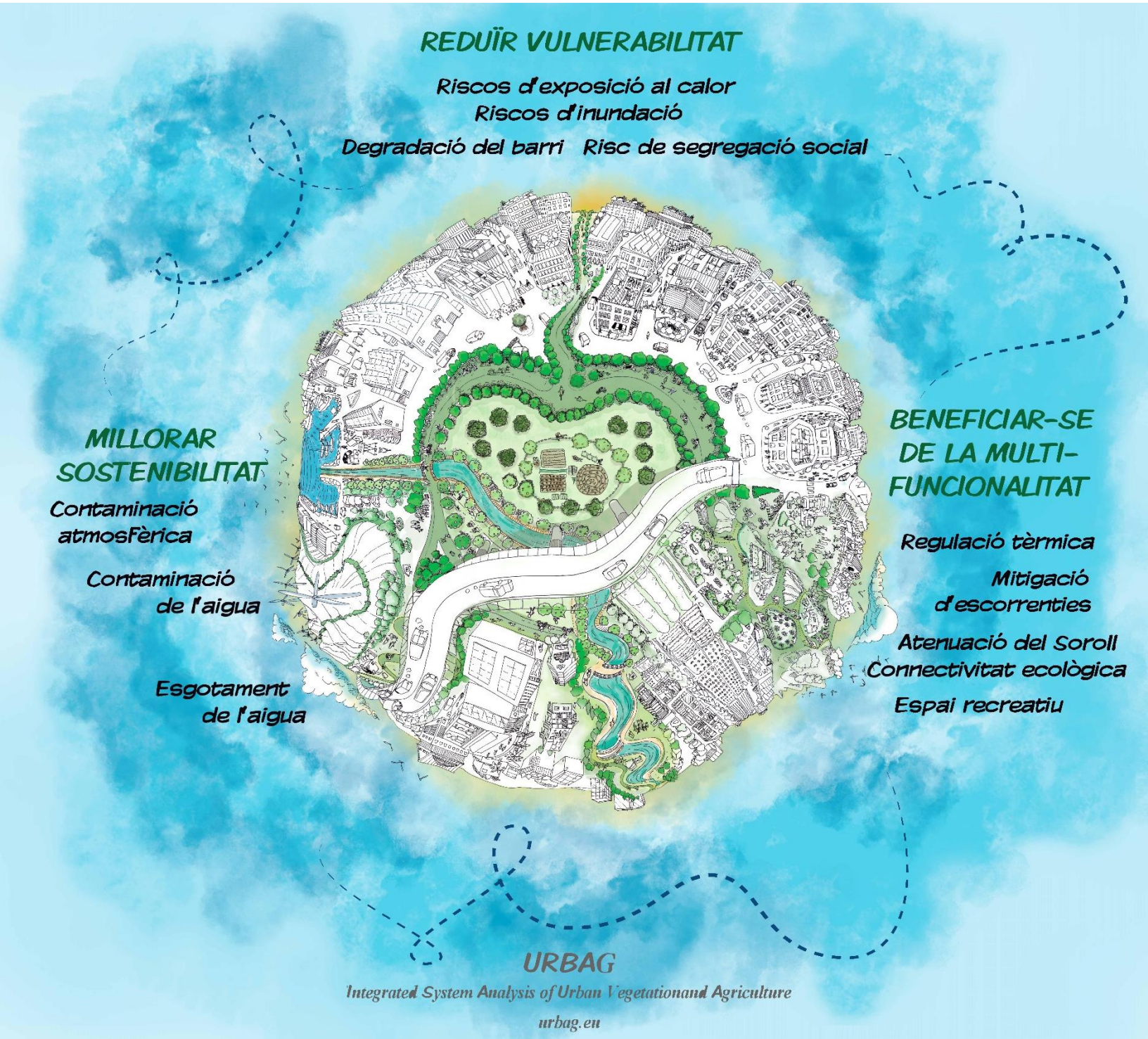
Green Corridors in the Metropolitan Area of Barcelona

Co-creating resilient, sustainable and multifunctional green infrastructures

ICTA - Metropolitan Science-Practitioners Exchange

Results report



Contents

1. Summary

- Green corridors (Eixos Verds in Catalan) are urban strips with high presence of vegetation that cross the urban fabric and link the different areas of the city.
- The Metropolitan Urban Master Plan plans to reinforce existing green axes and create new ones. There are currently about 750 km of roads that could be converted into Green Axes.
- The present study aims to create an integrated evaluation framework for Green Corridors through a participatory and co-creative process, focusing on the dimensions of Vulnerability, Multifunctionality and Sustainability.
- The research consisted of a survey and a participatory process where the most relevant criteria for evaluating these infrastructures under each of the dimensions were chosen and weighted.
- Respondents of the survey considered that, when evaluating the Green Corridors, the most important dimension to take into account was Multifunctionality, and that the most important criterion to address was the connectivity between green infrastructures for ecological functions. In the case of Vulnerability, the most relevant criterion was heat exposure, while for Sustainability it was loss of habitat and ecological functions.
- Through the participatory process, participants agreed that connectivity between green infrastructure for social and ecological functions was a high priority criterion for the evaluation of the Green Corridors under the Multifunctionality dimension. In the case of the Vulnerability dimension, heat exposure was cited as the most significant aspect, while for the Sustainability dimension, water depletion was described as a relevant criterion for the evaluation of the Green Corridors.

2. Introduction

Urban green infrastructure is a key element for the proper functioning of cities, given the ecosystem services it provides. Among the elements that make up green infrastructure are green corridors: paths **with a high presence of vegetation** that penetrate and run through urban settlements, **connecting different urban and peri-urban green spaces**. The green corridors form a functional network, allowing the configuration of a true network of ecological, green and functional infrastructure (Ajuntament de Barcelona, 2013). Among their main functions is urban comfort, focused on civic use and the creation of a green, walkable and inclusive city. In addition, in terms of territory, green corridors are structural elements of urban spaces **that connect urban settlements with each other.** (Ajuntament de Barcelona, 2012). As an example, in the city of Barcelona there is the Collserola - Monjtuïc corridor, a green corridor that connects two of the largest natural areas of the city, as well as reaching the coast. Its route covers heterogeneous spaces such as Diagonal avenue, Les Corts square and Miró park, as well as the green elements that compose it.

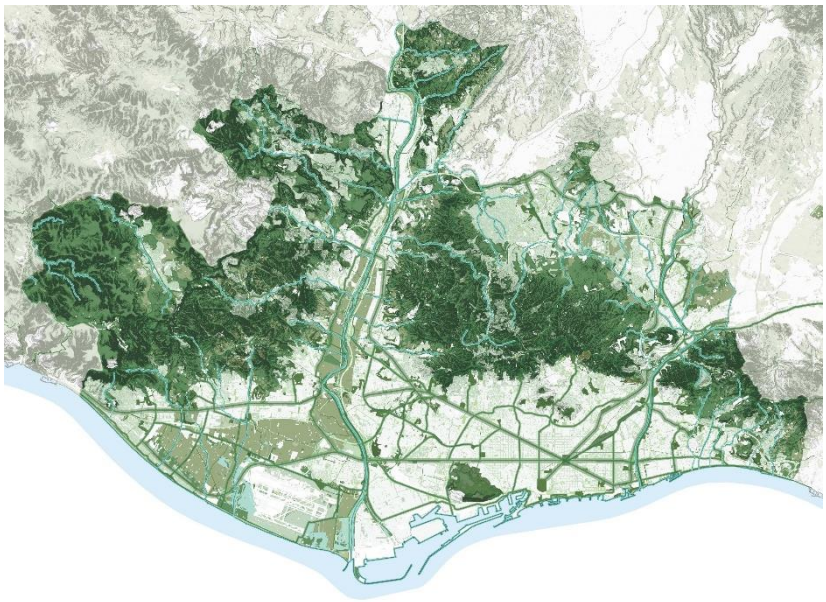


Figure 1. Network of Green Corridors in the Metropolitan Area of Barcelona (PDU, 2019)

The Metropolitan Urban Master Plan (PDU) is currently being developed, a tool that will define the organization and urban planning of the Metropolitan Area of Barcelona for the coming decades. Among its proposals is the development of a metropolitan structure that articulates the urban metropolis and links it with peripheral territories, making use of different elements, among them the structuring Green Corridors that will interlace urban spaces and naturalize the environment, through the connection of parks, public facilities, transportation and natural spaces. It is planned to reinforce existing green corridors and create new ones. There are currently about 750 km of roads that could be converted into Green Corridors.

3. Evaluation of the Green Corridors and participatory co-creation process.

URBAG is a research group of the Institute of Environmental Sciences and Technologies of the Universitat Autónoma de Barcelona, whose objective is to examine how green infrastructures can provide the greatest number of benefits in urban spaces while making efficient use of resources. Under this premise, the group included Green Corridors as an object of study to apply and **develop its integrated assessment framework** (see Fig. 2) of nature-based solutions on the dimensions of Vulnerability, Multifunctionality and Sustainability.

The study is based on a participatory process for the co-creation of the evaluation of the Green Corridors, in which stakeholders from civil society, public administration and the private sector, interested in the development of these infrastructures, were involved. The co-creation process focuses on **generating results based on the exchange of knowledge among participants**. To this end, it promotes dialogue between actors with different points of view with the intention of reaching a consensus on social and environmental issues. *Green Corridors in the Metropolitan Area of Barcelona - Co-creating resilient, sustainable and multifunctional green infrastructures* was carried out under these premises and consisted of a survey and a participatory dynamic. Its objectives were the dissemination of studies on the Green Corridors and the selection, discussion and weighting of the criteria to evaluate them.

***Vulnerabilty**: exposure to social and environmental risks and the difficulty of individuals, groups or ecological systems to adapt to changes in the environment. The social aspect includes disadvantaged groups such as the elderly or people with motor disabilities.*

***Mulifunctionality**: the ability of nature-based solutions to provide a variety of ecosystem services and benefits. These can be of different kinds, such as supporting, by providing natural habitats for animal species*
natural habitats for animal species, provisioning of fruits and vegetables, regulating, such as runoff, and cultural, which refers to the ability to provide spaces for recreational or spiritual experiences.

***Sustainability:** Ability to preserve the activities and infrastructure of an area over time without compromising natural resources and biological ecosystems, while maintaining and promoting a good standard of living within society.*

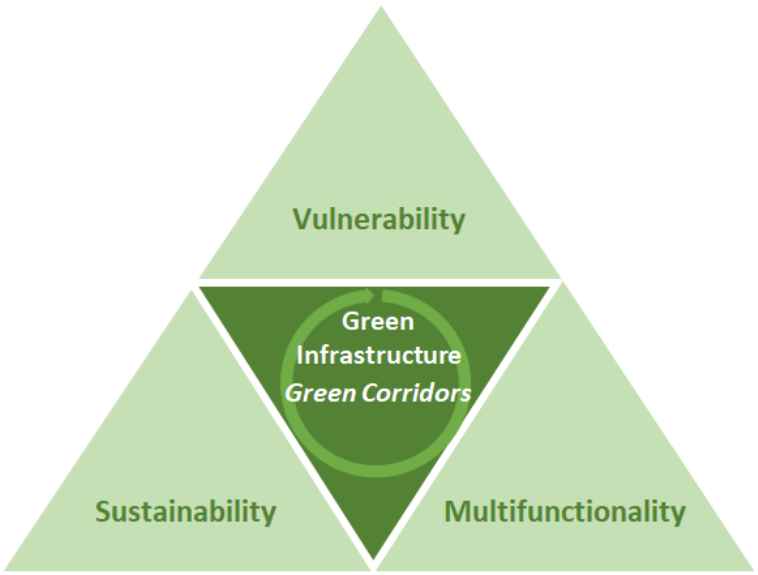


Figure 2. Integrated assessment of nature-based solutions based on the dimensions of Vulnerability, Multifunctionality and Sustainability. Adapted diagram from Langemeyer et al., 2021

4. Results

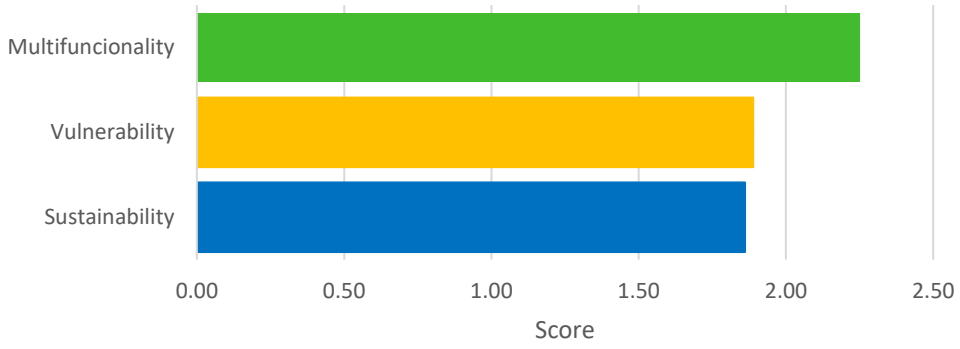
4.1. Survey

The survey was sent three weeks before the event to the 57 registered participants and was answered by 36 of them. It aimed to understand the participants' perspectives on the Green Corridors and their relationship with the dimensions of *Vulnerability*, *Multifunctionality* and *Sustainability*. The most relevant results are shown below:

Question 1: *For you, what would be the main **objective** that the Green Corridors should fulfill?*
Type of question: open-ended. Methodology: coding by Grounded Theory.

Coded responses	Number of responses
Improving ecological and social connectivity	15
Improving quality of life, health and well-being	13
Provision of multiple ecosystem services	10
Promotion and maintenance of biodiversity	9
Promotion and maintenance of ecosystem functionality	4
Urban naturalization	4
Improving urban structure and design	3
Provision of green spaces	3
Provision of environments for connecting with nature	3
Improving urban accessibility	3
Fostering the transition to a sustainable city	3
Climate change protection and mitigation	2
Improving urban mobility	2
Thermal regulation	2
Noise attenuation	1
Urban regeneration	1
Air quality improvement	1
Total	**79**

Question 2: *In this study we considered three dimensions under which to evaluate the Green Corridors, how **important** do you consider each one to be?*
Type of question: ranking. Methodology: Borda method



Question 3: *Below is a list of **criteria for assessing Vulnerability** in the AMB. Please arrange them in order of the level of importance you consider appropriate.*

Type of question: ranking. Methodology: Borda method

Vulnerability		
Criteria	**Ranking**	**Score**
Exposure to heat	#1	8.71
Exposure to air pollution	#2	8.57
Lack of connectivity between green infrastructures for social functions	#3	7.86
Existence or risk of social segregation	#4	7.57
Exposure to noise	#5	7.43
Lack of opportunities to interact with natural environments	#6	7.43
Neighborhood degradation	#7	7.14
Food poverty and malnutrition	#8	5.86
Lack of connectivity between green infrastructures for ecological functions	#9	5.43
Lack of opportunities for development of cultural and recreational experiences	#10	4.43
Flood, runoff and soil erosion risks	#11	4.29
Fire risks	#12	3.29

Question 4: *Below is a list of **criteria for assessing Multifunctionality** in the AMB. Please arrange them in order of the level of importance you consider appropriate.*

Type of question: ranking. Methodology: Borda method

Multifunctionality		
Criteria	**Ranking**	**Score**
Connectivity between green infrastructures for ecological functions	#1	11.00
Thermal regulation	#2	9.47
Connectivity between green infrastructures for social functions	#3	8.47
Reduction of atmospheric pollution	#4	8.18
Provision of environments for connecting with nature	#5	7.53
Reduction of greenhouse gases	#6	7.53
Mitigation of runoff and soil erosion	#7	7.35
Provision of environments for social cohesion/integration	#8	7.00
Promotion of food sovereignty and healthy eating	#9	5.82
Noise attenuation	#10	5.53
Provision of environments for recreational experiences	#11	5.35
Fire risk mitigation	#12	4.12
Improved aesthetics of the territory	#13	3.65

Question 5: *Below is a list of **criteria for assessing Sustainability** in the AMB. Please arrange them in order of the level of importance you consider appropriate.*

Type of question: ranking. Methodology: Borda method

Sustainability		
Criteria	**Ranking**	**Score**
Loss of habitat and ecological functions	#1	7.50
Water pollution	#2	7.33
Water depletion	#3	6.17
Air pollution	#4	5.17
Soil contamination	#5	5.17
Greenhouse gas emissions	#6	4.33
Depletion of material resources	#7	4.00
Economic burdens	#8	3.17
Loss of social functions and negative social effects	#9	2.17

4.2. Participatory process

Due to the sanitary restrictions associated with COVID-19, the participatory process was carried out remotely on May 6, 2021. Participants were divided into six groups, each working on a different dimension and focusing on two **typologies of AMB cities: dense and sprawled** (see Figure 3). The group work consisted of three steps: first, the **selection of the relevant criteria** for the Green Corridors' evaluation under the corresponding dimension/typology, starting from a list of criteria pre-selected by the organizing team that could be supplemented or reduced according to the judgment of the participants (see Appendix 1); the second step consisted of **discussing** the importance of each of the selected criteria, and the third of **weighting** them individually, and then aggregating them to obtain a group total.

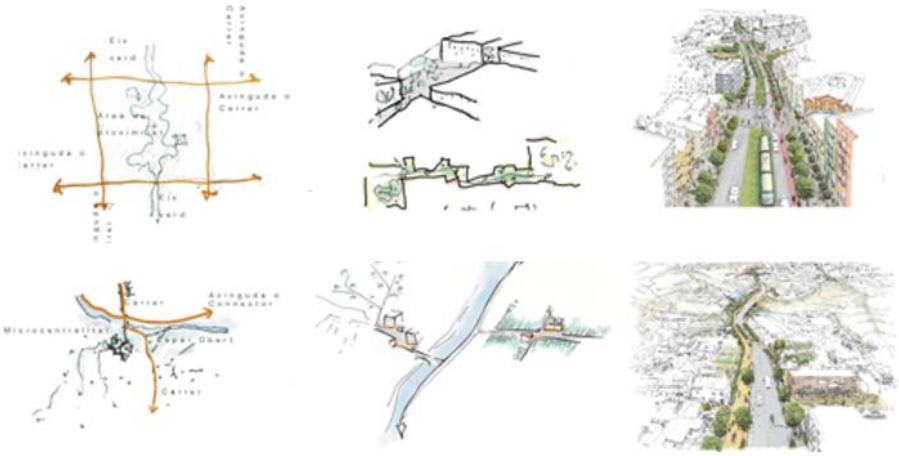


Figure 3. Graphical examples of dense (top) and sprawled cities (bottom)

Vulnerability

The following is the list of **criteria selected and weighted** by the groups for the evaluation of the Green Corridors under the *Vulnerability* dimension in the dense and sprawled typologies.

Vulnerability		
Selected criteria	**Dense city**	**Sprawled city**
Heat Exposure	45	55
Environmental education/awareness *	35	0
Existence or risk of social segregation	35	20
Exposure to noise	35	25
Lack of opportunities for cultural and recreational experiences	35	11
Lack of opportunities for cultural and recreational experiences	30	43
Exposure to air pollution	30	35
Lack of connectivity between green infrastructures for social functions	30	24
Lack of opportunities to engage with natural environments	20	0
Neighborhood degradation	5	0
Food poverty and malnutrition	0	42
Lack of connectivity between green infrastructures for ecological functions	0	45

Criteria with rating = 0 indicate that the group did not consider it relevant for the evaluation exercise.

**Criteria created by the groups during the participatory discussion.*

Multifunctionality

The following is the list of **criteria selected and weighted** by the groups for the evaluation of the Green Corridors under the *Multifunctionality* dimension in the dense and sprawled typologies

Multifunctionality		
Selected criteria	**Dense city**	**Sprawled city**
Connectivity between green infrastructures for social functions	70	40
Thermal regulation	50	0
Connectivity between green infrastructures for ecological functions	45	75
Improved aesthetics of the territory	30	0
Provision of environments for social cohesion/integration	30	0
Noise attenuation	25	0
Reduction of atmospheric pollution	20	0
Mitigation of runoff and soil erosion	10	0
Provision of environments for recreational experiences	10	20
Provision of environments for bonding with nature	10	20
Promoting food sovereignty and healthy eating	0	45

Criteria with rating = 0 indicate that the group did not consider it relevant for the evaluation exercise.

Sustainability

The following is the list of criteria selected and weighted by the groups for the evaluation of the Green Corridors under the *Sustainability* dimension in the dense and sprawled typologies

Sustainability		
Selected criteria	**Dense city**	**Sprawled city**
Water depletion	73	50
Increased density (traffic, people) in nearby areas*	49	0
Loss of social functions and negative social effects	44	0
Economic burdens	38	50
Depletion of material resources	35	0
Contamination of aquifers*	33	0
Loss of alternative uses of space (displaced public transport)*	26	0
Loss of social functions and negative social impacts	25	0
Loss of social functions and negative social impacts	23	57
Greenhouse gas emissions	21	50
Soil contamination	11	0
Air pollution	11	0
Impacts from electromagnetic fields*	11	0
Noise pollution	0	43
Marine pollution	0	75
Water pollution	0	75

Criteria with rating = 0 indicate that the group did not consider it relevant for the evaluation exercise.

**Criteria created by the groups during the participatory discussion.*

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1. Appendix 1: participatory process

1.1. Pre-selection of criteria - Vulnerability

Vulnerability	
Criteria	**Description**
Exposure to air pollution	Presence of pollutants in the atmosphere that are harmful to health and the environment.
Exposure to heat	Presence of heat waves in urban areas and groups affected by its effects.
Exposure to noise	Excess noise produced by human activities that generates negative effects on people's health.
Flood, runoff and soil erosion risks	Accumulation and overflow of water that impacts people's safety, urban infrastructure and soil quality.
Fire risks	Fires that put people and infrastructure at risk.
Existence or risk of social segregation	Social gaps associated with economic, cultural, ethnic, gender, and other differences.
Lack of opportunities for the development of cultural and recreational experiences	Lack of opportunities for cultural and recreational experiences, related to leisure, recreation and maintenance of cultural heritage.
Lack of opportunities to interact with natural settings	Lack of opportunities for linking with natural environments, creating connections with nature and environmental awareness.
Lack of connectivity between green infrastructures for social functions	Lack of vegetation along urban routes for pedestrians and cyclists.
Lack of connectivity between green infrastructures for ecological functions	Lack of ecological corridors that enable the transfer and mobility of species.
Food poverty and malnutrition	Groups of people that for economic, educational or spatial reasons have difficulty maintaining healthy diets.
Neighborhood degradation	Deterioration of spaces, streets, infrastructure and buildings that make up the neighborhoods.

1.2. Pre-selection of criteria - Multifunctionality

Multifunctionality	
Criteria	**Description**
Reduction of atmospheric pollution	Improved air quality for health and the environment
Thermal regulation	Temperature reduction during heat episodes
Greenhouse gas reduction	Carbon storage and sequestration or reduction of energy use
Noise attenuation	Reduced noise from human activities (e.g. traffic, building construction)
Runoff and soil erosion mitigation	Increased water uptake, reduction of erosive effects on soil and support to the sewage system (e.g. flood attenuation)
Fire risk mitigation	Reduction of the incidence, intensity or speed of fire propagation
Provision of environments for social cohesion/integration	Meeting points where residents and neighbors can meet, interact and create social bonds.
Provision of environments for recreational experiences	Spaces to develop cultural and recreational experiences related to leisure and recreation.
Provision of environments for nature linkages	Spaces that allow the creation of connections with nature and the development of environmental awareness.
Connectivity between green infrastructure for social functions	Urban paths with vegetation for pedestrians and cyclists.
Connectivity between green infrastructures for ecological functions	Ecological corridors that enable the transfer and mobility of species
Promotion of food sovereignty and healthy eating	Provision of food and environments that promote healthy eating
Improved aesthetics of the territory	Neighborhood beautification through green infrastructures

1.1. Pre-selection of criteria - Sustainability

Sustainability	
Criteria	**Description**
Water depletion	Loss of water reserves due to unsustainable consumption (e.g. irrigation of green spaces).
Water pollution	Discharge of pollutants into water (e.g. nitrogen from fertilizers)
Greenhouse gas emissions	Greenhouse gas emissions (e.g. from wetland creation and green infrastructure management)
Soil contamination	Accumulation of pollutants in soil (e.g. nitrogen accumulation)
Air pollution	Release of particulate pollutants into the air (e.g. emissions of pollen and volatile organic compounds from trees)
Economic loads	Costs associated with the creation and management of green infrastructures (e.g. tree pruning)
Depletion of material resources	Construction materials for green infrastructure (e.g. permeable pavements)
Loss of habitat and ecological functions	Replacement of (natural) spaces by green infrastructure and displacement of wildlife (e.g. creation of an agricultural area where a forest once existed)
Loss of social functions and negative social effects	Change of social dynamics due to the transformation of an area (e.g. displacement of residents, increase in crime and perception of insecurity)