Driving Urban Transitions

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MAIN CODE

urban climate shelters in schoolyards

Report D1.2

Preliminary MAINCODE Methodology

WP 1 | Conceptualising MAINCODE Methodology
Task 1.2 | Set up the MAINCODE Methodology

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Preliminary MAINCODE Methodology

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1. Introduction: What is this Document About

Work Package 1 (WP1), led by POLITO and co-led by SDU, aims to provide the theoretical framework for the implementation of Urban Climate Shelters (UCS) in schoolyards. Report D1.2 is specifically dedicated to Task 1.2 of WP1, which focuses on the definition of the **Preliminary MAINCODE Methodology**, conceived as a methodological framework to guide and support the analysis, development, and implementation of UCS in schoolyards.

The Preliminary MAINCODE Methodology consists of six steps stated below:

- **Mapping urban vulnerability and exposure**, with the aim of understanding the main climate-related challenges and identifying vulnerable groups within the areas targeted for intervention;
- **Identifying local needs** by overlaying climate-related social vulnerability with the spatial distribution of the school network;
- **Selecting the most suitable schoolyards** based on urgency criteria, prioritising those located in the most vulnerable areas;
- **Engaging relevant stakeholders**, including the local community, policymakers, practitioners, and local private companies;
- **Co-designing** interventions in the selected schoolyards;
- **Ensuring an effective upscaling process**, so that the solutions developed can be expanded and replicated in other contexts.

On this basis, *Task 1.2* focused on the analysis of methodologies adopted for the implementation of climate shelters in school settings across the 22 selected MAINCODE Case Studies (MAINCODE Report D1.1). Each case study was analysed to collect empirical and operational insights for each of the six steps described above.
The objective of *Task 1.2* is therefore twofold:

- to provide a solid basis for validating the MAINCODE Methodology.
- to inform and support the development of the MAINCODE pilot cases.

Report D1.2 is structured as follows. *Section 2* describes the methodological approach adopted to conduct the analysis. *Section 3* presents the results: first, an overview of the collected data is provided, including empirical examples related to each methodological step. Lastly, in *Section 4,* the Preliminary MAINCODE Methodology is presented.

2. Approach to the Methodology Analysis of Case Studies

This section describes the methodological approach adopted for the analysis of the 22 selected MAINCODE Case Studies, structured into two main phases of investigation.
The first phase consists of a **Preliminary Screening**, aimed at selecting only those case studies that explicitly present and describe a methodology. Accordingly, this phase considered exclusively cases that not only adopt a methodological framework, but also clearly articulate it in a way that makes it identifiable and extractable from the available documentation.

Once this set of methodologies was identified, a **Second Screening**, conceived as in-depth analytical phase, was conducted. During this phase, each methodology was systematically compared and aligned with the six steps described in the previous section. Specifically:

- the first verified whether the methodology included activities related to the mapping of social and climate risks;
- the second analysed the presence of a local needs assessment, through an joined reading of social and climate vulnerabilities in relation to the school network;
- the third focused on the analysis of any urgency criteria adopted for the selection of schools or intervention spaces;
- the fourth examined whether and how the local community and key stakeholders were involved;
- the fifth analysed the co-design methods and tools, if any, employed across the different case studies;
- finally, the sixth evaluated the presence of strategies or measures aimed at ensuring project scalability and replication.

Table 1 presents in detail the guiding questions associated with each analytical phase.

	Guiding questions	**Guiding answers**	**What does it mean operationally?**
Preliminary Screening	Is the methodology explicit and extractable?	Yes or No	Check if the case study presents a clear process for transforming schools into climate shelters. Cases that describe only a single step (e.g., co-design) are excluded.
Second Screening	Does the methodology consider mapping social and climate risk in order to understand the climate challenge and vulnerable groups present in the area to be transformed?	Yes or No + which tool/ method/analysis	Look for evidence that the city used maps, GIS analysis, risk assessments, or vulnerability indexes to identify where climate hazards and social vulnerabilities overlap. Check if indicators such as climate risk maps, socio-demographic data layers, or vulnerability assessments guiding site selection are used.
	Does the methodology involve identifying local needs by overlaying social and climate vulnerability with the school network?	Yes or No + description of the tools/ method	Check if the city cross-referenced climate and social data with the location of schoolyards to prioritise interventions (maps or analyses combining vulnerability and school distribution).
	Does the methodology involve selecting appropriate schools/spaces based on urgency criteria, starting with the most vulnerable areas?	Yes or No + description of which urgency criteria	Look for an explicit prioritisation process, criteria or scoring systems used to choose which schoolyards were transformed first (e.g., heat exposure level, flood risk, social deprivation).
	Does the methodology involve the wider local community, including policy makers, professionals and local private companies?	Yes or No + which tool/ method of involvement	Check if there is mention of multi-stakeholder involvement: workshops, partnerships, consultation processes, or participatory planning with authorities, professionals, NGOs, or private actors.
	Which co-design methods/tools does the methodology consider for the development of interventions in the selected schoolyards?	Description if the tool/method of co-design used	Identify in which way children, teachers, parents, or local residents took part in the design process of the shelter (e.g., participatory design sessions, surveys, design workshops).
	Does the methodology include measures to ensure a successful project replication process?	Yes or No + which measures	Look for explicit mechanisms for scaling up the initiative (e.g., guidelines for replication, monitoring frameworks, evaluation results, or policies ensuring continuity and knowledge transfer).

Table 1 | Guidelines for analysing the methodologies of the 22 selected MAINCODE Case Studies

3. Results of Methodology Analysis of Case Studies

This section describes the results of the analysis, with some examples from the 22 selected MAINCODE Case Studies illustrated in Figure 1.

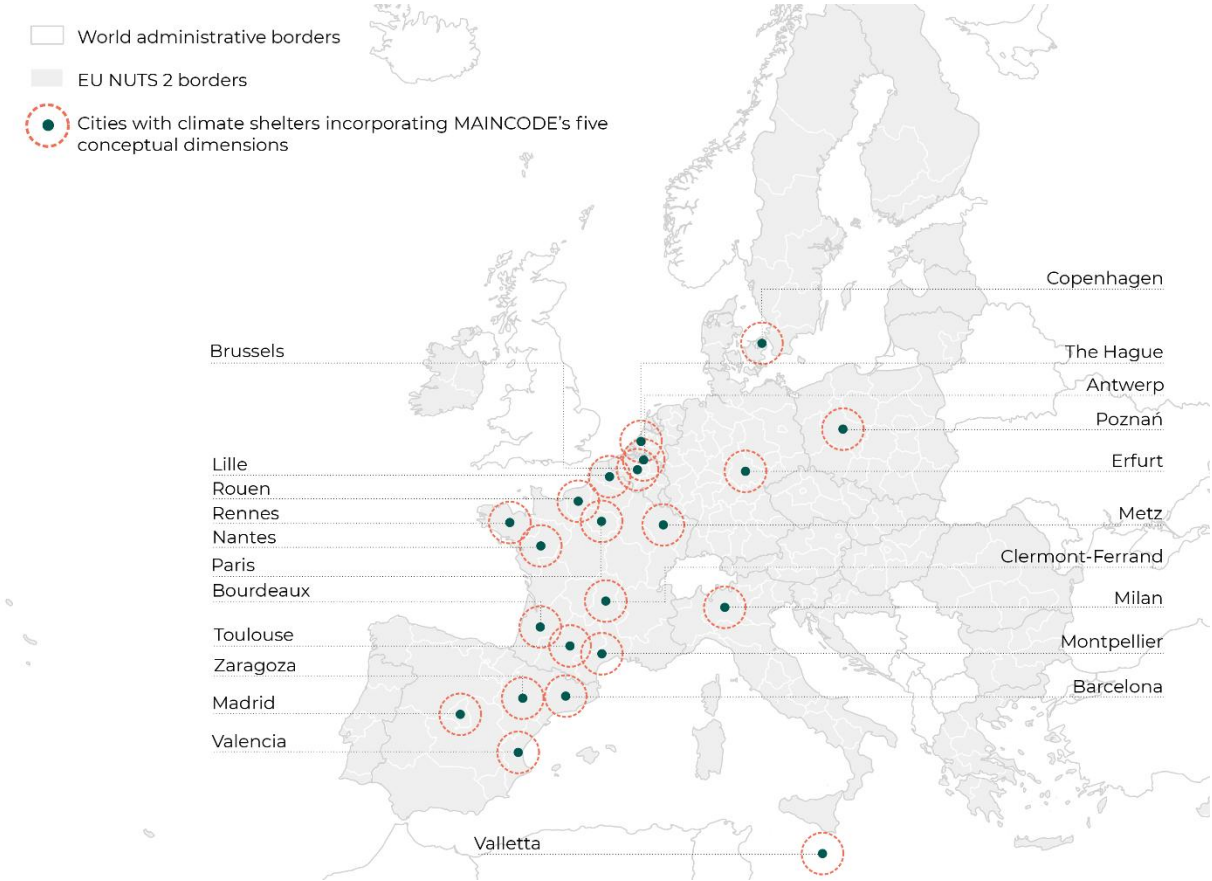

Figure 1 | Case studies

3.1 Overview of Case Study Methodologies | Preliminary Screening

This section presents the results of the first phase, the Preliminary Screening. Overall, the analysis revealed that **15** of the 22 analysed **case studies present and describe an explicit methodology**, as shown in Figure 2. However, it is worth noting that the cities of Rouen, Lille, Montpellier, and Toulouse do present a methodology, but this corresponds to the same framework adopted in Paris (the OASIS Method).

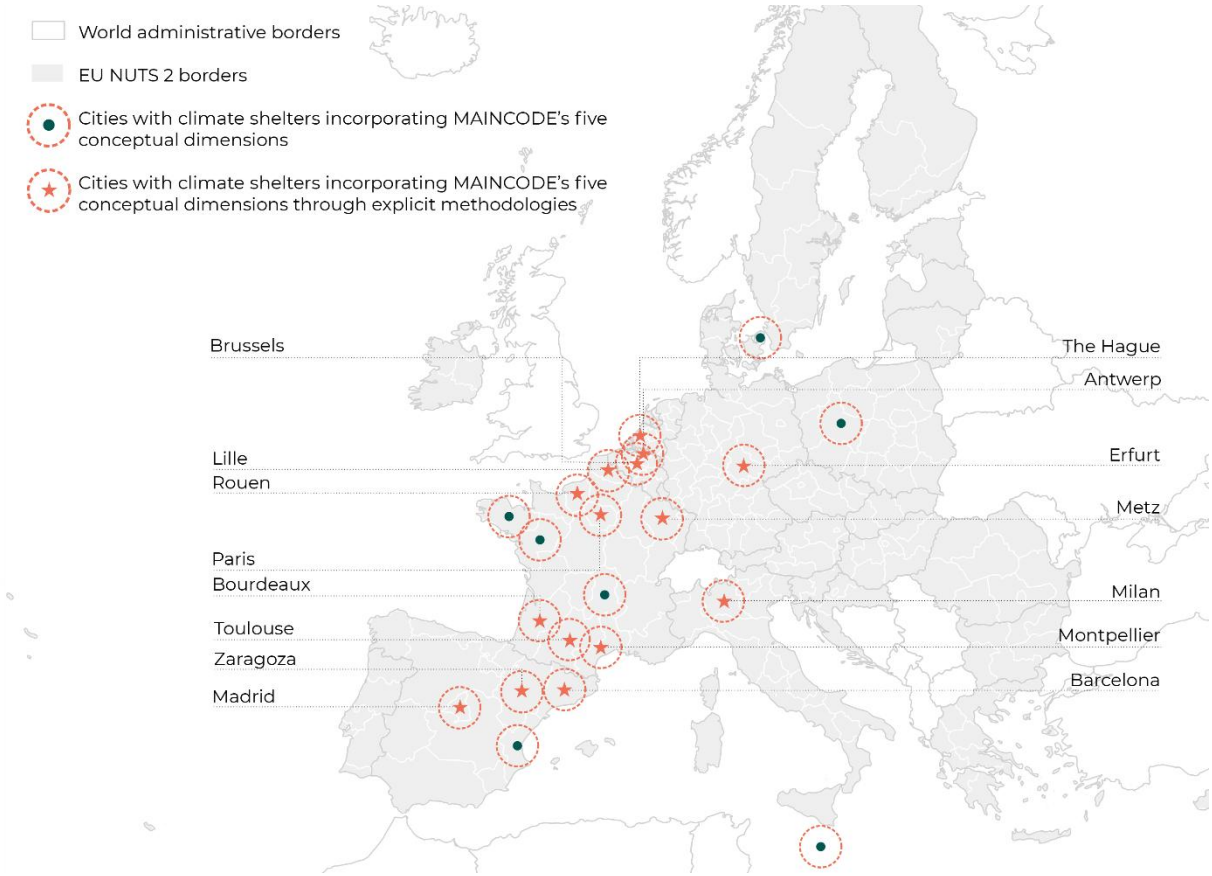

Figure 2 | Case studies with an explicit methodology

3.2 Step-by-step Methodology Review | Second Screening

This section presents the results of the second phase of analysis and answers the guiding questions of the Second Screening. Since 4 of the 15 selected case studies, Rouen, Lille, Montpellier, and Toulouse, follow the Paris OASIS method, they were excluded from the analysis. Consequently, **11 cases were examined in depth in this second screening**. Indeed, as illustrated in Figure 3, the analysis shows that, of the 22 case studies analysed, 11 present an explicit methodology, 7 present no methodology, while 4 follow an explicit methodology (Rouen, Lille, Montpellier, and Toulouse). Additionally, Figure 4 details which case studies address each methodological step and provide relevant methodological insights. Lastly, each guiding question from the Second Screening is addressed.

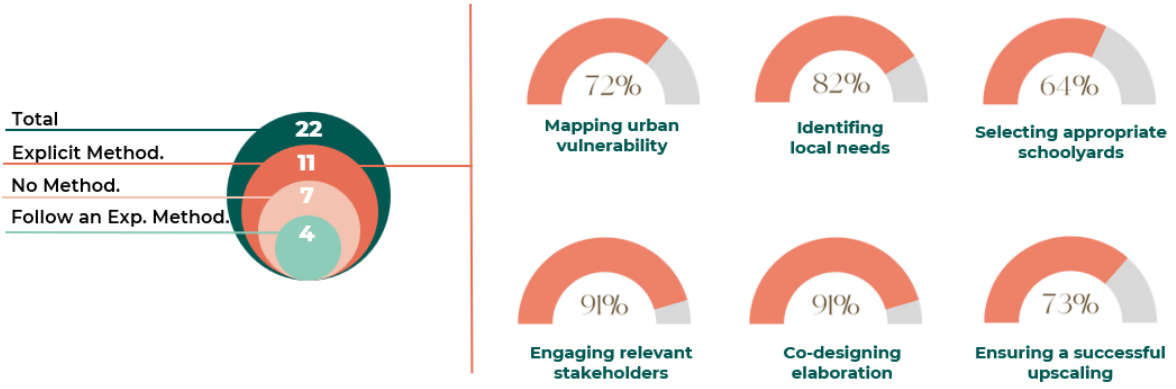

Figure 3 | Overview of the results

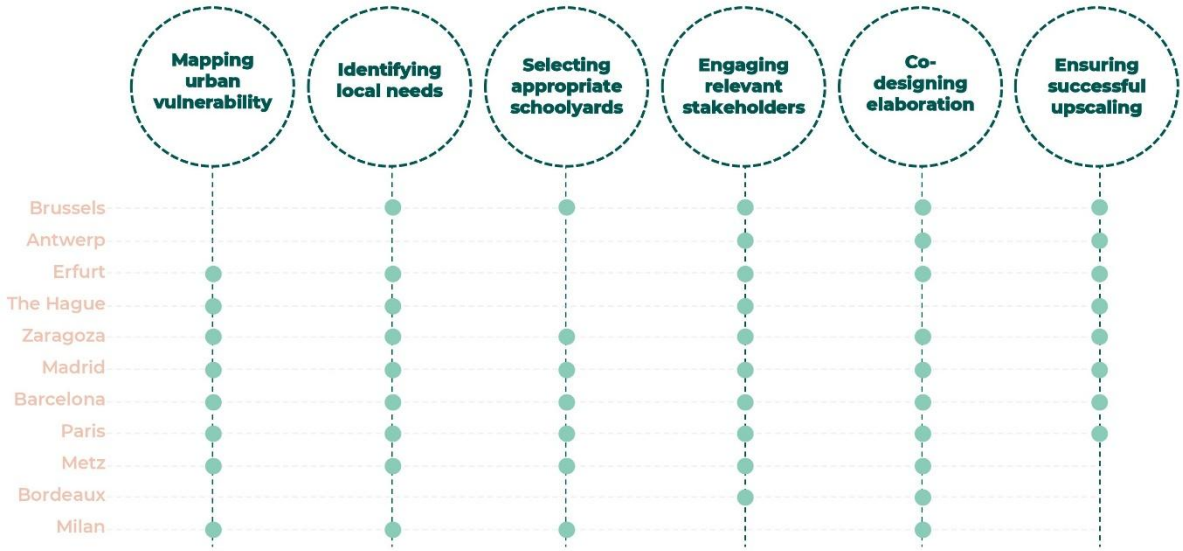

Figure 4 | Steps addressed by the 11 case studies

Does the methodology consider mapping social and climate in order to understand the climate challenge and vulnerable groups present in the area to be transformed?

The analysis shows that **72% of the cases provide information on mapping social and climate vulnerability**. Two cases are described here.

The first one is **Paris**, in which the project combined climate hazard mapping with an assessment of social vulnerability to identify areas facing the highest levels of risk and to understand how different population groups would be affected. Following the implementation of interventions, a structured assessment of social and environmental impacts was conducted. This relied on a combination of on-site observations, surveys, weather-station measurements, and simulations to compare environmental and social conditions before and after the redesign (Sitzoglou, 2020).

The second one is **Madrid**. The project built upon the diagnostic framework developed within the MICOS project, which analysed the condition of playgrounds in public schools to

identify those most in need of intervention. The assessment focused on key indicators of climate vulnerability, including heat stress, limited vegetation cover, impermeable surfaces, and traffic exposure. Although no specific GIS-based tool was reported, the assessment clearly integrated environmental vulnerabilities, such as heat and flooding risks, with social considerations related to child safety, accessibility, and equality, demonstrating a comprehensive approach to urban climate vulnerability mapping (AdapteCCa.es).

Does the methodology involve identifying local needs by overlaying social and climate vulnerability with the school network?

The analysis shows that **82% of the cases provide information on identifying local needs**. Two cases are described here.

The first one is **Milan**, where a spatial analysis was developed by overlapping the locations of nurseries, preschools, and primary schools with a daytime land surface temperature map (Comune di Milano, 2021). This made it possible to identify areas where children are most exposed to heat stress during the day and to accurately pinpoint school environments requiring priority intervention. By integrating climate data within the school network, the analysis supports targeted and equitable adaptation measures.

The second one is **Metz**, where the identification of local needs was based on two parallel analyses (aguram.org). The first consisted of an environmental assessment focusing on physical and ecological factors such as surface permeability, air quality, ground and ambient air temperature during periods of intense heat, and the quality and presence of vegetation. The second involved a use-based analysis, drawing on direct observations of recess periods as well as participatory workshops conducted with teachers and children. This combined approach allowed the project to integrate environmental conditions with everyday practices and user experiences, ensuring that identified needs reflected both climatic exposure and actual patterns of use.

Does the methodology involve selecting appropriate schools/spaces based on urgency criteria, starting with the most vulnerable areas?

The analysis shows that **64% of the cases provide information about the selection criteria of schoolyards**. Three cases are described here.

The first one is **Milan**, where the selection process was guided by a set of criteria aimed at identifying schools facing the highest levels of urgency (Comune di Milano, 2021). These included the vulnerability of users and their exposure to heat, the type of school, and the assessed level of thermal risk. In addition, Milan considered other factors, such as reports from parents highlighting experiences of thermal discomfort in surrounding areas. This combination of quantitative indicators and community feedback allows for a more nuanced identification of priority sites.

The second one is **Paris**, which followed a similarly comprehensive approach, structuring its selection criteria across four main categories (Sitzoglou, 2020): social, environmental, technical, and other complementary factors. Social criteria focus on prioritising neighbourhoods with higher levels of vulnerability, including areas with a high proportion of low-income households or refugee populations. Environmental criteria assess local microclimatic conditions, with particular attention to the presence and intensity of urban

heat island effects. Technical criteria address the urgency of renewing or upgrading existing schoolyard infrastructure and equipment. Finally, additional selection criteria are applied to ensure diversity and feasibility, including direct street access, a minimum surface area, variation across districts, diverse demographic contexts, and the inclusion of different age groups of children.

The third one is **Brussels**, which, in contrast with the previous cases, bases its selection primarily on existing official urban development and planning documents. Priority was given to schools lacking access to green spaces, those located in areas identified as strategic within the Regional Development Plan, and sites recognised in regional plans as contributing significantly to the urban heat island effect (environnement.brussels).

Does the methodology involve the wider local community, including policy makers, professionals and local private companies?

The analysis shows that **almost all cases (91%) provide information about local stakeholder involvement**. Three cases are described here.

The first one is **Antwerp**, where specialists were engaged to provide guidance on key aspects of the projects, including plant selection, the design and construction of natural play areas, and the development of green roofs or climate-resilient rooftop playgrounds. This targeted involvement ensured that environmental and design interventions were technically sound and aligned with climate-adaptation objectives (antwerpen.be).

The second one is **Erfurt**, where the project adopted a collaborative approach that included local private companies and professionals. Local companies participated as sponsors, contributing resources and support, while communication and design professionals were involved in assisting with the promotion and visibility of the initiative. This highlighted the role of partnerships between public actors and the private sector in advancing schoolyard transformation projects (Junggeburth et al., 2023).

The third one is **Paris**, where a more comprehensive and inclusive stakeholder engagement strategy was implemented, involving a wide range of actors at multiple levels. The project brought together municipal authorities, technical and environmental experts, community-engagement organisations, researchers, construction professionals, school communities, and local residents throughout all phases of the process. An important element of this approach was the establishment of “OASIS Collectives” as community stewardship groups, which were designed to familiarise residents with the open-schoolyard concept and encourage active participation. While broader public engagement proved difficult to sustain, the involvement of local NGOs and their established networks played a crucial role in maintaining participatory processes and supporting community involvement (Sitzoglou, 2020).

Which co-design methods/tools does the methodology consider for the development of interventions in the selected school playgrounds?

The analysis shows that **almost all cases (91%) provide information about co-design processes**. Two cases are described here.

The case of **Brussels** focused his co-design activities primarily on the ex-ante phase of the process (bubble.brussels): first with consultations with students and teachers to identify

needs, followed by workshops to explore preferred activities. In Brussels, this involvement extended into the in-itinere stages of design, ensuring that the input of the users informed the initial development of the schoolyards. In the case of Brussels, all schoolyard users participated in a structured, multi-step participatory process. The process involved 8 steps, including: (i) a technical diagnosis; (ii) meetings with a steering committee; (iii) student awareness days; (iv) consultations with adult stakeholders; (v) discussions of proposed development plans; (vi) sketching sessions; (vii) preparation of preliminary designs; and (viii) presentation of the preliminary designs to users. This ensured that both children and adult actors contributed to shaping the schoolyard design from the outset.

The case of **Bordeaux**, by contrast, extended co-design beyond the ex-ante phase to include both ex ante and in-itinere stages (equalsaree.org). The process began with preliminary consultations and workshops similar to the case of Brussels, but it also incorporated participatory workshops during the construction phase. This allowed stakeholders to be directly involved in the creation of the courtyard spaces, fostering an iterative, inclusive design process that integrated feedback throughout implementation.

Does the methodology include measures to ensure a successful project expansion process?

The analysis shows that **73% of the cases provide guidance on upscaling strategies**. Two cases are described here.

Among the cases examined, **Paris** represented the largest and most comprehensive example, having expanded from a neighbourhood pilot project to a citywide program. The project not only transformed numerous schoolyards but also developed digital maps to identify and promote “cool places” for the community. These maps functioned as a knowledge repository accessible to other French cities, facilitating the dissemination of best practices. Over time, the program expanded its scope to include all public schoolyards in Paris, completing more than 130 sites, which were documented through an interactive map. Beyond Paris itself, the initiative established the OASIS Schoolyards Observatory, a digital platform designed to share and promote similar projects. The platform aimed to inspire other municipalities and designers to adopt schoolyard transformations based on the OASIS model, providing a space where implemented projects could be showcased. While the platform aspires to evolve into a global repository, it currently features projects primarily from Paris and other French cities (SciencesPo.fr).

The case of **Antwerp** illustrated a different approach to upscaling, focusing on the integration of schoolyard greening within broader urban planning and climate adaptation policies. Specifically, the city incorporated these initiatives into its 2030 Climate Plan, embedding schoolyard transformations into long-term strategies for urban resilience and sustainability. This approach demonstrates how aligning localised interventions with city-level planning frameworks can support sustainable and systematic upscaling (childrenandnature.org).

4. Conclusion: Preliminary MAINCODE Methodology

The **Preliminary MAINCODE Methodology** comprises six interrelated steps that are **currently being implemented and tested in the two Pilot cities of Turin and Halandri**. It represents an intermediate stage in an iterative research and implementation process, bridging exploratory analysis and full methodological validation. The six steps are supported by evidence gathered across the 22 MAINCODE selected Case Studies, ensuring both empirical grounding and transferability. The MAINCODE Methodology forms a coherent framework that links social and climate vulnerability assessment, co-design and governance mechanisms for the development of UCS in schoolyards. **Each step is described in detail in the following sections, outlining its purpose, analytical approach and role within the overall methodology**. Once the implementation progresses and lessons from the pilots are consolidated, the MAINCODE Preliminary Methodology will evolve into the Validated MAINCODE Methodology, strengthening its robustness, effectiveness and replicability across diverse urban contexts. Finally, Figure 5 showcases the overall structure of the Preliminary MAINCODE Methodology.

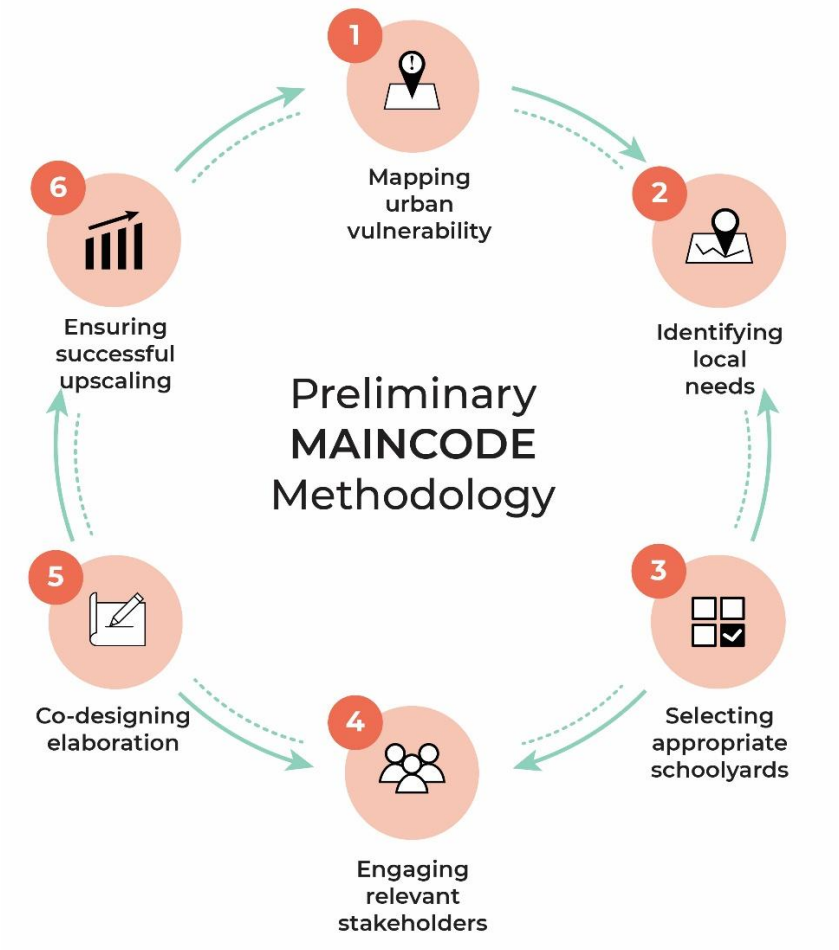

Figure 5 | Preliminary MAINCODE Methodology

1. Mapping urban vulnerability and exposure to understand the climate challenge and the vulnerable groups that are in the area to be transformed

Purpose: *To clearly identify which areas are most affected, which groups are most vulnerable, and where UCS in schoolyards can have the greatest impact.*

A place-based, data-driven assessment underpins the methodology. This means the analysis must be grounded in locally available data, adapted to the specific context, scale and data quality of each city.

- Mapping **climate vulnerability** such as extreme heat, urban heat islands, flooding, drought, storms or landslides using the best available local data.
- Mapping **social vulnerability** such as low income, age, migration, health, overcrowding, disability.
- Mapping **exposure**, including population density, school locations, mobility patterns, and other sensitive infrastructures.
- Producing a **combined overlap map** that reveals where climate and social vulnerabilities are spatially concentrated.
- Understanding **which neighbourhoods and school areas** face the greatest climate-related stressors and equity gaps.

2. Identifying local needs through the overlapping of the climate and social vulnerability with the school network

Purpose: *To translate the citywide climate and social analysis into real local needs and determine which schools require intervention.*

- Overlaying the **entire school system** (nurseries, kindergartens, primary and secondary schools) on the climate and social vulnerability map.
- Identifying **priority schools** located in overlapping zones of high climate and social vulnerability.
- Conducting **local diagnosis** at these schools, addressing:
    - deficits in shading, vegetation, and permeability,
    - lack of water management or retention areas,
    - micro-climatic discomfort zones (hot spots, glare),
    - safety, accessibility, inclusion and user needs,
    - specific vulnerabilities of young children and sensitive groups.
- Reviewing **how the schoolyards are currently used** by children, teachers, families, and the surrounding community.

3. Identifying local needs through the overlapping of the climate and social vulnerability with the school network

Purpose: *To invest in resources where impact is highest, urgency is greatest, and long-term success is most feasible.*

- **Climate & social vulnerability:** Schools located in the highest-vulnerability clusters of combined climate hazard + social vulnerability + exposure.
- **User vulnerability & school type:** Priority for nurseries, kindergartens and primary schools, because younger children are physiologically more vulnerable to heat, spend more time outdoors, benefit more from naturalised play environments, and enable stronger co-design processes with families.
- **Community-shelter potential:** Schoolyards that can be safely opened to the wider community outside school hours (direct street access, separate gates).
- **Transformability & baseline conditions:** Schoolyards with highly paved, low-albedo surfaces, minimal shade, lack of vegetation, or impermeable materials. Courtyards where small or modular interventions can rapidly reduce heat, improve comfort, or manage stormwater.
- **Size & potential impact:** Larger courtyards or those serving many students and neighbourhood residents are prioritised.
- **Institutional willingness & feasibility:** Strong commitment from the school leadership, teachers, staff and parent groups, as willingness is essential for co-design and future maintenance.

4. Engaging relevant stakeholders among the wider local community, policymakers, practitioners and local private companies

Purpose: *To ensure legitimacy, shared ownership, local knowledge integration, and long-term care for the redesigned schoolyards.*

Who could be involved:

- **Educational community:** students, teachers, support staff, and parents.
- **Local community:** neighbours, citizen groups, youth associations, residents.
- **Public authorities:** municipal departments (education, climate, environment, planning, health, mobility, social services).
- **Professional actors:** planners, architects, designers, environmental experts, NGOs.
- **Local private companies:** construction firms, nurseries, material suppliers, sponsors, technical service providers.

How engagement could happen:

- Workshops and meetings for co-design and feedback.
- Awareness activities with students and families.
- Collaborative planning sessions with municipal and technical partners.
- Hands-on activities (planting, small interventions) to build ownership.
- Consultations throughout design, implementation and maintenance.

5. Co-designing elaboration in selected schoolyards

Purpose: *To develop site-specific, community-endorsed solutions that strengthen climate resilience, improve well-being and enhance learning environments.*

Co-design ensures that the transformation of schoolyards reflects the needs, ideas and experiences of the whole education community, especially children. It combines creative participation with technical feasibility to produce meaningful, climate-responsive designs.

- **Working with children as key informants**, recognising their right to participate and their unique knowledge of how the playground works in daily life (observations, drawings, mapping, exploration activities).
- **Engaging teachers, families, lunchtime monitors, and external groups** through structured reflection, observation and proposal activities, each adapted to their role in the school community (e.g., "internal work" appraisal processes).
- **Holding facilitated co-creation sessions** where all stakeholder groups share their findings, agree on priorities and build a collective understanding of what the redesigned schoolyard must achieve (comfort, naturalisation, diverse play, inclusion, shade, water, permeability).
- **Collaborating with planners, architects and designers** to translate community ideas into feasible designs, ensuring proposals align with safety, budget, climate-shelter requirements and ensuring a space that is naturalised, coeducational, community-oriented, inclusive, balanced, and multifunctional.
- **Iterating designs through feedback loops**, where preliminary plans are reviewed by children, teachers, parents and monitors, and adjusted to better reflect priorities and eliminate barriers to future use.
- **Developing the playground's educational project** in parallel with physical design (uses, dynamics, play values, inclusive practices, conflict management), ensuring that the new space supports learning, well-being and community use over time.

6. Ensuring a successful upscaling process

***Purpose**: To consolidate UCS as a citywide climate adaptation strategy, supported by policy, technical guidance, and governance structures, and to enable its replication in other cities.*

- **Building the theoretical foundation of UCS:** Develop and validate the MAINCODE Methodology based on a rigorous theoretical framework, literature review and analysis of best practices.
- **Developing a citywide strategy:** Expand UCS from pilot schools to a coordinated network across the city, identifying additional schoolyards and public facilities that can serve as green and emergency shelter nodes.
- **Assessing trade-offs and barriers:** Evaluate socio-economic-environmental trade-offs, synergies and implementation barriers using systems thinking, mapping and multicriteria analysis, supported by interviews and focus groups.
- **Formulating policy recommendations:** Co-develop MAINCODE policy guidance with municipal authorities and stakeholders to support long-term governance, investment and integration into city planning.
- **Creating a practitioner toolkit:** Produce the MAINCODE Toolkit with design guidelines, abacuses and NbS principles to facilitate replication and adaptation of UCS in other cities.
- **Supporting long-term maintenance and replication:** Establish clear governance and monitoring structures and ensure knowledge is fed back into the strategy, strengthening future upscaling and replication.
- **Strengthening learning, communication and replication:** Feed insights from implementation and stakeholder engagement into updated methods, toolkits and policies. Produce Tales of UCS to document transformations and inspire wider adoption. Provide a Toolkit for Schools to support school-led co-design and climate learning. Communicate results through publications, popular science summaries, outreach campaigns and ambassador activities. Foster a community of practice to share experiences and enhance replication across cities.

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