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Green Urban Public Spaces Accessibility: A Spatial Analysis for the Urban Area of the 14 Italian Metropolitan Cities Based on SDG Methodology

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Abstract: Among the most significant impacts related to the spread of settlements and the densification of urban areas, the reduction in the availability of public green spaces plays a central role in the definition of livable cities, in terms of the environment and social cohesion, interaction, and equality. In the framework of target 11.7 of the Sustainable Development Goals (SDG) 11, the United Nations has established the objective of ensuring universal, safe, and inclusive access to public spaces by 2030, for women, children, the elderly, and people with disabilities. This study proposes the evaluation of this objective for the urban area of the 14 Italian metropolitan cities, as defined by EUROSTAT and adopted by the United Nations and the Nature Restoration Law (NRL). A methodology based on open-source data and network analysis tools is tested for the provision of an unprecedented mapping of the availability and accessibility to green urban public spaces, which shows that less than 30% of metropolitan city residents have access to a green space within 300 m on foot, according to OpenStreetMap data (less than one in five for the Urban Atlas data). Furthermore, a critical analysis on the geometric and semantic definition of green urban public spaces adopted by the main European and international tools is carried out, which underlines the strategic role of crowdsourcing but also the need for mapping rules that make the data more consistent with the monitoring objectives set at the institutional level.

Keywords: urban areas; DEGURBA; green urban public spaces; spatial analysis; accessibility; SDG; ecosystem services; 3-30-300 rule; OpenStreetMap; population spatialization

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1. Introduction

1.1. State-of-the-Art

The evolution of urban areas in recent decades has been characterized by progressive acceleration and significant evolution, which holds crucial new challenges to ensure sustainability and a good quality of life in cities.

According to estimates by the World Urbanization Prospect, 68% of the global population will live in urban areas by 2050, resulting in a loss of another 1.2 million km^2 of land for the construction of new buildings and infrastructure, often in public places and private green areas [1].

Many studies have shown the beneficial effects of greenery on health, in terms of improved perceived well-being, mental health, reduction in cardiovascular disease, and decreased mortality, but also improvement in air quality, climate mitigation (and reduction in mortality associated with heat waves, which caused between 55,000 and 72,000 deaths in Europe in the years 2003, 2010, and 2022), water infiltration, and landscape and esthetic benefits by improving social cohesion, interaction, and equality [2–7]. The presence of well-managed and fairly large green areas also has an economic benefit, with effects on property values and commercial activities [8]. In spite of that, the European Commission Joint Research Centre estimates that in Europe, only 44% of the urban population has access to a public park within 300 m, with significant variations between Eastern and Mediterranean cities [9]. Several thematic policies and strategies recognize the role of green spaces in urban areas and the need to safeguard them and ensure their accessibility. In Italy, the introduction of urban planning standards (the Ministerial Decree of 2 April 1968 n.1444 establishes that for each new settlement a minimum of 18 m^2 per inhabitant must be foreseen for public spaces, 9 of which are intended for public greenery, excluding the areas pertaining to road infrastructures) has safeguarded urban green spaces from urbanization processes, but this often translates into a merely quantitative application that does not consider the quality of green areas in terms of accessibility and ecosystemic and social functions. This has led to neglect of the positive effects of natural capital in terms of landscape, esthetics, historical–cultural identity, and accessibility, often reducing them to an element of urban furniture in the interstices of the city [10–12]. Tools such as the National Strategy for Urban Green [13] have been developed with the aim of stimulating political and cultural transformation and supporting new forms of planning capable of emphasizing the contribution of green infrastructures and Nature-Based Solutions (NBS) in both urban and rural contexts. The recent Nature Restoration Law (NRL) [14] obliges all European Union member states to eliminate the net loss of urban green areas by 2030 and to ensure their improvement by 2050. Actually, green areas have become crucial indicators to promote the integration of biodiversity values in urban planning.

The growing interest in cities and in settlement and demographic dynamics has highlighted the need for definitions of urban areas, green spaces, and accessibility that are spatially explicit, supported by scientific evidence, and recognized by the main regulatory instruments. The introduction of the United Nations Sustainable Development Goal 11 "Make cities inclusive, safe, resilient and sustainable" has provided standardized definitions and methodologies for mapping urban areas [15] but the definition of green spaces, especially public ones, is not yet univocal. Typically, green public spaces in urban areas are public parks but can also include private gardens, forests, playgrounds, rows of trees along road infrastructures, or blue infrastructures, depending on the objectives of the analysis. At present, there is no universally accepted definition of green urban public spaces (GUPSs), but it varies according to the specific context and objectives [16–21]. At a regulatory level, the Nature Restoration Law [14] introduced a definition of urban greenery to be conserved and implemented immediately. This definition includes all trees, bushes, shrubs, permanent herbaceous plants, lichens and mosses, ponds, and watercourses within cities and small urban agglomerations and excludes all artificial cover and arable land (the measures envisaged for agricultural ecosystems are described in Article 11).

To assess the impacts of green urban areas on human health and well-being, it is important to consider other aspects in addition to the presence of vegetation, such as size, ownership regime, proximity, accessibility, uses, and the functions they host [22]. With reference to size, the 3-30-300 rule [23], adopted by the IUCN, recommends green areas of at least one hectare, as does the study by Matilda Annerstedt Van Den Bosch [24]. The ownership regime allows for evaluation of the function of the green area to promote equality, inclusion, and social interaction, as also supported by SDG 11.7 ("by 2030, provide universal access to safe, inclusive, and accessible green and public spaces, particularly for women and children, older persons, and persons with disabilities"). In the absence of detailed information or mapping of the ownership regime or usability of green areas, the training module of target 11.7.1 suggests the use of the OpenStreetMap (OSM) database [25]. "Accessibility by proximity" [26] considers the theory of "15 min cities", as the possibility for a person to reach relevant daily points of interest (grocery stores, health or recreational areas such as green areas) within 15 min on foot or by bicycle; Deda Next has implemented an algorithm to automatically calculate the proximity index to points of interest [27].

The concept of accessibility has taken on different meanings over time that require combining the normative dimension with the qualitative and quantitative ones [28]. Many studies analyze the accessibility to GUPSs by considering different tools, definitions, study areas, and techniques. There are calculation experiences based on the definition of a buffer around the areas of interest (therefore referring to the distance as the crow flies from the target [29,30]; other studies refer to travel times and others still to the distance referred to the road network [31]). In addition, the assessment is also conditioned by the characteristics of the different elements involved [32]; in fact, to evaluate the accessibility to GUPSs, it is important to appropriately represent the urban areas (the area within which the accessibility to GUPSs is evaluated), the GUPSs (to be accessed) and the relative access points, the distances (to be covered to access the GUPSs), and the population (which can access the GUPSs). The urban area can be identified with respect to different approaches. Poelman and Giuliani consider the footprint of the Urban Atlas [33] Functional Urban Areas (FUA) [34,35] as Della Rosa does too [36], while other experiences refer to the entire municipal territory [27,37]; the UN SDGs introduced the concept of DEGURBA [15] based on the methodology adopted by Eurostat, which represents settlements through the definition of thresholds on the number of inhabitants and population density. This tool is officially adopted by the Nature Restoration Law [14] and the targets related to SDG 11 [25,38]. GUPSs can be identified starting from Urban Atlas classes "1.4—Green urban areas" [36,37] and "3—forest" [34], or by extracting representative categories of green public spaces from OSM by combining land use/cover information with reference to protected areas, agricultural areas, cemeteries, sports areas, green furniture, or even large wooded areas on the edges of the settlement fabric [35,39]. Once GUPSs have been identified, a key aspect for assessing accessibility is the availability of information on their access points, which greatly affects the results of the analysis, especially when using network analysis tools to assess distances, which are more accurate than methodologies based on Euclidean distance [36]. Due to the difficulty in finding the real access points, the centroids of the GUPSs polygons [27,35] or the arrangement of access points at regular intervals along the perimeter of the polygon can be considered [25,34,36,37,40]. Reliable information on the spatial distribution of the population is needed to assess the portion of inhabitants who are near the GUPSs and therefore have access to them. In this sense, it is important to have a spatialized population dataset or to define a criterion for producing it, starting from the most detailed demographic data available. The DEGURBA methodology suggests the use of the Eurostat Population Grid (updated to 2011 for the Italian territory), while in Italy, the ISTAT population data are updated annually with respect to the municipal territory and every 10 years with respect to the census sections (sub-municipal detail, available for 2001, 2011, and 2021) [41].

1.2. Objectives and Structure of the Research

The general objective of this study is the evaluation of accessibility at a national scale using the methodology provided by UN SDG indicator 11.7.1 ("Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities"), with reference to green open public spaces, which are one of the three components considered by the indicator metadata, together with gray and blue infrastructures. The focus on green spaces is due to their importance in the current framework of European and international policies—first of all the new Nature Restoration Law, the SDG 11.7.1 itself, or at the national level, the forestation interventions provided by the National Recovery and Resilience Plan (NRRP). In this sense, the accessibility assessment was made in compliance with the definitions and calculation methodologies provided by the regulatory context to obtain spatial data suitable for the decision-making processes, e.g., for the identification of priority areas for urban forestry intervention.

A specific objective concerns the analysis of the technical phases for the calculation of accessibility to GUPSs, with a focus on the input data available for the Italian territory, evaluating their suitability for this purpose in relation to characteristics such as spatial resolution, update frequency, classification system, and spatial coverage. In detail, OSM and UA have been considered, which are among the most detailed data available for mapping urban areas; they are based on different classification systems and mapping and updating logics. UA belongs to the Copernicus Land Monitoring Service (CLMS) and is produced and updated according to a standardized methodology that provides a homogeneous mapping on the main FUAs in terms of minimum mapping unit, classification system, reference year, and accuracy; OSM has higher geometric and temporal heterogeneity, but offers a much wider coverage and is more detailed than UA and more flexible from the thematic point of view, also allows for the introduction of new attributes.

The last specific objective is the assessment of the state of accessibility to GUPSs in the urban areas of the 14 Italian metropolitan cities (delimited through the Eurostat DEGURBA methodology), also with the introduction of two auxiliary indices that describe the presence of GUPSs per capita compared to the total urban green spaces per capita.

This research offers, for the first time, a national-scale assessment of accessibility to GUPSs in compliance with the legal indications of NRL for urban areas monitoring and based on an SDG methodology, allowing us to obtain coherent and comparable estimates between different areas of the Italian territory, all using the most detailed and updated available data (ISTAT population data for census sections and ISPRA LCM) and providing operative ideas that can also be useful for applications in other territorial contexts.

The methodology illustrated in this paper is divided into six phases, whose overview is provided in Section 2.1; in Section 2.2, the choice of the study area is illustrated, i.e., the urban area (according to the DEGURBA methodology) of the 14 Italian metropolitan cities; Section 2.3 describes the allocation of the population and of the starting points in the centers of each cell of a hexagonal grid; Section 2.4 illustrates the classes taken into consideration by the OSM and UA data for the identification of GUPSs and the approach used to identify the access points; Section 2.5 illustrates which elements of the OSM road network that have been considered for the walking routes from the starting points to the access points to the GUPSs, while Section 2.6 describes the calculation of accessibility to GUPSs, considering a maximum walking distance of 300 (threshold indicated by the IUCN rule 3-30-300) and 400 m (indicated by the metadata of SDG 11.7.1).

2. Materials and Methods

2.1. Overview

In this research, indicator 11.7.1 of the United Nations Sustainable Development Goals (UN SDGs) was evaluated for the urban area of the 14 Italian metropolitan cities (MCs), with reference to Green Urban Public Spaces (GUPSs) accessibility.

The urban area of metropolitan cities was delimited using Eurostat's DEGURBA methodology, implemented on Italian territory starting from a 10 m-resolution population grid relating to 2021, produced by the ISPRA on ISTAT data (spatializing the ISTAT population data by census sections on residential buildings of the ISPRA/SNPA National Land Consumption Map).

The accessibility assessment requires the definition of a starting point, an arrival point (to be accessed), and the path between them. Actually, the following operations were carried out:

1. Definition of starting points and spatialization of the resident population of the surrounding area. For the access points, a hexagonal mesh grid was created, considering the centers as the starting points of the routes and on which the spatialized population was allocated;

2. Identification of GUPSs and related access points, with reference to Urban Atlas and OpenStreetMap data. For the OSM access points, those mapped by the "gate" and "entrance" tags were considered; in their absence, the intersection was made between GUPSs and roads or, thirdly, an access was inserted every 100 m along the perimeter of the GUPSs. For UA, it was only possible to consider one access point every 100 m along the perimeter;
3. Definition of the routing network, to be covered on foot, to access the GUPSs from the starting points, defined from the OSM walkable road network;
4. Identification of the shortest route to access from a starting point to the nearest GUPSs. For this purpose, it is considered that the inhabitants located in each hexagon of the grid have access to a green area if the nearest GUPSs can be reached by walking no more than 300 or 400 m. The threshold of 400 m is indicated by the metadata of SDG 11.7.1, while the threshold of 300 m refers to the IUCN 3-30-300 rule, which establishes that every inhabitant must be able to access a park within 300 m, 30 percent of each neighborhood must be wooded, and at least three trees should be visible from every window.

2.2. Study Area

The analysis was carried out on 14 Italian metropolitan cities, considering the portion of their territory classified as an urban area by the DEGURBA methodology (Figure 1), which was adopted by the United Nations Statistical Commission in its 51st session (March 2020) and more recently by the NRL.

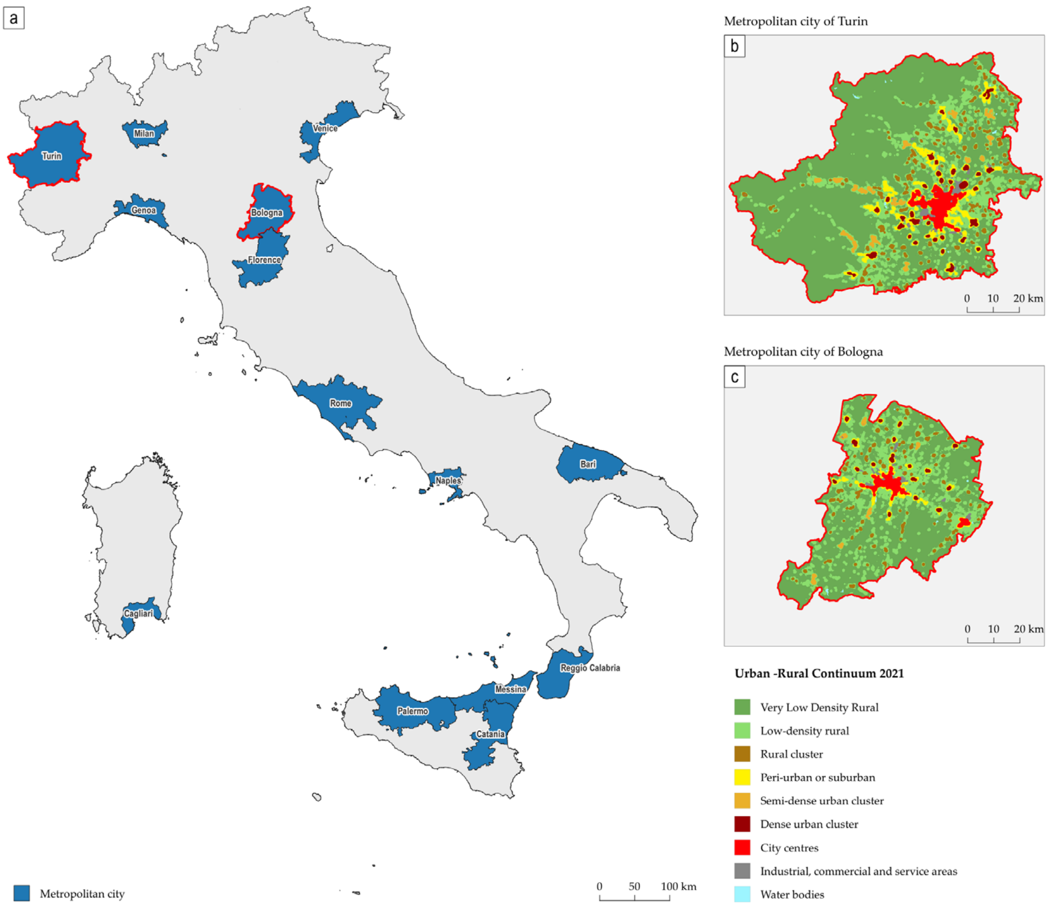

Figure 1. Study area. This research focuses on the 14 Italian metropolitan cities (**a**). On the right, there is an example of the urban–rural continuum for the MCs of Turin (**b**) and Bologna (**c**), used as a reference to delimit the urban area (urban centers and dense urban clusters) on which accessibility was assessed.

The reference to the DEGURBA definition of urban area is required by the metadata of the SDG indicator 11.7.1 (and by other indicators relating to SDG 11, such as 11.3.1 [38]), and is also the official reference for the Nature Restoration Law (for the identification of municipalities subject to legal obligations and to select priority areas of intervention). Furthermore, reference is made to metropolitan cities because they are the subject of significant funding under the NextGenerationEU plan, in particular by mission 2, component 4, investment 3.1 "protection and enhancement of urban and extra-urban greenery" of the NRRP. Such investments are planned to improve the quality of life and well-being of citizens through reforestation interventions that counteract problems related to air pollution, the impact of climate change and the loss of biodiversity. In Italy, the ISPRA represents the urban–rural continuum according to the DEGURBA methodology by spatializing the ISTAT population data with respect to the national land consumption map (LCM) [42] and obtaining a 10 m-resolution product which identifies nine classes based on population density and total population information; in this study, the portion of the metropolitan city that falls into the most populated classes was considered, i.e., the urban centers (population > 50,000 inhabitants and population density $\geq$ 1500 inhabitants per km^2) and dense urban clusters (population $\geq$ 5000 inhabitants and population density $\geq$ 1500 inhabitants per km^2). In the following, "urban area" will mean the surfaces mapped as "urban center" and "dense urban cluster" by the DEGURBA map produced by the ISPRA on 2021 data for the Italian territory. In the first version of the data presented in the previous publication (relating to municipal population data for 2018), the thresholds were adapted to the national context; the version considered in this work (which is based on population data for 2021 by census sections) maintains the population and population density thresholds indicated by DEGURBA. Table 1 summarizes the total areas of MCs and the portion of their territory classified as urban centers and dense urban clusters, taken into consideration for the accessibility; in detail, the urban area occupies 6.3% of the MCs.

Table 1. Total surface area of the 14 Italian metropolitan cities and of the portion of their territory classified as "urban centers" and "dense urban clusters" according to the DEGURBA methodology.

MC	Total Surface	Urban Area	
	ha	ha	%
Tourin	682,973	25,319	3.7
Genoa	183,517	10,855	5.9
Milan	157,674	49,513	31.4
Venice	247,039	8770	3.6
Bologna	370,199	9288	2.5
Florence	351,351	11,937	3.4
Rome	535,581	61,856	11.5
Naples	117,398	50,126	42.7
Bari	382,540	14,670	3.8
Reggio Calabria	318,303	5789	1.8
Palermo	499,302	14,282	2.9
Messina	324,678	6294	1.9
Catania	355,303	15,800	4.4
Cagliari	124,964	6216	5.0
Total	4,650,821	290,716	6.3

The considered MCs represent 15% of the national territory, include more than a third of national "urban centers" and "dense urban clusters", and the main national initiatives for the enhancement of green infrastructures in urban and suburban areas are focused on them [13].

2.3. Identification of Starting Points and Spatialization of the Population

2.3.1. Identification of Starting Points

To define the starting points, a 50 m-apothem hexagonal mesh grid was created. The centroid of each hexagon was taken as a starting point to evaluate accessibility to the nearest GUPSs for the population residing in the hexagon.

The hexagonal grid is widely used for accessibility studies, ensuring a better distribution of sampling points, since it keeps a constant distance between the centers of the meshes compared to the square grid [27,40,43,44].

2.3.2. Population Spatialization

For each hexagon, the resident population was calculated, starting from a population spatialization methodology already described in a previous study by the working group ([42]) and following the steps below (Figure 2):

1. The most detailed population data were identified. In Italy, the ISTAT publishes population data aggregated by census sections (which offer a sub-municipal level of detail) every 10 years, starting from 1991. This study is based on the new ISTAT data updated to 2021.
2. The population was allocated within the census sections by introducing the ISPRA national land consumption map (LCM) and the Copernicus Land Monitoring Service land cover and land use data as ancillary data. The LCM is a 10 m-resolution raster which provides an annually updated consumed land mapping for the Italian national territory. For each census section, the residential population was uniformly distributed across the LCM pixels classified as built-up areas for residential use and which fall under the section itself. In the absence of residential LCM pixels, the population was spread across all the built-up areas of the census section, or, in the absence of built-up pixels, a uniform distribution of the population was maintained across the entire census section. The population density information in the fictitious sections was finally added[1].
3. The previous operation produced a 10 m-resolution raster for the entire study area, which associates a population value to each LCM pixel. It was then crossed with the hexagonal grid to attribute to each hexagon the population of the underlying pixels. To calculate accessibility, the centroid of each hexagon is associated with the population of the entire hexagon.

2.4. Identification of GUPSs and Related Access Points

2.4.1. Identification of GUPSs

GUPSs are the end point against which accessibility is assessed and were identified starting from OSM and UA data.

- From OpenStreetMap (OSM), the green spaces described by the key “Leisure” and the tags “Park” and “Garden” were extracted. Starting from the ITO Map Green space access map (which indicates a range of green spaces, their availability for use, and their access status) and analyzing OSM tags under the “Leisure” key [39], these two tags were identified as the most suitable for the selection of green open public spaces in the Italian context. The “parks” classified as “protected areas” by the tag “boundary” were excluded, since the perimeter of the protected areas is linked to a form of government of the territory and do not necessarily identify an area open to the public (in fact, within them it is also possible to find privately owned agricultural areas).
- From Copernicus Urban Atlas Land Cover/Land Use 2018 (UA), the class “1.4—Artificial non-agricultural vegetated areas” polygons were considered, which includes the subclasses of “1.4.1—Green urban areas” and “1.4.2—Sport and leisure facilities”. In detail, only polygons covered by artificial surfaces for less than 20% were selected

(evaluated using the ISPRA LCM).
For both data, only polygons larger than 0.5 ha were considered [23,25].

- The threshold for the percentage of consumed land on UA polygons was defined to exclude areas with a high presence of artificial surfaces, such as sports fields, stadiums, squares, theaters and auditoriums, cemeteries, riding stables, and sports centers.
- On the threshold on the minimum size of polygons, the IUCN rule 3-30-300 suggests considering green areas of at least one hectare; in this research, a threshold of 0.5 ha was defined for the entire study area to preserve many polygons smaller than one hectare (thus enhancing the information content of the input data) while maintaining areas large enough to guarantee the provision of ecosystem services, e.g., in terms of cooling capacity [45].

Among all the polygons with these characteristics, those that fell (entirely or partially) within the urban area of the analyzed MC were considered as green urban public spaces (GUPSs).

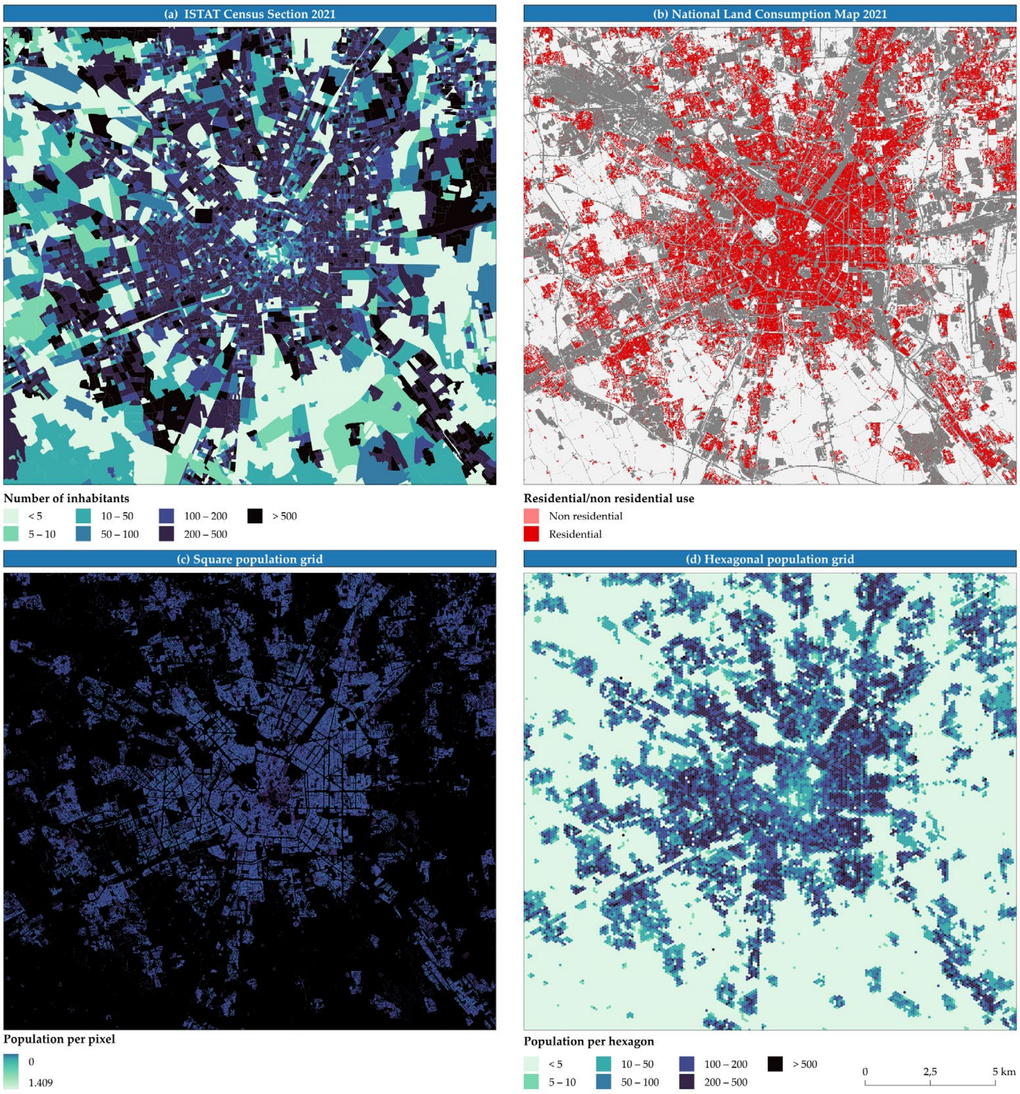

Figure 2. Operational phases for population spatialization: ISTAT census sections for 2021 (**a**), each themed with respect to the resident population. Residential and non-residential built-up areas of the ISPRA LCM (**b**); population spatialized on the built-up area (**c**); spatialized population aggregated with respect to the hexagonal grid, used for the accessibility assessment (**d**).

2.4.2. Identification of GUPS Access Points

The identification of access points to GUPSs requires the availability of detailed information on the edges of the considered green areas, in terms of location of the entrances and their possible limitations.

OSM maps punctual information, called nodes, referring to the accesses to buildings, infrastructures and GUPSs. Actually, OSM GUPS access points were identified by first where the following two conditions are verified:

- OSM nodes classified by the “barrier” key and the “gate[2]” and “entrance[3]” tag, located inside or at the perimeters of the selected green areas can be found;
- Intersection points between OSM streets and OSM GUPS polygons can be derived.

Where neither of the two conditions are met, an access point was defined every 100 m along the perimeter of the GUPSs, according to the indications provided by the SDG indicator 11.7.1 metadata [25].

For the UA GUPSs, only access every 100 m along the perimeter was considered.

2.5. Creation of the Routing Network

To perform a network analysis capable of automatically identifying the best walking route from a starting point to one or more GUPSs in the urban area of interest, the OSM database relating to the road network was used.

Raw OSM data in OSM format were acquired from the Geofabrik download server and transformed into a network dataset using the open-source OSM Editor add-on developed for ESRI ArcMap v.10.4 users, preparing a network configuration xml file. The rules established in the configuration file refer exclusively to the use of walkable road infrastructures, considering the key “highway” and the following tags: “primary”, “primary_link”, “secondary”, “secondary_link”, “tertiary”, “tertiary_link”, “unclassified”, “residential”, “service”, “cycleway”, “cyclestreet”, “bicycle_road”, “footway”, “pedestrian”, ”path”, ”sidewalk”, ”steps”, ”track”, ”construction”, ”escape”, ”bridleway”, ”living_street”. Barriers to movement along the roads were not considered, while, when origins and destinations were not located along the infrastructure network, the distance of each point from the closest network element was considered.

The OD cost Matrix tool implemented in ESRI ArcGis Pro software version 3.2.2 was used to evaluate the routes, considering the distance in meters as a cost attribute and searching for each starting point (the centroids of the hexagons) the closest GUPSs within a maximum distance of 10 km.

The cost matrix provides the “lines” that connect starting points and end points; for each starting point, the shortest path to a GUPS was considered.

2.6. Evaluation of Accessibility to GUPSs

In line with the indications of target 11.7 and with the 3-30-300 rule, this study allowed for evaluation of the total population belonging to the starting point of each hexagon that has access to a GUPS within a certain walking distance. The calculation was carried out both with reference to a distance of 300 m, referring to the IUCN rule 3-30-300, and to a distance of 400 m, defined by the metadata for the calculation of the SDG indicator 11.7.1:

$$GUPS\ Accessibility = \frac{Pop_{wa}}{Pop_{Tua}} * 100$$

where

Pop_{wa} = Total population with access to GUPS (within 300 m or 400 m)
Pop_{Tua} = Total population in urban area

2.7. Evaluation of Supporting Indicators

To evaluate the availability of GUPSs on the total vegetated surface of the urban area, an auxiliary indicator was calculated relating to the urban green spaces (UGSs) surface area per capita (1), which was compared with the GUPSs surface area per capita (2), calculated with respect to both OSM and UA. The UGSs surface area was evaluated starting from the Copernicus CLC+ Backbone 2021 data [46].

$$UGS\ Per\ Capita = \frac{UGS_{Sua}}{Pop_{Tua}} \quad (1)$$

$UGS_{Sua} = Total\ UGS\ Surfaces\ in\ urban\ area\ \left[\mathrm{m}^2\right]\ with\ respect\ to\ UA\ and\ OSM$
$Pop_{Tua} = Total\ population\ in\ urban\ area$

$$GUPS\ Per\ Capita = \frac{GUPS_{Sua}}{Pop_{Tua}} \quad (2)$$

$GUPS_{Sua} = Total\ GUPS\ Surfaces\ in\ urban\ area\ \left[\mathrm{m}^2\right]$
$Pop_{Tua} = Total\ population\ in\ urban\ area$

3. Results

3.1. Identification of Starting Points and Population Spatialization

The spatialization of the population for only the portion of the territory of the 14 MCs classified as urban area by the DEGURBA methodology is shown in Figure 3.

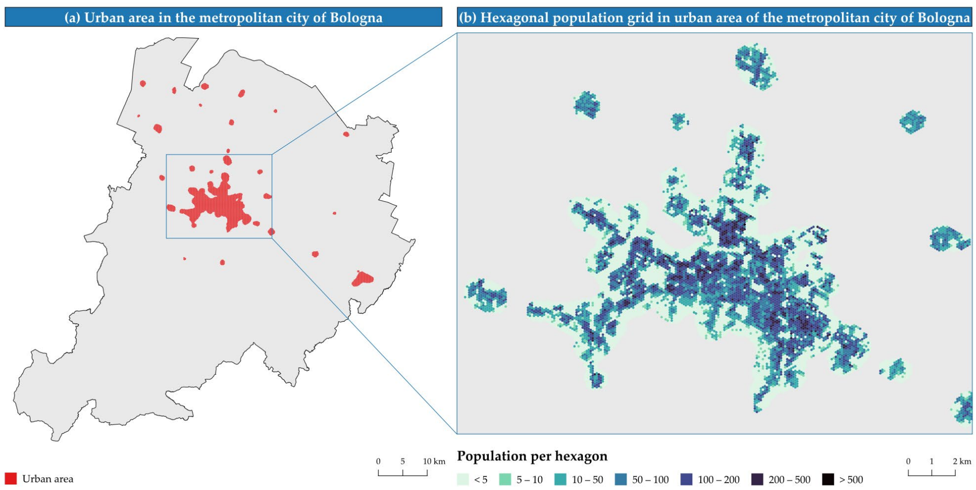

Figure 3. Urban area (**a**) and spatialized population in the urban area (**b**) with reference to the MC of Bologna.

The resident population throughout the metropolitan territory and the urban area of MC are synthesized in Table 2. Over three quarters of the population of the 14 MCs live in urban areas, with minimum values in Venice (44%), Messina (47.1%), and Reggio Calabria (48.3%), while Milan and Naples exceed 92%. The cities that exceed the national average are, in order, Bari (84%), Cagliari (83%), Rome, and Genoa (80%).

Table 2. Total population (number of inhabitants) and population in urban area (number of inhabitants and percentage on the total population) of the 14 Italian MCs.

MC	Total Population	Population in Urban Area	
	Inhabitants	Inhabitants	% of Total Pop.
Tourin	2,208,370	1,556,719	70.5
Genoa	817,402	654,077	80.0
Milan	3,214,630	2,978,997	92.7
Venice	836,916	368,138	44.0
Bologna	1,010,812	562,695	55.7

Table 2. *Cont.*

MC	Total Population	Population in Urban Area	
	Inhabitants	Inhabitants	% of Total Pop.
Florence	987,260	626,038	63.4
Rome	4,216,874	3,384,763	80.3
Naples	2,931,250	2,710,728	92.5
Bari	1,226,784	1,030,954	84.0
Reggio Calabria	522,127	252,003	48.3
Palermo	1,208,991	868,424	71.8
Messina	603,229	284,205	47.1
Catania	1,077,515	803,756	74.6
Cagliari	421,688	350,559	83.1
Total	21,283,848	16,432,056	77.2

3.2. Identification of GUPSs and Related Access Points

3.2.1. Identification of GUPSs

The identification of GUPSs was made with respect to both OSM and UA green spaces (Figure 4).

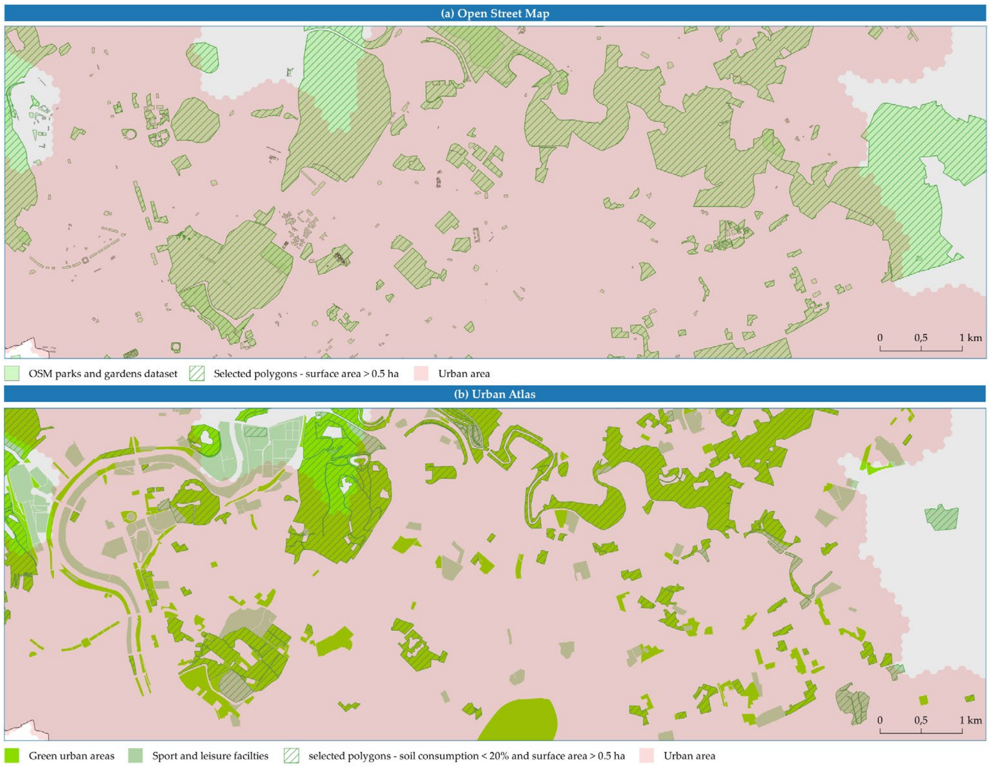

Figure 4. Example of the municipality of Rome for the procedure of the selection of GUPSs, compared to the OSM data (**a**) and UA (**b**). For OSM, only the polygons classified with the tags "Garden" and "Park" larger than half a hectare were selected. For UA, the polygons classified as "1.4—Artificial non-agricultural vegetated areas" larger than half a hectare and with less than 20% of consumed land were considered.

For OSM, starting from the almost 24,000 polygons classified with the tags "Garden" and "Park", the 5333 larger than half a hectare were selected, for a total surface area of 33,610 hectares.

Regarding UA, from the 13,421 polygons classified as "1.4—Artificial non-agricultural vegetated areas" on the whole territory of the 14 MC, the 4526 larger than half a hectare and with consumed land lower than 20% were selected, for a total of 15,378 hectares. The results for each MC are reported in Appendix A.

The threshold for the maximum percentage of consumed land allowed us to exclude areas not assimilable to GUPSs which belong to the UA class "1.4—Artificial non-agricultural vegetated areas", e.g., cemeteries, sports fields, auditoriums, green areas affected by land take, and other highly artificialized urban public spaces, such as some squares (Figure 5).

Figure 5. Examples of some types of areas mapped by UA as "1.4—Artificial non-agricultural vegetated areas" excluded from the accessibility assessment thanks to the filter on the maximum percentage of consumed land, such as cemeteries (**a**), sports fields (**b**), highly artificialized squares (**c**), and areas affected by land consumption (**d**).

The dimensional threshold of 0.5 ha allowed us to exclude very small areas from both datasets and was particularly effective on OSM, which maps, for example, small polygons of roads pertaining to vegetation, roundabouts, and flower beds because of its variable minimum mappable unit.

The thresholds reduced the differences between the two datasets in terms of number of mapped areas (the remaining differences concern the different polygon shapes), since at the beginning OSM maps many more small-sized areas than UA and UA includes spaces that cannot be assimilated to GUPSs (which can be eliminated from the start by OSM through an appropriate selection of tags).

Considering the green open public spaces larger than half a hectare (for OSM) and with less than 20% CL (for UA) that fall within the urban area, the GUPSs were obtained (Table 3).

Table 3. Portion of green open public spaces larger than half a hectare (for OSM) and with less than 20% of CL (for UA) that fall within the urban area of the 14 MCs in terms of surface and percentage of MC total surface. UA data are not available for Messina.

	GUPSs			
	OSM		**UA**	
Città Metropolitana	**ha**	**% on Urban Area**	**ha**	**% on Urban Area**
Tourin	1603	6.3	1117	4.4
Genoa	214	2.0	135	1.2
Milan	4208	8.5	3050	6.2
Venice	300	3.4	670	7.6
Bologna	1430	15.4	678	7.3
Florence	776	6.5	510	4.3
Rome	5957	9.6	3222	5.2
Naples	911	1.8	864	1.7
Bari	188	1.3	124	0.8
Reggio Calabria	22	0.4	15	0.3
Palermo	353	2.5	212	1.5
Messina	45	0.7	-	-

Table 3. *Cont.*

	GUPSs			
	OSM		UA	
Città Metropolitana	**ha**	**% on Urban Area**	**ha**	**% on Urban Area**
Catania	88	0.6	64	0.4
Cagliari	264	4.2	153	2.5
Total	16,359	5.6	10,814	3.7

GUPSs larger than half a hectare constitute half of the OSM green open public spaces and approximately two-thirds of those by UA, occupying just under 6% of the urban area for OSM and just under 4% for UA, with a maximum in Bologna in both cases (15.4% for OSM and 7.3% for UA). Accessibility has been assessed in relation to these areas, according to SDG11.7.1 metadata indications.

3.2.2. Identification of GUPS Access Points

The identification of the access points (Figure 6) carried out considering the mapped nodes, the intersection between GUPSs and roads and, in their absence, a point every 100 m, gave the results in Table 4.

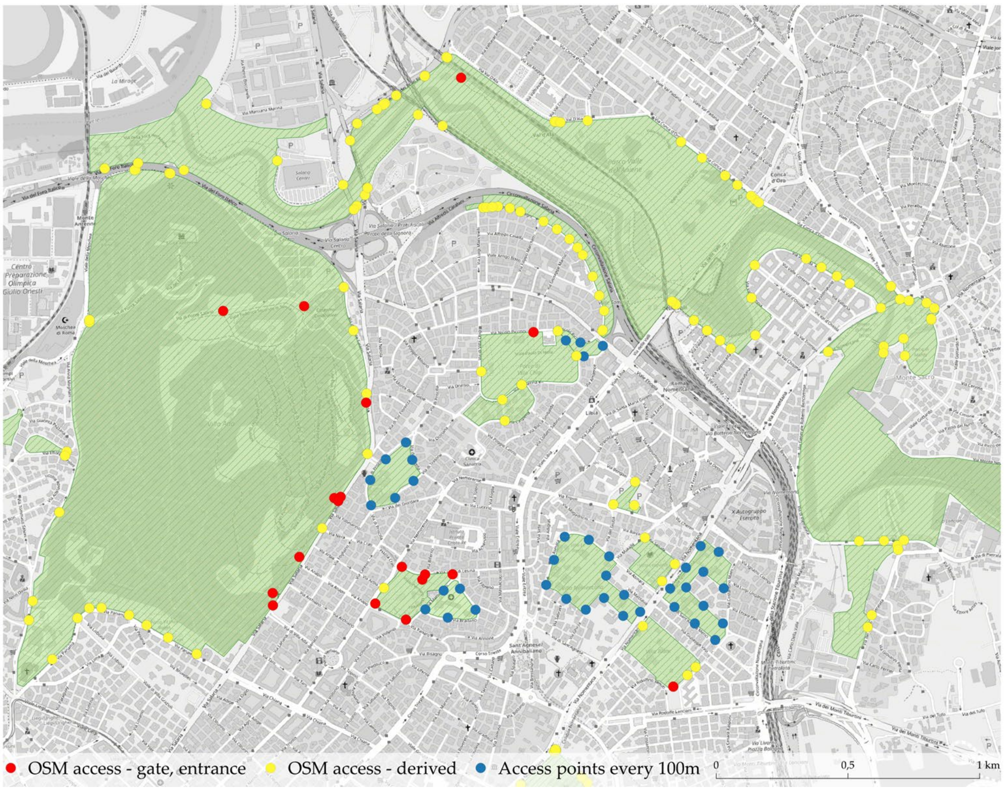

Figure 6. GUPS access points. In red are the access points mapped in OSM, in yellow those obtained by intersection between GUPSs and road network, in blue the points every 100 m along the perimeter. The latter were considered in the absence of the first two for OSM and for all UA GUPSs.

For OSM GUPSs, 35,646 access points were identified, two thirds of which derived from the intersection between GUPS polygons and the road network and less than one in 10 already mapped by OSM as "gate/entrance". For the UA database, only accesses every 100 m along the perimeter were considered.

Table 4. OSM GUPS access points identified considering the mapped points, the intersection between GUPSs and roads, and, in their absence, a point every 100 m.

	Number of Accesses to GUPSs			
MC	**Gate/Entrance**	**Derivati**	**ogni 100 m**	**Total**
Tourin	279	2.718	794	3.791
Genoa	130	569	49	748
Milan	942	8.221	845	10.008
Venice	77	1.263	437	1.777
Bologna	192	4.818	660	5.670
Florence	113	2.147	549	2.809
Rome	729	758	4.429	5.916
Naples	139	1.036	857	2.032
Bari	58	431	258	747
Reggio Calabria	9	129	51	189
Palermo	36	233	139	408
Messina	20	68	81	169
Catania	61	200	201	462
Cagliari	66	674	180	920
Total	2.851	23.265	9.530	35.646

3.3. Evaluation of Accessibility to GUPSs

The evaluation of accessibility to GUPSs starting from the centers of the hexagons in the urban areas produced the results in Figure 7 and Appendix B.

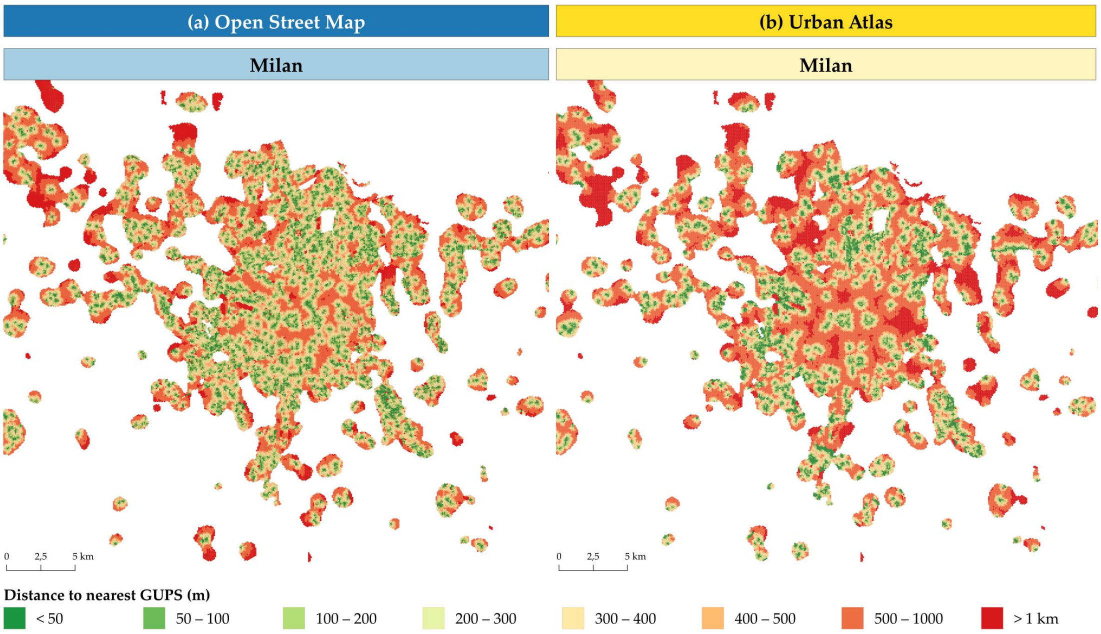

Figure 7. Example of the result of the calculation of accessibility to GUPSs compared to OSM (**a**) and UA (**b**) on the city of Milan. The accessibility mapping for all 14 MCs is reported in Appendix B.

By evaluating the resident population of the hexagons that have access to a GUPS within 300 m (considering the IUCN threshold) and within 400 m (considering the SDG 11.7.1 indicator metadata threshold), the results of Table 5 were obtained.

Considering OSM, approximately 28% of the population living in urban areas has access to a GUPS within 300 m, with values below the national average in Genoa and in the MCs of the south and the islands; the value rises to 40% considering a radius of 400 m. Milan and Bologna guarantee access to an OSM GUPS within 300 m on foot to more than half of the population; to these Turin and Florence are added when considering a maximum distance of 400 m.

Table 5. Number of inhabitants with access to a GUPS within 300 or 400 m from the starting point, with reference to the OSM and UA databases.

	Population That Has Access to a GUPS							
	OSM				**UA**			
	Within 300 m		**Within 400 m**		**Within 300 m**		**Within 400 m**	
MC	**Number of Inhab.**	**% ***	**Number of Inhab.**	**% ***	**Number of Inhab.**	**% ***	**Number of Inhab.**	**% ***
Tourin	590,640	37.9	839,799	53.9	279,268	17.9	420,090	27
Genoa	124,725	19.1	192,809	29.5	103,234	15.8	159,562	24.4
Milan	1,484,951	49.8	1,978,162	66.4	891,384	29.9	1,283,206	43.1
Venice	104,030	28.3	155,779	42.3	75,664	20.6	114,489	31.1
Bologna	318,255	56.6	411,987	73.2	217,860	38.7	289,490	51.4
Florence	247,748	39.6	347,600	55.5	163,729	26.2	239,398	38.2
Rome	994,934	29.4	1,427,518	42.2	738,062	21.8	1,031,376	30.5
Naples	333,286	12.3	514,773	19	469,901	17.3	677,108	25
Bari	193,773	18.8	308,033	29.9	56,421	5.5	86,897	8.4
Reggio Calabria	15,958	6.3	25,114	10	6830	2.7	10,101	4
Palermo	85,910	9.9	133,860	15.4	108,735	12.5	166,965	19.2
Messina	19,836	7	32,444	11.4	-	-	-	-
Catania	58,901	7.3	99,027	12.3	33,929	4.2	54,310	6.8
Cagliari	67,043	19.1	107,180	30.6	77,038	22	117,162	33.4
Total	4,639,989	28.2	6,574,084	40	3,222,055	19.6	4,650,153	28.3

(*) Percentage of population that has access, compared to the total population of the urban area.

The values obtained by considering the UA GUPSs are about 10 percentage points lower than OSM ones, for both 300 m and 400 m radius. Less than a fifth of the population has access to a UA GUPS within 300 m, and even in this case Genoa and the metropolitan cities of the south and the islands (except for Cagliari) show values below the national average. The value reaches just under a third considering a maximum distance of 400 m and only the metropolitan city of Bologna ensures access to a GUPS for more than half of the population.

3.4. Evaluation of GUPSs per Capita

The CLC Plus Backbone total green urban area per capita ranges from 53.2 m^2/inhabitant (Turin) to 91.9 m^2/inhabitant (Rome), with a national average value of just under 75 m^2/inhabitant (Table 6).

Table 6. Total green areas per capita (from CLC Plus Backbone) and public green areas per capita (from OSM and UA) in urban areas.

MC	**Urban Green Spaces**	**UGS per Capita**	**OSM GUPSs per Capita**	**UA GUPSs per Capita**
	[ha]	**[m^2/ab]**	**[m^2/ab]**	**[m^2/ab]**
Tourin	8288	53.2	10.3	7.2
Genoa	5185	79.3	3.3	2.1
Milan	18,534	62.2	14.1	10.2
Venice	3035	82.4	8.1	18.2
Bologna	3862	68.6	25.4	12.0
Florence	5108	81.6	12.4	8.1
Rome	31,110	91.9	17.6	9.5
Naples	21,808	80.4	3.4	3.2

Table 6. *Cont.*

MC	Urban Green Spaces	UGS per Capita	OSM GUPSs per Capita	UA GUPSs per Capita
	[ha]	[m^2/ab]	[m^2/ab]	[m^2/ab]
Bari	5117	49.6	1.8	1.2
Reggio di Calabria	2091	83.0	0.9	0.6
Palermo	5882	67.7	4.1	2.4
Messina	2709	95.3	1.6	-
Catania	6916	86.0	1.1	0.8
Cagliari	2441	69.6	7.5	4.4
Total	122,087	74.3	10.0	6.6

Regarding the availability of green urban spaces for public use, OSM shows values 7 times lower (10.0 m^2/inhabitant), with UA over 10 times lower (6.6 m^2/inhabitant) compared to the total urban greenery.

Bologna has the highest value according to OSM data (25.4 m^2/inhabitant) and it is also the MC with the second highest value for UA data (12.0 m^2/inhabitant), while for UA, Venice is the city with the highest value (18.2 m^2/inhabitant). Only a third of the MCs offer a GUPS per capita value in line with the limit of 9 m^2/inhabitant set as the national urban planning standard, with a minimum in Reggio Calabria and Catania for both OSM and UA.

4. Discussion

This study presents for the first time a large-scale assessment of GUPS accessibility in Italy based on the official UN methodology for SDG indicator 11.7.1. The evaluation is strictly dependent on the availability of adequate input data on starting points, road networks (accessible on foot), green urban areas (to be accessed), and the related access points.

With reference to the starting points, the regular hexagonal mesh grid allows for good coverage of the study area and is easily updatable, replicable, and interpretable. It also offers a more homogeneous representation of the starting points and a more realistic distribution of the population in the urban area, compared to other studies that consider, for example, the centroids of the census section polygons [36]. A more detailed representation would require information on the location of individual residential buildings and their access points, which are however often not easily available or regularly updated. In Italy, data about residential buildings are collected in cadastral databases or in the "national synthesis database" (DBSN), both of which are not always updated and with differences from region to region. As an alternative, the OSM database can be used, but by considering the inhomogeneity of the update of this dataset compared with other official data such as the LCM.

The OSM road network on the 14 MCs is satisfactory except for a few inhomogeneities and omissions that affect the calculation of accessibility in the corresponding hexagons. Actually, the participatory approach underlying the mapping activity in OSM allows for correcting errors in the dataset, which are then validated by the OSM volunteer community [47].

The identification of GUPSs and the related access points are the most critical aspects, both from a geometric and semantic point of view, both for UA and OSM.

From a semantic point of view, the identification of GUPSs requires a good knowledge of the study area in terms of LC and LU. LC information allows for the identification of the vegetated areas and is easily obtainable through remote sensing or existing LC data, while the LU information is necessary to discriminate public and private uses, e.g., internal courtyards of buildings, private gardens, and the green components of street furniture.

The two input datasets show different results in terms of the number and extension of mapped GUPSs; the UA database has temporal, spatial, and semantic homogeneity, ensuring a uniform and standard mapping of green urban areas on the main FUAs, but also includes areas with nothing in common with GUPSs (cemeteries, auditoriums, highly artificial squares, theaters, sports fields, villas, etc.) or previously natural areas where land take has occurred since 2018 (the reference year of the most recent version of the data) and that need to be filtered. For this purpose, the threshold for the percentage of consumed land was introduced. The threshold, defined in this phase for the entire study area, can lead in some cases to an underestimation of accessibility. However, this result, although conservative, can be improved by considering different thresholds in relation to the specificities of the territorial contexts or by introducing ancillary data, such as the census provided by municipalities (which, however, are often not available) according to law 10/2013 "Regulations for the development of urban green spaces" (which was the starting point for valorizing the role of green spaces in cities not only from an environmental point of view but also from a social and cultural one). This activity will be one of the main future developments of this research. OSM is a very powerful tool to support studies that require LU information, especially at a detailed scale and for large territories, thanks to its great versatility, the valorization of information from those who know the territory, and the possibility of implementing even further new information. It also offers higher margins of improvement and refinement than UA in the definition of specific semantics for the assessment of accessibility, thanks to the open approach.

The OSM structure offers many possibilities for representing objects through keys and tags, but currently the description of GUPSs is often too incomplete to be fully used for accessibility assessment. Additional information on the usability of green urban areas should be implemented, e.g., to distinguish open areas with free access from private areas or with restricted, occasional, or paid access. In this sense, the compilation of the "access" and "fee" tags, as already foreseen in the OSM mapping system [39], should be encouraged. In addition, OSM can support the evaluation of cultural ecosystem services provided by GUPSs, since the mappers' in-depth knowledge of the territory provides information on the usability and potential of an area such as esthetic, spiritual, educational, and recreational values. These aspects are linked to the experiential sphere and cannot be deduced through remote sensing or other similar monitoring tools. An example is the activity carried out in the municipality of Rome to evaluate the appreciation of public green spaces by the population through information extracted from social networks [37]. Actually, these considerations would also be useful for the description of the road network, to integrate the mapping criteria by introducing attributes related to the usability of the route, e.g., in terms of perceived sense of safety, presence of obstacles or architectural barriers or slope, an example is the Bike Improver Day initiative in Trento, to collect information on the cycling network in terms of user satisfaction and perception of risk and/or degradation of the infrastructure.

However, the crowdsourcing population of the OSM database introduces critical issues related to the homogeneity of the mapping, from a thematic and geometric point of view, to be considered when reading the data. The variable minimum mapping unit and the GUPS definitions affect the shape of the polygons and the attribution of tags, which depend greatly on the sensitivity of the operator, leading to results that are often inconsistent or misleading.

Figure 8 shows some of the main critical issues encountered in the analysis of the OSM "park" and "garden" tags, which affect the accessibility assessment. In some cases, roundabouts or avenues are mapped as "parks" (Figure 8a,b) that have trees but do not have characteristics that would make them GUPSs. In other cases, both areas open to the public and private gardens or spaces with public access restrictions are mapped with the same "tag" (Figure 8c,d). A further critical issue is the lack of homogeneity in the mapping of some green areas, which are partially or incompletely delimited.

The choice of selecting polygons with a minimum size of 0.5 hectares allows for the exclusion of areas from the calculation that generally are not GUPSs (especially roundabouts, green furnishing, or green courts); this threshold had a greater effect on OSM, while it had less impact on UA, which has a MMU similar to the threshold.

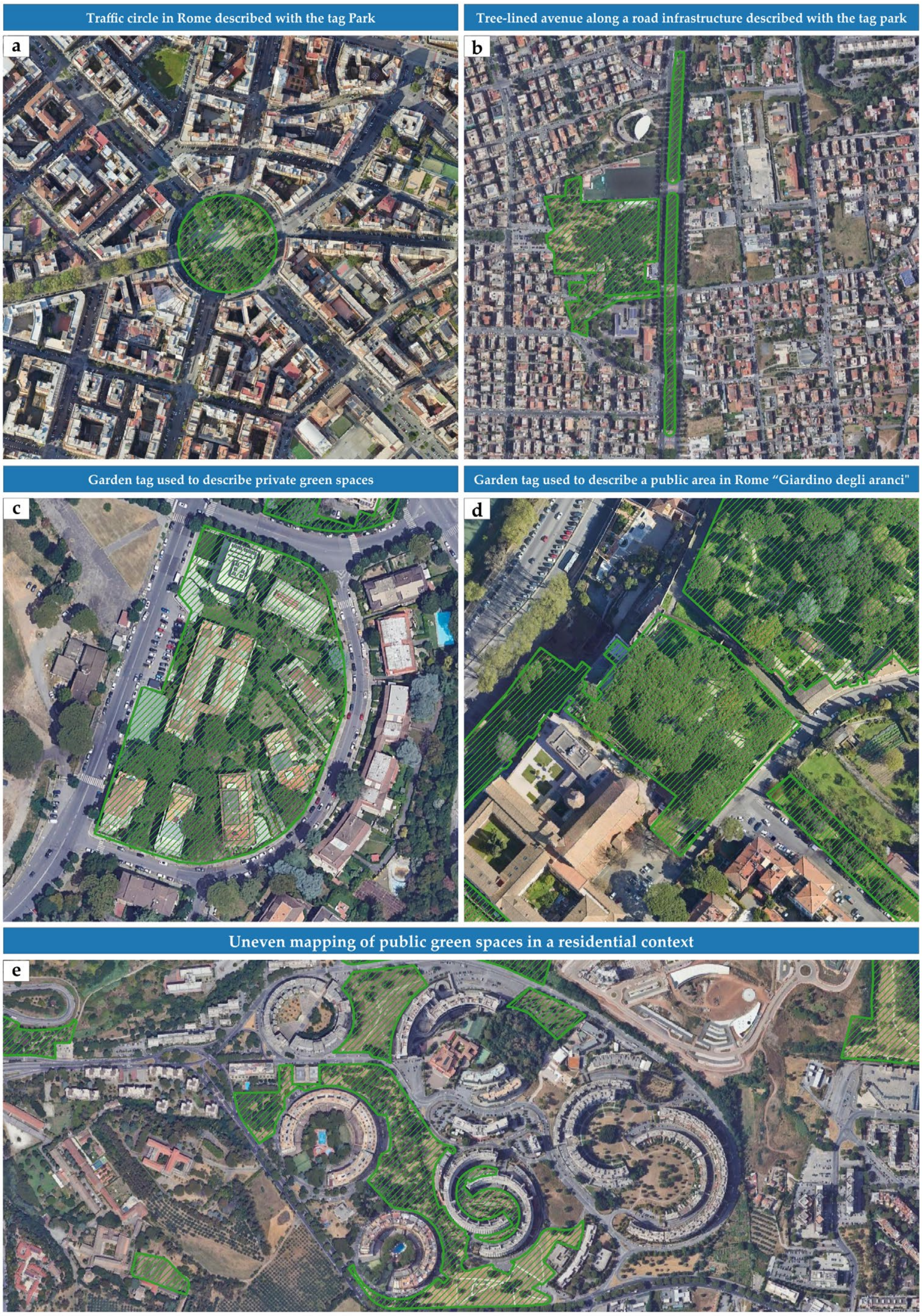

Figure 8. Examples of mapping in the OSM data (identified in the figures with green polygons) that influence the accessibility assessment.

Overall, both datasets show limitations and potential for GUPS identification, although OSM appears more promising, especially in identifying access points and in evaluating the actual possibility of access. The homogeneity and standardization of UA make it appear as a perfect dataset for the assessment of accessibility; however, the rigid definition of green urban areas provided by the class "1.4—Artificial non-agricultural vegetated areas" (which forces the identification of a strategy and/or ancillary data to filter non-GUPS areas, such as cemeteries and sports fields), the reduced update frequency (which causes losing track of areas that have changed in the meantime, for example, due to land take), the limited spatial coverage (available only for European FUAs with at least 50,000 inhabitants), and the absence of information on accesses (which forces the definition of fictitious accesses) strongly condition the identification of GUPSs. OSM, despite having greater heterogeneity in the quality of the mapping, offers a much wider spatial coverage and greater possibilities of interaction with the data thanks to the open approach, with the opportunity to introduce tailor-made mapping criteria for the needs of accessibility assessment.

The information on access points is partial on OSM and not provided by UA. The introduction of derived points has allowed us to reduce the number of polygons without accesses; however, the mapping of these entities should be encouraged, and are essential to evaluate the accessibility of a GUPS.

In the case of UA, the introduction of fictitious accesses every 100 m may have led to an overestimation of accessibility, especially in green areas with a limited number of accesses (for example where the perimeters of green areas have fences or surrounding walls). On OSM, the overestimation of accessibility is more limited and may only affect polygons for which access information is not natively provided or where such information could not be derived by cross-referencing the GUPSs with the road network.

The availability of adequately spatialized and updated demographic data is a further element that greatly affects the evaluation of accessibility, since it determines the distribution of the population around the GUPSs. In Italy, the ISTAT census sections data are a valid support for the spatialization of the population, but the update frequency (10 years) conditions the monitoring. The municipal population data are updated annually and are spatializable (on the residential buildings of the LCM), even if they do not allow for consideration the uneven distribution of the population within the municipality. To improve the distinction of residential buildings from the rest of the construction, ISPRA has started a classification activity of the land use of consumed land [48,49], allowing for the methodology to free itself from input data coming from heterogeneous sources and valorizing the knowledge of the territory of the regional agencies (ARPA).

The tools analyzed in this research are an important starting point for conducting assessments related to the accessibility of open public spaces in urban areas, which is essential, especially considering the obtained results. In this sense, developing monitoring tools to observe territorial dynamics in detail is an essential prerequisite for defining effective actions and initiatives. Furthermore, tools of this type are essential to respond to institutional requests in a technically adequate way, first and foremost the monitoring of accessibility to public urban greenery envisaged by the UN and the 2030 Agenda for Sustainability.

Analyzing the results, in the urban areas of the 14 MCs, less than one person in three has access to a GUPS within a 300 m walking distance (less than one in five for the UA data), and in 9 of the 14 metropolitan cities, the availability of GUPSs per capita is less than the 9 m^2/inhabitant required by the Urban Standards Law [50]; in fact, even if the total greenery in the urban area is an order of magnitude higher than the GUPSs, this also includes non-usable areas, such as roundabouts, green areas pertaining to infrastructures or street furniture, private agricultural areas, and green areas of private gardens. Moreover, significant differences are noted between cities in the north and center compared to those in the south and on the islands, which show the lowest values of availability and accessibility to GUPSs regardless of the input data (OSM or UA).

The results obtained on the availability of GUPSs are consistent with what emerges from the European plan NextGenerationEU, which allocates more than half of the funds foreseen for Italy for new forestation interventions to the MC of the south and the islands, of which implementation in urban areas can increase the presence of configured public areas (similar to GUPSs) and which can contribute to improving accessibility and the provision of multiple other recreational and regulatory ecosystem services in urban context.

In this sense, this research aims to have practical value, and to offer a series of useful tools to support policy makers in achieving the legal objectives imposed by the UN SDGs or in managing the financing of forestry projects envisaged by the PNRR, e.g., in identifying priority areas for new interventions, but also to support the development of restoration plans envisaged by NRL. For this purpose, methodologies officially adopted by the main regulatory instruments that deal with urban areas and urban greenery (NRL, the SDGs, the PNRR) have been considered, operating on two fronts: firstly, by providing an accessibility mapping in line with the legislation, directly usable for the identification of critical areas or priority areas of intervention; then, analyzing and evaluating the limits of the data currently available to achieve a representation closer to reality.

These limitations have mainly affected the mapping of GUPSs and their access points while the mapping of the road network is satisfactory, and the new population data for census sections offer great added value to producing detailed spatialized demographic data for Italy, useful for the representation of the urban area in line with the legal indications.

The reflections reported in this work are, however, perfectly valid in all areas covered by OSM and UA. This research concerned the urban area of the 14 Italian MCs, but the evaluation can be extended to other areas of the Italian territory or to the entire national territory, thanks to the coverage of the population grid (spatialized by the ISPRA starting from ISTAT 2021 data) and the OSM data (relating to the representation of the road network and green areas). The global coverage of OSM data makes it possible to extend the considerations presented in this work relating to the road network, green areas, and access points to even outside of the European territory, while the spatialization of the population (and, consequently, the representation of the urban area according to DEGURBA) require the availability of reliable and updated demographic and residential building data. In this sense, the CLMS high-resolution layer data allow for the exact replication of the spatialization of the population on any area of the European territory for which population data are available. Alternatively, for non-European areas, it is possible to use the world population grid or the Eurostat DEGURBA layer, which offer global coverage, albeit with a spatial resolution of 1 km.

5. Conclusions

The availability of timely and detailed information on the presence, characteristics, and accessibility of GUPSs is a crucial element in defining policies and initiatives for the management of urban areas for the near future [51]; this is with a view to increasing the resilience of settlements to extreme climate events, improving the quality of life of citizens, and maximizing the provision of ecosystem services provided by GUPSs.

The crucial importance of the correct management of urban areas is also evident considering the recent approval of the NRL, which establishes a halt to land consumption in urban areas and requires EU member states to develop a monitoring plan for urban green areas based on Copernicus or national data. Urban greenery is also at the center of national initiatives, such as the VeBS project (the good use of green and blue spaces for the promotion of health and well-being) [52], supported by the Ministry of Health and coordinated by the Istituto Superiore di Sanità with the participation of the ISPRA, which promotes the use and benefits of green and blue infrastructures in urban areas and protected areas.

This research is a part of the ISPRA activities on land consumption monitoring and urbanization dynamics in Italy [42]. It explores, for the first time, the feasibility of a large-scale evaluation of accessibility to GUPSs, based on freely accessible data at European (UA) and global (OSM) scales and following the UN methodology for the calculation of SDG indicators. Actually, the accessibility to GUPSs shown in this work is one of the three components of the SDG indicator 11.7.1, together with access to gray and blue infrastructures. The complete calculation of the indicator is one of the main and upcoming developments of this research activity, which is, however, an important step in monitoring the sustainable development goals required by the 2030 agenda.

This study proposes a technical analysis on spatial data available for the entire European territory (UA) and at global level (OSM), considering their aptitude to identify GUPSs, their access points, and road infrastructure. It therefore constitutes an important starting point to support further studies of this nature on different territorial realities and to support the improvement of currently available crowdsourcing products, such as OSM. The workflow is scalable and replicable on all the main national and international urban contexts, and the intermediate products, such as the population grid or the perimeter of urban areas [15,42], are freely accessible and usable for conducting further studies.

For example, the population grid finds application in the improvement of the methodology developed by Deda Next within the Horizon Europe project "USAGE", which works on datasets at different scales, from the local (city) to the national and European level. In addition to the introduction of orography in the calculations of walkability through digital terrain models (DTMs) from different sources and with different accuracies, the national population dataset is halfway between local-level applications (successfully carried out on the Municipality of Florence), and implementations on global-level data (on a GHSL basis for the population and OSM for addresses and buildings).

The tools and observations developed in this research can also support other types of analyses, such as the link between access to greenery, climate comfort, and risks associated with the UHI phenomenon or territorial inequalities between urban areas with different income capacities. The analysis of the representation and classification of GUPSs also provides interesting insights to support the monitoring of these areas even beyond the assessment of accessibility, for example, as an ancillary indicator for compliance with the regulatory obligations of the Nature Restoration Law on the protection of green areas in urban contexts.

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Data Availability Statement: The datasets presented in this article are not readily available because the data are part of an ongoing study. Requests to access the datasets should be directed to the corresponding author.

Conflicts of Interest: Author Piergiorgio Cipriano was employed by the company Deda Next Srl. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Appendix A Selection of Suitable Green Spaces

Table A1. For the territory of each of the 14 MCs, the following are shown: the areas mapped with the "Garden" and "Park" tags by OSM (in terms of total number of patches, number of patches with an area greater than half a hectare, and their total surface area) and areas classified as "1.4—Artificial non-agricultural vegetated areas" by UA (in terms of total number of patches, number of patches with consumed land <20%, and their total area). OSM = OpenStreetMap, UA = Urban Atlas, CL = consumed land.

MC	OSM Patches			UA Patches		
	Count (Total)	Count (>0.5 ha)	Surface (ha) (>0.5 ha)	Count (Total)	Count (CL < 20%, >0.5 ha)	Surface (ha) (CL < 20%, >0.5 ha)
Tourin	2990	624	2089	1808	594	1865
Genoa	636	108	235	442	129	248
Milan	4449	1380	4721	2217	877	3813
Venice	1238	336	854	981	256	670
Bologna	1913	1002	3623	787	411	1151
Florence	926	273	776	801	305	763
Rome	2924	765	5957	2847	1000	4892
Naples	3620	340	6694	1455	468	985
Bari	1114	151	281	624	104	200
Reggio Calabria	397	41	55	178	21	64
Palermo	436	74	425	551	137	302
Messina	497	41	96	-	-	-
Catania	2306	85	288	365	78	111
Cagliari	513	113	7516	365	146	314
Total	23,959	5333	33,610	13,421	4526	15,378

Appendix B Accessibility Maps to GUPSs in MC According to OSM and UA

From Figures A1–A4. The results of the accessibility evaluation with respect to the GUPSs mapped by OSM and UA are reported for the remaining 10 MCs not shown in Figure 7.

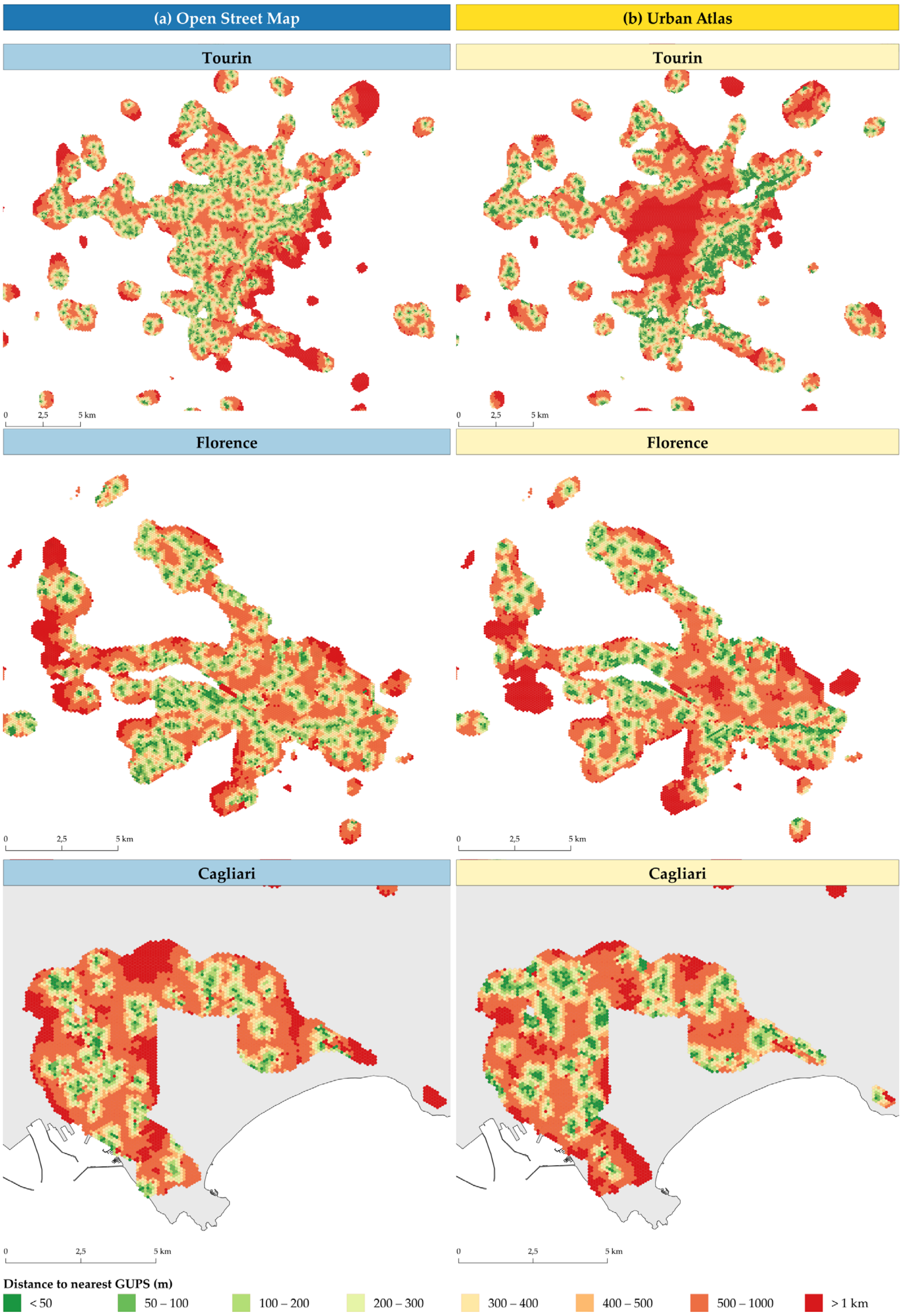

Figure A1. Accessibility to GUPSs compared to OSM (**a**) and UA (**b**) in the cities of Tourin, Florence, and Cagliari.

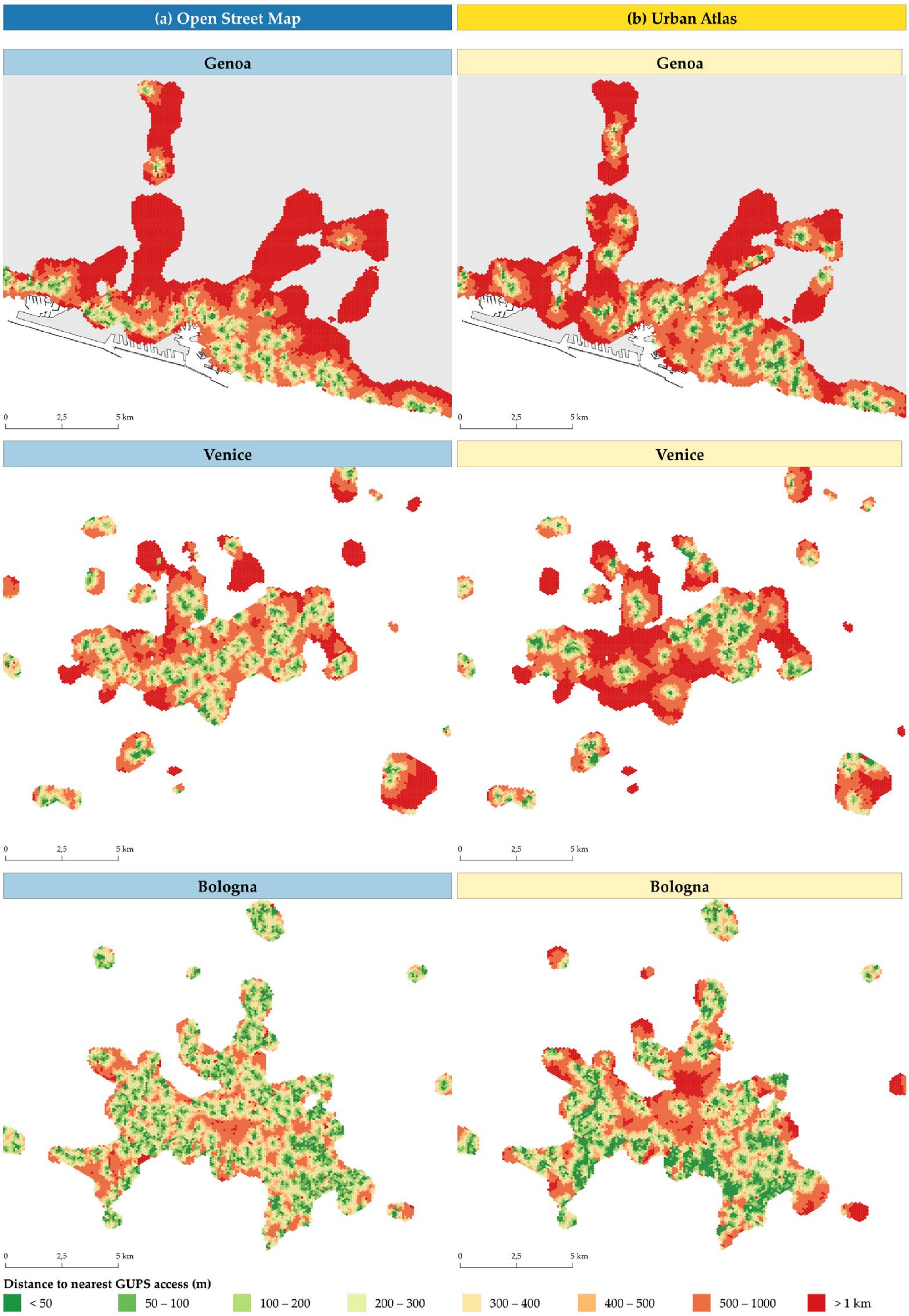

Figure A2. Accessibility to GUPSs compared to OSM (**a**) and UA (**b**) in the cities of Genoa, Venice, and Bologna.

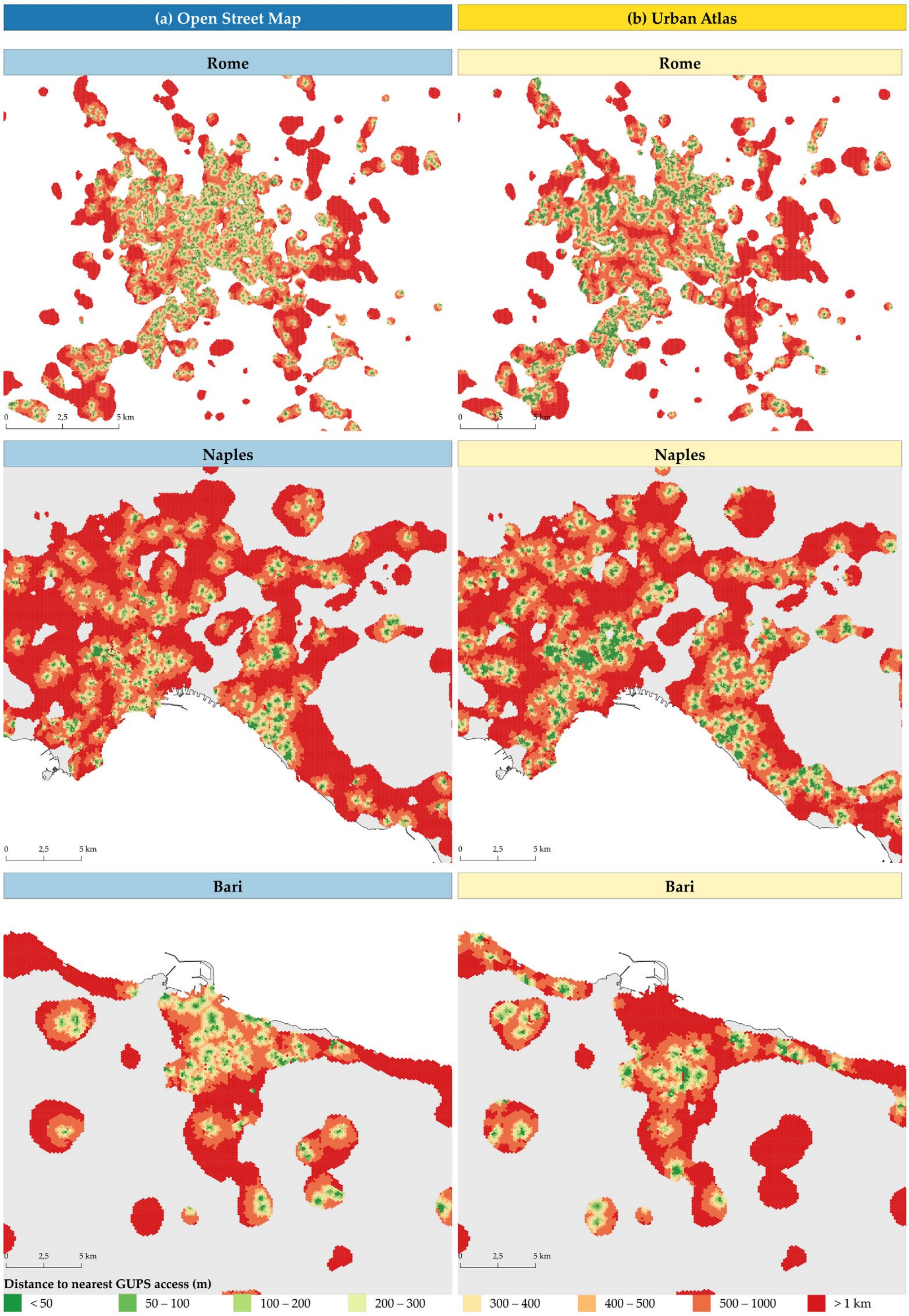

Figure A3. Accessibility to GUPSs compared to OSM (**a**) and UA (**b**) in the cities of Rome, Naples, and Bari.

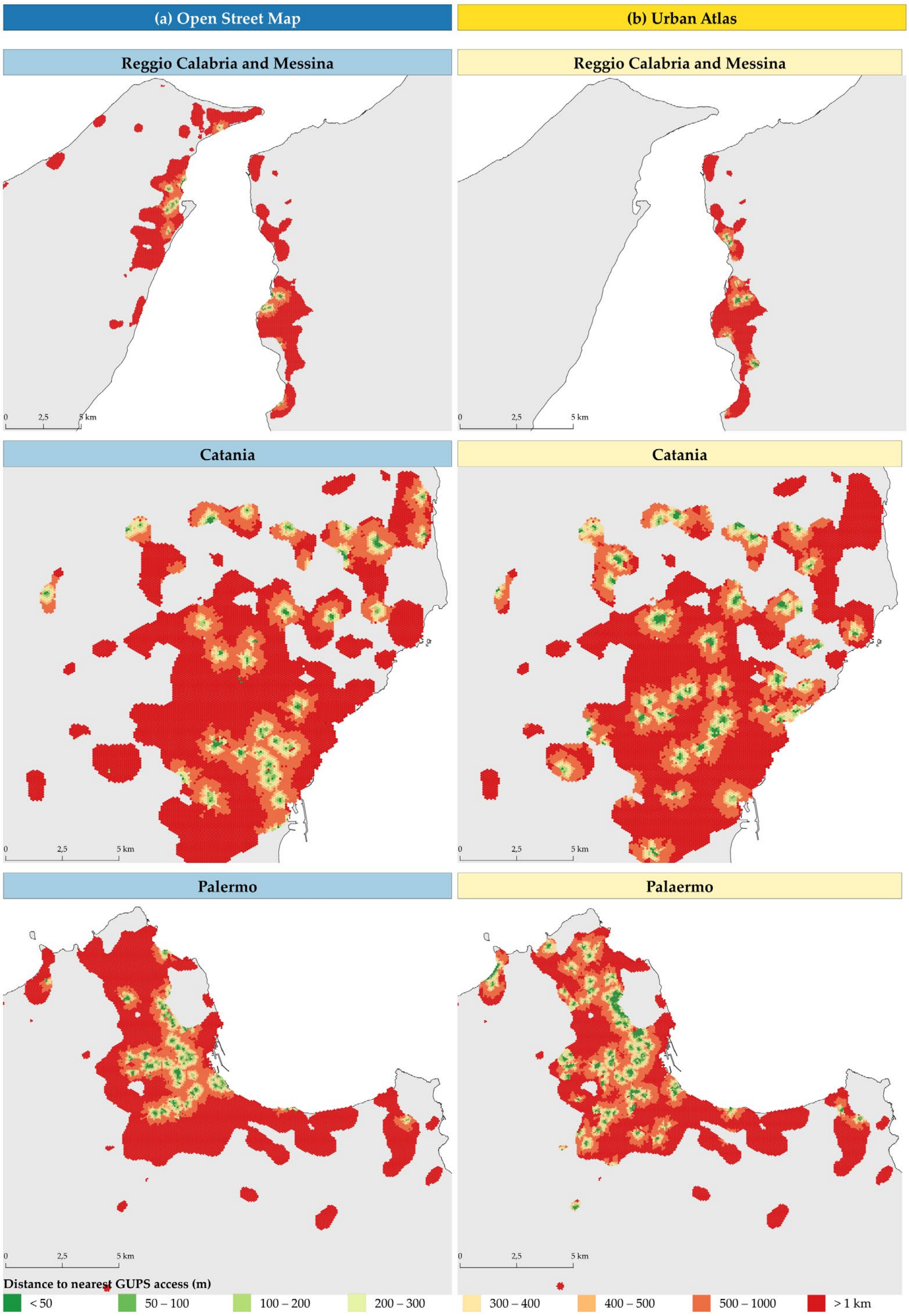

Figure A4. Accessibility to GUPSs compared to OSM (**a**) and UA (**b**) in the cities of Reggio Calabria, Messina, Catania, and Palermo.

Notes

1 The fictitious sections are introduced to allocate people without an official address, such as homeless people registered in the registry and allocated to a conventional address established by the municipality, individuals registered in the registry at associations or reception facilities, or residents in municipalities affected by seismic events.

2 The "Gate" tag indicates the presence of physical barriers such as doors or gates.

3 The "Entrance" tag is used to describe the point at which it is possible to enter a building or an enclosed area, in the absence of a physical barrier.

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