Gender mainstreaming in urban planning: the potential of Geographic Information Systems and open data sources.

Jose Carpio-Pinedo*, Sonia de Gregorio Hurtado, Inés Sánchez de Madariaga

Department of Urban and Regional Planning, Universidad Politécnica de Madrid (UPM), Madrid, Spain

* Correspondence: jose.carpio@upm.es

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While gender mainstreaming has become a key principle for fostering equality across all fields of policy, actual implementation in the field of urban planning is still underdeveloped. We posit that Geographic Information Systems (GIS) and open data sources can and should be useful tools that effectively contribute to devising more effective ways of implementing a gender-sensitive agenda in urban planning. We take the case of Madrid to illustrate how these tools can contribute to gender mainstreaming in planning by building a methodology based on the concepts of infrastructures for everyday life and the perception of safety.

Keywords: gender mainstreaming (GM); infrastructures for everyday life; perceived safety; Geographic Information Systems; open data; Madrid.

Introduction: Practical tools to support gender mainstreaming in urban planning

The structural, social, economic and political transformation that took place during the 1970s and 1980s significantly changed public policies at city level. At that time, comprehensive, planning policy models came under pressure from critics who questioned bureaucratic institutions and their rather uniform and standardized range of services and provision (Röber & Schröter, 2007). Those sceptical of institutional practice questioned the rational planning approach that had been central to urban planning over previous decades. With that approach, “planners have assumed that people were more or less the same; a standardised unit with

homogenous needs. This had led planning techniques to deal purely in numbers of people" (Healey, 1997: 99), within a socio-cultural transformational framework characterised by the emergence and growing visibility of new players: the social sciences. The public policy debate then turned its attention to the existence of different identities, rationales, needs in daily life, and experiences in the city.

This new social policy gave visibility to social groups that had been particularly neglected during the “planning era”. The work by feminist scholars from the 1970s onwards contributed to visualizing the lack of policy attention paid so far to women’s needs in the city , writing about planning and gender and giving way to the greater theoretical interest which characterised the 1990s: the “connections between planning, the city and gender" (Fainstein and Servon, 2005, p. 9). The theoretical and empirical work by feminist scholars strongly reflected how advancement towards gender equality could be more effective, recognizing that progress was slow and sector-based. This work, together with the commitment of women’s organisations and practitioners, resulted in a relevant step forward at the Fourth United Nations World Conference on Women held in Beijing (1995): gender mainstreaming was established as a major global strategy for the promotion of gender equality (United Nations, 2002). Following this strategy, the EU adopted gender mainstreaming within the Treaty of Amsterdam (1999) as a policy approach that placed the contribution, perspectives and priorities of both women and men at the centre of attention for development (Sánchez de Madariaga & Roberts, 2013). From that moment on, gender mainstreaming has been widely recognised as a relevant tool for improvement in urban planning systems, as it provides an insight into different gender-related views, needs and aspirations, and how public policies can address these in an effective and equitable way.

In order to support decision-makers, practitioners and technicians in the materialisation of this vision, a relevant effort has been made over the last 15 years to provide manuals for gender mainstreaming in urban planning and policies (Damyanovic, Reinwald, & Weikmann, 2013; Reeves, Parfitt, & Archer, 2012; Sánchez de Madariaga, 2004). However, despite these efforts and the legal provisions put in place, GM has come up against significant barriers at the policy design and implementation stages. The few cities that have demonstrated a consistent commitment to this vision report a wide range of key obstacles (e.g. Senatsverwaltung für Stadtentwicklung, 2011). The field of urban planning has proved particularly resistant to taking into account the diverse needs and realities of women and men. One of the main barriers for cities is the lack of tools to clearly highlight women’s needs in the face of decision-makers, practitioners, technicians and the local community.

As Horelli and Wallin (2013, p. 11) put it, “the planning of public services and urban space ignores the local level where they will actually be used”. The daily life of those that need to combine care work and professional responsibilities - mainly women - is a neighbourhood issue. If this group and its local needs are taken into account in urban planning processes, these plans can act as the basis for land use policies oriented towards supporting a city of

proximity, through the nearby location of public amenities and private facilities, parks, shops and work places, effectively connected through safe routes to housing areas. This question has been pointed to as one of the new challenges of urban planning (Boccia, 2013).

This paper explores how we can use comprehensive, multi-topic tools such as Geographic Information Systems (GIS) and open data to advance in a method aimed at providing more detailed, comprehensive, gender-relevant spatial analysis. With this aim and taking the city of Madrid as a case study, we address two main issues: firstly, access to infrastructure for everyday life, and secondly, perceived safety. Both have been selected due to their inclusion in feminist literature on geography as having important consequences for the way people) conduct their daily life, particularly with reference to women, who are largely responsible for family-related care. Neither the tools nor the criteria are new in concept, however the combination of the two remains unexplored in the context of gender mainstreaming.

The paper consists of five sections: part 1, as an introduction; part 2 presents the conceptual framework; part 3,the methodology and case study; and finally, part 4, which discusses the results of the study. Finally, part 5 presents the conclusions and points to a number of policy approaches to support GM in urban planning by drawing upon the methods presented.

Conceptual framework: improving urban planning by using gender-sensitive spatial analysis tools.

All groups within society have different needs, aspirations, perceptions and priorities as regards the urban environment, housing, public facilities and mobility. Research based on empirical evidence shows that these differences are not normally considered by urban planners. In contrast, the work of planners and policy makers has historically been universalist, implicitly taking a male point of reference (Fainstein & Servon, 2005). Nevertheless, urban planning is not gender neutral. The insufficient attention to women needs within planning processes reproduces a *gendered* city, based on a spatial distribution with long walking distances to transport, shops, schools, health services, and workplaces, which significantly affects the way the population (particularly women) experience their surroundings (Sassen, 2015). The literature has demonstrated that “women suffer particular disadvantage within a built environment designed with little attention to gender considerations” (Greed, 2006, p. 180). Consequently, many authors have argued that urban planning can make an important contribution to spatialized gender inequality (Fainstein & Servon, 2005; Reeves et al., 2012; Sánchez de Madariaga & Roberts, 2013).

The concept of Infrastructures for Everyday Life

Feminist geographies have looked at gender issues through diverse approaches (welfare,

politics, identities, etc.), however all have highlighted that traditional urban planning overlooks increasing unpaid care: caring for children, the elderly, and sick or handicapped relatives, in addition to housework. These responsibilities have traditionally been assigned to women and, as such, focussed on by feminist scholars, even though this care is not exclusive to women. The dual role of women in society as both wage-earners and unpaid caregivers determines the needs and expectations they have of urban environments. More specifically, their lives are constrained by their accessibility to certain urban services such as education or healthcare. In an attempt to conceptualize this accessibility, the idea of a "new everyday life" emerged as relevant in the 1990s; a concept first developed by the Nordic women's movement and later by their European colleagues (Horelli & Wallin, 2013, p. 233). This idea explores the correspondence and contradictions between theories and daily experience, and the perceptions and repeated action of inhabitants, with researchers often reaching key conclusions which dismantle or rebuild theoretical constructs. Gilroy and Booth (1999) point out that the concept lies in the demands anticipated by Hayden. For Hayden, it was necessary "to develop a new paradigm of the home, neighbourhood and city, to begin to describe the physical, social and economic design of a human settlement that would support, rather than restrict, the activities of women and their families" (Hayden, 1980, p. 170).

According to Horelli and Wallin (2013, p. 233), this New Everyday Life is "a concrete utopia" in which the physical separation of key activities -work, care and housing- is replaced by their integration within their residential environment. The concept focuses on "how women accomplish their daily routines and it is committed to creating material and socio-cultural support structures: the infrastructures for everyday life" (Gilroy & Booth, 1999, p. 309).

In the same vein, the EuroFEM research network stressed the relevance of "infrastructures for everyday life", comprising planning and development of local services accessible from the home (Horelli, 2002; see also Horelli et al., 2000; Horelli and Vepsä, 1994). Infrastructures for everyday life are understood as "all that it takes, in a practical sense, for individuals and households to 'go on' from one day to the next" (Jarvis, Cloke, & Kantor, 2009, p. 131). Among these facilities, public healthcare and education centres play a major role. Considering this need for social and cultural infrastructure, Gilroy and Booth point out that urban planning has the capacity to shape everyday living conditions, supporting them or making them difficult, since planning can adopt, firstly, either a holistic vision, with emphasis on connections between activities and land use, or secondly, a sectoral approach that emphasizes the separation of daily activities (Gilroy & Booth, 1999, p. 309). As an example of the first view, in the of the EuroFEM project review, these authors point to the Frauen-Werk-Stadt project for a residential neighbourhood in Vienna in 1992 as a benchmark (for a description of the projects see: De Gregorio Hurtado, 2015; Ullmann, 2013) . Among many other measures which support women in their everyday life, the Vienna project included various amenities near housing, i.e. a doctor's surgery, a kinder-garden, shops and a police station. The strategic location of these services is

also seen in other EuroFEM projects that adopted a physical approach to integrating the "everyday life" concept.

Starting from the potential of "infrastructures for everyday life" to address the needs of all social groups, this study has identified urban planners' attention to spatial layout and timing activities of daily life, highlighting contingencies in daily routines. At the same time, GIS and open data could be excellent instruments, since they are closely connected to the geo-location of the infrastructures in question. The type, number, and location of public and private facilities in the city are largely decided by urban planners, so the use of GIS and open data are valuable aids in accurately identifying needs in terms of "infrastructures for daily life". Due to the nature of these tools, this approach cannot cover all the qualitative aspects concerned however we feel that such tools can help us planners and policy makers "to understand the practical needs of everyday life and respond to citizens' needs in appropriate ways" (Gilroy & Booth, 1999, p. 322). The method that we propose can act as a basis for spatial diagnosis in planning decisions and citizen participation. Some of these possible processes are discussed in this text after presenting the results of our analysis.

Perceived safety in urban areas:

The literature argues that one of the main reasons for including gender within urban planning is motivated by the differences in perception of the urban environment by women and men (Listerborn, 2002; Roberts, 2013; Wekerle & Whitzman, 1995). This is because men and women attribute different meanings to environmental spatial stimuli, which affects their behaviour. This results in a different perception of safety in urban areas depending on the characteristics of the public area, such as streets with natural surveillance (Valentine, 1989) and morphological factors. As Ceccato (2012: 311) points out, women often report higher levels of fear and anxiety than men in the urban environment, "regardless of age, socio-economic status, ethnic-cultural and educational background and disability".

This subjective feeling of safety in public places leads women to avoid empty streets , whilst they feel safer on streets with natural surveillance, as Jane Jacobs (1961) put it: the presence of active frontage (e.g. shops) or activities on/next to the pavement, since people such as shopkeepers and passers-by could come to the rescue if necessary. Perceived safety is related to other factors, such as the level of night lighting; the level of visibility along walking routes; the quality and maintenance of urban areas, the use of public areas, or the possibility of escaping in the case of aggression. Many of these principles were first proposed by the *Women's safety guide,* published in Montreal in the early 1990s (Women in Cities International, 2010), and later widely adopted in gender-sensitive space design and in gender audit walks. One of these principles has to do with the capacity of seeing and being seen in the public space (ibid.), which is directly related with the level of activity in streets, and thus, strongly associated with women's route choices within urban environments (Van Nes & Nguyen, 2009).

As the second relevant criterion of the methodology, we adopt perceived safety in public places, considering that this ties in with the concept of "infrastructures for everyday life" by introducing a factor that explains how women move around in the urban environment, which c can also be approached effectively using GIS and open data.

Finally, we have explored the intersectionality approach (Crenshaw, 1991). This approach considers the interrelationships between factors of social differences: ethnicity, age, sexual orientation, level of education, abilities, level of income, local/immigrant, family characteristics, neighbourhood, etc., avoiding an oversimplification of women's needs. By adopting this approach, we have explored how access to city infrastructure intersects with: 1) household income; and 2) child population distribution in the city. These questions have been selected among others as urban distribution of the child population and households by income category is not spatially homogeneous. By introducing these variables into the study, we aim to avoid over-generalised results by assuming that all women have the same needs and expectations regarding their urban environment. By doing so, we are able to answer questions such as: 1) Do high income women choose to live in areas with good access to city infrastructure; or rather, do they also live in areas with poorer accessibility, given that higher income enables them to afford to own a car? 2) Do women with children tend to live in areas with better access to infrastructures for childcare? This kind of question is important to consider to achieve more inclusive planning for better urban environments.

Geographic Information Systems (GIS):

GIS applications integrate a wide range of computer-based tools for editing, managing and improving the analysis of spatial data, and can be considered a worldwide breakthrough in Geography and Planning since their origin in the 1960s. They can be used to map natural resources or conduct a land inventory to analyse population censuses. Despite the fact that some authors consider GIS 'ubiquitous' nowadays (Maliene, Grigonis, Palevičius, & Griffiths, 2011), the application of GIS to critical studies such as feminist geographies (Kwan, 2001) remains mainly unexplored, thus providing, great potential in that direction (Kwan, 2002b, 2002a).

Open data:

The trend in open data is more recent but has attracted great interest and support (Nugroho, Zuiderwijk, Janssen, & de Jong, 2015). Open data are universally accessible datasets, free of charge or at a reasonable cost, available in different formats, and permits reuse, transformation and redistribution (Open Knowledge International, n.d.). Its positive impacts are diverse, "such as transparency and accountability of government, participation of and self-empowerment for citizens, economic growth and also stimulation of innovation through the re-use of data" (Nugroho et al., 2015, p. 287). Open data appears as a common ground and an opportunity to

engage institutions, grassroots associations, scholars and the private sector simultaneously.

The versatility of both open data and GIS has the potential to link and integrate the different needs of women in their diversity, within one single methodology. This versatility is also consistent with the intersectional approach adopted by the study.

Methodology

Case Study: Madrid

Our case study centres on the city of Madrid (3,141,991 inhabitants as per 2015): the capital of Spain. Madrid inner city consists of a rich diversity of environments in terms of density, land use and urban morphology (Bataller Enguix, López de Lucio, Rivera Blasco, & Tejera Parra, 2004). Also, interestingly for this study topic, welfare and quality of life have received special attention from Madrid governments, which have prioritised good provision of educational, health, cultural, transport and sports facilities for decades (López de Lucio, 1999) . Indeed, Madrid citizens acknowledge a high quality of life : 88.2% of interviewees responded that quality of life in Madrid was 'good' or 'very good' in a recent survey (Ayuntamiento de Madrid, 2015). However, interestingly, interviewees' evaluation of the quality of life in their neighbourhood seemed to be significantly lower (65.6% answered 'good' or 'very good'). This points to a lower level of satisfaction with the local neighbourhood, again an interesting result of this study.

The economic crisis and the structural budget adjustment required by the EU have had a negative impact on the public budget for basic services. High levels of social provision now face major challenges arising from social budget cutbacks. The reduction in funding availability is one more reason for taking a strategic approach to the provision of more cost-effective infrastructures for everyday life and their location in the city, in order to enhance equal opportunities for all.

Open data sources

All sets of data used in this study are open data sources, as defined in the introduction. Four different data sources at three institutional levels –municipal, regional and national– were necessary. Coordination of data collection and publication between different institutions raises governance-related issues that go beyond the scope of this work.

For the Madrid case study, the main data sources correspond to the municipal government (Madrid City Council.) and the regional government (Comunidad de Madrid. Instituto de Estadística, n.d.). Neither of the two sources covers all the everyday infrastructure relevant for this study, however the combination of the two sources enables a complete range of facilities to be mapped (see 3.4). The number of households per plot was obtained from the Spanish *Cadastre* (Land Register) (Ministerio de Hacienda y Función Pública. Dirección

General de Catastro, n.d.). These have been mapped on a GIS layer using their X and Y coordinates.

For the intersectional analysis, data on childhood and income levels were obtained from Spain's National Institute of Statistics datasets (Instituto Nacional de Estadística (INE), 2013), within the European Commission – Eurostat's Cities-Urban Audit initiative. The level of aggregation of these data is the neighbourhood area, so this is less detailed than all other data layers.

GIS tools

Firstly, for spatial analysis, the main GIS tool is ArcGIS 10.3 - Network Analyst Service Area. This tool draws service/buffer areas around any location within a specified distance. Instead of drawing a Euclidean circle from the location (i.e. straight-line, crow-fly buffer zones), this more advanced tool is constrained by road availability, road density, connectivity and block sizes (Figure 1), and defines a service area that better reflects the on-street experience (Gutiérrez & García-Palomares, 2008).

Service areas for each type of infrastructure for everyday life have been calculated, so that total overlap ('Union' tool) can indicate the number of infrastructures that can be reached from each location.

Figure 1: Network-based service areas (grey areas) compared with Euclidean, crow-fly buffer areas. Source: authors.

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Infrastructure access: Analysis and evaluation framework

The available data map a wide range of infrastructures for the care of a) children; b) the elderly; c) sick relatives; and d) domestic maintenance. Also, accessibility to transport services implies reaching more services of a different nature in distant areas of the city. The full list of infrastructures and their data sources are given in Table 1. This also includes the criteria set to assess the level of accessibility to these infrastructures. Service areas for each facility have been drawn for two different distance ranges: 0-400 and 401-800 metres. These ranges have been taken as two relevant levels of proximity in Spanish cities (Hernández Aja, 1997) and correspond to approximately 0-5 and 5-10 minutes' walking distance and have been evaluated with 2 and 1 points respectively. Access to metropolitan train stations obtains a double score as it enables access to a large number of facilities all around the city.

The list of infrastructures is based upon the concepts of "infrastructures for everyday life", as explained in Part 2, after revising the full list of facilities in the city of Madrid in line with this conceptual framework.

Access to shops was assessed in a different way, as one shop did not usually cover all needs. Consequently, in this case, we adopted the principle of the more shops in the proximity, the better. The total number of shops in the proximity was translated into a scale from 0 to 4: no points (no shops within 400m), 1 point (1-50 shops), 2 points (51-150 shops) and 4 points (more than 151 shops within 400m).

In sum, this evaluation framework provided a scoring system (0-28 points) to describe the level of accessibility to infrastructures for everyday life at each location. The results of the assessment were mapped and quantified for a number of variables, such as the number of households.

Table 1. Infrastructures within the analysis and their corresponding data sources. Source: authors.

Infrastructures for Everyday Life	Type of care	Data Source	Points by distance		Public/ Private info
			<400 m	<800 m	
Nursery school	**Children care**	Regional	2	1	YES
Primary school		Regional	2	1	YES
Playground area		Municipal	2	1	N/A
Areas to rest / spend time		Municipal	2	1	N/A
Sports centre		Municipal	2	1	NO
Day care centre	**Elderly care**	Municipal	2	1	NO
Health centre	**Ill relative care**	Regional	2	1	NO
Specialty medical centre		Regional	2	1	NO
Pharmacies		Regional	2	1	N/A
Shops	**Home maintenance**	Regional	1 to 4	-	N/A
Metro stations	**Access to facilities in distant areas**	Regional	2	1	N/A
Metropolitan train stations		Regional	4	2	N/A

At this first stage of the study, all the evaluation scores were arbitrary, as they were not weighted according to caregivers' experience and perception of importance or actual frequency of use, taking into account the different needs of different groups of women. A lack of elements to include in this weighting was one of the main limitations of this study and should be reconsidered in the case of actual application. Preliminary surveys on the perception, and frequency of use of the different facilities could be one way to approach this question.

Perceived safety: through safe streets ('active network')

As introduced above, a relevant gender issue in urban environments is the perception of safety and indirect surveillance. In practice, this is ensured by the location of ground-floor businesses and metro stations.

An 'active network' of streets was created by selecting all street segments at 80 metres or less from a shop or metro station. The 'active network' includes most of central Madrid and the old town centre. On the outskirts, in residential suburbs and newly developed areas, the network lacks continuity, with many street segments with no shops, which could be a serious issue for women's convenience while walking. For this reason and to better understand its relevance, we also ran every analysis twice: firstly, considering all possible routes in the city and secondly, only the routes through the 'active network' where the level of perceived safety for women would be acceptable.

Intersectional approach: income level and childcare.

GIS tools enabled multiple datasets to be integrated, provided that there was a common spatial reference. The different variables were linked using ArcGIS 10.3 'Intersect' tool. In this study, to explore the 'intersectional' questions introduced, we compared accessibility results against the level of income and the percentage of population under 14 years old in each neighbourhood. This age limit is a standard in the Spanish census, aimed at defining the most dependent minors.

The latter variables are publicly available from Spain's National Institute of Statistics (Instituto Nacional de Estadística (INE), 2013), but in the form of summarized statistical values for each neighbourhood. These values imply a lower scale of definition than achievable for the accessibility analysis; however, we considered that it was worth exploring the potential of the results to find an answer to some of the 'intersectional questions' regarding income level and childcare.

An important point relating to the level of income was whether the infrastructures for everyday life were privately-owned or managed, and thus fee-paying or not. This is an issue for some families, as they cannot necessarily afford to make use of the closest amenities to their homes if these are fee-paying. The case of Madrid is especially interesting here, due to its large number of fee-based services and their coexistence with free public facilities. However, a

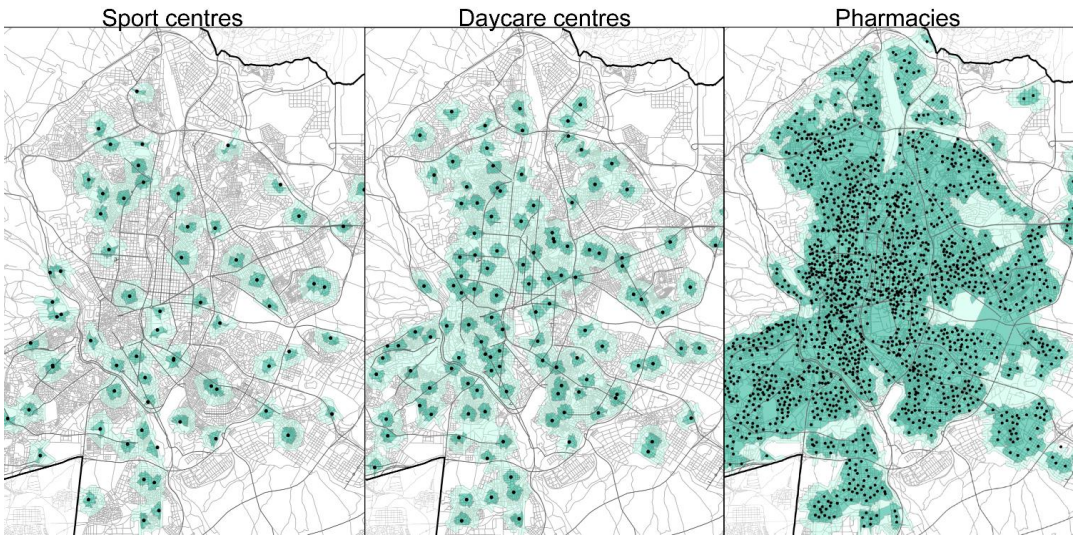
significant constraint for our work was that available open data did not always include a public/private classification. Whereas this distinction might not be relevant or applicable to some infrastructure types, it was crucial other facilities where this information was missing, e.g. health centres. For our case study, only educational facilities –nursery and primary schools- included this information. Thus, we mapped the levels of accessibility either including or excluding fee-paying educational facilities, so as to visualise this issue; however, a more detailed analysis with a complete public/private distinction was not possible at this stage.

Discussion of the results

Visualizing and quantifying access to infrastructures for everyday life.

The first group of maps shows access to only one type of infrastructure for everyday life. A comparison of these maps explains the very different patterns of distribution and accessibility of different types of facilities across the different districts of the city. Looking at Figure 2, it is easy to appreciate that only a small proportion of the population can reach a sports centre after a 10-minute walk, whereas a pharmacy can be reached in less than 5 minutes from most locations in the city.

Figure 2: Distribution and accessibility to sports centres, health centres and pharmacies. Source: Authors.



The type of representation in Figure 3 compared the provision of public and private education centres, and the different levels of accessibility including/excluding these. This clearly explains how much easier childcare is in a specific area of the city if fee-paying schools can be afforded (and families are willing to do so).

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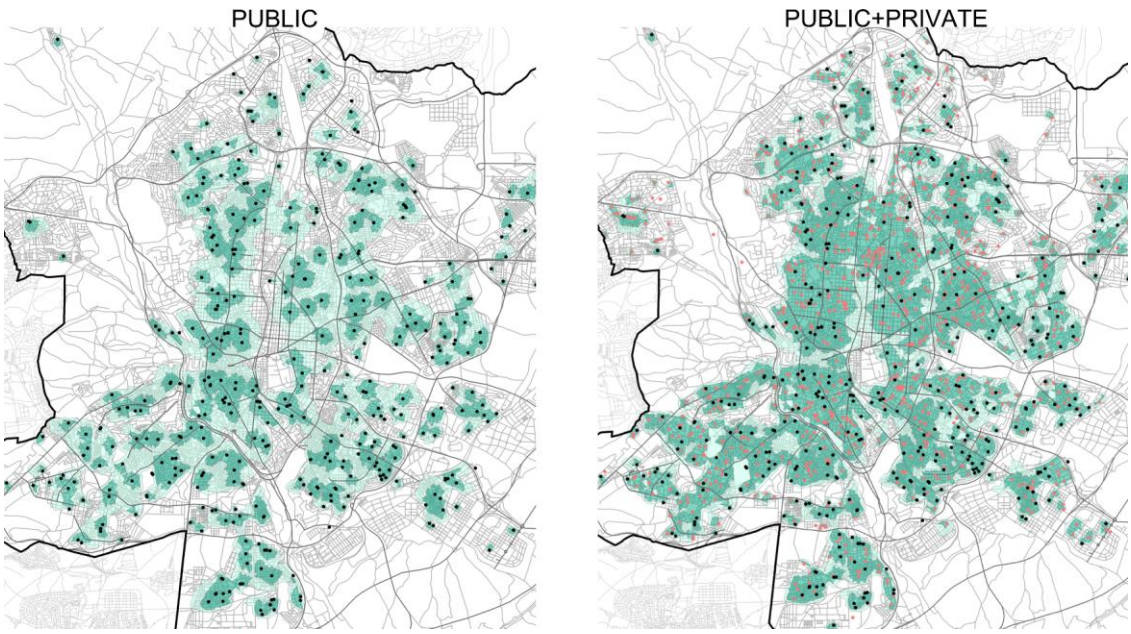
Figure 3: Distribution and accessibility to only public versus public + private everyday infrastructures. Source: authors.



Summary maps were produced to obtain a global score at each location, taking into account the level of access to all infrastructures for everyday life. The map shown in Figure 4 is a zoom-in sample to show the high level of detail that these tools and this methodology achieve. The ranges help to visualize the global score for each location, following the evaluation framework described in Table 1.

This kind of map can be adapted to different criteria, as described in the methodology. It is especially interesting to compare the global score summary maps, for the different analyses. Figure 5 visualises the impact of the lack of safe streets and active frontage, which was especially relevant in the outskirts of the city. Maps in Figure 5 identify y areas with poorer accessibility to everyday infrastructures, taking into account women's route choices on the basis of the level of perceived safety, however the methodology could also provide precise figures to assess overall level of accessibility.

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Figure 4: Summary map: score for total access to everyday infrastructures. Source: author

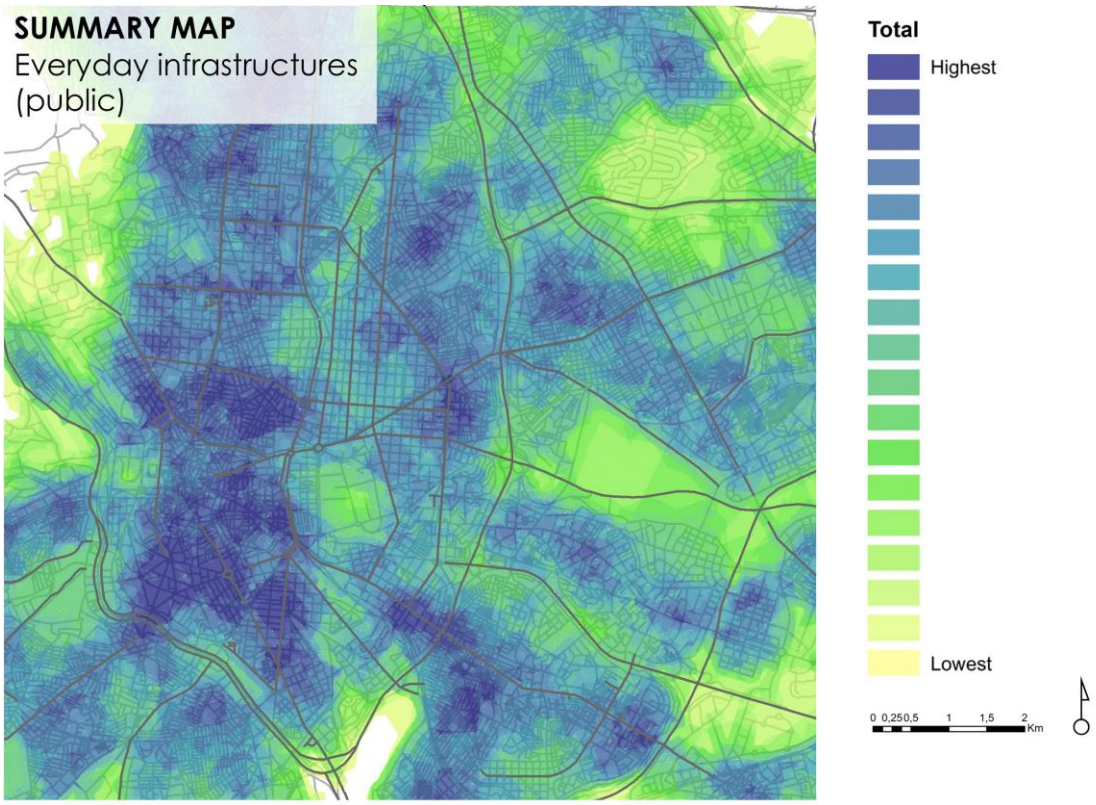
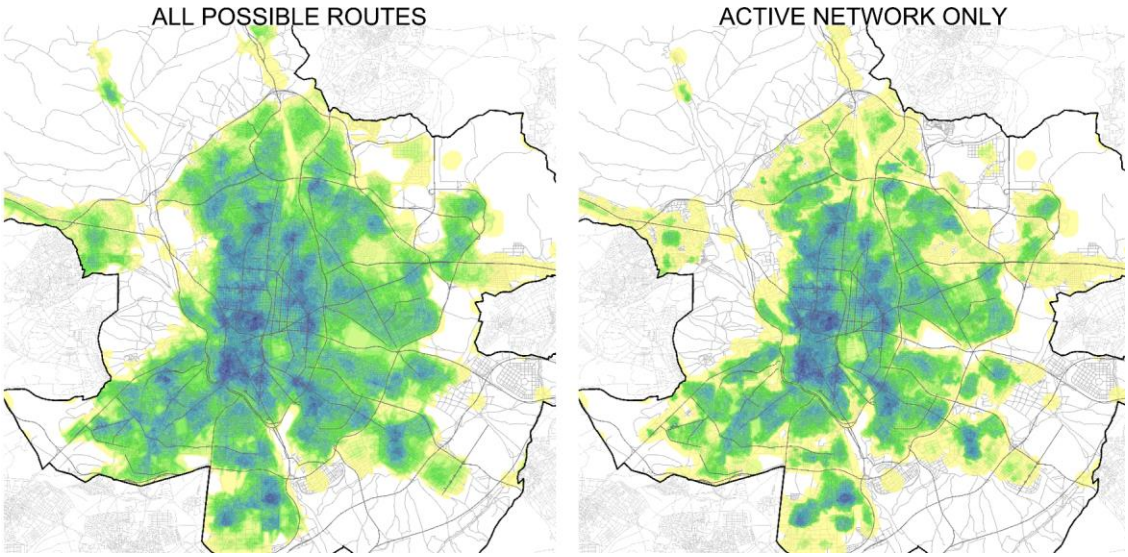


Figure 5: Total access score - All routes versus active network. Source: authors.



The geodata from the Spanish *Cadastre* (Land Register) maps residential units per plot, while GIS tools are able to count the number of households in each score area. The results show that there is a normal distribution of households as regards the global score for accessibility, with an average value of 13.35 out of 28 points following the scoring system

described in Table 1. The overall situation is arguably quite positive, with 79.8% of households receiving 10 or more points as a global score: i.e. quick access (<400-metre walk) to 5 types of basic amenities and up to 10 types within 800m walking distance.

Table 2. Number of households and percentage per access score. Source: authors.

Score	Households	%	Score	Households	%
27	65	0.0%	**13**	115,314	8.0%
26	501	0.0%	**12**	103,455	7.2%
25	892	0.1%	**11**	93,532	6.5%
24	6.522	0.5%	**10**	76,274	5.3%
23	12,908	0.9%	**9**	55,587	3.9%
22	25,616	1.8%	**8**	43,447	3.0%
21	40,165	2.8%	**7**	33,448	2.3%
20	60,440	4.2%	**6**	33,260	2.3%
19	73,565	5.1%	**5**	29,607	2.1%
18	82,564	5.7%	**4**	23,011	1.6%
17	104,042	7.2%	**3**	19,470	1.4%
16	112,177	7.8%	**2**	20,370	1.4%
15	119,906	8.3%	**1**	28,231	2.0%
14	121,585	8.4%	**0**	4,333	0.3%
13	115,314	8.0%	**Total**	1,440,287	100.0%

Intersectional questions: level of income.

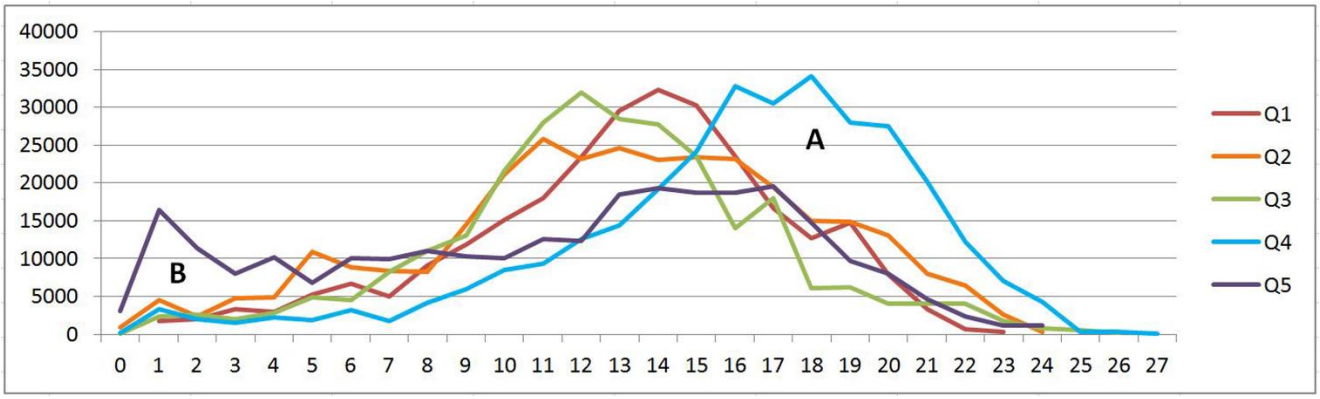
Table 3 shows the classification of the 1,440,287 households in Madrid by accessibility to facilities (from 0 to 27 points) and by level of income (in rows, neighbourhoods divided into five 'quintiles', from the 20% of neighbourhoods with lower income -Q1- to the 20% with higher income -Q5-). Results showed that the poorest 60% of households (Q1, Q2 and Q3) had a similar average score (13.19, 13.02 and 12.65, respectively) and distribution to the overall sample. Interestingly, the upper-middle 20% (Q4) was clearly living in areas with higher accessibility to facilities (marked as ‘A’ in Figure 6), whilst the wealthiest 20% of households were the only group that did not follow a normal distribution, with a very high number of households with a 0-5 score (20.8%, in contrast to 8.7% for the whole sample, marked as ‘B’ in Figure 6).

By mapping all households with 0-5 points by income level (Figure 7), it was possible to identify that households with a higher income were mostly located in suburbs with detached housing in the northern half of Madrid, an area where transport surveys showed that private cars were the preferred mode of transport. Less affluent areas *with low accessibility to basic services were less extensive in general.*

Table 3. Number of households per access score and level of income (thousands). Source: authors.

SCORE	0 - 1	2 - 3	4 - 5	6 - 7	8 - 9	10 -11	12 -13	14 -15	16 -17	18 -19	20 -21	22 -23	24 -25	26 -27	TOT.	AVG
Q1	1.9	5.3	8.1	11.7	20.9	33.1	52.9	62.5	40.2	27.4	11.2	1.0	0.0	0.0	**276.4**	**13.19**
Q2	5.4	7.1	15.7	17.3	22.7	46.8	47.7	46.4	42.6	29.9	21.0	9.1	0.3	0.0	**312.0**	**13.02**
Q3	2.5	4.6	7.7	12.9	24.0	49.5	60.4	51.2	31.9	12.4	8.1	5.7	1.3	0.2	**272.3**	**12.65**
Q4	3.4	3.5	4.1	4.9	10.1	17.7	27.0	43.3	63.2	62.1	47.7	19.2	4.6	0.4	**311.1**	**16.12**
Q5	19.5	19.4	17.0	20.0	21.3	22.6	30.8	38.1	38.2	24.4	12.6	3.5	1.2	0.0	**268.5**	**11.43**
TOTAL	**32.6**	**39.8**	**52.6**	**66.7**	**99.0**	**169.8**	**218.8**	**241.5**	**216.2**	**156.1**	**100.6**	**38.5**	**7.4**	**0.6**	**1,440**	

Figure 6: Graph - number of households per access score and level of income. Source: authors.



Intersectional questions: childcare.

The other exploration concerned the access to childcare services (the five types listed in Table 1) and the current location of households with children (under 14 years). Table 4 includes the number of households by accessibility to childcare facilities from 0 to 10 points) and five levels of child population (from the fifth with neighbourhoods with the lowest percentage of under 14-year-old -Q1-, to the fifth with the highest proportion -Q5-).

Paradoxically, we observed extensive areas of mismatch: some of the neighbourhoods with more children (Q5) had very reduced access to the appropriate amenities, especially in the outskirts; while, in contrast, some of the neighbourhoods with fewer children (Q1) had excellent access in the more central and other areas. These imbalances were mapped as requiring action (Figure 9).

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Figure 7: Areas with low access to infrastructures (0-5 points), by level of income. Source: authors.

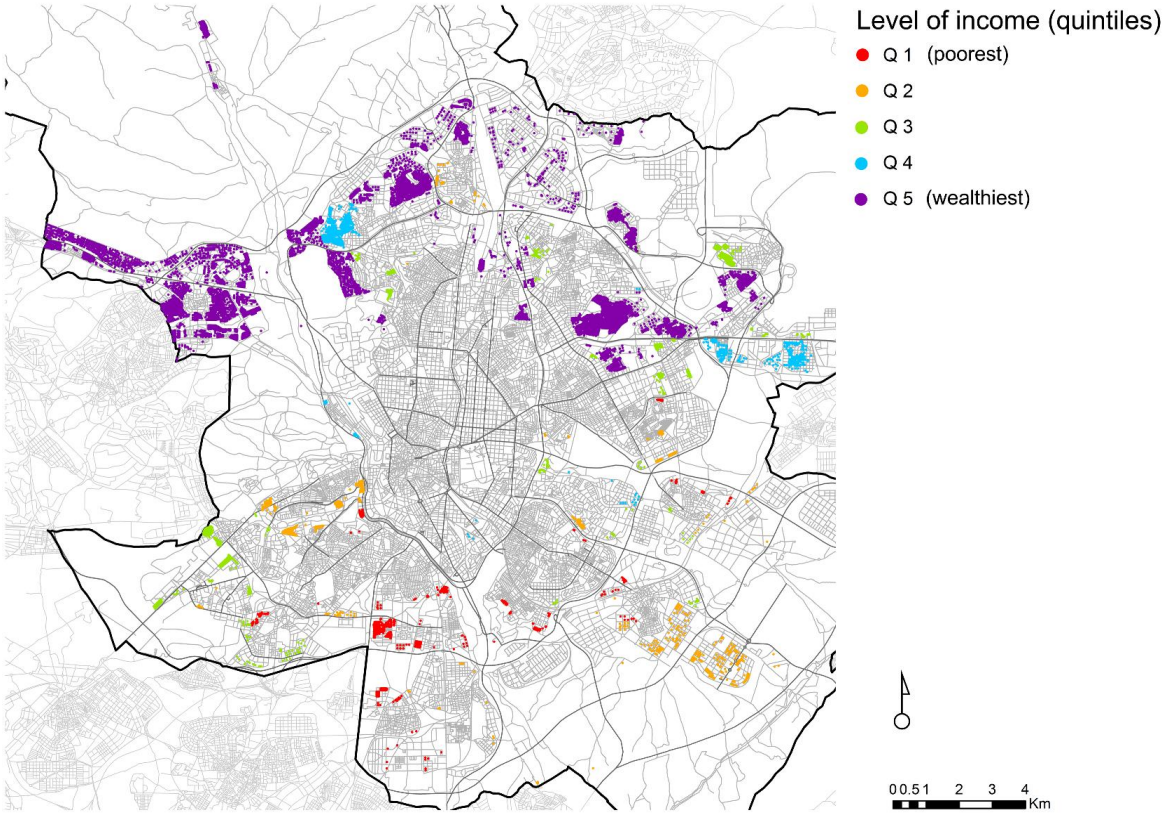

Table 4. Number of households per access to childcare facilities score and per level of under-14 population. Source: authors.

	0	1	2	3	4	5	6	7	8	9	10	Total
Q1	496	1,310	2,308	12,256	41,173	54,239	105,390	63,893	35,111	15,328	1,008	332.512
Q2	2,296	3,305	21,173	11,218	60,456	53,711	62,851	40,401	31,881	2,631	1,151	291.074
Q3	6,561	5,928	16,290	17,817	39,691	57,423	68,819	51,916	23,817	5,640	818	294.720
Q4	4,703	7,784	24,934	21,707	45,825	40,937	67,151	37,626	14,476	6,500	1,263	272.906
Q5	52,692	20,473	39,111	20,967	32,209	18,413	30,412	16,304	8,157	9,198	1,139	249.075
Total	**66,748**	**38,800**	**103,816**	**83,965**	**219,354**	**224,723**	**334,623**	**210,140**	**113,442**	**39,297**	**5,379**	**1.440.287**

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Figure 8: Graph - number of households per access to childcare facilities score and per level of under-14s. Source: authors.

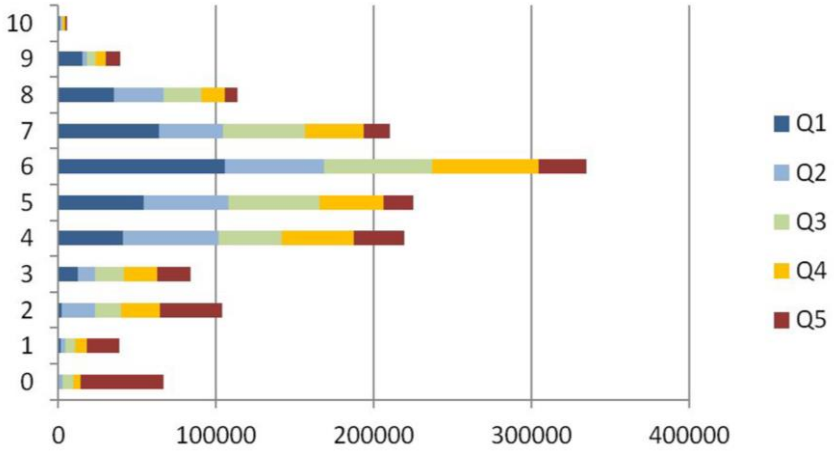
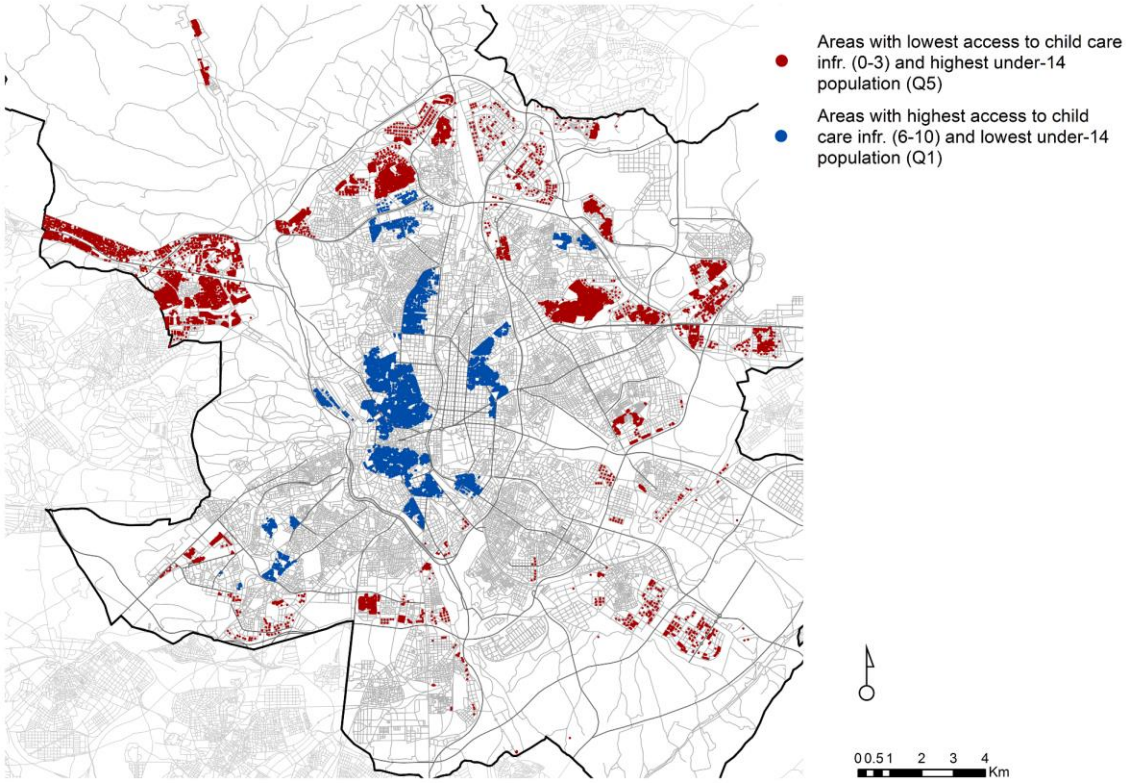


Figure 9: Age-infrastructures mismatch areas: lowest under-14 population (Q1) in the best equipped areas (6-10 points) and highest under-14 population (Q5) in poorly-equipped areas (0-3points) . Source: authors.



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Applicability - Urban planning and policy avenues

The type of methods proposed and results presented can provide valuable information for planning and policy strategies. The first application is quite obvious: the service area maps provide an immediate analysis for optimal location of new facilities in relation to already existing ones, and also identify overlapping service areas that may justify the change in the use of specific facilities.

The total access score maps are useful to identify the best equipped areas, where it would be wise to foster redensification strategies or public improvement schemes. The same maps also identify poorly-equipped areas, where new neighbourhood facility projects are necessary. Moreover, we believe that the 'intersectional' analysis identifies the areas where those new facility projects are most urgent, due to the local socio-demographic characteristics and the higher ratio of vulnerable population.

The comparison of results for all routes or for the active network may be only the basis for a number of strategies to improve the perception of safety in key street segments. This objective may be achieved by a number of planning actions, such as land use change stimulation, the relocation of street businesses or redesign projects for public spaces.

Finally, the graphical nature of GIS outputs may potentially increase the reach of the analysis results, enabling easier understanding by a non-technical, wider public. This is particularly important in the context of decision-making in urban planning processes including participation-based processes, where clear maps shown to non-experts can help them to understand urban space variables. These maps can be particularly useful in gender audits, such as the ones made obligatory under Spanish law to evaluate the gender-related impact of new planning developments.

We believe that the proposed methods and tools are reproducible in other cities in developed countries, where similar databases are generally available. However, it is true that data availability could be an obstacle in developing countries.

Table 5. Planning and policy avenues. Source: authors.

Type of method applied	**Examples in this study**	**Diagnosis**	**Planning / Policy strategy or action**
Service Area maps	Figures 1-3	New facility service area in relation to other similar facilities	1. Optimal location of new facilities (maximizing service area and avoiding service area overlaps)
Service Area maps	Figures 1-3	Identification of overlapping service areas	2. Change of use of individual facilities. E.g. from school to health centre, or from private to public school.
Total access score maps	Figures 4-5	Identification of well-equipped areas	3. Redensification strategies
			4. Public realm improvement schemes
Total access score maps: Active network versus All Paths	Figure 5	Important street segments without natural surveillance	5. Land use change stimulation: ground-floor retail units
			6. Strategic location of street activities: kiosks, taxi stops.
			7. Redesign for safety. E.g. visibility, street lighting.
'Intersectional analysis'	Figures 6-9	Identification of prior intervention areas due to local socio-demographics and vulnerable groups	8. Prior New Neighbourhood Facility Projects
Any	Any	Any	9. Public participation processes: Increase of broader public understanding, visualization, etc.

Conclusions

GIS and open data have proved their potential to support methodologies for gender mainstreaming in urban planning, particularly for the analysis of accessibility to 'infrastructures for everyday life'. This technology can better support the daily life of people who need to combine productive work with family care - usually women. Previously, the literature had approached these topics applying a case-by-case logic which did not admit city-wide diagnosis and planning strategies. These tools now enable the development of methodologies on a detailed scale of analysis (as small as a lot of land or playground), but applicable to large urban areas. We acknowledge that due to the nature of the tools used, the complex qualitative factors associated with 'infrastructures for everyday life' cannot be addressed and that this is a limitation of the work. However, we consider that the use of GIS and open data contribute to the spatial extent of analysis (all spaces in the city in systematic detail), its visualization and

quantification to foster gender mainstreaming in planning practice and policies.

The work undertaken has given rise to a different kind of conclusions. As regards the tools used, we have identified a number of shortcomings, such as the lack of coordination between data sources for open data. Two of the main aspects identified are the different scales of accuracy and the diverse cartographic standards. The fact that data from four different institutions have been necessary to address a rather simple topic is also illustrative of the need for cooperation and coordination. Also, some datasets have not included the necessary detail to deal with relevant gender-sensitive issues. For example, the study has highlighted the relevance of the public/private nature of the facilities. Regarding the use of GIS, we found that some data layers were defined with abstract geometries, not showing street-level experience.

The results for the case of Madrid suggest that the methodology developed can be exported to other cities. They show that the city is well-equipped, with most households having good accessibility to basic amenities and in tune with the survey on quality of life run by the City Council (Ayuntamiento de Madrid, 2015). However, some issues have come to light. In particular, the lack of shops with active frontage has a substantial impact on the level of accessibility in the outskirts, potentially limiting the way in which women use these areas and pointing out a policy issue that would not have been identified in a study focussed only on the provision of services. A first policy recommendation for the case of Madrid would be to integrate facility location strategies with retail location planning so that all basic amenities could be accessible through pedestrian routes perceived as safe. Also, regarding the relationship between income levels and accessibility to infrastructures, suburbs with residential detached housing were found to be the most difficult areas for family care, whereas more densely populated, mixed-use areas won the highest scores. This shows the differences in household location choices between higher income families and average and lower-income families. The former usually relied on the support of domestic workers and owned more than one car. While the former could afford to live far from community infrastructures, for the latter it was crucial to live in a complex 'city with short distances', a principle argued by feminist scholars as crucial to support the daily life of all citizens and particularly carers and wage-earners.

In this regard, this study confirms that the concept of 'infrastructures for everyday life' is particularly relevant to support the daily life of women in the most vulnerable socio-economic groups, as income strongly determines the way in which women with professional and family responsibilities use the city. In an era in which European cities witness how increasing income disparities are resulting in spatial patterns of socio-economic segregation (Musterd, Marcińczak, van Ham, & Tammaru, 2017), the concept of “infrastructures for everyday life” becomes a relevant tool to prioritise access to these kind of (public) services in the neediest neighbourhoods. Our study suggests that the inclusion of this vision in the city agenda could be transformative from a gender perspective and guide relevant decision-making with regard to the location of amenities and budget priorities. Integrating the socio-demographic dimension has been valuable to a deeper analysis of the topics. The richest 20% are the only group with a

significant presence in the areas with the lowest access to basic services and the areas where they live are the most extensive with poor access to facilities. The study maps a number of smaller lower income areas with the lowest level of access to childcare facilities (marked in Figure 9). The lowest income areas are where women find most barriers to coping with the burden of care and paid employment. We are committed to undertaking an accurate study of these, which will be one of the following steps undertaken by this study. Finally, regarding age and accessibility to services, we have noticed a mismatch between the areas with better access to infrastructures for childcare and the areas where most children actually live. This imbalance is potentially related to the affordability of housing for young families, an ageing population in mature urban areas, and centre-periphery dynamics, which could be counteracted through an efficient facility planning.

The conclusions achieved for the case of Madrid have identified a number of proposals to improve the quality of life of women in its different districts. A first step could be a process of awareness-raising of decision-makers, public servants, and the relevant stakeholders in the context of different public participation-based processes on going in the city. A second step could be confronting the quantitative, spatial results of our study with the qualitative knowledge and perceptions of the local community to improve methods adopted.

The next stages of the study should complete the missing information and increase consistency in the diverse datasets, manually if necessary. Also, the scoring values in the evaluation framework would benefit from a calibration using non-arbitrary weighting for each type of basic amenity, as well as distances. The view of women and caregivers must be integrated within the process of designing the methodology. Moreover, entering into detail on street quality, e.g. access-for-all design or safe pedestrian crossings would be an excellent feature. This level of detail would better address the on-street experience of women, although this does not seem feasible for a city-wide analysis but rather for a more reduced area of the city.

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