



# CREST

Climate resilient coastal urban  
infrastructures through digital twinning



## CREST

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### D2.2 Citizen Science research protocol (WP2)



Funded by the  
European Union

This project has received funding from  
the European Union's Horizon 2020  
research and innovation programme  
under grant agreement No 101003758

Project Name: CREST – Climate resilient coastal urban infrastructures through digital twinning

Urban Europe

Call: ERA-Net Urban Transformation Capacities (ENUTC)

Project Duration: 04.2022-03.2025 (36 months)

Project No: 101003758

D2.2 Citizen Science research protocol – both for particular (3 urban areas) and universal usage (WP2).

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# D2.2 CITIZEN SCIENCE RESEARCH PROTOCOL (WP2)

A framework document that can be  
tailored for the European coastal areas:  
Kołobrzeg community (Poland),  
Bordeaux (France), and Møre og  
Romsdal Fylkeskommune (Norway)

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Date of submission: 31<sup>st</sup> of March, 2023



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## Introduction

Struggling for a climate resilient coastal urban infrastructure through digital twinning – citizen science approach based on three coastal areas in Poland, France, and Norway is the main objective of the project. A common methodology in the spirit of “citizen science” is a key for better understanding of “resilience” question. The citizen science approach supports the creation of the information society, it develops civil attitudes. The information is most crucial, both its collection and its perception by the community. In that manner, the citizen science approach, benefits from artificial intelligence and augmented reality to provide significant advances that can have a transformative impact on audience engagement on climate change issues. A ground-breaking methodology developed by AugumentCity is the way to support digital city twins, which combine both data and “what if” scenarios to be analysed and visualised in an interactive tool for use by policymakers, scientists, businesses, and citizens. The digital twinning methodology is for demonstrating, co-creating, and mobilising stakeholders for capacity building through collective decision-making in three European urban areas for a resilient urban infrastructure adapted to climate change.

While the CREST project is a response to the significant dynamics of climate change, the cloud of information on resilience may be a real need for action. Digital twinning is intended to underpin a data-driven approach for policy makers, public authorities and local authorities. It allows for defining challenges properly and understanding resilience question. Better anticipation of the future disaster is based on the multidimensional diagnosis through a various indicators predefined by ISO norm and U4SSC methodology. Visualization allows to create a scenario with multiple possible solutions as well as case study development paths. Furthermore, it gives a unique opportunity to include non-professionals (lay citizens) in the process, as voluntary data collectors and co-performers of the research. Wide public participation and a tangible effect, such as visualization of a given issue, are required for the method's quality and efficiency. An image that defines a problem triggers discussion and further research steps, such as a workshop. Anticipation of the future ensures that the best of several possible solutions is developed, including disaster scenarios to prove the best implementation variants.

## Objectives of the study

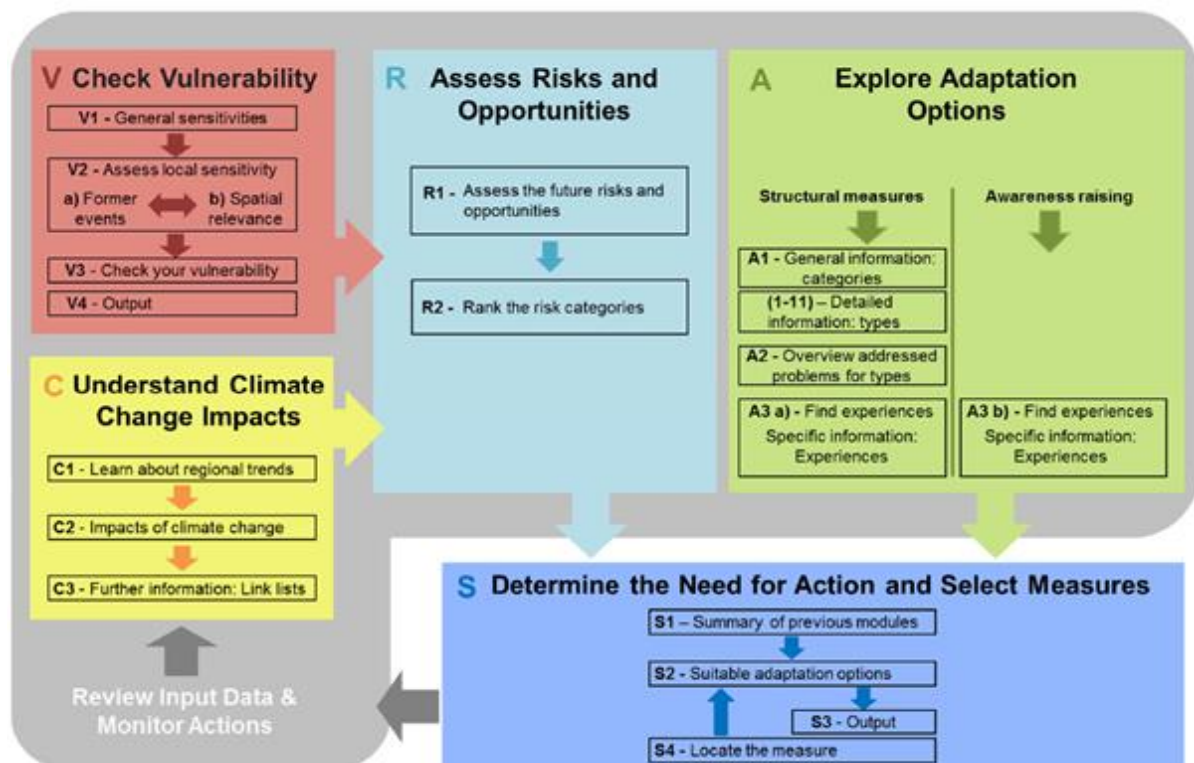
Is there a universal meaning of “resilience”? The main purpose of this study is to indicate what kind of city components support resilience. Local resources sustain adaptiveness to threats, disasters, and urban challenges. The study’s difficulty lies in penetrating layers of the urban fabric, starting with the social layer and examining its self-organisation, vitality, and self-help mechanisms. Next, social infrastructure, public services, and the effectiveness of local policies; and then hard issues, including technical infrastructure and the way the city is designed as a spatial structure with green corridors, the protection of natural resources, and the implementation of blue and green infrastructure. Consequently, we deal with the city’s adaptability to current challenges. Another aim of this study is to check how the respondents define and perceive the term “resilience”, including the transnational communes perspective, in the context of the analysed regions. Referring to the climate change of the coastal areas, another goal is to determine the specific features of Kołobrzeg's, Bordeaux's and Møre og Romsdal Fylkeskommune communes’ resilience by identifying challenging

places in the context of urban planning, and identifying a specific aspect of the topic. Digital twinning developed by Augmencity will contribute to solving some of the urban problems

## Theoretical background

Climate change has a significant impact on life in cities. Extreme temperatures impact sea level rise and consequent adverse events such as floods, droughts, and storms, with costly impacts on basic urban services, infrastructure, housing, livelihoods, and health. Cities are responsible for 75% of CO<sub>2</sub> emissions, so their stakeholders need to come up with out-of-the-box solutions to promote innovation and stimulate cities' resilience by reducing the negative impacts of climate change. However, to address a problem, key threats have to be defined in order to location of various cities. How resilience varies on core threats, common for all the places, and those that occur more likely locally. Moreover, social perception of threats has to be defined and combined with a sectoral policies outlined.

Citizen science offers diverse methodological tools for combining various techniques to increase social participation. However, desk research plays a key role as an introductive defining the main conditions, challenges, and issues caused by climate change.



**ADAPTATION RISK ASSESSMENT. SOURCE: GUIDANCE FOR DEVELOPING CLIMATE-PROOF CITY REGIONS, Adaptation Compass, p. 65.**

The general framework for risk assessment is seen as a wide process that absorbs each aspect of city prosperity, from social to build fibre. According to the 'Future Cities' project's output, Adaptation Risk Assessment, known as the 'Adaptation Compass', our research is focusing on a better understanding of climate change impact and its roots in local community vulnerability. The CREST' methodology intends to pre-define risks and problems by case study municipalities to explore individual adaptation options under design thinking workshops. In other words, the aim of 'CREST' research is to support

the mitigation of chosen resilience issues that are highly significant from the perspective of citizens. That requires a multidisciplinary approach to research composition based on 'citizen science, an understanding of urban studies, and environmental design itself.

## Hypothesis

Understanding and defining "**community resilience**" is a critical first step in understanding local challenges and threats, as well as their scopes and fields. Actually, no unique association of "resilience" with environmental, social, or green and blue infrastructure questions is seen. Ensuring significance indicators, actions, and real meaning for the local context in the spirit of co-creation with several profiles of stakeholders (scientific, public, private, and civil society).

The urban environment continues to suffer from a lack of blue and green infrastructure networks that cover the majority of the city's critical areas. **Heat island effect** as a serious challenge to the question of why waves of heated air increased temperature in urban spaces. The issue is exacerbated by the city's lack of green and water area networks. Greenery that absorbs pollutants, smog, and improves retention are both lacking of trees crowns' coverage beneath impervious surfaces. **Flash floods** are another urban challenge that cities face, and that dimension of blue and green infrastructure has to be expanded. The most recognised issue in social discourse is **smog**. Is it also a key challenge to reduce resilience in coastal areas? But is the threat from water more significant? It can be presumed that a certain hierarchy of threats will expose selected aspects of resilience.



**TABLE 1. PRE-DEFINED CATALOGUE OF ACTIONS ON RESILIENCE AND SPECIFIC GOALS**

Sphere of the urban environment	Actions on climate resilience	Threat / urban challenge	Indicator
<b>Precipitation</b>	<b>Flood resilience</b>	flood, i.e. flash flood, urban flood	<ul style="list-style-type: none"> <li>• <a href="#">High water levels,</a></li> <li>• <a href="#">Share of area at risk of flooding and waterlogging</a></li> </ul>
		flood form the sea water	<ul style="list-style-type: none"> <li>• <a href="#">High water levels,</a></li> <li>• <a href="#">Share of area at risk of flooding and waterlogging</a></li> </ul>
		increase of sea level	<ul style="list-style-type: none"> <li>• <a href="#">Dynamics of shoreline changes: Water &amp; Wetness — Copernicus Land Monitoring Service</a></li> </ul>
	<b>Drought resilience</b>	long-term periods without rainfall	<ul style="list-style-type: none"> <li>• <a href="#">Number of days minus number of days with precipitation</a></li> </ul>
		low water periods	<ul style="list-style-type: none"> <li>• <a href="#">Periods of "low flow"</a></li> </ul>
		water shortages	<ul style="list-style-type: none"> <li>• <a href="#">Drought risk map</a></li> </ul>
	<b>Extreme rainfall occurrence</b>	heavy rains	<ul style="list-style-type: none"> <li>• <a href="#">Number of days with precipitation &gt; 50 mm</a></li> </ul>
		heavy snowfalls	<ul style="list-style-type: none"> <li>• <a href="#">Number of days with snow cover &gt; 50 cm</a></li> </ul>
		negative effects of landslides	<ul style="list-style-type: none"> <li>• <a href="#">Land share of active landslides in municipalities</a></li> </ul>
<b>Thermic</b>	<b>Air temperature</b>	higher maximum temperatures	<ul style="list-style-type: none"> <li>• <a href="#">Mean maximum air temperature</a></li> </ul>
		lower minimum temperatures	<ul style="list-style-type: none"> <li>• <a href="#">Mean minimum air temperature</a></li> </ul>
		waves of heat (≥3 days)	<ul style="list-style-type: none"> <li>• <a href="#">Number of days with maximum temperature ≥ 35°C</a></li> </ul>
		waves of cold air (≥3 days)	<ul style="list-style-type: none"> <li>• <a href="#">Number of frost days, number of days with maximum temperature &lt; 0°C</a></li> </ul>
		surface urban heat island effect	<ul style="list-style-type: none"> <li>• <a href="#">SUHI</a></li> </ul>
<b>Air</b>	<b>Air pollution</b>	extended period of non-crossed air pollutant concentration	<ul style="list-style-type: none"> <li>• <a href="#">Air quality data archive</a></li> </ul>
		smog	<ul style="list-style-type: none"> <li>• <a href="#">Polish quality air index</a></li> </ul>
<b>Wind</b>	<b>Wind</b>	strong winds and gale	<ul style="list-style-type: none"> <li>• <a href="#">Wind speed archive</a></li> </ul>
		storm and hail	<ul style="list-style-type: none"> <li>• <a href="#">Storm archive maps</a></li> </ul>
<b>Social tissue</b>	<b>Community self-aid</b>	disasters and urban challenges	<ul style="list-style-type: none"> <li>• <a href="#">Quality of life indicator</a></li> </ul>

SOURCE: BASED ON AUTHORS' OWN ELABORATION, SEE 'D2.1 STATE OF THE ART COMPACT REPORT ON REGIONAL CLIMATE STRATEGIES AND CHALLENGES (WP2)'.

# Objectives and assumptions

## MATRIX OF KEY ISSUES, STEP BY STEP QUESTIONS

<b>Name of action</b>	A map with action localization or a graphic depicting the key point
<b>Description</b>	What will the action be?
<b>Aim of the adaptation</b>	What will be archived?
<b>Measurement/indicator</b>	What is the measure/indicator of the goal?
<b>Responsibility</b>	Who is responsible for the implementation?
<b>Risk</b>	What risk is mitigated/reduced?
<b>Existing instruments; legal, formal, financial obstacles</b>	Is there any legal, financial, or strategic documentation that supports the achievement of the goal or the implementation of the measure? Are there any legal, financial instruments, strategic documents that are limiting or blocking the implementation of the measure and the achievement of the objective?
<b>Status of implementation</b>	What steps were are undertaken? What is the current status of action?
<b>Next steps</b>	What additional steps must be taken to archive the goal and action? What are the short, medium, and long-term perspectives required steps to be undertaken?
<b>Assets</b>	What is needed to be done?
<b>Estimated cost</b>	Estimated cost of implementation?
<b>Estimated benefits</b>	Estimated benefits from the action and its functioning
<b>Obstacles</b>	What are the obstacles of implementation/aim achievement?
<b>Linkup among sectors/domains</b>	Trans-sectoral influence, and its impact on a various stakeholders
<b>Aims to have an impact on a variety of sectors and domains</b>	Range of impacts among sectors and domains? Positive and negative aspects
<b>Time schedule and deployment time</b>	How much time is need for the implementation, and scheduled date of implementation
<b>Environmental impact assessment</b>	Range of environmental impacts
<b>Time for the adaptation achievement</b>	How much time is needed to achieve adaptation?
<b>Associated actions</b>	Number of associated actions to the core ones

## Research outline

Key performance indicators (KPIs) were recapped at the initial stage of the research to justify the selection of the main threats and challenges that are shaping resilience. KPIs were selected to be twinned and monitored in the coastal areas of Kołobrzeg community (Poland), Bordeaux (France), and Møre og Romsdal Fylkeskommune (Norway). Various aspects of 'resilience' question are examined. The initial study serves as a window to an understanding of resilience' through desk research of literature, urban policies, and big data analysis based on KPIs.

Apart from the KPIs social perception of urban resilience is a crucial point of the 'citizen science' approach. Examination of a given issue requires several research methods to be implemented, taking into account various research groups (i.e., citizens, professionals, activists, policymakers, city users, etc.). It is worth emphasizing that this research approach assumes the voluntary participation of respondents but does not exclude openness and encouragement to participate in the study by all interested in the subject. Research starts with interactive, face-to-face meetings, observations, and workshops involving the local community in creative and unconventional involvement in the co-creation of resilience. All studies have one common element and, due to the specificity of the study group, different accents in their perception of an issue.

The study opens with a focus group consisting of representatives of various stakeholders. The perspective of what 'resilience' is, what dimensions it has, and in what context it appears in the discourse on the city is discussed. Getting to know the context of the term is aimed at finding the roots in its definition. In this way, cognition will become a semantic accent; implicitly, it may concern the social dimension (social resilience), the technical dimension related to urban infrastructure, or the natural dimension related to climate change and the urban environment. This method, in the form of a pilot, will allow for the specification in an online survey. This form of quantitative research will complement the qualitative research and allow for the identification of key problems in case study, which will be questioned under workshop methods (world cafe and design thinking). The world cafe method will select one issue that can be solved through participatory co-design in the city space (n in the city space (e.g. landscaping, event or space-making, the tool/procedure designing).

It is worth noting that research in three areas is carried out independently by national research teams. This research protocol is a framework document, and the research procedure will be adapted to the needs of the local context, which may result in the application of the described research methods to a different extent.

## Research location

The research will be carried out stationary in the coastal areas of Kołobrzeg (Poland), Bordeaux (France), and Møre og Romsdal Fylkeskommune (Norway). Moreover, field research is supplemented with online tools, such as surveys carried out independently by national research teams.

## Stakeholders and study participants

In the development of the research apparatus, it is extremely crucial to identify the partners and stakeholders who will be involved in the process of conducting the research. A predefined list of basic stakeholder groups can be indicated, which includes groups of interest, individuals, and organizations that are ultimately participants in social consultations. It should be emphasized that the 'citizen science' approach is based on voluntary participation in the research process and it has limited influence on a sample composition.

- city dwellers, in particular exposed to the natural threats, including: the risk of flooding (incl. those, who are inhabiting flood plains), urban heat island occurrence, landslides areas,
- non-governmental organizations (i.e. clubs, associations, which are focused on climate question),
- representatives of the business sector, i.e. entrepreneurs whose economic activity may be disrupted in connection with climate threats and/or adaptation measures, as well as representatives of entities that are potential threat makers or contribute to their strengthening and who are parties to conflicts in the process of adaptation measures,
- representatives of professional chambers and associations, especially those, who holds the status of public trust profession, i.e. urban designers, architects, engineers, representatives of universities.
- visitors, and 'city users', those who are commuting to the city for a short-term or long-term stay and not residing permanently in the city of residence. Cities have become the most visited places on our planet (cf. Wearing et al. 2010) and from the Martinotti's (1996) concept, it can be concluded that tourists are the main city category users. Most often, this type of visitor visits the city for a short period of time: quickly, intensively, and only once. Relevance of that group plays a significant role in areas of touristic reception (such as Kołobrzeg, coastal spa resort) and metropolises (Bordeaux) that absorb vast workflows.

The research stakeholders' key groups are listed below. The first group to participate in the study are **high school pupils**. The involvement of this group results from the fact that the age range includes young people who are at the same time entering the age when they acquire the right to participate in elections and the possibility of active action for their place of residence. This age group is also particularly exposed to negative climate changes, but it is also the most aware of them and most often activates projects related to climate change.

The second group of participants will include students of nearby **universities**, which, in addition to the courses typically taught at universities, also have courses dedicated to coastal areas, so they develop knowledge and competences that allow them to understand the dynamics of climate change as well as the areas and elements that require adaptation to dynamic climate changes.

The third group will consist of **residents** of the Kołobrzeg commune.

**Professionals, public officers, policy policymakers.** The side, i.e., representatives of local **NGOs**, who, through the initiatives implemented within their organizations, can have a real impact on the process of shaping changes in the fields of urban policy and spatial development of the analysed area, as well as environmental and climate challenges.

The last group will be patients of Kołobrzeg, which has been a health resort for many years. Tourists who take advantage of the city's charms and rich offer can bring a new perspective to many elements of the studied area that are difficult for residents to capture. Thus, incorporating this group into our methodology will allow us to gather additional information as well as an external perspective and opinion.

## Recruitment of participants

Recruitment of participants for the study will take place through an advertising campaign prepared and implemented in social media targeted at the local area, invitations sent directly to target institutions, and the involvement of local government authorities. The duration of the recruitment process will be approximately 1-2 months. Recruitment will take place in the second and third quarter of 2023. The study will be carried out in 2023. Participants in the study will be divided into groups

based on their age, place of residence (resident, non-resident of case study area), and target (i.e. activist, policymaker, professionalist, pupil/student, city user, patient, tourist, etc.). The overriding feature of selection is voluntary participation in the study.

## Research procedural definitions

Keywords: climate resilience, community resilience, climate change, digital twin

ICPP Sixth Assessment Report defines **climate resilience** as follows: "Resilience in this report is defined as the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure as well as biodiversity in case of ecosystems while also maintaining the capacity for adaptation, learning and transformation. Resilience is a positive attribute when it maintains such a capacity for adaptation, learning, and/or transformation."

**Community resilience** is the sustained ability of a community to use available resources (energy, communication, transportation, food, etc.) to respond to, withstand, and recover from adverse situations (e.g. economic collapse to global catastrophic risks). This allows for the adaptation and growth of a community after disaster strikes (Norris, Stevens, 2008).

**Climate change** is the significant variation of average weather conditions becoming, for example, warmer, wetter, or drier—over several decades or longer. It is the longer-term trend that differentiates climate change from natural weather variability (O'Neill, et al., 2016).

**Digital twin** is a digital representation of an intended or actual real-world physical product, system, or process (a physical twin) that serves as the effectively indistinguishable digital counterpart of it for practical purposes, such as simulation, integration, testing, monitoring, and maintenance (Jones, et al., 2020; Tao, et al., 2022).

**Survey.** This research method is based on collecting information through the self-completion of a survey questionnaire by the respondent. Data will be obtained by asking questions on the basis of a special questionnaire delivered in two ways to the survey group, which is in electronic form (via the Internet) and in paper form (directly) (Jamsen & Corley, 2007). An additional possible form for obtaining responses is the use of a mobile application. The questionnaire will consist of both closed and open-ended questions (Groves et al., 2011).

**Focus group workshop.** A focus group is a group interview in which the interaction of the participants leads to the development of knowledge (Myers, 2019). The researchers act as moderators, supplying a literature-based research topic to discuss. In general, researchers use focus groups as an exploratory technique in developing a new research area, as a source for generating hypotheses, or as a way to interpret previous studies' findings. Effective focus groups require group homogeneity, allowing for discussion in a familiar and shared language (Schiele et al., 2022). Researchers may use focus groups with other data collection methods such as surveys or observations strongly recommended by Kidd and Parshall (2000) to enhance confidence in the research findings. The focus groups' ideal group size classically is recommended to be 4 to 8, sometimes up to 12 participants (Saunders et al., 2009). A focus group approach can be a fall back, in case the number of experts showing up at the scheduled date falls below the minimum threshold (Schiele et al., 2022).

**World café workshop.** Based on the assessment of the effectiveness and involvement of participants, the research procedure will be based on the World-Café workshop method. World-Café



is a workshop method that allows you to build groups of 12 to 2,000 participants. This method is based on a structured conversational process designed to facilitate open discussion in intimate settings. The effect of the discussion undertaken is the generation of various ideas that allow access to the "collective intelligence" of the participants and understanding and learning from many points of view.

However, the world café has several amendments, particularly in its design, which distributes sub-research-questions to different tables, having participants randomly rotate between the tables and successively discuss each sub-question in small groups. This allows for the cross-pollination of ideas, leading to richer data collection (Fouché & Light, 2011). Moreover, the world café, which is normally organized as a one-day workshop, has the advantage of speeding up research, compared to classical sequenced forms of qualitative enquiry such as expert interviews which are frequently stretched over many weeks or months. It has also been argued that the world café could be a method to bridge the academic practitioner gap (Silva & Guenther, 2018).

The café is a large group process that harnesses the energy of small groups' discussions to develop insights and shared learning regarding a topic of interest. In a world café, which usually takes no more than one day, the moderators who design and conduct the session stimulate a series of parallel conversations around carefully crafted key questions that are important for the group. As part of the world café's design, Brown and Isaacs ensure that all participants understand the context of their work together; this understanding involves having the world café's facilitators clarify the café's purpose and broad parameters and share the issues that the group will discuss. They also stress the importance of encouraging all participants to contribute to the discussion and to "listen together for patterns, insights and deeper questions" (Brown & Isaacs, 2005).

**Participatory design workshop & design thinking.** Participatory design makes it possible to learn about user needs and preferences early in the design process through facilitated group workshops. The result is early design ideas, respond to user requirements. In this method, a team of people representing stakeholders in the design process (users, designers, marketers, executives) work together on a given conceptual design that responds to business objectives and user requirements (Vandekerckhove, et al., 2020). Group members use common materials such as coloured index cards, sticky notes, markers, flip charts, scissors and tape. These simple tools help reduce leadership issues, de-emphasize technology and methodology, and encourage communication and creativity. Methodological elements such as the recruitment and management of stakeholders, the use of performance measures, and the use of tools play a key role in PD research (Frauenberger, et al., 2015).

Design thinking is an analytical and creative approach that focuses on the concerns, interests and values of the user - in city's case, the citizen (Razzouk, & Shute, 2012). Design Thinking (DT) was identified as a possible approach that could help create such solutions, and contribute to Strategic Sustainable Development (SSD) (Maher, et al., 2018). In DT methodology, the emphasis is on accessibility and relevance to creative, innovative and potentially strategic problem solving across disciplines (Depiné, et al. 2017).

It can be applied to some aspect of a community, a neighbourhood or the city as a whole. In addition, its use can be adopted on at least two crucial aspects in an innovative urban ecosystem: in the technological sphere, involving the still unexplored potential of new customized services to the citizen; and in concern to the needs and interests of the citizens which can be solved with frugal technology or no technology at all, but which can still transform their quality of life (Depiné, et al. 2017).

## Ethical issues

Participants in the study will complete the relevant documents expressing their consent to participate in the study. At the same time, they will be informed that they can access the information obtained about them and, at any time, without giving a reason, withdraw consent to its use and demand its removal.

## Data storage

The data obtained from the respondents will be stored and used in accordance with the latest recommendations and data management policy, developed individually for the purposes of this project. At the same time, the data obtained will be processed in a collective manner, and personal data that could in any way determine the identity of the surveyed persons will be anonymized.

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# Annex 1. Outline for case study research at Bordeaux Metropolis

## Hypothesis: local threats and urban challenges

Faced with the threats we have identified in the above section, BM has defined a resilience strategy around 4 ambitions (global objectives):

1. A peaceful metropolis serving the living environment of its inhabitants and of sustainable development

To achieve this, a number of policies has been implemented, mainly oriented towards the renaturation of the city and the fight against greenhouse gas emissions:

- Use urban planning documents (in France: "PLU - Plan Local d'Urbanisme") to:
  - Encourage land sobriety in urban planning documents, as the National Level has set the objective of ZAN (Zero Net Artificialization) by 2050
  - Preserve natural and agricultural areas (Bordeaux Metropole is proud to have half of its territory in natural areas), preserve ecological continuity, maintain agricultural activity
- Public spaces: fight against "heat islands" through vegetation, "living sidewalks" (vegetation of sidewalks by residents), prevent soils to be waterproof ("désimperméabilisation")
- Renaturation of the city: the objective is to plant "1 million trees" in public spaces, but also by encouraging individuals to do so
- Action on mobility: encourage soft mobility (bicycle paths), invest in public transport, etc.

2. A territory that is resilient in the face of risks and that promotes sober use in a logic of preservation of natural resources

Territorial resilience is "*the capacity of a territory to sustainably preserve the well-being of its population in the face of all types of crisis*".

This is achieved through the following program:

- Energy renovation of housing, offices, public buildings
- Local production of renewable energy, development of heating networks
- Waste plan: reduce and valorise
- Animation, information, communication
- Takeover of water management
- Strategy against floods (under development)

The "energy strategy" is more detailed in a planning document called the PCAET (Plan Climat Air-Energie Territorial), which specifies the objectives in terms of energy: (1) carbon neutrality by 2050 and (2) positive energy territory, by developing renewable energies and preserving air quality.

Regarding the strategy against flood, the Bordeaux metropolitan area is subject to the influence of both the rivers (Garonne and Dordogne) and their main tributaries as well as the ocean during a storm event: this is a river-sea regime. 17 communes of Bordeaux Metropole are thus subject, in whole or in part, to this risk, representing 1/3 of the territory located below the highest water level of the Garonne and 40,000 people living in flood-prone areas.

3. A territory in transition that fights against inequalities and exclusion, and promotes responsible and inclusive economic development

The planning tool for this ambition is the Economic Development Plan. One of the main objective is the development of the social and solidarity economy on the metropolitan territory. Tourism has to be sustainable and responsible (ISO 2010 certification)

#### 4. A territory concerned with preserving the good health of its inhabitants

The issue of food independence is important in Bordeaux: cooperation contracts with neighbouring agricultural territories, development of an agricultural and food resilience strategy (under development). Moreover, establishment of a Low Emission Zone (LEZ): ban on traffic for the most polluting vehicles (by 2024)

This study will focus on some dimensions of resilience, mainly the flood risk management, biodiversity preservation and fight against “heat islands”.

**TABLE 2. PRE-DEFINED CATALOGUE OF ACTIONS ON RESILIENCE AND SPECIFIC GOALS (BORDEAUX)**

Sphere of urban environment	Actions on climate resilience	Threat / urban challenge	Indicator
<b>Precipitation</b>	<b>Flood resilience</b>	flood, i.e. flash flood, urban flood	<ul style="list-style-type: none"> <li>• <a href="#">Annual frequency of flooding</a></li> <li>• <a href="#">Annual frequency of extreme precipitation events.</a></li> </ul>
		increase of sea level	<ul style="list-style-type: none"> <li>• <a href="#">Dynamics of shoreline changes: Water &amp; Wetness — Copernicus Land Monitoring Service</a></li> </ul>
	<b>Drought resilience</b>	long-term periods without rainfall	<ul style="list-style-type: none"> <li>• <a href="#">Standardized Index of Precipitation and Evapotranspiration (SPEI)</a></li> <li>• <a href="#">Standardized Precipitation Index (SPI)</a></li> </ul>
	<b>Extreme rainfall occurrence</b>	heavy rains	<ul style="list-style-type: none"> <li>• <a href="#">Standardized Index of Precipitation and Evapotranspiration (SPEI)</a></li> <li>• <a href="#">Standardized Precipitation Index (SPI)</a></li> </ul>
<b>Thermic</b>	<b>Air temperature</b>	higher maximum temperatures	<ul style="list-style-type: none"> <li>• <a href="#">Average temperature during the hot months (July-August)</a></li> </ul>
		lower minimum temperatures	<ul style="list-style-type: none"> <li>• <a href="#">Average temperature during the cold months (January-February)</a></li> </ul>
		waves of heat (≥3 days)	<ul style="list-style-type: none"> <li>• <a href="#">Annual frequency of extreme heat events</a></li> </ul>
		surface urban heat island effect	<ul style="list-style-type: none"> <li>• <a href="#">Magnitude of urban heat island effects (atmospheric)</a></li> <li>• <a href="#">Temperature difference between normal districts and urban heat islands</a></li> </ul>

## Research outline

In order to broaden and explore the topic of urban resilience, it is crucial to conduct research that, by its nature, allows for the collection of data, allowing us to determine how resilience and its components are crucial for the urban community from the perspective of climate change. Therefore, this project assumes conducting research based on several research schemes, which will allow for a comprehensive analysis of the above issues, taking into account the acquisition of comprehensive



data relevant to the development of the urban area from the perspective of threats and directions of counteraction. The data will focus on the subject of resilience and urban challenges in the BM area. The method of collecting them will be based on the main research protocol proposed by the WP1 leader, and will be adapted to local context. We plan to carry out a study, which will be interactive, face-to-face meetings involving the local community in creative and unconventional involvement in the above research issues.

We propose to conduct two studies. The first will bring together students, with whom we will engage in interactive participation through activity in groups of several people as well as through the use of a mobile application prepared for research purposes. The mobile application will be developed by the CREST partners from Poland, and will be used on the Bordeaux Metropolis case study as long as it is available and ready to be used. This app will consist of a set of tasks involving the participants over the course of several months. Its main goal is to carry out tasks that require several months of commitment and to maintain interactive contact with participants, allowing for the building of an active social group. The main objective is to understand what resilience means for university students; the application will ask them questions about the different dimensions of resilience as measured in WP1. We will also include a set of survey questionnaires developed for the purpose of the research. Students will also take part in interactive meetings and be asked to complete tasks developed using a mobile application.

The second group of participants will be representatives of NGOs operating in the area and involved in the development of local environmental and social initiatives, knowing the specificity of the region. We will define precisely which associations to mobilize on the basis of exchanges with the metropolis of Bordeaux.

## Research procedure

### Survey

This research method is based on collecting information through the self-completion of a survey questionnaire by the respondent. Data will be obtained by asking questions on the basis of a special questionnaire delivered in two ways to the survey group, which is in electronic form (via the Internet) and in paper form (directly) (Jamsen & Corley, 2007). An additional possible form for obtaining responses is the use of a mobile application. The questionnaire will consist of both closed and open-ended questions (Groves et al., 2011). The questionnaire will be prepared by the team leading this research task WP2, and then validated by those responsible of the French case study, in order to insure its application and implementation on the Bordeaux Metropolis study case.

### Focus group workshop

The second way to collect information is based on realization of a focus group. It is a group interview in which the interaction of the participants leads to the development of knowledge (Myers, 2019). The researchers act as moderators, supplying a literature-based research topic to discuss. In general, researchers use focus groups as an exploratory technique in developing a new research area, as a source for generating hypotheses, or as a way to interpret previous studies' findings. Effective focus groups require group homogeneity, allowing for discussion in a familiar and shared language (Schiele et al., 2022). Researchers may use focus groups with other data collection methods such as surveys or observations strongly recommended by Kidd and Parshall (2000) to enhance confidence in the research findings. The focus groups' ideal group size classically is recommended to be 4 to 8, sometimes up to 12 participants (Saunders et al., 2009). A focus group approach can be a fall back, in case the number of experts showing up at the scheduled date falls below the minimum threshold (Schiele et al., 2022).

The French team will organize and implement focus group with the support of an “interview guide” that will be provided by the WP2 leader in order to give an overall coherence to the approach in the 3 study areas. This guide will give indications on how to carry out the focus group, how it should be carried on, and how to organize the main points to be discussed by the participants. As for the survey, the main guide will be discussed with the case study leaders to ensure applicability to the local contexts.

## Stakeholders and study participants

In the development of the research apparatus, it is extremely crucial to identify the partners and stakeholders who will be involved in the process of conducting the research. A certain predefined list of basic stakeholder groups can be indicated, which includes groups of people and organizations that are ultimately participants in social consultations:

- city dwellers, in particular exposed to the natural threats, including: the risk of flooding (incl. those, who are inhabiting flood plains) or urban heat island occurrence,
- members of the Bordeaux Metropolis
- non-governmental organizations such as associations, which are focused on climate question),
- representatives of business sector, i.e. entrepreneurs whose economic activity may be disrupted in connection with climate threats and/or adaptation measures, as well as representatives of entities that are potential threat makers or contribute to their strengthening and may be engaged in conflicts during the process of adaptation measures,,
- representatives of professional chambers and associations, especially those, who holds the status of public trust profession, i.e. urban designers, architects, engineers,
- representatives of universities.

The first group of participants will include students of nearby **universities**, which, in addition to the courses typically taught at universities, also have courses dedicated to coastal areas, so they develop knowledge and competences that allow them to understand the dynamics of climate change as well as the areas and elements that require adaptation to dynamic climate changes.

The second group is composed of **Professionals, public officers, policy makers** (focus group). The side, i.e., representatives of local **NGOs**, who, through the initiatives implemented within their organizations, can have a real impact on the process of shaping changes in the fields of urban policy and spatial development of the analyzed area, as well as environmental and climate challenges.

## Inclusion criteria

The main criterion will be related to the place of residence. Due to the fact that BM is a very attractive city from residential point of view, our sample will be constituted by main residents of BM taking into account both main city resident (Bordeaux) and other city residents (Talence, Pessac, etc.).

## Recruitment of participants

This stage of the research will be carried out in collaboration between the 3 French partners (INRAe, BSE, ACCENT SUD), and will mobilize the institutional actor of the Bordeaux metropolis.

Recruitment of participants for the study will take place through an advertising campaign prepared and implemented in social media targeted at the local area of the BM area, invitations sent directly to target institutions, and the involvement of local government authorities. The duration of the

recruitment process will be approximately 1-2 months. Recruitment will take place in the first and second quarters of 2023.

The study will be carried out in and the third and fourth quarters of 2023. Participants in the study will be divided into groups based on their age. The first group of participants will be students in their final and penultimate year of secondary school. The next group will include students. The next two are representatives of NGOs and patients of the town (tourists).

## CONSORTIUM





# CREST

## D2.2 Citizen Science research protocol (WP2)



Funded by the  
European Union

This project has received funding from  
the European Union's Horizon 2020  
research and innovation programme  
under grant agreement No 101003758



# CREST

Climate resilient coastal urban  
infrastructures through digital twinning

