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E-participation in mapping and typology development: community gardens in Krakow and Brussels

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ABSTRACT

This study compares community gardens in Brussels and Krakow through a mixed-method, participatory approach combining digital mapping, surveys, and qualitative interviews. It develops a typology based on emergence drivers, governance models, spatial patterns, and socio-ecological functions. Findings reveal context-specific governance: Brussels is dominated by bottom-up initiatives facing sustainability challenges, while Krakow features more hybrid municipal–community models. Spatially, gardens cluster in dense, lower-income areas in Brussels and in high-density, mixed-housing districts in Krakow. Participatory mapping proved crucial in reconciling official data with on-ground realities. The typology offers a practical tool for planners to design context-sensitive strategies integrating gardens into resilient urban systems.

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1. Introduction

Contemporary cities face increasing pressures due to rapid urbanization, land-use conflicts, and shifting socio-economic dynamics (Han *et al.*, 2018). As space becomes limited and populations grow, issues like food security, social equity, environmental sustainability, and public health converge, creating complex challenges in urban environments (Roberts & Shackleton, 2018). Within this context, community gardens (CGs), often developed as grassroots initiatives aimed at addressing a range of interconnected urban concerns (Senes *et al.*, 2016). While CGs are often lauded for their manifold benefits, significant gaps persist in understanding how governance frameworks, cultural heritage, and spatial planning intricately shape their emergence and management. This study advances beyond existing literature by offering a direct comparative analysis of CGs in a Western European city (Brussels) and a post-socialist city (Krakow), highlighting how socio-political legacies and urban development trajectories differently influence CG formation, governance, and spatial patterns. Moreover, the role of digital participatory mapping remains underexplored, particularly in its capacity to enhance spatial accuracy and stakeholder engagement. In this study, digital participatory mapping is defined as a collaborative cartographic approach that enables residents and stakeholders to contribute spatial data and contextual insights via digital platforms (Cochrane & Corbett,

2020). Addressing these knowledge gaps is essential for informing urban planning policies that aim for long-term community resilience and inclusive urban development.

The evolution of CGs in different urban contexts reflects varied socio-political, cultural, and spatial influences. In Western Europe, cities like Brussels have witnessed CGs flourish primarily through grassroots environmental activism, aligning with formal sustainability agendas (Cahn *et al.*, 2018; Mercier & Mercier, 2018). Conversely, post-socialist cities such as Krakow exhibit a reorientation of traditional allotment gardens, influenced by heritage conservation and urban redevelopment processes (Mokras-Grabowska, 2020; Tomczyk & Basińska, 2022). Despite these contextual differences, both cities present opportunities to investigate how digital participatory mapping can serve as a methodological tool for fostering inclusive urban planning. This study thus engages with existing literature to critically assess the methodological, socio-spatial, and governance aspects of CGs, ensuring a nuanced, context-sensitive understanding of these urban phenomena.

To develop a robust typology of CGs, insights from existing literature on urban agriculture and sustainability were instrumental. This typology is structured around four interrelated dimensions that capture the socio-spatial diversity and adaptive nature of community gardens. First, emergence reasons reflect motivations such as environmental concerns, social inclusion, food security, and cultural or economic drivers, which vary according to local socio-political contexts. Second, governance structures encompass top-down, bottom-up, and hybrid models, illustrating the diverse forms of stakeholder engagement and institutional support shaping CG operations. Third, location factors address spatial distribution, accessibility, and integration with broader urban planning strategies, revealing how physical settings influence the functions and sustainability of CGs. Lastly, functions encompass multiple roles, including food production, environmental stewardship, education, and social integration, highlighting the multi-functional contributions of CGs to urban resilience. By clearly operationalizing these dimensions, the typology not only synthesizes existing literature but also provides a novel framework for comparative analysis across divergent urban contexts.

By comparing these two cities, this research aims to: (1) examine how digital participatory mapping, as both a methodological and empowerment tool, enhances spatial understanding and stakeholder engagement; (2) build a comparative typology that reflects the socio-spatial diversity, governance models, and adaptive functional of CGs in contrasting contexts; and (3) examine how governance frameworks, spatial planning, and cultural heritage influence the emergence and management of CGs. The study's findings will provide actionable recommendations for integrating CGs into broader urban planning frameworks. These recommendations aim to help urban policymakers, planners, and community organizations design CG projects that support social inclusion, environmental sustainability, and long-term community resilience.

2. Literature review

The evolution of CGs provides valuable context for understanding their current roles. European gardening traditions, particularly allotment gardens, have long contributed to urban resilience by supporting food production and recreational needs. However, these traditions vary across the continent due to diverse geographical, historical, social,

cultural, economic, and political contexts. For example, Poland and Belgium, two countries from which the case studies in this paper are drawn, exemplify distinct approaches to urban gardening. In both contexts, allotment gardens emerged as early responses to food insecurity and industrial urbanization, particularly gaining traction in the early 20th century. However, it was after WWII and especially during the post-socialist transformation in Poland that major divergences occurred (Bellows, 2010; Bell *et al.*, 2016). In Poland, *Rodzinne Ogrody Działkowe* (Family Allotment Gardens) were established during the interwar period to address food shortages and offered green recreational spaces amid rapid urbanization (Mokras-Grabowska, 2020). These roles became even more pronounced during the communist period. Following the systemic transformation of 1989, the function of these spaces shifted significantly from subsistence gardening to more multifunctional uses, including leisure, ecological education, and civic engagement (Bellows, 2010; Bell *et al.*, 2016). More recently, a growing body of scholars has begun to examine the rise of CGs in post-socialist Poland. These CGs, distinct from traditional allotments, have emerged primarily since the 2010s and are often associated with grassroots environmental activism, participatory governance, and urban regeneration projects (Barszczewska-Woszczyk, 2020; Maćkiewicz & Jeziorek, 2024). For instance, studies in Warsaw, Krakow, and Poznań highlight the role of CGs in fostering social cohesion, offering inclusive green infrastructure, and responding to the densification of post-socialist housing estates (Wojcieszak-Zbierska, 2024; Rancew-Sikora *et al.*, 2025). These works emphasize that CGs in Poland are shaped not only by civic initiative but also by partnerships with cultural institutions and local governments, often operating in tension between bottom-up ideals and top-down frameworks (Maćkiewicz & Jeziorek, 2024). In Belgium, early 20th-century philanthropic gardening efforts aimed to alleviate poverty and improve public health, forming the foundation for contemporary CG movements in Brussels (Cahn *et al.*, 2018; Mercier & Mercier, 2018). The evolution of community gardens there was later reinforced by environmental movements and migrant-led initiatives, especially from the late 1990s onwards (Certomà & Notteboom, 2015).

For clarity, this study defines allotment gardens as formally regulated parcels of land allocated to individuals or families for food cultivation, often supported by national or municipal frameworks. In contrast, CGs refer to collectively managed urban spaces where diverse stakeholders collaborate on cultivation, social interaction, and environmental stewardship, usually with an emphasis on shared governance, education, and inclusivity (Guitart *et al.*, 2012; Bell *et al.*, 2016; Kwartnik-Pruc & Droj, 2023). These conceptual distinctions are key in understanding both the governance models and the spatial logic of urban gardening.

Meanwhile, in North America, CGs emerged in response to urban poverty and food insecurity in the late 19th century, experiencing renewed momentum in the 1970s due to rising environmental activism and community-based efforts (Lawson, 2005). These different historical trajectories reflect the influence of local socio-political factors and highlight the need for comparative studies to understand how CGs are established and adapted across regions (Fox-Kämper *et al.*, 2018; Djokić *et al.*, 2018).

Although previous studies highlight CGs' ability to foster social cohesion, environmental awareness, and local food security (Wakefield *et al.*, 2007; Blair, 2009; Hagey *et al.*, 2013; Langemeyer *et al.*, 2017), knowledge gaps remain. Many studies focus on the

benefits of CGs but offer limited insight into how governance structures, property rights, and cultural values influence their spatial distribution and sustainability in urban planning contexts (Fox-Kämper *et al.*, 2018; Deep, 2023). Several recent publications explicitly address CG development in post-socialist cities, highlighting how post-communist transitions have shaped civic engagement, land-use policy, and institutional relationships in urban gardening (Borčić *et al.*, 2016; Škamlová *et al.*, 2020). These works emphasize region-specific constraints, such as weak tenure security, inconsistent municipal support, and contested public space, that distinguish the CG experience in Central and Eastern Europe (CEE) from its Western counterparts. This study addresses a knowledge gap (Miles, 2017) by investigating CG typologies in two distinct national contexts, post-socialist Krakow and Western European Brussels, uncovering patterns that are under-explored in comparative studies.

In terms of methodological approaches in urban studies, participatory mapping has emerged as a powerful tool for incorporating community-driven knowledge into urban planning, spatial analysis, and decision-making processes (Cochrane & Corbett, 2020; Narbaitz Sarsura, 2024). It enables stakeholders, including local residents, to map and identify key spatial issues such as access to public spaces, resource distribution, and community assets (Laituri *et al.*, 2023). In particular, e-participatory mapping has gained prominence as digital tools and Geographic Information Systems (GIS) facilitate broader participation and data collection in urban planning, disaster management, and neighborhood regeneration (Pánek, 2018; Rawat & Yusuf, 2020). By engaging diverse participants, including marginalized groups, e-participatory mapping ensures more inclusive planning outcomes and fosters spatial accuracy (Weyer *et al.*, 2019; Akmentina, 2022). However, despite its extensive use in urban planning, its application in urban agriculture and CG research remains limited (Ramos *et al.*, 2019; Codato *et al.*, 2024; Gemperle *et al.*, 2024). Studies in urban farming contexts often focus on traditional participatory techniques such as in-person workshops or interviews, with few employing digital mappings to integrate community perspectives systematically (Guitart *et al.*, 2012).

This study addresses this methodological gap (Miles, 2017) by applying e-participatory mapping to CG research, specifically engaging CG practitioners: users with unique hands-on knowledge of land use, social interactions, and local environmental management. Unlike general participatory mapping, which typically involves non-specialized community members, this approach draws on the expertise of CG practitioners to enrich spatial data. By combining e-participatory mapping with complementary methods, including desk research, surveys, and semi-structured interviews, this research evaluates the effectiveness of this approach in capturing dynamic spatial and functional data about CGs. Furthermore, this method assesses whether digital mapping, when used alongside other techniques, improves spatial accuracy and fosters stakeholder engagement in CG planning and development.

Finally, typologies of CGs are another key focus of this study. Research has highlighted CGs' multifunctional roles in addressing food security (Hagey *et al.*, 2013), promoting environmental education (Blair, 2009), fostering social cohesion (Wakefield *et al.*, 2007), and mitigating urban challenges such as the heat island effect (Langemeyer *et al.*, 2017). CGs also contribute to local economies by supporting small-scale food production and neighborhood revitalization (Burley *et al.*, 2011). Existing typologies typically classify

CGs based on governance models, garden size, or primary functions (Firth *et al.*, 2011; Guitart *et al.*, 2012; Bell *et al.*, 2016). However, these frameworks often lack a cross-regional dimension, particularly in the context of comparative studies between post-socialist cities in CEE and Western European cities. As such, this study addresses a population gap (Miles, 2017) by comparing CG typologies between Krakow and Brussels, analyzing how governance models, socio-political contexts, and location-specific drivers influence CG development and operation.

Drawing on theoretical and empirical insights, the typology framework used in this study examines four key dimensions:

- **Emergence reasons:** Understanding why CGs are established is essential for grasping their evolving roles in urban environments. Motivations can range from addressing environmental concerns, such as biodiversity preservation and climate resilience, to fulfilling social needs like community building and providing accessible green spaces (Veen *et al.*, 2015; Kingsley *et al.*, 2019). In some cases, food security and economic drivers also play significant roles, especially in lower-income neighborhoods where fresh produce may be scarce (Burley *et al.*, 2011). The initial motivations behind CG creation influence their design, stakeholder involvement, and long-term sustainability.
- **Governance structures:** Governance models critically impact how CGs are managed, sustained, and integrated into broader urban planning frameworks. These structures can range from top-down municipal programs, where city authorities lead garden development, to bottom-up community initiatives driven by local residents (Faehnle, 2014; Derlukiewicz *et al.*, 2021; Zhang *et al.*, 2022). Hybrid models that combine both approaches also exist, allowing for shared decision-making and resource allocation (Beavin *et al.*, 2022). Analyzing governance structures provides insights into power dynamics, stakeholder responsibilities, and the level of community engagement.
- **Location factors:** The spatial distribution of CGs significantly influences their accessibility, functions, and alignment with urban development goals (Fox-Kämper *et al.*, 2018; Benis *et al.*, 2018). Factors such as proximity to residential areas, availability of underutilized land, and integration within existing green networks affect the role CGs play in urban ecosystems. In dense urban settings like Brussels, CGs may occupy unconventional spaces such as rooftops or courtyards.
- **Functions:** CGs serve multiple, evolving roles that extend beyond their original purposes. Many gardens promote food production and environmental stewardship through biodiversity conservation and pollution mitigation (Wakefield *et al.*, 2007; Langemeyer *et al.*, 2017). Social integration is another critical function, as CGs provide spaces for community interaction, cultural expression, and educational activities (Corkery, 2004; Lloyd & Paige, 2022). In some cases, CGs support artistic or political activities, reflecting broader social movements or community identities (Salwa, 2022). By examining the diverse functions of CGs, this study reveals how these spaces adapt to changing community needs and environmental challenges.

These typologies aim to provide a comprehensive framework that not only captures the socio-spatial diversity of CGs but also highlights their adaptive roles in response to evolving

urban challenges. However, given the diversity of CG development across different contexts, further refinement of these typologies is necessary, as certain dimensions, particularly related to post-socialist transitions, remain underdeveloped in the literature.

This study's comparative approach is well-suited to uncovering these gaps, identified above. By analyzing CGs in Krakow, a post-socialist city with a strong allotment garden tradition undergoing redefinition amid urban growth and heritage preservation (Mokras-Grabowska, 2020; Tomczyk & Basińska, 2022), and Brussels, a multicultural Western European city driven by grassroots environmental activism (Cahn *et al.*, 2018; Mercier & Mercier, 2018), the research examines how socio-political and historical contexts shape CG emergence, governance, and sustainability.

By comparing these two cities, this research aims thus to:

- Assess the effectiveness of digital participatory mapping in improving spatial accuracy and fostering stakeholder engagement.
- Develop a comparative typology of CGs, highlighting their socio-spatial diversity, governance models, and multifunctional contributions.
- Examine how governance frameworks, spatial planning, and cultural heritage influence the emergence and management of CGs.

The study's findings will provide actionable recommendations for integrating CGs into broader urban planning frameworks. They aim to help urban policymakers, planners, and community organizations design CG projects that support social inclusion, environmental sustainability, and long-term community resilience.

3. Research design

This study employed a mixed-methods approach to investigate the spatial distribution, governance structures, and multifunctional roles of CGs in Krakow and Brussels. Combining desk research, surveys, participatory mapping, field observations, and semi-structured interviews, the methodology reconciled inconsistencies in official records, engaged local stakeholders in data validation, and generated both quantitative and qualitative insights. These methods were carefully selected and iteratively refined to meet the study's objectives, following established practices in urban research (Creswell, 2014; Bryman, 2016). The iterative nature of the research, illustrated in Figure 1, reflects the feedback loops between stages, ensuring data accuracy and contextual depth while accommodating the evolving nature of CGs. To address potential biases associated with low survey response rates, additional qualitative interviews and iterative mapping consultations were used as mitigation strategies to validate and enrich the data.

3.1. Desk research and preliminary CGs identification

The research began with desk-based reviews of official records and supplementary sources to compile an initial inventory of CGs in both cities. In Krakow, primary data were retrieved from the municipal website of Zarząd Zieleni Miejskiej (ZZM), which listed 19 active gardens (Zarząd Zieleni Miejskiej W Krakowie, 2023). This dataset was cross-referenced with local news articles, neighborhood association records, and social

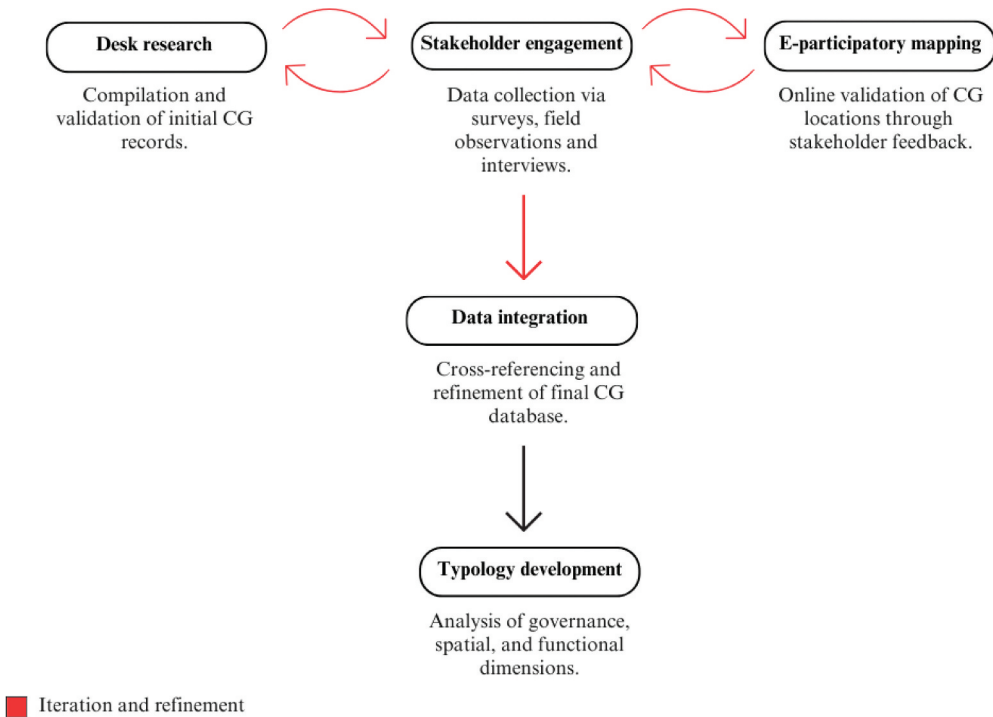


Figure 1. Iterative methodology cycle for understanding community gardens in Krakow and Brussels (author, 2025).

media platforms maintained by gardening groups (e.g. Wyborcza.pl, 2023). Similarly, in Brussels, the initial database was drawn from Environnement.brussels and supplemented by district-level registers, listing 204 gardens updated in 2018¹ (environnement.brussels) and expert-developed map from 2012 (nobohan.be)².

Initial comparisons revealed inconsistencies: figures ranged from 16 to 20 gardens in Krakow and from 176 to 204 in Brussels. To resolve these discrepancies, we engaged in a validation exercise by cross-referencing official records with data from local NGOs, informal community networks, and direct consultations with garden coordinators. In Krakow, where data collection concluded in February 2024, one site was confirmed inactive, and another one was classified as allotment garden, reducing the final operational count to 17. In Brussels, data collection ended in December 2023, during which we confirmed that four gardens were under development, and two were recently closed, resulting in 198 active sites. Stakeholder follow-ups addressed cases where gardens remained listed despite their closure, ensuring that the dataset was accurate and current.

Additionally, during the desk research phase, a comprehensive dataset was compiled for each identified community garden, encompassing the following information: Geographical coordinates, Name, Contact information, Location, District name and type (e.g. center, suburb), including demographic variables, Position (e.g. rooftop, park, courtyard, wasteland), Area (in square meters), Year of establishment, Operational status since 2013 (closed: Yes or No), Ownership

type (e.g. municipality, lender, housing community, common), Involved parties (e.g. schools, municipality, social entrepreneurs, citizens), Practitioners (e.g. producer, citizen, activist, consumer, entrepreneur, volunteer), Accessibility (e.g. open, closed, opening hours), Perceived as temporary (Yes or No), Functions (e.g. cultivation, recreation, education, therapy, artistic, socialization/integration), Facilities (e.g. compost, greenhouse, water source, eco-hotel, fences, gate, tool shed), Governance structure (e.g. top-down, bottom-up), Land use status (e.g. illegal, legal, building zone), Emergence reasons (motivations). This detailed dataset provided a foundational understanding of each garden's characteristics, informing subsequent phases of the research.

3.2. Survey design and administration

Following the desk research, structured surveys were distributed to individuals or groups responsible for overseeing each garden. The survey included 18 questions designed to gather data on garden size, governance structures, funding mechanisms, primary functions, and challenges (Table 1). The questions were tailored to reflect collective operational realities rather than individual opinions, aligning with the participatory nature of the research.

To improve response rates, surveys were administered in Polish (Krakow) and French (Brussels). In Krakow, 17 verified gardens received the survey, with 6 complete responses returned (a 35% response rate). In Brussels, surveys were sent to representatives of 198 gardens, yielding 55 submissions, 40 of which were complete (a 20% effective response rate after accounting for duplicates and partial responses). While these rates are typical of participatory urban research (Cochrane & Corbett, 2020), we acknowledge this limitation and addressed it by conducting complementary fieldwork and follow-up interviews. The responses provided sufficient diversity to identify common patterns in governance, spatial characteristics, and community challenges across both cities.

Survey data directly informed the next research stages. Responses regarding garden size, user numbers, and organizational structures guided the participatory mapping phase, while governance and funding insights contextualized field observations and semi-structured interviews.

3.3. E-participatory mapping

The participatory mapping phase was conducted online, making use of e-participatory mapping method that allowed stakeholders to contribute remotely. This approach aligns with established principles of participatory mapping, emphasizing community collaboration while leveraging digital tools for spatial representation and stakeholder feedback (Rawat & Yusuf, 2020). We used the open-source Umap platform, based on Leaflet.js, which allowed participants to annotate spatial data directly via an interactive interface accessible without login or special software. The tool is mobile-friendly and respects GDPR by avoiding IP tracking.

Participants, particularly those who had completed the survey, were invited to review and annotate maps online. They provided corrections, clarifications, and updates about

Table 1. Surveys questions used for the study (author, 2023).

Category	Survey questions
General information	1. What is the name of your community garden? 2. Who created your community garden and when? 3. Who currently manages your community garden? 4. Why was your community garden created?
Spatial characteristics	5. What is its location? (Provide the full address, including postal code) 6. Where is it situated? (e.g. wasteland, in a courtyard, on rooftops, etc.) 7. What is its surface area? (in square metres)
Land ownership and support	8. Who owns the land? (e.g. private owner, public, association, etc.) 9. Has your garden received any subsidies? (e.g. municipal financial support) 10. Have you collaborated with other community gardens or participated in similar initiatives or events?
Accessibility and users	11. Is your garden accessible and open to everyone? (e.g. Yes, but only from 10 AM to 10 PM) 12. Who has access to the garden? (e.g. gardeners, citizens, students, etc.) 13. How many people visit the garden? (e.g. 20 per day, 20 per week)
Garden activities and features	14. What activities take place in the garden? (e.g. art workshops, educational workshops, gardening, etc.) 15. What features can be found in your community garden? (e.g. raised beds, open soil, water collectors, etc.)
Challenges and future plans	16. Have you encountered any issues during the creation or maintenance of your garden? 17. Do you perceive the community garden as a temporary space? 18. What are your future plans for the community garden?

other CGs to ensure the spatial data accurately reflected active gardens. Iterative feedback was a key feature of this process. For example, stakeholders highlighted issues such as gardens that had been decommissioned or newly established sites that had not been captured in the initial records. One Brussels organizer commented, ‘*We realized our collective actually manages multiple plots, not just the single site listed,*’ highlighting how group discussions and digital review clarified organizational boundaries.

In Krakow, initial records included allotment gardens, some of which were later reclassified based on stakeholder input. In Brussels, participants confirmed the closure of two gardens listed as active in official documents and identified four under development. The final maps integrated this feedback, producing a dynamic and up-to-date representation of CGs, reflecting their evolving nature and user-driven modifications.

To ensure ethical standards, informed consent was obtained at the beginning of all survey and mapping communications. Mapping contributors were informed of the non-commercial research purpose and the anonymized nature of their input. No personally identifiable information was published, and all digital participation was voluntary.

This e-participatory mapping process proved essential for bridging gaps in desk research, resolving inconsistencies, and ensuring that the spatial data captured nuanced on-the-ground realities.

3.4. Field observations and semi-structured interviews

Field observations and semi-structured interviews provided qualitative depth to the quantitative and spatial data. Site visits focused on physical layouts, accessibility, community interactions, and infrastructure, revealing features often omitted from official documentation, such as informal gathering areas, shared tool storage, and on-site composting.

A total of 11 semi-structured interviews, seven in Brussels and four in Krakow, were conducted with garden coordinators, practitioners, and representatives of municipal or green management organizations. In Brussels, interviews included members of Collectif Ipé, local NGO, who provided insights into the citywide coordination of community-led green spaces. In Krakow, interviews were conducted not only with community garden organizers but also with managers of allotment gardens, as these spaces remain highly visible and relevant in the city's post-socialist urban green infrastructure. The inclusion of allotment managers aimed to contextualize the transition and coexistence between historical allotment systems and emerging community gardens, offering comparative insight into governance models, land-use conflicts, and cultural perceptions of urban gardening.

Interview questions were partially derived from survey responses to maintain consistency while allowing for the exploration of emergent themes. Topics included governance models, funding challenges, volunteer coordination, and land-use negotiations with municipal authorities. Although efforts to engage municipal officials were limited, practitioners' insights effectively bridged this gap by highlighting discrepancies between policy intentions and on-the-ground realities.

3.5. Data integration and analysis

The final phase of the methodology involved integrating data from desk research, surveys, e-participatory mapping, field observations, and interviews into a unified case-study database (Bryman, 2016). Cross-referencing and triangulating findings helped resolve discrepancies. For example, when survey responses diverged from official records, follow-up inquiries clarified inconsistencies.

To develop a robust typology of CGs, insights from existing literature on urban agriculture and sustainability were instrumental; focusing on four key dimensions: (1) emergence reasons, including environmental concerns, social needs, and cultural or economic drivers; (2) governance structures, encompassing top-down, bottom-up, and hybrid models; (3) location factors, such as spatial distribution, accessibility, and alignment with urban planning goals; and (4) functions, covering food production, environmental stewardship, and social integration. This typology provides a comprehensive and context-sensitive framework to capture the diversity of CG development and operational models in different urban settings. By integrating empirical data and theoretical insights, the typology aids in understanding CGs as dynamic interventions that adapt to shifting socio-ecological demands and governance arrangements, contributing to practical urban planning and policy recommendations.

4. Findings

4.1. Spatial distribution and participatory mapping analysis

The spatial distribution of CGs in Krakow and Brussels reveals how historical development, socio-economic dynamics, and urban planning strategies shape their establishment and evolution. By integrating e-participatory mapping with quantitative spatial data, this study refined official datasets, identified discrepancies, and captured essential

details about CG locations and their multifunctional roles. This iterative mapping process not only enhanced spatial accuracy but also fostered stakeholder engagement by incorporating local practitioners' knowledge. The mapping outcomes are central to understanding the emergence of CGs, their socio-spatial diversity, and their role in broader urban contexts.

In Krakow, the digital participatory mapping validated the existence of 17 active CGs after correcting two misclassified sites from initial records ([Figure 2](#)). Many of these gardens emerged from the reorientation of traditional allotment garden practices, evolving into contemporary community gardens that integrate nature into urban settings.

These CGs are distributed across three key urban contexts: historic inner-city neighborhoods, socialist-era housing estates and post-1989 housing developments ([Figure 3](#)). Four CGs within Krakow's dense historic core (e.g. Salwator CG) operate in areas where heritage conservation intersects with urban growth. These CGs have adapted over time, transitioning from food production spaces to multifunctional hubs offering social, educational, and cultural programs. In post-1989 urbanised areas, CGs like Macierzanki or Pychogród, address a lack of green spaces resulting from rapid housing development. They often serve as hubs for neighborhood interactions, reflecting residents' grassroots responses to urban expansion. Conversely, CGs in socialist era, in

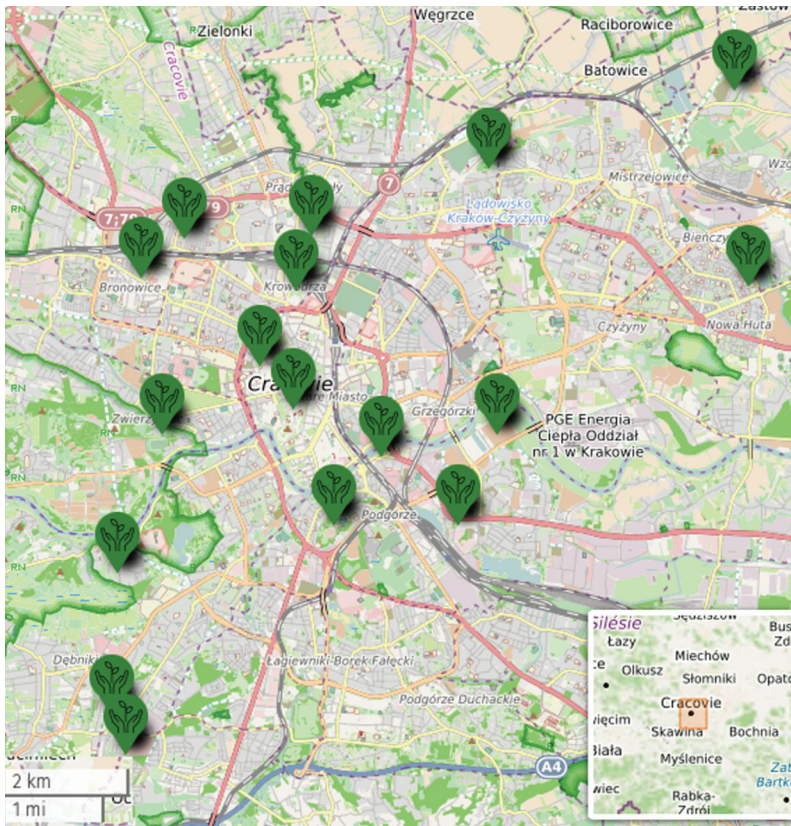


Figure 2. View of online tool used for e-participatory mapping of community gardens in Krakow. (Source: Own study³, 2024)

neighborhoods such as Nowa Huta, CGs like Teatralny CG, housing estates occupy repurposed communal spaces initially planned under centralized state control. These gardens represent a shift toward locally driven initiatives, where residents reclaim under-utilized land for community-oriented uses.

Most CGs are concentrated near high-density residential zones (Figure 3), aligning with Krakow’s strategy of integrating green infrastructure into its urban regeneration efforts (Zarząd Zieleni Miejskiej W Krakowie, 2023). This distribution demonstrates how CGs serve as tools for addressing urban renewal and promoting sustainable community engagement. Unlike in Brussels, where income distribution data were available for analysis, such detailed socio-economic data for Krakow were unavailable, limiting the ability to directly assess how CG locations correlate with income levels. However, the spatial placement of CGs near key residential areas suggests their role in catering to diverse urban communities and supporting inclusive urban development.

In Brussels, the initial listing of 204 CGs was refined to 198 thanks to digital participatory mapping, which identified six inactive or under-development sites (Figure 4).

CGs in Brussels are distributed across neighborhoods with varying socio-economic profiles, reflecting their responsiveness to local community needs (Figure 5). In lower-income districts, CGs address food insecurity, mitigate social isolation, and foster community

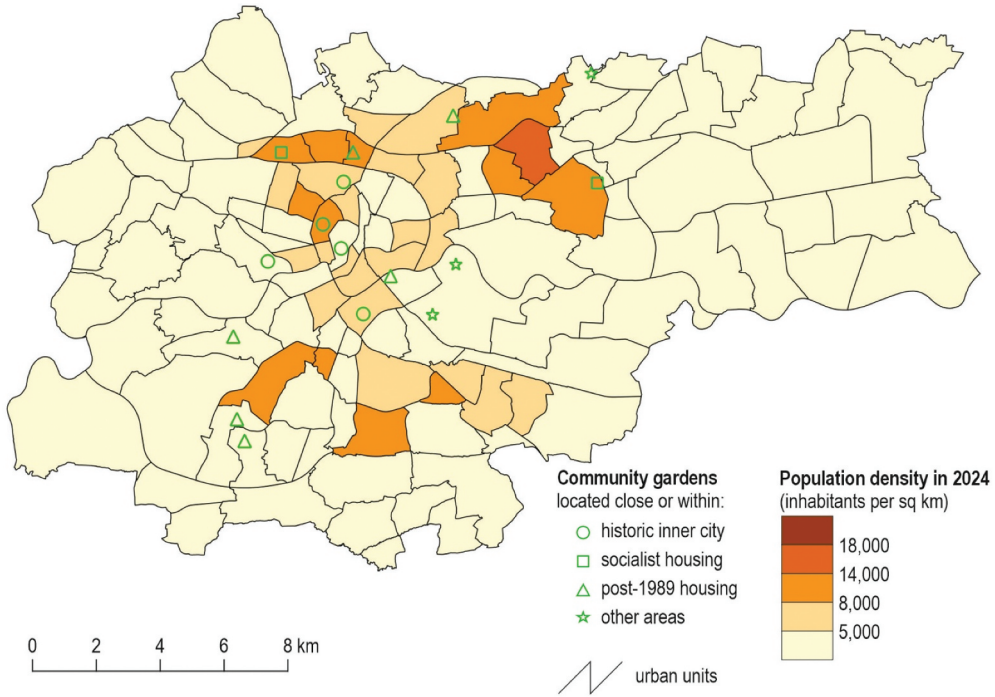


Figure 3. Spatial distribution of community gardens in Krakow by population density and housing typology. (Population density by hexagon (inhabitants per km²) and CG location by urban area type: historic inner city, socialist housing, post-1989 housing, and other zones). (Source: Own study based on Krakow Urban System of Spatial Information, 2025. Urban System of Spatial Information⁴).

building. One practitioner emphasized that *‘the garden brings neighbors together in a building where many live alone,’* highlighting the role of CGs in creating inclusive, shared spaces.

In wealthier areas, CGs focus more on educational and recreational activities, such as biodiversity workshops and sustainable gardening programs. These spaces often collaborate with schools and local organizations, demonstrating the city’s tradition of using community gardens to support broader educational and ecological goals. Figure 6 depicts how CGs cluster in high-density, mixed-income neighborhoods, showcasing their multifunctional nature and adaptability. This uncovers important distinctions between single-purpose food production sites and multi-use hubs that combine social, ecological, and educational activities.

The comparison of CG distribution in Krakow and Brussels reveals key differences rooted in their respective historical legacies and governance frameworks. In Krakow, the distribution reflects a post-socialist urban landscape where hybrid governance models facilitate municipal support for integrating CGs into city planning. By contrast, Brussels demonstrates a more bottom-up approach, with CGs emerging through grassroots initiatives that address diverse socio-economic challenges.

Overall, e-participatory mapping not only improved spatial data accuracy but also revealed how CGs serve multifunctional roles and adapt to various socio-economic contexts. These findings underscore the importance of flexible governance models and participatory approaches in fostering resilient, inclusive urban green spaces.

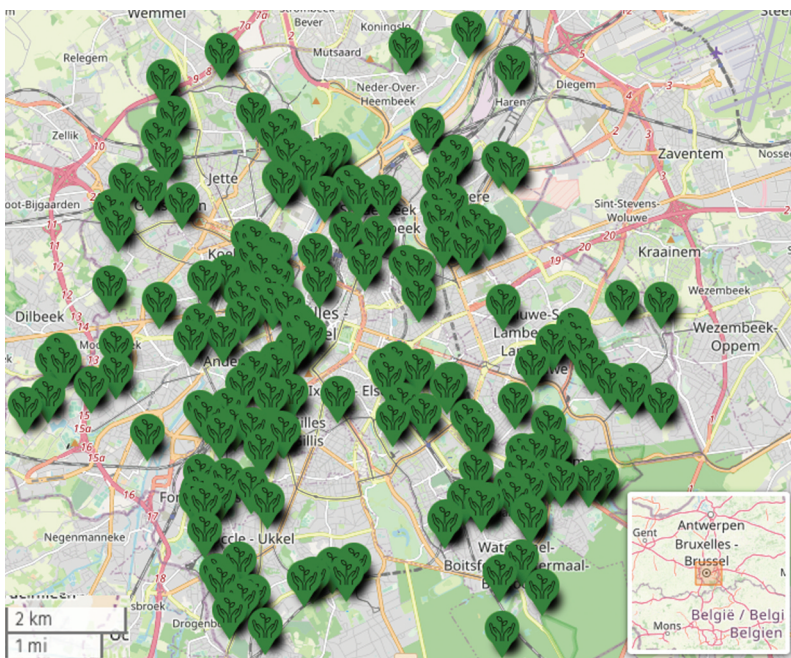


Figure 4. View of online tool used for e-participatory mapping of community gardens in Brussels. (Source: Own study⁵, 2024)

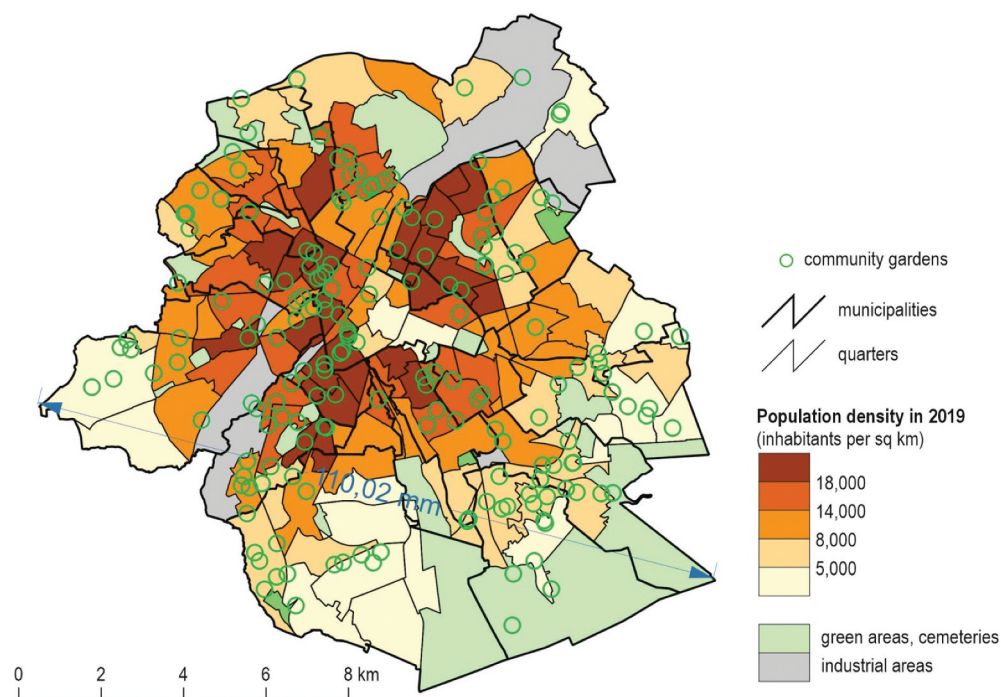


Figure 5. Spatial distribution of community gardens in Brussels by population density. (Population density by quarter in inhabitants per km². Community garden locations overlaid. Green and industrial areas shown for reference). (Source: Own study based on Monitoring des Quartiers⁶, 2025)

4.2. Typologies of community gardens

This section analyzes four key dimensions that shape the development and operation of CGs in Krakow and Brussels: emergence reasons, governance structures, location factors, and functions. By examining these dimensions, the analysis highlights how socio-economic, cultural, and spatial contexts influence the diversity of CGs.

4.2.1. Emergence reasons

The motivations for establishing community gardens in Brussels and Krakow (Figure 7) reflect both institutional objectives and grassroots initiatives, shaped by their unique urban contexts. In Brussels, ecological priorities dominate, with 90% of surveyed gardens citing goals such as biodiversity enhancement, climate resilience, and environmental stewardship. Social motivations are equally significant, with 85% of gardens emphasizing the need to provide accessible green spaces in dense urban areas where private gardens are rare. Education is another prominent driver, as over three-quarters of respondents highlighted the importance of ecological learning delivered through structured programs and pedagogical gardens. Additional catalysts, such as artistic expression, recreation, and political engagement, further underscore the multifaceted nature of CGs in the city (Cahn *et al.*, 2018; Mercier & Mercier, 2018).

Krakow's gardens demonstrate similarly diverse motivations but with a distinct emphasis on horticultural traditions. Nearly all CGs in Krakow prioritize planting and

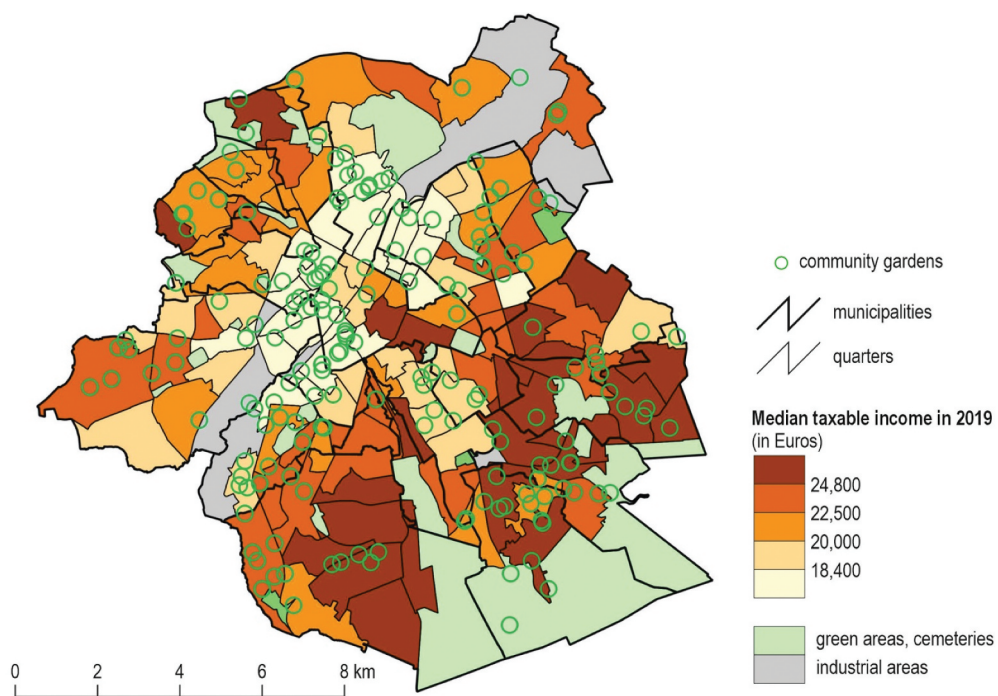


Figure 6. Spatial distribution of community gardens in Brussels by median taxable income. (Median taxable income by quarter in Euros. Community garden locations overlaid. Green and industrial areas shown for reference). (Source: Own study based on Monitoring des Quartiers⁷, 2025)

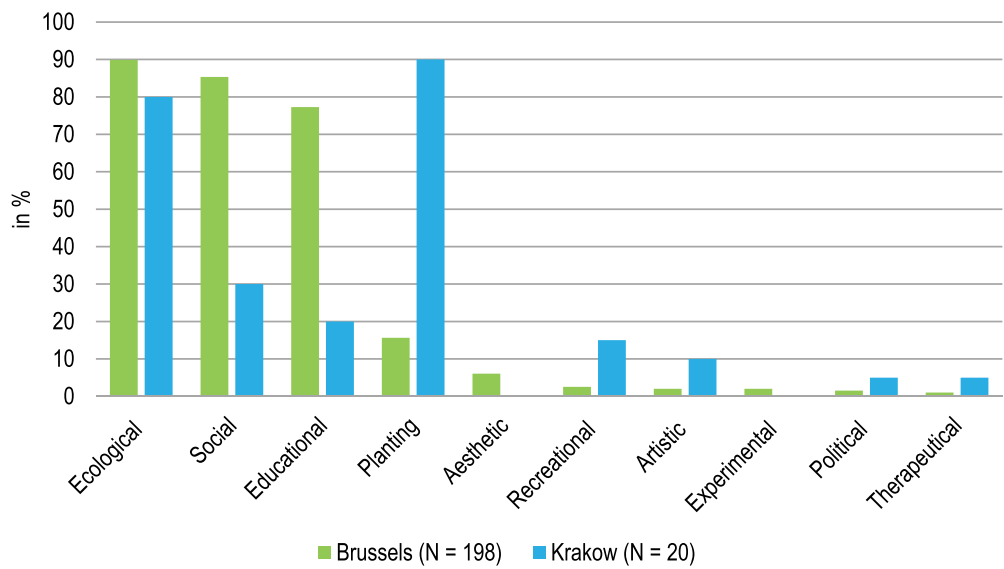


Figure 7. Emergence reasons CGs in Brussels and Krakow (in %). (Source: Own study, 2024)

cultivation, blending older allotment practices with community-oriented goals. Six gardens identified social aspirations, emphasizing collective work and socialization, while four cited educational objectives aimed at youth engagement and ecological awareness. Some projects also reflect unique aims, including therapeutic uses, art-based installations, and platforms for political activism. One participant explained, *‘Our group started primarily as a way to learn about organic growing, but we quickly realized we also needed a place where people could gather, especially families with children.’* These findings, based on surveys, interview data and institutional analysis, suggest that while ecological, social and educational motivations are common to CGs in both cities, their institutional integration differs. In Brussels, CGs are often supported by policy instruments such as regional grants (e.g. ‘Inspire the Neighborhood’) and integrated into urban green space planning (Certomà & Notteboom, 2015; Beavin *et al.*, 2022). In Krakow, by contrast, several gardens emerged from informal or grassroots initiatives with limited initial support and often evolved from or alongside traditional allotment practices (Mokras-Grabowska, 2020; Kwartnik-Pruc & Droj, 2023).

Although reorientations of allotment gardening have occurred elsewhere in Europe (e.g. Denmark or the UK), studies suggest that in CEE cities, this reorientation is often shaped by specific historical legacies of land use, privatization, and transitional governance (Bellows, 2010; Djokić *et al.*, 2018). Thus, in the Polish case, this path dependency helps explain how CGs continue to draw on both grassroots experimentation and the physical infrastructure or spatial logic of former allotment sites.

4.2.2. Governance structure

The governance arrangements of CGs in Brussels and Krakow reflect varied balances between grassroots initiatives and institutional support. In Brussels, 60% of surveyed gardens operate under bottom-up models, where residents initiate and manage projects independently. These efforts are often supported by intermittent municipal or regional funding programs, such as ‘Inspire the Neighborhood’ by Brussels Environment (2018), which provides grants and technical assistance. Non-governmental organizations, such as ‘Le début des haricots,’ also play a vital role in coordinating projects and offering resources. However, participants reported challenges, including reliance on external funding and difficulties sustaining momentum once initial grants expire. One respondent noted, *‘Our garden depends on volunteers, but when funding runs out, it’s hard to maintain enthusiasm.’*

This strong bottom-up orientation illustrates Brussels’ broader planning ethos, which encourages civic initiatives while avoiding full municipal control. While empowering, this model may lead to fragmented support across districts, inconsistent long-term planning, and reliance on volunteer burnout or project fatigue. Interviews revealed that although gardens often begin informally, formalization through NGO partnerships or limited subsidies is necessary to ensure land tenure and infrastructure.

In Krakow, governance structures demonstrate a hybrid model. Fifty-five percent of surveyed gardens were initiated by local residents who later sought assistance from Zarząd Zieleni Miejskiej (ZZM), the city’s green management body. This collaboration results in shared governance, with communities retaining decision-making power while benefiting from municipal support for land access, materials, and training programs.

Meanwhile, 35% of gardens were established directly by ZZM, reflecting a top-down model. Although this approach ensures alignment with broader urban planning objectives, it risks lower levels of community ownership if not managed collaboratively. Approximately 10% of gardens provided insufficient data to classify their governance, indicating the need for further research into less formalized arrangements.

This hybrid dynamic in Krakow reflects a transition from the top-down legacy of allotment garden regulation toward more participatory modes. ZZM's role as both facilitator and regulator has led to a dual track: some gardens are embedded in city greening programs (e.g. pocket parks), while others emerge more organically but later require formal recognition. This can create tensions, particularly around access to public resources or recognition of informal groups, yet it also enables alignment between local knowledge and municipal strategy.

Comparatively, the key distinction lies in the sequencing and source of institutional engagement: in Brussels, citizen initiatives lead and institutions follow selectively; in Krakow, institutions often initiate or formalize community initiatives. While both approaches offer benefits, autonomy in Brussels and policy integration in Krakow, they also face challenges: governance fragmentation versus bureaucratic rigidity. These findings align with studies suggesting that successful urban greening often depends on structured institutional support for grassroots initiatives, balancing autonomy with sustainable resource allocation (Faehnle, 2014; Derlukiewicz *et al.*, 2021). The evidence here reinforces the importance of co-production frameworks, particularly where land-use and civic engagement goals intersect.

4.2.3. Location factors

The spatial distribution of CGs in Brussels and Krakow (Figure 8) reflects their respective urban contexts, land-use strategies, and planning incentives. Research on urban greening interventions (Wong *et al.*, 2003; Benis *et al.*, 2018) underscores the value of utilizing diverse spaces, from parks to rooftops, to mitigate urban heat, enhance biodiversity, and foster social interaction. In Brussels, CGs are dispersed across courtyards (39%), wasteland sites (22%), and municipal parks (18%), with additional sites found on rooftops, streets, and unconventional locations such as roundabouts. This wide geographic spread illustrates the city's dense urban fabric and proactive search for creative infill opportunities, particularly in older neighborhoods where vacant lots or shared courtyards are often the only viable options. For example, one garden organizer described transforming an underused courtyard into a communal space that now hosts both ecological workshops and social events.

Krakow's gardens, by contrast, are predominantly located in public parks, which account for 45% of surveyed sites. This reflects municipal efforts to integrate CGs into park redevelopment projects, often led by ZZM. Other locations include wasteland parcels and private courtyards, though these are less common. The emphasis on park-based gardens suggests a strategic approach to enhance community engagement through public green spaces. As one gardener noted, '*We repurposed an underutilized park corner, working with ZZM to secure permits and build some gardening beds for workshops.*' Only one of Krakow's CGs is located on rooftops, likely due to differences in building stock and urban density compared to Brussels. These patterns reveal how land availability, municipal priorities, and local activism shape the spatial distribution of CGs in each city.

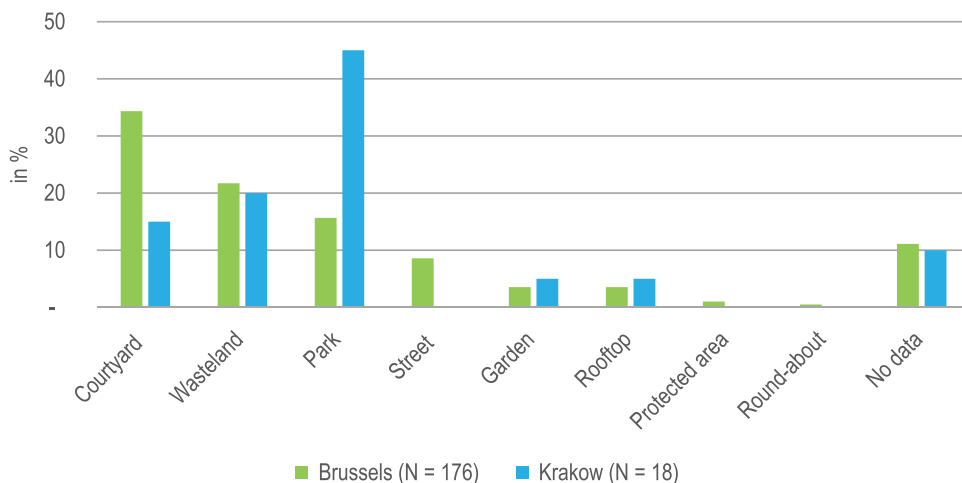


Figure 8. Location factors of CGs in Brussels and Krakow. (source: own study, 2024).

4.2.4. Functions

The functions of CGs in Brussels and Krakow (Figure 9) reflect their adaptability to local needs, often exceeding their original goals to address broader community aspirations. Planting and cultivation here refers to the shared practice of growing edible or ornamental plants, central to all CGs and forming the basis for broader social, educational, and ecological functions. In Brussels, 65% of gardens prioritize social cohesion, hosting collective workdays, open-door workshops, and cultural events that bridge linguistic and ethnic divides. Educational initiatives are prominent in half of the gardens, often through partnerships with schools or structured programs on composting, organic farming, and climate adaptation. One practitioner emphasized, *‘Art and gardening go hand in hand here. We’ve hosted painting workshops and small exhibitions alongside the planting beds.’*

In Krakow, ecological goals dominate, reflecting the city’s transformation from a post-socialist allotment tradition to a broader community gardening culture. Nearly all surveyed gardens cited biodiversity conservation, pollution mitigation, or aesthetic improvements as primary objectives. Social cohesion also ranks highly, with about half of the gardens serving as gathering points for neighborhood interactions. Educational initiatives, while less institutionalized than in Brussels, are growing in prominence, with several projects partnering with schools and NGOs to teach urban farming and waste reduction. One unique example is a predominantly female-led garden that integrates ecofeminist perspectives, demonstrating how CGs can serve as platforms for social and political activism.

These findings align with existing research indicating that CGs rarely serve static purposes but instead evolve in response to changing community needs and external conditions (Wakefield *et al.*, 2007; Hagey *et al.*, 2013). The multifunctional nature of CGs underscores their potential to address diverse urban challenges, from fostering social inclusion to advancing ecological sustainability. However, their success often hinges on adaptive governance and sustained community engagement, particularly in dynamic urban environments like Brussels and Krakow.

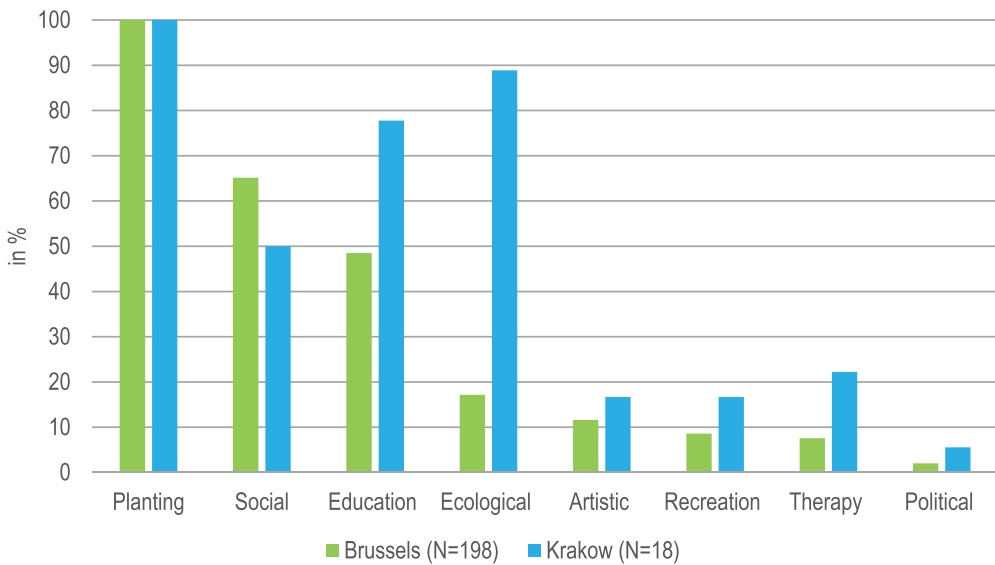


Figure 9. Functions of CGs in Brussels and Krakow. (Source: Own study, 2024)

5. Discussion

The findings highlight how different socio-political, historical, and urban contexts influence the emergence, management, and adaptation of CGs. However, while both Krakow and Brussels present distinct trajectories, their governance models are not mutually exclusive; rather, they illustrate different points on a continuum of institutionalization. In Krakow, CGs often evolve from regulated allotment traditions toward more community-oriented forms, while in Brussels, grassroots gardens gradually seek formalization and municipal support. These pathways are shaped by historical legacies, such as post-socialist land use in Krakow and liberal planning frameworks in Brussels, and socio-political cultures of civic engagement and state intervention. These findings confirm prior research indicating that governance models, particularly hybrid or well-supported bottom-up approaches, can play a crucial role in shaping the sustainability and long-term functionality of CGs, while top-down models may be less effective if not coupled with active community participation (Fox-Kämper *et al.*, 2018; Zhang *et al.*, 2022).

The typology developed in this study serves as a strategic framework for observing and categorizing CGs, allowing researchers and urban planners to target specific cases for in-depth investigation. By classifying CGs based on emergence reasons, governance structures, spatial distribution, and functions, the typology aids in identifying key differences and commonalities across urban contexts. For example, gardens with hybrid governance models in socio-economically disadvantaged areas may require different interventions compared to grassroots-driven gardens in high-density neighborhoods. These distinctions are particularly relevant in post-socialist cities where formal planning cultures coexist with informal civic practices, and where CGs may be tied to residual perceptions of allotment gardens or resistance to institutional control. These results extend previous typology-based studies (Firth *et al.*, 2011; Guitart *et al.*, 2012; Rogge & Theesfeld, 2018; Anderson *et al.*, 2019; Jansma *et al.*, 2024) by incorporating a cross-regional comparative

dimension, offering insights into how CGs adapt differently in post-socialist and Western European contexts. While developed in the European context, this typology is adaptable to cities in the Global South, where informal land tenure, high-density conditions, and community reliance on food production present similar governance challenges. Future research could test this typology in cities undergoing rapid urban expansion or conflict-driven restructuring. This typology is not static; it is adaptable to different cities and scalable, making it a valuable tool for urban planners seeking to prioritize interventions and allocate resources effectively.

The comparative analysis underscores the importance of context-specific governance structures supporting earlier studies that emphasize the need for flexible governance models (Faehnle, 2014). Krakow's hybrid approach offers lessons on how municipal involvement can support community efforts, while ensuring alignment with broader urban planning goals. Conversely, while Brussels highlights the potential of citizen-driven models in adapting CG functions to diverse urban needs as also demonstrated in studies of grassroots urban movements (Derlukiewicz *et al.*, 2021). However, each model faces constraints: in Krakow, some residents reported frustration over bureaucratic delays or limited co-decision opportunities, while in Brussels, bottom-up gardens frequently cited financial precarity and volunteer fatigue. The study's findings suggest that balancing grassroots participation with institutional support can provide sustainable frameworks for CG development across various socio-political contexts.

E-participatory mapping played a central role in the methodological framework, enhancing spatial accuracy and resolving discrepancies in official records by integrating practitioner feedback. The iterative process revealed temporal changes, such as newly established gardens and inactive sites, emphasizing the dynamic nature of CGs. This finding is consistent with studies on participatory GIS applications in urban planning (Cochrane & Corbett, 2020), which highlight the value of engaging local stakeholders to capture continuously changing spatial data. Moreover, while Codato *et al.* (2024) and Gemperle *et al.* (2024) primarily focused on traditional participatory methods, this study expands their work by demonstrating the effectiveness of digital participatory mapping in CG contexts. Nonetheless, this method presents limitations. Uneven stakeholder engagement, shaped by digital literacy, time availability, or language, may skew spatial feedback toward more organized or digitally connected groups. In areas with lower engagement, such as under-resourced neighborhoods, gardens may remain unmapped or misrepresented. Future research should incorporate longitudinal studies and follow-up mapping exercises to better capture changes over time, especially as CGs adapt to shifting socio-economic conditions or new environmental pressures. Studies in urban agriculture suggest that mapping outcomes improve when supported by continuous collaboration among researchers, local organizations, and policymakers (Ramos *et al.*, 2019).

The integration of survey data and qualitative interviews provided further depth, uncovering governance challenges, socio-spatial dynamics, and stakeholder experiences that would be difficult to observe through mapping alone. While the surveys were valuable for gathering quantitative insights, they were also constrained by incomplete responses and a limited respondent base, especially in Krakow. These limitations, compounded by language diversity and informal structures, made direct field observations and interviews crucial for data validation. Expanding the socio-economic data

collected during surveys, such as neighborhood stability and income levels, would further refine the typology and improve its applicability across diverse contexts.

The findings provide practical suggestions for policymakers and urban planners. E-participatory mapping could be institutionalized as part of urban green space monitoring systems to enable real-time updates on CG locations, functions, and status. This would help cities identify emerging CGs, monitor their development, and ensure they meet evolving community needs. To achieve this, municipal departments could integrate mapping tools such as Umap into existing open-data platforms. Coordinating with local NGOs or garden federations may enhance outreach, while hosting annual ‘mapping weeks’ or linking participation to small grants could incentivize contributions. These could include training sessions, user-friendly mapping platforms, or incentives to encourage long-term participation, ensuring that practitioners contribute continuously to the accuracy and comprehensiveness of CG data.

The typology developed here can guide resource allocation by prioritizing CGs that address key socio-ecological goals, such as biodiversity conservation or food security in underserved areas. Integrating CGs into broader green infrastructure plans would enhance their contributions to urban resilience, particularly in cities facing rapid urbanization or socio-economic transitions. For example, Langemeyer *et al.* (2017) and Wakefield *et al.* (2007) emphasized CGs’ role in ecological and social sustainability, and this study builds on their findings by highlighting how CGs can adapt across cities with distinct urban planning frameworks. Moreover, the findings extend the work of Blair (2009) by showing that CGs are not limited to food production but can evolve into multifunctional hubs serving educational, ecological, and cultural purposes.

6. Conclusion

In conclusion, this study demonstrates the value of context-sensitive, participatory, and mixed-method approaches to understanding community gardens in complex urban environments. It contributes to ongoing debates on how CGs can be sustained through adaptive governance, responsive planning, and digital tools. While the comparative focus on Brussels and Krakow sheds light on contrasting trajectories, the analytical frameworks developed here can inform future research and practice in a variety of contexts, including Global South cities facing similar constraints around land, participation, and institutional capacity. Strengthening links between civil society and planning institutions remains central to unlocking the full potential of CGs as catalysts for socio-ecological transformation.

Notes

1. The environmental map of Brussels used in this study is available online and can be accessed through Brussels Environment’s interactive map platform (2018): <https://geodata.environnement.brussels/client/view/9c49fffb-1a01-4b15-954e-9c8bc9558216>.
2. The map of community gardens in Brussels can be accessed online via the interactive platform provided by Nobohan (2012): <https://www.nobohan.be/webmaps/potagers/map.html>.
3. Interactive participatory maps of community gardens in Brussels and Krakow were developed using Umap, an open-source tool based on OpenStreetMap. These publicly accessible

maps support the spatial analysis of governance models and stakeholder engagement. The map of Krakow is accessible at <http://u.osmfr.org/m/882202/>

4. Accessed in October 2024 at <https://msip.krakow.pl/>
5. The digital participative map of Brussels is accessible at <http://u.osmfr.org/m/860548/>
6. Accessed in October 2024, <https://monitoringdesquartiers.brussels/>
7. Accessed in October 2024, <https://monitoringdesquartiers.brussels/>

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