as permeable pavements or infiltration ponds, were additional measures proposed (in Piran and Massa).

Inland flooding was another hazard addressed in several CCLLs. Here, the prioritised measures included floodable park (Benidorm), riparian reforestation (in Massa, Oarsoaldea, Oeiras, Vilanova i la Geltrú, and Benidorm), as well as river network maintenance measures like riverbed restitution and renaturing (in Vilanova i la Geltrú) and floodplain enlargement (in Oeiras). Planting trees emerged as an optimal solution in the CCLLs of Oarsoaldea, Benidorm, and Gdansk.

Moreover, green spaces were both considered appropriate to address coastal and inland flooding in Oarsoaldea, Piran, and Gdansk (referred to as green infrastructure in Dublin). This measure was regarded as appropriate to combat heatwaves in Oarsoaldea and Piran. Green spaces, along with floodable parks, were also prioritised to address storm surges in Gdansk and Dublin. For droughts, historic wells, and water reservoirs (in Piran) were proposed. Additionally, the introduction or restoration of seagrass meadows was suggested as a measure to counter coastal erosion in Samsun.

A closer examination of the MCA process and the results obtained from the ten CCLLs provided **valuable complementary insights**, including:

- **A discussion on ecosystem services of EBA measures -** often knowledgeable stakeholders brought into the discussion additional EBA measures that were previously unexplored or not considered. This occurred, for example, in the CCLLs of Benidorm, Samsun and Vilanova i la Geltrú. Some examples of such measures include the carbon absorption capacity of sand or the role of including local and climate-resilient vegetation to foster that service. Additionally, stakeholders mentioned the potential promotion of social interaction through features such as pedestrian paths, bike lanes and green spaces in general.

- **Consideration of EBA measures and proposing the MCA procedure for other areas not considered in the current case studies -** For instance, stakeholders from Oeiras and Samsun suggested that a wider area than the one analysed could benefit from ecosystem restoration, implementation, and maintenance, including specific whole river restoration in the former CCLL. In Gdansk there was a rejuvenated interest in the historic water retention system that perhaps could be restored throughout the city.

- **Stakeholders' realisation that synergistic actions between organisations already addressing climate adaptation through EBA implementation could lead to better resilience -** This was particularly noticed in Oarsoaldea and Gdansk, where there was a noticeable appreciation of joint conversations about the natural environment and efforts to counteract climate change.

- **The realisation that individual participants could have an opposing opinion on EBA implementation -** This occurred in Piran, were some participants that were both residents and professionals operating within the CCLL, expressed some wishes or ideas that might be conflicting with an employer's attitude and not be ventilated in public.

- **Recognition that minimal or no intervention can also be an effective solution -** This was highlighted in the case study of Dublin, where participants indicated that EBA measures, such as floodable parks, involve natural processes and require less intervention compared to other options, while also contributing to flood risk mitigation.

- **The difficult practice of labelling EBA measures as short-term versus long-term solutions against climate change –** Uncertainty about the effectiveness of EBA measures in the long-term was frequently pointed out by stakeholders in various CCLLs.

4.1.2. Stakeholder engagement and co-creation process

It is important to notice that any prior organized MCA CCLL meeting (either on-line or on-site) initiated and emphasized the **co-creation process**, whereby any preliminary EBA list was subject to discussion and elaboration. Thus, this co-creation process either occurred directly (but passively) during – and prior to - step 0, or at any moment during preparatory CCLL meetings in a more active manner, depending on the informed and existing experience among the non-project stakeholders. Hence, the start of the co-creation process varied, with a potential influence by SCORE facilitators on enhancing stakeholder involvement early on while establishing the CCLL and/or during the MCA process. Moreover, this variation is contingent upon stakeholders' knowledge and openness regarding building climate resilience through EBA/NBS implementation. For example, the city councils of Benidorm and Sligo were quite informed about EBA/NBS and had a fundamental active role in the MCA preparation phase. Strikingly however, while Sligo (and Dublin) CCLL seemed to have most participants from civil society, Benidorm CCLL, despite its city council's involvement as facilitator, had no citizens present during the whole MCA procedure. The absence of citizens was observed for Massa and Oarsoaldea CCLLs as well, whereas entrepreneurs were missing in Dublin, Massa, and Oeiras. CCLLs with all Quadruple Helix representatives, not specifically equally distributed, were noticed during the MCA process of Gdansk, Piran and Vilanova CCLLs.

It must be noted that stakeholder involvement within the MCA process is very much dependent on the availability of those stakeholders recruited by their professional background during office hours. While much depends on the employer organisation's flexibility, a well-prepared MCA facilitation event, scheduled well in advance, can inform the participant about the required time commitment. Hence, the reservation of 1-2 hours for the on-line preparatory session and half of an office day for the implementation session, should be considered a minimum requirement. For those cases implementing the MCA in a single one-day session, allocating 4 to 5 hours is considered an acceptable timeframe. However, as already mentioned, condensing the whole MCA procedure might influence the co-creation process. This is particularly relevant after the weighting of evaluation criteria (step 5), as it is crucial to allocate for stakeholders to discuss the final prioritisation rank of EBA options (step 6). This is an essential part of the co-creation process; thus, CCLL team should consider prior how they would like to use the MCA process as a co-creation tool.

As general conclusions from the analysis executed by the 10 SCORE CCLLs it is obvious that the outcomes from the MCA procedures depend on the participating stakeholders within each CCLL. Consequently, the effectiveness of this method may differ based on the composition of the CCLL and the geographical context of its implementation. Moreover, the implemented MCA across all the CCLLs show that Quadruple Helix stakeholders have a general appreciation for the co-creation process. When stakeholders are committed and given sufficient time to participate, they actively engage in fruitful interactions. Occasionally, stakeholders even promote discussions that extend beyond the initial study area or climate threat considered. Thus, the MCA represents a valid tool to be considered within the co-creation policies regarding climate adaptation.

4.2. Lessons learnt and replicability

In the context of SCORE, MCA has been proven to be an effective process for promoting the integration of various knowledge and preferences of stakeholders when selecting the most relevant EBA for each CCLL. In addition to studying the benefits of the different EBA, it is relevant to investigate how the application of the MCA process has varied across the ten CCLLs within the context of the Living Lab approach. This section aims to cross-analyze the advantages, limitations, and potential improvements of the MCA process for identifying, evaluating, and prioritizing EBA. The information collected from the monitoring and evaluation (M&E) surveys[2], online discussions, feedback meetings, and the reporting and fact sheets from the workshops, were used to elaborate a critical review on the MCA process, including future recommendations and opportunities for improvement. The following subsections reproduce the questions included in the surveys and discuss the answers obtained.

4.2.1. Advantages

What worked well (i.e., strengths) in terms of MCA?

Firstly, it is important to note that the MCA workshops were successfully held in the ten locations of the CCLLs. Consequently, from each CCLL, a list of the EBA most highly valued by stakeholders was obtained after going through different phases of discussion and shared evaluation. One of the strengths has been the meeting space generated during the MCA process. This meeting space, among stakeholders from the same area, who in some cases did not know each other personally, has allowed new types of meaningful relationships and collaborations between local entities to emerge. For example, some CCLLs have used the material from the MCA to carry out dissemination activities with schools and other local centres. Additionally, CCLLs from the same geographical area (*e.g.*, Sligo and Dublin in Ireland) were able to exchange perspectives on the MCA process. The exchange of ideas and knowledge

[2] Two surveys distributed, one for CCLL core teams and one for the participating stakeholders.

during the MCA process among participants from different disciplines has been another highly valued aspect. For this interaction to occur, participants have highlighted both the formal discussions and brainstorming sessions involved in the MCA phases, as well as the informal discussions that took place during coffee breaks at the workshop. Clarity in explanations of key concepts, timings, and the welcoming and open atmosphere for everyone to participate and express their opinions have been other positive aspects surrounding the MCA. In some cases, there was also a demand for the MCA to last only one day instead of two, with the aim of gathering as many participants as possible.

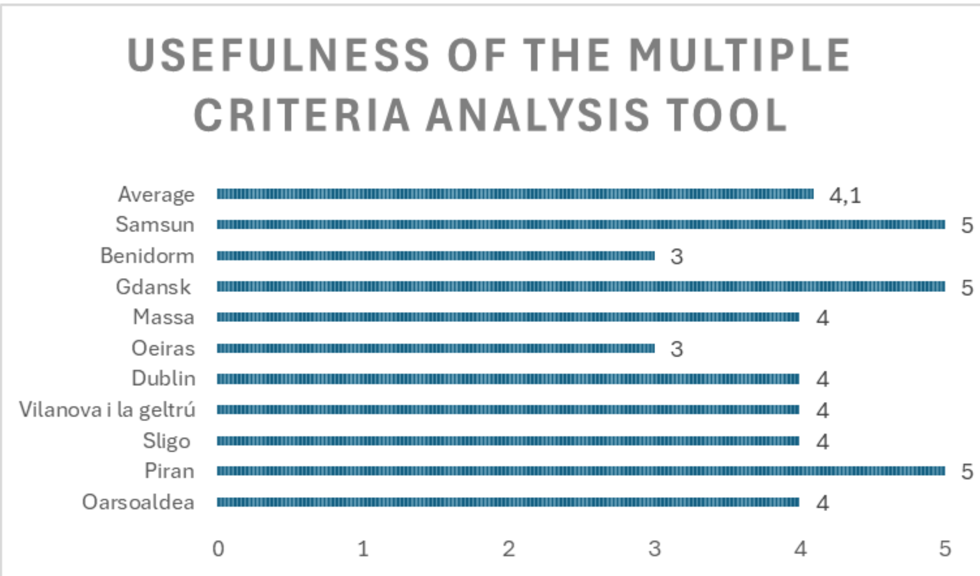
Another successful point has been the ability to gather a significant number of stakeholders for each workshop. In general, an average of between 15 and 20 participants was achieved in MCA activities, although they were not always evenly distributed across the Quadruple Helix (*i.e.*, academia, industry, public sector and civil society).

In cases where WP7 facilitators did not speak the local language, the presence of local facilitators, derived from the CCLL team, was very relevant, as they facilitated bringing the contents and technical aspects of the MCA closer to the participants. Adapting the contents and methodologies of the MCA to the local context involved facilitating explanations and contents in the local language, thus more ideas can emerge, and stakeholders feel freer to express themselves.

The great diversity of participants, belonging to different disciplines, made it even more necessary to add descriptive materials about the EBA, such as posters or infographics. These additional materials, serving as a reference to document the decisions of stakeholders with no to minimal scientific or technical expertise, has been another success in the MCA process. Displaying visual materials about the EBA options under discussion also showed to be valuable to stimulate informal conversations among the stakeholders during breaks. It served as an ice breaker to discuss examples in the region, previous experiences, and potential synergies with existing projects and plans.

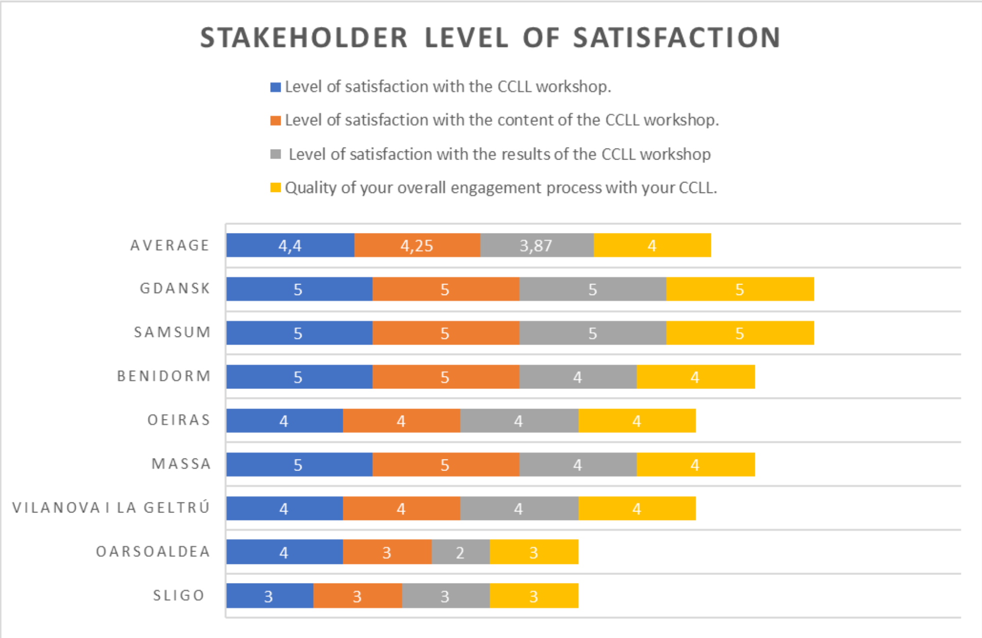
Positive impressions about the MCA have also been reflected in the results of the questionnaire filled out by the CCLL teams and stakeholders. A total of 27 responses from members of the CCLLs core team positively rated, with an average of 4.1 out of 5 on a Likert-scale, the usefulness of the MCA as a decision-making tool (Figure 25).

Figure 25: CCLL core team MCA evaluation



In addition, the 41 responses obtained from the stakeholders' questionnaires, merged in an average of 4.1 out of 5 when ranking different aspects regarding their level of satisfaction during the MCA workshops (**Error! Not a valid bookmark self-reference.**).

Figure 26: Stakeholders level of satisfaction with MCA workshop



4.2.2. Limitations

What did not work well (i.e., weaknesses) in terms of MCA?

Beyond positive evaluations, other more critical assessments have also been obtained, which allow for identifying areas for improvement in the MCA process. On repeated occasions, despite the considerable assistance of stakeholders, low participation of members from the private sector and industry has been identified in the workshops. This has posed a challenge in terms of finding ways to increase the interest of this sector in promoting the co-implementation of EBA. A good example to encourage the participation of the private sector can be found in the CCLL of Samsun, which has established a collaboration with the company British American Tobacco (BAT). BAT has offered to finance some of the activities of the CCLL based on the CSR model (Corporate Social Responsibility). The company is interested in supporting sustainable farming (green farms), education and capacity-building activities and agriculture activities in the Kizilirmark Delta. Secondly, the absence of civil society has also been noted. This group's participation can be interesting to bring to the table types of traditional knowledge and delve into the possible interrelationships of EBA in relation to the territory's historical use. Absence among invited stakeholder groups could be due to scheduling limitations and disparity in the availability of representatives from each sector. On the other hand, stakeholders of some CCLLs, such as Samsun and Benidorm, reside or work far from the study areas, which makes it difficult to meet in person.

While the diversity of knowledge and experiences is one of the strengths of the MCA, it can also sometimes be a drawback. A challenging point has been the interaction between stakeholders and experts when arguing for or against EBA. Stakeholders with no minimal scientific or technical expertise had difficulties understanding the connection between the EBA pre-selected by SCORE and the benefits or risks they aimed to mitigate. For example, in the case of Sligo CCLL, these difficulties arose as some stakeholders did not understand the benefits that the restoration of shellfish and seaweed aquaculture could bring in reducing flood risk on the coast (*e.g.*, carbon sequestration, increased biodiversity, or new jobs). There were also complexities in the case of Samsun in understanding the nature of some of the proposed EBA, for example, the case of dune restoration presented uncertainties between protecting existing natural dunes or whether the option of creating artificial dunes was also being considered. Several members of the CCLLs agreed that in this attempt to involve experts and non-experts, the EBA were presented too superficially, without highlighting other important conditions, such as the short or long-term impact characteristic of the different EBA. Another limitation or difficulty in the selection of measures refers to divergent objectives among stakeholder groups. In the case of Massa, it was noted how more environmentalist discourses looked at co-benefits (*e.g.*, social, cultural, educational) while arguments from an engineering perspective focused on solving a single objective, aimed at minimizing ecological risk. The over-representation of certain sectors can also influence the final ranking of EBA. In the case of Benidorm CCLL, the municipal water company voted more positively for EBA related to terrestrial flooding, giving less significance to those measures related to coastal erosion.

Contrary to more theoretical approaches to MCA process and calculations, there is a demand to present EBA in a more practical way, focusing on the impact that these measures can have on the daily lives of people and the local community. Remarkably, different participants also showed interest in finding ways to share and promote the results of the MCA more extensively with the external community of the CCLL.

Other limitations in the MCA process are linked to logistical aspects. On some occasions, the participation process was limited because some participants did not have smartphones and could not contribute to online voting. Other opinions suggest condensing the preliminary workshops and MCA development into a single day. In addition, the workshops could be made more flexible and adapted to unforeseen (weather) events that may compromise the attendance of stakeholders at the workshop, as was the case in Oeiras. Significantly, the CCLLs also expressed concern about the viability of implementing the selected EBA, especially regarding the administrative barriers that often arise and financial constraints that could emerge after the implementation of SCORE.

4.2.3. Potential Improvements

What can potentially be improved in the current MCA? What recommendations can be provided in future MCA applications within and beyond the SCORE CCLLs?

The monitoring processes carried out jointly with the CCLLs has allowed identifying the most successful aspects of the MCA process and other areas for improvement. The observations made in this section are connected to other studies that have extensively examined the application of the MCA process in the field of nature conservation (Adem Esmail & Geneletti, 2018). The results of these latter authors coincide in pointing out key aspects in the improvement of MCA, such as involving stakeholders meaningfully in the design of evaluation criteria, increasing transparency in MCA phases that are often confusing (*e.g.*, meaning of weights, quantification of criteria), and conducting a sensitivity analysis at the final stage to test the robustness of the outcomes. At a general level, it could be distinguished three main phases in the MCA process: 1) decision context and structuring, where evaluation criteria are defined according to local needs, 2) analysis, where criteria are implemented (scoring, weighting), and 3) decision, where the final ranking of selected EBA is elaborated (Adem Esmail & Geneletti, 2018).

Regarding the structuring and decision context of the MCA carried out in the SCORE project, a series of points were highlighted: the need to find a balance between the involved sectors and to include members of the private sector and civil society; to define clear and consensus objectives (*e.g.*, between ecological and social or cultural perspectives); to offer alternatives that satisfy the visions and values of the participants; and to schedule workshops according to local requirements (1 or 2 days, in-person or online, weekdays or weekends, etc.).

A successful example in creating partnerships with the private sector is found in the Samsun CCLL in its partnership with BAT. Appealing to the environmental and social responsibility of some environmentally committed companies can encourage relations with the private sector, which would also benefit from participating in these projects. Second, jointly defining the problem and acknowledging the values and preferences of the participants is a good way to increase the acceptability of the measures chosen at the end of the process. Alternative value-driven approaches would allow expanding the focus beyond EBA and technical notions to facilitate more areas of consensus. Building on this foundation, other studies have modified some aspects of MCA to generate other methodologies, such as the "Community Voice Method (CVM)" where scoring and ranking of criteria are replaced by deliberation, negotiation, and majority voting (Ranger et al., 2016). This more deliberative approach would allow resolving inequities during voting processes where one group of stakeholders is more represented than the rest.

Regarding the analysis and decision phases, it is important to increase the understanding of proposed measures among non-expert stakeholders by providing relevant information and explaining the scoring system for the EBA under the MCA process. First, to bring stakeholders without prior knowledge closer to the suggested EBA, it would have been beneficial to send some type of contextual information in advance. In certain CCLLs, such as Vilanova and Oarsoaldea, this practice was implemented, but it could also become a standard procedure. Also, before proceeding with the analysis of the measures, a space for open questions could be dedicated to clarifying the most important doubts regarding technical aspects and EBA present in the catalogue. Members of a CCLL team have noted that the presence of a specific expert in EBA would have been beneficial to ensure a more exhaustive debate. Furthermore, to address uncertainties that may have arisen during the MCA, it is advisable to conduct a sensitivity analysis at the end of the process. Regarding alternatives during voting, iPads or laptops could be provided to participants who do not have the necessary technological resources to carry out the online voting. Finally, with the aim of amplifying the results obtained during the MCA, CCLLs could improve the dissemination of the results by using local news media to reach the local population. Among the CCLLs, strategies for disseminating and communicating the results will enhance the understanding of EBA among key actors, increase the interest among different stakeholders, and to continue the discussion with the opportunities for the EBA in the CCLLs, among others.

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APPENDIX 1. GLOSSARY OF EBA MEASURES ADDRESSED IN THE MCA

Afforestation
Planting trees or sowing seeds in areas that have never been forested, to create a forest. This measure contributes to reduce land erosion, to increase slope stability and regulate water flow and also, to protect communities from natural hazards, to increase carbon sequestration, and to recharge water supply.

Beach nourishment
Replenishment or nourishment of the lost beach sediment with suitable (preferably indigenous or identical) filling sediments, and preferably retrieved from local sources. The objective is to protect the beach and increase the carrying capacity for recreation purposes under increasing sea-level rise.

Bioswales
Landscape depression that receives and filters water runoffs back to the sewer water system through water-holding vegetation and organic materials. Bioswales are channels designed to concentrate and channel stormwater runoff while removing debris and pollution. Bioswales can also be useful for recharging groundwater. They consist of a drainage course with slightly inclined sides. These are most effective if placed near roofs, roads, parking lots and driveways to catch and direct water coming from hard surfaces. This measure contributes to reduce infiltration and filter out pollutants.

Cliff stabilisation
Measures to prevent cliff recession and increase the stability of the slope through re-vegetating the slope or placing sand or pebbles at the foot of the cliff (littoral strip reloading). This measure seeks to reduce marine erosion at the foot of the cliffs and reduce negative environmental and landscape impact.

Dry stone terraces
It concerns the methodology related to making stone constructions by stacking landscape-available stones upon each other, without using any other materials (like cement, concrete, etc.) except sometimes dry soil. The stability of the structures is ensured through the careful selection and placement of the stones, and like these dry-stone structures have shaped numerous, diverse landscapes, forming various modes of dwelling, farming and husbandry.

Estuary protection and regeneration
The process of managing the estuary landscape to reinstate natural processes restoring biodiversity and providing benefits to both people and wildlife. Estuaries are stabilised by reducing the force of incoming waves, while constituting an important source of carbon sequestration in coastal areas. They serve as physical buffers that retain excess water, to dissipate wave energy, to stabilize shorelines.

Filter strips
Drainage designed to absorb water and reduce the drained impervious area. It is usually covered with grass and installed nearby/on top of the drainage system incorporated along roads and paths, but it is also found in residential and commercial areas. They are vegetated strips of land designed to absorb water and reduce permanently drained and often impervious areas. Usually installed along highways and streets as a drainage system but it is also found in residential and commercial areas. Efficiency is gained when used in combination with other Sustainable Urban Drainage Systems (*e.g.*, retention and infiltration ponds; floodable and water parks; rain gardens; bioswales; permeable pavements; bio-retention cells; etc.). This measure seeks to reduce drained impermeable area, absorb water, and filter out pollutants.

Floodable Park
Parks that combine vegetation with soil depression areas to absorb excess water runoff. These areas decrease excess floodwater during flooding episodes, to reduce water flow entering the public sewage, and create vegetated buffer areas reducing the effects of flooding and storm surges.

Floodplain enlargement

A floodplain or flood plain is an area of land adjacent to a river. Floodplains stretch from the banks of a river channel to the base of the enclosing valley, and experience flooding during periods of high discharge. Enlargement and restoration of river floodplains, consisting out of lowering the level and/or increasing the width of the flood plain area next to a riverbed, removal of old sediment, planting of native grasses, shrubs, trees, invasive species removal.

Green dykes

Green dykes rely on natural materials, such as clay, wood, rocks and stones, covered with grass or similar vegetation to create an elevated seaward/slope that reduces wave impact. The grass cover protects the dyke from erosion during extreme events. The introduction and/or restoration of green dykes reduce wave impact by implementing flood defence interventions based on natural sedimentations.

Green infrastructure

Roads and paths (for motorized and non-motorized traffic respectively) aligned/bordered/surrounded with significant presence of vegetation, trees, and plants, that link outstanding natural areas within the city with similar environmental characteristics.

Green roofs and green walls

Green surfaces composed by plants with weak roots on the top of buildings/houses, or their front walls. Smaller size infrastructure can also be covered with these layers (*e.g.*, bus stop shelters). This measure is intended to provide insulation of buildings, to reduce indoor temperature of buildings, to absorb storm water, to save energy by reducing cooling and heating loads, to create places where people can meet.

Green spaces

Increase the urban canopy layer and plant coverage by introducing or restoring the green areas and increasing the number of urban parks and gardens. This measure is intended to contribute to the sustainable urban development by the introduction of designed and expansion of more natural urban landscape.

High water channel

When water levels in a river rise above a certain height, and the risk of flooding is consequently high, a canal can help reduce water levels upstream. The canal is essentially a branch of a river with the entrance upstream and the exit downstream, acting as a diversion to drain extremely high-water levels of a river through a different route, so that the water can flow more quickly towards the sea.

Historic wells and reservoirs

Urban water retention ponds in the form of well or cistern designed to catch water from a higher elevation (roof and sloped streets) and temporarily hold run-off from precipitation. Piran had many, and most were made of a central stone shaft connected deeper down with a stone cistern encapsulating a certain capacity like a sunken room. Such underground infrastructure usually was surrounded by sand, to provide natural filtering of the water, before it was collected into the cistern/shaft, and the street surface above it consisted usually of water-permeable stone pavement.

Infiltration pond

Land depressions designed to have water-storage capacity and manage surface runoff water during rainfall events, with intention to gradually release the water until completed drained. The ponds act as natural aquifer recharge, collecting water and allowing natural filtration. It is used to manage stormwater runoff, prevent flooding and downstream erosion, and improve water quality in an adjacent river, stream, lake or bay. This measure seeks to hold water run-off from impermeable surfaces, to allow settlement of sediments and pollutants, to restore natural infiltration to groundwater, to respond to water scarcity and drought.

Maintenance of river network

Maintenance action, which includes periodic cleaning and clearing of stretches of the river with the objective of maintaining river connectivity and transport capacity, thus reducing flood flows.

Marram grass planting
Planting vegetation on sand dunes for coastal protection.

Peatland restoration
Restoration of the original peatland by rewetting the surface area through blocking canals, restoration of peat vegetation and planting of (resilient) peat species, to reduce flood risk and improve water quality.

Permeable pavements
This measure is considered a Sustainable Urban Drainage Systems (SUDS). These are measures designed to absorb excess water and reduce the impervious area to increase drainage. It allows voids, often using sand of fine rocky material, to have an open structure, or are made of partially pervious materials. Water can pass through or around the individual stones, into the underlying soil.

Planting of trees
Planting trees in streets and paved floors to provide shadow to streets, sidewalks, and buildings. This measure contributes to regulate temperature and shading, to provide cool urban streets, to control pollution levels, to improve inhabitants' health, to encourage biodiversity.

Rainwater garden, water parks
Multi-levelled gardens or parks with shallow depressions that use a special mix of sand and compost that allow water to soak in rapidly. Plants are used to filter stormwater runoff from roof tops, driveways, and streets for reabsorption.

Rainwater harvesting
Rainwater harvesting is the collection and storage of rain, rather than allowing it to run off. Rainwater is collected from a roof-like surface and redirected to a tank, cistern, deep pit (well, shaft, or borehole), aquifer, or a reservoir with percolation, so that it seeps down and restores the ground water.

Retention pond
Green landscape designed to collect water from a higher elevation and permanently hold run-off from precipitation, melted water, and flooding episodes. This intervention is designed to improve the drainage capacity, reduce flood risk, and reduce hazardous impact of storm surges.

Riparian reforestation
A riparian forest or riparian woodland is a forested or wooded area of land adjacent to a body of water such as a river, stream, pond, lake, marshland, estuary, canal, sink or reservoir. It implies landscape management process to restore natural processes, increase biodiversity and provide benefits to both people and wildlife. This process involves the planting of native and climate-resilient species along the banks of the stream, revegetation of micro-watersheds and the riverbed. This measure is intended to slow run-off and capture sediment before it reaches the water course, to limit down-stream flood damage to properties and livelihoods, to and avoid landslides.

River regularisation
River intervention, including desilting the bed of the river, as well as clearing and reconfiguring the outflow section. The objective of this measure is to increase the transport capacity along the river network and, consequently, a reduction in flood flows.

Riverbank maintenance
Erection of wooden box structures, rockfill or similar structures on the riverbanks to maintain the layout of the river network, guaranteeing the stability of the bank slopes. Green cover and geotextiles are additional measures suitable to maintain the riverbanks.

Riverbank heightening
This involves raising the right (downstream) riverbank with natural materials, such as clay covered with grass or similar vegetation to create a slope towards the stream to reduce runoff from the stream. The green cover protects the embankment from erosion during extreme events. Geotextile strips made of natural polymers are proposed to

be installed between the clay and the green cover to increase the durability of the filter layers and prevent run-off of soil during flood events.

River stream-bed depth restitution and renaturing

Restore the original depth level of the river streambed to accommodate larger water flows and prevent overflowing. Reduction of peak flows and flooding in the stream, providing more space for water fluctuations. It also facilitates sediment transport and storage.

Sand dyke

Sand dykes are intended to prevent coastal erosion and consequent loss of sand, acting as a defence against flooding.

Sand dune management and restoration

This measure is related with planting indigenous climate-resilient dune plants that pioneer revegetation, and will facilitate to naturally regenerate the dune ridge. The objective is to reduce flood risk and storm surges, to support biodiversity, to reduce negative environmental and landscape impact.

Seagrass meadow restoration

Seagrass meadows are underwater ecosystems formed by saltwater plants with roots and rhizomes anchored in the seafloor sand. Meadows can be restored by natural recolonization or transplantation. Seeding and relocation of viable seedlings, or mature plants from healthy donor beds, can be performed by adding seeds to biodegradable adhesive and subsequently plant it below the sediment surface. The objective of this measure is to restore and enhance vital seagrass beds in coastal zones; to stabilize marine sea bottoms; to enhance carbon sequestration and ecosystem service provision.

Selfish and seaweed aquaculture

Aquafarms can be introduced to the marine shoreline or enriched with long and vertical lines, and floating canopies, to which shellfish and seaweeds adhere and attach in socks. Cages can be attached to the lines as well with oyster cages directly on sea bottom/shore. This measure serves as a marine shoreline physical buffer, moderating wave energy and extreme weather events, to mitigate coastal (sea bottom) erosion.

Sustainable Drainage Systems

Sustainable drainage systems are a collection of water management practices that aim to align modern drainage systems with natural water processes and are part of a larger green infrastructure strategy.

Urban dune

Artificial vegetated dunes to down the loss of sand that occurs on the beach after adverse climatic events such as floods or storms surges. The vegetation cover over the dune protects it from erosion during extreme events, while enhancing its natural values.

Urban farming

Urban agriculture practices to grow crops or animals for personal consumption or to sell locally within and around cities. It comprises activities such as aquaculture, livestock, plants, and food production. This measure contributes to increase resilience of the food system, to provide food security, to increase the urban presence of plants and animals.

Watershed restoration

Landscape bioengineering (with selective plant species) to produce a watershed marshland. Examples include contour farming, planting trees on hillsides, planting fruit trees within crop plots to provide shade for the plants or reinforcing salt tolerant vegetation buffers. This measure is intended to restore the ability of a watershed ecosystem to function, to increase water capacity and reduce surface water runoff.

Wetland restoration

Restoration of wetland landscape with installation of ditches for rewetting, cutbacks to enable flooding, clearing trees, changes in land-use and agriculture measures, planting climate-resilient species, promote growth of other suitable species (*e.g.*, through nitrogen fixation). In addition to reduce flood damage, this measure enables groundwater recharge, improves water quality, and reduces pests affecting agriculture.

APPENDIX 2. DISSEMINATION MATERIALS

- Workshop invitation examples

Oeiras (Portugal). November 2023

Benidorm (Spain). December 2023

- Dissemination of workshop results - examples

Samsun (Turkey). December 2023

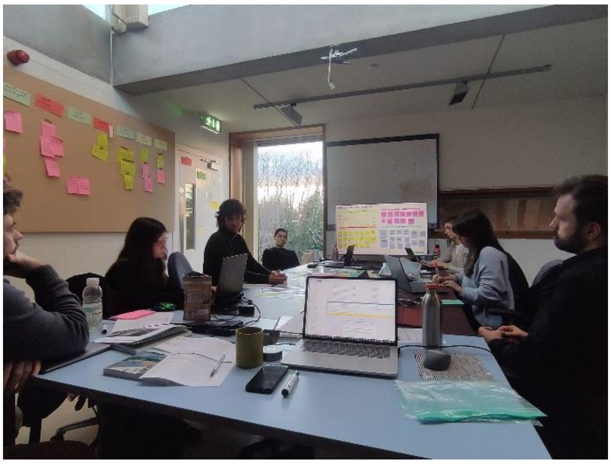
Piran (Slovenia). February 2023

Oarsoaldea (Spain). February 2023

Vilanova i la Geltrú (Spain). March 2023

Gdansk (Poland). December 2023

- Workshop pictures



Dublin (Ireland). November 2023

Sligo (Ireland). March 2023

Samsun (Turkey). December 2023

Benidorm (Spain). December 2023

Oeriras (Portugal). November 2023

Vilanova i la Geltrú (Spain). March 2023