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Assessing Context-Specificity and Transferability of a Spatial Multi-Criteria Analysis Tool for Participatory Planning of Urban Agriculture: A Comparative Study of Montreal and Utrecht

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Mémoire présenté en vue de l'obtention du diplôme de *Maîtrise ès sciences appliquées*

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Ce mémoire intitulé :

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présenté par **Pascale ROY**

en vue de l'obtention du diplôme de *Maîtrise ès sciences appliquées*

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RÉSUMÉ

L'agriculture urbaine (AU), par sa multifonctionnalité, offre une multitude de bénéfices, allant de la production alimentaire à la résilience climatique. Toutefois, son intégration dans les processus de planification urbaine est longtemps demeurée marginale, limitant ainsi son déploiement à l'échelle du tissu urbain. Les systèmes d'aide à la planification, et plus particulièrement l'aide à la décision multicritères (ADMC) couplée aux systèmes d'information géographique (SIG) ont été développés et utilisés pour supporter la planification de l'AU et d'autres infrastructures vertes. Toutefois, leur application à l'AU reste encore peu étudiée, particulièrement dans des approches comparatives et participatives impliquant les parties prenantes à toutes les étapes du processus. De plus, l'influence du contexte sur le développement de ces outils et sur la transférabilité de leurs résultats demeure insuffisamment comprise. Cette recherche vise donc à combler ces lacunes en analysant comment le contexte façonne le développement et les résultats d'un cadre SIG-ADMC pour la planification de l'AU, afin de mieux définir les limites de transférabilité de ces approches et de soutenir leur adaptation à différents milieux urbains.

Ce mémoire adopte une approche comparative à travers deux études de cas portant sur l'application d'un cadre participatif SIG-ADMC pour la planification stratégique de deux formes d'agriculture urbaine : les jardins partagés au sol et les jardins partagés sur toit. Les cas étudiés sont Montréal (Canada) et Utrecht (Pays-Bas). Plus précisément, cette étude analyse dans quelle mesure chaque composante du cadre, allant des objectifs et de leur pondération, aux attributs et aux échelles de valeur, est sensible au contexte ou potentiellement transférable et quelle est l'influence de leurs transferts sur les résultats de planification.

Une analyse comparative structurée, combinant des approches descriptives et statistiques, a été menée à l'ensemble des étapes du processus, incluant les dynamiques de participation, les hiérarchies d'objectifs, la pondération des objectifs ainsi que la cartographie de l'adéquation. Les résultats montrent que les critères de planification sont globalement similaires d'un contexte à l'autre, suggérant un certain degré de transférabilité conceptuelle du cadre. Toutefois, des différences apparaissent dans la pondération et la priorisation des objectifs : les participants de Montréal et d'Utrecht présentent néanmoins un niveau d'accord plus élevé pour les jardins sur toit que pour les jardins au sol. De plus, la sélection des attributs et la définition des échelles de valeur sont fortement influencées par la disponibilité des données et le jugement des experts. L'exclusion

des critères spécifiques au contexte ainsi que l'utilisation de pondérations transférées entre Montréal et Utrecht peuvent modifier, voire augmenter, les scores d'adéquation, sans toutefois affecter de manière importante l'identification des zones prioritaires d'implantation.

Ces résultats permettent de mieux cerner les conditions de transférabilité des systèmes d'aide à la planification d'un contexte à un autre et d'identifier des leviers concrets pour leur adaptation. Plus largement, cette recherche met en lumière le rôle structurant du contexte dans la conception et l'application des outils de planification, tout en contribuant à une intégration plus stratégique de l'agriculture urbaine au sein de systèmes urbains résilients et équitables.

ABSTRACT

Urban agriculture (UA) offers multifunctional benefits ranging from food production to climate resilience, yet its integration into urban planning remains limited in practice. Planning support systems (PSS), particularly GIS-based multi-criteria decision analysis (GIS-MCDA), have been developed to support this integration, but their application to the AU has yet to be thoroughly studied, particularly in comparative and participatory approaches that involve stakeholders at every stage of the process. Furthermore, the influence of context on the development of these tools and on the transferability of their components remains poorly understood. This research therefore aims to address these gaps by analyzing how context shapes the development and outcomes of a GIS-ADMC framework for urban planning, in order to better define the limits of transferability of these approaches and to support their adaptation to different urban settings.

This thesis presents a comparative case studies application of a participatory GIS-MCDA framework for planning ground-level and rooftop shared gardens in Montreal, Canada, and Utrecht, the Netherlands. It investigates how each component of the framework, from objectives and weighting to attributes and value scales are sensitive to the context, and how their transferability affects planning outcomes.

A structured comparative analysis was conducted across all steps of the process, including participation patterns, hierarchies of objectives, weighting results, and suitability mapping. Results show that siting criteria are largely consistent across contexts, supporting a degree of conceptual transferability. However, differences emerge in objective prioritization, with stronger agreement among participants for rooftop systems than for ground-level gardens. Attribute selection and value scales are strongly constrained by data availability and expert judgment.

Sensitivity analyses further demonstrate that excluding context-specific criteria and using transferred weights between Montreal and Utrecht affects the distribution of suitability scores (i.e., often inflating them when only shared criteria are considered) while leaving priority areas for implementation largely unchanged. These findings clarify the conditions under which PSS can be transferred across contexts and provide actionable guidance for their adaptation. Overall, this research advances the understanding of context-sensitive planning tools and supports the more effective integration of UA into resilient and equitable urban systems.

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LISTE OF SYMBOLS AND ABBREVIATIONS

GI	Green infrastructure
GIS	Geographic Information System
MCDA	Multi-Criteria Decision Analysis
NBS	Nature-based solution
PSS	Planning support system
SSANTO	Spatial Suitability Analysis Tool
UA	Urban agriculture

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CHAPTER 1 INTRODUCTION

Urban agriculture (UA), as a form of green infrastructure (GI) such as rooftop gardens, community gardens and food forests, is increasingly recognized for its multifunctionality and its potential to enhance urban resilience and contribute to climate change mitigation (Langemeyer et al., 2021; Meerow & Newell, 2017). Recognized for their potential to provide ecosystem services, support food security, and foster social cohesion (Evans et al., 2022; Petrovic et al., 2019; Tomatis et al., 2023), UA systems need to be strategically planned to maximize their benefits and minimize their implementation constraints (Lin et al., 2017; Menconi et al., 2020). Planning-support systems (PSS) including Geographic Information System – Multi-Criteria Decision Analysis (GIS-MCDA) tools are increasingly used and developed for application in GI and UA planning (Bousquet et al., 2023; Kamali et al., 2025; Smith et al., 2021). Despite their potential, PSS and GIS-MCDA tools remain demanding in terms of data, skills, and transparency, which limits their adoption in practice (Pettit et al., 2018; P. Russo et al., 2018). In addition, these tools are often highly sensitive to local conditions, including spatial, institutional, and socio-cultural factors (Lerer et al., 2015; Page et al., 2020). As a result, frameworks developed in one context may not be directly applicable in another, raising questions about their generalizability and robustness.

Kuller et al. (2019) introduced a spatial suitability analysis tool, SSANTO (Spatial Suitability ANalysis TOol), which integrates biophysical, socio-economic, planning, and governance criteria with those related to the ecosystem services provided by green infrastructure to generate suitability maps. Originally developed for Melbourne, its adaptation to Quebec by Lacroix et al. (2024) represented an initial step toward improving understanding of such tool's transferability.

1.1 Comparative participatory case studies

This thesis applies a comparative case study design, focusing on Montreal (Canada) and Utrecht (Netherlands). These two cities differ in size and the level of institutional support for UA, providing a relevant basis for examining context-specific influences on planning processes and outcomes of UA. Through workshops and consultations with stakeholders and experts in both cities, each step of the GIS-MCDA process is co-developed, enabling a systematic comparison of how context influences the structure of the process.

1.2 Objectives

This research aims to conduct a comparative analysis of the development of a planning support system (PSS) across two distinct urban contexts. Through this comparison, it seeks to generate novel insights for researchers and practitioners on the transferability and adaptability of such tools, by assessing the extent to which both the approach and its outcomes depend on context. To achieve this main objective, the following sub-objectives are accomplished:

1) Investigate the extent to which context influences participation in PSS development;
2) Assess convergence and divergence in the selection of criteria (organized into hierarchies of objectives) for UA siting between contexts;
3) Quantify within-city and between-city agreements in terms of objectives' priorities;
4) Evaluate the level of influence of context, data availability or expert judgment on the attributes and the value scales;
5) Test the sensitivity of suitability maps outputs to context specificities.

1.3 Organization of the thesis

This thesis is organized into six chapters. Chapter 1 introduces the research context, outlines the research objectives, and presents the basis of the comparative methodology. Chapter 2 reviews the literature on UA and its planning context, as well as on PSS and GIS-MCDA, including their development trajectory and context-specificity. It concludes by linking these concepts to provide an overview of the current state of development and application of PSS and GIS-MCDA techniques for UA planning. Chapter 3 provides an overview of the methodology, with detailed explanations of key components. Chapter 4 consists of the main scientific article developed in this thesis, presenting the comparative case studies, including the objectives, methods, results, and potential implications for the development and transferability of PSS. Chapter 5 offers a general discussion of the strengths and limitations of the research project, and its implications for spatial planning of UA. It also highlights the contributions of this research to advancing knowledge on PSS transferability. Finally, Chapter 6 concludes by summarizing the contributions of the thesis and outlining directions for further research.

CHAPTER 2 LITERATURE REVIEW

2.1 Urban agriculture

2.1.1 Definition and typology

In the growing literature pertaining to urban agriculture (UA), different definitions of the term were suggested but no standardization of it is yet universally accepted (Douziech et al., 2024; Jansma et al., 2024; Opitz et al., 2016; Quon, 1999). Sometimes, UA is loosely defined as agricultural activities within urban areas (Horst et al., 2017; Opitz et al., 2016). At other times, Mougeot's (2000) definition, explicitly emphasizing the "agriculture – urban ecosystem" connection as a distinguishing feature of the concept, is preferred: "UA is an industry located within (intra-urban) or on the fringe (peri-urban) of a town, a city or a metropolis, which grows or raises, processes and distributes a diversity of food and non-food products, (re-)using largely human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area". This definition showcases the diversity of dimensions UA is made of.

However, as with the definition, there is not yet a globally accepted and lasting division of dimensions nor typologies. Despite many attempts over the years to provide guidance toward a global classification, most either proved difficult to apply beyond local and national contexts or lost relevance over time (Jansma et al., 2024). Mougeot (2000) identified six dimensions in its early work aiming at clarifying and documenting UA: the types of economic activities (e.g., production, transformation, processing, marketing), the location of the activity (e.g., intra- or peri-), the types of areas (e.g., land-use category, on-plot or off-plot, built-up or open space), the scale of the production (e.g., individual, family, micro, small, medium, national), the types of products (e.g., food, non-food, livestock) as well as the destination of the products (e.g., self-consumption, trade). In an overview of urban agriculture in Europe, Lohrberg et al. (2016) also focused on six crucial dimensions: a market dimension (e.g., local, national, international level of commercialization), a spatial dimension (e.g., urban, peri-urban), a functional dimension (e.g., food or non-food and service functions such as landscape features, recreation, education, and health), a motivational dimension (e.g., subsistence, leisure, well-being of the practitioner), an origin dimension (e.g., top-down/bottom-up, institutional/guerilla gardening) as well as an actor dimension (e.g., business investor, hobby farmer, public authority).

Building on Goldstein et al.'s work (2016), Douziech et al. (2024) proposed five categories of UA systems: (1) building-integrated quasi-closed systems, (2) building-integrated conditioned systems, (3) ground-based conditioned systems, (4) building-integrated open systems, and (5) ground-based open systems. Alternatively, Jansma et al. (2024) defined six types of UA systems: (1) urban farm, (2) community park, (3) do-it-yourself garden/farm, (4) zero acreage farm, (5) social farm and (6) community garden. Overall, these classification frameworks often only capture specific dimensions of the concept (Douziech et al., 2024; Jansma et al., 2024). UA is this umbrella term that includes a diverse array of systems that overlap within and between them depending on the lens through which they are considered (Goldstein et al., 2016; Jansma et al., 2024; Lin et al., 2017). Examples of such multi-dimensional systems include school gardens, community or allotment gardens, greenhouses, food forests or urban farms, among others.

2.1.2 Multifunctionality

Given its diverse forms, UA holds significant potential to deliver a variety of benefits. In fact, its multifunctionality is a central focus in UA research even though empirical evidence or quantitative work supporting some of its purported benefits is sometimes still limited (Dona et al., 2021; Gittleman et al., 2017; Orsini et al., 2013; Rolf, 2020). Ecosystem services were identified using two systematic reviews focused on urban agriculture, including specific types such as rooftop gardens, community gardens, and allotments, revealing a broad range of functions provided by these systems (Evans et al., 2022; Huan et al., 2024). Table 2.1 first synthesizes the ecosystem services explicitly identified in these reviews for UA systems overall or for specific system types, while the last column provides empirical evidence supporting the relationships reported by the two systematic reviews.

Through its multifunctionality, UA provides a large range of benefits and ecosystem services that serve urban resilience. Defined as “the ability of urban systems not only to maintain essential functions but also to improve its original conditions” (Datola, 2023), urban resilience is multidimensional, dynamic and complex. Central to the concept is the notion of “diversity” which relates to the existence of several functionalities which together enhance the ability of adaptation to a large spectrum of diverse circumstances (Ribeiro & Pena Jardim Gonçalves, 2019). Urban resilience emphasizes improving baseline conditions while enabling cities to adapt, evolve, and transform in the face of disturbances.

Table 2.1 Multifunctionality of UA systems and supporting references

Function	Type of UA system			References
	Urban agriculture (Evans et al., 2022)	*Garden* (Huan et al., 2024)	*Rooftop* (Huan et al., 2024)	
Soil quality	✓	✓		*urban agriculture:* (Edmondson et al., 2014; Wu & Congreves, 2024)
Nutrient cycling	✓	✓	✓	*urban agriculture :* (Brown et al., 2023)
Carbon sequestration	✓	✓	✓	*garden :*(Whittinghill et al., 2014; Zhao et al., 2024) *rooftop:* (Whittinghill et al., 2014)
Water retention, regulation and management	✓	✓	✓	*garden :* (Chapman et al., 2022) *rooftop:* (Kolasa-Więcek & Suszanowicz, 2021; Whittinghill et al., 2015; Wright et al., 2021)
Microclimate and temperature regulation	✓	✓		*urban agriculture:* (Anderson & Gough, 2022)
Pollination and seed dispersal	✓	✓	✓	*garden :* (Potter & LeBuhn, 2015) *rooftop:*(Ksiazek et al., 2012)
Habitat for pollinators, species and wildlife	✓	✓		*garden :* (App et al., 2022; Borysiak et al., 2017)
Urban biodiversity		✓		*garden :* (Borysiak et al., 2017; Egerer et al., 2024)
Biological control and disease regulation	✓	✓		*garden:* (Burks & Philpott, 2017)
Aesthetic appreciation	✓	✓	✓	*garden :* (Hou & Grohmann, 2018) *rooftop :* (Loder, 2014)
Nature contact		✓		*garden :* (Truong et al., 2022)
Environmental education			✓	*rooftop:* (Zambrano-Prado et al., 2021)
Lifestyle and wellbeing		✓	✓	*garden :* (Koay & Dillon, 2020; Maćkiewicz & Asuero, 2021) *rooftop* : (Yan Li & Du, 2024)
Physical and mental health	✓	✓	✓	*garden :* (Koay & Dillon, 2020; Maćkiewicz & Asuero, 2021) *rooftop:* (Lee et al., 2015; Mesimäki et al., 2017)
Sense of place	✓			*garden:* (Petrovic et al., 2019; Strunk & Richardson, 2019)
Recreation and leisure	✓	✓		*garden:*(Breuste & Artmann, 2023)
Sense of belonging to a group		✓		*garden :* (Menconi et al., 2020; Truong et al., 2022)
Social integration and cohesion	✓	✓	✓	*garden :*(Camps-Calvet et al., 2016) *rooftop:* (Mesimäki et al., 2017)
Food production	✓	✓	✓	*garden :* (Corrigan, 2011) *rooftop :*(Xie et al., 2025)

2.1.3 As green infrastructure

UA has been discussed mostly apart from green infrastructure (GI) and nature-based solution (NBS) although numerous parallels exist between the concepts (Evans et al., 2022). GI is defined by the European Commission as a "strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, while also enhancing biodiversity" (European Commission, 2013). Encompassing GI, NBS is defined by the International Union for Conservation of Nature (IUCN) as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016, p. 4). Over the last ten years, new terms started to emerge such as "productive green infrastructure" (Lin et al., 2017), "edible green infrastructure" (A. Russo et al., 2017) "food-productive green infrastructure" (Bohn & Chu, 2021) or lastly "edible NBS [nature-based solution]" (Mino et al., 2021). Although none of those terms entered common usage, the multifunctionality of UA continued to be a subject of interest and this perspective provided a basis for drawing connections between UA and related concepts like GI and NBS (Pradhan et al., 2023; Rolf, 2020).

Evans et al. (2022) conducted a systematic literature review to synthetize the benefits and trade-offs of integrating urban green infrastructure and urban agriculture for ecosystem service delivery and concluded that both GI and UA are alike in their capacity to supply multiple ecosystem services. Among sixteen types of infrastructure, parks, green spaces, community gardens and allotment gardens emerged as the most multifunctional ones, based on the diversity rather than the performance of ecosystem services provided, each dispensing over sixteen of the nineteen ecosystem services considered, and spanning all four service categories (i.e., cultural, provisioning, regulating and supporting) (Evans et al., 2022). Shared benefits and ecosystem services range from social and recreational functions, along with climate regulation and biodiversity support (Artmann & Sartison, 2018; Lin et al., 2017; Rolf, 2020; A. Russo et al., 2017). However, one mentioned limitation concerned the degree to which urban agriculture functions as a public space, as certain forms, for instance allotment gardens, are sometimes restricted in terms of spatial and temporal accessibility, in contrast to other types of green infrastructure such as parks (Contesse et al., 2018). Further parallels were drawn between certain types of GI and UA in the way that their implementation was both spatially constrained and often ended up being planned on disused urban spaces (Contesse et al., 2018; Lin et al., 2017).

2.1.4 Planning process

For a long period of time, the lack of established connection between the GI concept and UA was reflected in the absence of the latter in the urban planning agenda (Pothukuchi & Kaufman, 1999). A survey of 22 planning agencies across U.S. communities mentioned seven reasons for the food system's limited consideration in urban planning (Pothukuchi & Kaufman, 2000). Amongst those reasons, urban planners explicitly specified: the missing link between the food system and the built environment (which is their primary focus), the dichotomy between rural and urban food policies, the lack of funding by the government for food system planning, the predominance of the private sector in the food system limiting the planner's role and the impression that the food system requires no intervention and functions well as it is. Around the same time, another survey of 26 urban planning professionals from 18 cities around the world identified key-planning constraints for urban farmers (Quon, 1999). "Lack of formal recognition of urban agriculture in planning policy", "lack of clear government responsibility for the various aspects of urban agriculture" and "lack of resources, technical and financial support for urban farmers from the government" were all mentioned, echoing the limitations highlighted in the other survey (Quon, 1999, p. 56). Another constraint identified by Quon's survey (1999) was the lack of knowledge and appreciation for the socio-economic and environmental role of urban agriculture.

Although research interest in highlighting the benefits of UA and its connections with concepts such as GI and NBS grew over the years, a persistent lack of awareness of the multifunctionality of UA continued to be noted as a limiting factor in its recognition in urban planning as a strategy for sustainable urbanization and urban resilience (Artmann & Sartison, 2018; Langemeyer et al., 2021). Given the saturation of the urban fabric and the limited recognition of UA's contribution to sustainability, its planning was often relegated to disused sites and vacant lots, frequently as a temporary land use until a more economically productive function arose (Castillo et al., 2013; Contesse et al., 2018; Horst et al., 2017). With land access recognized as a primary obstacle to the development of UA, it became essential to elaborate spatial planning strategies and tools that effectively identify potential land for the implementation of UA (Cassatella & Gottero, 2025; Castillo et al., 2013; Lovell, 2010). In this context, Geographic Information Systems (GIS), particularly applications such as suitability land analyses and land inventories, began to emerge as tools to plan for UA systems (e.g., community gardens) (Lovell, 2010; Mendes et al., 2008). Nevertheless, the overall planning trend continued to assign UA a reduced role in long-term land-use strategies, pointing to the necessity of developing more robust methods for its integrated inclusion in spatial planning processes (Horst et al., 2017; Langemeyer et al., 2021).

2.2 Planning support systems

2.2.1 State of the art of PSS

Planning support systems (PSS) are geo-information based, computer automated tools that integrate theories, data, information, knowledge, and methods to support the planning process (Geertman & Stillwell, 2003). They are characterized by their practical purpose and application; they contribute directly to planning tasks such as information management, communication, and analytical work, all within a specific planning context and scale. PSS translate meaningful information into scenario-based planning outputs, thereby creating structured starting points for dialogue around complex and evolving planning challenges (Geertman & Stillwell, 2004; Pettit et al., 2018). These tools have therefore the potential to support collective and participatory planning approaches at different stages of the planning process (Page et al., 2020; Rittenbruch et al., 2022).

However, PSS are not immune to the availability–implementation gap (Page et al., 2020; Pettit et al., 2018). When implemented following a predominantly top-down planning approach rather than including stakeholder involvement, PSS may fall short to meet user needs and planning task requirements (Flacke et al., 2020). On the other hand, while involving stakeholders can address these limitations, developing PSS with stakeholder participation remains time-consuming and resource-intensive (Geertman & Stillwell, 2009; Street et al., 2019)." First identified by Vonk et al. (2006) and reaffirmed more than ten years later by Russo et al. (2018), this availability–implementation gap has been associated with factors such as complexity of use, limited user-friendliness, and insufficient transparency and perceived reliability. Thus, PSS navigate between complexity and simplicity; they translate complex systems into formats that are sufficiently understandable but also reliable to ensure their practical relevance, usability and effectiveness (Geertman, 2006; Pettit et al., 2018).

Another key factor contributing to the gap between the development of PSS and their effective adoption is the context sensitivity of their application. Both the development and implementation processes in addition to the outcomes are highly context-specific, which limits the transferability of such tools to settings other than those in which they were originally developed (Geertman, 2006). To ensure that planning processes are supported rather than hindered by these tools, PSS must be carefully attuned to their context (Jiang et al., 2022). Contextual factors identified in the literature include institutional arrangements, governance structures, decision-making culture, user characteristics, and data availability (McEvoy et al., 2019; Pelzer et al., 2015). Because user needs vary across local settings, expectations regarding the capabilities and performance of the tool also differ accordingly (P. Russo et al., 2018).

2.2.2 GIS-MCDA

Within the family of PSS, Geographic Information System – Multi-Criteria Decision Analysis (GIS-MCDA) combines geographic data and stakeholder value judgments to assess the performance of alternative options (Malczewski, 2006). These two concepts complement each other and constitute the strength of this combination. On the one hand, GIS offers powerful capabilities to store, manage, analyze, and visualize geospatial data. On the other hand, MCDA provides a set of procedures for structuring decision problems and prioritizing alternatives to generate compromise solutions (Boroushaki & Malczewski, 2010; Malczewski, 1999). Their combined ability to integrate preferences, structure decisions, and foster collective understanding of issues makes them particularly suited to complex challenges such as urban agriculture or green infrastructure planning (Lovell, 2010; Smith et al., 2021). The integration of MCDA with GIS has enabled significant advances in spatial decision support and participatory GIS. Indeed, these developments have been argued to reduce top-down opportunism in spatial planning and decision-making by providing a replicable and accountable procedure (Kuller et al., 2021; Malczewski, 2006).

As a sub-category of PSS, it is unsurprising that GIS-MCDA systems face similar challenges in terms of complexity, accessibility, and the resources required for implementation. The development context of the tool is again cited as a source of variation and influence (Lerer et al., 2015). The adaptation of MCDA has mostly been studied in single case studies, limiting our understanding of its broader transferability (Bousquet et al., 2023). Caution is advised regarding the applicability of a tool developed elsewhere, and further research is needed to better understand the limits and appropriate uses of these tools when decision-makers seek solutions that are both adaptive and reliable (Bagstad et al., 2013; Lerer et al., 2015).

2.3 Applications of GIS-MCDA in UA planning

Strategically locating UA is crucial for its effective contribution to urban resilience (Menconi et al., 2020). Given the diversity of benefits associated with UA and the spatial trade-offs involved in its implementation, planning tools are helpful to support decision-making regarding where such systems should be integrated into cities. MCDA-GIS provides a framework for addressing these complex spatial decisions and has already been widely used to support planning for more conventional forms of green infrastructure (Bousquet et al., 2023; Goodspeed et al., 2022). Applications in the field of UA have been less extensively studied than those for other forms of green infrastructure, partly due to the long-standing ambiguity surrounding the place of UA into urban planning (Horst et al., 2017; Pothukuchi & Kaufman, 1999). Documented MCDA-GIS applications in UA are listed in Table 2.2 along with a summary of the criteria they highlighted in each study, noting that the absence of certain criteria for specific systems (e.g., green roofs) reflects differences in the variables included in the reviewed studies rather than their definitive irrelevance to those systems.

Table 2.2 Criteria for planning urban agriculture (through MCDA-GIS process or other strategic planning strategy)

Criteria		**Type of systems**			**Source** ([1]: MCDA-GIS study; [2]: either MCDA or GIS separately, spatial planning, spatial optimization)
		Urban agriculture	*Garden*	*Green roof*	
Envrionment	Land size	✓	✓		*urban agriculture:* (Kamali et al., 2025)[1] (Newell et al., 2022)[2] *garden:* (Caneva et al., 2020)[2]
	Land value	✓			*urban agriculture:* (Weerakoon, 2014)[1]
	Land use	✓	✓		*urban agriculture:* (Kamali et al., 2025; Türker & Akten, 2023; Ustaoglu, 2021; Weerakoon, 2014)[1] (Newell et al., 2022)[2] *garden:* (Sonneveld et al., 2021)[1] (Limerick et al., 2023; Mack et al., 2017)[2]
	Vacant land	✓	✓		*urban agriculture:* (Newell et al., 2022; Russell et al., 2023)[2] *garden:* (Smith et al., 2021)[1] (Limerick et al., 2023; Mack et al., 2017; Zhang, 2022)[2]
	Elevation	✓			*urban agriculture:* (Ustaoglu, 2021)[1]
	Land slope	✓	✓		*urban agriculture:* (Kamali et al., 2025; Ustaoglu, 2021; Weerakoon, 2014)[1] (Türker & Akten, 2023)[2] *garden:* (Caneva et al., 2020; Limerick et al., 2023)[2]
	Erosion	✓			*urban agriculture:* (Ustaoglu, 2021)[1] (Türker & Akten, 2023)[2]

Criteria		Type of systems			Source ([1]: MCDA-GIS study; [2]: either MCDA or GIS separately, spatial planning, spatial optimization)
		Urban agriculture	*Garden*	*Green roof*	
Envrionment	Soil pedology and geology	✓	✓		*urban agriculture:* (Ustaoglu, 2021)[1] (Türker & Akten, 2023)[2] *garden:* (Sonneveld et al., 2021)[1] (Caneva et al., 2020)[2]
	Soil drainage requirement	✓			*urban agriculture:* (Ustaoglu, 2021)[1] (Newell et al., 2022; Türker & Akten, 2023)[2]
	Water management	✓		✓	*urban agriculture:* (Weerakoon, 2014)[1] *green roof:* (Gohari et al., 2023; Langemeyer et al., 2020)[2]
	Imperviousness surface	✓	✓		*urban agriculture:* (Newell et al., 2022)[2] *garden:* (Smith et al., 2021)[1]
	Access to water supply	✓	✓		*urban agriculture:* (Ustaoglu, 2021; Weerakoon, 2014)[1] (Türker & Akten, 2023)[2] *garden:* (Sonneveld et al., 2021)[1] (Caneva et al., 2020)[2]
	Sunlight		✓		*garden:* (Caneva et al., 2020; Limerick et al., 2023)[2]
	Aspect	✓			*urban agriculture:* (Ustaoglu, 2021)[1] (Türker & Akten, 2023)[2]
	Length of growing period		✓		*garden:* (Sonneveld et al., 2021)[1]
	Heat vulnerability		✓	✓	*garden:* (Smith et al., 2021)[1] (Zhang, 2022)[2] *green roof :* (Langemeyer et al., 2020)[2]
	Heat islands		✓	✓	*garden:* (Smith et al., 2021)[1] *green roof :* (Gohari et al., 2023; Langemeyer et al., 2020)[2]
	Biodiversity conservation		✓	✓	*garden:* (Caneva et al., 2020)[2] *green roof:* (Gohari et al., 2023; Langemeyer et al., 2020)[2]
	Noise pollution			✓	*green roof:* (Gohari et al., 2023)[2]
	Air pollution	✓		✓	*urban agriculture:* (Kazemi & Hosseinpour, 2022)[1] *green roof:* (Gohari et al., 2023)[2]
	Distance to urban traffic	✓	✓		*urban agriculture:* (Türker & Akten, 2023)[2] *garden:* (Codato et al., 2024)[1] (Caneva et al., 2020)[2]
	Distance to local pollution	✓	✓		*urban agriculture:* (Kazemi & Hosseinpour, 2022)[1] (Türker & Akten, 2023) *garden:* (Sonneveld et al., 2021)[1] (Caneva et al., 2020)
	Environmental sensitivity	✓			*urban agriculture:* (Weerakoon, 2014)[1](Türker & Akten, 2023; Weerakoon, 2014)[2]
	Type of ownership			✓	*green roof:* (Gohari et al., 2023)[2]
	Scenery of landscape			✓	*green roof:* (Gohari et al., 2023)[2]
Accessibility	Population density	✓	✓	✓	*urban agriculture:* (Weerakoon, 2014)[1] (Russell et al., 2023; Thapa et al., 2021)[2] *garden:* (Codato et al., 2024; Smith et al., 2021)[1] (Zhang, 2022)[2] *green roof:* (Langemeyer et al., 2020)[2]
	Residential density	✓	✓		*urban agriculture:* (Ustaoglu, 2021; Weerakoon, 2014)[1] *garden:* (Codato et al., 2024; Smith et al., 2021)[1] (Zhang, 2022)[2]
	Workplace proximity		✓		*garden:* (Smith et al., 2021)[1]
	Market proximity	✓	✓		*urban agriculture:* (Ustaoglu, 2021)[1] *garden:* (Sonneveld et al., 2021)[1]
	Community space/services proximity	✓	✓	✓	*urban agriculture:* (Newell et al., 2022)[2] *garden:* (Codato et al., 2024; Smith et al., 2021)[1] (Caneva et al., 2020; Zhang, 2022)[2] *green roof:* (Langemeyer et al., 2020)[2]
	School proximity		✓		*garden:* (Caneva et al., 2020)[2]

Criteria		Type of systems			Source ([1]: MCDA-GIS study; [2]: either MCDA or GIS separately, spatial planning, spatial optimization)
		Urban agriculture	*Garden*	*Green roof*	
Accessibility	Green space proximity		✓		*garden:* (Caneva et al., 2020) [2]
	Parking proximity		✓		*garden:* (Codato et al., 2024) [1]
	Bikeability		✓		*garden:* (Codato et al., 2024; Smith et al., 2021) [1] (Zhang, 2022) [2]
	Mass transit accessibility		✓		*garden:* (Codato et al., 2024; Smith et al., 2021) [1] (Zhang, 2022) [2]
	Walkability			✓	*green roof:* (Langemeyer et al., 2020) [2]
	Road accessibility	✓	✓		*urban agriculture:* (Ustaoglu, 2021) [1] *garden:* (Sonneveld et al., 2021) [1] (Caneva et al., 2020) [2]
	Vehicle ownership	✓			*urban agriculture:* (Kamali et al., 2025) [1] (Thapa et al., 2021; Türker & Akten, 2023) [2]
	Distance to existing green space (e.g., park, garden)	✓	✓	✓	*urban agriculture:* (Kazemi & Hosseinpour, 2022) [1] (Newell et al., 2022) [2] *garden:* (Codato et al., 2024; Smith et al., 2021) [1] *green roof:* (Langemeyer et al., 2020) [2]
Population	Income	✓	✓	✓	*urban agriculture:* (Kamali et al., 2025) [1] (Thapa et al., 2021) [2] *garden:* (Codato et al., 2024; Smith et al., 2021) [1] (Limerick et al., 2023; Mack et al., 2017) [2] *green roof:* (Langemeyer et al., 2020) [2]
	Unemployment rate	✓		✓	*urban agriculture:* (Kamali et al., 2025) [1] *garden:* (Limerick et al., 2023; Mack et al., 2017) [2] *green roof:* (Gohari et al., 2023) [2]
	Education level	✓	✓		*urban agriculture:* (Thapa et al., 2021) [2] *garden:* (Limerick et al., 2023; Mack et al., 2017)
	Health	✓	✓	✓	*urban agriculture:* (Kamali et al., 2025) [1] (Thapa et al., 2021) [2] *garden:* (Smith et al., 2021) [1] (Mack et al., 2017) [2] *green roof:* (Gohari et al., 2023) [2]
	Ethnicity/race	✓	✓	✓	*garden:* (Smith et al., 2021) [1] (Limerick et al., 2023; Mack et al., 2017) [2] *green roof:* (Langemeyer et al., 2020) [2]
	Elderly		✓		*garden:* (Codato et al., 2024) [1]
	Renter/owner occupancy		✓		*garden:* (Limerick et al., 2023; Mack et al., 2017) [2]
	Existing social cohesion		✓		*garden:* (Codato et al., 2024) [1]
	Safety for women		✓		*garden:* (Sonneveld et al., 2021) [1]
Food	Proximity to food desert	✓	✓		*urban agriculture:* (Russell et al., 2023) [2] *garden:* (Smith et al., 2021) (Mack et al., 2017; Zhang, 2022) [2]
	Distance to fresh produce outlets	✓	✓	✓	*urban agriculture:* (Kamali et al., 2025) [1] (Newell et al., 2022; Thapa et al., 2021) [2] *garden:* (Mack et al., 2017) [2] *green roof:* (Langemeyer et al., 2020) [2]

Note. The green roof category also includes studies addressing green roofs more broadly, rather than specifically UA.

2.4 Highlights of gaps in the literature

Urban agriculture, with its diverse forms and multifunctional benefits, presents unique opportunities for strategic urban planning but has long struggled to be integrated into formal planning processes (Langemeyer et al., 2021). Although analytical spatial tools exist, their development and application across different contexts are still insufficiently explored. Research on GIS-MCDA has largely been limited to single case studies and rarely involved stakeholders throughout the entire process, restricting insights into the transferability of tools and approaches (Bousquet et al., 2023). Contextual factors further shape participatory planning support systems (PSS), yet comparative analyses examining their influence on both process and outcomes are still limited (Geertman, 2006; Lerer et al., 2015). This thesis addresses these gaps by developing a hierarchical GIS-MCDA framework for UA planning in two urban contexts and comparing its development to clarify limits of transferability and assess sensitivity to context.

CHAPTER 3 OVERVIEW OF METHODOLOGY

3.1 Context

This research compares the development of participatory GIS-MCDA frameworks for planning ground-level and rooftop shared gardens in Montreal (Canada) and Utrecht (the Netherlands). Frameworks were based on SSANTO, a GIS-MCDA planning support system for blue-green infrastructure (Kuller et al., 2019), and adapted from Lacroix et al. (2024) participatory process.

Ground-level and rooftop shared gardens were selected to capture both conventional and novel forms of urban agriculture (Evans et al., 2022; Hardman et al., 2022). Montreal and Utrecht were chosen for their diverse levels of institutional support to UA and city size, allowing exploration of context effects on participation and framework development.

3.2 Participatory process

The participatory process behind the GIS-MCDA framework was structured in four steps, each aligned with specific sub-objectives:

1. Stakeholder Management – Stakeholders were identified, categorized, and prioritized to ensure diverse representation across actor types, scales, expertise, and relationships (sub-objective 1).
2. Workshops 1: Objectives and Hierarchies – Planning objectives were derived from literature, prior frameworks, and team consultations, and organized into hierarchical means–ends networks (sub-objective 2).
3. Workshops 2: Weighting Objectives – Stakeholders assigned weights to objectives using swing weighting method (sub-objective 3).
4. Consultations: Attributes and Value Scales – Experts and stakeholders selected measurable attributes linked to objectives and defined value scales (sub-objective 4).

3.3 Comparative analysis and suitability maps

The outcomes of each component of the participatory process were compared between the two cities to identify patterns of similarity and difference, thereby helping assess the context-specificity and potential transferability of the resulting elements. Structured descriptive and statistical methods were applied to assess convergence/divergence in the different outcomes (sub-objectives 1 to 4).

Suitability maps were produced under different configurations of hierarchies of objectives and weights to further assess the limits of transferability in terms of influence on planning outcomes. Again, statistical methods were applied to test the sensitivity of suitability maps to context-specificities and further validate the potential of transferability (sub-objective 5).

Further details regarding the methodology are given in section 4.5 Methods.

CHAPTER 4 ARTICLE 1: TRANSPLANTING URBAN AGRICULTURE PLANNING: ASSESSING CONTEXT-SENSITIVITY AND TRANSFERABILITY OF A SPATIAL MULTICRITERIA ANALYSIS FRAMEWORK ACROSS CANADIAN AND DUTCH CITIES

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4.2 Abstract

Urban agriculture (UA) can significantly contribute to urban resilience, but its benefits depend on strategic spatial implementation. Planning support systems (PSS), such as GIS-MCDA frameworks, have been developed to support this process; however, their adaptability and transferability remain constrained by context-sensitivity. Through a comparative case study in Montreal (Canada) and Utrecht (the Netherlands), this research analyzes the development of a comprehensive GIS-MCDA framework for UA planning to assess how context influences both the approach and its outputs, while advancing comparative, large-scale analyses in urban agriculture planning. Results indicate that siting criteria are largely consistent across contexts, suggesting a degree of transferability at the conceptual level and enabling the identification of shared planning objectives. Differences emerge in planning objectives prioritization, with higher agreement between cities observed for rooftop shared gardens than for ground-level systems. The selection of attributes and value scales is strongly shaped by data availability and expert judgment, highlighting context-dependent constraints and low transferability. Although removing context-specific

objectives and applying weights transferred between Montreal and Utrecht can shift and potentially inflate suitability scores, the identification of priority areas for implementation remains largely consistent. Overall, this comparative analysis demonstrates how context shapes each component of the framework, clarifies the limits of transferability, and provides practical guidance for adapting PSS to new urban settings.

4.3 Keywords and highlights

Keywords: urban agriculture, PSS, transferability, GIS-MCDA, urban planning

- Siting objectives for urban agriculture are largely consistent across contexts.
- Participants agree more on the prioritization of rooftop shared garden objectives.
- Choice of attributes are highly guided by data availability and expert judgement.
- Transferable components shift upward the range of suitability scores.
- Transferable components have little influence on planning outcomes.

4.4 Introduction

Urban resilience sits at the heart of today's urgent urban agenda around the world (Datola, 2023; Meerow et al., 2016; UN-Habitat, 2024). Defined as "the ability of urban systems not only to maintain essential functions but also to improve its original conditions" (Datola, 2023, p. 5), urban resilience is multidimensional, dynamic and complex. Central to the concept is the notion of "diversity" which relates to the existence of several functionalities which together enhance the ability of adaptation to a large spectrum of diverse circumstances (Ribeiro & Pena Jardim Gonçalves, 2019).

In this context, urban agriculture (UA), including systems such as community and allotment gardens, rooftop farms and urban orchards, stands out for its multifunctionality and its contribution to multiple dimensions of urban resilience (Evans et al., 2022; Langemeyer et al., 2021; Pradhan et al., 2023). Like other forms of blue-green infrastructure, it can support the natural dimension of urban resilience, which encompasses the ecological and environmental resilience, through ecosystem and land management functions, including biodiversity support, microclimate regulation and stormwater management (Anderson & Gough, 2022; App et al., 2022; Kolasa-Więcek & Suszanowicz, 2021; Meerow & Newell, 2017). Although sometimes considered overstated by some (Korth et al., 2014; Siegner et al., 2018; Zezza & Tasciotti, 2010), UA also contributes to urban food resilience (Barthel & Isendahl, 2013; Menconi et al., 2020; Tomatis et al., 2023), as it provides an alternative and complementary source of food within the predominantly globalized food system (Corrigan, 2011). Moreover, UA contribution to the social dimension of urban resilience is broadly acknowledged (Menconi et al., 2020; Säumel et al., 2019; Tomatis et al., 2023), as urban gardening initiatives and activities are consistently associated with community building, social cohesion and collective engagement (Mesimäki et al., 2017; Petrovic et al., 2019; Truong et al., 2022).

Strategically locating UA is crucial for its effective contribution to resilience (Menconi et al., 2020). Nevertheless, a lack of awareness of the multifunctionality of UA and a lack of formal recognition of UA in planning policy have repeatedly emerged in the literature over the years as limiting factors for its recognition in urban planning as a strategy for sustainable urbanization and urban resilience (Artmann & Sartison, 2018; Langemeyer et al., 2021; Pothukuchi & Kaufman, 2000; Quon, 1999). Sporadically, UA had been associated with concepts of green infrastructure (GI) and nature-based solutions (NBS) through terms such as "productive green infrastructure" (Lin et al., 2017), "edible green infrastructure" (Russo et al., 2017), "food-productive green infrastructure" (Bohn & Chu, 2021) and "edible NBS " (Mino et al., 2021). These parallels with GI and NBS concepts were reinforced not only by common benefits and functions but also by shared challenges between UA systems and some types of GI and NBS. In particular, their implementation was and still is both spatially constrained and often ends up being planned on disused urban spaces (Contesse, 2018; Lin et al., 2017).

Urban planning faces increasing complexity, marked by multiple objectives and constraints, uncertainties related to data and future developments, and the need to make decisions within tight deadlines (Lombardi & Ferretti, 2015). To meet these challenges, Planning Support Systems (PSS) emerged in the mid-1990s as spatial tools specifically designed to support planning tasks (Geertman & Stillwell, 2009). PSS are characterized by their practical purpose and concrete application: they contribute directly to planning tasks such as information management, communication, and analysis, all within a specific planning context and scale (Geertman & Stillwell, 2003). Within the family of PSS, Multi-Criteria Decision Analysis supported by Geographic Information Systems (GIS-MCDA) combines geographic data and stakeholder value judgment to assess the performance of alternative options (Malczewski, 2006). The integration of GIS with MCDA has enabled significant advances in spatial decision support and participatory GIS. Indeed, these developments have been argued to reduce top-down opportunism in spatial planning and decision-making by providing a replicable and accountable procedure (Kuller et al., 2021; Malczewski, 2006).

PSS and GIS-based multicriteria decision analysis have been recognized as highly context-dependent, advising caution regarding their transferability and adaptation while contributing to a gap between their availability and their practical implementation across contexts (Lerer et al., 2015; Page et al., 2020; Pettit et al., 2018). More recently, Lacroix et al. (2024) adapted and developed a GIS-MCDA–based PSS originally developed in Australia, to the Quebec context. This tool, named *Spatial Suitability ANalysis TOol* (SSANTO), integrates stakeholder-defined and weighted objectives, spatial data, and value functions to generate suitability maps that support planning decisions for the implementation of blue-green infrastructures. Their findings showed that while the transferability of PSS components varies across methodological elements, such as objectives, attributes, spatial data, and value scales, many of these components remain potentially transferable, either worldwide (objectives and attributes) or at least at a regional scale (spatial data and value scales).These findings contrast with earlier perspectives emphasizing strong context-dependency, highlighting the importance of further examining how such tools are developed and applied across different settings.

Thus, two key research gaps emerge. First, the integration of UA into urban planning remains limited and underrepresented within GI siting. Moreover, the influence of context-dependency on the transferability of PSS and their outputs is still insufficiently understood. To address those, this research analyzes the development of a GIS-MCDA–based PSS framework for UA planning, with the goal of assessing how context influences both the approach and its outputs.

The study is guided by the following objectives:

1) Co-develop a comprehensive GIS-MCDA suitability framework for UA, integrating stakeholders' inputs to support the strategic siting of UA systems;
2) Investigate the extent to which context influences the components of the GIS-MCDA–based PSS;
3) Test the sensitivity of suitability maps to transferable components of the GIS-MCDA–based PSS.

The adaptation of MCDA has mostly been studied in single case studies and has rarely involved stakeholders at every stage, limiting our understanding of the broader transferability of such participatory processes (Bousquet et al., 2023). In the urban agriculture literature, the scarcity of comparative case studies and large-scale analyses has similarly limited the ability to identify broader patterns in development and planning across diverse geographical and socio-political contexts (Ribeiro et al., 2023). By comparing two distinct urban contexts through a comparative case study, we aim to clarify how context shapes each component of the framework, define limits to transferability, and provide practical guidance for adapting PSS to different settings, thereby supporting more strategic planning practices for UA in varying contexts.

4.5 Methods

This research was structured as a comparison of the outcomes of the development of a comprehensive GIS-MCDA framework for ground-level and rooftop shared gardens planning in two different urban contexts. The framework was based on the *Spatial Suitability ANalysis TOol* (SSANTO), a GIS-MCDA-based PSS for blue-green infrastructure planning (Kuller et al., 2019). Building on Lacroix et al.'s (2024) participatory process, we developed the framework for those two UA systems and structured it into the following four steps: (step 1) implementing stakeholder management, (step 2) identifying criteria, referred to as objectives, and organizing them into a hierarchy of objectives (workshops 1), (step 3) eliciting stakeholder preferences through objectives' weighting (workshops 2), (step 4) selecting spatial attributes for all objectives and eliciting their value scales, which allow translating datasets into spatial suitability scores (consultations). Suitability maps were subsequently generated by applying the developed frameworks in the two case study cities, Montreal (Canada) and Utrecht (the Netherlands). We first examined the influence of context on the different components of the participatory process to highlight potentially transferable elements. We then tested the transfer of these components between cities by generating suitability maps using transferred configurations and comparing them with suitability maps produced using the full city-specific frameworks. This second phase allowed us to assess both the practical transferability of the components and the extent to which their transfer influenced the planning outcomes of the GIS-MCDA tool.

4.5.1 Study context

4.5.1.1 Geographical scope

The choice of studying Montreal and Utrecht was guided by the diverse case selection technique outlined by Seawright & Gerring (2008), whereby cases are chosen to exemplify contrasting values on key dimensions. Although Montreal and Utrecht have established climate adaptation approaches, comparable levels of data availability, and similar socio-economic conditions, they differ in terms of city size and the level of institutional support for UA.

Montreal and Utrecht are two Global North cities with comparable standards of living that are expecting and adapting for impacts of climate change (Gemeente Utrecht, 2022; Ville de Montréal, 2025). Utrecht, covering 99.21 km^2, is the fourth most populous city in the Netherlands, with a population of 378,140 residents and a population density of 3,812 inhabitants per km^2 (Gemeente Utrecht, 2026). The 498 km^2 forming the island of Montreal are divided into 16 municipalities averaging 4,419.3 inhabitants per km^2 and a total population of 2,172,259 inhabitants (Institut de la statistique du Québec, 2025). In this study, the term "Montreal" was used to refer to this territory for consistency with the terminology most commonly employed by stakeholders[1].

Differences in their surrounding environments shape how Utrecht and Montreal interact with urban agriculture. In the Netherlands, the Randstad–Groene Hart planning framework establishes a strict separation between urban development and agricultural land resulting in no clear policy support system established for the development of UA (Haenen et al., 2018; Medema et al., 2024; Ministry of Infrastructure and the Environment, 2012). It is nonetheless a living component of the city, largely operating outside direct municipal administration and coordination. In contrast, the City of Montreal's engagement with UA started as early as 1975, with the institutionalization of a municipal community garden program and evolved up to the elaboration of a Strategic Plan for Urban Agriculture in 2021 (Ville de Montréal, 2021) as well as to Montreal being acknowledged as the global capital of UA (Druine & Duchemin, 2023).

4.5.1.2 System scope

The choice of studying ground-level shared gardens and rooftop shared gardens, two types of UA systems, distinguished primarily by the area of production, was motivated by an interest in studying both a conventional and a more novel form of UA (Evans et al., 2022; Hardman et al., 2022; Lin et al., 2017). Shared gardens, used here as an umbrella term encompassing different types of gardens such as community gardens, allotment gardens and collective gardens, are defined as spaces for growing vegetables and plants, divided into individual plots or organized as a common area, accessible to a specific group of people (Mestiri & Berthold, 2024).

[1] It is important to recognize that the island of Montreal (*Tiohtià:ke*) is located on unceded Indigenous territories, historically recognized as a gathering place for many First Nations, including the Kanien'kehá:ka Nation.

4.5.2 Participatory process design

The participatory process consisted of four steps presented in Figure 4.1 and further explained in the following sections.

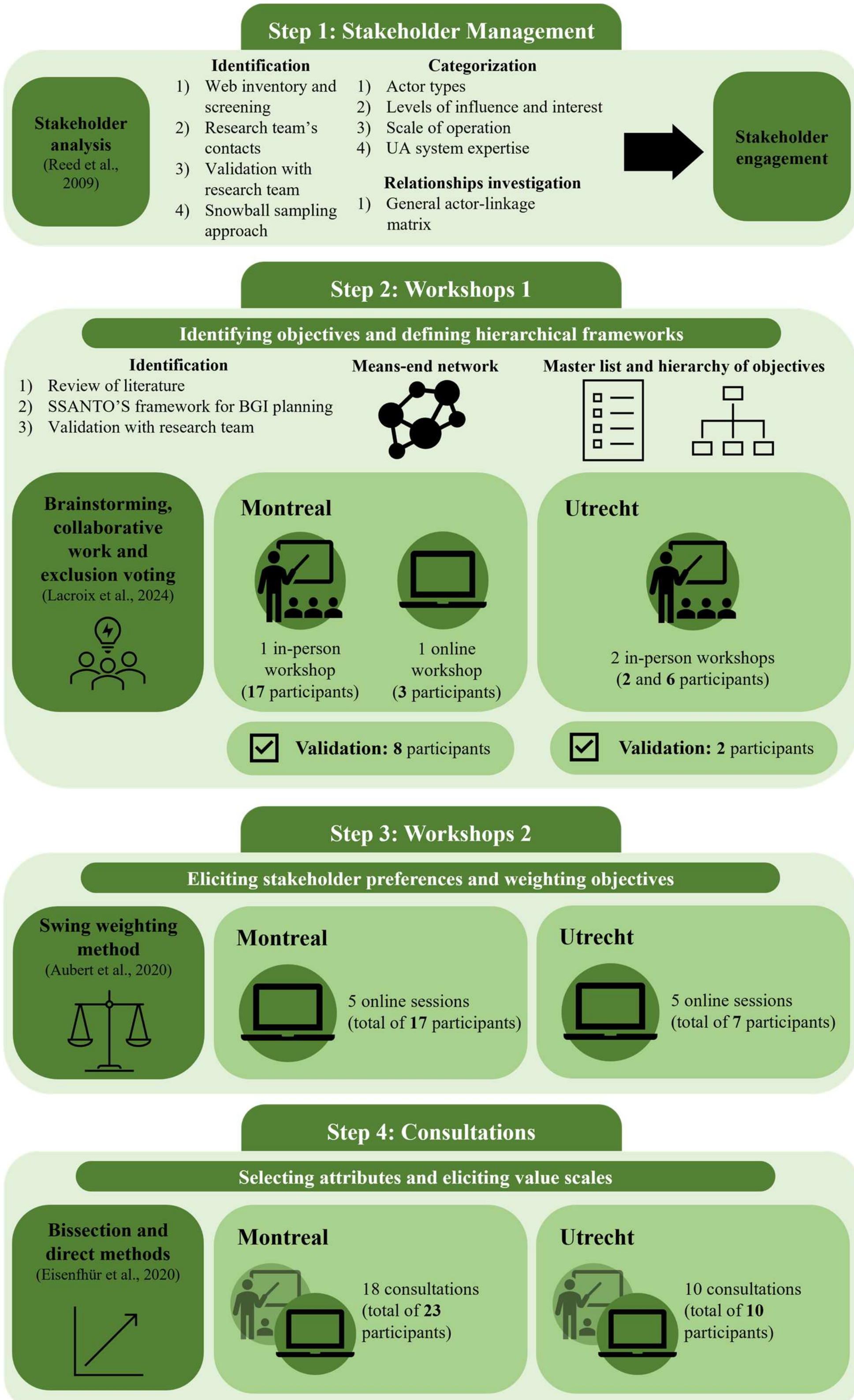

Figure 4.1 Participatory process design

4.5.2.1 Implementing stakeholder management

Given the decisive role of stakeholders in shaping the outcomes of a participatory process (de Vente et al., 2016), stakeholder management, starting with stakeholder analysis, is key. Following Reed et al. (2009) three-steps methodology, we first identified relevant stakeholders in both studied cities. Stakeholders were first identified through a web inventory and a screening of portraits, guides, strategies and development plans relating to urban agriculture, urban food system and urban sustainability and resilience. The preliminary list was further enriched by the authors' and research team members' contacts in the field. As a final identification step, we followed a snowball sampling approach reflecting methods similar to those used by Sanyé-Mengual et al. (2016) and Schulp et al. (2022).

We continued with categorizing stakeholders, to support the identification process and minimize the likelihood of omitting relevant actors (Stanghellini, 2010). Four analytical categorizations, established on a theoretical perspective of the system's structure and dynamics, were conducted. Among them, the main categorization was based on actor types, leading to the identification of seven stakeholder groups adapted from Di Fiore et al.'s (2021), Sanyé-Mengual et al.'s (2016) and Zambrano-Prado et al.'s (2021): urban farmers, food system actors, local and national governments, local administrators, technicians and developers, academics and researchers, local residents, and others. Further details on these actor types and the other analytical categorizations are provided in section SI-1.1.1. Finally, stakeholders' relationships and interaction were investigated with a general actor-linkage matrix of the seven actor categories (Table SI-2).

Building on stakeholder analysis, stakeholder engagement focused on strategically prioritizing stakeholders for recruitment to ensure diversity of perspectives and representation across actor categories. Further details regarding this step are provided in the section SI-1.1.1.

4.5.2.2 Workshops 1: Identifying objectives and defining hierarchical frameworks

Criteria for UA siting were first retrieved from three main sources: (1) review of literature including prior published examples of spatial suitability analyses for UA as well as published studies highlighting benefits and constraints associated with urban agriculture, (2) adapted SSANTO's existing spatial suitability framework for BGI planning (Lacroix et al., 2024), and (3) consultation with research team members. More details about the review of literature and the sources consulted for criteria identification are presented in sections SI-1.2.1 and SI-1.2.2.

Criteria were formulated as planning objectives in accordance with the process developed by Lacroix et al. (2024), drawing on methods outlined by Eisenführ et al. (2010). Those identified objectives were further differentiated according to two suitability perspectives (Kuller et al., 2017, 2019). The first perspective refers to the opportunities that a site offers for UA systems implementation (the idea of "UA needs a place"). The second perspective refers to the needs of a site in terms of the potential benefits (ecosystem services, including supporting, provisioning, regulating, and cultural services) derived from UA systems implementation (the idea of "a place needs UA"). Means-ends networks helped differentiate between means and fundamental objectives (Eisenführ et al., 2010), as well as between opportunities and needs (section SI-1.2.3). The goal of workshops 1 was to co-define planning objectives and validate the master list of objectives previously identified. Participants engaged in a series of activities based on Lacroix et al.'s (2024) methodology, including individual brainstorming, collaborative grouping of objectives, individual sorting of objectives as well as a group discussion (section SI-1.2.4). Results from workshops 1 were analyzed to determine which objectives should be added to or excluded from the initial hierarchy, after which a final validation step with stakeholders led to the development of the final co-created hierarchies (section SI-1.2.5).

4.5.2.3 Workshops 2: Eliciting stakeholder preferences and weighting objectives

The goal of workshops 2 was to elicit stakeholders' preferences and derive weights for the planning objectives. Consistent with the work of Lacroix et al. (2024) and Rioux et al. (2025), objective weights were elicited using the swing weighting method through an online tool developed by Aubert et al. (2020) (section SI-1.3). All participants completed four questionnaires, corresponding to the combination of the two UA systems and the two suitability perspectives.

4.5.2.4 Consultations: Selecting attributes and eliciting value scales

The goal of the consultations was to select attributes, which correspond to measurable elements, linked to objectives and to elicit their corresponding value scales. Because the attributes represent different elements and are therefore presented in different units, they must be converted to a common scale. This step, known as value scaling, standardizes the values of different variables to enable comparability between objective values (Eisenführ et al., 2010). Preparatory work conducted prior to value-scale elicitation with experts is detailed in section SI-1.4.1.

For continuous attributes (e.g., population density expressed in inhabitants/km²), value scales were elicited using the bisection method (Eisenführ et al., 2010). This approach first defines the worst and best attribute levels, then identifies the midpoint value ($x_{0.5}$), followed by two additional points that bisect the resulting intervals ($x_{0.25}$ and $x_{0.75}$). For discrete or binary attributes (e.g., types of ownership), the direct method was employed, which consists of ranking the possible options and then assigning values to the ranked categories.

4.5.3 Comparative data analysis

To investigate the transferability of GIS-MCDA–based PSS components across contexts, the comparative analysis was structured in two analytical phases (Figure 4.2). First, we examined the influence of context on PSS components through between-city comparisons of the participatory process outcomes in Montreal and Utrecht. Second, we evaluated the influence of potentially transferable components on planning outcomes through within-city scenario analyses comparing suitability maps generated under different hierarchy and weighting configurations.

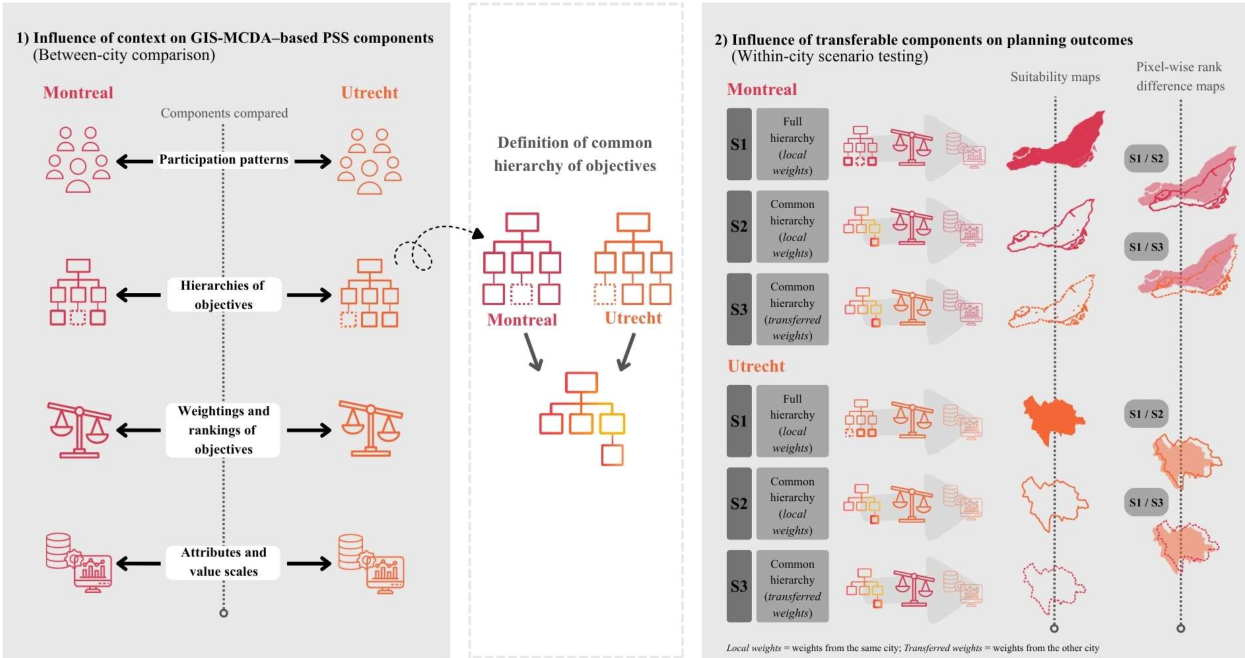

Figure 4.2 Comparative analysis structured in two main analytical phases

4.5.3.1 Between-city comparison of participatory process components

To assess convergence and divergence across contexts, we first employed structured descriptive methods. We systematically compared the outcomes of the two cases for three elements: participant composition, objective hierarchies as well as attributes and their corresponding value scales. For each element, we summarized patterns of similarity and difference, using tabular overviews and frequency distributions to highlight both shared trends and context-specific variations. The comparison of objective hierarchies further enabled the identification of a common hierarchy of objectives composed exclusively of sub-objectives shared between Montreal and Utrecht. This common hierarchy was subsequently used in the transferability analyses described in section 4.6.2.

Given the small sample sizes and the distributional characteristics of the data, we primarily employed non-parametric statistical methods. For all analyses, a value of $\alpha < 0.05$ indicated statistical significance.

We computed Kendall's coefficient of concordance (W) to assess the level of agreement among raters. This coefficient evaluates the degree of agreement in rankings assigned to a set of subjects (here, sub-objectives) by multiple raters (here, stakeholders). It ranges from 0 to 1, with 0 indicating no agreement among raters and 1 indicating perfect agreement. We used Schmidt's (1997) Kendal's W interpretation table to describe levels of agreement.

To assess the correlation between mean weightings of the sub-objectives in Montreal and Utrecht, we computed both Kendall's τ, or Kendall's rank correlation coefficient, which is a non-parametric statistic test that measures the strength and direction of association between ranked variables, and Pearson's correlation coefficient, which is a parametric statistic test that quantifies the linear relationship between continuous variables (here, the mean weightings themselves rather than their ranks). The coefficients range from -1 to 1, where 0 indicates no correlation and 1 and -1 indicate perfect concordance or discordance, respectively (Lovric, 2011).

To evaluate differences at the level of individual sub-objectives, we computed the Mann–Whitney U test with Benjamini–Hochberg procedure (Lovric, 2011). It compares the distributions of a variable between two independent groups (here, participants from Montreal and Utrecht) based on rank data. Both the p-value and the effect size (r), the most commonly reported effect size measure for the Mann–Whitney U test (Berry et al., 2018), were calculated to assess both the statistical significance and the magnitude of the differences.

4.5.3.2 Within-city scenario analysis of planning outcomes

The second analytical phase evaluated how potentially transferable PSS components influenced planning outcomes within each city. Rather than comparing Montreal and Utrecht directly, this phase compared suitability maps generated under different transferability scenarios within the same territorial context. Three suitability map scenarios, with varying components described below, were produced for each city:

1. Full hierarchy using local weights (S1);
2. Common hierarchy using local weights (S2);
3. Common hierarchy using the other city's weights (S3).

The second scenario isolated the influence of restricting the analysis to transferable objectives, whereas the third scenario further evaluated the influence of transferring stakeholder preference patterns between contexts. After the production of suitability maps based on full hierarchy, objective weights associated with the common hierarchy were renormalized by rescaling the values derived from the swing weighting method to the remaining common objectives. For all scenarios, spatial masks were applied to exclude buildings from the ground-level shared garden suitability maps and to preserve only buildings on the rooftop garden suitability maps. To ensure consistent data coverage across the study area, the analyses were restricted to the territory of the city of Montreal, excluding the reconstituted cities.

First, for visual assessment of score distributions across scenarios, we plotted the density of suitability scores. In addition, to assess differences in distribution of suitability values between the maps, we conducted statistical analyses on the pixel values of the maps. More specifically, the paired Wilcoxon signed-rank test was applied, testing for median differences while accounting for the paired nature of the data (Lovric, 2011). The magnitude and direction of these differences were quantified using the rank-biserial correlation (r_{rb}) as an effect size measure. To further compare the overall distributions, we performed the Kolmogorov–Smirnov (KS) test, which captures broader distributional differences that may not be reflected in median values alone. Varying from 0 to 1, where 0 represents two identical distributions, it quantifies the maximum difference between two functions, detecting differences in shape, spread, and central tendency (Lovric, 2011). Finally, Spearman rank correlations were applied to quantify the degree of monotonic association between the full and subset suitability maps and thus evaluate whether the relative ranking of locations is preserved under different configurations. Like for Pearson's correlation coefficient, the values range from −1 to 1, where 0 indicates no association and 1 and −1 indicate perfect positive or negative associations, respectively.

4.6 Results

4.6.1 Contextual variation and convergence in participatory process components

4.6.1.1 Similarity in actor-type distributions but differences in participation levels

A total of 40 participants took part in the participatory process in Montreal and 17 in Utrecht (Figure 4.3). Participation remained consistently higher in Montreal across the different steps of the process, yet Montreal is approximately five times larger and more populous than Utrecht. Additionally, 12 stakeholders in Montreal and 7 in Utrecht participated in at least two of the three stages of the process (Table 4.1).

Table 4.1: Distribution of participants by number of steps completed in the participatory process

	Participants (3/3 steps)	**Participants (2/3 steps)**	**Participants (1/3 steps)**	**Total number of participants**
Montreal	8	4	28	40
Utrecht	1	6	10	17

In both cities, the distribution of participants across actor types was similar at each step of the process (Figure 4.3). Urban farmers and food system actors were only minimally represented across the three steps. During workshops 1, local and national government representatives constituted the largest group of participants in both cities (Montreal: 7 and Utrecht: 4). During workshops 2, governmental actors remained strongly represented and continued to form the largest group (Montreal: 6 and Utrecht: 2), tied with academics and researchers in Montreal and with local administrators, technicians and developers in Utrecht. For consultations in Montreal, local and national governments were again the most frequently consulted experts (12) alongside academics and researchers (9). In Utrecht, academics and researchers constituted the largest group (5), accounting for half of the experts consulted.

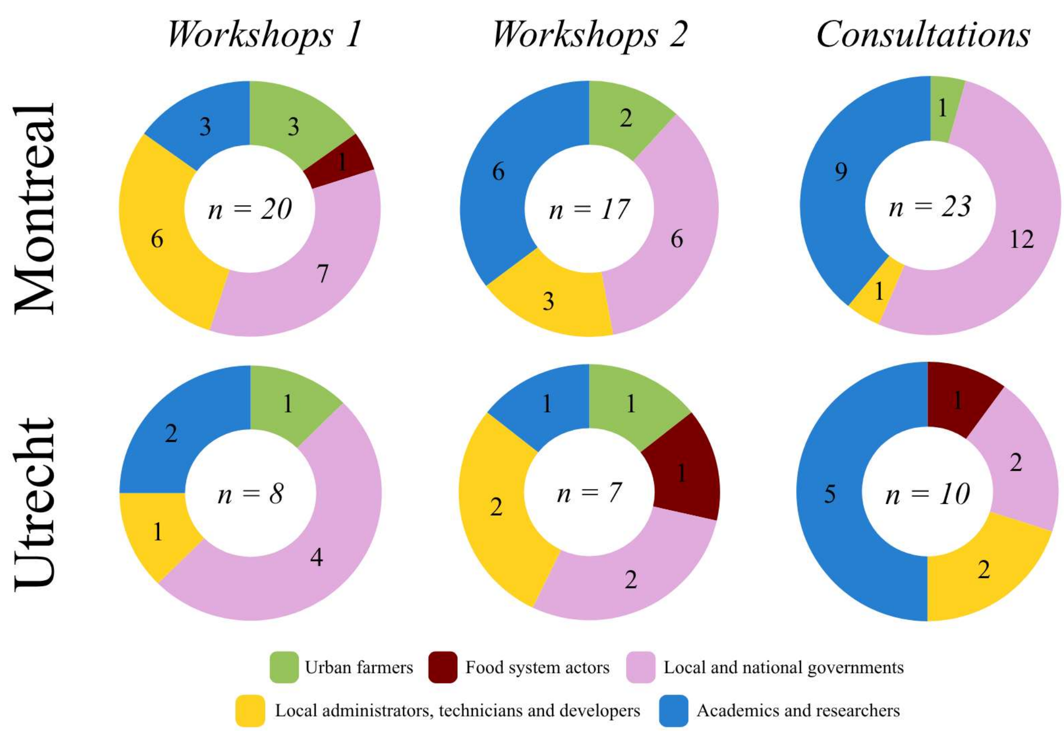

Figure 4.3 Distribution of participants by actor types in Montreal and in Utrecht across the three steps of the participatory process

4.6.1.2 Global convergence of hierarchies of objectives enabling the creation of common hierarchies between Montreal and Utrecht

Following workshops 1 results analysis, five sub-objectives were excluded by Montreal's participants from the initial hierarchies and four by Utrecht's participants (Table 4.2). Participants in Montreal justified the exclusion of *maximize locating on fertile soil* by indicating that soil fertility could be improved through soil replacement or amendment, which is common practice when establishing new gardens. In Utrecht, this same premise was reinforced by the perception that soils across the city are relatively homogeneous. Following similar reasoning as for the previous excluded sub-objective, the perceived homogeneity of soils across Utrecht was mentioned to limit variation in drainage conditions, reducing the perceived relevance of this sub-objective by participants. Accessibility by public and active transportation was likewise regarded as relatively homogeneous throughout the city. In Montreal, stakeholders considered the sub-objectives related to conflicts with building foundations and noise pollution to be irrelevant to the UA systems under discussion.

Table 4.2: Excluded sub-objectives from the initial hierarchies

Type of system	Perspective	**Excluded sub-objectives**	**MTL**	**UTR**
Ground-level shared gardens	Opportunities	↑ locating on fertile soil	X	X
		↑ locating on sites with optimal drainage conditions		X
		↓ conflicts with building foundations	X	
		↓ land acquisition costs	X	
	Needs	↑ locating near public and active transportation		X
Rooftop shared gardens		↑ the visibility of the roof	X	X
		↓ noise pollution	X	

Note. Arrows denote direction of objective: maximixe (↑) and minimize (↓)

Across both the needs and opportunities perspectives, all four final hierarchies contained between 11 and 13 sub-objectives. When minor wording differences were omitted and sub-objectives referring to the same underlying concept counted as one (e.g., *maximize locating on roofs with sufficient space* and *maximize locating on sites with sufficient space*), a total of 34 distinct sub-objectives were identified across all hierarchies: 19 related to opportunities and 15 related to needs. Comparing the rooftop shared garden hierarchies of Utrecht and Montreal showed that they had 10 sub-objectives in common for needs and 10 for opportunities. For ground-level shared gardens, 11 needs-related sub-objectives and 10 opportunities-related sub-objectives were shared between the two cities. Across both system types, Montreal's hierarchies included five sub-objectives exclusive to the city, three of which were introduced following participants' suggestions (Figure 4.4 & Figure 4.6). Utrecht's hierarchies included four exclusive sub-objectives, two of which were added following participants' suggestions (

Figure 4.5 & Figure 4.7).

Overall, Montreal's and Utrecht's hierarchies of objectives shared most sub-objectives, with only a few exclusive sub-objectives to each city. This high level of overlap enabled the creation of common hierarchies of objectives for both ground-level shared gardens and rooftop shared gardens (section SI-2.1.1).

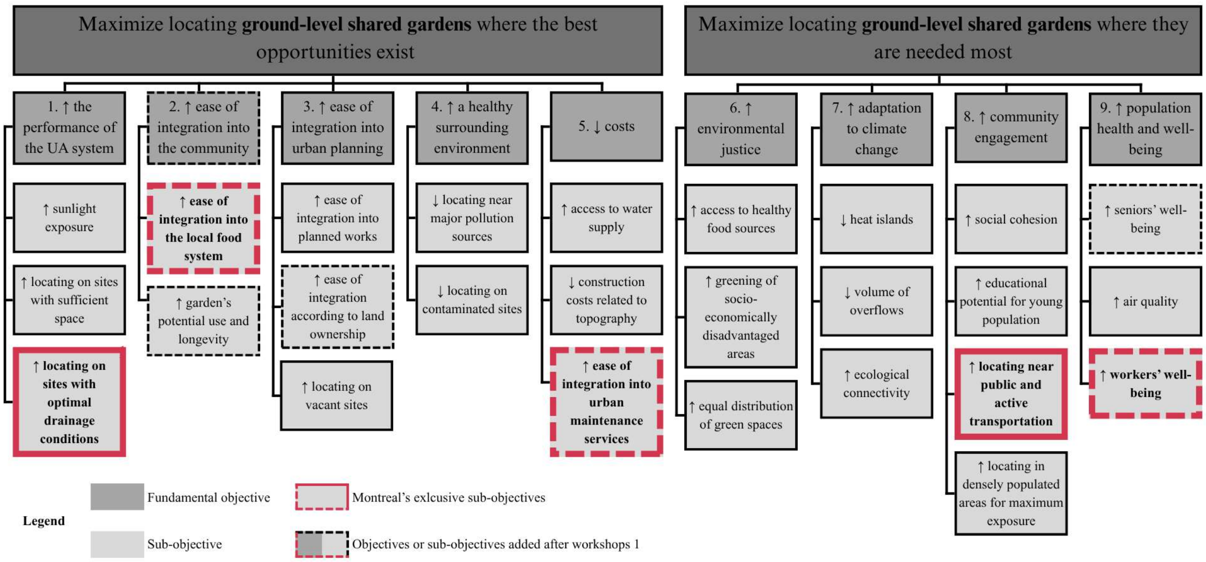

Figure 4.4 Montreal's final hierarchy of objectives for ground-level shared gardens.

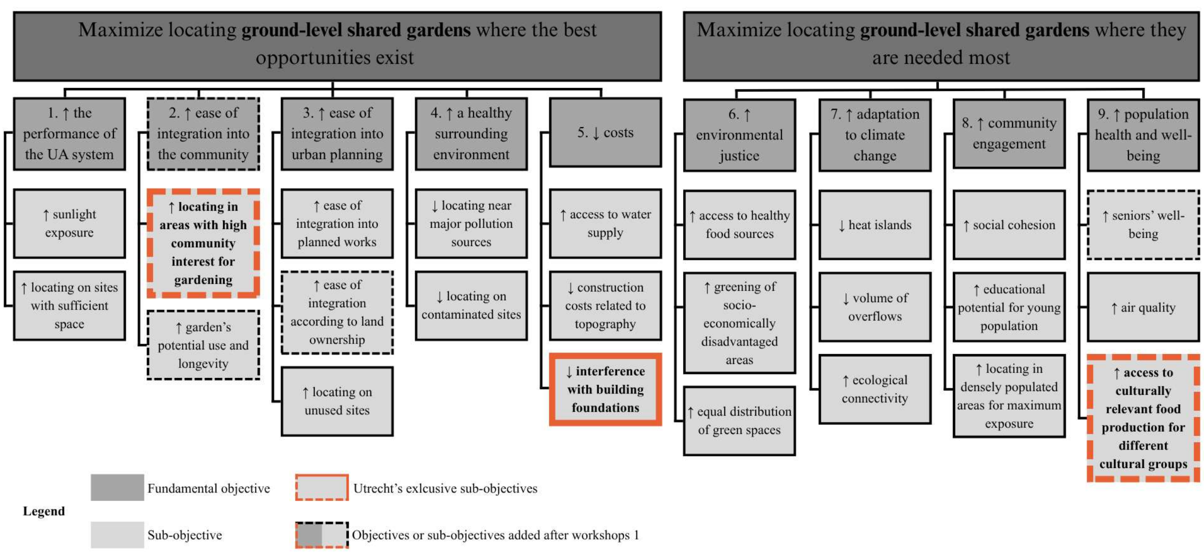

Figure 4.5 Utrecht's final hierarchy of objectives for ground-level shared gardens.

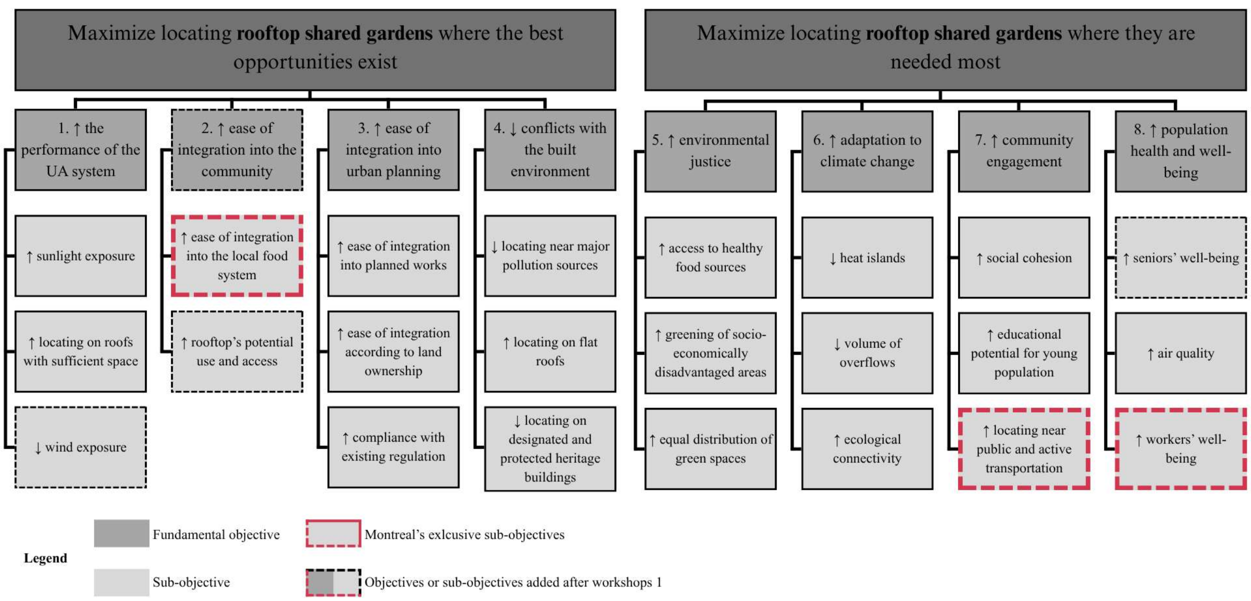

Figure 4.6 Montreal's final hierarchy of objectives for rooftop shared gardens.

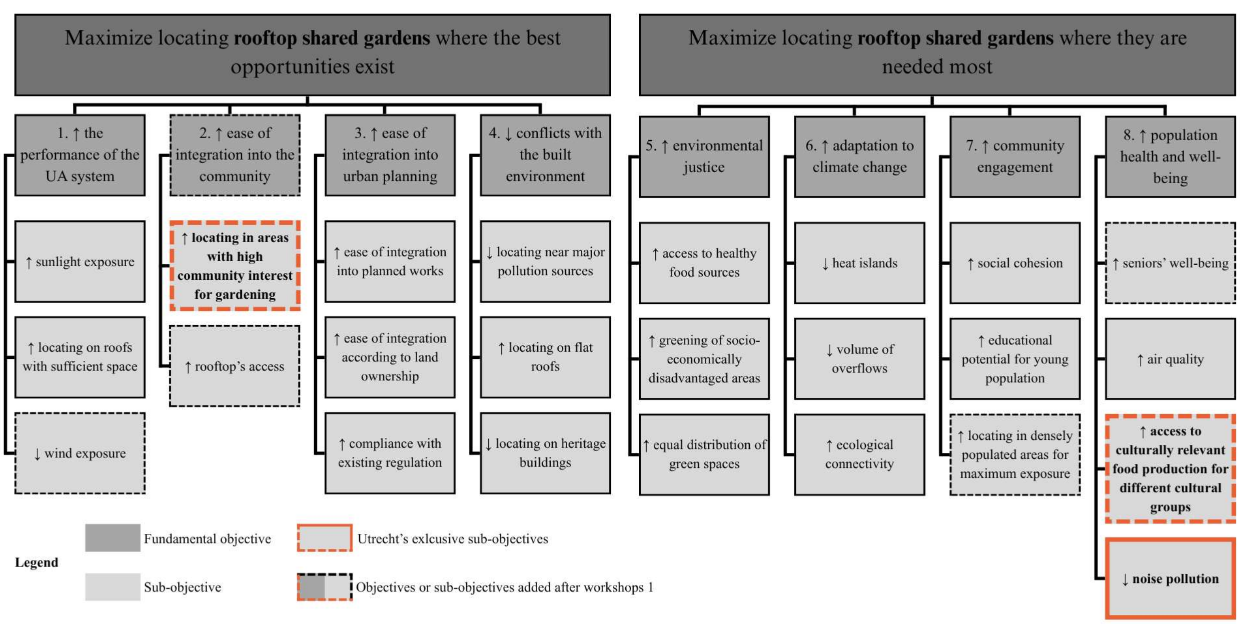

Figure 4.7 Utrecht's final hierarchy of objectives for rooftop shared gardens.

4.6.1.3 Weightings and rankings: low within-city agreement and varying between-city agreement across system types

Weightings and rankings of exclusive sub-objectives

Final mean weights of all sub-objectives are provided in section SI-2.1.2. Across the two cities and the two UA systems, mean weights varied between 0.02 and 0.16 with an average weight of 0.08. Among the exclusive sub-objectives from each hierarchy, nine out of eleven were ranked relatively low, namely at the seventh place or lower, with mean weights between 0.04 and 0.07. This suggests that most city-specific sub-objectives have limited influence on overall prioritization. The only exception is Utrecht's sub-objective *maximize locating in areas with high community interest for gardening*, which ranked second for both ground-level and rooftop gardens (mean weight = 0.12).

Within city-agreement on weightings and rankings of objectives

Kendall's W computed for both the full hierarchies and the common hierarchies of objectives were consistently very similar (except for opportunities – ground-level shared gardens), indicating that the agreement results are robust to restricting the hierarchy to the subset of shared objectives (Table 4.3). Utrecht's Kendall's W values were systematically higher than Montreal's, with most values indicating a moderate level of agreement for Utrecht and a weak level of agreement for Montreal.

Table 4.3: Within-city agreement in sub-objective rankings: Kendall's coefficients of concordance (W) for the full and intersection hierarchies

Type of system	Perspective	City	Kendall's W (full)	Kendall's W (common)
Ground-level shared gardens	Opportunities	Montreal	0.28	0.21
		Utrecht	0.32	0.29
	Needs	Montreal	0.25	0.26
		Utrecht	0.38	0.36
Rooftop shared gardens	Opportunities	Montreal	0.23	0.24
		Utrecht	0.36	0.35
	Needs	Montreal	0.20	0.19
		Utrecht	0.43	0.42

Between city agreement on weightings and rankings of objectives

Mann–Whtiney U test allowed to compare ranks derived from renormalized weights from the common hierarchy between Montreal and Utrecht. For ground-level shared gardens, three needs sub-objectives (*maximize equal distribution of green spaces*, *maximize social cohesion*, and *maximize seniors' well-being*) were ranked significantly differently between the two cities (Figure 4.8). The first two were rated more highly by participants in Utrecht, whereas *maximize seniors' well-being* received higher ranks in Montreal. For opportunities, only one sub-objective (*minimize construction costs related to topography*) showed a statistically significant difference in weight, this sub-objective being evaluated more highly by participants in Montreal. No significant differences were observed between the two cities for rooftop shared gardens (Figure SI-11).

Ranks of the sub-objectives based on the mean renormalized weights from the common hierarchy were compared between Montreal and Utrecht. In the rank scatterplots, sub-objectives lying close to the 45° diagonal line indicate a high level of agreement in the prioritization of these sub-objectives. Notably, both cities showed complete agreement in prioritizing access to and use of shared gardens (opportunities perspective) for both types of systems (Figure 4.9). Stakeholders in both cities also assigned a low priority to *maximize seniors' well-being* for rooftop shared gardens. Sub-objectives ranked identically by participants from Montreal and Utrecht were distributed across low, middle, and high ranks for both suitability perspectives and systems. Overall, identical rankings occurred more frequently under the opportunities perspective, with six shared rankings across both systems and one under the needs perspective.

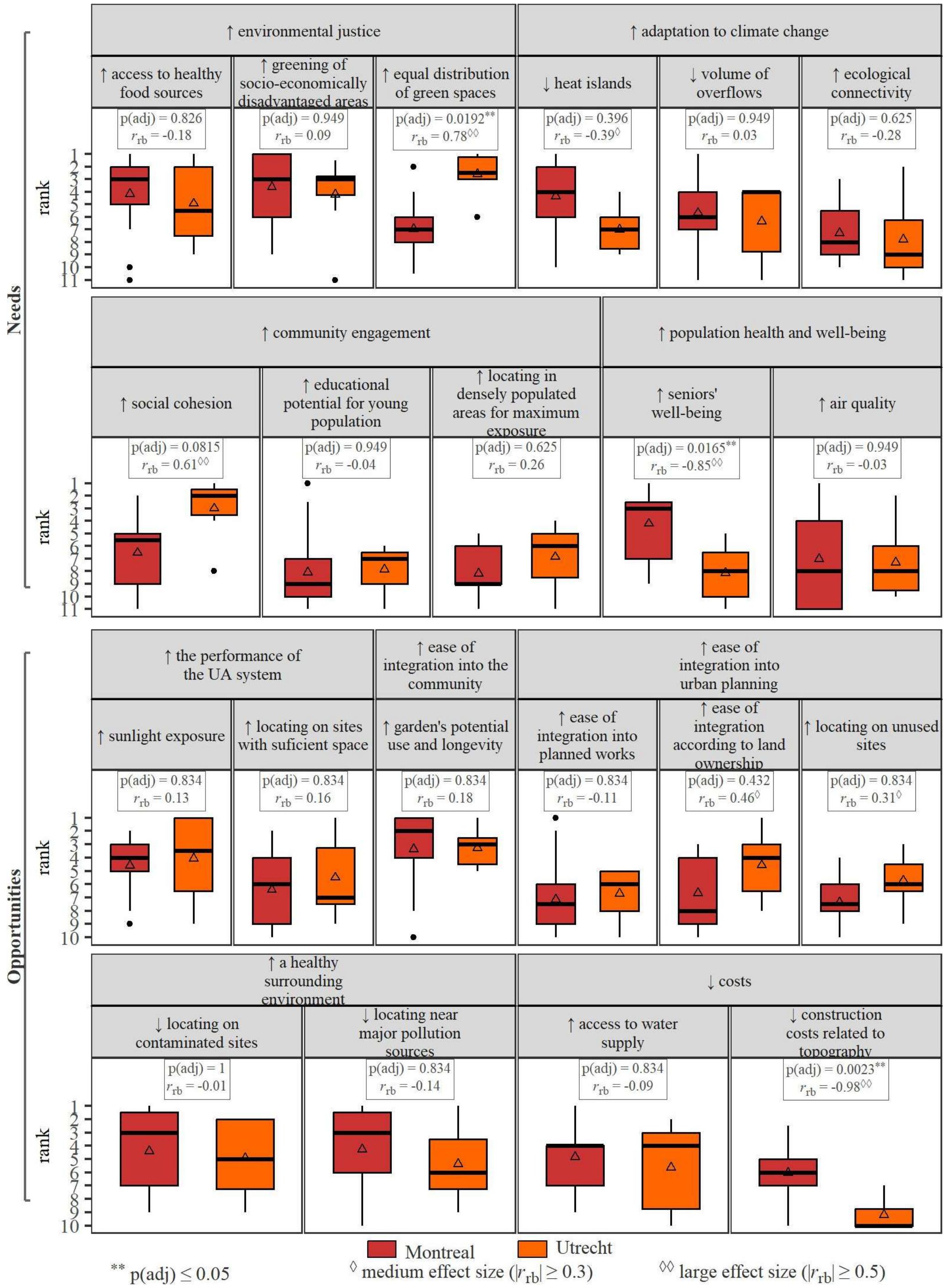

Figure 4.8 Boxplots showing the distribution of ranks derived from renormalized weights for each sub-objective for ground-level shared gardens. Differences between cities were assessed using Mann–Whitney U tests; p-values and effect sizes (r) are displayed.

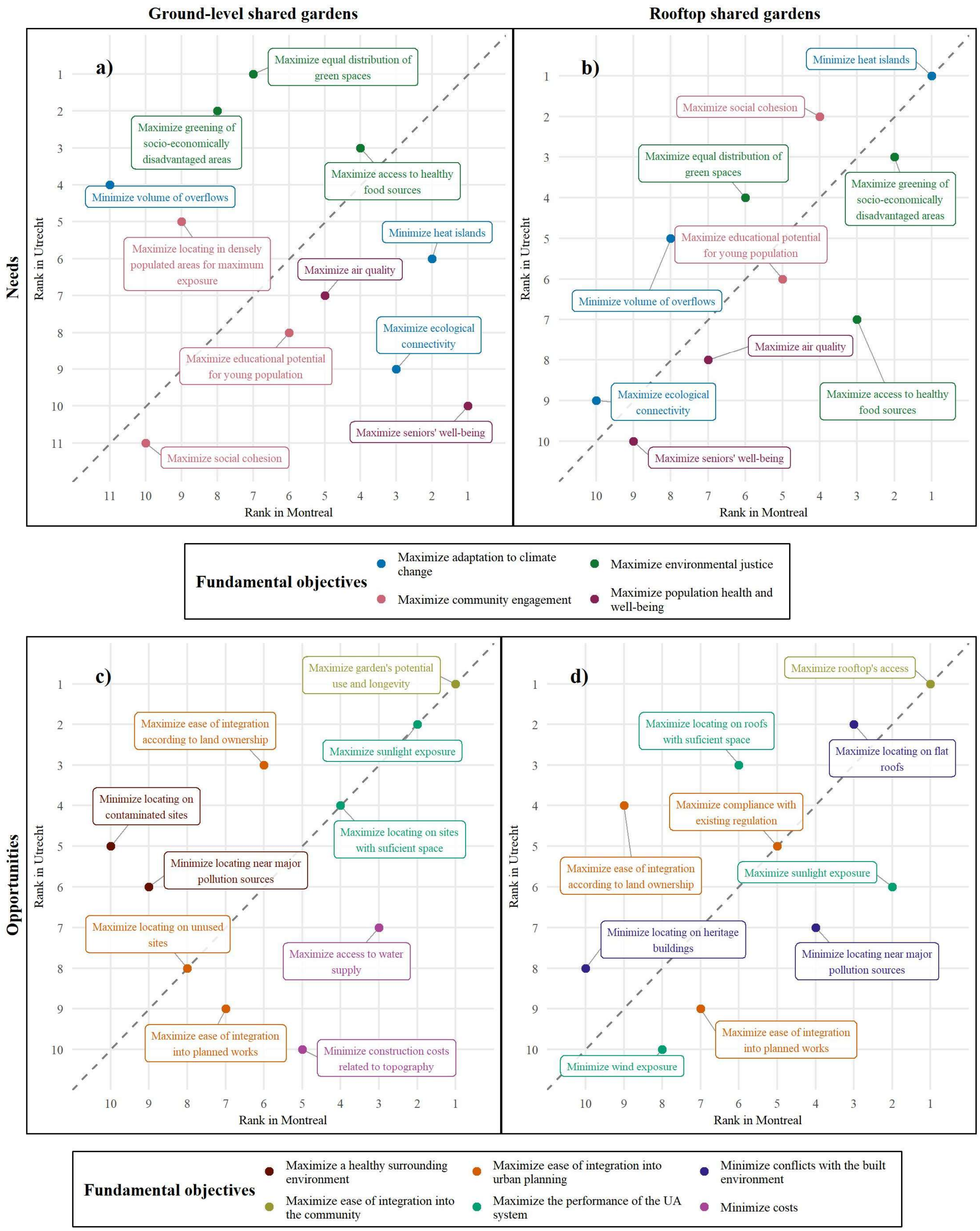

Figure 4.9 Rank scatterplots comparing Montreal and Utrecht priorities for both UA systems and suitability perspectives.

Beyond visual inspection, levels of similarity and agreement were assessed for both mean renormalized weights and ranks of the common hierarchy with Pearson's correlation coefficient and Kendall's τ (Table 4.4). For ground-level shared gardens, none of the similarity or agreement measures reached statistical significance. For rooftop shared gardens under the opportunities' perspective, Pearson's correlation coefficient revealed a statistically significant strong association of mean weights, whereas Kendall's τ showed a moderate but non-significant correlation of ranks. For needs, a near-significant strong similarity was observed between mean weights ($\alpha = 0.058$), and Kendall's τ indicated a statistically significant high correlation for rankings. These results highlighted that similarity in mean weights does not necessarily correspond to similarity in rankings: participants may agree on the relative importance of sub-objectives without agreeing on their prioritization, and vice versa.

Table 4.4: Between-city similarity in sub-objective priorities across systems and perspectives based on Pearson's correlation (mean weights) and Kendall's τ (derived ranks of mean weights)

Type of system	**Perspective**	**r**	**α**	**Kendall's τ**	**α**
Ground-level shared gardens	Opportunities	0.610	0.06116	0.422	0.1083
	Needs	0.223	0.5101	0.127	0.6481
Rooftop shared gardens	Opportunities	0.664	0.03611	0.422	0.1083
	Needs	0.616	0.05805	0.511	0.04662

Overall, context-specific objectives received relatively low weights, while within-city agreement on objective rankings remained moderate. Weighting structures for rooftop shared gardens showed greater potential for transferability, as no significant between-city differences were observed and both ranking and weighting measures displayed some level of correlation, whereas transferability appeared less stable for ground-level shared gardens.

4.6.1.4 Sources of divergence of attributes and value scales between cities

Attributes associated with sub-objectives differed between the hierarchies developed for Montreal and Utrecht (Table 4.5). Among the 28 sub-objectives, only seven shared the exact same attribute in both cities, while four had some attributes in common. Seven sub-objectives were represented by multiple attributes used in combination in Montreal's hierarchy, whereas this occurred twice in Utrecht's hierarchy.

All value scales are presented in section SI-2.1.3 (with associated geospatial datasets in section SI-1.4.2) and value scales of common continuous attributes are presented in Figure 4.10. Even when the same attributes were used in both cities, their value scales differed. Notably, the value scales associated with the attributes site area and roof area differed substantially between the two cases. For instance, a suitability score of 1 corresponds to a site area of 5000 m² in Montreal, whereas in Utrecht a similar area is associated with a score very close to 0. Conversely, for the roof area attribute, a suitability score of 1 in Utrecht corresponds to approximately 100 m², while this value is associated with a suitability score close to 0 in Montreal. However, sometimes, value scales that appear visually different are nonetheless grounded in a similar underlying logic. For example, in the ecological connectivity value scales, a distance of 100 m from green spaces acted as a turning point in both cities, distinguishing more favorable from less favorable sites. The main distinction therefore concerned how consulted experts distributed suitability values across intermediate and surrounding distances, potentially reflecting contextual differences such as city size.

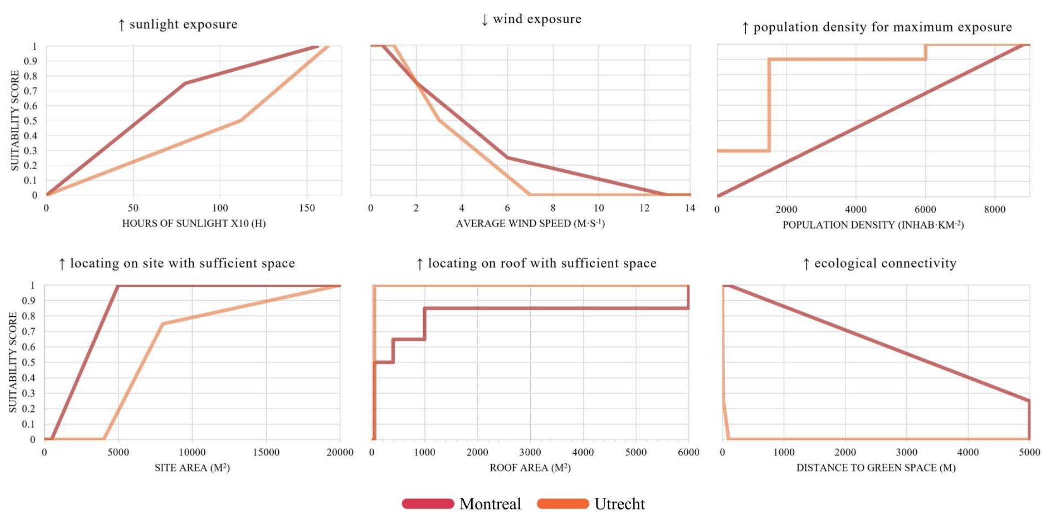

Figure 4.10 Value scales of continuous attributes sharing the same attributes between Montreal and Utrecht.

Differences in attribute selection across the two cities leading to limited transferability of this component were primarily associated with data availability, followed by expert judgement and, to a lesser extent, context. Data availability referred to situations where the choice of an attribute was constrained by the datasets accessible in each case study. For example, for the sub-objective *maximize locating on flat roofs*, slope percentage was derived from a digital surface model in

Montreal as no dataset was readily available, whereas in Utrecht, the available dataset representing percentage of flat roof coverage was directly used. Context referred to differences in how a concept was defined or understood within a specific geographical or institutional setting. For example, for the sub-objective of *maximizing access to healthy food supply*, variation in attribute selection reflected contextual differences, as the concept of food deserts was less scalable in a city such as Utrecht. Expert judgement captured divergences emerging from the participatory process, where experts interpreted and operationalized concepts differently based on their knowledge and experience. For instance, in Utrecht, the sub-objective related to topography was associated with urban infiltration opportunities, as the expert consulted emphasized the direct link between elevation and drainage conditions.

Table 4.5: Sources of divergence of attributes

Sub-objective	Type of system	Sources of divergence			Attributes	
		Data availability	Context	Expert judgement	Montreal	Utrecht
↑ sunlight exposure	G-L SG R SG				▪ Number of hours of sunlight x 10	▪ Number of hours of sunlight x 10
↑ locating on sites with sufficient space	G-L SG				▪ Site area	▪ Site area
↑ locating on roofs with sufficient space	R SG				▪ Roof area	▪ Roof area
↓ wind exposure	R SG				▪ Average wind speed	▪ Average wind speed
↑ garden's potential use and longevity	G-L SG			✓	▪ Distance to green space	▪ Type of community facility
↑ rooftop's access	R SG	✓			▪ Opening hours of public building	▪ Type of usage
↑ ease of integration into planned works	G-L SG R SG	✓			▪ Specific urban planning plan and area of opportunity	▪ Type of project
↑ ease of integration according to land ownership	G-L SG	✓			▪ Type of ownership	▪ Type of site accessibility
↑ ease of integration according to land ownership	R SG				▪ Type of ownership	▪ Type of ownership
↑ locating on unused sites	G-L SG	✓			▪ Presence of vacant site	▪ Presence of construction site
↑ compliance with existing regulation	R SG		✓		▪ Building height	▪ Roof size
↓ locating near major pollution sources	G-L SG R SG			✓	▪ Distance to main road ▪ Distance to railroad ▪ Distance to industrial zone	▪ Distance to non-static pollution source (e.g., main road, railroad)
↓ locating on contaminated sites	G-L SG	✓			▪ Soil quality post-decontamination ▪ Soil quality pre-decontamination ▪ Type of land use	▪ Type of contamination risk ▪ Expected soil quality
↑ locating on flat roofs	R SG	✓			▪ Roof slope percentage	▪ Percentage of flat roof coverage
↓ locating on heritage buildings	R SG		✓		▪ Status of heritage building	▪ Type of monument building
↑ access to water supply	G-L SG			✓	▪ Distance to connection point to the municipal water supply network	▪ Groundwater depth
↓ construction costs related to topography	G-L SG			✓	▪ Slope percentage	▪ Slope percentage ▪ Urban infiltration opportunities
↑ access to healthy food sources	G-L SG R SG		✓		▪ Food desert index ▪ Distance to existing community garden	▪ Distance to unhealthy food supply
↑ greening of socioeconomically disadvantaged areas	G-L SG R SG	✓			▪ Equity index for living environments (social and economic dimensions)	▪ Socioeconomic status score
↑ equal distribution of green spaces	G-L SG R SG			✓	▪ Distance to community garden ▪ Distance to green space ▪ Distance to green alleyway	▪ Distance to green space and community garden
↓ heat islands	G-L SG R SG	✓			▪ Intensity of heat island	▪ Average temperature difference between cities and rural areas
↓ volume of overflows	G-L SG R SG	✓			▪ Type of surface ▪ Distance to retention basin	▪ Urban infiltration opportunities
↑ ecological connectivity	G-L SG R SG				▪ Distance to green space	▪ Distance to green space
↑ social cohesion	G-L SG R SG			✓	▪ Equity index for living environments (social dimension)	▪ District with people in need of social interaction
↑ educational potential for young population	G-L SG R SG			✓	▪ Presence of kindergarten ▪ Distance to school (e.g., preschool, elementary and high school education institution)	▪ Distance to school (e.g., preschool, primary and secondary education institution)
↑ locating in densely populated areas for maximum exposure	G-L SG				▪ Population density	▪ Population density
↑ seniors' well-being	G-L SG R SG			✓	▪ Presence of seniors' house or center ▪ Percentage of seniors	▪ Distance to seniors' center
↑ air quality	G-L SG R SG	✓			▪ Air quality index	▪ Fine dust concentration

Note. Grey cells indicate no divergence between the attributes of the two cities. Attributes in red diverge and attributes in green converge between the two cities.

4.6.2 Effects of transferable components on suitability maps and planning outcomes

Results from section 4.6.1 indicated that objective hierarchies and weighting structures exhibited greater transferability potential between contexts than attributes and value scales. The following analyses therefore examined the effects of using common hierarchies and transferred weightings on suitability maps and planning outcomes.

4.6.2.1 Suitability maps

Final suitability maps were produced using SSANTO for: (A) the cities of Montreal and Utrecht; (B) two garden typologies, namely ground-level shared gardens and rooftop shared gardens; (C) three planning perspectives being opportunities, needs and combined; (D) three scenarios including full hierarchy with local weights (S1), common hierarchy with local weights (S2) and common hierarchy with transferred weights (S3). All suitability maps are presented in section SI-2.2. Figure 4.11 provides an example of the maps generated for the three planning perspectives for ground-level shared gardens in Montreal. Suitability scores ranged from 0 (lowest suitability) in dark blue to 1 (highest suitability) in yellow although the suitability maps globally showed a uniform tonal range.

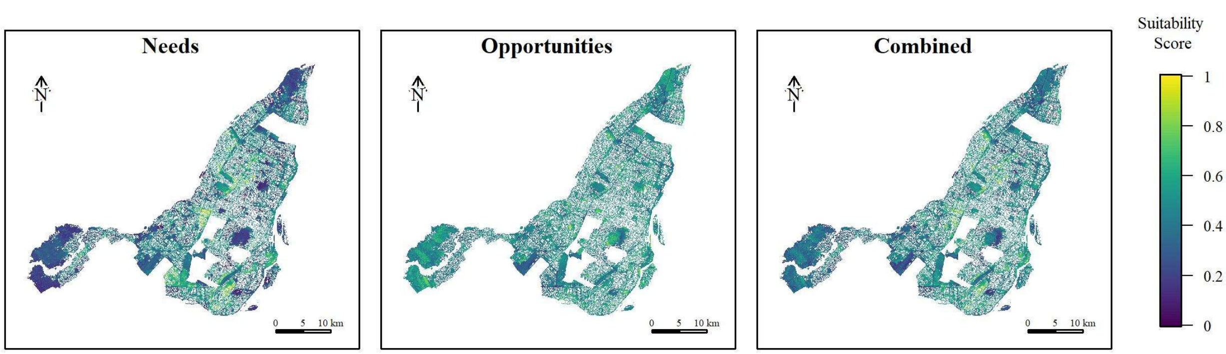

Figure 4.11 Example of suitability maps from three planning perspectives (needs, opportunities, combined) for ground-level shared gardens in Montreal.

4.6.2.2 Overestimation of suitability scores with the common hierarchies

This pattern of predominance of mid-range suitability scores is further detectable in density plots, where suitability scores are widely distributed between 0.2 and 0.8 (Figure 4.12). Density plots, which show normalized distribution of suitability scores, revealed a tendency for common hierarchies, both with local and transferred weights, to shift suitability scores towards the right, suggesting overall higher suitability scores than with the full hierarchy.

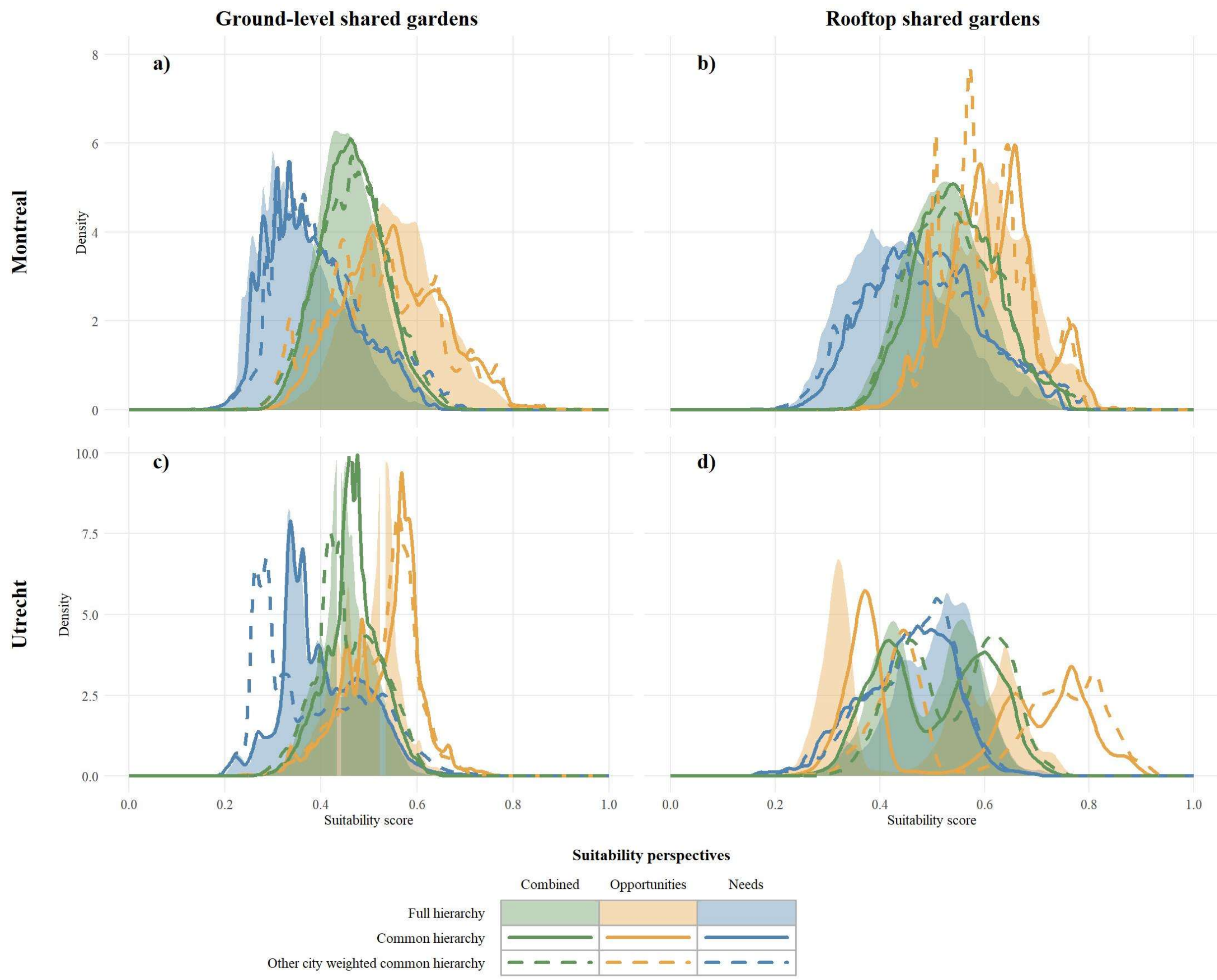

Figure 4.12 Density plots showing the distribution of suitability scores from suitability maps for Montreal (a, b) and Utrecht (c, d) and for ground-level (a, c) and rooftop (b, d) shared gardens.

Results of the statistical comparison of the suitability score distributions between full-hierarchy and common-hierarchy maps for Montreal and Utrecht are presented in Table 4.6. The Kolmogorov–Smirnov statistic (D) showed consistently low values across all systems, perspectives and cities, indicating overall similarity between the distributions. Only in Utrecht, the opportunities perspective for both systems produced higher D values, indicating greater differences between the suitability score distributions derived from the common hierarchies (using either local or transferred weights) and those derived from the full hierarchy. However, Wilcoxon effect sizes (r) revealed more pronounced directional shifts. Globally, r values were further away to 0 which indicated stronger difference between the distributions. Moreover, r values were negative, indicating higher values generated with the common hierarchies than with the full hierarchy. For both systems with the opportunities, Montreal made exception to those trends with positive and small *r* values, meaning the full hierarchy led to higher suitability scores but very close to those of the common hierarchies. These contrasting results reflected the different aspects captured by the two tests: while the KS statistic primarily measures similarity in the overall shape of the distributions, the Wilcoxon effect size is more sensitive to systematic shifts in score ranks or central tendency. Together, these results suggested that the use of common hierarchies generally preserved the overall structure of suitability patterns, while still producing consistent shifts in suitability score magnitudes in relation to the full hierarchy.

Table 4.6 Statistical comparison of suitability score distributions across comparative scenarios for both cities and both UA systems

Type of system	**Perspective**	**City**	**Scenarios**	**KS Statistic (D)**	**Effect size (Wilcoxon r)**
Ground-level shared gardens	Needs	Montreal	S1/S2	0.11	-0.73
			S1/S3	0.20	-0.86
		Utrecht	S1/S2	0.02	-0.36
			S1/S3	0.27	0.10
	Opportunities	Montreal	S1/S2	0.08	0.06
			S1/S3	0.18	0.27
		Utrecht	S1/S2	0.35	-0.98
			S1/S3	0.31	-0.83
	Combined	Montreal	S1/S2	0.06	-0.21
			S1/S3	0.10	-0.21
		Utrecht	S1/S2	0.19	-0.93
			S1/S3	0.12	-0.20
Rooftop shared gardens	Needs	Montreal	S1/S2	0.19	-0.84
			S1/S3	0.19	-0.82
		Utrecht	S1/S2	0.26	0.86
			S1/S3	0.22	0.92
	Opportunities	Montreal	S1/S2	0.04	0.15
			S1/S3	0.12	0.27
		Utrecht	S1/S2	0.31	-1.00
			S1/S3	0.42	-1.00
	Combined	Montreal	S1/S2	0.11	-0.65
			S1/S3	0.10	-0.44
		Utrecht	S1/S2	0.15	-0.35
			S1/S3	0.25	-0.99

Note. Tests were performed on n = 1,970,296 pixels (Utrecht – ground-level shared gardens), n = 653,871 pixels (Utrecht – rooftop shared gardens), n = 4,846,236 pixels (Montreal – ground-level shared gardens) and n = 2,594,758 pixels (Montreal – rooftop shared gardens). All comparisons were statistically significant ($p < 0.001$). Significance of the KS test was confirmed on a random subsample of n = 100,000 pixels.

4.6.2.3 Overall stability of site priority rankings

Spearman correlation coefficients quantify the degree of agreement in rank ordering of pixels between scenarios, by comparing how each pixel is ranked in one suitability map versus another and measuring the strength of the resulting monotonic relationship in ranks. Overall, the results indicated very high rank consistency across scenarios, with all coefficients remaining above 0.77 and most above 0.90, suggesting that the spatial prioritization of pixels is largely preserved despite modifications in hierarchies and transfer of weightings (Table 4.7). A consistent pattern was observed across all systems, cities, and perspectives: comparisons between S1 and S2 yielded higher correlations than comparisons between S1 and S3. This effect was more pronounced for ground-level shared gardens, where correlations decreased more noticeably between S1/S3, particularly for the opportunities and combined perspectives, suggesting higher sensitivity of these configurations to scenario changes. In contrast, rooftop shared gardens showed only marginal differences between S1/S2 and S1/S3, with correlations remaining extremely high and nearly unchanged across scenarios, indicating stronger stability of ranking patterns under alternative weighting schemes for rooftop systems.

Rank difference maps display the spatial distribution of pixel-level rank differences between scenarios, where rank difference represents the extent to which each pixel moves up or down in rank between two suitability maps (Figure 4.13 & Figure 4.14). Values range from 0% (no change in rank position) to 70% (strong displacement in ranking), grouped into five classes (0–15%, 15–30%, 30–45%, 45–60%, 60–70%). For reference, a 100% rank difference would represent the maximum possible displacement, where a pixel moves from the highest-ranked position (rank 1) in one scenario to the lowest-ranked position in the other, or vice versa, indicating a complete reversal in relative standing. Thus, lower classes therefore indicate areas where pixels maintain a very similar priority ranking across scenarios, while higher classes highlight zones where the spatial prioritization of suitability changes more substantially.

Table 4.7 Correlation coefficients between suitability maps across comparative scenarios for both cities and both UA systems

Type of system	Perspective	City	Scenarios	Spearman Correlation (ρ)
Ground-level shared gardens	Needs	Montreal	S1/S2	0.973
			S1/S3	0.946
		Utrecht	S1/S2	0.993
			S1/S3	0.925
	Opportunities	Montreal	S1/S2	0.859
			S1/S3	0.776
		Utrecht	S1/S2	1.000
			S1/S3	0.964
	Combined	Montreal	S1/S2	0.892
			S1/S3	0.810
		Utrecht	S1/S2	0.988
			S1/S3	0.916
Rooftop shared gardens	Needs	Montreal	S1/S2	0.965
			S1/S3	0.962
		Utrecht	S1/S2	0.935
			S1/S3	0.956
	Opportunities	Montreal	S1/S2	0.903
			S1/S3	0.883
		Utrecht	S1/S2	1.000
			S1/S3	0.995
	Combined	Montreal	S1/S2	0.952
			S1/S3	0.943
		Utrecht	S1/S2	0.985
			S1/S3	0.985

Note. Tests were performed on n = 1,970,296 pixels (Utrecht – ground-level shared gardens), n = 653,871 pixels (Utrecht – rooftop shared gardens), n = 4,846,236 pixels (Montreal – ground-level shared gardens) and n = 2,594,758 pixels (Montreal – rooftop shared gardens).

Overall, the maps revealed a strong dominance of low rank differences across all cases, indicating high stability in spatial prioritization despite scenario changes. In all configurations, most pixels fell within the 0–15% class, meaning that most of the territory experienced only minor shifts in ranking between scenarios. The highest class (60–70%) covered only a small fraction of pixels and is therefore not reported in the map information boxes.

In Montreal, rank differences were more heterogeneous, especially for ground-level shared gardens with a visibly darker overall pattern compared to other maps (Figure 4.13 (a1 to b3)). The S3/S1 comparison showed the highest level of spatial variation, indicating greater sensitivity of ground-level suitability rankings to scenario changes in Montreal, particularly under S3 (Figure 4.13 (b1 to b3)). In contrast, rooftop shared gardens exhibited a more uniform light pattern in both cities, reflecting stronger robustness of ranking structures for rooftop systems regardless of scenario or weighting scheme (Figure 4.13 & Figure 4.14 (c1 to d3)).

Despite these differences, a consistent finding was that a substantial part of the territory remained in the lowest difference class: more than 57% of Montreal and above 80% of Utrecht. This indicated that, even where differences occurred, they remained spatially limited, as they never exceeded 50% of the territory. Overall, these results suggested that planning outcomes were highly stable spatially, and more importantly even for rooftop shared gardens, with only low percentage areas exhibiting meaningful rank reordering.

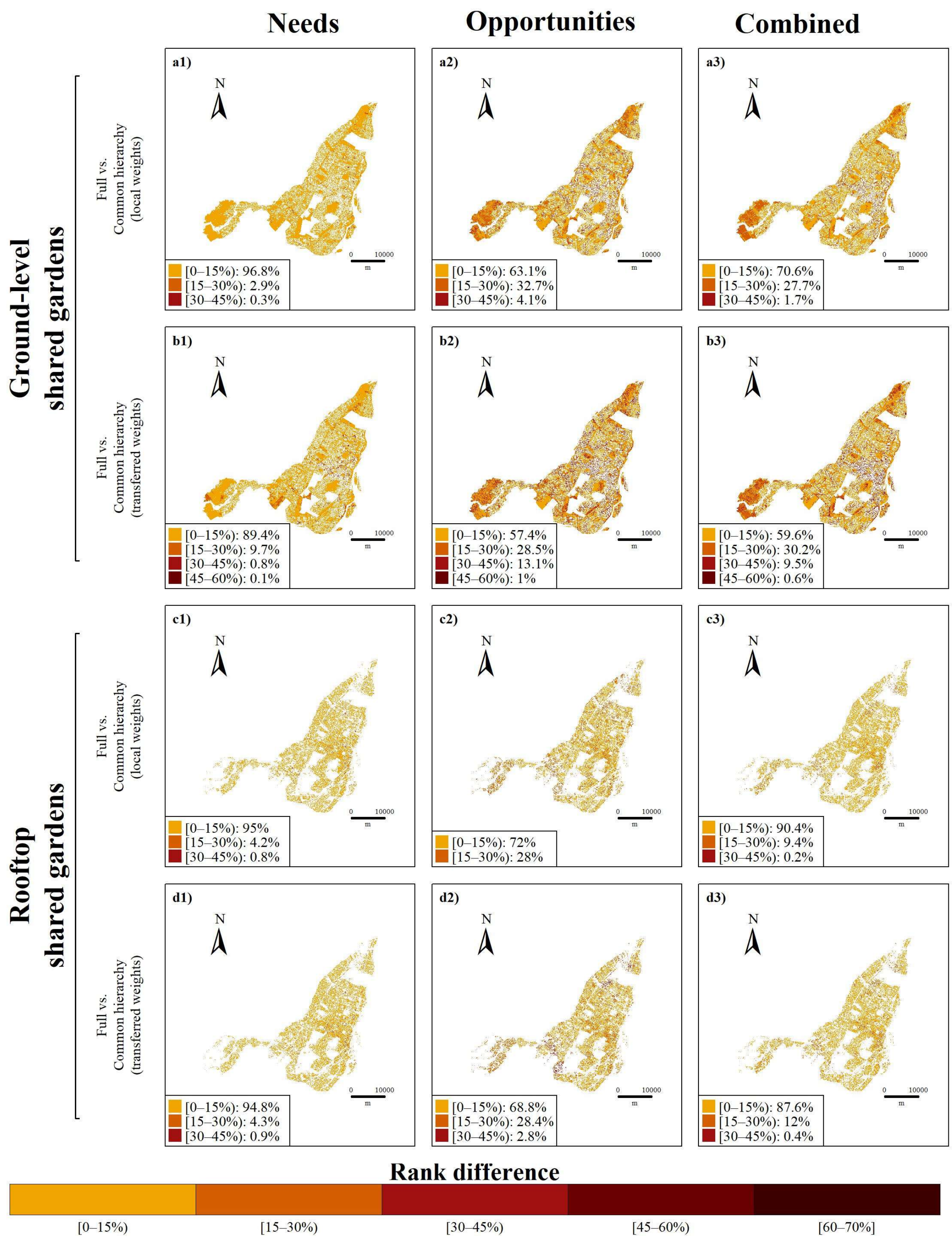

Figure 4.13 Rank difference maps comparing suitability maps resulting from analysis scenarios for Montreal.

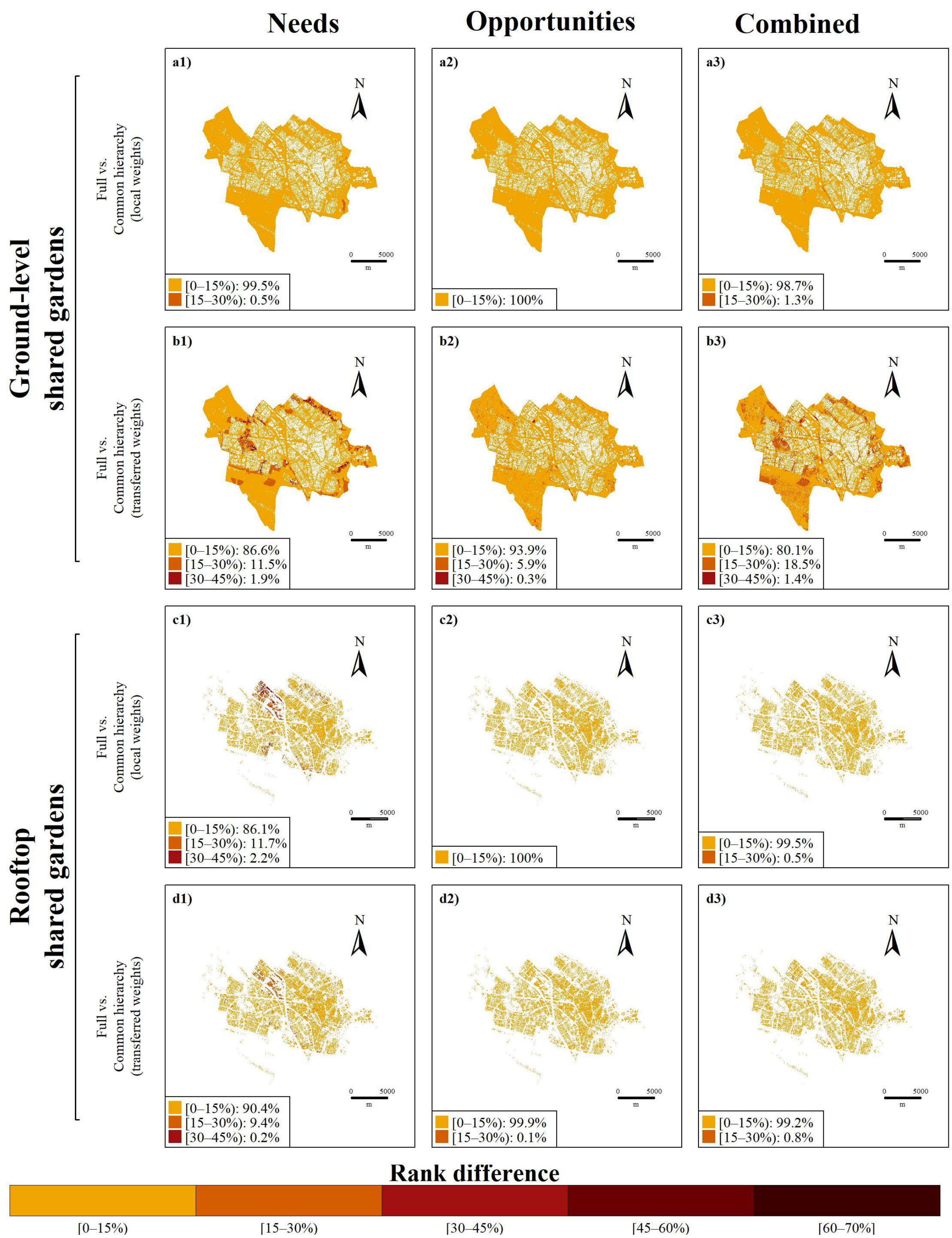

Figure 4.14 Rank difference maps comparing suitability maps resulting from analysis scenarios for Utrecht.

4.7 Discussion

In this section, we examine the patterns of convergence and divergence observed across the different steps of the GIS-MCDA framework development in the two case studies. We also assess the influence of context-specific criteria and weights on map outputs, as well as the transferability of the framework components across settings. We finally discuss key limitations.

4.7.1 Differential transferability across components of framework

Although objectives are often assumed to transform across space and time (Madsen et al., 2017), our results partly challenged this assumption. A substantial proportion of objectives were shared between Montreal and Utrecht, suggesting that some UA planning objectives may be broadly transferable across cities, which is in line with findings of Lacroix et al. (2024). Nevertheless, the transferability of these objectives may be limited beyond Global North cities with similar socio-economic conditions between our case studies. Urban agriculture is associated with different sets of benefits across contexts, often emphasizing leisure, recreational, and environmental functions in the Global North, and food security and livelihood support in the Global South, although these distinctions are not absolute (Dona et al., 2021; Pham, 2020; Zezza & Tasciotti, 2010).

Still, context-specific differences were also observed. For instance, Utrecht participants excluded the sub-objective *maximize locating near public and active transportation*, likely reflecting the already well-developed transportation infrastructure in the Netherlands. Even when objectives were retained after workshops 1, contextual differences emerged in their weighting; for example, *minimize costs related to topography* received very low importance in Utrecht, as the topography is mostly flat with a maximum elevation of 19 m in comparison to Montreal with a maximum elevation of 233 m.

Agreement on objective weightings across cities was higher for rooftop gardens than for ground-level gardens. One possible explanation is that the rooftop shared gardens hierarchy was structurally simpler and less contentious, with one less fundamental objective on the opportunities side. In addition, as shown by Kirby et al. (2021), perceptions and priorities can vary across UA system types, which may contribute to these differences. This may also reflect the more standardized nature of green roofs compared to the more diverse forms of ground-level shared gardens. While previous research suggested that preference formation in public decision-making follows similar mechanisms across cultures and contexts (Kuller et al., 2023), this pattern was only partially observed here, limiting the generalizability of this finding.

Among the components of the GIS-MCDA process, the selection of attributes and value scales showed the greatest divergence between the two cities. These differences were closely linked to the availability and structure of local datasets, a well-documented limitation for the transferability of PSS (McEvoy et al., 2019; Pelzer et al., 2015). Our results also indicated that expert judgment significantly influenced both the selection of attributes and the construction of value scales. Similar observations regarding the subjectivity of value scaling were reported by Langhans & Lienert (2016). Translating planning objectives into operational indicators also proved challenging for participants as stakeholders rarely use indicators in planning and at times disagree on their definitions, consistent with findings by Skrydstrup et al. (2020).

4.7.2 Stability of spatial planning outcomes using transferable components

Analyses on suitability maps showed that using transferable framework components, such as hierarchies and weightings, had limited influence on spatial planning outcomes. Although the removal of context-specific objectives and the use of transferred weighting structures generally produced a rightward shift in suitability score distributions, spatial prioritization patterns remained highly consistent across scenarios. This suggested that context-specific objectives mainly functioned as marginal or “borderline” criteria, exerting limited influence on the relative ranking of sites despite affecting absolute suitability values. Under transferred weighting structures, ground-level shared gardens exhibited a larger drop in correlation coefficients when transferred weights were applied (S1/S3) compared with the use of local weights under the common hierarchy (S1/S2), whereas rooftop shared gardens showed only limited variation between scenarios. This aligns with the fact that significant between-city differences in ranking patterns were only identified for ground-level systems through the Mann–Whitney U test. Moreover, such conservation in the planning outcomes across different weight configurations for rooftop shared gardens is consistent with Strager & Rosenberger (2006) who similarly observed robust prioritization of high-value areas under varying weighting schemes in land conservation planning.

Overall, these findings suggest that planning outcomes are generally robust to the use of transferable common hierarchies and weighting structures, particularly for rooftop shared gardens. The consistently high correlations observed for rooftop systems indicated that transferred weighting structures exert minimal influence on pixel-ranking outcomes, reinforcing the robustness and transferability of planning frameworks for this typology across contexts.

4.7.3 Limitations and further research

Although measures were taken to reduce potential bias from Montreal being the majority of the research team members' home city (e.g., stakeholder analyses in Montreal and Utrecht, Dutch-speaking facilitator for workshops 1 as well as Dutch and English materials in Utrecht), the research team's existing professional networks may have facilitated recruitment in Montreal. Differences in participation between cities may also reflect another methodological factor. Recruitment in Utrecht for the first workshop occurred in early spring, coinciding with the start of the growing season which limited availabilities of potential stakeholders working in agriculture, while Montreal recruitment took place in winter. The strong influence of stakeholders in participatory MCDA processes highlights the importance of efficient recruitment methods.

Haag et al. (2019) suggest that a reasonably broad set of objectives can be elicited with five to nine participants, while their worst-case results indicate a more conservative estimate of ten to fifteen participants. Utrecht's smaller participant number (8 compared to 20 in Montreal) may therefore have influenced the outcomes of both the hierarchy creation step and the level of agreement observed on sub-objective rankings. In the hierarchy creation process, the mention or omission of objectives during the brainstorming activity was considered alongside formal exclusion votes to decide on the final exclusion of certain objectives. With fewer participants, such decisions may have been more sensitive to individual perspectives and thus more volatile. At the same time, Utrecht's smaller participant base showed stronger consensus than Montreal, whereas Montreal's larger group captured a wider diversity of viewpoints. These limitations may have been further reinforced by the limited representation of stakeholders like urban farmers and food system actors across the three participatory steps and both cities, potentially reducing the extent to which operational realities were reflected in the results. Overall, variation in participation levels and compositions between the two cities may have influenced the range of perspectives represented, as well as the robustness, sensitivity, and generalizability of the statistical analyses and participatory outcomes.

While weighting structures appeared broadly transferable across contexts, this apparent stability should be interpreted with caution. Within-city agreement on sub-objective rankings was not consistently strong, reflecting substantial diversity in stakeholder preferences regarding UA benefits and constraints (Sanyé-Mengual et al., 2020). As a result, the similarity in weighting structure observed between cities for rooftop shared gardens may not reflect a genuine shared prioritization structure, but rather the aggregation of heterogeneous responses that cancel each other out and converge toward similar values in both contexts. This phenomenon, referred to as spurious unanimity (Mongin, 2016), occurs when diverse individual preferences aggregate into moderate collective means that may not represent any participant's actual viewpoint. Such aggregation effects are recognized limitations of participatory MCDA processes (Forman & Peniwati, 1998; van den Hove, 2006) and suggest caution when interpreting similarity in aggregated weights as evidence of transferability.

Future research should focus on expanding the analysis to a broader and more diverse set of contexts. Comparative experiments using simulated or expanded stakeholder datasets across multiple cities could help quantify the sensitivity of map outputs to different context-specific parameters and further assess the transferability of GIS-MCDA–based PSS components.

4.8 Conclusion

This study explored the development of a participatory GIS-MCDA framework for urban agriculture siting across two cities, with the aim of examining how context shape components of a GIS-MCDA–based PSS, identifying transferable components of the process, and assessing how these components influence planning outcomes. While the extent to which context influences participation could not be fully determined due to methodological limitations, the analysis of hierarchies of objectives revealed substantial convergence between cities, with only limited context-specific differences, suggesting potential transferability of this component. Between-city agreement in terms of weightings and rankings of objectives was higher for rooftop shared gardens than for ground-level shared gardens, indicating potential transferability of weightings for this type of UA system. Divergence of attributes and value scales was mostly due to the influence of local data availability and local expert judgment and limited the transferability of this component.

Furthermore, the analysis of suitability maps indicated that using common hierarchies and transferred weighting structures generally shifted suitability score distributions upward, while spatial prioritization patterns remained largely robust across configurations, particularly for rooftop shared gardens. Overall, these findings suggest that participatory GIS-MCDA frameworks for UA converge on certain components despite some context-specific differences, and that these converging components may be transferable across contexts similar to the case studies, given the limited influence of those transferred components on planning outcomes.

These findings do not imply nor recommend that local participation should be ignored in the future development or adaptation of PSS. Rather, they highlighted the importance of understanding which steps of the process require stronger contextual adaptation, thereby supporting a more efficient allocation of time and resources when transferring and implementing GIS-MCDA-based tools. Ensuring that such tools remain grounded in local contexts is essential for their legitimacy, relevance, and acceptance by users.

Overall, the proposed framework supports more strategic planning for UA siting and can serve as a strong starting point for applications in other contexts, as some of its components show potential in terms of transferability. Future research should examine their applicability in cities with more diverse socio-economic or climatic conditions, particularly in the Global South, where the transferability of objectives and participatory processes remains to be explored.

CHAPTER 5 GENERAL DISCUSSION

As the article within this thesis has already discussed the concrete comparison results, the discussion here focuses on the framework and participatory process itself, highlighting lessons learned from its implementation in the two case studies.

The development of participatory GIS-MCDA frameworks for urban agriculture planning highlighted important nuances in how stakeholders and experts interpreted objectives and attributes. Consultations revealed that objectives were in some cases understood differently depending on participants' backgrounds and experiences. These differences underscore the challenge of integrating diverse perspectives into a structured decision-making process while ensuring that the resulting outcome accurately reflects participants' intentions. Such variation in understanding also helps explain observed divergences in priorities and agreement patterns between participants and contexts and is in line with Langhans & Lienert's observations (2016).

The findings point to clear benefits in adopting a more iterative GIS-MCDA process (Malczewski, 1999). Stronger feedback loops between workshops, stakeholders, and experts would allow objectives, attributes, and value scales to be revisited and refined as new insights emerge. In this study, weighting workshops were conducted before value scale sessions, limiting opportunities to adjust hierarchies based on knowledge gained during later stages. An iterative approach could help mitigate initial assumptions, support convergence in priorities, and strengthen the reliability of the resulting suitability maps across contexts.

Moreover, attention to stakeholder management is equally critical. Differences in participation levels and engagement strongly influence outcomes, particularly in weighting exercises and agreement measures. The observed variability between contexts reflects not only differences in participant numbers but also in diversity and composition. Although the predominant actor type was the same in Montreal and Utrecht across workshops, there was no exact alignment between the participants of both cities (e.g., Montreal's Workshop 1 included more local administrators, technicians, and developers). Structured recruitment and engagement strategies could reduce such variability, improving the comparability of results and supporting more robust decision-making across cities.

Stakeholder composition also affects the inclusiveness and adaptability of the framework. In this study, participation was largely limited to professional stakeholders, which may have constrained the capture of practical, site-level knowledge and community priorities. Expanding the process to include local residents could enrich the analysis, providing complementary experiential insights. However, doing so would likely require further adaptations to the process, to ensure it remains accessible and meaningful to a broader audience.

Overall, these reflections highlight the interplay between stakeholder perspectives, methodological design, and context-specific constraints in participatory GIS-MCDA. Recognizing and addressing these factors can improve both the technical robustness and participatory legitimacy of planning support systems for urban agriculture, enhancing their adaptability and usefulness across diverse urban settings.

CHAPTER 6 CONCLUSION AND RECOMMENDATIONS

Presented as a comparative study, this thesis examined the development of participatory GIS-MCDA frameworks for planning ground-level and rooftop shared gardens in two distinct urban contexts, Montreal and Utrecht. The research detailed the varying structuring of objectives, weightings, and value scales in the two contexts, and how these factors ultimately shape suitability maps for UA implementation. Results showed convergence in the overarching hierarchies of objectives across contexts, with some context-specific nuances, suggesting a strong potential for transferability of the hierarchies of objectives. Measures of agreement between contexts indicated that prioritization of objectives for rooftop gardens seemed more globally aligned than those for ground-level shared gardens. Data availability proved to be a key constraint on the transferability of attributes.

Suitability map outputs generally displayed higher scores when based on the common hierarchy (both with local and transferred weights), reflecting the effect of concentrating on shared sub-objectives and potentially overestimating the suitability of certain areas relative to the full set of objectives. Importantly, however, all implementation scenarios consistently identified similar priority areas for planning and implementation, with stronger correlations observed for rooftop shared gardens than for ground-level shared gardens. This indicates that while absolute suitability values may shift depending on the hierarchy used, the relative spatial priorities for UA action remain mostly robust.

Beyond framework development, future work could incorporate a step in which generated suitability maps are reviewed and discussed with local stakeholders. Such an approach would move the analysis beyond technical outputs toward a broader evaluation of the planning process itself, allowing assessment of both the acceptability and usability of the GIS-MCDA outputs in real-world decision-making contexts. Integrating this step could provide feedback on how well participatory frameworks support UA planning across diverse urban settings, bridging the gap between spatial modeling and implementation.

Overall, this thesis demonstrates that participatory GIS-MCDA frameworks exhibit convergence across urban contexts in certain aspects. These findings provide a foundation for improving PSS for UA, promoting more resilient, equitable, and inclusive urban food systems.

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APPENDIX A ARTICLE ─ SUPPLEMENTARY MATERIAL

Supplementary information

Transplanting urban agriculture planning: Assessing context-sensitivity and transferability of a spatial multicriteria analysis framework across Canadian and Dutch cities

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1. SI-Methods

1.1. Participatory research design

1.1.1. Implementing stakeholder management

In line with the geographical footprint approach to stakeholder identification described by Colvin et al. (2016), we geographically bounded our search to (1) the Island of Montreal and (2) the Municipality of Utrecht with exceptions to include provincial, regional or nearby cities actors when they were directly involved in projects implemented in Utrecht or when no equivalent actor was identified within the municipality (e.g., for green roof initiatives).

Moving to the second step of the stakeholder analysis, we completed four analytical categorizations, building on the idea that the strength of such analytical approach improves when further attributes are considered (Reed et al., 2009). The primary categorization was based on actor types, providing the core structure of the analysis.

Table SI-1 Descriptions and examples of the seven actor types

Actor types	**Description**	**Examples**
Urban farmers	They are effective food producers, either professional or amateur farmers, that cultivate food in different locations and settings but always within the urban context.	Garden associations, food coops, individual farmers, NPOs, community centers
Food system actors	They are globally involved in the urban food system but do not take part in the production step.	Farmers' union, food policy council, NGOs promoting local markets
Local and national governments	They are involved in policymaking which can influence the promotion or exclusion as well as general effectiveness of UA projects.	City councils, municipality councils, ministries or agencies responsible for agriculture, environment, health, park
Local administrators, technicians and developers	They are not directly involved in UA; they administer public services, provide technical support or execute development projects; thus, their decision-making can impact the development of UA especially in terms of urban planning and infrastructure.	Public service workers, real estate developers, urban planners, agronomists, architects, engineers, environmental specialists
Academics and researchers	They provide evidence-based insights and knowledge that can inform decisions about UA.	People from universities or research institutions
Local residents	They can encourage or impede UA implementation as UA activities can lead to land, usage and value conflicts. An emphasis is put on groups that are usually more marginalized.	–
Others	–	–

The second categorization consisted of an interest and influence matrix (Mendelow, 1981), one of the most frequent and used approach in environmental management projects (Bendtsen et al., 2021; Reed et al., 2009; Sharpe et al., 2021) as it helps better understand the power dynamics between stakeholders. It assesses the level of influence the stakeholder has over the decision-making process as well as the level of interest the stakeholder has in the decision-making process and the outcome. Thus, stakeholders were divided into four quadrants and categorized as "Subjects", "Key players", "Context setters" and "Crowd" (Reed et al., 2009).

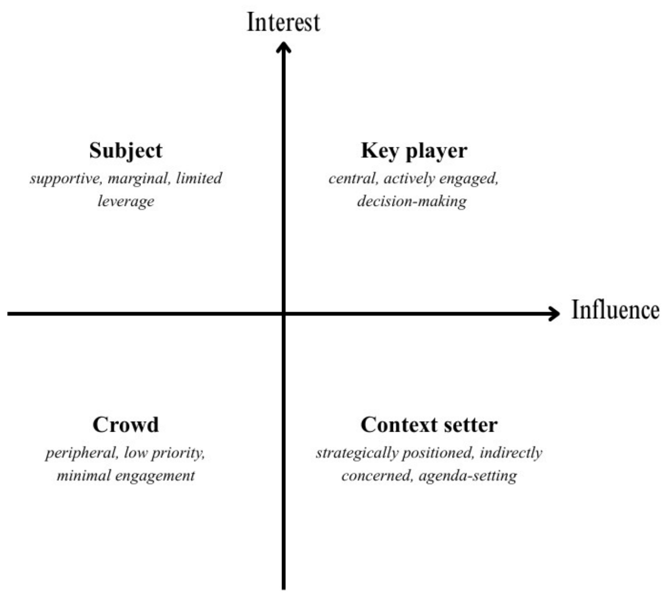


Figure SI-1 Interest-influence matrix

Moreover, stakeholders were categorized according to the scale at which they were conducting their activities. Five scales were considered: district, municipal, provincial, regional and national. Identified stakeholders for which the scale of operation was unspecified or vague (e.g., professors) were assigned "not applicable" (N/A). The stakeholders were furthermore divided according to if their expertise related to UA in general, or on specific systems such as gardens or roofs. Identified stakeholders that were not directly involved in UA (e.g., urban planners) were also assigned N/A.

Given the level of detail required for this study, a general actor-linkage matrix with the seven actor categories was constructed to provide an overall view of the dynamics among stakeholders involved in UA. Following Reed et al.'s (2009) actor-linkage matrix method, relationships between the types of actors previously defined were described as conflictual, complementary, collaborative or not linked. Those relationships were determined by the author based on reported dynamics in previous studies (Boamah et al., 2024; Di Fiore et al., 2021; Gandra De Carvalho et al., 2026; Provć et al., 2015; Stoeva, 2025).

Table SI-2 Actor-linkage matrix with the seven types of actors involved in UA

	Urban farmers	Food system actors	Local and national governments	Local administrators, technicians and developers	Academics and researchers	Local residents
Urban farmers	Cooperation	Cooperation	Conflict	Conflict	—	Cooperation
Food system actors	Complementarity	—	Complementarity OR Conflict	—	—	—
Local and national governments	Cooperation	—	—	Conflict	Complementarity	—
Local administrators, technicians and developers	Cooperation	—	—	—	—	—
Academics and researchers	—	—	Complementarity	Complementarity	—	—
Local residents	—	—	Conflict	—	—	—

Note. **Conflict**: situations where stakeholders' ambitions or actions are not aligning or even competing, generating tensions. **Complementarity**: situations where stakeholders pursue distinct but mutually reinforcing roles or objectives. **Cooperation**: situations where stakeholders engage into information sharing and joint action toward shared goals.

Building on stakeholder analysis, stakeholder engagement consisted first of prioritizing stakeholders. The contact list was structured around the four analytical categorizations, namely the interest-influence matrix, the actor types, the stakeholders' scale of operation and the stakeholders' system expertise. For workshops 1 and 2, priority was given to stakeholders to support representation across all categories of these four dimensions, with particular attention to diversifying perspectives. Actors belonging to the "Academics and researchers" category were deliberately less represented in workshops 1 and 2, as these were designed to prioritize engagement with stakeholders from practice and professional settings. Recruitment for workshops 2 was built upon engagement in workshops 1. Previous participants were automatically reinvited, and individuals who had expressed interest but were unable to attend the first workshop were also included. In Utrecht, as workshops 2 (step 3) were conducted concurrently with the consultations (step 4), experts were subsequently invited to participate to workshops 2. For the consultations, experts or expert stakeholders from Montreal and Utrecht were invited to participate based on their practical knowledge or their subject-specific expertise.

Finally, power dynamics and inter-actor relationships were considered alongside system component expertise to divide working groups during workshops 1. Attention to power dynamics and relationships between stakeholders is considered critical for supporting effective group dynamics in environmental management projects (de Vente et al., 2016; Reed et al., 2018).

1.2. Workshops 1: Identifying objectives and defining hierarchical frameworks

1.2.1. Research strategies

We conducted a first literature review covering three main topics: (1) urban agriculture, (2) nature-based solutions for water management, and (3) planning strategies. The initial goal was to examine the established links between these concepts and to better understand how urban agriculture is framed within the blue-green infrastructure literature from a planning perspective. Based on this first screening, we subsequently refined our research scope by excluding nature-based solutions for water management from our research command to focus specifically on the relationship between urban agriculture and planning. This refinement aimed to identify relevant spatial planning criteria for urban agriculture, with a particular focus on ground-level and rooftop gardens. The literature search was conducted using the Web of Science database and was limited to peer-reviewed articles published in English. Retrieved records were screened by applying the following search strings to titles, abstracts, keyword plus, and author keywords. They were further screened based on their relevance for identifying benefits and constraints associated with garden implementation.

Research strategy 1: ("urban agriculture" OR UA OR "urban garden*" OR "urban farm*" OR "peri-urban agriculture" OR UPA OR "peri-urban garden*" OR "peri-urban farm*" OR "urban and peri-urban farm*" OR UPF OR "innovative urban agriculture" OR IUA OR "open environment agriculture" OR OEA OR "urban horticulture" OR "community garden*" OR "domestic garden*" OR "allotment garden*" OR "garden allotment*" OR "food garden*" OR "edible garden*" OR "food forest*" OR "edible forest garden*" OR "rooftop farm*" OR "edible city" OR "edible cities" OR "edible neighborhood*" OR "edible landscap*" OR foodscap*) AND ("stormwater manag*" OR "rainwater manag*" OR "water manag*" OR "flood manag*" OR "urban drainage" OR "nature-based solution*" OR "nature based solution*" OR NBS OR "blue green system*" OR "blue-green system*" OR BGS OR "blue green infrastructure*" OR "blue-green infrastructure*" OR BGI OR "green infrastructure*" OR GI OR "green stormwater infrastructure*" OR GSI OR "sustainable drainage system*" OR "sustainable urban drainage system*" OR SUDS OR "low impact development" OR LID OR "low impact urban design and development" OR LIUDD OR "best management practice*" OR BMP* OR phytotechnologies OR phytotechnology OR "sponge city" OR "sponge cities" OR "water resilien*" OR " water sensitive urban design" OR WSUD) AND ("planning tool*" OR "planning model*" OR "planning method*" OR "spatial plan*" OR "urban plan*" OR "spatial research tool*" OR "spatial research model*" OR toolkit*)

Research strategy 2: ("urban agriculture" OR "urban garden*" OR "peri-urban garden*" OR "innovative urban agriculture" OR "open environment agriculture" OR OEA OR "urban horticulture" OR "community garden*" OR "allotment garden*" OR "garden allotment*" OR "collective garden*" OR "open garden*" OR "educational garden*" OR "food garden*" OR "edible garden*" OR "rooftop farm*" OR "rooftop garden*" OR "edible city" OR "edible cities" OR "edible neighborhood*" OR "edible landscap*" OR foodscap*) AND ("urban planning" OR "planning support system*" OR "multi-criteria decision analysis")

1.2.2. Sources of decision criteria

Table SI-3 Sources of decision criteria considered as objectives

Objectives	**Type of system**	**Quebec SSANTO framework** (Lacroix et al., 2024)	**Others**
Maximize locating on fertile soil	G-L SG		2; 15; 17; 18
Maximize exposure to sunlight	G-L SG R SG		2; 11
Maximize locating on sites with optimal drainage conditions	G-L SG		12; 17; 18
Maximize locating on unused sites	G-L SG		10; 11; 12; 13; 14; 21
Minimize interference with building foundations	G-L SG	X	
Maximize the longevity of the garden	G-L SG		6
Maximize ease of integration into planned works	G-L SG R SG	X	
Maximize locating on sites with sufficient space	G-L SG	X	2; 7; 12
Maximize locating on roofs with sufficient space	R SG		7; 12
Maximize locating on flat roofs	R SG		9
Maximize the potential use of the garden	G-L SG		2; 3; 12; 14; 21
Minimize locating near major pollution sources	G-L SG R SG		2; 3; 17
Minimize locating on contaminated sites	G-L SG		2; 8; 15; 17
Maximize access to water supply	G-L SG		2; 15; 17; 18; 19
Minimize construction costs related to topography	G-L SG	X	2; 7; 10; 18; 19
Minimize land acquisition costs	G-L SG		19
Minimize locating on listed heritage buildings	R SG		20
Maximize ease of integration according to land ownership	R SG	X	5
Minimize conflicts with existing regulation	R SG		20
Maximize equal distribution of green spaces	G-L SG R SG	X	3; 8; 12; 14
Maximize greening of socio-economically disadvantaged areas	G-L SG R SG	X	3; 7; 9; 10; 11; 14; 16
Maximize the visibility of the rooftop garden		X	5

Objectives	Type of system	Quebec SSANTO framework (Lacroix et al., 2024)	Others
Minimize heat islands	G-L SG R SG	X	5; 9; 14; 21
Minimize risk of overflows	G-L SG R SG	X	5; 12; 14; 19
Maximize ecological connectivity	G-L SG R SG	X	2; 5; 9
Maximize social cohesion	G-L SG R SG		1; 4
Maximize educational potential for young population	G-L SG R SG		2
Maximize access to healthy food sources	G-L SG R SG		7; 9; 11; 12; 13; 14; 16; 21
Maximize air quality	G-L SG R SG		5; 8
Minimize noise pollution	R SG		5
Maximize locating near public and active transportation	G-L SG	X	3; 14; 21
Maximize locating in densely populated areas	G-L SG		3; 9; 13; 14; 16; 19; 21

1 (Camps-Calvet et al., 2016); 2 (Caneva et al., 2020); 3 (Codato et al., 2024); 4 (Evans et al., 2022) 5 (Gohari et al., 2023); 6 (Hou & Grohmann, 2018); 7 (Kamali et al., 2025); 8 (Kazemi & Hosseinpour, 2022); 9 (Langemeyer et al., 2020); 10 (Limerick et al., 2023); 11 (Mack et al., 2017); 12 (Newell et al., 2022); 13 (Russell et al., 2023); 14 (Smith et al., 2021); 15 (Sonneveld et al., 2021); 16 (Thapa et al., 2021); 17 (Türker & Akten, 2023); 18 (Ustaoglu et al., 2021); 19 (Weerakoon, 2014); 20 (Zambrano-Prado et al., 2021); 21 (Zhang et al., 2022)

1.2.3. Means-end network and initial hierarchies

Four separate networks were developed for UA system planning, organized along the dimensions of “opportunities” and “needs” and of “ground-level shared gardens” and “rooftop shared gardens”. Within each network, objectives were grouped thematically to facilitate the identification of overarching objectives. Based on these means–ends networks, we developed a master list and hierarchy of objectives to support workshop 1 activities, with overarching objectives structured as upper-level (or fundamental) objectives and linked objectives as lower-level (or sub-objectives).

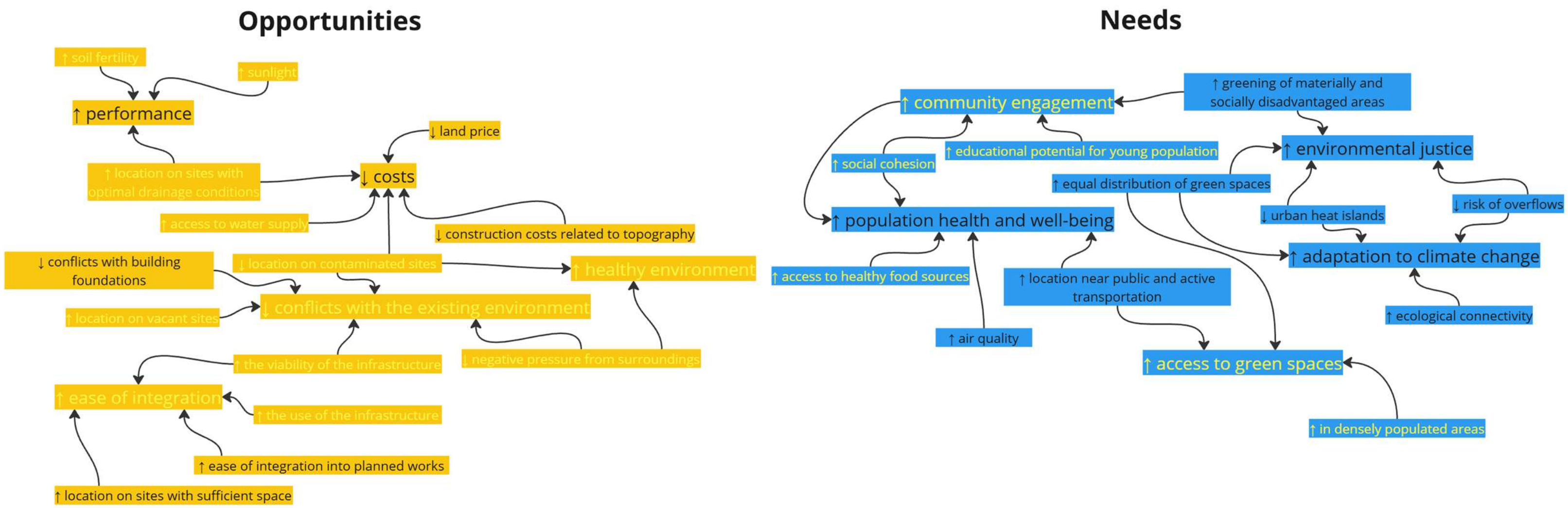


Figure SI-2 Initial means-end network for ground-level shared gardens.

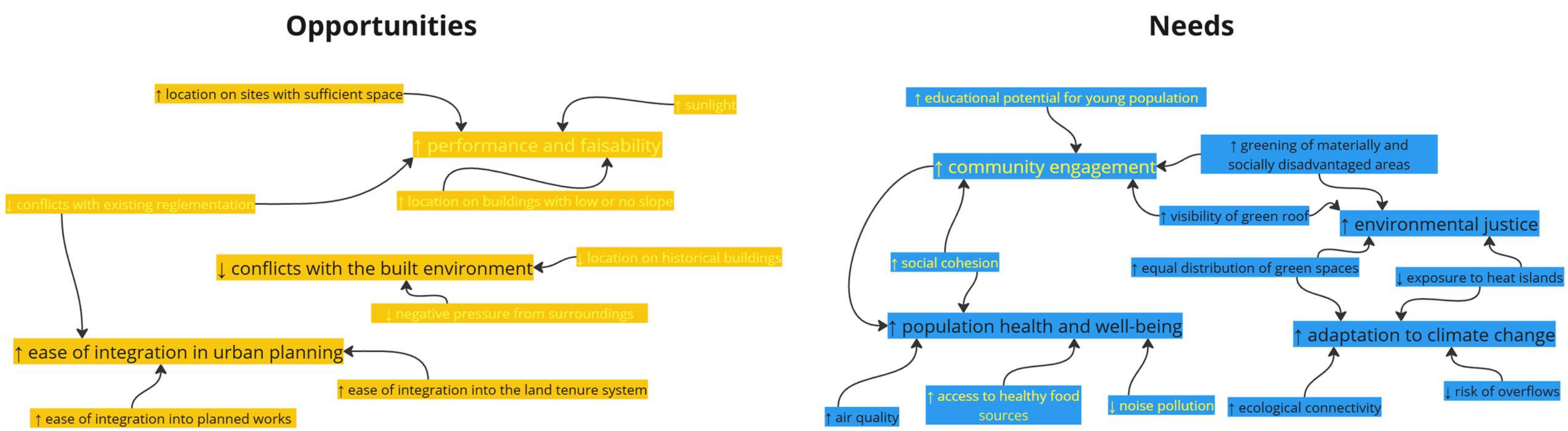


Figure SI-3 Initial means-end network for rooftop shared gardens.

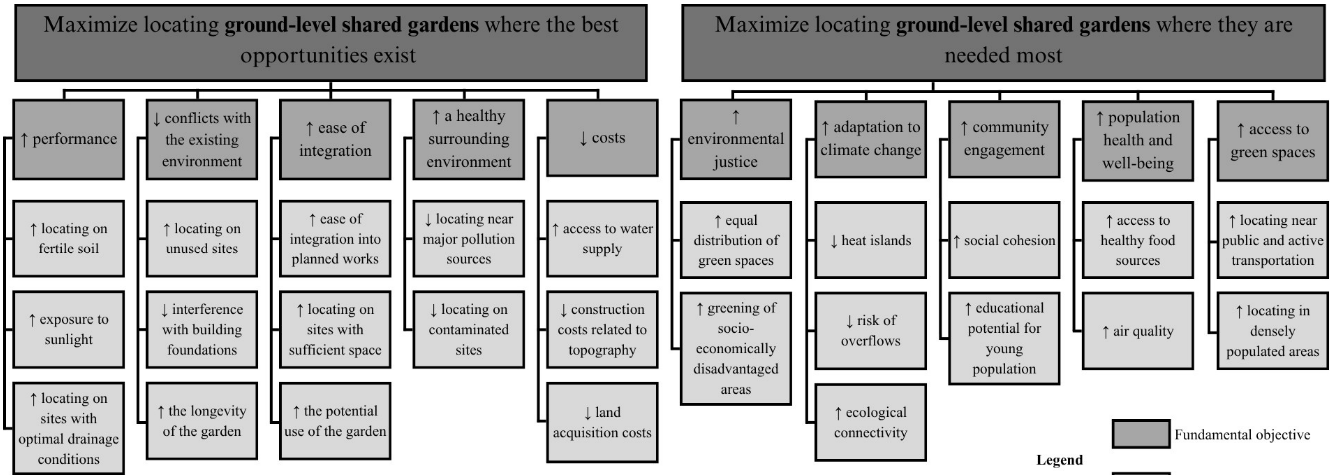


Figure SI-4 Initial hierarchy of objectives for ground-level shared gardens.

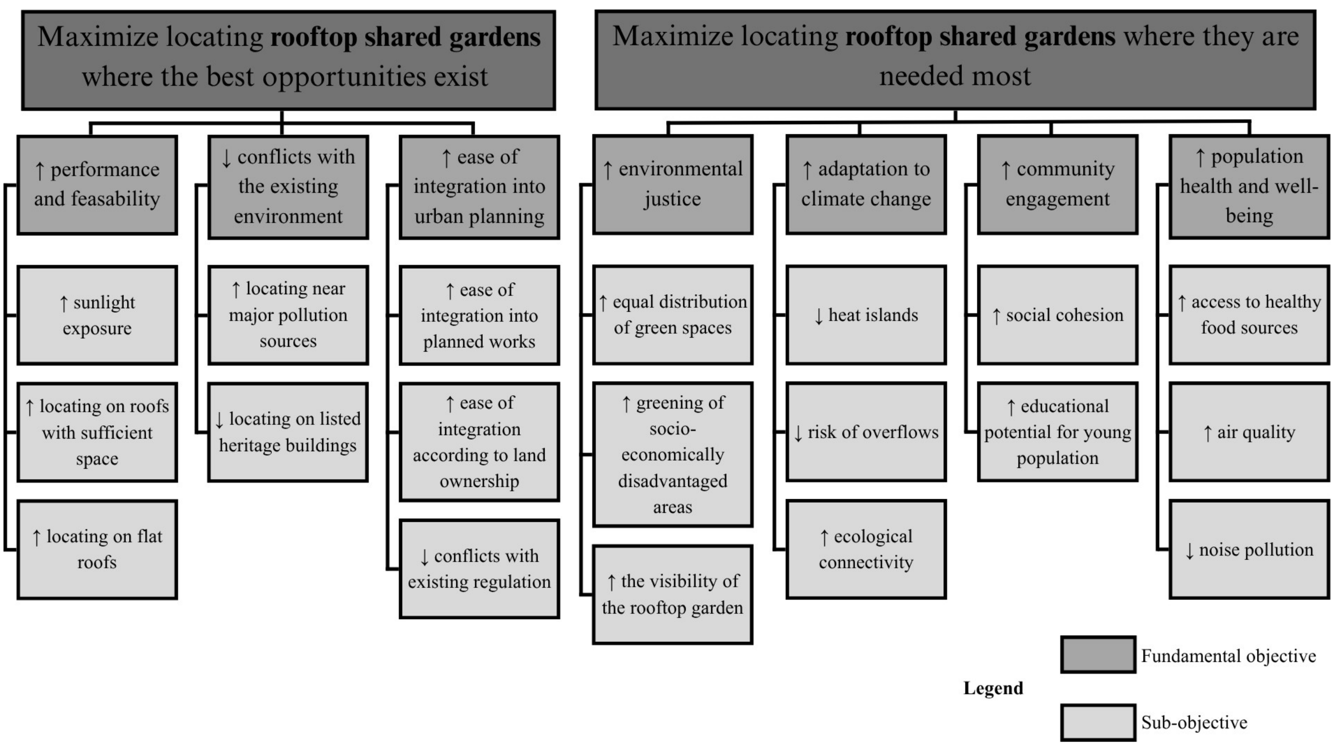


Figure SI-5 Initial hierarchy of objectives for rooftop shared gardens.

Table SI-4 Master list of sub-objectives (opportunities perspective)

Opportunities side: Maximize on sites/roofs where the best opportunities exist			
Sub-objectives	**Type of system**		**Descriptions**
	Montreal	**Utrecht**	
1. Maximize sunlight	G-L SG R SG	G-L SG R SG	Sunlight is essential for good plant growth.
2. Maximize locating on sites/roofs with sufficient space	G-L SG R SG	G-L SG R SG	The cultivable area influences the productive aspect of the infrastructure.
3. Maximize locating on sites with optimal drainage conditions	G-L SG		A well-drained site limits soil waterlogging and promotes healthy root systems.
4. Minimize wind exposure	R SG	R SG	Strong winds have the potential to cause physical damage to crops.
5. Maximize ease of integration into the local food system	G-L SG R SG		Proximity to other players in the food system encourages pooling of resources.
6. Maximize garden's/roof's use and longevity/accessibility	G-L SG R SG	G-L SG R SG	Proximity to other places and facilities frequented by the population or building's physical and temporal accessibility facilitates its use by the public.
7. Maximize locating in areas with high community interest for gardening		G-L SG R SG	Areas with strong community interest are more likely to have people that can and want to take care of the garden.
8. Maximize ease of integration according to land ownership	G-L SG R SG	G-L SG R SG	The type of owner (e.g. private, public, cooperative) has an impact on the ease of use of the land or building.
9. Maximize ease of integration into planned works	G-L SG R SG	G-L SG R SG	Selecting sites with future work planned on them avoids conflicts and improves long-term compatibility.
10. Maximize locating on unused/vacant sites	G-L SG	G-L SG	The use of unused or underutilized spaces limits conflicts with existing developments.
11. Maximize compliance with existing regulation	R SG	R SG	Compliance with current regulations avoids legal and administrative hurdles.
12. Minimize locating near major pollution sources	G-L SG R SG	G-L SG R SG	The presence of heavy road traffic, air traffic and heavy industry pollutes crops.
13. Minimize locating on contaminated sites	G-L SG	G-L SG	As a result of previous activities on site, urban soils may contain pollutants.
14. Maximize locating on flat roofs	R SG	R SG	A flat surface is necessary for cultivation and productivity.
15. Minimize locating on heritage buildings	R SG	R SG	Listed heritage buildings present greater construction constraints and often lack the load-bearing capacity.
16. Maximize access to water supply	G-L SG	G-L SG	The presence of a water source is a prerequisite for crop irrigation.
17. Minimize construction costs related to topography	G-L SG	G-L SG	A fairly flat area is ideal for cultivation, while slopes require more costly work.
18. Maximize ease of integration into urban maintenance services	G-L SG		It reduces operational complexity and maintenance burden.
19. Minimize interference with building foundations		G-L SG	No root impact to building foundations limits costly structural repairs.

Table SI-5 Master list of sub-objectives (needs perspective)

Needs side: Maximize sites/roofs where gardens are most needed			
Sub-objectives	**Type of system**		**Descriptions**
	Montreal	**Utrecht**	
1. Maximize access to healthy food sources	G-L SG R SG	G-L SG R SG	The creation of a new opportunity for access to healthy food in places where food sources are more limited.
2. Maximize greening of socio-economically disadvantaged areas	G-L SG R SG	G-L SG R SG	Food security and the well-being of vulnerable communities is improved with more gardens and green roofs.
3. Maximize equal distribution of green spaces	G-L SG R SG	G-L SG R SG	Access to green spaces in the city is not evenly distributed.
4. Minimize heat islands	G-L SG R SG	G-L SG R SG	Increased plant cover helps cool heat island zones.
5. Minimize volume of overflows	G-L SG R SG	G-L SG R SG	Dense, mineralized urban areas encourage runoff and the risk of overflow, while gardens help to absorb rainwater.
6. Maximize ecological connectivity	G-L SG R SG	G-L SG R SG	By strengthening ecological corridors, biodiversity is enhanced.
7. Maximize social cohesion	G-L SG R SG	G-L SG R SG	The most socially vulnerable people benefit from a meeting place where they can create links and interactions.
8. Maximize educational potential for young population	G-L SG R SG	G-L SG R SG	Gardens and green roofs offer learning opportunities for raising awareness and sharing knowledge about the environment and agriculture.
9. Maximize locating near public and active transportation	G-L SG R SG		The site's proximity to various sustainable means of transport makes it more accessible.
10. Maximize locating in densely populated areas for maximum exposure	G-L SG	G-L SG R SG	Locating gardens in densely populated areas maximizes co-benefits for a larger number of people.
11. Maximize air quality	G-L SG R SG	G-L SG R SG	Vegetation can improve air quality.
12. Maximize seniors' well-being	G-L SG R SG	G-L SG R SG	Sites close to seniors' centers are ideal for improving seniors' well-being, recognizing that gardening contributes to good mental health.
13. Maximize workers' well-being	G-L SG R SG		Sites close to workplaces and other commercial areas are conducive to improving workers' well-being, recognizing that gardening is a way to combat stress.
14. Maximize access to culturally relevant food production for different cultural groups		G-L SG R SG	Some cultural groups would benefit having access to a garden to cultivate produce that cannot be find in supermarkets.
15. Minimize noise pollution		R SG	Rooftop gardens can act as sound buffers.

1.2.4. Workshops 1 flow

Two workshops of 2 h 30 were held in each city. They took place in February 2025 in Montreal and in May 2025 in Utrecht. All participants were assigned a unique number to ensure anonymity in the results analysis. Workshops in Montreal were conducted in French, while those in Utrecht were conducted in English, with support in Dutch when required. Small adjustments to the activities were realized when workshops involved only two or three participants.

1. *Brainstorming*
    a. Individual brainstorming of objectives on separate sheets for opportunities and needs.
    b. Guided individual brainstorming, where each participant received an additional piece of information (aspect or perspective) to stimulate reflection.
    c. Peer-inspired individual brainstorming, where participants exchanged their sheets to build on ideas generated by others.
2. *Collaborative grouping and association*
    a. Small group discussion based on all participants' brainstorming sheets for a specific system and perspective to identify and write the key objectives on notes.
    b. Association of the notes generated during step 2a with the hierarchical structures of objectives previously built by the research team (*participants were not informed of the existence of those hierarchies prior to this step).
3. *Individual sorting and group discussion*
    a. Individual review of the master list of objectives identified in the literature by the research team and vote to exclude those considered irrelevant.
    b. Large group discussion about participants' exclusion votes on preliminary hierarchies as well as the newly proposed objectives during step 2.

1.2.5. Post-workshops 1 analysis and integration

All objectives generated during the brainstorming and grouping steps were considered for potential inclusion. Largely following Lacroix et al.'s (2024) objectives inclusion conditions list, objectives were assessed according to the first four conditions listed below, then grouped by similar themes and further evaluated using the two last conditions. Following the individual sorting, two conditions for excluding objectives were also defined. Final exclusion decisions were also informed by explanations provided during the large group discussion following the individual voting step.

Table SI-6 Inclusion and exclusion conditions during discussions on modifying the initial objective hierarchies

Analysis	Description
Condition for inclusion of a UA planning objective	1. it concerns one of the two types of urban agriculture (UA) systems studied.
	2. the objective can be measured through a spatial attribute.
	3. it is not a design objective (i.e., it relates to the choice of location rather than the design of the system).
	4. it is clearly defined and specific rather than overly broad.
	5. it is not a means objective subordinate to an existing means objective.
	6. it was generated by more than one participant during the individual brainstorming and mentioned in the literature.
Conditions for exclusion of a UA planning objective	1. received at least 30% exclusion votes.
	2. received more than 15% exclusion votes, was never mentioned during brainstorming, and was not associated with other objectives during the grouping step.

We reproduced means-end networks using the revised set of objectives in order to construct balanced hierarchies reflecting participants' perspectives. Finally, the co-created hierarchies were shared with participants by email to gather feedback on the revised structures. Structured to include between 10 and 15 objectives for each perspective (opportunities and needs), the final hierarchies followed Liquete et al.'s (2016) and Marttunen et al.'s (2019) recommendations to limit the number of objectives per level to maintain clarity and avoid asymmetric bias across branches.

1.3. Workshops 2: Eliciting stakeholder preferences and weighting objectives

These 1h30 workshops took place over the month of April 2025 in Montreal and between July and December 2025 in Utrecht. The weighting questionnaires were available in French in Montreal and in either Dutch or English in Utrecht, allowing participants to select their preferred language version, with translations generated using an AI translation tool.

The swing weighting process was conducted separately for each of the branches of the objective hierarchy. For each branch, participants rank-ordered vignettes representing alternatives and assigned relative ratings to them. To determine the weights of the upper-level objectives, a last swing exercise was performed using the most important objective from each branch, which participants again rank-ordered and rated. These steps allowed the computation of sub-objective weights through an initial normalization within each branch, followed by a second normalization at the upper level of the hierarchy (Equation 1):

$$w_r = \frac{p_r}{\sum_{i=1}^{m} p_i} \cdot \frac{p_s}{\sum_{j=1}^{n} p_j} \quad (1)$$

with w_r the global weight of sub-objective r, p_r the score given to the sub-objective r (lower level in the hierarchy), m the number of sub-objectives within a branch, p_i the swing scores of all m sub-objectives within that same branch, p_s the score given to the objective s (corresponding to the upper level in the hierarchy), n the number of objectives at the upper level (corresponding to the number of branches) and pj the swing scores of all n upper-level objectives

1.4. Consultations: Selecting attributes and eliciting value scales

1.4.1. Preparatory work and consultations

Prior to eliciting value scales with experts, a literature review was conducted to identify examples of spatial attributes previously used in GIS–MCDA applications related to UA. At the same time, geospatial datasets were selected such that multiple attributes were representable in the different study contexts. Priority was given to accessible, ready-to-use data from open-access municipal, provincial, or national databases to facilitate the reproducibility of results. When necessary, additional datasets were created to represent the selected attributes. Finally, the objectives were organized into thematic categories to facilitate the consultation process and help identify experts with relevant expertise.

Consultations took place between May and December 2025 in Montreal and between September and December 2025 in Utrecht. Sessions lasted between 30 minutes and 1h55 and involved one to three participants each. When possible, consultations included more than one expert to integrate diverse perspectives and support more robust aggregated judgments (Caley et al., 2014). Consultations were facilitated by two members of the research team in Montreal and Utrecht, and conducted in French or English in Montreal, and in English in Utrecht.

Table SI-7 Role, sector of activity and expertise of each expert consulted in Montreal to define and validate measurable attributes

# expert	Role	Sector of activity	Expertise	Date
E1	Community garden coordinator	Municipal	Geography	May 16, 2025
E2	Landscape architect	Professional	Green roof	June 2, 2025
E3	Retired professor	Academic	Urban forestry	June 5, 2025
E4	Project manager	Institutional	Agrology, urban agriculture	June 9, 2025
E5	Urban agriculture and controlled environment consultant	Institutional	Agrology, urban agriculture	June 9, 2025
E6	Research officer	Institutional	Biology, toxicology	June 9, 2025
E7	Assistant professor	Academic	Food safety, nutrition, public health, social inequality	June 16, 2025
E8	Research officer	Institutional	Food system, adaptation to climate change, environmental sciences	June 16, 2025
E9	Specialized scientific advisor	Institutional	Public health, nutrition, geography	June 16, 2025
E10	Specialist in adaptation and sustainable management	Institutional	Adaptation to climate change, sustainable management	June 16, 2025
E11	Scientific coordinator	Institutional	Adaptation to climate change, health	June 16, 2025
E12	Assistant professor	Academic	Landscape ecology, ecosystem services, biodiversity science, urban ecology	June 18, 2025
E13	Project manager	Professional	Urban agriculture, biodiversity	June 20, 2025
E14	Sustainability development officer	Municipal	Urban planning, socio-ecological transition	June 20, 2025
E15	Associate professor	Academic	Food systems, urban agriculture, adaptation to climate change, gentrification	June 26, 2025
E16	Planning Consultant	Municipal	Urban planning	July 3, 2025
E17	Associate professor	Academic	Landscape ecology, ecological modelling	July 4, 2025
E18	Planning consultant	Municipal	Urban planning, adaptation to climate change, stormwater management	July 7, 2025
E19	Full professor	Academic	Environmental justice, green gentrification, urban griculture and food systems	July 7, 2025
E20	Department head	Institutional	Public health, occupational health	July 8, 2025
E21	Research officer	Institutional	Public health, occupational health	July 8, 2025
E22	Planning consultant	Municipal	Urban studies, social inequality	August 8, 2025
E23	Section head	Municipal	Urban planning, heritage conservation	December 19, 2025

Table SI-8 Role, sector of activity and expertise of each expert consulted in Utrecht to define and validate measurable attributes

# expert	Role	Sector of activity	Expertise	Date
E1	Managing director	Professional	Food systems, community building, global sustainability	September 25, 2025
E2	Associate professor	Academic	Sustainability governance, climate justice, adaptation to climate change	October 29, 2025
E3	Associate professor	Academic	Food systems, social inequality	October 30, 2025
E4	Project manager	Institutional	Soil contamination, groundwater contamination, risk assessment	November 12, 2025
E5	Director	Professional	Green roof	November 17, 2025
E6	Urban area climate adaptation coordinator	Institutional	Adaptation to climate change, agriculture	November 19, 2025
E7	Gardener	Academic	Horticulture, biodiversity, ecology	November 20, 2025
E8	Associate professor	Academic	Sustainable land management, ecological restoration and rehabilitation	December 7, 2025
E9	Associate professor	Academic	Urbanism, community building, innovative housing	December 11, 2025
E10	Director	Professional	Project management, nature	December 15, 2025

1.4.2. Geospatial datasets

Table SI-9 Geospatial datasets for Montreal

	Dataset Information (Montreal)					
# Dataset	Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
1	Sunligh hours (Heures au soleil)	https://shademap.app/	ShadeMap	Meta and World Resources Institute (WRI)	World	2023
2	Property assessment unit (Unités d'évaluation foncière)	https://donnees.montreal.ca/dataset/unites-evaluation-fonciere	Données ouvertes Montréal	Service des finances et de l'évaluation foncière	Island of Montreal	2017
3	Buildings (CARTO-BAT-TOIT (Bâtiments))	https://donnees.montreal.ca/dataset/batiment-2d	Données ouvertes Montréal	Service des infrastructures du réseau routier	City of Montreal	2016
4	Geology (Géologie et épaisseur des dépôts meubles)	https://donnees.montreal.ca/dataset/geologie-des-depots-meubles	Données ouvertes Montréal	Service des infrastructures du réseau routier - Division expertise et soutien technique	Island of Montreal	1975
5	Slopes (Pentes (Liens de téléchargement par feuillet 1/20 000 (Aperçu des feuillets) (Lidar - Modèles numériques (terrain, canopée, pente, courbe de niveau))))	https://www.donneesquebec.ca/recherche/dataset/produits-derives-de-base-du-lidar/resource/c5538932-a7ca-4dca-acda-b39e86542910	Données Québec	Ministère des Ressources naturelles et des Forêts	Province of Quebec	2024
6	Mean Wind Speed	https://globalwindatlas.info/en/	Global Wind Atlas	DTU Wind + World Bank Group	World	2025
7	Community services and organizations in food security	https://foodmap.anagraph.io/en	Montreal Food Map	Food Justice and Sustainability Hub (Dawson College)	Island of Montreal	2019
8	Large parks, neighborhood parks, and public spaces (Grands parcs, parcs d'arrondissements et espaces publics)	https://donnees.montreal.ca/dataset/grands-parcs-parcs-d-arrondissements-et-espaces-publics	Données ouvertes Montréal	Service des grands parcs, du Mont-Royal et des sports	City of Montreal	2020
9	Public spaces and buildings (Lieux et bâtiments à vocation publique)	https://donnees.montreal.ca/dataset/lieux-batiments-vocation-publique	Données ouvertes Montréal	Service de la concertation des arrondissements et de l'expérience citoyenne	City of Montreal	2026
10	Areas of Opportunity (2050 Urban Planning and Mobility Plan) (Secteurs d'opportunité (Plan d'urbanisme et de mobilité 2050))	https://donnees.montreal.ca/dataset/secteurs-d-opportunite-plan-d-urbanisme-et-de-mobilite-2050	Données ouvertes Montréal	Service de l'urbanisme et de la mobilité - Direction de l'urbanisme	City of Montreal	2025
11	Amended land registry (Cadastre modifié)		Research team		City of Montreal	2023
12	Land use (Utilisation du sol)	https://observatoire.cmm.qc.ca/produits/donnees-georeferencees/#utilisation_du_sol	Observatoire du Grand Montréal	Communauté métropolitaine de Montréal	Island of Montreal	2022
13	Buildings - elevation (CARTO-BAT-COTE (Bâtiments))	https://donnees.montreal.ca/dataset/batiment-2d	Données ouvertes Montréal	Service des infrastructures du réseau routier	City of Montreal	2016

# Dataset	Dataset Information (Montreal)					
	Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
14	Geobase - Road network (Géobase - réseau routier)	https://donnees.montreal.ca/dataset/geobase	Données ouvertes Montréal	Service des infrastructures du réseau routier - Division de la géomatique	Island of Montreal	2026
15	Rail network (Réseau ferroviaire)	https://www.donneesquebec.ca/recherche/dataset/reseau-ferroviaire	Données Québec	Ministère des Transports et de la Mobilité durable	Province of Quebec	2025
16	Major Land Use Designations (Land Use and Development Plan - Land Use and Density) (Grandes affectations du territoire (Schéma d'aménagement et de développement - Affectation du sol et densité d'occupation))	https://donnees.montreal.ca/dataset/schema-affectation-densite	Données ouvertes Montréal	Service de l'urbanisme et de la mobilité	Island of Montreal	2025
17	Contaminated land management directory (Répertoire des terrains contaminés (GTC))	https://www.donneesquebec.ca/recherche/dataset/repertoire-des-terrains-contamines-gtc	Données Québec	Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs	Province of Quebec	2026
18	Digital surface model (Modèle numérique de surface)	https://donnees.montreal.ca/fr/dataset/modele-numerique-de-surface-mns	Données ouvertes Montréal	Service des infrastructures du réseau routier - Division de la géomatique	Island of Montreal	2015
19	List of historic buildings (Liste des immeubles patrimoniaux (PUM 2050) Annexe 3 (Patrimoine et paysages (Plan d'urbanisme et de mobilité 2050)))	https://donnees.montreal.ca/dataset/patrimoine-et-paysages-plan-d-urbanisme-et-de-mobilite-2050	Données ouvertes Montréal	Service de l'urbanisme et de la mobilité - Direction de l'urbanisme	City of Montreal	2025
20	Sites and buildings protected under the Cultural Heritage Act (Sites et immeubles protégés en vertu de la Loi sur le patrimoine culturel)	https://donnees.montreal.ca/dataset/sites-immeubles-proteges-lpc	Données ouvertes Montréal	Service de l'urbanisme et de la mobilité	Island of Montreal	2025
21	Administrative boundaries of the Montreal metropolitan area (Limites administratives de l'agglomération de Montréal (arrondissements et villes liées))	https://donnees.montreal.ca/dataset/limites-administratives-agglomeration	Données ouvertes Montréal	Service des infrastructures du réseau routier	Island of Montreal	2025
22	Food desert index (Indice de désert alimentaire 2021 (Indices de désert alimentaire et d'accessibilité aux commerces d'alimentation))	https://www.donneesquebec.ca/recherche/dataset/indices-de-desert-alimentaire-et-d-accessibilite-aux-commerces-d-alimentation	Données Québec	Institut national de santé publique du Québec (INSPQ)	Province of Quebec	2021
23	Community gardens (Jardins communautaires)	https://donnees.montreal.ca/dataset/jardins-communautaires	Données ouvertes Montréal	Service des grands parcs, du Mont-Royal et des sports	City of Montreal	2024
24	Living environment equity index (Indice d'équité des milieux de vie, 2024 (Indice d'équité des milieux de vie))	https://donnees.montreal.ca/dataset/indice-equite-milieux-vie	Données ouvertes Montréal	Service de la diversité et de l'inclusion sociale	City of Montreal	2024
25	Disadvantage index (Indice de défavorisation du Québec 2021)	https://www.donneesquebec.ca/recherche/dataset/indice-de-defavorisation-du-quebec-2021	Données Québec	Institut national de santé publique du Québec (INSPQ)	Province of Quebec	2021

	Dataset Information (Montreal)					
# Dataset	Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
26	Green alleyways (Ruelles vertes)	https://donnees.montreal.ca/dataset/ruelles-vertes	Données ouvertes Montréal	Arrondissements	Island of Montreal	2025
27	Heat islands (Îlots de chaleur 2023 (images satellite) (îlots de chaleur))	https://donnees.montreal.ca/dataset/ilots-de-chaleur	Données ouvertes Montréal	Bureau de la transition écologique et de la résilience	Island of Montreal	2023
28	Metropolitan canopy index (Indice canopée métropolitain)	https://observatoire.cmm.qc.ca/produits/donnees-georeferencees/#indice_canopee	Observatoire du Grand Montréal	Communauté métropolitaine de Montréal	Island of Montreal	2023
29	Retention basins (Cuvettes de rétention 2021 (polygones simplifiés) (Cuvettes de rétention d'eau de ruissellement))	https://donnees.montreal.ca/dataset/cuvettes-retention-eau-ruissellement	Données ouvertes Montréal	Bureau de la transition écologique et de la résilience	Island of Montreal	2021
30	Kindergardens (Installations SGEE (Installations-MFA-2026-01-31))	–	Ministère de la Famille	Direction de l'information stratégique	Province of Quebec	2026
31	Educational institutions (Établissements d'enseignement (Localisation des établissements d'enseignement du réseau scolaire au Québec))	https://www.donneesquebec.ca/recherche/dataset/localisation-des-etablissements-d-enseignement-du-reseau-scolaire-au-quebec	Données Québec	Ministère de l'Éducation et Ministère de l'Enseignement supérieur	Province of Quebec	2026
32	Bus and subway routes (Tracés des lignes de bus et de métro)	https://donnees.montreal.ca/dataset/stm-traces-des-lignes-de-bus-et-de-metro	Données ouvertes Montréal	Société de transport de Montréal - Planification et développement des réseaux	Island of Montreal	2025
33	Bike path network (Réseau cyclable)	https://donnees.montreal.ca/dataset/pistes-cyclables	Données ouvertes Montréal	Service des infrastructures du réseau routier - Division des transports actifs et collectifs	Island of Montreal	2026
34	Residential population density (Densité d'occupation résidentielle du territoire 2021 (Densité résidentielle du territoire))	https://www.donneesquebec.ca/recherche/dataset/densite-d-occupation-residentielle-du-territoire	Données Québec	Ministère des Affaires municipales et de l'Habitation	Province of Quebec	2021
35	Residential care facilities and long-term care facilities (Centres d'hébergement et soins de longue durée (CHSLD))	https://cartes.inspq.qc.ca/geoportail/	Géoportail de santé publique du Québec	Institut national de santé publique du Québec (INSPQ)	Province of Quebec	NA
36	Retirement homes (Résidences pour personnes agées)	https://cartes.inspq.qc.ca/geoportail/	Géoportail de santé publique du Québec	Institut national de santé publique du Québec (INSPQ)	Province of Quebec	NA
37	Population distribution by age	https://datacentre.chass.utoronto.ca/census/	CHASS Data Centre	University of Toronto - Faculty of Arts & Science	Canada	2021
38	Census geography (Géographie du recensement de 2021 harmonisée pour le Québec (Géographie du recensement de 2021 harmonisée pour le Québec))	https://www.donneesquebec.ca/recherche/dataset/geographie-recensement-2021-harmo	Données Québec	Institut de la statistique du Québec	Province of Quebec	2021
39	Air quality monitoring network geographic areas (RSQA - Secteurs géographiques)	https://donnees.montreal.ca/dataset/rsqa-secteurs-geographiques	Données ouvertes Montréal	Service de l'environnement	Island of Montreal	2022

# Dataset	Dataset Information (Montreal) Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
40	Air quality index by area (IQA par secteur (2022-2024) (RSQA - indice de la qualité de l'air (historique)))	https://donnees.montreal.ca/fr/dataset/rsqa-iqa-historique	Données ouvertes Montréal	Service de l'environnement	Island of Montreal	2022-2024

Table SI-10 Geospatial datasets for Utrecht

# Dataset	Dataset Information (Utrecht) Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
1	Hours of sun exposure	https://shademap.app/	ShadeMap	Meta and World Resources Institute (WRI)	World	2023
2	Onbegroeidterreindeel (Bare terrain part)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-onbegroeidterreindeel	Open Utrecht Portaal	Basisregistratie Grootschalige Topografie Informatie- en Procesmanagement	Gemeente Utrecht	2026
3	Gebouwen (INSPIRE geharmoniseerd) (Buildings)	https://www.pdok.nl/introductie/-/article/gebouwen-inspire-geharmoniseerd-	Publieke Dienstverlening Op de Kaart (PDOK)	–	Netherlands	2025
4	Mean Wind Speed	https://globalwindatlas.info/en/	Global Wind Atlas	DTU Wind + World Bank Group	World	2025
5	Gis Wijk Shapefile (District borders)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-gis-wijk	Open Utrecht Portaal	Informatie- en Procesmanagement	Gemeente Utrecht	2026
6	Voorscholen (Preschools)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-voorscholen	Open Utrecht Portaal	Voorziening Data Informatie- en Procesmanagement	Gemeente Utrecht	2026
7	Adressen hogescholen en universiteiten (Addresses of colleges and universities)	https://www.duo.nl/open_onderwijsdata/hoger-onderwijs/adressen/hogescholen-en-universiteiten.jsp	Open onderwijsdata	Dienst Uitvoering Onderwijs - Ministerie van Onderwijs, Cultuur en Wetenschap	Netherlands	2026
8	Schoolvestigingen basisonderwijs (Primary education school locations)	https://www.duo.nl/open_onderwijsdata/primair-onderwijs/scholen-en-adressen/	Open onderwijsdata	Dienst Uitvoering Onderwijs - Ministerie van Onderwijs, Cultuur en Wetenschap	Netherlands	2026
9	Hoofd- en nevenvestigingen (Main and branch offices)	https://www.duo.nl/open_onderwijsdata/voortgezet-onderwijs/adressen/	Open onderwijsdata	Dienst Uitvoering Onderwijs - Ministerie van Onderwijs, Cultuur en Wetenschap	Netherlands	
10	Welzijnsinstellingen (Welfare institutions)	https://open.utrecht.nl/dataset/welzijnsinstellingen	Open Utrecht Portaal	Team OpenData Utrecht Maatschappelijke Ontwikkeling	Gemeente Utrecht	2022

# Dataset	Dataset Information (Utrecht) Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
11	Woonzorgcentrum (verzorgingshuis) (Residential care center (nursing home))	https://www.filica.nl/ (identified on https://www.regelhulp.nl/onderwerpen/mijn-situatie/ouderen/verzorgingshuis)	Filica	–	Netherlands	2026
12	Gir Cul Gu Religieus Erfgoed 20220401 Join 20251229 (Religious heritage)	https://open.utrecht.nl/dataset/geoserver-kv-ruimte-openbaar-gir-cul-gu-religieus-erfgoed-20220401-join-20251229	Open Utrecht Portaal	KV RUIMTE OPENBAAR Informatie- en Procesmanagement	Gemeente Utrecht	2026
13	CBS Bestand Bodemgebruik 2017 (CBS Soil use file 2017)	https://www.pdok.nl/introductie/-/article/cbs-bestand-bodemgebruik-2017	Publieke Dienstverlening Op de Kaart (PDOK)	Centraal Bureau voor de Statistiek (CBS)	Netherlands	2017
14	CBS Postcode6	https://www.pdok.nl/introductie/-/article/cbspostcode6	Publieke Dienstverlening Op de Kaart (PDOK)	Centraal Bureau voor de Statistiek (CBS)	Netherlands	2024
15	Basisregistratie Adressen en Gebouwen (BAG) (Basic Registration of Addresses and Buildings (BAG))	https://www.pdok.nl/introductie/-/article/basisregistratie-adressen-en-gebouwen-ba-1	Publieke Dienstverlening Op de Kaart (PDOK)	Directie Operatie, Dienstverlening en Registratie, afdeling Data-, Proces- en Informatiemanagement	Netherlands	2026
16	Bouwprojecten en stedelijke ontwikkeling (Construction projects and urban development)	https://www.utrecht.nl/wonen-en-leven/bouwprojecten-en-stedelijke-ontwikkeling	Gemeente Utrecht	Wonen en leven	Gemeente Utrecht	2025
17	Openbaar en niet-openbaar gebied (Public and note public areas)	https://www.klimaateffectatlas.nl/en/retrieving-data	Klimaateffectatlas	Deltares	Netherlands	2024
18	Corporatiekaart (Corporation map)	https://open.utrecht.nl/dataset/utrecht-geo-corporatiekaart	Open Utrecht Portaal	Municipality of Utrecht ArcGIS Online Data Informatie- en Procesmanagement	Gemeente Utrecht	2026
19	Huurobjecten vastgoed (Rental properties real estate)	https://open.utrecht.nl/dataset/huurobjecten-vastgoed	Open Utrecht Portaal	Team OpenData Utrecht Vastgoedorganisatie Utrecht	Gemeente Utrecht	2023
20	Hoofdwegen volgens Richtlijn Omgevingslawaai 2022 (INSPIRE geharmoniseerd) (Main roads according to environmental noise directive 2022)	https://www.pdok.nl/introductie/-/article/hoofdwegen-richtlijn-omgevingslawaai-	Publieke Dienstverlening Op de Kaart (PDOK)	Ministerie van Infrastructuur en Waterstaat	Netherlands	2026
21	Spoorwegen (Railways)	https://www.pdok.nl/introductie/-/article/spoorwegen	Publieke Dienstverlening Op de Kaart (PDOK)	ProRail	Netherlands	2025
22	Old fuel tanks (Brandstofttanks)	–	Gemeente Utrecht	Ontwikkelorganisatie Ruimte (Openbare Ruimte, Klimaat en Groen Ondergrond)	Gemeente Utrecht	

	Dataset Information (Utrecht)					
# Dataset	Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
23	Nuisance act (Hinderwet, Hinderwet 4)	–	Gemeente Utrecht	Ontwikkelorganisatie Ruimte (Openbare Ruimte, Klimaat en Groen Ondergrond)	Gemeente Utrecht	
24	Historical activity (Historische activiteit)	–	Gemeente Utrecht	Ontwikkelorganisatie Ruimte (Openbare Ruimte, Klimaat en Groen Ondergrond)	Gemeente Utrecht	
25	Old polluted filled waterways (Gedempte sloten)	–	Gemeente Utrecht	Ontwikkelorganisatie Ruimte (Openbare Ruimte, Klimaat en Groen Ondergrond)	Gemeente Utrecht	
26	Soil quality map	–	Gemeente Utrecht	Ontwikkelorganisatie Ruimte (Openbare Ruimte, Klimaat en Groen Ondergrond)	Gemeente Utrecht	
27	Platte daken in Nederland (BAG) (Flat roofs in the Netherlands)	https://nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/metadata/e90a8483-77d1-40ab-89fc-344842047637	Nationaal Georesiter	Rijksinstituut voor Volksgezondheid en Milieu (RIVM)	Netherlands	2022
28	Beeldbepalend Pand (Iconic building)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-beeldbepalend-pand	Open Utrecht Portaal	Team Erfgoed Ontwikkelorganisatie Ruimte	Gemeente Utrecht	2026
29	Rijksmonumenten (National monuments)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-rijksmonumenten	Open Utrecht Portaal	Team Erfgoed Ontwikkelorganisatie Ruimte	Gemeente Utrecht	2026
30	Gemeentelijke Monumenten (Municipal monuments)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-gemeentelijke-monumenten	Open Utrecht Portaal	Team Erfgoed Ontwikkelorganisatie Ruimte	Gemeente Utrecht	2026
31	Gemiddelde Laagste Grondwaterstand (GLG)(Mean lowest groundwater level (GLG)	https://www.klimaateffectatlas.nl/en/retrieving-data	Klimaateffectatlas	Nationaal Water Model	Netherlands	2018
32	Actueel Hoogtebestand Nederland (AHN) (Current Elevation Model Netherlands (AHN)) DTM (Digital Terrain Model (DTM) 0,5m)	https://www.pdok.nl/introductie/-/article/actueel-hoogtebestand-nederland-ahn	Publieke Dienstverlening Op de Kaart (PDOK)	Rijkswaterstaat - Ministerie van Infrastructuur en Waterstaat	Netherlands	2025
33	Stedelijke infiltratie kansen (Urban infiltration opportunities)	https://www.klimaateffectatlas.nl/en/retrieving-data	Klimaateffectatlas	Deltares	Netherlands	2021
34	Gemeentegrens Shapefile (Municipal boundary)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-gemeentegrens	Open Utrecht Portaal	Informatie- en Procesmanagement	Gemeente Utrecht	2026
35	Archeologische Waardenkaart (Archaeological Value Map)	https://open.utrecht.nl/dataset/geoserver-utrechtopen-archeologische-waardenkaart	Open Utrecht Portaal	Team Erfgoed Ontwikkelorganisatie Ruimte	Gemeente Utrecht	2025
36	Fast food	https://overpass-turbo.eu/	Open Street Map	–	Netherlands	NA

	Dataset Information (Utrecht)					
# Dataset	Dataset Name	Link	Data source	Responsable	Geographic Coverage	Temporal Coverage
37	Sociaal-economische status; scores per wijk en buurt, regio-indeling 2021 (Socioeconomic status; scores by district and neighborhood, regional classification 2021)	https://opendata.cbs.nl/portal.html?_la=nl&_catalog=CBS&tableId=85163NED&_theme=378	CBS Open data Statline	–	Netherlands	2019
38	Stedelijk hitte-eiland effect (UHI) (Urban heat island effect (UHI))	https://www.atlasleefomgeving.nl/stedelijk-hitte-eiland-effect-uhi	Atlas Leefomgeving (Atlas of the living environment)	Rijksinstituut voor Volksgezondheid en Milieu (RIVM)	Netherlands	2022
39	Population Distribution (INSPIRE harmonized)	https://www.pdok.nl/introductie/-/article/cbs-bevolkingsspreiding-population-distribution-	Publieke Dienstverlening Op de Kaart (PDOK)	Centraal Bureau voor de Statistiek (CBS)	Netherlands	2025
40	Fijnstof 2023 (PM2,5) (	https://www.atlasleefomgeving.nl/kaarten	Atlas Leefomgeving (Atlas of the living environment)	Rijksinstituut voor Volksgezondheid en Milieu (RIVM)	Netherlands	2023
41	District and neighborhood map 2022 version 3 (Wijk- en buurtkaart 2022 versie 3)	https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/geografische-data/wijk-en-buurtkaart-2022	–	Centraal Bureau voor de Statistiek (CBS)	Netherlands	2022
42	Geluid in Nederland	https://www.atlasleefomgeving.nl/kaarten	Atlas Leefomgeving (Atlas of the living environment)	Rijksinstituut voor Volksgezondheid en Milieu (RIVM)	Netherlands	2022

2. SI-Results

2.1. Participatory process components

2.1.1. Common hierarchies

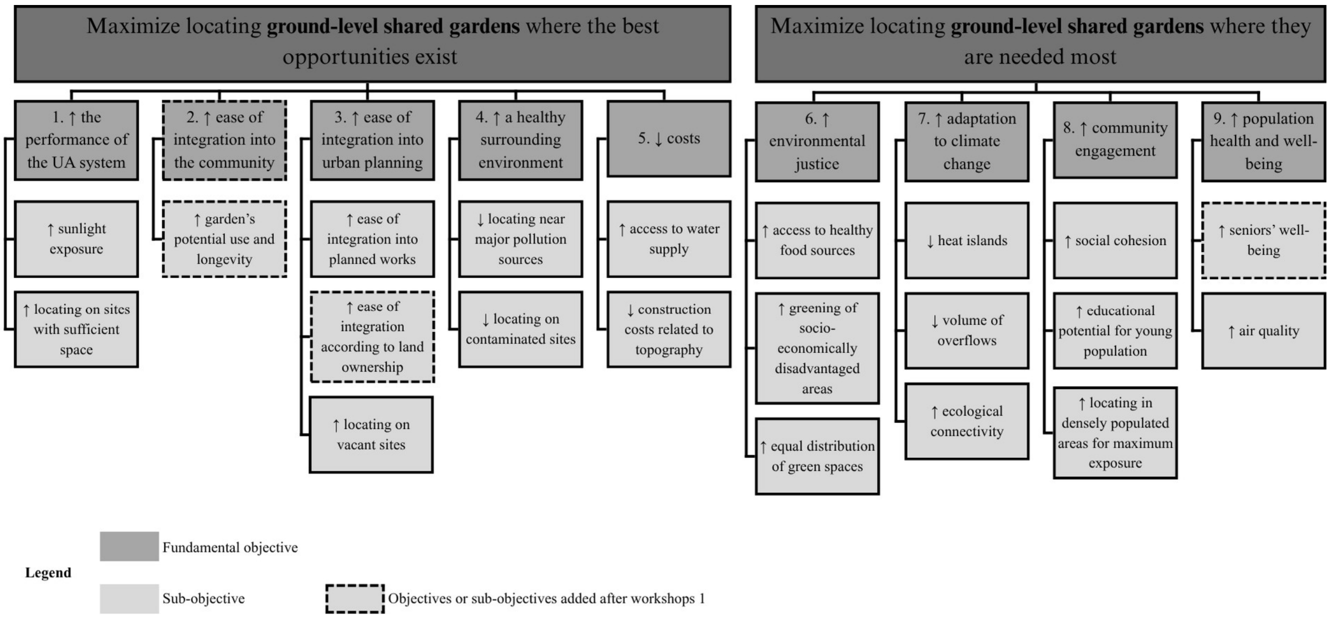


Figure SI-6 Common hierarchy for ground-level shared gardens.

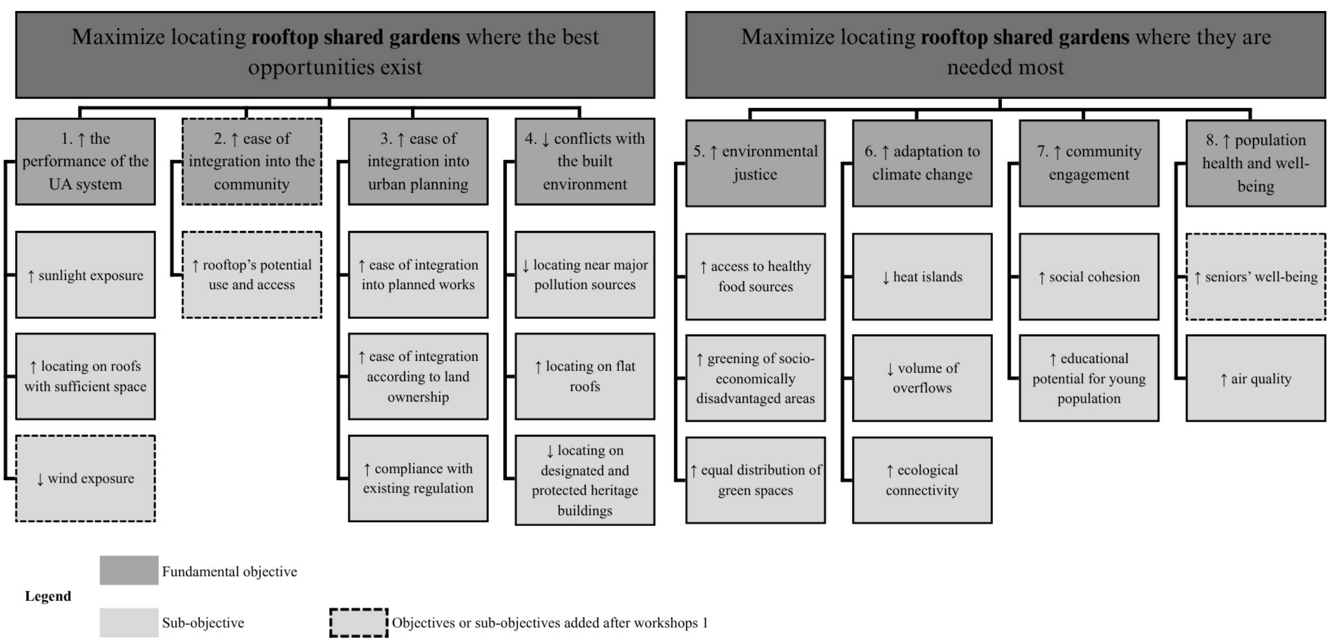


Figure SI-7 Common hierarchy for rooftop shared gardens.

2.1.2. Weightings of sub-objectives

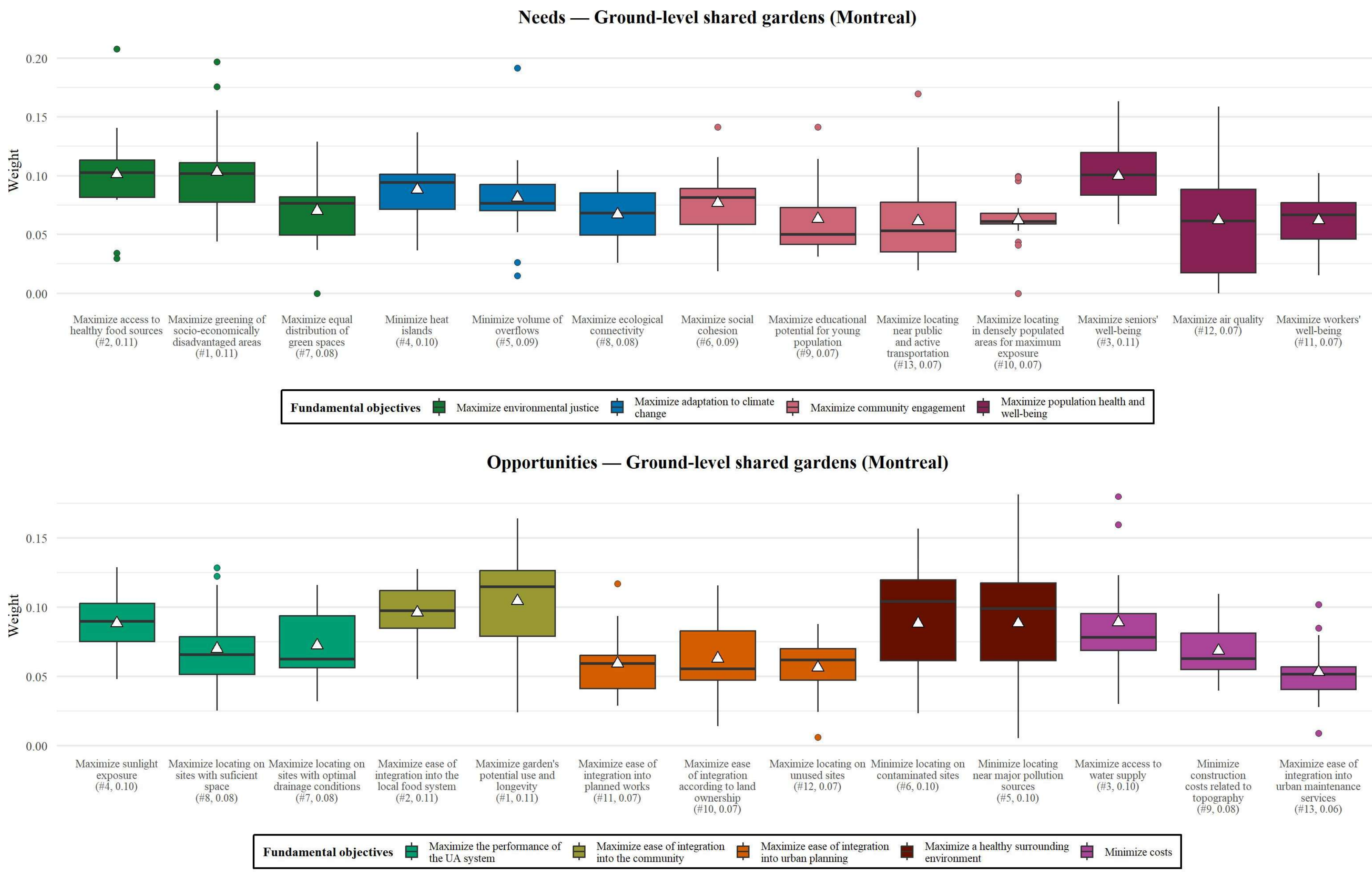


Figure SI-8 Boxplots presenting weightings of sub-objectives in Montreal for ground-level shared gardens.

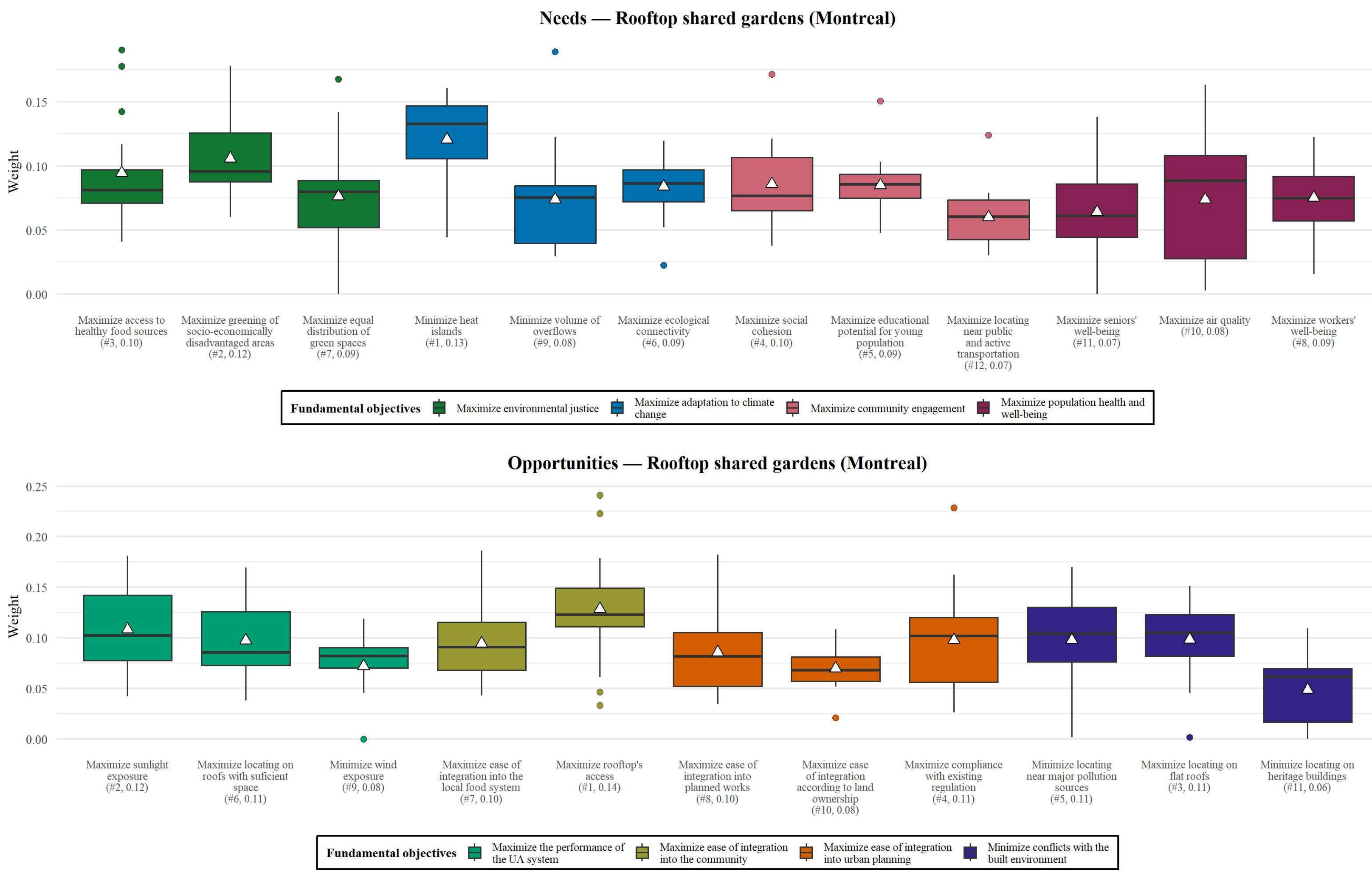


Figure SI-9 Boxplots presenting weightings of sub-objectives in Montreal for rooftop shared gardens.

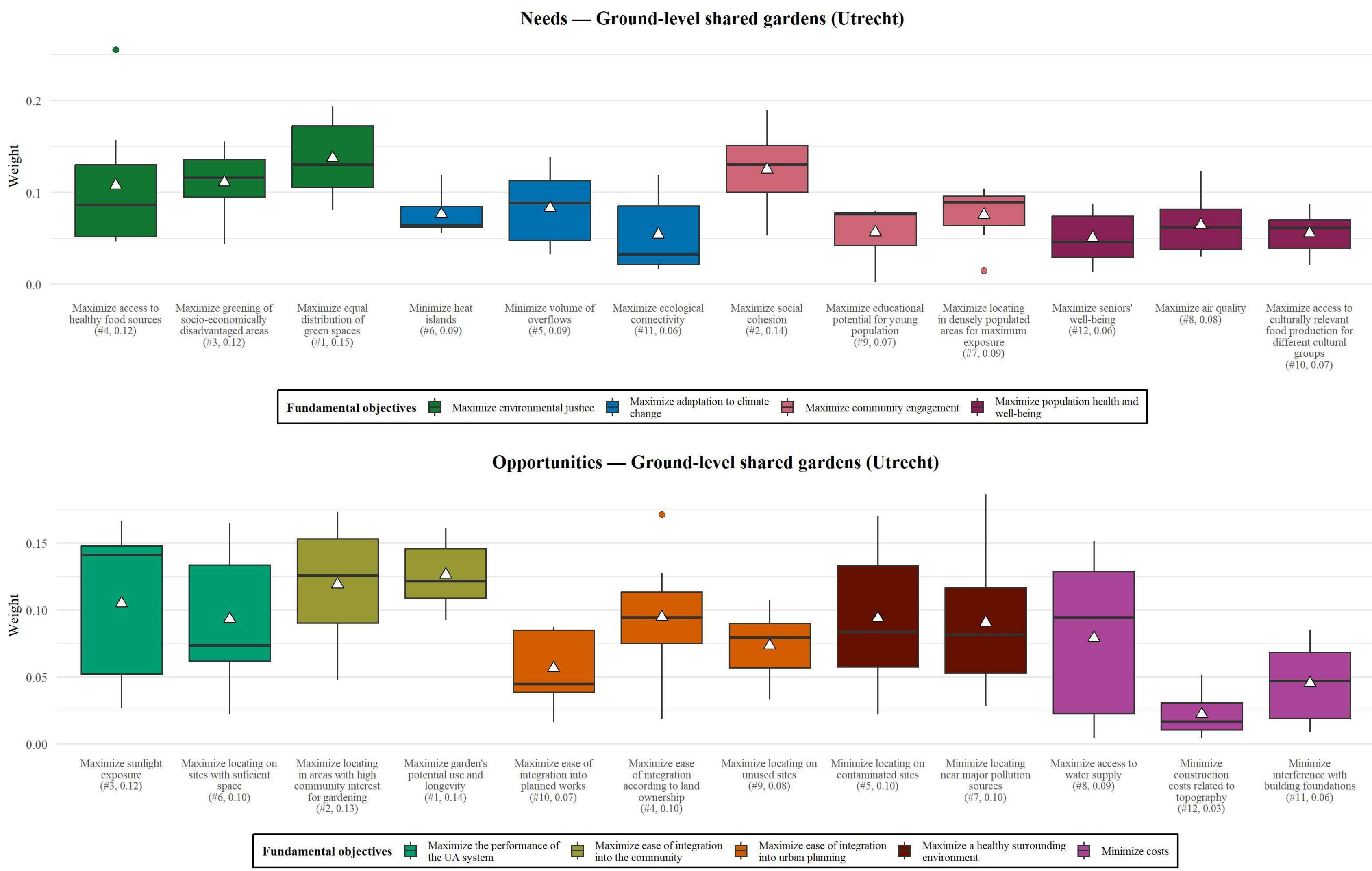


Figure SI-10 Boxplots presenting weightings of sub-objectives in Utrecht for ground-level shared gardens.

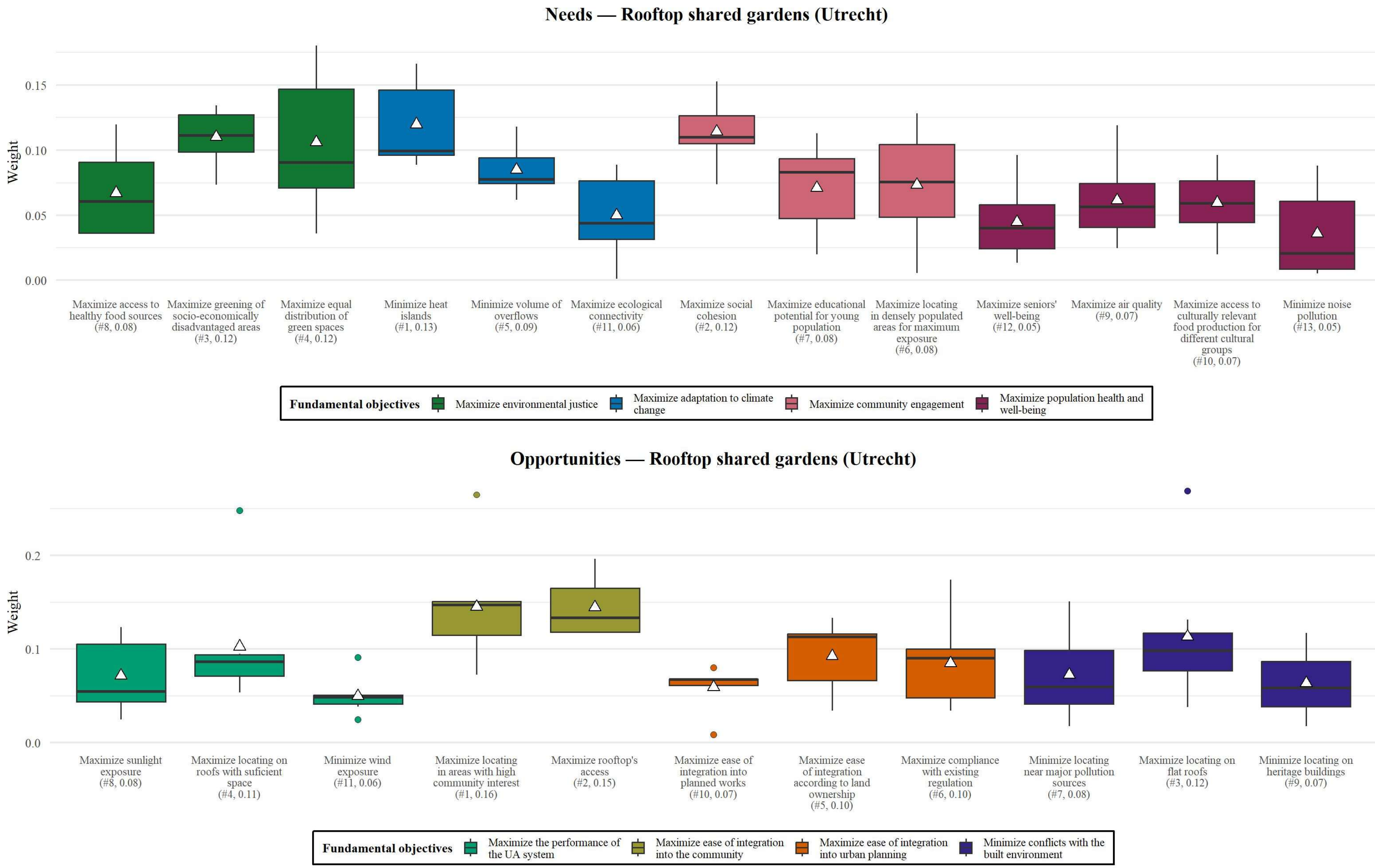


Figure SI-11 Boxplots presenting weightings of sub-objectives in Utrecht for rooftop shared gardens.

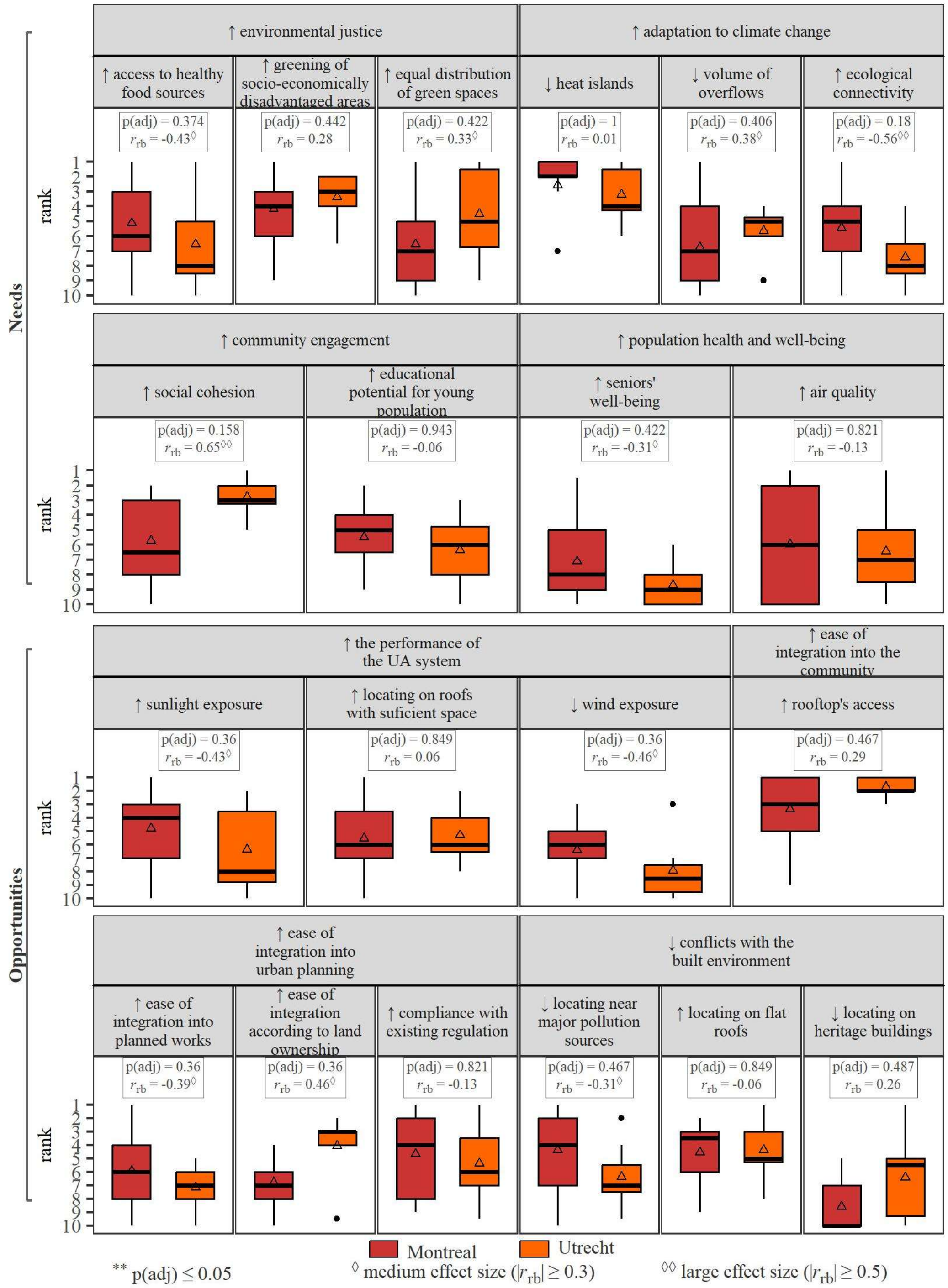


Figure SI-11 Boxplots showing the distribution of ranks derived from renormalized weights for each sub-objective for ground-level shared gardens. Differences between cities were assessed using Mann–Whitney U tests; p-values and effect sizes are displayed.

2.1.3. Attributes and value scales

Table SI-11 Value scales for Montreal

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
1.1 Sunlight	Number of hours of sunlight x 10	h	Continuous	1	✓	G-L SG, R SG	1	≥151	↑	Maximum number of hours of sunlight (x10) in Montreal on the 21st of June 2023	· Required sunlight exposure can vary by crop, with some plants needing more hours than others (e.g., 8 h/day for a lettuce is excellent whereas 8 h/day for a tomato is good).
							0.75	80			
							0	0			
1.2 Site_Size	Site area	m2	Continuous	2, 3	✓	G-L SG	1	≥5000	↑	(Number of plots of the largest garden in one of Montreal's district * City of Montreal's average plot size (e.g., 15 m²)) + Estimate of shared spaces area (e.g., pathways and storage)	· The value scale may vary depending on the garden type and implementing organization, with collective gardens potentially requiring less extra shared spaces since all garden area is automatically shared. · The number of plots per garden is derived from observed minimum and maximum garden sizes in the expert's district and may vary depending on expert input.
							0.5	2737.5			
							0	≤475		(Number of plots of the smallest garden in one of Montreal's district * City of Montreal's average plot size (e.g., 15 m²)) + Estimate of shared spaces area (e.g., pathways and storage)	
1.3 Drainage	Soil type	–	Categorical	4		G-L SG	1	sandy sediments (sédiments sablonneux (7, 6, 2b, 2c))	–	Sand infiltrates well.	
							0.66	mixed sediments (sédiments mélangés (3, 2a, 1, 1-3, 1-2-3))			
							0.5	rock (roc (R))		If rock is deep and mixed or sand sediments are at the surface level, infiltration is good. If rock is at the surface level, infiltration is poor.	
							0.33	clay sediments (sédiments			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
								argileux (8, 5, 4))			
							0	peat (tourbe (9, 9a, 9b))		Peat retains water.	
							default value	rock (roc (R))			
	Slope percentage	%	Continuous	5	✓	G-L SG	0.5	< 1	–		· The value scale for *Minimize construction costs related to topography* is reused here, as both soil type and slope influence drainage.
							1	1			
							0.75	3			
							0.5	5			
							0	≥10			
1.4 Roof_Size	Roof area	m^2	Continuous	3	✓	R SG	1	≥6000	↑	(Bion, A. (2020). *Analyse de potentialité d'autosuffisance de l'île de Montréal et les opportunités de l'agriculture urbaine* [Mémoire de master, Université de Liège]. MatheO. https://matheo.uliege.be/handle/2268.2/10812)	
							0.85	6000			
							0.85	1000			
							0.65	1000			
							0.65	400			
							0.5	400			
							0.5	50			
							0	50			
							0	0			
1.5 Wind	Average wind speed	$m \cdot s^{-1}$	Continuous	6		R SG	0.5	≤0,5	↓	Wind speed of 0 m/s is not ideal because wind allows to lower the temperature if necessary.	· Critical wind speed can vary by crop, notably with respect to crop height.
							1	0.5		Equivalent to a "calm" wind speed. (Rouse, R. J., & Hodges, L. (2004). Windbreaks. In *Production of vegetables, strawberries, and cut flowers using plasticulture* (NRAES 133, pp. 57–66). Natural Resource, Agriculture, and Engineering Service.)	

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale			Justification	Recommendations or Warnings
							Suitability Score	Attribute Value	Direction		
							0.75	2		Equivalent to 4.5 mph which is the threshold for yield reduction of crops more sensitive to wind stress. (Rouse, R. J., & Hodges, L. (2004). Windbreaks. In *Production of vegetables, strawberries, and cut flowers using plasticulture* (NRAES 133, pp. 57–66). Natural Resource, Agriculture, and Engineering Service.)	
							0.5	4		Equivalent to 9 mph which is the most common threshold wind velocity associated to a physiological injury. (Rouse, R. J., & Hodges, L. (2004). Windbreaks. In *Production of vegetables, strawberries, and cut flowers using plasticulture* (NRAES 133, pp. 57–66). Natural Resource, Agriculture, and Engineering Service.)	
							0.25	6		Equivalent to 13,4 mph which is the most common threshold wind velocity associated to a mechanical injury. (Rouse, R. J., & Hodges, L. (2004). Windbreaks. In *Production of vegetables, strawberries, and cut flowers using plasticulture* (NRAES 133, pp. 57–66). Natural Resource, Agriculture, and Engineering Service.)	
							0	≥13		Equivalent to 30 mph which corresponds to a high damage score. (Skidmors, E. L. (1966). Wind and sandblast injury to seedling green beans. *Agronomy Journal*, *58*(3), 311–315. https://doi.org/10.2134/agronj1966.00021962005800030020x)	
2.1 Food_System	Distance to community service and organizatios in food security	m	Continuous	7	✓	G-L SG, R SG	1	≤400	↓	An ideal distance is under 5 minutes' walk (about 400 m), even when carrying materials.	
							0.5	1000			
							0	>2000		Access from the organization to the garden should be feasible on foot or by bike to keep participants engaged.	

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
2.2 Site_Use	Distance to green space	m	Continuous	8	✓	G-L SG	1	0	↓		
							0	>15		The 15 m value is based on the minimal distance from which a garden is visually noticeable.	
2.3 Roof_Use	Opening hours of public building	–	Categorical	9	✓	R SG	1	Weekends	–		· Future partnerships involving privately owned but publicly accessible roofs indicate that this sub-objective may also consider buildings beyond the public sector. · Obtaining data (e.g., accessibility and opening hours) on privately owned but publicly accessible roofs may be challenging.
							1	Week days in the evenings (16h-20h)		· Most gardeners are usually not available during working hours. · Watering plants during the day is not ideal for optimal plant functions; morning and evening are best.	
							0.75	Week days in the mornings (6h-9h)			
							0.3	Week days during working hours			
3.1 Planned_Works	Specific urban planning plan and area of opportunity	–	Boolean	10		G-L SG, R SG	1	Presence	–		
							0	Absence			
3.2 Site_Ownership	Type of ownership	–	Categorical	11		G-L SG	1	Private commercial (Privé commercial)	–	Private ownership types are ranked first, reflecting the perception that working with government actors is constrained by limited resources, lack of available land, and administrative complexity.	
							1	Private residential (Privé résidentiel)			
							1	Private industrial			
							1	Private other (Autre privé)			
							0.5	Municipal		Complexity increases with the level of government, with more distant levels	

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0.25	Provincial		(e.g., federal) perceived as more difficult to engage.	
							0	Federal (Fédéral)			
							default value	Municipal			
3.3 Vacant_Sites	Presence of vacant site	–	Boolean	12	✓	G-L SG	1	Presence	–		
							0	Absence			
3.4 Roof_Ownership	Type of ownership	–	Categorical	11		R SG	1	Private industrial	–		
							0.75	Private commercial (Privé commercial)			
							0.75	Private other (Autre privé)		Average of suitability scores for private lots, since this category was not presented to the interviewed expert.	
							0.5	Private residential (Privé résidentiel)			
							0.25	Federal (Fédéral)			
							0.25	Provincial			
							0	Municipal		It is ranked lowest, as this government is lacking funding for such projects.	
							default value	Private residential (Privé résidentiel)			
3.5 Regulation	Building height	m	Categorical	5, 13	✓	R SG	1	≤4	↓		· The reason behind this objective and this regulation is actually the risk of wind uplift. · Although RBQ legislation sets a maximum building height of 46 m, the expert provided a more detailed value scale linked to risk of wind uplift. While useful for more context, considering other values can seem unaligned with the regulation-focused sub-objective.
							1	24			
							0.75	24			
							0.75	40			
							0.55	40			
							0.55	46			
							0	≥46			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
4.1 Pollution_sources	Distance to main road	m	Continuous	14	✓	G-L SG, R SG	1	> 50	↑	Threshold for airborne pollution. (Werkenthin, M., Kluge, B., & Wessolek, G. (2014). Metals in European roadside soils and soil solution—A review. *Environmental Pollution*, *189*, 98–110. https://doi.org/10.1016/j.envpol.2014.02.025)	
							0.5	50			
							0.5	10		Important decrease of pollutant concentration after 10 m. (Säumel, I., Kotsyuk, I., Hölscher, M., Lenkereit, C., Weber, F., & Kowarik, I. (2012). How healthy is urban horticulture in high traffic areas? Trace metal concentrations in vegetable crops from plantings within inner city neighbourhoods in Berlin, Germany. *Environmental Pollution*, *165*, 124–132. https://doi.org/10.1016/j.envpol.2012.02.019)	
							0.25	10			
							0.25	5		Pollutant concentration significantly less after 5 m. (Senderewich, T., Goltz, D., Rodriguez-Gil, J. L., Laird, B., Prosser, R. S., & Hanson, M. L. (2024). Human health and environmental risk assessment of metals in community gardens of Winnipeg, Manitoba, Canada. *Environmental Science and Pollution Research*, *31*(13), 20293–20310. https://doi.org/10.1007/s11356-024-32196-2)	
							0	< 5			
	Distance to railroad	m	Continuous	15		G-L SG, R SG	1	> 500	↑	(Ma, J.-H., Chu, C.-J., Li, J., & Song, B. (2009). Heavy Metal Pollution in Soils on Railroad Side of Zhengzhou-Putian Section of Longxi-Haizhou Railroad, China. *Pedosphere*, *19*(1), 121–128. https://doi.org/10.1016/S1002-0160(08)60091-0)	
							0.75	500			
							0.75	300			
							0.5	300			
							0.5	100			
							0.25	100			
							0.25	50		Recommendation of 50 m as the minimum distance for heavily polluted zone. (Brtnický, M., Václav, P., Juřička, D., Kowal, P., Vašinová Galiová, M.,	

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	< 50		Baltazár, T., & Radziemska, M. (2022). Can rail transport-related contamination affect railway vegetation? A case study of a busy railway corridor in Poland. *Chemosphere*, *293*. https://doi.org/10.1016/j.chemosphere.2022.133521)	
	Distance to industrial zone	m	Continuous	16	✓	G-L SG, R SG	1	> 1500	↑	(Qi, C., Xu, M., Liu, J., Li, C., Yang, B., Jin, Z., Liang, S., & Guo, B. (2024). Source analysis and contribution estimation of heavy metal contamination in agricultural soils in an industrial town in the Yangtze River Delta, China. *Minerals*, *14*(3), 1–17. https://doi.org/10.3390/min14030279)	
							0	< 1500			
4.2 Contaminated_Sites	Soil quality post-decontamination	–	Categorical	2, 17	✓	G-L SG	1	≤ A	–		· Soil quality criteria are under review to ensure they are based on reliable studies, thus value scales may need updating accordingly.
							0.75	plage A-B, ≤ B			
							0.25	plage B-C, > B (total)			
							0	> RESC, > C, plage C-D, ≤ C			
							default value	plage B-C, > B (total)			
	Soil quality pre-decontamination	–	Categorical	2, 17	✓	G-L SG	1	≤ A	–		· If no decontamination has been carried out but the initial soil quality is known, applying the same value scale is appropriate.
							0.75	plage A-B, ≤ B			
							0.25	plage B-C, > B (total)			
							0	> RESC, > C, plage C-D, ≤ C			
							default value	plage B-C, > B (total)			
	Type of land use	–	Categorical	16		G-L SG	1	Predominantly residential (Dominante résidentielle)	–		
							1	Large green space or recreational area (Grand espace vert ou récréation)			

# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Suitability Score	Attribute Value	Direction	Justification	Recommendations or Warnings
	Attribute information			Dataset information		Value scale information	Value Scale				
							1	Agricultural (Agricole)			
							0.75	Conservation			
							0.25	Urban center (Centre-ville d'agglomération)		The increased presence of cars in city centers and the proximity of road infrastructure suggest this score.	
							0.25	Mixed-use (Activités diversifiées)			
							0.25	Large public footprint or major public infrastructure (Grande emprise ou grande infrastructure publique)			
							0	Indutrial (Industrie)			
							default value	Mixed-use (Activités diversifiées)			
4.3 Roof_Slope	Roof slope percentage	%	Continuous	3, 18	✓	R SG	1	≤ 2	↓	A slope of 2% is ideal for the roof drainage.	
							0.5	10			
							0	≥ 17		(Régie du bâtiment du Québec. (2015). *Critères techniques visant la construction de toits végétalisés* (p. 24). Régie du bâtiment du Québec. https://www.rbq.gouv.qc.ca/fileadmin/medias/pdf/Publications/francais/guide-criteres-techniques-construction-toits-vegetalises.pdf)	
4.4 Heritage_Buildings	Status of heritage building	–	Categorical	3, 19 ,20	✓	R SG	1	Any other building (Tout autre bâtiment)	–		· Heritage buildings are less suitable for two main reasons: technical constraints and legislative requirements.
							0.5	PUM heritage buildings (Immeubles patrimoniaux du PUM)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	Buildings protected under the Cultural Heritage Act (Immeubles protégés en vertu de la Loi sur le patrimoine culturel)			
							default value	Any other building (Tout autre bâtiment)			
5.1 Water_source	Distance to connection point to the municipal water supply network	m	Continuous			G-L SG	1	0	↓		· On the Island of Montreal, there are no major pressure or connection issues, as the network coverage is extensive.
							1	100			
							0	1000			
	Territory of the island of Montreal	–	Categorical	21		G-L SG	1	Presence	–		
							0	Absence			
5.2 Topography	Slope percentage	%	Continuous	5	✓	G-L SG	0.5	< 1	↓	A slope of 1% is required for surface drainage; a slope inferior to 1% will require some construction work.	· Although this objective is linked to cost minimization, it is also connected to erosion risk; slopes must be kept small primarily to reduce erosion.
							1	1		In order to have a surface drainage a slope of minimum 1% is required.	
							0.75	3		A slope of 3% is still considered a little slope and will not order massive construction work. (Agriculture and Agri-Food Canada. (2013, June 25). *Classe de pente de relief (LF_SLOPE)*. Canadian Soil Information Service. https://sis.agr.gc.ca/siscan/nsdb/slc/v3.2/let/lf_slope.html)	
							0.5	5		A slope of 5% is considered a gentle slope but requires construction work. (Agriculture and Agri-Food Canada. (2013, June 25). *Classe de pente de relief (LF_SLOPE)*. Canadian Soil Information Service. https://sis.agr.gc.ca/siscan/nsdb/slc/v3.2/let/lf_slope.html) Between 5% and 10% slope: a linear function is suggested.	

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	≥ 10		A slope of 10% or more is associated with the highest risk of soil erosion. (Agriculture and Agri-Food Canada. (2025, July 8). *Soil erosion*. Government of Canada. https://agriculture.canada.ca/en/environment/resource-management/indicators/soil-erosion)	
5.3 Maintenance	Type of street	–	Categorical	14		G-L SG	1	Local streets (classe 0 - Rues locales)	–	It is essential that the garden is accessible by truck to allow delivery of soil and compost as well as for cleaning.	
							1	Collector roads (classe 5 - Collectrices)			
							1	Secondary arteries (classe 6 - Artères secondaires)			
							1	Main arteries (classe 7 - Artères principales)			
							0.75	Highways (classe 8 - Autoroutes)			
							0	Some pedestrian walkways (classe 1 - Certaines voies piétonnières)			
							0	Business districts (classe 2 - Places d'affaires)			
							0	Dock (classe 3 - Quai)			
							0.5	Private (classe 4 - Privée)			
							0	Planned street (classe 9 - Rue projetée)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							default value	Local streets (classe 0 - Rues locales)			
6.1 Food_Access	Food desert index	–	Categorical	22		G-L SG, R SG	1	Food desert (Désert urbain (1))	–	Area where the average distance to food stores is greater than 1000 m + where deprivation is in the fifth quintile of national material deprivation. (Robitaille, É., & Thibault, J. (2025). *Fiche synthèse – Indice de désert alimentaire* (p. 3) [Fact sheet]. Institut national de santé publique du Québec. https://cartes.inspq.qc.ca/fiches/Geoportail_FS_MAPAQ_aliment_deserts.pdf)	
							0.5	Low urban access (Faible accès urbain (3))		Area where the average distance to food stores is greater than 1000 m.	
							0	Other sector (Autre secteur (999))		Area whose characteristics do not correspond to the previous categories.	
							default value	Other sector (Autre secteur (999))			
	Distance to existing community garden	m	Continuous	23		G-L SG, R SG	1	1000	↑		· Including distance to community gardens captures access to healthy options (fruit and vegetable availability through gardening), which is not reflected by the food desert index alone.
							0.5	870		As suggested by experts, this value was calculated in QGIS using the 'Join attributes by nearest' function, by averaging the shortest distances between community gardens.	
							0	0			
6.2 Material_Social_Deprivation	Equity index for living environments	–	Categorical	24		G-L SG, R SG	1	6	–		· The use of the Equity index for living environments is recommended over the INSPQ index, as its indicators are largely similar but it was specifically developed for the Montreal context.
							0.83	5			
							0.66	4			
							0.5	3			
							0.33	2			
							0.16	1			
							0	0			
		–	Categorical	24			1	1	–		

# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
	Attribute information			Dataset information		Value scale information					
	Equity index for living environments (social dimension)					G-L SG, R SG	0	0			
	Equity index for living environments (economic dimension)	–	Categorical	24		G-L SG, R SG	1	1	–		
							0	0			
	Material and social deprivation index	–	Categorical	25		G-L SG	1	C5: DA materially and socially very disadvantaged (C5: AD matériellement et socialement très défavorisées)	–		· For applications outside the Montreal area within Quebec, the INSPQ index is well suited due to its province-wide availability.
							0.8	C4: DA socially adavantaged but materially very disadvantaged (C4: AD socialement favorisée et matériellement très défavorisées)		"Materially very disadvantaged" was prioritized over "socially very disadvantaged" as it can improve access to affordable healthy food and provide microclimate regulation for populations with limited financial resources and limited access to cooling options such as air conditioning.	
							0.7	C3: materially adavantaged and socially very disadvantaged (C3: AD matériellement favorisée et socialement très défavorisées)			
							0.2	C2: DA average (C2: AD moyennes)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	C1: DA materially and socially very advantaged (C1: AD matériellement et socialement très favorisées)			
							default value	C1: DA materially and socially very advantaged (C1: AD matériellement et socialement très favorisées)			
	Material and social deprivation index	–	Categorical	25		R SG	1	C5: DA materially and socially very disadvantaged (C5: AD matériellement et socialement très défavorisées)	–		
							0.8	C4: DA socially adavantaged but materially very disadvantaged (C4: AD socialement favorisée et matériellement très défavorisées)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale			Justification	Recommendations or Warnings
							Suitability Score	Attribute Value	Direction		
							0.5	C3: materially adavantaged and socially very disadvantaged (C3: AD matériellement favorisée et socialement très défavorisées)		A lower score was assigned to this category for this type of system due to their more limited accessibility, limiting their potential contribution to social interaction.	
							0.2	C2: DA average (C2: AD moyennes)			
							0	C1: DA materially and socially very advantaged (C1: AD matériellement et socialement très favorisées)			
							default value	C1: DA materially and socially very advantaged (C1: AD matériellement et socialement très favorisées)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
6.3 Green_Spaces_Distribution	Distance to community garden	m	Continuous	23		G-L SG, R SG	1	>800	↑	(Smith, J. P., Meerow, S., & Turner II, B. L. (2021). Planning urban community gardens strategically through multicriteria decision analysis. *Urban Forestry & Urban Greening*, 58, 1–11. https://doi.org/10.1016/j.ufug.2020.126897)	· Different green spaces serve different functions, requiring separate value scales; for example, shared gardens should be located closer to green alleyways than to existing community gardens.
							0	<300		(Lacroix, S., Kuller, M., Gougeon, G., Petrucci, J., Lemieux-Chalifour, F., Rioux, A., Dagenais, D., & Bichai, F. (2024). Can we stop reinventing the wheel in blue-green infrastructure planning? Using value-focused thinking to enable transferability of a multicriteria planning support system. *Landscape and Urban Planning*, 252, 1–16. https://doi.org/10.1016/j.landurbplan.2024.105188)	
	Distance to green space	m	Continuous	8, 23	✓	G-L SG, R SG	1	>480	↑	According to expert's weighting scheme (community gardens = 1, green spaces = 0.6 and green alleyways = 0.3), the following distances were established.	
							0	<180			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
	Distance to green alleyway	m	Continuous	26		G-L SG, R SG	1	>240	↑		
							0	<90			
7.1 Heat_Islands	Intensity of heat island	–	Categorical	27		G-L SG, R SG	1	Heat island (Îlot de chaleur)	–		
							0.75	Warmer-than-average temperature (at risk) (Température plus chaude que la moyenne (à risque))			
							0.5	Temperature closer to average (Température plus proche de la moyenne)			
							0.25	Closer-than-average temperature (Température plus froide que la moyenne)			
							0	Oasis of freshness (Îlot de fraîcheur)			
7.2 Overflows	Type of surface	–	Categorical	28		G-L SG	1	1. Low mineral (road, parking) (1. Minéral bas (route, stationnement, etc.))	–		
							0.5	3. Low vegetation (crop, grass, etc.) (3. Végétal bas (culture, gazon, etc.))			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	2. High mineral (constructions) (2. Minéral haut (constructions))		This category corresponds to buildings so it relates to rooftop gardens rather than shared gardens.	
							0	4. High vegetation (canopy) (4. Végétal haut (canopée))		Trees have a bigger impact on water retention than gardens so they should remained.	
							0	0. No data (0. Aucune donnée)			
							0	5. Aquatic (5. Aquatique)			
	Distance to retention basin	m	Continuous	29		G-L SG	1	4 -20	↓		· Locating shared gardens near, but not directly on, retention basins could create synergies by enabling the use of stored water for irrigation.
							0	< 4		Canada Mortgage and Housing Corporation. (2004). *Rain gardens: Improve stormwater management in your yard*. https://publications.gc.ca/collections/collection_2011/schl-cmhc/nh18-24/NH18-24-53-2011-eng.pdf	
							0	> 20			
	Type of surface	–	Categorical	28		R SG	1	2. High mineral (constructions) (2. Minéral haut (constructions))	–	Except for the category High mineral, the other categories do not relate to buildings so they are irrelevant here.	
							0	1. Low mineral (road, parking) (1. Minéral bas (route, stationnement, etc.))			
							0	3. Low vegetation (crop, grass, etc.)			

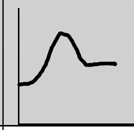
	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
								(3. Végétal bas (culture, gazon, etc.))			
							0	4. High vegetation (canopy) (4. Végétal haut (canopée))			
							0	0. No data (0. Aucune donnée)			
							0	5. Aquatic (5. Aquatique)			
7.3 Eco_Connectivity	Distance to green space	m	Continuous	8		G-L SG, R SG	1	<100	↓	Chan, L., Hillel, O., Werner, P., Holman, N., Coetzee, I., Galt, R., and Elmqvist, T. 2021 *Handbook on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index)*. Montreal: Secretariat of the Convention on Biological Diversity and Singapore: National Parks Board, Singapore. 70 Pages .	· Travel distances vary depending on insect and animal species. · Inter-patch connectivity instead of intra-patch connectivity was considered. · Physical barriers such as roads and buildings were not taken into account.
							0.25	5000		Zhao, H., Liu, D., Li, F., Liu, X., Niu, J., He, J., & Liu, Y. (2021). Incorporating spatio-temporal connectivity for prioritized conservation of individual habitat patches in a dynamic landscape. *Ecological Indicators*, 124. https://doi.org/10.1016/j.ecolind.2021.107414	
							0	>5000			
8.1 Social_Cohesion	Equity index for living environments	–	Categorical	24		G-L SG, R SG	1	6	–		
							0.83	5			
							0.66	4			
							0.5	3			
							0.33	2			
							0.16	1			
							0	0			
							default value	3			
		–	Categorical	24			1	1	–		

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
	Equity index for living environments (social dimension)					G-L SG, R SG	0	0			
8.2 Education_Potential	Presence of kindergarden	–	Boolean	2, 30	✓	G-L SG, R SG	0	Absence	–	With such young children, a garden is only relevant if implemented on the kindergarden's site.	· This objective is considered irrelevant for rooftop gardens due to additional constraints (e.g., safety) specific to rooftop settings.
							1	Presence			
	Distance to school (e.g., preschool, elementary, and high school levels)	m	Continuous	2, 31	✓	G-L SG, R SG	1	0	↓	The garden should be close enough for activities to be completed within a single class period (approximately 1 hour).	
							0.5	150			
							0	300			
8.3 Transportation	Distance to public transporation (bus or metro) stop	m	Continuous	32		G-L SG, R SG	1	0	↓		
							0	500		Beyond 500 m from a bus or metro stop, accessibility is likely to decrease as the distance becomes less acceptable for users.	
	Distance to bicycle path	m	Continuous	33	✓	G-L SG, R SG	1	0	↓		
							0	1000		At more than 1 km from a bicycle path, people are probably less comfortable using the bike on roads without reserved lanes for bikes.	
8.4 Pop_Density	Population density	inhab./km2	Continuous	34		G-L SG	1	8838.6	↑	A linear function represents well the suitability.	
							0.5	4 419.30		This value represents the average population density for the island of Montreal. (Gouvernement du Québec. (2023). *Portrait socioéconomique de Montréal*. https://www.quebec.ca/gouvernement/ministeres-organismes/economie/publications/portraits-socioeconomiques/montreal#c395736)	
							0	0			
9.1 Senior_Well being	Presence of seniors' house or center	–	Boolean	2, 35, 36	✓	G-L SG, R SG	1	Presence	–	Given the health of typical CHSLD or RPA residents, a garden is only relevant if located on-site.	
							0	Absence			
	Percentage of seniors	%	Continuous	37, 38	✓	G-L SG, R SG	1	100	↑		· There is also a good portion of the elderly population that does not live in CHSLD nor RPA.
							0.75	75			
							0.5	50			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0.25	25			
							0	0			
9.2 Worker_Well being	Presence of office and commercial zone	–	Boolean	12		G-L SG, R SG	1	Presence	–	Office spaces and commercial areas were suggested as zones in which workers can benefit from the reducing stress benefits and reducing heat benefits in addition to psycho-socio risks and musculo-squelletiques troubles.	
							0	Absence			
9.3 Air_Quality	Air quality index	–	Categorical	39, 40	✓	G-L SG, R SG	0	Good (1 to 25) (Bon (1 à 25))	–		· In toxicology and risk assessment, the precautionary principle generally applies, and the consulted expert preferred to follow this approach. · In addition, the extent to which vegetation effectively improves air quality at the city scale remains uncertain.
							0	Acceptable (26-50)			
							0	Bad (51+) (Mauvais (51+))			

Table SI-12 Value scales for Utrecht

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
1.1 Sunlight	Number of hours of sunlight x 10	–	Continuous	1	✓	G-L SG, R SG	1	162	–	Equivalent to 16.2 hours of sunlight (maximum value in Utrecht on the 21st of June 2023)	
							0.5	112		Equivalent to 11.2 hours of sunlight (shade for 5 hours during the day)	

	Attribute information			Dataset information		Value scale information					
							Value Scale				
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Suitability Score	Attribute Value	Direction	Justification	Recommendations or Warnings
							0	0		Shade all day	
	UV	–	Continuous	–	–	G-L SG, R SG			–	Shape of the UV value-scale curve, where the peak represents the most suitable UV level for plants.	· Since there is no difference of UV value across Utrecht, this attribute is not considered.
1.2 Site_Size	Site area	m^2	Continuous	2	✓	G-L SG	1	≥20000	↑		
							0.75	8000			
							0.5	4000			
							0	≤4000			
1.3 Roof_Size	Roof area	m^2	Continuous	3	✓	R SG	1	>50	↑	The minimal threshold considered is 50 m2, which corresponds to the size of a single plot.	
							0	<50			
1.4 Wind	Average wind speed at 10 m	$m \cdot s^{-1}$	Continuous	4		R SG	1	<1	↓		· The Venturi effect caused by buildings in an urban context can influence the shape and growth of plants but is often not captured by wind measurements.
							0.5	3			
							0	>7			
2.1 Communit y_Interest	District with people interested in neighborhood life and in nature	–	Categorical	5	✓	G-L SG, R SG	0.7	1	–	Binnenstad	
							0.6	2		West	
							0.6	3		Oost	
							0.6	4		Noordoost	
							0.6	5		Noordwest	

	Attribute information				Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0.5	6		Leidsche Rijn	
							0.5	7		Zuidwest	
							0.5	8		Vleuten-De Meern	
							0.4	9		Zuid	
							0.4	10		Overvecht	
							default value	6			
2.2 Site_Use	Type of community facility	–	Categorical	6-14	✓	G-L SG	0.8	Schools	–		
							0.8	Universities and colleges			
							0.8	Community centers (Buurthuis)			
							0.7	Elderly care centers			
							0.7	Religious institutions			
							0.6	Parks			
							0.6	Associations (student, etc.)		Data unavailable	
							0.4	Refugees centers		Data unavailable	
							0.1	Hospitals		Data unavailable (sensitivite data)	
							default value	Parks			
2.3 Roof_Use	Type of usage	–	Categorical	15		R SG	0.6	educational use (onderwijsfunctie)	–		
							0.6	healthcare use (gezondheidszorgfunctie)			
							0.6	retail use (winkelfunctie)			
							0.6	meeting use (bijeenkomstfunctie)			
							0.6	sports use (sportfunctie)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0.2	residential use (logiesfunctie)			
							0.2	office use (kantoorfunctie)			
							0.2	housing use (woonfunctie)			
							0.2	cell use (celfunctie)			
							0.2	industrial use (industriefunctie)			
							0.2	other uses (overige gebruiksfunctie)			
							default value	other uses (overige gebruiksfunctie)			
	Level of public access	–	Categorical	–	–		1	always open (fully accessible to the public)	–	Data representing this information are unavailable.	
							0,6	partly open (restricted access / limited hours)			
							0,2	never open (private access)			
3.1 Planned_ Works	Type of project	–	Categorical	16	✓	G-L SG	1	Green projects (Groenprojecten)	–	Due to property ownership, construction projects are more difficult to influence, yet, these projects , along with green projects, offer greater opportunities to engage people than traffic or energy projects.	
							0.5	Construction projects (Bouwprojecten)			
							0	Traffic projects (Verkeersprojecten)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	Energy projects (Energieprojecten)			
							default value	Construction projects (Bouwprojecten)			
3.1 Planned_ Works	Type of project	–	Categorical	16	✓	R SG	1	Construction projects (Bouwprojecten)	–	Construction projects are more likely to involve buildings than green projects.	
							0.5	Green projects (Groenprojecten)			
							0	Traffic projects (Verkeersprojecten)			
							0	Energy projects (Energieprojecten)			
							default value	Construction projects (Bouwprojecten)			
3.2 Site_Ownership	Type of site accessibility	–	Categorical	17		G-L SG	1	Public (4 - Openbaar)	–		· Using cadastral data can provide more precise information.
							0.5	Private (3 - Niet-openbaar)			
							0	Building (2 - Gebouw)			
							0	1 - Water			
3.3 Unused_Sites	Presence of construction site	–	Boolean	13		G-L SG	1	Presence	–		
							0	Absence			
3.4 Roof_Ownership	Type of ownership	–	Are	12, 15, 18, 19	✓	R SG	0.7	Housing corporations / Social housing providers	–		

# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Suitability Score	Attribute Value	Direction	Justification	Recommendations or Warnings
	Attribute information			Dataset information		Value scale information	Value Scale				
							0.7	Municipal real estate owners			
							0.7	Private project developers		Data unavailable	
							0.5	Corporate real estate owners			
							0.5	Religious institutions			
							0.3	Homeowner Associations (HOAs)		Data unavailable	
							0.2	Institutional investors		Data unavailable	
							0.1	Industrial property owners			
							0.1	Landlords		Data unavailable	
							0.1	Private individual homeowners		Data unavailable	
							default value	Corporate real estate owners			
	Type of usage	–	Categorical	–	–	R SG	0.8	educational use (onderwijsfunctie)	–		
							0.8	residential use (logiesfunctie)			
							0.7	healthcare use (gezondheidszorgfunctie)			
							0.7	office use (kantoorfunctie)			
							0.6	housing use (woonfunctie)			
							0.6	retail use (winkelfunctie)			
							0.5	meeting use (bijeenkomstfunctie)			

	Attribute information			Dataset information		Value scale information						
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0.4	sports use (sportfunctie)			
							0.3	cell use (celfunctie)			
							0.2	other uses (overige gebruiksfunctie)			
							0	industrial use (industriefunctie)			
3.5 Regulation	Roof size	m^2	Continuous	3	✓	R SG	1	≥12	↓	Generally, 70% of a roof is usable for vegetation, with the remaining area reserved for edge setbacks and technical installations. Considering additional circulation space for users, a more conservative estimate of 50% vegetated area is retained, resulting in a minimum roof size of 12 m^2 to meet the 6 m^2 vegetation threshold required for subsidies.	
							0	<12			
4.1 Pollution_sources	Distance to non-static pollution source (e.g., main road, railroad)	m	Continuous	20, 21	✓	G-L SG, R SG	1	100	↑		
							0.75	85			
							0.5	75			
							0.25	50			
							0	0			
4.2 Contaminated_Sites	Contaminated site	–	Categorical	–	–	G-L SG	0.8	No action needed	–	Data representing this information are unavailable.	
							0.5	Presence			
							0	Action needed			
	Type of contamination risk	–	Categorical	22-25	✓	G-L SG	1	No identified risk	–		
							0.5	Old fuel tanks (Brandstoftanks)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale			Justification	Recommendations or Warnings
							Suitability Score	Attribute Value	Direction		
							0.5	Nuisance act (Hinderwet, Hinderwet 4)			
							0.5	Historical activity (Historische activiteit)			
							0.25	Old polluted filled waterways (Gedempte sloten)			
							default value	No identified risk			
	Expected soil quality	–	Categorical	26		G-L SG	1	Agriculture/Nature (Landbouw/Natuur)	–		
							0.75	Residential (Wonen)			
							0.25	Industry (Industrie)			
							0	Water			
							0	Excluded area (Uitgesloten gebied)			
							default value	Excluded area (Uitgesloten gebied)			
4.3 Roof_Slope	Percentage of flat roof coverage	–	Continuous	27		R SG	1	Mostly flat roof (80-100) (80-100 grotendeels plat dak)	–		
							0.75	60-80			
							0.25	Partially flat roof (40-60 gedeeltelijk plat dak)			
							0	20-40			
							0	No flat roof (0-20 geen plat dak)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
							0	No data (geen gegevens)			
							default value	No data (geen gegevens)			
	Roof slope	°	Continuous	–	–	R SG	1	0	↓		
							0	>5			
4.4 Heritage_ Buildings	Type of monument building	–	Categorical	28-30	✓	R SG	1	Other buildings	–		
							0.5	Landmark buildings (Beeldbepalende gebouwen)			
							0.5	Municipal monument (Gemeentelijk monument)			
							0	National monument (Rijksmonument)			
							default value	Other buildings			
5.1 Water_Source	Groundwater depth	m	Continuous	31		G-L SG	1	≤0.1	↓		
							0.5	0.3			
							0	≥1			
5.2 Topography	Slope percentage	%	Continuous	32		G-L SG	1	<5	↓	(Caneva, G., Cicinelli, E., Scolastri, A., & Bartoli, F. (2020). Guidelines for urban community gardening: Proposal of preliminary indicators for several ecosystem services (Rome, Italy). *Urban Forestry & Urban Greening*, 56. https://doi.org/10.1016/j.ufug.2020.126866)	
							0.5	5			
							0	>15			
	Urban infiltration opportunities	–	Categorical	33		G-L SG	0.9	High (9,18) (Groot)	–		
							0.75	Moderate (4, 6, 12) (Matig)			
							0.5	Very high (27) (Zeer groot)			

# Sub-objective	Attribute information: Attribute Name	Units	Type of attribute	Dataset information: # Dataset	Handling required	Value scale information: Type of UA	Value Scale: Suitability Score	Attribute Value	Direction	Justification	Recommendations or Warnings
							0.3	Low (1, 2, 3) (Gering)			
							0	No data (0)			
							default value	No data (0)			
5.3 Building_ Foundations	Utrecht municipality territory	–	Boolean	34		G-L SG	1	Presence	–		· Nowhere existing building foundations constitute an issue since roots are not very deep in the case of a garden.
							0	Absence			
	Archeological potential or value	–	Categorical	35	–	G-L SG		Protected national monuments (Beschermde Rijksmonumenten)	–		· Potential subsurface constraints, such as old foundations or archaeological remains, may be problematic once excavation begins.
								Areas of high archaeological potential (Gebieden van hoge archeologische verwachting)			
								Areas of high archaeological value (Bebieden van hoge archeologische waarde)			
								Areas of low archaeological potential (Gebieden van lage archeologische verwachting)			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
								Areas of medium archaeologica l potential (Gebieden van middelhoge archeologisch e verwachting)			
								Areas of very high archaeologica l value (Gebieden van zeer hoge archeologisch e waarde)			
								Areas without archaeologica l value (Gebieden zonder archeologisch e waarde)			
6.1 Food_Access	Distance to unhealthy food supply	km	Continuous	36		G-L SG, R SG	1	0	↓		
							0.75	1			
							0.5	5			
							0.25	10			
							0	>50			
6.2 Material_Social_Deprivation	Socioeconomic status score	–	Continuous	37		G-L SG, R SG	0.7	< -0.144	↓		
							0.6	-0.004			
							0.55	0.068			
							0.4	> 0.336			
							0.55	NULL			
6.3 Green_Spaces_Distribution	Distance to green space and community garden	m	Continuous	13	✓	G-L SG, R SG	1	>1500	↑	Corresponding to approximately 5 minutes by bike.	
							0.75	800			
							0	<300			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
7.1 Heat_Islands	Average temperature difference between cities and rural areas	°C	Continuous	38		G-L SG, R SG	1	> 1.6	↑		
							0.5	1.2			
							0	< 0.4			
7.2 Overflows	Urban infiltration opportunities	–	Categorical	33		G-L SG, R SG	1	Very high (27) (Zeer groot)	–		
							1	High (9,18) (Groot)			
							0.8	Moderate (4, 6, 12) (Matig)			
							0	Low (1, 2, 3) (Gering)			
							0	No data (0)			
							default value	No data (0)			
7.3 Eco_Connectivity	Distance to green space	m	Continuous	13	✓	G-L SG, R SG	1	0	↓	Factors considered for those values include travel distances for insects as well as intervening infrastructure (e.g., roads).	
							0.75	2			
							0.5	5			
							0.25	15			
							0	>100			
8.1 Social_Cohesion	District with people in need of social interaction	–	Categorical	5		G-L SG, R SG	0.8	1	–	Overvecht	
							0.75	2		Zuidwest	
							0.5	3		West	
							0.5	4		Noordwest	
							0.5	5		Oost	
							0.5	6		Binnenstad	
							0.5	7		Zuid	
							0.5	8		Leidsche Rijn	
							0.5	9		Noordoost	
							0.3	10		Vleuten-De Meern	
							default value	5			

	Attribute information			Dataset information		Value scale information					
# Sub-objective	Attribute Name	Units	Type of attribute	# Dataset	Handling required	Type of UA	Value Scale: Suitability Score	Value Scale: Attribute Value	Value Scale: Direction	Justification	Recommendations or Warnings
8.2 Education_Potential	Distance to school (e.g., preschool, primary and secondary education institution)	m	Continuous	6, 8, 9	✓	G-L SG, R SG	1	0	↓		
							0.5	200			
							0	>500			
8.3 Pop_Density	Population density	inhab. /km^2	Continuous	39		G-L SG, R SG	1	> 6000	↑		
							0.9	4500			
							0.9	3000			
							0.9	1500			
							0.3	< 1500			
9.1 Senior_Wellbeing	Distance to seniors' center	m	Continuous	11		G-L SG, R SG	1	0	↓		· Retirement houses are becoming less common for elderly.
							0.75	250			
							0.5	500			
							0.25	1000			
							0	2000			
9.2 Air_Quality	Fine dust concentration	PM2,5	Continuous	40		G-L SG, R SG	1	<5	↓		
							0	>15			
9.3 Cultural_Groups	Percentage of people born outside the Netherlands with origins outside Europe	–	Continuous	41		G-L SG, R SG	0.9	>40	↑	Treshold point corresponds to the average percentage of people with birthplace outside of Netherlands.	
							0.7	30			
							0.7	20			
							0.5	10			
							0.3	<10			
							0.3	-99997 (no data)			
9.4 Noise_Pollution	Noise level	dB	Categorical	42		R SG	1	≤60	–		
							0.8	65			
							0.5	70			
							0.2	≥75			

2.2. Suitability maps

Figure SI-12 Suitability maps for ground-level shared gardens and rooftop shared gardens in Montreal under scenario 1

Figure SI-13 Suitability maps for ground-level shared gardens and rooftop shared gardens in Montreal under scenario 2

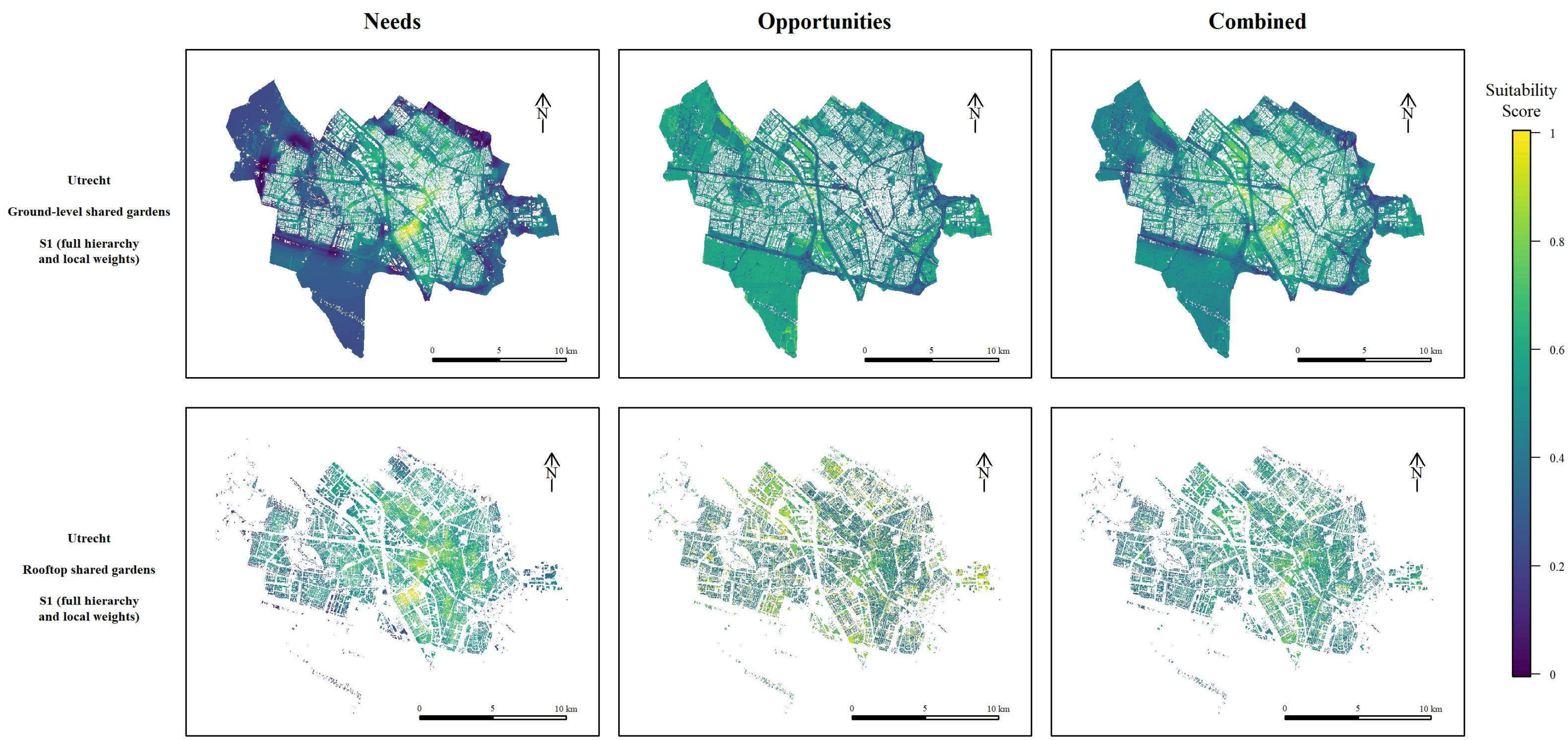


Figure SI-14 Suitability maps for ground-level shared gardens and rooftop shared gardens in Montreal under scenario 3

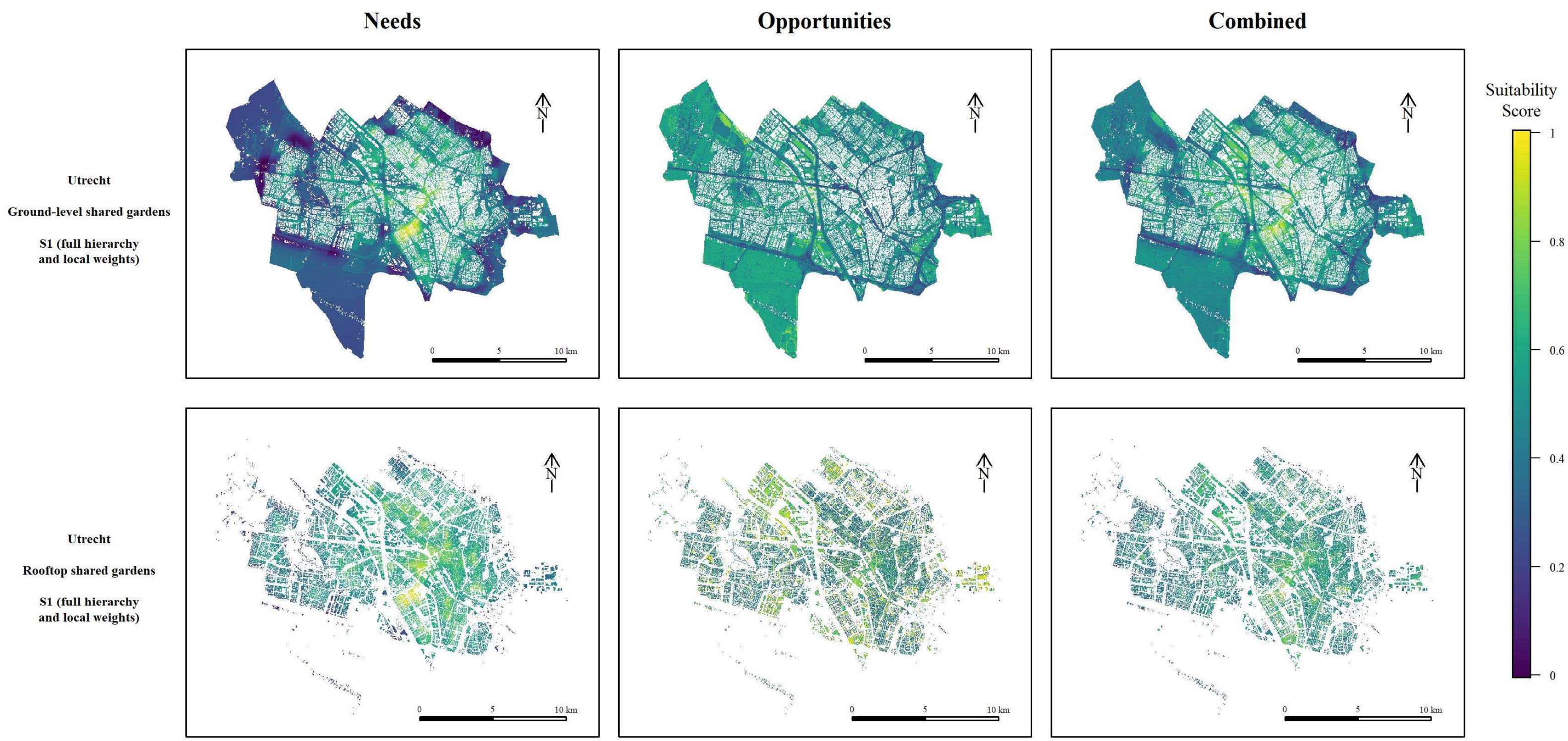


Figure SI-15 Suitability maps for ground-level shared gardens and rooftop shared gardens in Utrecht under scenario 1

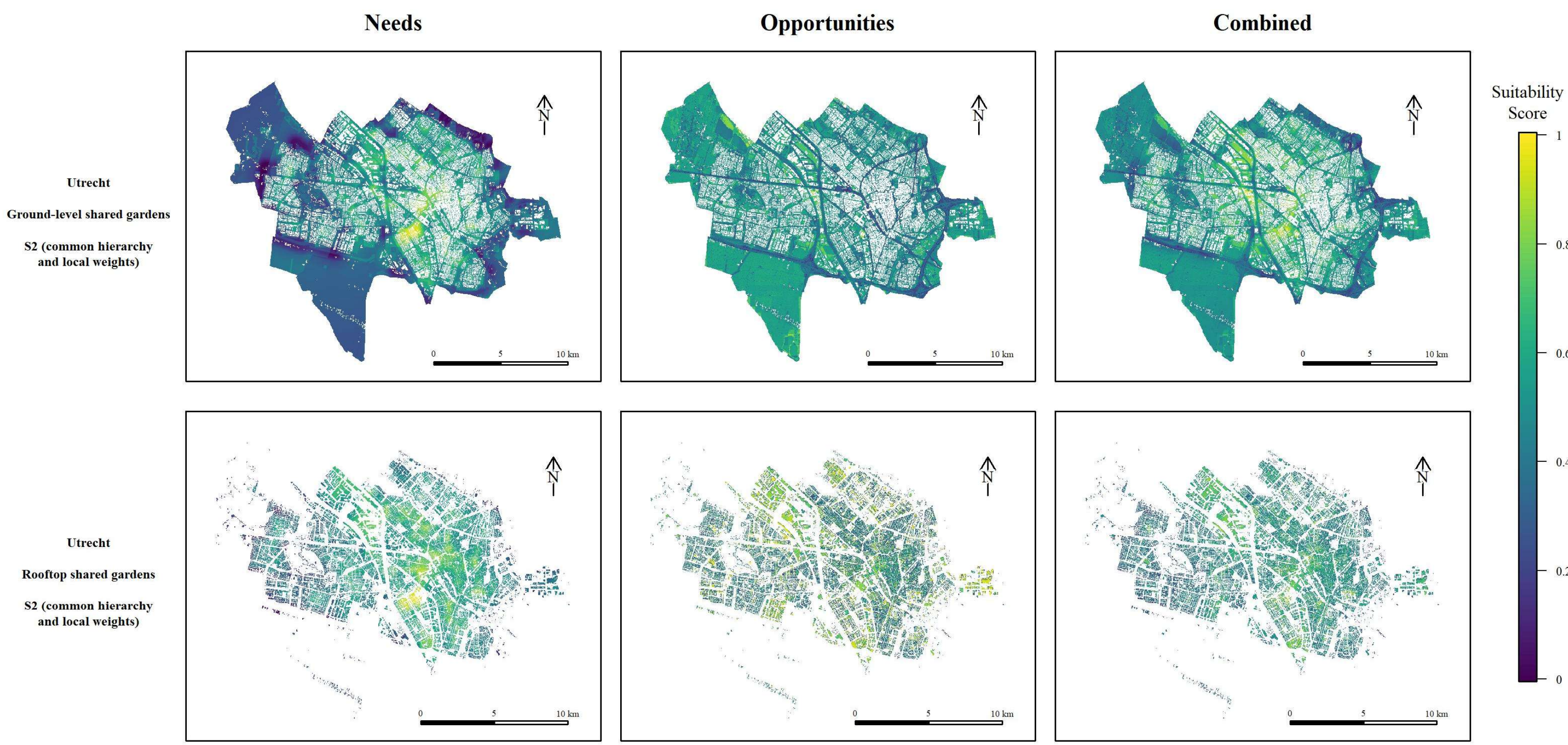


Figure SI-16 Suitability maps for ground-level shared gardens and rooftop shared gardens in Utrecht under scenario 2

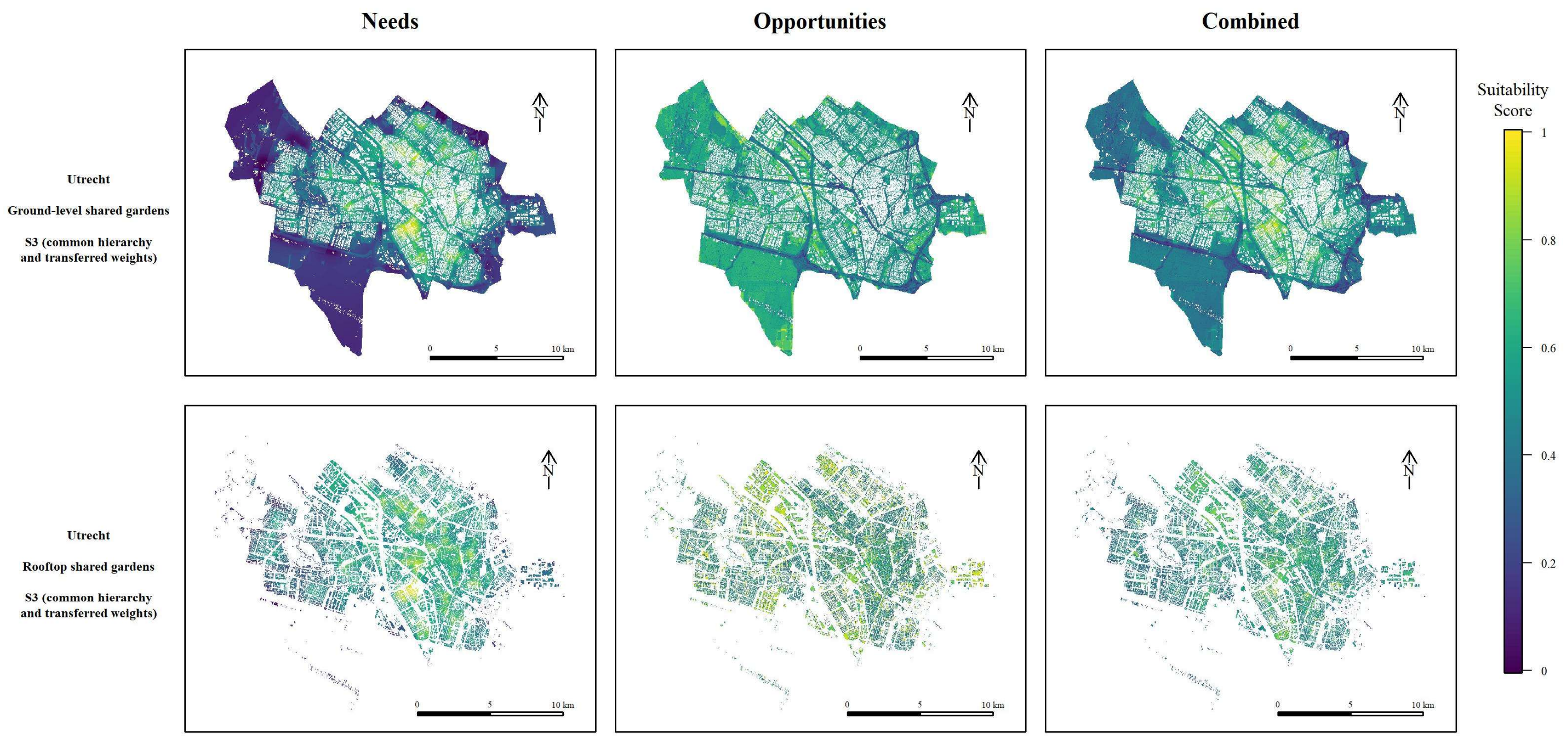


Figure SI-17 Suitability maps for ground-level shared gardens and rooftop shared gardens in Utrecht under scenario 3

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