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Using Maps to Boost the Urban Proximity: Analysis of the Location of Public Facilities according to the Criteria of the Spanish Urban Agenda

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Abstract: Developing analysis models that promote the sustainability, compactness and social balance of cities is particularly important in addressing post-pandemic urban planning. In this context, the population's proximity to public facilities is essential for achieving these objectives. Based on this framework, this paper analyses the city of Valladolid (Spain) under the criteria of distance between the population and public facilities proposed by the Spanish Urban Agenda. Specifically, the focus is on calculating the coverage of population with access to the facilities within the recommended distance thresholds using GIS techniques. The methods used relate the facilities with the distance to the population in the census sections, a highly detailed statistical unit. The results have been mapped as a decision making support tool for the city, and show how general coverage of access to facilities for the urban area as a whole is adequate, especially in terms of public transport services, and meets the recommendations of the Spanish Urban Agenda. Maps also reveal how some areas of the city are not covered by most public facilities.

Keywords: post-pandemic city; Spanish Urban Agenda; public facilities; maps; Valladolid

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1. Introduction

COVID-19 is fundamentally an urban crisis, since cities have been among the main contributors to the spread of the virus [1], concentrating almost 90% of cases and epicentres of the disease [2]. At the same time, cities are the places most affected by the pandemic, which has had an unequal impact on the population, as the risk is greater for more socio-economically vulnerable groups, areas and communities [3].

Given that cities are currently home to more than half the world's population, account for a large part of the economic activity and are responsible for most greenhouse gas emissions [4], post-pandemic urban planning is of particular relevance to international policy agendas. In this context, the concept of the 'post-pandemic city'—focused on creating a better city under a more egalitarian, sustainable and resilient society—has emerged with special force, while trying to return to pre-pandemic 'normality' [5,6], even considering the situation of the constant uncertainty of cities [7]. In other words, urban development needs models such as Mill's theory of economic development, which involves addressing the relationship between human and natural capital [8].

Just as other diseases have driven major urban transformations throughout history, COVID-19 is an opportunity to propose and experiment with transformative strategies and actions to create fairer and more resilient and sustainable cities [9]. In this respect, planners and academics are reflecting on whether the pandemic represents a real turning point towards a radical change in contemporary urban planning [1,10] as the urban models for this transition are still under discussion [11]. In this sense, it is essential to know the feelings and perceptions of the population about public services to address better city planning [12]. Prior to the pandemic, urban planners widely recommended sustainable and smart-city models as alternative solutions to various urban problems [13]. Now, the socio-spatial effects of the pandemic require lines of intervention aimed at healthy, sustainable and resilient cities, although the opposite models are also gaining momentum, driven by neoliberal dynamics that point towards sprawling, disperse and low-density urban models due to the sense of safety they apparently offer compared to greater urban density and compactness. In this sense, urban proximity environments are gaining interest in urban policies and are currently a key issue to achieve more sustainable cities. For this reason, this paper will expand into a greater reflection on this issue because the gap between academia and policy design has been bridged recently. There are different approaches to assess urban proximity (to transport facilities, green areas, hospitals, etc.), but there is a lack of examples that appraise whether the official technical guidelines (based on policy documents) are adequate. Consequently, urban planning allows cities to focus their urban model on improving citizens' quality of life and wellbeing. To achieve this goal, an adequate location of public facilities and services is paramount. These facilities are conceived as agents of social cohesion and are integrating elements with the ultimate aim of providing equal opportunities without distinctions based on income level or social group [14]. For example, Sustainable Development Goal (SDG) 11, 'Sustainable Cities and Communities', through the approach of making cities inclusive, safe, resilient and sustainable, includes among its specific objectives the provision of universal access to safe, inclusive and accessible, green and public spaces [15]. In this regard, UN-Habitat is working with national and local governments to help them prepare for, prevent, respond to and recover from the COVID-19 pandemic. Specifically, the UN-Habitat COVID-19 Response Plan aims to provide urban data, evidence-based mapping and knowledge for informed decision making [16].

Recovering Jane Jacobs' approach to the city [17,18] or the '15-min city' are examples of post-pandemic urban planning [19–21], which prioritises achieving adequate proximity and accessibility to public facilities in urban redesign as it minimises motorised traffic and improves the quality of life of the population. Nevertheless, research has shown some limitations apply to the '15-min city' model. Although its advantages are evident, in many cases we observe the difficulties in deploying this urban model [22–25]. For this reason, the facilities available in cities should be reviewed, their spatial distribution analysed and their distance to the population estimated in order to determine whether they are really useful and meet the proximity goals set out in the current urban policies. The role of the state policies to promote the transition to post-pandemic cities is essential; this is specified in Section 1.1 for the case of Spanish cities. In this framework, the capacity for analysis of Geographic Information Systems (GIS) and representing results using thematic mapping are of great importance to facilitate the transmission of information and strengthen decision making [26].

This paper analyses and maps in detail the distribution of the public facilities in the city of Valladolid (Spain) based on the availability and accessibility criteria established by the Spanish Urban Agenda (hereinafter 'the AUE', for its acronym in Spanish), a state policy aimed at promoting sound decision making in urban policies to make cities more sustainable and inclusive. The GIS analysis combining population data and the location of facilities makes it possible to determine the level of coverage of the facilities for potential users and, with this, to establish whether they are accessible and to assess their role in the city. In this respect, the level of coverage is interpreted as a simple accessibility value, understanding the concept of accessibility as the ease of reaching a destination from other points of origin in the territory, which summarises the opportunities for contact and interaction between certain origins and destinations [27]. Before reviewing the accessibility of facilities and their impact on the city, this paper evaluates the two different methods for analysing accessibility between population and facilities. This is an interesting exercise for post-pandemic urban planning in general and the results are useful for making urgent decisions to address the recovery of the city of Valladolid after the pandemic crisis. At the same time, it is a good example of how to plan a real city on the basis of policies that are being proposed from the technical and governmental spheres. However, and as will be seen in the Results section, it is difficult to achieve proximity environments for all public facilities. Nevertheless, the cartographic results allow us to identify the urban spaces where the improvement of the provision of facilities should be prioritized. Previous research has been studied for other Spanish cities, using maps to appraise proximity and urban conditions from academic or theoretical perspectives [18,22], but in this paper it is done through the guidelines established in the AUE.

Considering this context, the paper has been organised as follows: Section 1.1 presents the AUE as a model for the urban planning of Spanish cities in the post-pandemic framework; Section 1.2 describes the main characteristics and the urban model of the city of Valladolid as a case study; Section 2 features the data and methods used; Section 3 compiles the results; Section 4 serves as the discussion; and, finally, Section 5 contains the conclusions of the paper and lines of future work.

1.1. The AUE: Execution of the Agenda 2030 and the Urban Agenda for the European Union

In 2015, after a long participatory process, the member states of the United Nations approved the 2030 Agenda for Sustainable Development. This agenda defines a plan of action with a 2030 horizon for people, the planet and prosperity and bases its fundamental objectives on strengthening universal peace and access to justice [28,29]. Seventeen Sustainable Development Goals (SDGs) that replace the former Millennium Development Goals were established to implement the proposed actions. Additionally, the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) held in Quito, Ecuador, in 2016, adopted the New Urban Agenda, which represents a shared vision for sustainable development through urbanisation [30].

Following concurrent planning, an action plan was approved at the European level favouring the alignment of urban areas with the principles proposed by the 2030 Agenda and the New Urban Agenda. Thus, in 2016, the Urban Agenda for the European Union emerged, a document that the EU institutions, national governments, local authorities and stakeholders must implement through the development of a coherent set of actions that strengthen the urban acquis in national and European policies [29,31]. The 2030 Agenda and the Urban Agenda for the EU agree on the obligation to promote better regulation, easier access to funding and increased knowledge sharing on relevant issues for cities [31].

The AUE was established in 2019 to respond to the different international commitments signed by Spain [32]. The AUE is a government proposal to help make more sustainable and inclusive urban-policy decisions, based on a global and systemic vision and underpinned by multi-stakeholder collaboration [29]. The AUE was established following a long participatory process; it is a strategic, non-binding document and, therefore, voluntary. It also constitutes a working methodology and a process for all city stakeholders who seek equitable, fair and sustainable development [33].

The AUE offers a Decalogue of Strategic Goals (Table 1), which are further defined into 30 specific objectives and 291 action plans. These can be applied to any urban settlement regardless of its size, under the premises of economic, social and environmental sustainability. Although the AUE was designed prior to the pandemic, its content is fully consistent with the urban planning guidelines for the post-pandemic city.

Table 1. Strategic goals of the Spanish Urban Agenda. Source: AUE, 2019.

Strategic Goals of the Spanish Urban Agenda
1. Land-use planning and rational land use, to conserve and protect it
2. Avoid urban sprawl and revitalise the existing city
3. Prevent and reduce the impact of climate change and improve resilience
4. Manage resources sustainably and promote the circular economy
5. Promote proximity and sustainable mobility

6. Foster social cohesion and seek equity
7. Promote and favour the urban economy
8. Ensure access to housing
9. Lead and foster digital innovation
10. Improve intervention instruments and governance

Source: AUE, 2019.

All the strategic objectives established by the AUE are related to SDG 11, which aims to make cities more inclusive, safe, resilient and sustainable [15] and to ensure access to adequate housing and basic services by increasing inclusive and sustainable urbanisation.

Within this framework of action, and following the standards set by the AUE, the work focuses on the second strategic objective of avoiding urban sprawl and revitalising the existing city—in particular, its first specific objective: 'to define an urban model that promotes compactness, urban balance and the provision of basic services' [33]. This indicator analyses the percentage of the population close to the main basic services and its monitoring provides information on the degree of urban integration, thus facilitating the occupation and transformation of the land in accordance with sustainable development models.

1.2. Case Study: The City of Valladolid (Spain)

The city of Valladolid is located approximately in the geographic centre of the northwestern quadrant of the Iberian Peninsula (Figure 1). It is the political capital and the most populated city of the autonomous community of Castilla y León (Spain). With a surface area of 197.9 km^2 and a population of 299,370 inhabitants in 2021—according to Valladolid City Council's information service—its population density is 1512.7 inhab/km^2. As a result of the recent demographic growth of the city, it accounts for 57.5% of the total population of the province and 12.5% of the autonomous community. Valladolid ranks thirteenth among the most populated cities in Spain according to the Spanish National Statistics Institute (INE, for its acronym in Spanish), although it is classified among Spanish 'medium-sized cities' [34–36], which is why its study is interesting as an example for the urban planning of this type of city.

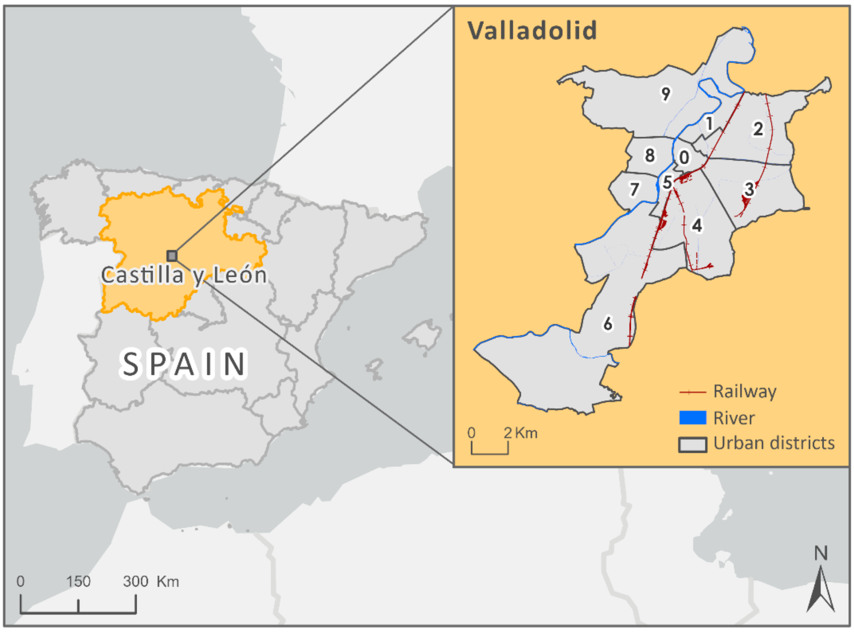

Figure 1. Location map of Valladolid. Authors' own elaboration.

Valladolid, as with other Spanish cities, has benefitted from the process of administrative decentralisation, which has mobilised a considerable amount of resources and personnel over the past 30 years [37]. In this context, the city has undergone important urban transformations, such as the creation of new neighbourhoods on the outskirts—where the younger population has settled—or a generalised ageing of the population in a large part of the centre [38]. The new urban fragments of accelerated development, of mid to low density, consolidated in the first years of the 21st century, a period characterised in Spain by an exceptional transformation of the urban and built space [35]. In the case of Valladolid, this transformation is paradigmatic among Spanish cities [38].

Today's city comprises 41 neighbourhoods grouped into 10 urban districts and its city landscape is the result of intense urban transformations that took place during the 20th century. The bourgeois area expanded towards the south—the only direction with no physical barriers—since the west is limited by the Pisuerga River, the north by the Esgueva River basin and the east by the railway [35]. These physical barriers determined the location of the working-class neighbourhoods, mostly in the east, which led to situations of socio-spatial segregation that still exist today, for example in the neighbourhoods of Barrio España and Las Delicias. These neighbourhoods located in the east of the city (districts one, two, three and four) have very low average household incomes, between 13,000 and 25,000 EUR per year and concentrate a large proportion of foreigners and unskilled workers according to Spanish National Institute of Statistics data. The recent urban growth has tended to fill existing voids with new urban developments, while, at the same time, measures have been taken to provide services to the peripheries and to improve connections between the neighbourhoods separated by the railway [35]. Additionally, new neighbourhoods have sprung up on the right bank of the river (districts seven, eight and nine) and in the south (district six) [38], attracting a young population with a higher income than those on the eastern side. The residents of this area of the city, next to the historic centre (districts zero and five), have the highest income levels. Many census sections exceed 50,000 EUR per household per year. In brief, there is a huge east–west gradient inequality, accentuated by the historical physical barriers that have been consolidated today and that act as an element of marginalisation and segregation.

2. Materials and Methods

2.1. Data Acquisition, Selection and Filtering

The spatial analysis of the facilities in Valladolid and the determination of the level of coverage of the population were based on georeferenced information (in vector SHP files, Table 2) provided by Valladolid City Council and implemented in a GIS (*ArcGIS 10.7.1*). The City Council also provided a data file containing the population of each district and census section of the city by five-year age groups.

The study could not be conducted at a higher level of detail, given that the most disaggregated scale available corresponds to the census sections. The spatial resolution of these units makes them particularly appropriate for the mesoscale study of urban matters [39]. However, having data at other scales (blocks) would have meant having information units capable of diagnosing urban problems with much greater precision than by census section or district [40].

Table 2. Information used and its origin.

Vector Layer (SHP)	Spatial Resolution	Source
Urban districts	150,000	Urban Cartography and Information Service (Valladolid City Council)
Census sections	150,000	Urban Cartography and Information Service (Valladolid City Council)
Municipal services	25,000	Urban Cartography and Information Service (Valladolid City Council)
Health facilities	25,000	Spatial Data Infrastructure of Castilla y León
Selective waste collection points	25,000	GIS portal of Valladolid City Council

Source: AUE, 2019.

To quantify the number of inhabitants covered by the facilities, the population data were incorporated into the census sections layer, while the information in the municipal services layer was filtered, keeping only those services that the AUE considers as basic.

2.2. Methodology Proposed by the Spanish Urban Agenda

The AUE has a system of indicators defining the optimal distances of the population to the services and facilities, which makes it possible to determine the proximity of the population to these. In total, eight basic types of facilities were used and classified by the kind of service they provide, in agreement with the classification of the AUE (Table 3).

Table 3. Basic services and considered optimal distance.

Basic Service	Formed of	Distance (Metres)
Food	Municipal markets	500
Educational facilities	Infant and primary education centres, Secondary education centres	300, 500
Health facilities	Health centres, hospitals	500, 1000
Social facilities	Social action centres, senior citizen centres, neighbourhood associations, immigration assistance, care and assistance services, soup kitchens	500
Sports facilities	Sports centres, stadiums, swimming pools, sports grounds	500
Cultural facilities	Libraries, civic centres, citizens’ initiative centres, cinemas, theatres	500
Waste collection points	Paper, glass and oil containers	100
Public transport	Urban bus stops	300

Source: AUE, 2019.

The distance considered for public transport stops is the result of the latest update of the AUE (September 2021) regarding descriptive data, and enables an approach to the current urban situation by integrating tools that cities may use to make their own decisions and thus meet the objectives set out in the Agenda.

Although the AUE considers the cultural category—libraries, museums and other cultural centres—and the entertainment category—cinemas, theatres and other leisure centres—separately, in this study, cinemas and theatres have been grouped under the cultural facilities category.

2.3. Selection Process by Location and Possible Methods

Once the basic facilities to be analysed and the distances to each of them were defined, the number of inhabitants they served was calculated using the census sections as a basis. The ‘Select by Location’ tool was applied for this purpose: the target layer consisted of sections with population and the source layer consisted of the location of facilities, that is, municipal services. Each category had been previously selected from the source layer so that the selection by location was conducted only on the selected facilities. As a result, only the census sections that met the standards established in the ‘Select by

Location' tool were selected. Finally, the last step consisted in applying the previously defined search distance corresponding to each category (Table 3).

The 'Select by Location' tool can be applied using two different methods:

- Method A: the target-layer entities are within a distance of the source-layer entity. This option creates a buffer with the indicated distance around the source-layer entities (the facilities) and selects all entities (all the census sections intersecting these buffers).
- Method B: the target-layer entities have their centroid location in the source-layer entity. This option selects an entity from the target layer (the census sections with population) when the centroid of its polygons is within the defined distance from the source entity (the facilities).

In order to determine which selection method is more suitable for the subsequent analyses, two of the facilities studied and the mapped results obtained by both methods are shown as an example (Figure 2).

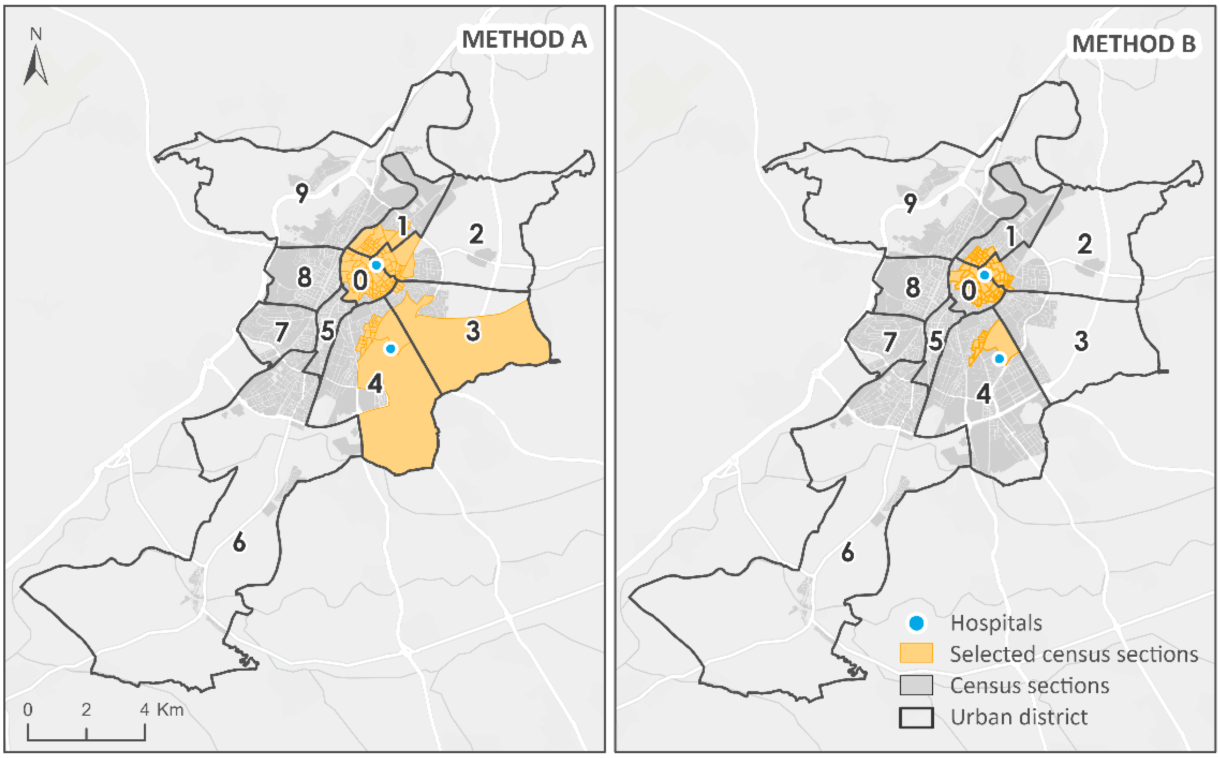

Figure 2. Comparison of selection (**Methods A**) and (**Methods B**). Authors' own elaboration.

Figure 2 shows that method A selects a larger number of census sections, while method B is more restrictive. In the example, method B is based on the distance from hospitals to the centroids of the census sections. The hospital in the southernmost part of the city is located in a large census section that is not selected, as its centroid exceeds the established distance of 1000 metres to the facility. However, it is clear that the hospital serves the population of this census section, so this method loses reliability in large and irregularly shaped polygons.

For the quantitative analysis, the data of the census sections that meet the conditions of distance to the facilities defined above have to be extracted. The process consists in using the statistics of each of the 20 columns in the table of attributes of the census sections with the population data by five-year age groups and by census section to transfer the sum of the age ranges to a macrotable. The aim is to know the total population of each age group covered by each facility category. This process is applied to the two methods described above and helps in selecting the most appropriate one.

The five-year age groups were classified to favour comparison between the two macro tables (one for each method) and give a quick idea of the structure of the population served by each facility.

Since disaggregated data were not available for each year, every effort was made to respect as far as possible the age groups corresponding to the life stages of the population, especially considering the blurred boundaries between childhood, adulthood and old age. Thus, the following classification was obtained:

- 0–14 years
- 15–29 years
- 30–49 years
- 50–64 years
- 65–79 years
- 80 years and over

The classification using data on the population served by each facility (Tables 4 and 5) allows one to produce comparative charts showing the relative values of each selection. The percentage of people out of the total of a certain age group covered by these facilities is also calculated, as this gives a better idea of the coverage of services in the city. This process will be carried out later.

Table 4. Population covered by the basic services analysed (Method A, within).

Basic Service	0–14	15–29	30–49	50–64	65–79	Over 80
Markets	8975	11,741	22,561	20,884	21,039	10,375
Educational facilities						
Infant and primary education	32,619	37,654	71,373	63,918	53,522	23,521
Secondary education	33,477	38,341	73,032	65,137	54,366	24,013
Healthcare facilities						
Health centres	28,434	34,820	62,852	59,037	49,016	22,342
Hospitals	11,431	14,213	27,274	23,612	22,450	11,390
Social facilities	34,082	39,986	73,997	67,678	55,627	24,373
Sport facilities	31,965	37,220	69,104	62,999	51,462	22,174
Cultural facilities	30,569	35,241	67,177	60,281	49,956	22,492
Containers	34,916	40,256	75,547	68,209	55,943	24,499
Public transport	34,916	40,256	75,547	68,209	55,943	24,499

Authors' own elaboration.

Table 5. Population covered by the basic services analysed (Method B, centroid).

Basic Service	0–14	15–29	30–49	50–64	65–79	Over 80
Markets	6772	8725	17,209	15,730	16,381	8103
Educational facilities						
Infant and primary education	21,814	27,576	49,329	46,752	41,961	18,940
Secondary education	25,289	31,440	57,018	53,197	46,993	21,207
Healthcare facilities						
Health centres	19,430	25,275	44,456	42,276	38,356	17,600
Hospitals	7796	9894	19,092	16,621	16,589	8564
Social facilities	27,251	33,704	61,554	57,686	50,746	22,436
Sport facilities	26,582	31,717	57,095	53,588	44,446	18,422
Cultural facilities	20,063	25,384	45,575	42,945	37,404	17,376
Containers	27,516	33,580	61,410	56,961	49,186	21,835
Public transport	32,152	37,749	70,808	64,250	54,218	23,682

Authors' own elaboration.

To determine which method is the most appropriate, in addition to a visual comparison, the population obtained using each method was also compared using a chart, following the previous example. These charts show the total population served by each facility by age group, since the aim is to determine which method groups the largest population. However, in order to analyse the results obtained once a selection method is chosen, the charts show the population served by that particular facility by age group as this gives a better idea of the structure of the population covered by each category.

As shown above, if method A is applied, the population covered by the facilities increases. This is because, by treating the census sections as polygons, when any part of that census section is within the indicated distance, it will be selected as a whole, and, therefore, its entire population will be included.

This does not happen with method B, since it is based on the centroid and is, therefore, more restrictive. Thus, the previous hypothesis gains strength, as method A is more convenient because it is better suited to the characteristics of the city of Valladolid. The selection by location using method B poses certain problems depending on the shape of the census section analysed: in small, regular census sections, the centroid considered fits quite well with the geometric centre of the polygon; in large, irregular census sections, however, the centroid does not coincide with the geometric centre due to these unequal shapes. These variations can introduce biases when selecting by location using method B, since the distance taken is from the facility to the established centroid, so if the defined interval is exceeded, that census section will not be selected, even if the facility is located within it.

In conclusion, the optimal method in both mapping and quantitative terms is method A, which considers the distance between the entities of the source layer and the target layer by creating areas of influence, as this is the type of selection by location that best reflects the current reality. Therefore this study will use this method.

2.4. Mapping for Decision Making

The results were represented in a series of maps that help evaluate the coverage situation of a selection of facilities as an example (infant and primary education centres, health facilities, sports facilities), following the indications of the AUE when representing the percentage of coverage of these services in the census sections using the following formula:

$$\text{Coverage (\%)} = \frac{\textbf{\textit{population covered in each census section}}}{\textbf{\textit{Total population covered by the service analysed}}} \times 100 \quad (1)$$

Formula (1). Percentage of coverage of each facility analysed. Source: AUE, 2019.

The percentage of coverage correlates the population of the census section included within the defined distance and the total population served by each of the facilities analysed; this indicator, therefore, measures the percentage of population with respect to the total covered by each facility for the different census sections. The thematic maps created to represent this information consider the semiotic premises needed to visualise and identify the spatial problems of the city.

Finally, a synthetic global map was made showing an accumulated value of global coverage for each census section considering the 10 types of facilities analysed as a whole. This map was created by coding all the coverage values according to the following weighting: value '1' for coverage between 0 and 33.3% of the population; value '2' for coverage between 33.3% and 66.6% of the population; and value '3' for coverage higher than 66.6% of the population according to the indications of the AUE. Subsequently, a summation of the cumulative values for each census section was applied, so that the final values of these will range, hypothetically, between 10 points minimum (10 facilities multiplied by 1 coverage point) and 30 points maximum (10 facilities multiplied by 3 coverage points).

3. Results

The results obtained are presented below. Firstly, Table 6 shows the level of coverage of the population for the entire city of Valladolid by the different types of facilities according to the optimal distances proposed by the AUE. Coverage is maximum—reaching 100% of the population—for basic services of selective waste collection and public transport (urban bus stops). The level of coverage is also excellent—higher than 90% of the population—for other facilities such as educational, social and sports centres. The coverage of the population is also good for cultural and health centres (basic or primary care). The lowest coverage levels are for hospitals and markets, although they cover approximately one-third of the population within the distances recommended by the AUE. Following this, the analysis focuses on the specific results for each type of facility (Table 7).

Table 6. Population covered (total and percentage) per facility according to the distances proposed by the AUE for the city of Valladolid.

Type of Facility	Total Population Covered	Percentage of Population of the Total for the City
Markets	95,535	31.9
Educational facilities		
Infant and Primary education	282,607	94.4
Secondary education	288,366	96.3
Healthcare facilities		
Health centres	256,501	85.7
Hospitals	110,370	36.9
Social facilities	295,743	98.8
Sports facilities	274,924	91.8
Cultural facilities	265,716	88.8
Selective waste collection points	299,370	100.0
Urban bus stops	299,370	100.0

Authors' own elaboration.

Table 7. Population covered (total and percentage) per facility according to the distances proposed by the AUE for each district.

District	Population/%	Markets	Inf. Primary Edu.	Secondary Edu.	Health Centres	Hospitals	Social Facilities	Sports Facilities	Cultural Facilities	Selective Waste Collection	Transport
0	Pop.	41,530	48,130	48,723	48,723	44,821	48,723	32,159	43,891	48,723	48,723
	%	85.2	98.8	100.0	100.0	92.0	100.0	66.0	90.1	100.0	100.0
1	Pop.	20,901	26,375	26,375	26,375	23,416	26,375	26,375	26,375	26,375	26,375
	%	79.2	100.0	100.0	100.0	88.8	100.0	100.0	100.0	100.0	100.0
2	Pop.	7005	22,702	22,702	19,243	18,142	22,702	22,702	22,702	22,702	22,702
	%	30.9	100.0	100.0	84.8	79.9	100.0	100.0	100.0	100.0	100.0
3	Pop.	8285	18,763	23,193	18,294	4,856	23,193	23,193	23,193	23,193	23,193
	%	35.7	80.9	100.0	78.9	20.9	100.0	100.0	100.0	100.0	100.0
4	Pop.	14,122	46,478	46,478	39,218	19,120	42,827	40,822	39,604	46,478	46,478
	%	30.4	100.0	100.0	84.4	41.1	92.1	87.8	85.2	100.0	100.0
5	Pop.	0	36,585	40,169	30,088	0	39,155	40,169	37,436	40,169	40,169
	%	0.0	91.1	100.0	74.9	0.0	97.5	100.0	93.2	100.0	100.0
6	Pop.	0	18,338	20,448	12,986	0	23,179	23,179	12,874	23,179	23,179
	%	0.0	79.1	88.2	56.0	0.0	100.0	100.0	55.5	100.0	100.0
7	Pop.	0	30,139	30,139	30,139	0	30,139	30,139	27,546	30,139	30,139
	%	0.0	100.0	100.0	100.0	0.0	100.0	100.0	91.4	100.0	100.0
8	Pop.	2962	24,017	24,017	18,748	0	24,017	24,017	23,256	24,017	24,017
	%	12.3	100.0	100.0	78.1	0.0	100.0	100.0	96.8	100.0	100.0
9	Pop.	0	12,527	8589	12,672	0	16,880	13,616	10,286	16,880	16,880
	%	0.0	74.2	50.9	75.1	0.0	100.0	80.7	60.9	100.0	100.0

Authors' own elaboration.

3.1. Markets

There are five public municipal markets in Valladolid, located mainly in the urban centre, so coverage for the whole the city (31.9%) is very low. However, this does not translate into poor access to food-shopping services, since only the coverage of public markets has been analysed here; the city actually has an excellent network of hypermarkets, supermarkets and local food stores. Access to markets is covered in 34.5% of the census sections, which is equivalent to 31.9% of the population. Districts zero and one have high coverage, whereas districts five, six, seven and nine have no public market, so coverage is zero. The average percentage of population covered in each census section is 35.8%.

3.2. Educational Facilities

The infant and primary education centres analysed include state schools, state-subsidised private schools and municipal nursery schools (87 facilities in total), within a considered distance of 300 metres (Figure 3). Coverage reaches 95% of the census sections, so the distribution of these facilities is very equitable throughout the city, even in the areas furthest from the centre. The average percentage of population covered in each census section is 42%, and 94.4% of the city's population is within the distance recommended by the AUE. Districts one, two, four, seven and eight achieved 100% coverage of the population served and the figures are adequate in the other districts—between 74.1% in district nine and 98.8% in district zero.

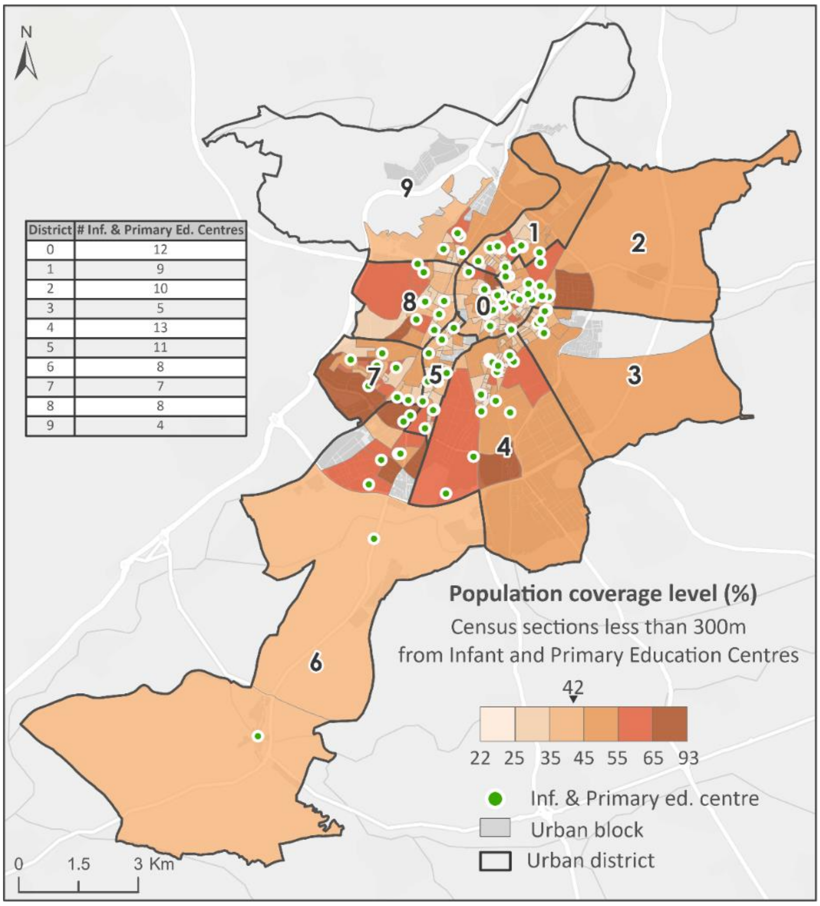

Figure 3. Map of Infant and Primary Education Centres.

Given that the infant and primary education centres and nursery schools serve children aged between 0 and 12 years, the analysis focused specifically on the existing coverage for the 0–14 age group. Thus, the child population located within less than 300 metres of the schools is 93.4% of the total child population of Valladolid. In the age group between 30 and 49, 94.5% of the population is covered by these facilities. This population makes up the potential childbearing age group in Spain since, according to data from the most recent fertility survey (Spanish National Institute of Statistics, 2018), the average age of childbearing in Spain is 31, so almost 80% of the population aged 25–29 years has not had children yet.

The secondary education centres analysed include state secondary schools and state-subsidised private schools offering compulsory secondary education (ESO) and the Spanish Baccalaureate. In total, 55 facilities were analysed. Coverage reaches 98.9% of census sections, which means maximum coverage for 96.3% of the population. These figures are higher than those for infant and primary education centres, since the considered distance is greater, 500 m compared to 300 m. In all districts, 100% coverage is reached except for district nine, where this figure falls to 50.9% and almost half of the census sections are not covered, representing one of the lowest percentages (37.2%) for the whole city (41.4%). The analysis of the 0–14 and 15–19 age groups revealed that 95% of the population, for both age groups, is covered within the distances established by the AUE.

3.3. Healthcare Facilities

Healthcare facilities were divided into two categories: health centres and hospitals. The facilities considered as health centres are outpatient clinics, specialist centres and points of continuous care, totalling 20 facilities distributed mainly in the compact urban area, with a greater presence in the centre and east of the city. The health centres cover 87.2% of census sections and 85% of the total population (Figure 4). Districts zero, one and seven have maximum coverage, whereas district six has the lowest coverage (56%), although there is great variability among the different census sections in this district.

Areas with an older population exhibit a greater presence of health centres, which means that 91.2% of the population aged 80 or above is covered by these facilities within the recommended distances. Coverage for the 0–14 age group is 81.4%.

Valladolid has only two hospitals, located in districts two and four. In any case, the 1000-m threshold recommended by the AUE means that 36.8% of the population and 40% of the census sections have access to hospitals. The average coverage of these facilities in the city is 35.7%. There are significant spatial contrasts between the city's neighbourhoods, since districts zero (92%), one (88.8%) and two (75.9%) have a high level of coverage compared to districts five, six, seven, eight and nine, which do not have access within 1000 m.

In the 30–49 age group, 24.7% has access to hospitals, while people over 80 years and those under 14 have an approximate coverage of only 10%.

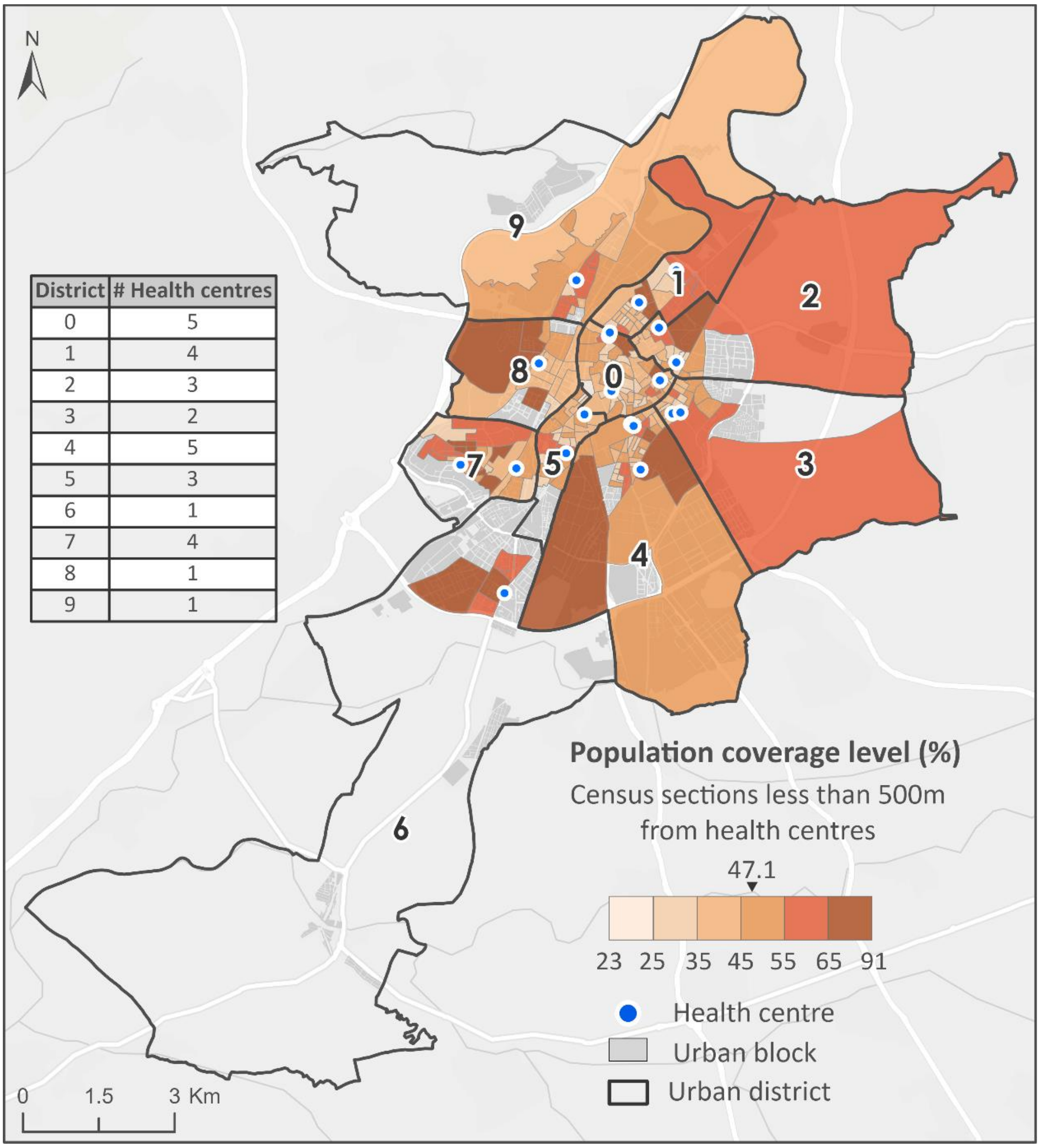

Figure 4. Map of health centres.

3.4. Social Facilities

Social facilities include social action centres, senior citizen centres, gender equality centres, immigration assistance office, care and assistance services, municipal soup kitchens and neighbours associations. A total of 90 social facilities distributed throughout the urban area were analysed, which means that all districts have a coverage of 100%, apart from districts four and five, which nevertheless exceed 90%. Social facilities are also present in vulnerable, low-income areas of the city, such as districts one, two, three and four (see Section 1.2). Overall, 99.2% of the census sections and 98.8% of the city's population are covered within a distance of 500 m.

3.5. Sports Facilities

The municipal sports facilities taken into account are sports centres, stadiums, swimming pools and sports grounds. There are 90 facilities in total, mainly located in the areas surrounding the centre, although they are distributed homogenously in the consolidated urban area. The coverage within the recommended 500 m is 91.8% of the population and 91.9% of the census sections (Figure 5).

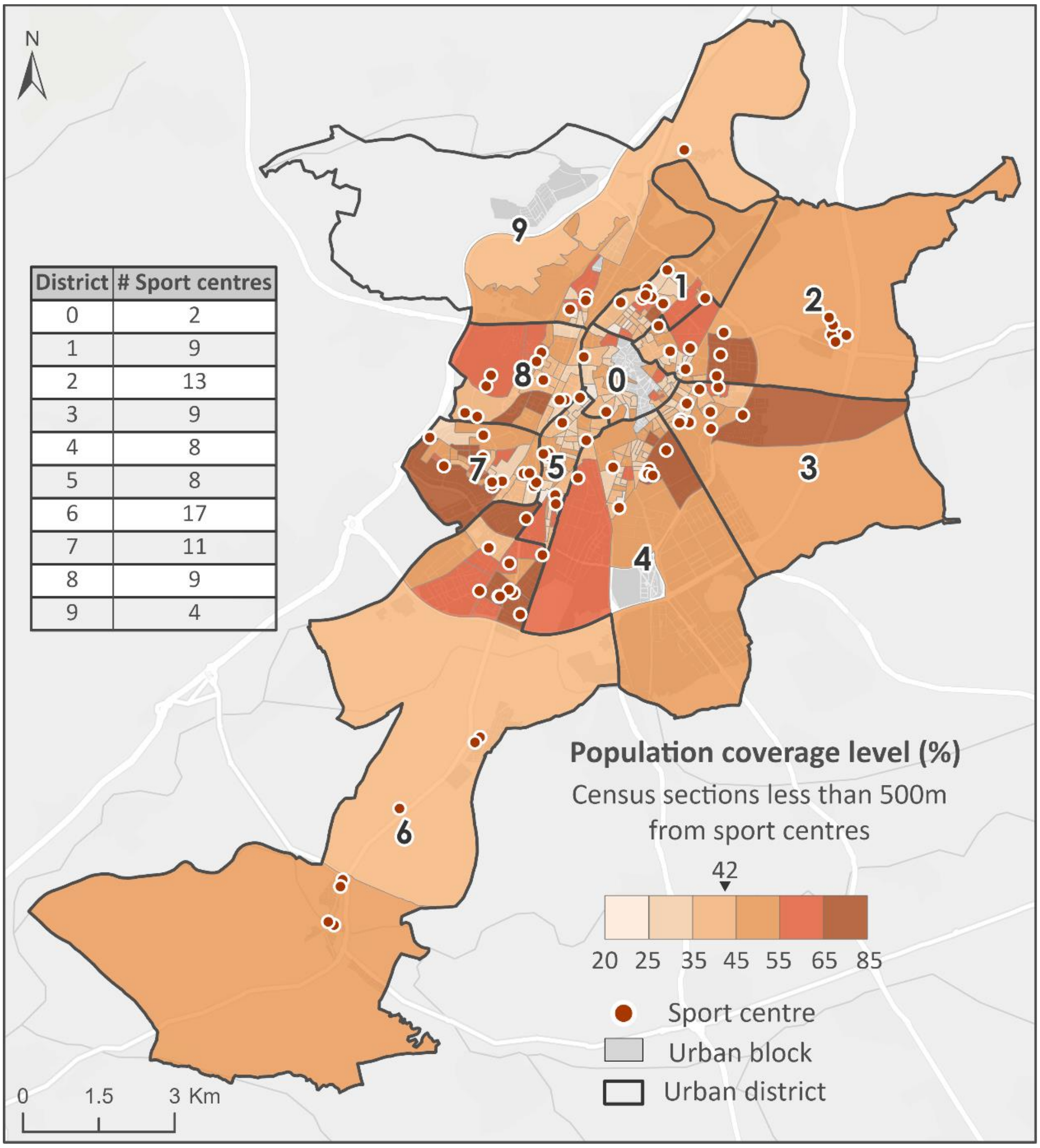

Figure 5. Map of sports facilities.

Due to the space requirements of these types of facilities, many of them are not in the city centre. Most are located in districts five, six, seven and eight—recently urbanised neighbourhoods that incorporated the development of sports facilities in their planning. All districts are covered almost 100%, with the exception of district zero, where 66% of the population has a sports facility within 500 m, which is nevertheless an acceptable figure.

In the 30–49 age group, 91.5% of the population is covered, and the 50–64 and 65–79 age groups are covered 92.4% and 92.0%, respectively. Of the child population in the 0–14 age group, 91.5% has access to sports facilities; this figure increases slightly to 92.4% for the population aged 15 to 29 years. These figures show a favourable situation for promoting physical activity and moving towards a healthier city model.

3.6. Cultural Facilities

The cultural facilities considered result from combining two categories established by the AUE, 'cultural' and 'entertainment' facilities. Only municipally managed services were analysed (libraries, civic centres and citizen initiative centres that hold different cultural activities such as theatrical performances and conferences), while private cultural or entertainment establishments were not included. In total, there are 35 facilities that cover 90% of the census sections and 88.8% of the population. The majority of these facilities are located in the city centre, with a high level of accessibility in districts one, two and three (100%) compared to district six (55.5%). The average overall coverage by cultural facilities in each census section is 43.1%.

Of the population over 80 years of age, 91.8% has access to cultural facilities within a distance of 500 m. The figures in the 30–49 and 15–29 age groups are similar, with 89% and 87.5%, respectively.

In summary, although the number of cultural facilities in the city is limited, their location favours an adequate average coverage of the population.

3.7. Selective Waste Collection Points

The selective waste collection points include containers for paper, cardboard, glass and oil. The data for plastic packaging and organic waste were not available and, therefore, these were not included. The distance established for this category is 100 m, so the number of collection points needed to cover the entire city adequately is high. There are 2162 facilities in total distributed throughout the city but the highest density is in the urban centre. All the census sections have full coverage, although there are differences between the eastern part, including districts one, two, three, four and zero (the urban centre)—with average values for each district lower than the total average for the city—and the western part (districts five, six, seven, eight and nine), which, except for district five, exceeds the city average by more than 10 points. This may be linked to the urban development of these areas and the population residing in them.

3.8. Public Transport

Municipal public transport in Valladolid is made up of a network of urban buses. To determine coverage of the population with respect to this facility, the analysis includes 575 bus stops. Out of these, 31 are located outside the municipal boundary of Valladolid, although they were included in the analysis as they serve people living within the municipality. Within the considered distance of 300 metres, these stops offer an ideal coverage of the city's population (100%) and all census sections have access to this service.

District four has more bus stops (21.4%), given that the combination of residential and industrial areas means that accessibility to bus stops must be high. District six, the city's most peripheral district, is the second in number of bus stops (14.3%), which implies a good planning of the public transport service to favour accessibility to the rest of the city and to achieve more sustainable mobility (Figure 6).

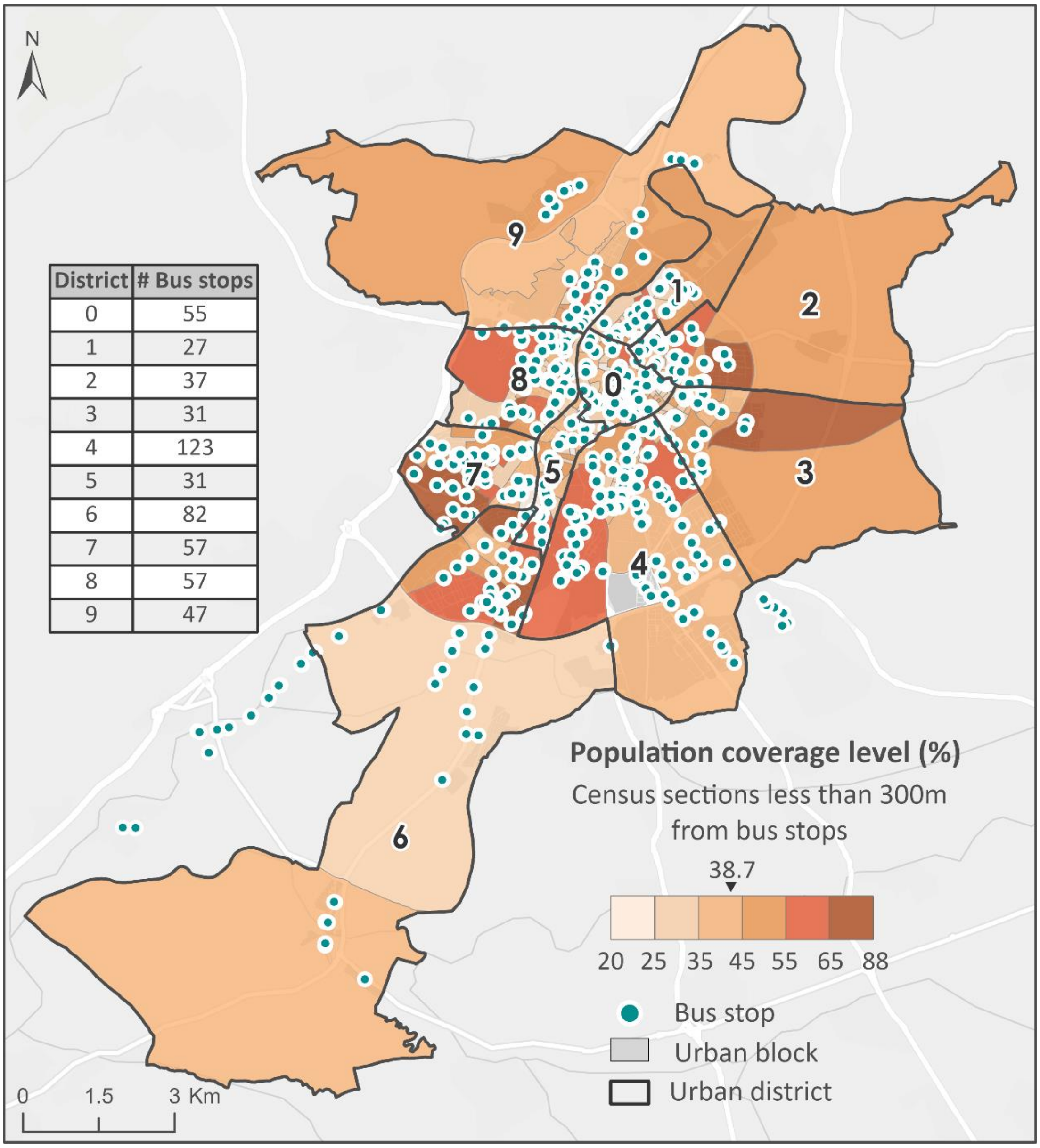

Figure 6. Map of bus stops.

3.9. Synthetic Global Map

Finally, Figure 7 shows the global coverage assessment map according to the method described in Section 2.4. In general, the map shows a high rating by section in 29.1% of sections (27.3% of the total population), an average rating in 32.9% of sections (36.8% of the population) and a low rating in 38.0% of sections (35.9% of the population). Most of the sections in districts zero, one, two, three and four are in a good situation, while the majority of the sections in districts five, six, seven, eight and nine have an average rating. District nine is the only one that does not contain any census section with high scores. Some sections of the historic city centre (district zero) obtain low scores as they lack some basic facilities—sports facilities, among others—due to their greater compactness, the density of the urban fabric and the fact that they were developed earlier and with less planning of public facilities than the more recent neighbourhoods on the periphery.

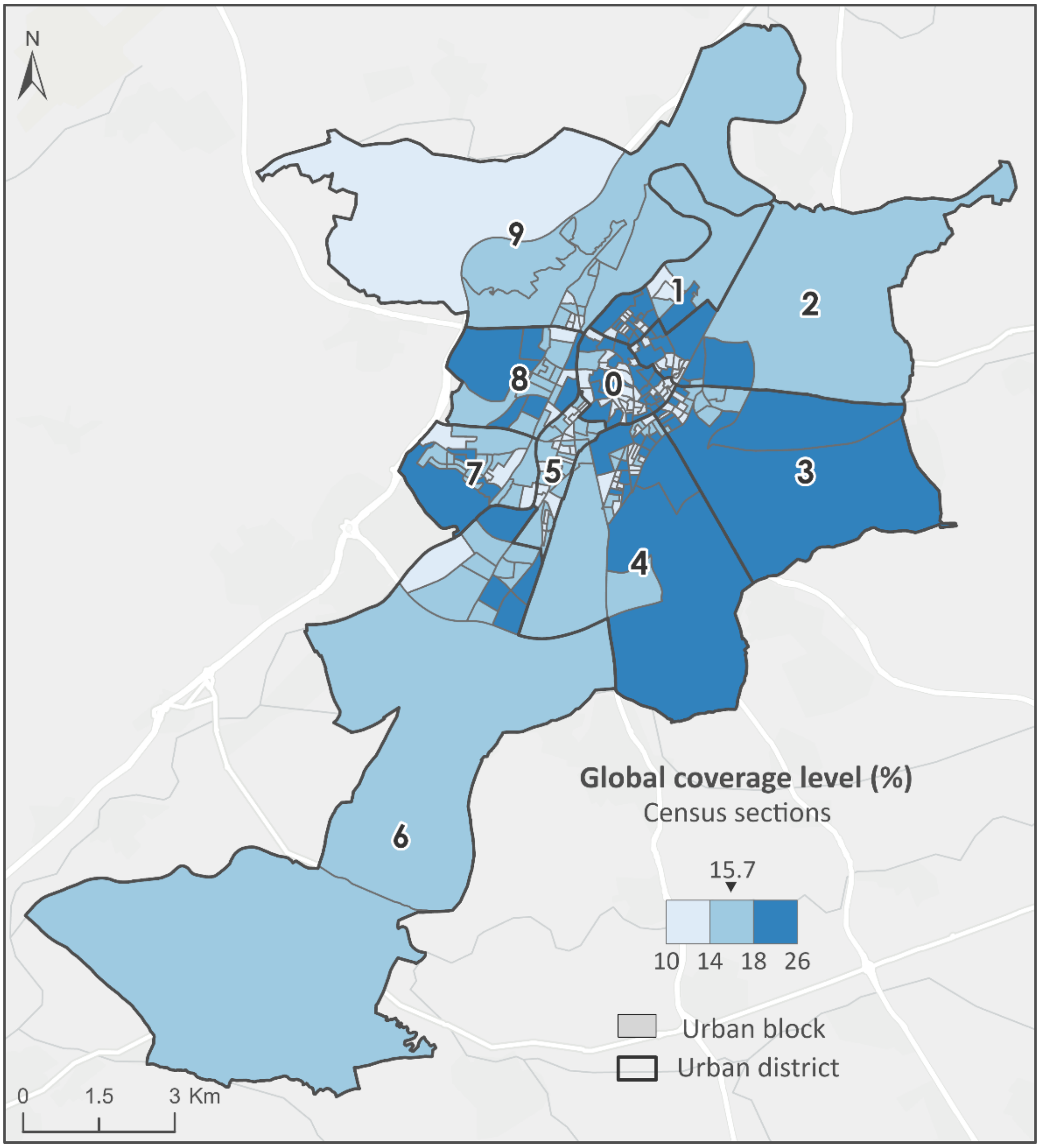

Figure 7. Map of global coverage level.

4. Discussion

Using spatial analysis to assess urban policies is a common practice for quantifying theoretical and/or real results; this assessment is often enriched and combined with a graphic and cartographic representation of the results to support decision making in urban planning. This paper has analysed a national-scale policy such as the AUE, which incorporates in its design and approaches the precepts of the New Urban Agenda and the Urban Agenda for the European Union. The formal proposal of the AUE as a tool for urban planning has been reviewed in previous works [26,31,40], although, in practice, this paper is the first contribution that attempts to diagnose a Spanish city from the perspective of the AUE using a selection of criteria focused on assessing the population coverage of access to different basic public facilities. The authors consider that this approach is fundamental in the context of post-pandemic urban planning, which seeks to create more equitable, sustainable and resilient cities [6]. Urban proximity environments and conditions have been studied previously for other Spanish cities through academic and theoretical approaches highlighting the value of cartography to identify different urban realities and as a useful tool for making decisions [18,22]. However, this article is based on the official guidelines of the AUE, which can serve as an example on how to assess and map proximity in cities and, ultimately, improve urban-planning policies. The results obtained present a model for implementing certain AUE indicators that can be replicated in any other Spanish city. It also serves as an exercise in urban planning for the city of Valladolid in a post-pandemic scenario.

In addition to the Urban Agenda for the European Union, there are many European policies aimed at responding to the challenge of having more socially and environmentally friendly cities. Therefore, it is time to reflect on the issue that we address in this paper in view of the significant number of projects (with great investment capacity) that emanate from these European policies. This is the case of the Horizon Europe program, which includes the mission of ensuring that 100 European cities become climate neutral by 2030, where Valladolid has been one of the cities selected [41]. Furthermore, the URBACT program (EU Urban Initiative) also focuses on cities and its main objectives are the development of innovative urban actions, as well as an urban development network [42]. Within the policies that can be aligned towards efficient urban development in these moments of uncertainty amid a post-COVID-19 situation, we can find the Recovery and Resilience Facility; these are the Next Generation funds [43]. Finally, we consider that this work provides a first approximation of the diagnosis of the city of Valladolid that will promote these policies.

The suitability of the results obtained regarding the selection of public facilities analysed is a fundamental topic of debate. The decision of not including other infrastructure was based on the availability of information, but also on the indicators proposed by the AUE, which are general for Spanish cities and for a city-scale analysis, not for a detail-scale analysis. Therefore, this study has obvious limitations as it does not include many of the private facilities of the city (mainly health, commercial, sports and cultural facilities); if they had been included, the results for some urban areas, especially the peripheral districts, would have improved, though not enough to reach those of the city centre, given its already excellent coverage. Urban green areas were not analysed either, an indicator considered in several research studies focusing on the healthy and post-pandemic city [44] that would certainly have influenced some assessments by rewarding the greener areas of the city to the detriment of those with higher population and building density.

The results obtained in this study are conditioned by the existing administrative divisions in the city, which do not necessarily respond to criteria related to the distribution of the population throughout the territory, but rather to administrative and political convenience [45]. The exploratory analysis conducted revealed that the census section provides sufficient detail for assessing the city model proposed by the AUE, due to the average dimensions of these spatial units. Census sections are commonly used in the research of different urban issues in Spain [36] as they allow analysis at city and district scales when aggregated and visualised as a whole, while also recognising the neighbourhood or urban sector scales. However, progress must be made towards achieving greater detail with scales that allow very specific decisions to be made for those areas where the planned action will have greater impact. In order to deepen this analysis, it would be necessary to have highly detailed socio-demographic information such as that on an urban block or building level, given that the increase in scale multiplies the heterogeneity of the spatial distribution of social phenomena and provides socio-territorial insights of great interest to urban planners and actors [26]. In the case analysed, the average surface area of the sections is 0.54 km^2 and the average population is 1160.3 inhabitants, with values ranging between 0.01 km^2 and 24.2 km^2 for the smallest and largest sections, respectively, and between 593 and 2631 inhabitants for the least and most inhabited sections, respectively. As explained in Section 2.3, these data validate the selection method used. Although the entire population of each section within the distances established by the AUE for each of the categories analysed were not included in the selection method, it is plausible to assume that the entire population of the census section will certainly have equivalent access, on average, to the facilities considered. In any case, the urban district scale was also analysed, which is less precise than the census section but very appropriate for developing urban rebalancing policies at the global city level.

There is also the possibility of working with grids, based on the raster method, which allows more detailed results and helps differentiate socio-demographic behaviours that may vary according to streets or transects [39]. This method also increases comparability between units, since they are all the same size [46], regardless of the variable analysed.

Finally, the analysis of the demographic structure focused on the potential users of the facilities helps determine whether these facilities are located coherently with respect to the main service for which they are designed and whether they, therefore, guarantee the involvement of all population groups, thus favouring the construction of a more inclusive city. In this sense, adjusting urban facilities and design to the needs of the population is essential for progress towards a city that is accessible to all citizens irrespective of their characteristics, circumstances and needs.

5. Conclusions

This paper has analysed the coverage of the population of Valladolid, Spain, with respect to the main public facilities under the guidelines of the AUE, a framework document aimed at guiding Spanish cities towards achieving the goals proposed in the 2030 Agenda. The research context considered was the post-pandemic city model that prioritises the population's proximity to services and resources to minimise motorised traffic and promote equity in the urban distribution of opportunities.

Specifically, the results obtained increased knowledge about AUE Strategic Goals 1 (Land-use planning and rational land use, to conserve and protect it); 2 (Avoid urban sprawl and revitalise the existing city); 3 (Prevent and reduce the impacts of climate change and improve resilience); 5 (Promote proximity and sustainable mobility), 6 (Promote social cohesion and seek equity) and 10 (Improve intervention and governance instruments). Furthermore, this contribution helps develop useful knowledge for the achievement of the SDGs, specifically goal 11.

The medium size of the city of Valladolid in the Spanish and European urban contexts helps shed light on the applicability of the new urban policies as a tool for efficient, well-targeted urban planning. Specifically, the results show a very good situation for the coverage of most of the facilities analysed, although the central areas of the city generally exhibit better levels of coverage compared to the peripheral neighbourhoods. All the public services analysed, with the exception of municipal markets, cover more than 75% of the population in the entire city. This reality corresponds to the usual model of Spanish and Mediterranean cities where there is a majority urban model that is sustainable in itself, at least from the perspective of equity and accessibility to basic services. However, this situation is at a critical moment due to the adverse socio-economic effects of the COVID-19 pandemic on the population, but also to the neoliberal forces of the real estate market that try to sell the 'advantages' of low-density, peripheral residential areas as the safest housing formulas with respect to the virus. Tools such as the AUE are undoubtedly essential for revisiting, through new analysis indicators aim at comprehensive urban planning, in the sustainable and resilient post-pandemic city model where urban compactness—although it has not been analysed in this study—is a definite factor in obtaining excellent results in terms of coverage.

This paper has emphasised the role of thematic mapping as a key tool for gaining an in-depth knowledge of the urban reality and as an ideal method for decision making by all urban actors. The spatial analysis conducted helped quantify the population covered by the different municipal services and determine the urban areas with deficiencies or inequalities compared to other parts of the city. Thus, with regard to the location of new facilities, under the framework of action established by the AUE, the following interventions are proposed, favouring compactness and urban balance and following sustainable development models in future urban extensions:

- Strengthening the provision of public facilities in areas far from the compact urban area, especially in districts five, seven and nine.
- Integrating public facilities in transition areas between residential and economic activity areas, improving the coverage of their inhabitants, as in district four.
- Taking advantage of large undeveloped areas in different census sections to install new facilities and improve coverage of the neighbouring population.
- Planning new constructions so that they allow for the subsequent incorporation and conversion of facilities according to the needs of residents and changes in the demographic structure.

These measures will help decrease the distance of the population to facilities, thus reducing dependence on private vehicles and favouring walking or cycling, which, in turn, promotes sustainable mobility, one of the goals pursued by the AUE. Furthermore, the correct combination of these measures will allow the city to adapt to the AUE standards, making an effort to alleviate the inequalities that exist in certain areas and ensuring that the entire population has equal access to all basic municipal facilities of the city.

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