

# Innovative solutions for climate change adaptation in coastal areas

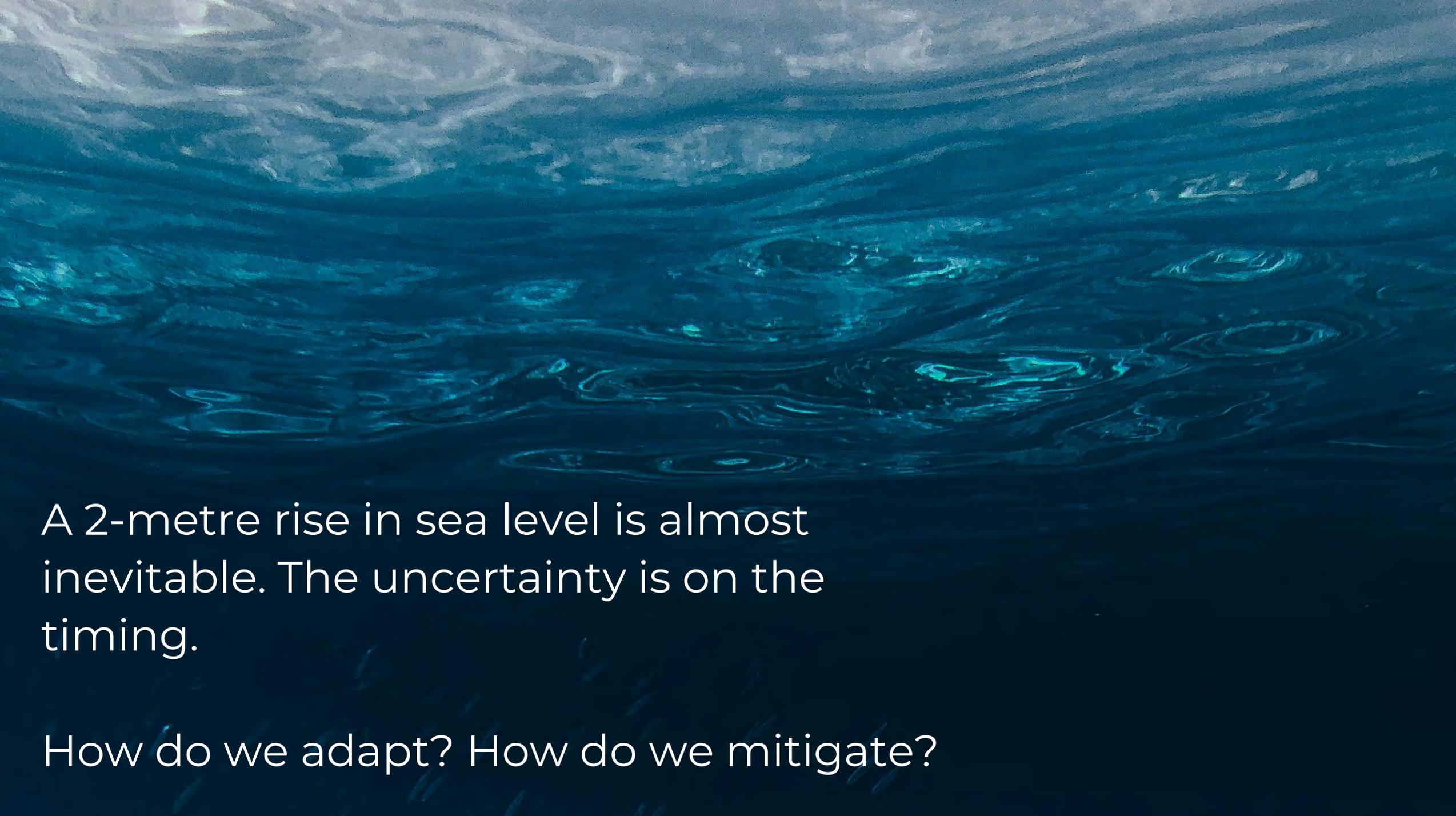
*When Green and Digital tools meet  
Living Labs*

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003534





A 2-metre rise in sea level is almost inevitable. The uncertainty is on the timing.

How do we adapt? How do we mitigate?

# Smart control of the climate resilience in European coastal cities



**28**  
Partners



**12**  
Countries



**4**  
Years



**2021-  
2025**



**10M**  
Euros

- 1 Sligo, **Ireland**
- 2 Dublin, **Ireland**
- 3 Oeiras, **Portugal**
- 4 Vilanova i la Geltrú, **Spain**
- 5 Benidorm, **Spain**
- 6 Oarsoaldea, **Spain**
- 7 Massa, **Italy**
- 8 Piran, **Slovenia**
- 9 Samsun, **Turkey**
- 10 Gdańsk, **Poland**



## CHALLENGES

### Water and Climate Related Hazards and Sectoral Impacts

#### HAZARDS

- Coastal flooding 
- Land flooding 
- Coastal erosion 
- Coastal storm surge 

#### IMPACTS

- Risk to tourism 
- Loss of cultural heritage 
- Damage to commercial buildings 
- Damage to residential buildings 
- Energy networks 
- Agricultural stress 
- Loss of wetlands 
- Loss of animal habitat 
- Damage to civil infrastructure 
- Risk to local economy 

## INTEGRATED SOLUTIONS

### Ecosystem Based Approaches

- Agroforestry 
- Reforestation 
- Floodplain management 
- Sustainable agriculture 
- Sustainable forest management 
- Integrated coastal zone management 
- Mangrove or wetland restoration 
- Sustainable land management 

### Smart Technologies and Digital Platforms

- Digital twin solution prototypes 
- GIS early warning support platform 
- SCORE ICT Platform (SIP) 
- Application Program Interface (API) 
- Low-cost sensing technologies and citizen science kits 
- Transferable financial risks and products platform 

### Living Lab Methods

Switch of user roles from consumers to prosumers



Shorter time between development and market deployment



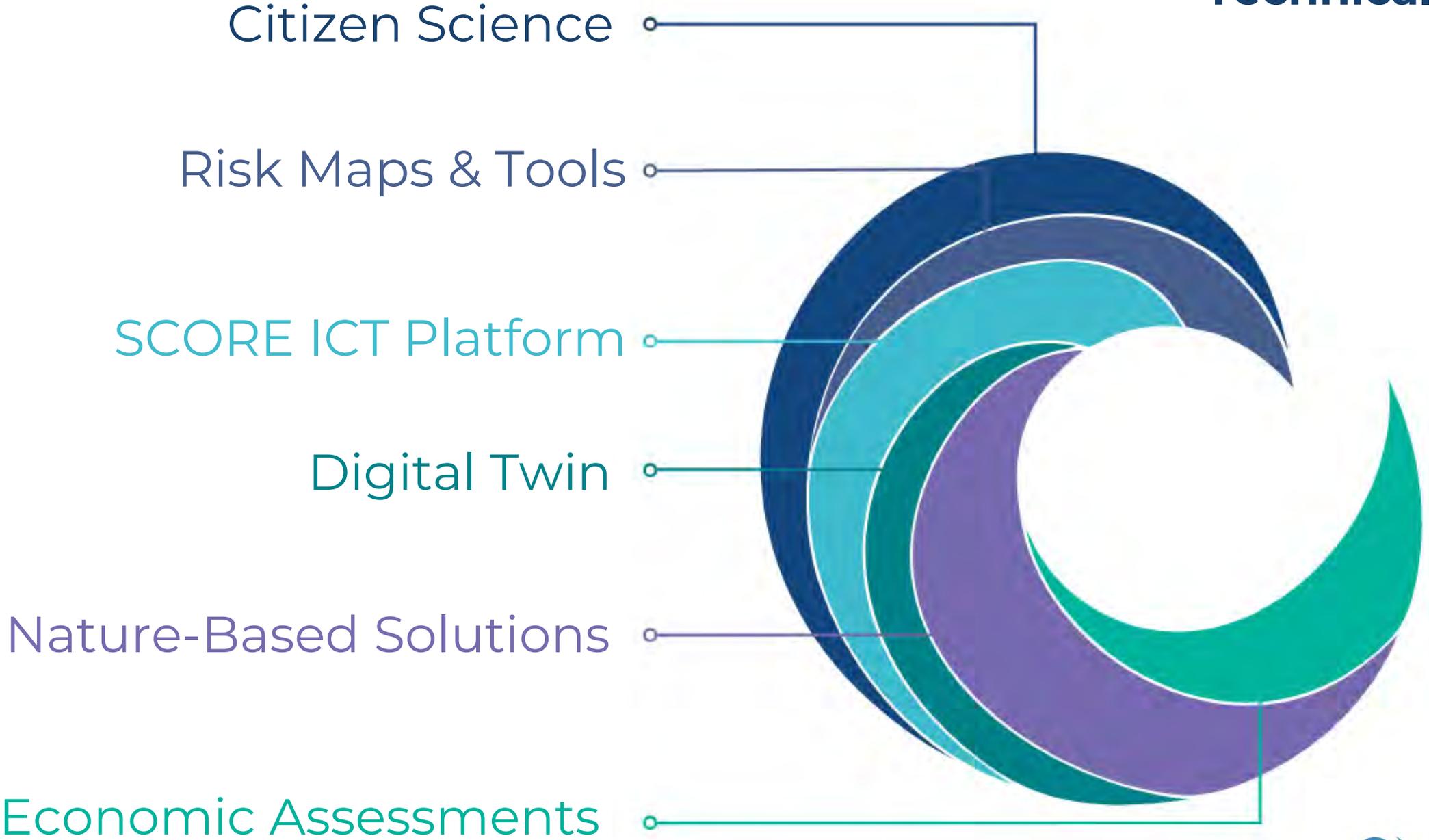
Growing penetration of digital ICT solutions into citizens' daily lives



Collaboration, Replication and Dissemination

CLIMATE AND WATER-RESILIENT URBAN AREAS

# Technical Results



## Impact & Legacy

We built more than tools - we built relationships, inspired new ways of working, and created real momentum for resilient coastal cities.



# Agenda

**Session 1:** Co-Creation & Living Labs – Rethinking Climate Adaptation

**Session 2:** Data-Driven and Nature-Based Adaptations – Tools for Today & Tomorrow

Smart Control of the Climate Resilience in European Coastal Cities



Smart Control of the Climate Resilience in European Coastal Cities

# Thank you!

**Dr. Salem Gharbia**

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an Atlantaigh

Atlantic  
Technological  
University

# Co-Creation & Living Labs – Rethinking Climate Adaptation



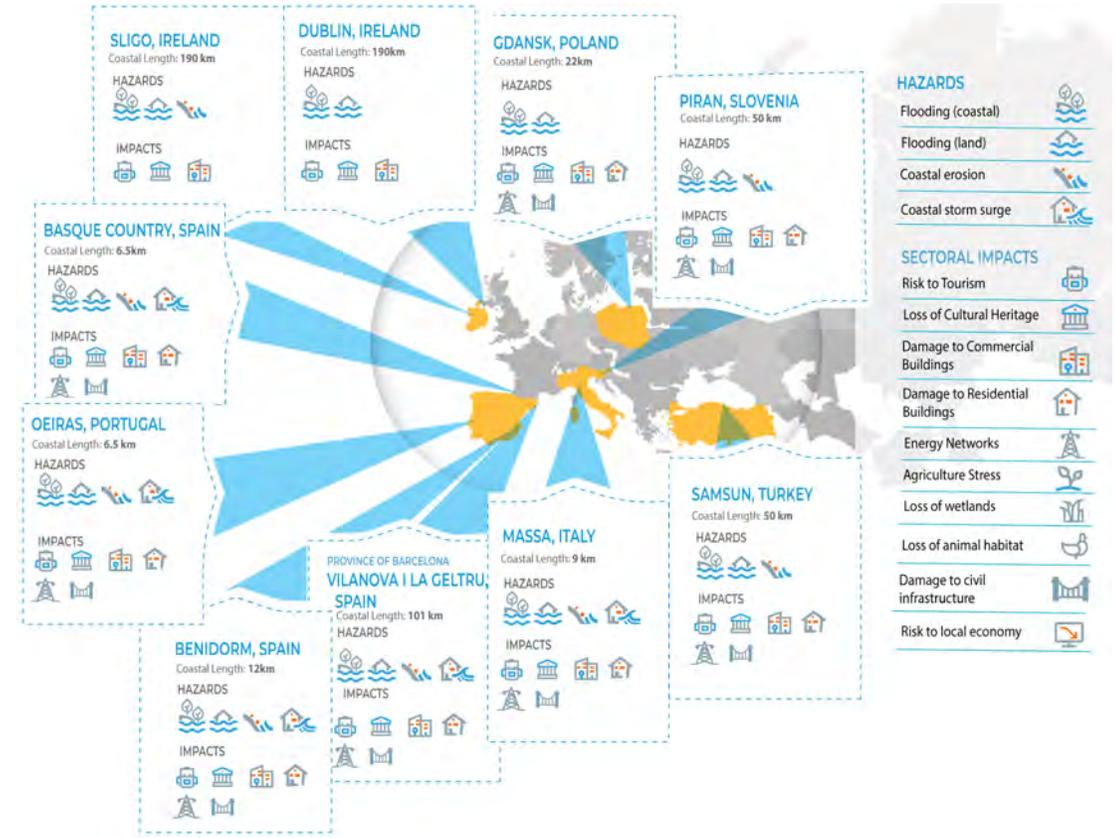
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# A Coastal City Living Lab

CCLLs are based on the Living Labs concept but **focus on co-designing and co-developing coastal city interventions and activities** through novel **Ecosystems Based Approaches (EBAs)**, involving all relevant stakeholders in the development of it.

A CCLL is an **innovation intermediary**, which orchestrates an ecosystem of actors in a specific region **to tackle specific challenges related to sea level rise, coastal erosion and extreme events**.

SCORE established 10 CCLLs that involve citizens, scientists, policy makers and other stakeholders in providing prototype coastal city early-warning systems. These CCLLs learn from each other in different frontrunner and follower roles, ensuring engagement, empowerment and learning throughout the process.



# Co-creation and Co-design

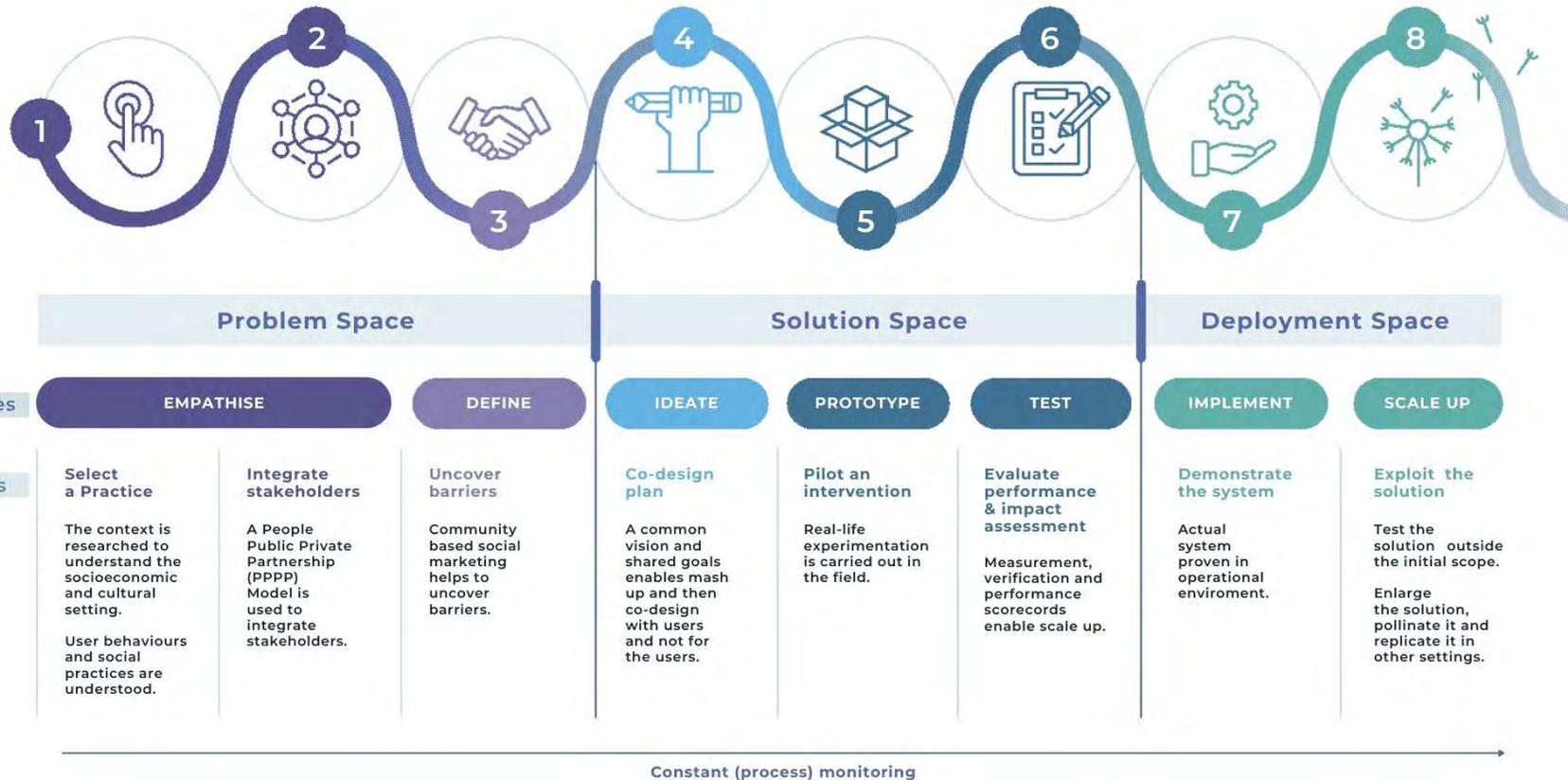
**Co-creation** is understood as a process that, based on the identified needs, aims to develop results that involve knowledge flows and absorptive capacities from all actors involved across the entire economic and social environment, referred to the addressed needs (European Commission, 2016).

*“In the case of SCORE, co-creation is the outcome of the process where different knowledge, values and expertise evolve to build a consistent and sustainable CCLL”*

*“In the case of SCORE, the solutions needed to adapt to the climatic hazards each Coastal City is facing will be co-designed through the CCLL ”*

**Co-design** is a specific instance of the broader concept of co-creation and refers to the creativity of designers and people not trained in design working together in the design development process.

# Co-creation in SCORE through the Living Lab Integrative Process



## SCORE Co-Creation toolkit



### Toolkit

Discover which tools fit best on the target of your co-creation journey

[> See more](#)

**Community engagement in solutions**

# The SCORE CCLL Outcomes



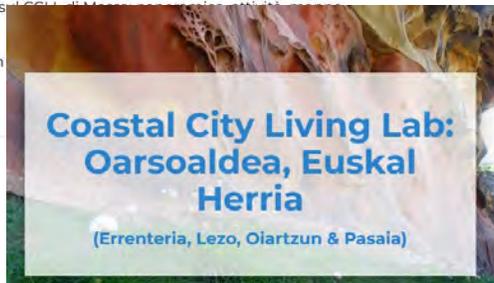
Massa Coastal City Livi... [View GeoStory](#)

a geostory from Massimo Perna / March 5th 2024

Informazioni s...

Info Location

Title



Oarsoaldea CCLL Geos... [View GeoStory](#)

a geostory from Xabier Sesn...

Introduction to CCLL Identifying Hazards & Solutions Community GeoSur...

overview

Info Location

Title



Piran Coastal City Livi... [View GeoStory](#)

a geostory from Cecil Meulenberg / February 1st 2024

Explore the latest activities of the Piran CCLL.

Info Location

Title

Piran Coastal City Living Lab (slovenian)

Owner

Cecil Meulenberg

The **CCLLs' co-created values**—such as ecosystem-based adaptations (EbAs), smart sensors, digital twins and ICT platforms played a **crucial role** in demonstrating **the network's technological advancements** while **driving societal and environmental impact** within coastal cities.



# The SCORE CCLL Outcomes

## Climate Change in Oarsoaldea

Oarsoaldea's Environmental Hazards



### How can Ecosystem-Based Approaches help?

Ecosystem-based approaches (EBAs) are green solutions to help restore ecosystems. EBAs help protect communities against environmental hazards.

Oarsoaldea's Coastal City Living Lab met with community members to prioritise the most relevant EBA's for our region.

#### Open Green Spaces

Improving and increasing green spaces (i.e., parks & green strips) to promote environmental regeneration, sustainable development and social cohesion.



Addressed Risks



#### Planting Trees

Planting trees to shade streets, sidewalks and building, protects communities during heatwaves, while promoting biodiversity in urban areas.

Addressed Risks



#### Reforestation of Riverbanks

Planting vegetation to slow runoff and limit flood damage, and protect our communities from landslides.

Addressed Risks



## Climate Change in Piran

Piran's Main Environmental Hazards



### How can Ecosystem-Based Approaches help?

Ecosystem-based approaches (EBAs) are green solutions to help restore ecosystems. EBAs help protect communities against environmental hazards.

Piran's Coastal City Living Lab met with community members to prioritise the most relevant EBA's for the historic town centre.

#### Planting Trees

Planting trees to shade streets, sidewalks and buildings, protects communities during heatwaves, while promoting biodiversity in urban areas.



Addressed Risks



#### Renovation of water wells



Historic wells and reservoirs will retain rainwater and provide fresh water during the summer months, improving the quality and quantity of water.

Addressed Risks



#### Multi-Purpose EBA Area

Using multiple EBAs, such as planting trees, urban farming and rain gardens will increase green urban spaces and rainwater retention.

Addressed Risks



## Climate Change in Sligo

Sligo's Main Environmental Hazards



### How can Ecosystem-Based Approaches help?

Ecosystem-based approaches (EBAs) are green solutions to help restore ecosystems. EBAs help protect communities against environmental hazards and provide co-benefits, including job opportunities, improved water quality and biodiversity.

Sligo's Coastal City Living Lab met with community members to prioritise the most relevant EBA's for our region.

#### Afforestation

Planting trees can reduce flood risk while providing recreational opportunities, supporting biodiversity, and capturing carbon.



Addressed Risks



#### Peatland Restoration

Peatland restoration in Sligo's Ox Mountains will support carbon capture and reduce flood risk, support biodiversity, and create job and tourism opportunities for the community.

Addressed Risks



#### Wetland Restoration

Wetlands and marshes play an important role in flood-prevention and provide opportunities for carbon capture, supporting biodiversity, and recreational activities.

Addressed Risks



## Climate Change in Vilanova i la Geltrú

Vilanova's Environmental Hazards



### How can Ecosystem-Based Approaches help?

Ecosystem-based approaches (EBAs) are green solutions to help restore ecosystems. EBAs help protect communities against environmental hazards.

Vilanova's Coastal City Living Lab met with community members to prioritise the most relevant EBA's for our region.

#### Combination of EBAs

Using multiple EBAs, including the rehabilitation of riverbanks, river bed restoration and increased river bank height, will protect against flooding.



Addressed Risks



#### Riverbank Restoration



Planting stabilising and climate change-resistant vegetation along the riverbank will reduce runoff, limit flood damage and prevent landslides.

Addressed Risks



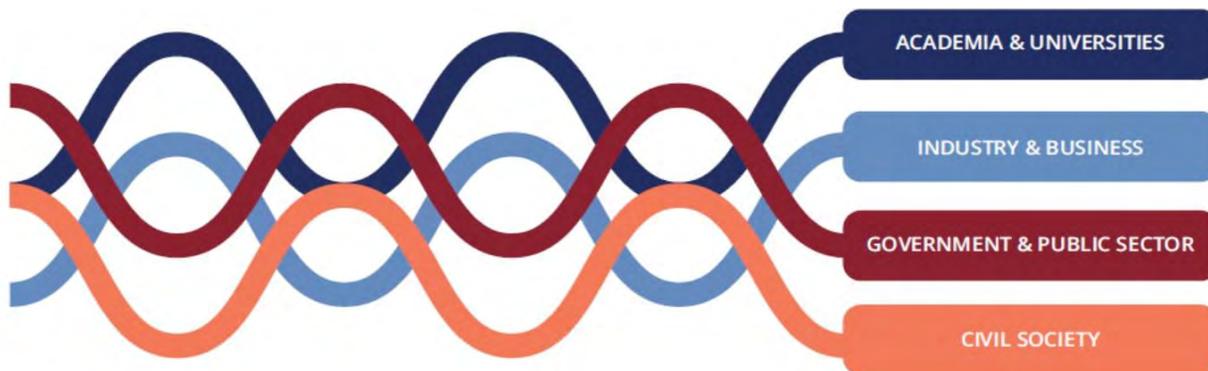
#### Riverbed Restoration

Restoring the original riverbed depth by removing concrete materials and vegetative debris will accommodate increased water flows and help avoid flooding.

Addressed Risks



# The SCORE CCLL Legacy



The CCLLs' co-creation activities with four key actors—**government, academia, industry, and citizens**—have built a legacy of sustained engagement on climate issues while fostering innovation in coastal climate adaptation.

# The SCORE CCLL Outcomes

## CCLLs Citizen Science Activities

- Empowered local communities to actively participate in data collection, making observations and analyzing information
- Enhanced research capacity, promoted public engagement, environmental awareness



# The SCORE CCLL Outcomes



Empowering communities thanks to the first SCORE Training School



Joint policy recommendations for climate adaptation in European coastal cities



Engaging the younger generation in designing our cities with Minecraft



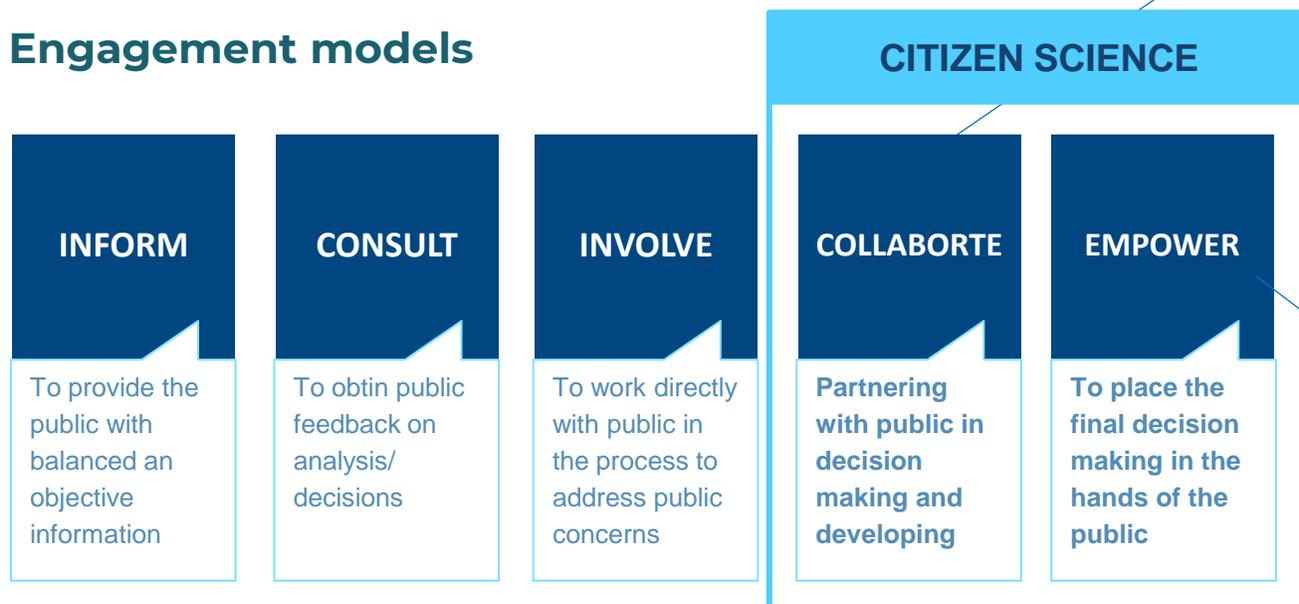
Terraces site visit with students in Piran

*The CCLLs' have achieved significant tangible and non-tangible project results linked to their efforts in fostering strong relationships with key partners and stakeholders allowing CCLLs to effectively mainstream results in the wider community.*

## What is Citizen Science?

**Citizen Science (CS)** refers to a broad range of activities in which individuals from diverse backgrounds **actively contribute to scientific research in meaningful ways**, beyond simply serving as subjects in medical experiments or participants in social science studies.

## Engagement models



### COLLABORATE

- Passive sensing
- Volunteer Computing
- Environmental and Ecological Observation



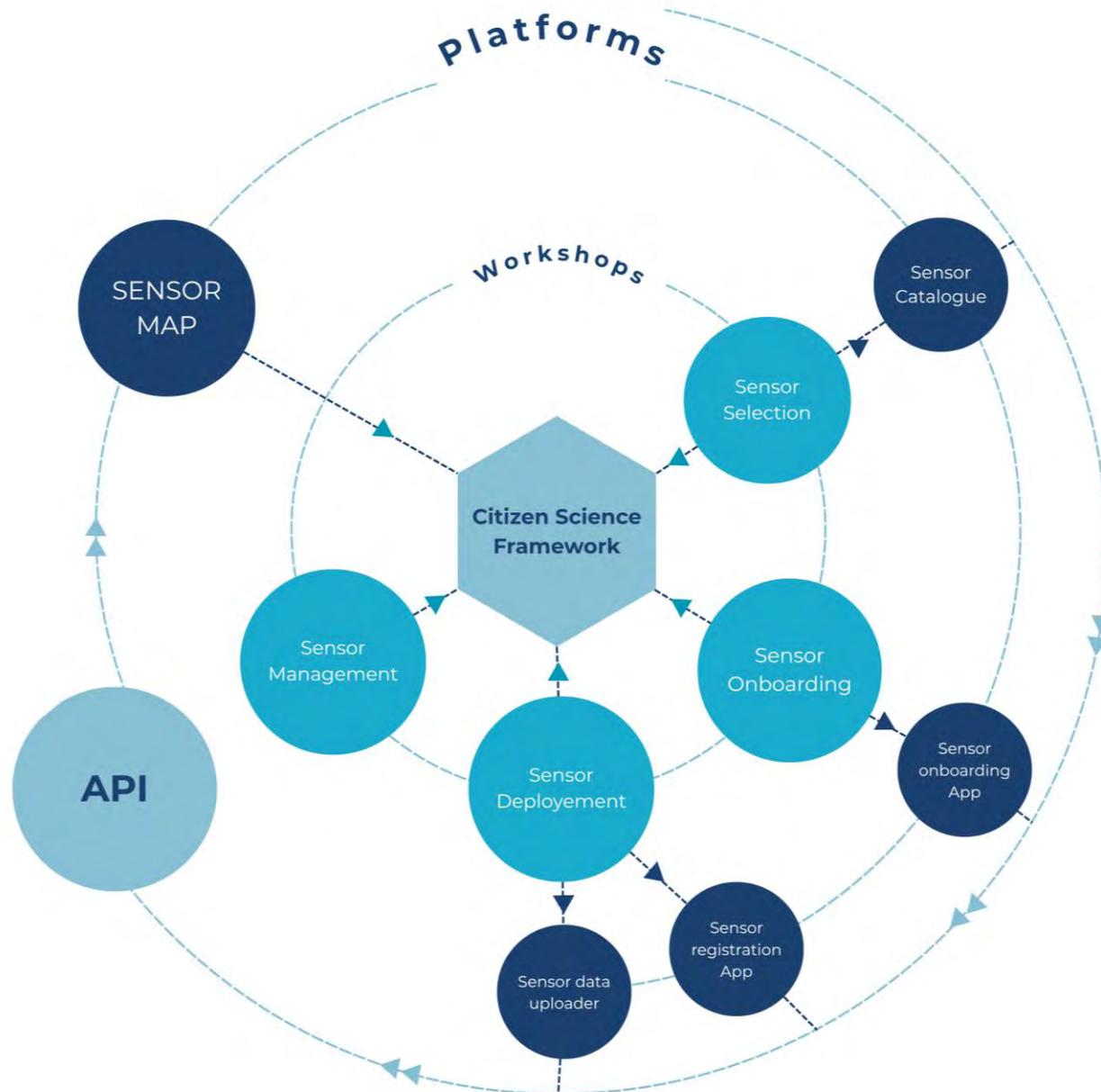
### EMPOWER

- Participatory Sensing
- Civic/ Community Science

## A framework for Community-based Monitoring and Citizen Science

The framework uniquely combines **stakeholder workshops** with **SCORE tools**, and it's supported by a set of **low-cost, easily replicable environmental sensors**.

These tools and sensing devices enable the systematic collection of **hyper-local data** on parameters such as temperature, humidity, and water quality and level.



# SCORE Sensors Catalogue



The low-cost sensor catalogue served as a key resource during the **sensor selection workshops**.

These workshops involve stakeholders to **identify suitable low-cost sensors for specific environmental challenges** using the Sensor Catalogue.

The selection is guided by criteria such as ease of use, relevance to the local context, and availability of resources.

Filters to sort by hazards

Hazards (multiple selection): Filter by

Monitored parameter: Filter by

Installation complexity: Filter by

Price range: € 0 to € 2000

Reset filters

Hover over each sensor to see a brief description, and click on a sensor to view detailed information



€ 400

**SmartLNB**

Satellite device used as rain probe which can be used to monitor rain. Does not require connectivity as it communicates with the data center using a satellite service.





# Sensors Selection Workshops in each CCLL





## Become a Citizen Scientist

Join Our Personal Weather Station and Air Quality Monitor Initiative in Dún Laoghaire!

As part of the SCORE project's commitment to harnessing the power of citizen science for climate change monitoring, we are thrilled to invite you to participate in our latest initiative: the installation of personal weather stations and air quality monitors in your home or back garden.

What's in it for you?

- **Free kit:** The weather stations and air quality monitors are free for volunteers.
- **Site Analysis:** Our expert team will analyse your site to ensure it is optimal for your chosen sensor.
- **A-Z Guide:** Volunteers will receive a comprehensive guide for a seamless installation and onboarding process.
- **Technical Support:** if at any moment, you experience difficulties with the stations, our team will be on-hand to help.
- **Free weather data:** all the data produced by your station will be available to not only SCORE and University College Dublin, but also to you.



## Sensor Onboarding Workshops

*The onboarding app provided clear, **step-by-step guidance on the assembly and deployment of sensors**, ensuring attendees could independently set up and utilise them for environmental monitoring.*

*Facilitators introduced the onboarding materials, offering hands-on demonstrations and troubleshooting techniques to address potential technical challenges.*

**score** CCLLs Sensors Onboarding

Step 21 of 42

**ENTER YOUR SCORE WEATHER STATION ID. THIS HAS BEEN PROVIDED TO YOU VIA EMAIL, AND SHOULD BE LOCATED ON THE WEATHER STATION BOX.**

For example, SCORE\_PWS\_01

Name (required)

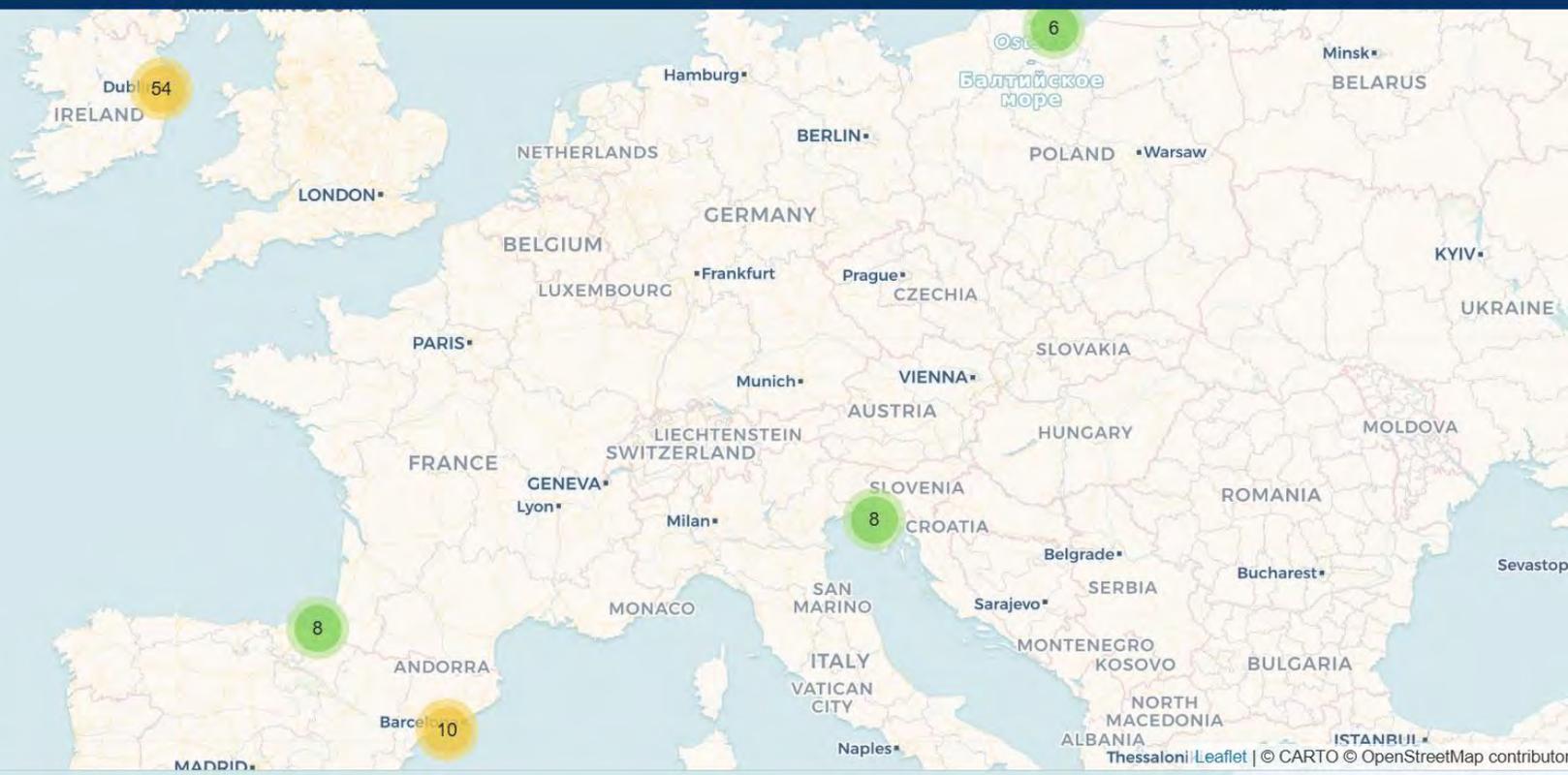
Elevation (optional)

Device hardware (optional)

Surface type

Height Above Ground

[« Previous step](#)
[NEXT STEP »](#)



CCLL Tags: null      System Tags: offline      Owner: SCORE

<b>114°</b> WIND DIRECTION	<b>2.7 km/h</b> WIND SPEED	<b>2.7 km/h</b> WIND GUST	<b>1001.02 HPa</b> ATMOSPHERIC PRESSURE	<b>0 mm/h</b> PRECIPITATION RATE
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Want to see trends? Click on a value to display its time series chart

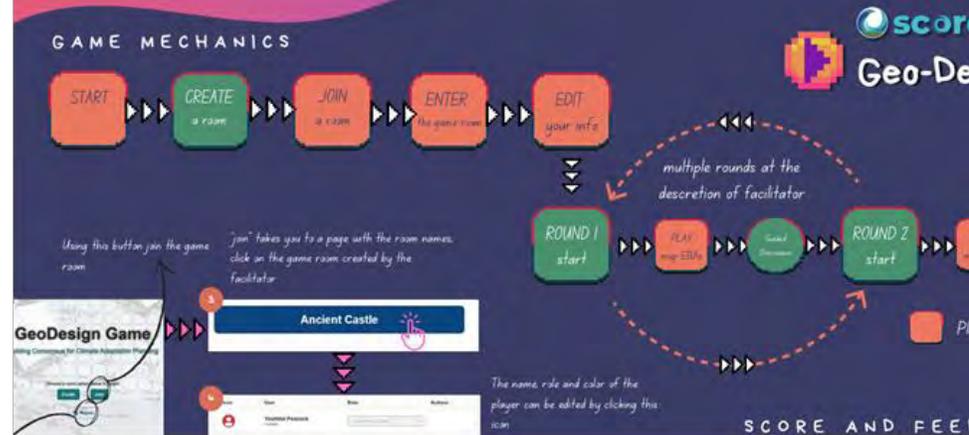
Sensor ID: IBLANC18

Last observation: 2025-05-12T08:46:29Z

Platform provider: Weather Underground PWS

# What is a Geogame?

Geogames are a type of **serious game** (particular purpose, beyond only entertainment) that use **virtual or physical representations** of the real world, employing mechanics designed to foster the acquisition of spatial analysis skills.



The screenshot shows the GeoDesign Game interface. On the left, a sidebar displays game statistics: Budget €27000, Time 02:16, and Developer Role. Below this is a 'Solutions' list with categories like Floodable Park (€9000), Green roofs and green walls (€8000), Green spaces (€9000), Maintenance of river network (€7000), Permeable pavements (€8000), Planting of trees (€7000), and Rainwater garden, water parks (€9000). The main area is a map of Rotterdam with several green roof icons. A pop-up window for 'Green roofs and green walls' provides details: Location: 51.9014 lat, 4.4848 lng, Price: €8000, Placed by: Developer, Placed in round: 1, Votes count: 0, and a 'Show More Info' button.



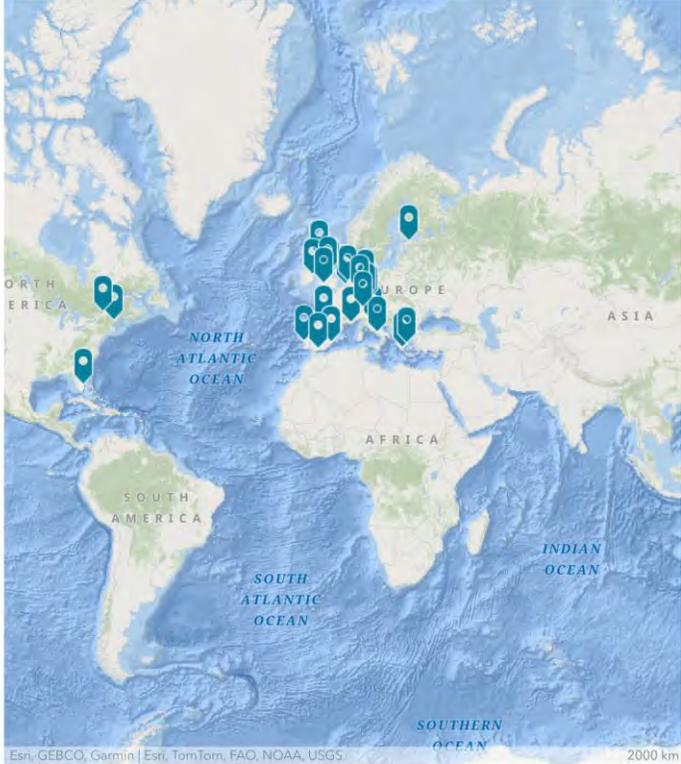
# Ecosystem-Based Approaches: Catalogue and Evaluations

 SCORE Ecosystem-Based Adaptation Catalogue



Case Study Map Tour Landscapes Hazards Hazards and Landscapes Authors to be contacted on beh...

 Afforestation	 Reforestation	 Green spaces	 Green corridors
 Planting of trees	 Urban farming	 Green roofs and green walls	 Grasslands
 Retention ponds	 Infiltration ponds	 Floodable park	 Rainwater garden
 Filter strips	 Bioswales	 Wetlands	 Peatlands
 Saltmarshes and mudflats	 Estuaries	 Riparian reforestation	 Watersheds



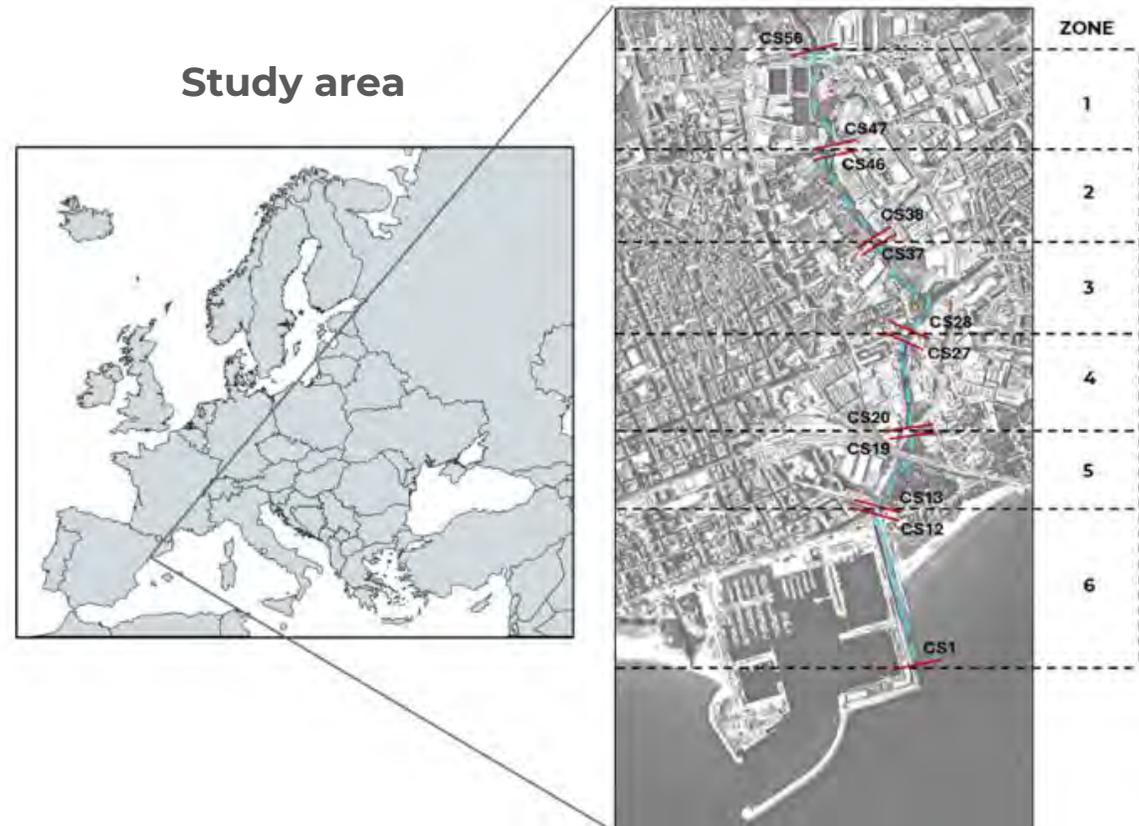
Esri, GEBCO, Garmin | Esri, TomTom, FAO, NOAA, USGS 2000 km

In: <https://score-eu-project.eu/>

# Ecosystem-Based Approaches: Catalogue and Evaluations

## SOCIOECONOMIC EVALUATION USING MULTICRITERIA AND COST-BENEFIT ANALYSES

- ◆ **Vilanova i la Geltrú:** 47 km south of Barcelona, ~68,800 residents.
- ◆ **Past overflowing of the temporary river *Torrent de la Piera*** disrupted roads, sidewalks, and access.
- ◆ **Rivers' capacity to manage rising flood risks is limited** as urban development reduces floodplains.
- ◆ **Restoration of the stream** with EBA measures along a ~3km section.



Source: Adapted with changes from Mapchart.net and Visor SigPac: <https://sigpac.mapama.gob.es/feqa/visor/>.

# Ecosystem-Based Approaches: Catalogue and Evaluations

## SOCIOECONOMIC EVALUATION USING MULTICRITERIA AND COST-BENEFIT ANALYSES

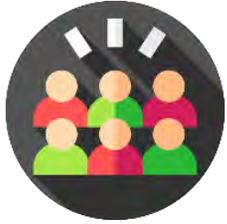


Source: Aigües de Vilanova i la Geltrú



# Ecosystem-Based Approaches: Catalogue and Evaluations

## MULTICRITERIA ANALYSIS (MCA)



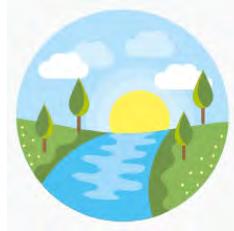
### Workshop in March 2023:

29 participants from academia, citizens groups, government, private sector.



### Evaluation criteria:

- Perception of flood risk reduction
- Biodiversity conservation and improvement
- Heat stress reduction
- Water quality improvement
- Landscape aesthetic value
- Carbon capture and sequestration



### Measures (final ranking):

- #1 Combination of measures (all except filter strip)
- #2 Renaturing along river stream banks
- #3 Restitution of river stream-bed depth and renaturing
- #4 Heightening the river stream bank
- #5 Implementing a filter strip

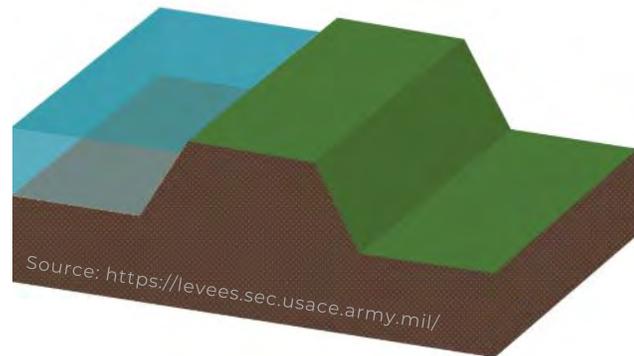
# Ecosystem-Based Approaches: Catalogue and Evaluations

## COST-BENEFIT ANALYSIS (CBA)

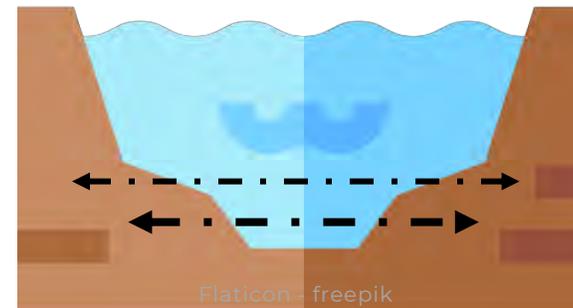
### ◆ Adaptation measures (separate and combined):

#### ◆ 1) Raising the right riverbank with an earthen levee

Use of geoen지니어ing (live slope grid) and greening with geofibre and vegetation.



#### ◆ 2) Widening the riverbed while maintaining the gradual slope of the stream



# Ecosystem-Based Approaches: Catalogue and Evaluations

## COST-BENEFIT ANALYSIS (CBA)

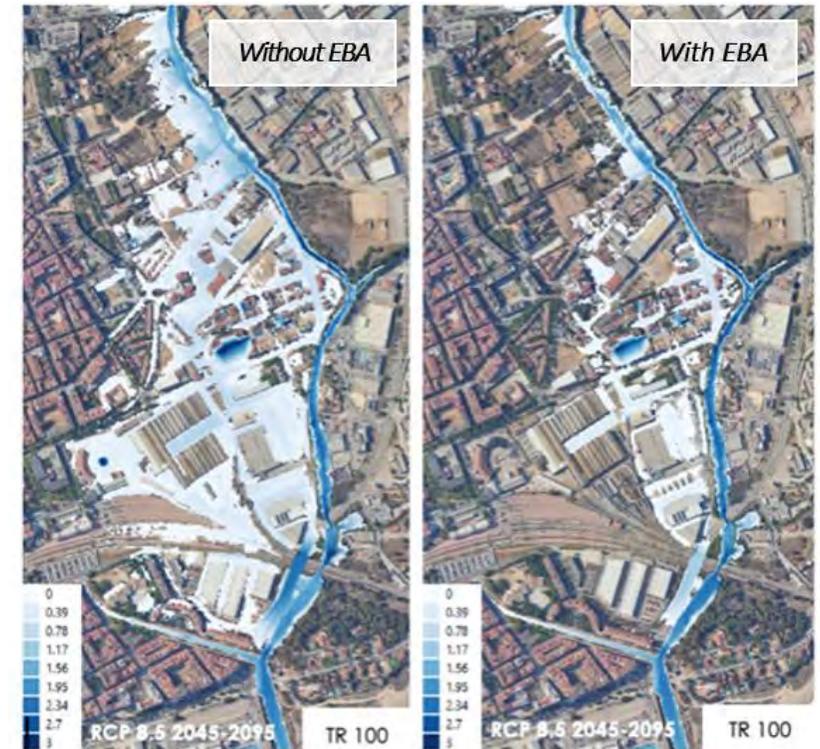
### Methodological considerations:

- ◆ Adaptation vs. inaction.
- ◆ Timeframe: 2024-2065.
- ◆ Scenarios RCP 4.5 and 8.5.
- ◆ Benefits (avoided losses) and Costs (investment and 1% annual maintenance costs).
- ◆ Discount rate: 3%.
- ◆ Sensitivity analysis: DR (1%; 5%); and 2% annual maintenance costs.

### Main results:

- ◆ **Benefits outweigh costs** with a positive NPV: ranging from 79.4 to 88.3 M€.
- ◆ Other benefits (biodiversity, carbon capture, etc.) and indirect flood impacts not considered, potentially underestimating total benefits.

Hazard maps for river flood



Source: Beden et al. (2014).

# Thank you!

 [www.score-eu-project.eu](http://www.score-eu-project.eu)

 [contact@score-eu-project.eu](mailto:contact@score-eu-project.eu)



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# Samsun CCLL





Dune restoration



Samsun CCLL

Pond



# Piran CCLL



# Piran CCLL



# Vilanova i la Geltrú CCLL



## Habitats

Identificació i descripció dels diferents hàbitats de Vilanova i la Geltrú.

Tipus d'hàbitats:

1. Praderals

2. Bosc de ribera

3. Camps de conreu

4. Zones de muntanya

5. Zones de marjal

6. Zones de marjal salada

7. Zones de marjal d'aigua dolça

8. Zones de marjal de mar

9. Zones de marjal de marja

10. Zones de marjal de marja salada

11. Zones de marjal de marja d'aigua dolça

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19. Zones de marjal de marja de marja d'aigua dolça

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30. Zones de marjal de marja de marja salada

31. Zones de marjal de marja de marja d'aigua dolça

32. Zones de marjal de marja de marja de mar

## Medi mar

Identificació i descripció del medi mar de Vilanova i la Geltrú.

Tipus de medi mar:

1. Marjal de mar

2. Marjal de marja

3. Marjal de marja salada

4. Marjal de marja d'aigua dolça

5. Marjal de marja de mar

6. Marjal de marja de marja

7. Marjal de marja salada

8. Marjal de marja d'aigua dolça

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26. Marjal de marja de marja

27. Marjal de marja salada

28. Marjal de marja d'aigua dolça

29. Marjal de marja de mar

30. Marjal de marja de marja

31. Marjal de marja salada

32. Marjal de marja d'aigua dolça

# Vilanova i la Geltrú CCLL



# ZONA HUMIDA DE LA PLATJA LLARGA



- Itinerari interior permanent.
- Itinerari restringit (Vegeu horari)
- Itinerari costaner permanent.

Vostè es troba aquí.

**LA ZONA HUMIDA DE LA PLATJA LLARGA ÉS UN ESPAI NATURAL EN RESTAURACIÓ.**

Es fan constants esforços per millorar els seus valors naturals, agraiem que els respecteu.



Prohibit sortir dels itineraris pedestres



Endueu-vos les deixalles



Aiguamoll



Respecteu la fauna



Prohibit el pas a animals

## HORARI D'ATENCIÓ AL VISITANT

Dissabtes i diumenges

de 9:30 h a 13:30 h i de 15:00 h a 19:00 h.

## HORARI DE L'ITINERARI RESTRINGIT

Dissabtes i diumenges: 9:30 h a 19:00 h.





# Oeiras CCLL





# Oeiras CCLL



# Gdansk GCLL





# Thank you!

 [www.score-eu-project.eu](http://www.score-eu-project.eu)

 [contact@score-eu-project.eu](mailto:contact@score-eu-project.eu)



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