MAPPING THE INVISIBLE: INTERDIMENSIONAL GEOGRAPHIES OF URBAN FOOD INSECURITY

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Abstract. This research proposes an interdimensional framework for analysing urban food insecurity from a spatial and systemic perspective. The study focuses on the Metropolitan City of Rome, a heterogeneous territory of 121 municipalities that combines dense urban centres, peri-urban transition zones, and rural agricultural areas, while displaying significant socioeconomic inequalities and infrastructural disparities. The framework integrates five analytical dimensions—economic food self-sufficiency, physical food self-sufficiency, healthy diet affordability, physical accessibility, and solidarity-based provisioning—drawing on georeferenced, administrative, and socioeconomic data. The multi-scalar analysis identifies "blacked-out food areas", that is, territories where all dimensions of food access collapse simultaneously, revealing structural vulnerabilities that conventional indicators fail to capture. By shifting attention from emergency responses to systemic territorial diagnostics, the research develops a replicable model for place-based food policies. It also highlights the need for multi-level governance to reduce disparities, strengthen resilience, and rebuild inclusive food environments, where food access is understood not only as nutrition but as a component of people's substantive freedoms.

1. Introduction

Despite growing food availability in high-income countries, structural food insecurity remains pervasive, particularly in metropolitan areas where poverty, spatial inequality, and infrastructural fragmentation converge. In these contexts, food insecurity is not merely a matter of scarcity or income, but a multidimensional condition shaped by spatial, social, and institutional barriers to access. The Metropolitan City of Rome offers a compelling case study: a socio-territorially diverse region spanning dense urban centres, peri-urban belts, and rural zones, marked by persistent inequalities and uneven development. To analyse these dynamics, this research develops an interdimensional framework that integrates five analytical dimensions—economic food self-sufficiency, physical food self-sufficiency, healthy diet affordability, physical accessibility, and solidarity-based provisioning—drawing on spatial, administrative, and socioeconomic data. The aim is to move beyond static indicators—such as income thresholds or caloric intake—and toward a dynamic understanding of how people's capabilities to access, choose, and afford healthy food are shaped by place. Designed to be both diagnostic and

operational, the framework identifies localized vulnerabilities and informs equitable, place-based food policies.

By intersecting these dimensions, the analysis reveals what we define as *"blacked-out food areas"*. Borrowing a metaphor from digital cartography, these are territories that remain blank or uncharted on the conventional map of food systems. They are places where all channels of access—productive, economic, spatial, and supportive—collapse simultaneously, producing conditions of compounded vulnerability. In practical terms, residents in these zones may be unable to rely on local production, face prohibitive food prices, encounter significant barriers to physical access, and have limited or no recourse to solidarity-based safety nets.

These areas are not merely disadvantaged; they are structurally disconnected from the circuits of food provision, and thus risk being rendered invisible to policy interventions grounded in aggregated or sectoral indicators. As highlighted in our previous work (Bernaschi *et al*., 2023, p. 6), they constitute "*areas where people are socially excluded and, therefore, cannot enjoy the same substantive food-related freedoms as people in other areas*". Their invisibility is politically consequential: by escaping conventional diagnostics, they perpetuate hidden geographies of exclusion, reinforcing the divide between formal recognition and lived deprivation. At a time when cities must move beyond emergency responses to confront the systemic roots of food insecurity, recognising and mapping these *blacked-out food areas* becomes a crucial step. The Roman case not only illustrates the depth of territorial disparities, but also provides a replicable analytical model that contributes to debates on food justice and spatial inequality, while informing policy tools to reduce disparities, strengthen resilience, and guarantee food access as a right.

2. Rethinking Food Insecurity: Capabilities, Food Environments, and Urban Inequalities

The conceptualization of food insecurity has evolved significantly. While early frameworks focused on availability and caloric intake (Sen, 1985), more recent approaches have expanded to include access, agency, sustainability, and equity (HLPE, 2020; Fanzo *et al*., 2020; von Braun *et al*., 2021). According to the 1996 World Food Summit, food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food. This definition has since been enriched by the concepts of *agency*—the capacity to make autonomous food decisions—and *sustainability*, referring to the long-term viability of food systems within environmental and social boundaries (Clapp *et al*., 2022).

In high-income contexts, food insecurity rarely reflects scarcity. Instead, it emerges from structural exclusions that constrain people's real ability to access and choose food. This aligns with Sen's capability approach, which frames food security as a matter of substantive freedoms—the real opportunities individuals have to lead

a life they value (Sen, 1985). In this perspective, food insecurity stems from material, social, and institutional barriers, not merely from income gaps. Central to this understanding is the concept of *food environments*—the physical, economic, policy, and sociocultural contexts that shape food practices (Turner *et al*., 2018; Downs *et al*., 2020). Food environments are influenced by infrastructure, mobility, market structures, and social capital. Access depends not only on the presence of food outlets, but also on transport availability, disposable income, time constraints, and support networks. Research on "food deserts"—areas with limited availability of fresh and nutritious foods—and "food swamps"—areas where unhealthy, ultra-processed options dominate—shows how such environments exacerbate inequalities by restricting access to healthy diets (Cummins & Macintyre, 2002).

Italian evidence illustrates how these structural dynamics translate into inequality. In 2022, about 5.6 million individuals and 1.9 million households lived in absolute poverty, with higher incidence in Southern regions and among families with children (ISTAT, 2023). The EU indicator AROPE (At Risk of Poverty or Social Exclusion) shows that nearly one in five Italians is at risk, with disproportionate effects on women, young people, and foreign residents. At the same time, food inflation between 2018 and 2023 raised the average monthly cost of a household diet from €526 to €655, increasing its weight from 20% to 25% of family expenditure, with peaks of 28% in Southern Italy. Essential categories such as fruit (+19%), vegetables (+22%), dairy (+24%) and vegetable oils (+34%) saw the sharpest price increases, further eroding affordability (Marino *et al*., 2025).

These pressures undermine not only food affordability but also diet quality. Comparative estimates indicate that the diet recommended by the *Guidelines for Healthy Eating* (CREA, 2019) is, on average, less costly than the one actually consumed. Yet cultural, economic, and informational barriers limit its adoption (Bernaschi *et al*., 2023). This paradox illustrates how structural constraints hinder the exercise of food-related capabilities even in contexts of apparent abundance. Alongside economic measures, experiential indicators offer complementary insights. Since 2022, ISTAT has integrated the Food Insecurity Experience Scale (FIES) into EU-SILC surveys, revealing that about 1.5% of the Italian population—over 800,000 people—experience moderate or severe food insecurity, with higher prevalence in the South and among families with children (FAO *et al*., 2023; ISTAT, 2023). Local surveys in Rome confirm similar dynamics: in peripheral municipalities, households report reducing food variety, skipping meals, or giving up nutrient-rich foods (Marino, Bernaschi & Felici, 2025). Such inequalities are deeply territorialized. Processes such as gentrification, uneven development, and the withdrawal of public services from peripheral areas reinforce the spatial concentration of vulnerabilities. As Dahrendorf (1989) noted, *life chances* depend not only on personal choices but also on the structural conditions that enable them. In this sense, eating well is not

simply a private act, but a territorial and relational phenomenon shaped by the interplay of markets, infrastructures, and welfare systems.

3. Data and Methodology

This research adopts an interdimensional and spatially explicit approach to examine food insecurity in the Metropolitan City of Rome, comprising 121 municipalities with diverse socio-territorial profiles. The analysis integrates georeferenced, statistical, administrative, and documentary data to build a territorial diagnosis structured around five analytical dimensions: economic food self-sufficiency, physical food self-sufficiency, healthy diet affordability, physical accessibility, and solidarity-based provisioning.

Physical Food Self-Sufficiency Index (PFSSI). The PFSSI assesses whether local agricultural land can meet the dietary needs of the resident population. It is defined as the ratio between the Utilised Agricultural Area (UAA) per capita—measured from the ISTAT Agriculture Census (2020)—and the agricultural land required to satisfy dietary needs under four consumption models (omnivorous, omnivorous without fish, vegetarian, vegan). The methodology follows Stella *et al.* (2019), but replaces CORINE land cover data with UAA to improve statistical accuracy and coherence with national agricultural statistics. Per-capita land requirements were estimated by converting caloric needs into hectares through crop yields and food loss coefficients (Stella *et al.*, 2019), with reference values ranging from 0.47 ha per capita for an omnivorous diet to 0.18 ha per capita for a vegan diet.

Economic Food Self-Sufficiency Index (EFSSI). The EFSSI captures the economic dimension of territorial self-sufficiency by comparing the value of local agricultural production with the monetary value of resident food demand. Agricultural output was estimated by multiplying municipal UAA (ISTAT, 2020) with crop-specific gross sale coefficients provided by CREA (2023) at the provincial level, thereby estimating the potential economic return of land use (limited to the capital fondiario component, excluding livestock, agritourism, and processing). Food demand was calculated from ISTAT household consumption statistics (2024, reference year 2023), which provide detailed expenditure data at the regional and sub-regional level.

Food Affordability Index (FAI). The FAI measures the extent to which household resources are sufficient to sustain a healthy diet. It compares equivalised household income/consumption capacity with the monthly cost of a nutritionally adequate diet. The diet model follows the *Italian Dietary Guidelines* (CREA, 2019) and was operationalised into a basket of 63 essential food items. Prices were collected through multi-channel surveys of supermarkets, discount stores, and open-air markets across municipalities, and were integrated with socio-economic data from ISTAT (2023) at both municipal and district scales.

Physical accessibility was analysed by mapping the distribution of food retail infrastructure, including supermarkets, discount stores, local markets, and solidarity purchasing groups. The main data source was the AIDA – Archivio Italiano delle Imprese (Chamber of Commerce), complemented with field surveys for validation and classification of outlets. A one-kilometre walking distance was adopted as a threshold, in line with established standards in food-access research and urban planning studies (Moreno *et al*., 2021). Areas lacking food outlets within this range were classified as food deserts.

Solidarity-based provisioning was assessed by mapping 815 food aid initiatives, identified through the SIFEAD – Sistema Informativo degli Enti che Distribuiscono Aiuti Alimentari (2024), the Lazio Region's Solidarity Fund, and our own field surveys. Indicators such as initiative density and beneficiary ratios were cross-referenced with affordability and vulnerability data to reconstruct the geography of solidarity-based food access across the metropolitan area.

Finally, by intersecting the five axes—PFSSI, EFSSI, FAI, physical accessibility, and solidarity provisioning—the analysis defines *"blacked-out food areas"* as an operational category: territories where all forms of access collapse simultaneously. Their empirical identification and territorial distribution are presented in the results section.

4. Results: Mapping the Intersections of Food Vulnerability in the Metropolitan City of Rome

The spatialisation of food insecurity in the Metropolitan City of Rome reveals uneven distributions of resources and overlapping vulnerabilities across metropolitan, peri-urban, and rural contexts. Rather than a simple rural–urban divide, the analysis exposes layered geographies of exclusion, fragility, and resilience emerging from the five axes introduced above.

4.1 From Productive Capacity to Land Availability: Economic and Physical Dimensions of Food Self-Sufficiency

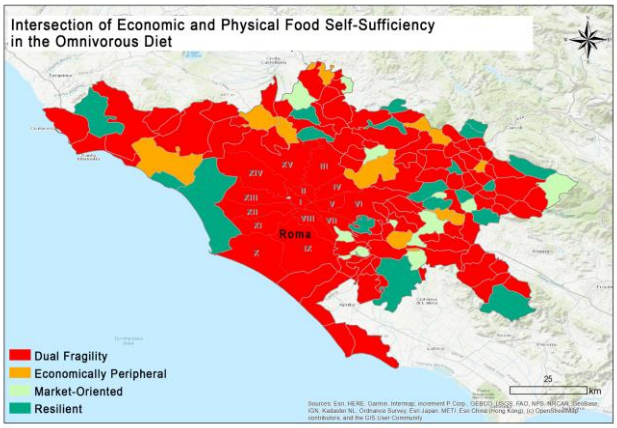
The analysis of food self-sufficiency in the Metropolitan City of Rome highlights a deeply uneven agro-productive landscape shaped by demographic pressure and territorial constraints. The Economic Food Self-Sufficiency Index (EFSSI) shows that 67 out of 121 municipalities—home to about 93% of the population—fall below the sufficiency threshold. Rome itself illustrates this paradox: despite high absolute output, local provisioning remains inadequate due to demographic demand and specialisation in non-essential, high-value crops such as wine grapes and ornamental plants (ISTAT, 2020; CREA, 2023). By contrast, 54 municipalities exceed the threshold, but they are sparsely populated and located in peripheral zones,

accounting for only 7% of residents. This spatial disconnect between productive capacity and demographic distribution raises critical concerns of territorial equity. In some high-performing municipalities, short supply chains and direct sales strengthen economic value and local autonomy, while diversified production systems combining cereals, vegetables, and legumes align more closely with nutritional needs.

The Physical Food Self-Sufficiency Index (PFSSI), based on Utilised Agricultural Area (SAU) and dietary models, reveals even stronger structural limitations. Only 14.8% of municipalities can meet nutritional needs under an omnivorous diet, rising to 34.4% under a vegan diet (Stella *et al.*, 2019; ISTAT, 2020). Most areas remain dependent on external supply chains. The deficit is most acute in urban and peri-urban zones, where SAU is fragmented or reduced by speculative development, while rural municipalities, despite larger land availability, often lack investment, infrastructure, and logistical capacity. Additional challenges include soil degradation, irrigation gaps, and an ageing agricultural workforce. This paradox—where agricultural potential is abundant where demand is low and scarce where demand is high—exposes systemic fragility in the regional food system and underscores issues of territorial equity.

Figure 1 illustrates the intersection of EFSSI and PFSSI under an omnivorous diet, classifying municipalities into four categories: (i) double fragility, with poor performance on both indices; (ii) economically marginal areas, with sufficient land but weak market integration; (iii) market-oriented municipalities, with high economic output despite limited agricultural land; and (iv) resilient territories, combining physical capacity with economic viability. This typology underscores the uneven geography of food resilience, affecting both rural margins and densely populated metropolitan districts. Mapping these interactions provides a nuanced territorial diagnosis essential for the design of equitable, place-based food policies.

Figure 1- *The Intersection of Economic and Physical Food Self-Sufficiency in the Omnivorous Diet.*



Source: Authors' own elaboration based on ISTAT (2020), CREA (2023), and Stella et al. (2019) data

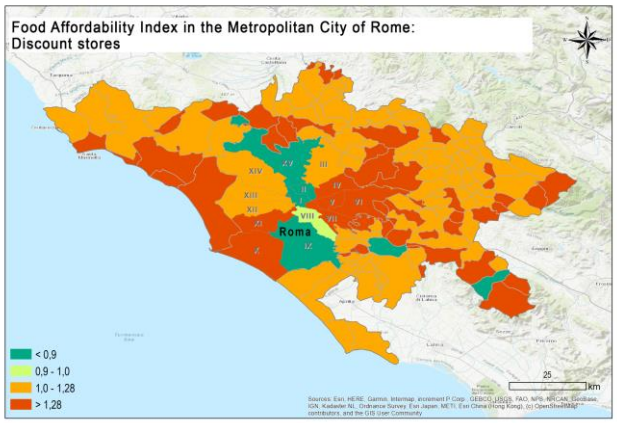
4.2 The Cost of Healthy Eating: Economic Barriers to Food Access

Affordability, understood as the economic dimension of food access, is a key driver of metropolitan food insecurity, shaped by structural poverty, price disparities, and uneven retail provision. The Food Affordability Index (FAI) highlights sharp territorial inequalities: most peripheral and rural municipalities score above 1.28[1], indicating that maintaining a healthy diet often forces households to cut back on other essential expenses such as housing, energy, and transport. By contrast, central and coastal areas display lower values, reflecting higher average incomes, denser retail networks, and a wider presence of discount formats that help ease pressure on household budgets. At the municipal level, disaggregation by retail format shows that discount stores partly mitigate affordability gaps in disadvantaged zones, particularly in the southern and eastern periphery of the metropolitan area. Yet their spatial distribution remains highly uneven. As shown in Figure 3, critical conditions arise when the FAI exceeds 1.28, a situation characterizing 31 out of 121 municipalities (around 25.6% of the metropolitan area). In contrast, when supermarkets and local markets are considered, inaccessibility extends to almost the entire metropolitan territory, underscoring a deeper structural weakness of these retail formats. Nevertheless, some "accessibility niches" remain—mainly in the

[1] Taking 1 as the benchmark threshold for FAI, values above 1.28—corresponding to food costs 28% higher than the average expenditure of urban households in Central Italy—are considered at risk, based on the standard deviation observed across municipalities.

Castelli Romani area and in selected districts within the city of Rome—where the FAI falls below or close to the threshold of 1, suggesting relatively better access conditions. Overall, the evidence points to the compensatory role played by discount stores, which help reduce affordability disparities despite their uneven coverage, while also revealing the persistence of profound territorial inequalities in food access across the metropolitan landscape.

Figure 3 - *Food Affordability Index (FAI) related to discount stores in the Metropolitan City of Rome.*



Source: Authors' elaboration on municipal-level food price data (July 2023); Statistical Bulletin of the Municipality of Rome (2023); household food expenditure and average total consumption data from ISTAT (2023).

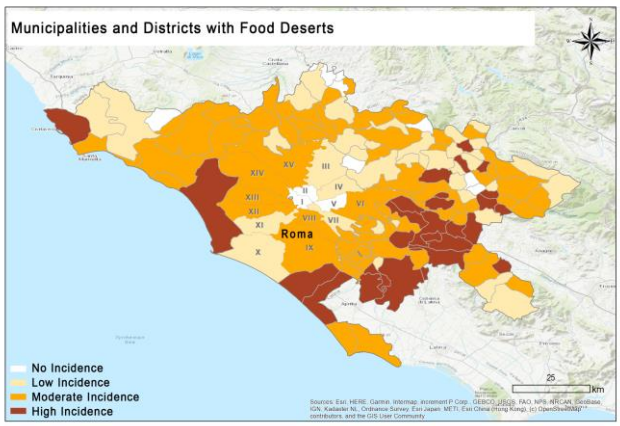
4.3 From Food Deserts to Solidarity Gaps: Infrastructures of Access

The analysis of food access through physical and solidarity infrastructures reveals a markedly uneven geography across the Metropolitan City of Rome. Food deserts (Fig. 4)—defined as areas lacking food outlets within 1 km—are concentrated in peripheral and peri-urban municipalities, particularly where transport services are weak. Districts such as Tor Bella Monaca, Corviale, and Ponte di Nona are especially affected, combining high poverty and unemployment with large shares of vulnerable groups, including elderly residents and migrants. Overall, between 20% and 50% of municipal surfaces fall within food deserts, reflecting systemic failures in local provisioning.

Solidarity-based infrastructures (Fig. 5)—including food banks, solidarity emporia, and community kitchens—exceed 800 across the metropolitan area but are disproportionately concentrated in central districts, leaving rural and suburban municipalities underserved. Reliance on these initiatives is substantial, yet cross-

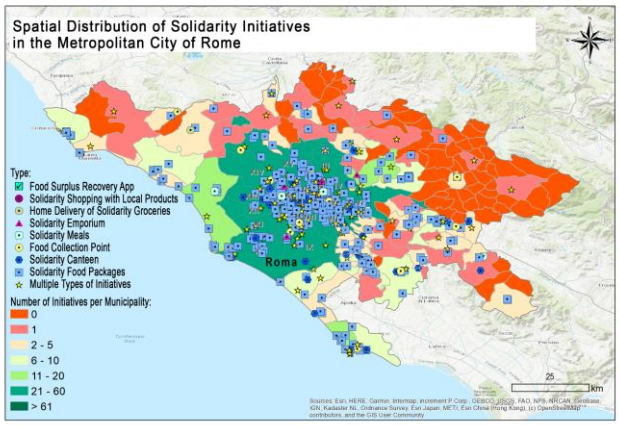
referencing with the Food Affordability Index (FAI) reveals a critical mismatch: precisely the peripheral municipalities—such as IV, V, VI, VII, IX and part of X—and many outer municipalities beyond the GRA, where economic vulnerability is greatest, record the lowest density of initiatives, sometimes fewer than five or none at all. These infrastructures remain fragile, dependent on volunteers, donations, and short-term funding, and are particularly vulnerable to demand surges in times of crisis.

Figure 4 - *Food Deserts.*



Source: Authors' elaboration on AIDA (2023).

Figure 5 - *Spatial Distribution of Solidarity Initiatives in the Metropolitan City of Rome*.



Source: Authors' elaboration on SIFEAD (2023) and documentary analysis.

4.4 Blackout Food Areas: When the System Fails

Overlaying the five analytical dimensions—economic and physical food self-sufficiency, healthy diet affordability, physical access, and solidarity-based provisioning—identifies a critical category: *blacked-out food areas*. These zones represent a systemic breakdown, where multiple barriers converge and render food insecurity invisible to conventional diagnostics (Fig. 6). They are not limited to rural margins but also include densely populated districts, where demographic pressure intersects with infrastructural decay, economic marginalisation, and weak social cohesion. In such contexts, food systems are critically undermined: residents cannot produce food, sustain a healthy diet, access retail outlets, or rely on solidarity networks. The result is cumulative and intergenerational vulnerability. Addressing *blackout areas* requires moving beyond emergency aid. More durable responses depend on territorial investment in infrastructure, support for diversified local production, measures to stabilise incomes and prices, and governance arrangements that integrate community-level perspectives. Embedding food access within broader strategies of territorial equity is essential to reconnect these areas to the metropolitan fabric.

Figure 6- *Blacked-Out Food Areas in the Metropolitan City of Rome.*

Source: Authors' elaboration.

5. Concluding Reflections

Blacked-out food areas illustrate how market mechanisms alone are insufficient to secure equitable and resilient food environments. They are territorial manifestations of systemic failure, where infrastructural gaps, economic pressures, and social vulnerabilities converge to restrict people's substantive freedoms to

access healthy diets. Overcoming these structural deficits requires strong institutional intervention. Emergency aid can only mitigate symptoms; durable solutions depend on public investment in infrastructures, redistributive measures that counterbalance spatial disparities, and regulatory frameworks that stabilise prices and incomes. These efforts must be embedded in multi-level governance that coordinates state actors, local administrations, civil society, and market stakeholders. Addressing *blackout areas* is therefore not only a matter of food policy but of economic policy more broadly, aimed at reducing inequalities, strengthening resilience, and ensuring that all territories contribute to and benefit from metropolitan development. Embedding food access in this wider framework allows food systems to become both more resilient and more inclusive, supporting long-term social and economic sustainability.

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